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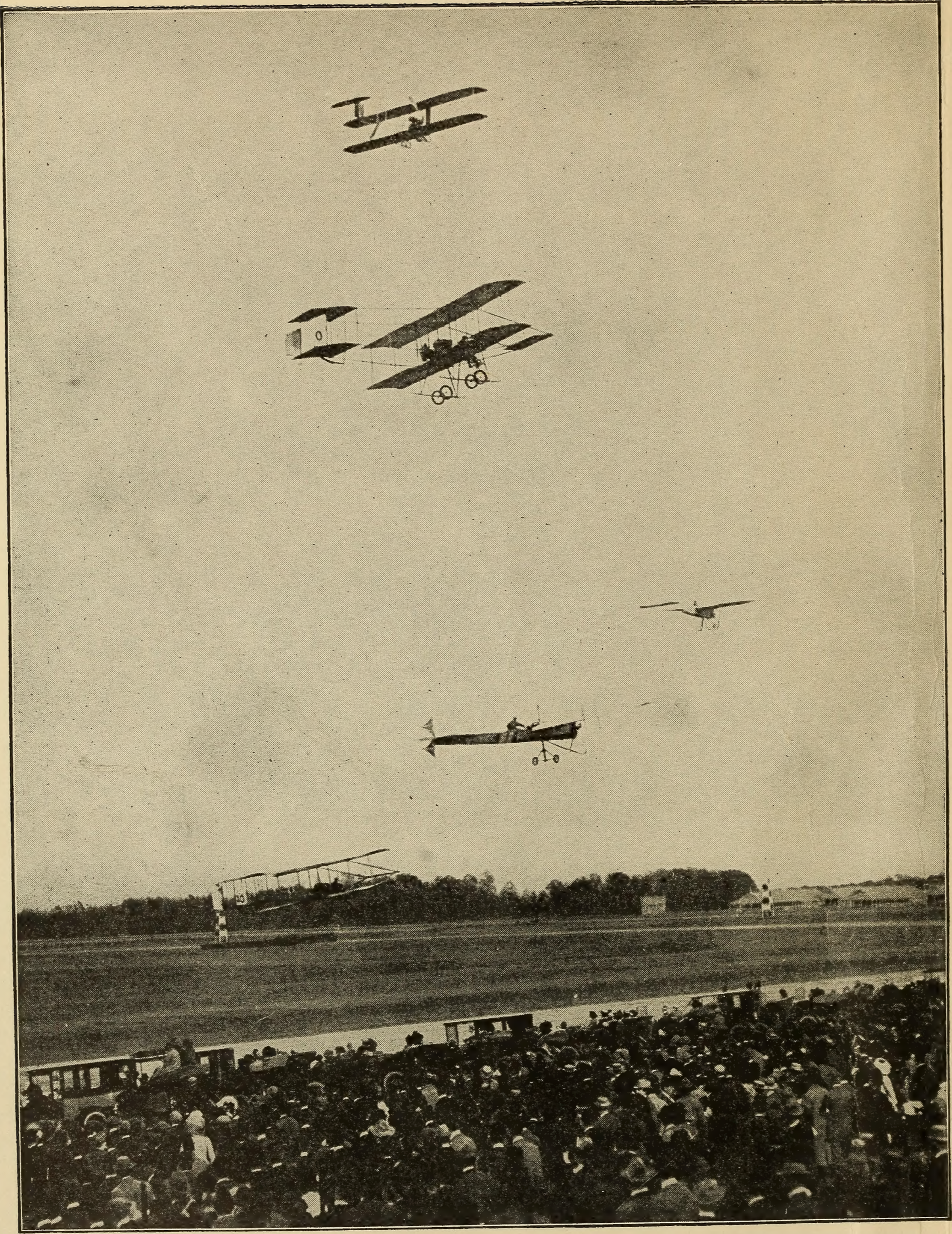

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FIVE AEROPLANES IN FLIGHT AT THE SAME TIME.

An exceptionally good picture taken at the recent Airship meeting at Belmont Park, N. Y., which shows the different makes. From the top, Wright Biplane, Curtiss Biplane, Bleriot Monoplane, Antionette Monoplane, Farman Biplane.

The World's Workshop

Science Invention Discovery Progress

A Pictorial Library for Home Reading, covering all the very latest events in the Workshops of the Industrial, Scientific and Natural World.

A GRAPHIC ACCOUNT OF THE AMAZING ACHIEVEMENTS WHICH BEST TELL OF THE GENIUS, SPIRIT AND ENERGY OF THE AGE AND DEPICT THE GRAND MARCH OF IMPROVEMENT IN THE VARIOUS DOMAINS OF HUMAN ACTIVITY.

WONDERFUL INDEED IS THIS WORLD'S WORKSHOP, FOR ITS DOORS ARE OPEN WIDE AND ALL THAT IS WITHIN CAN BE SEEN AND UNDERSTOOD—WHETHER IT BE IN AN AIRSHIP ABOVE THE CLOUDS, UPON OR UNDER THE SEA, IN THE CITY, TOWN OR COUNTRY; ALL THAT HAS BEEN WROUGHT BY MAN FOR THE PROGRESS AND ADVANCEMENT OF THE WORLD IS ARRAYED UNDER THE BROAD HEAD "THE WORLD'S WORKSHOP."

A Comprehensive Volume of live subjects so presented as to make it equally adaptable for pleasant reading, ready reference, accurate instruction or careful study.

By

W. J. Jackman, M. E., Author of "Flying Machines, Construction and Operation," "A B C of the Motor Cycle!" "Facts for Motorists," etc.

Trumbull White Noted Traveler and Author

Ferdinand Ellsworth Cary, A. M. Celebrated Historian and Writer

EMBELLISHED AND ILLUMINATED WITH

FIVE HUNDRED PHOTOGRAPHIC ILLUSTRATIONS

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Dedicated

TO THE
MEN AND WOMEN
IN
EVERY WALK OF LIFE
WHO
BY AMBITION AND INDUSTRY
HAVE ACCOMPLISHED
THE MARVELS AND WONDERS
PORTRAYED IN
THE WORLD'S WORKSHOP.

INTRODUCTION

This is the Marvelous Age, the age of triumphant Progress. Follow the records of mankind down through all the centuries scrutinize the achievements of the race, and more and more conspicuous becomes the fact that in no other period of the world have such wonderful advances in material and industrial progress been made. Within the last decade we have seen hundreds of inventions and discoveries, any one of which would be sufficient to illuminate a whole century of the Middle Ages.

The history of man is shown in his works. From the days of the cave and cliff dwellers, the days of stone hatchets and bronze tools, the days of primitive life and primitive emotions, we have come to a day when the race is housed and fed and clothed and enlightened as never before, with improvement still a constant tendency. A palace in medieval times did not contain the genuine comforts of a mechanic's home of today. A Monarch two centuries ago could not have half the real conveniences or the luxuries at his command that are easily in the possession of any modern householder. So, it is of high interest to examine the workshops of today, to observe the sources and the methods of the amazing activities that are enthroned in our high places.

Inventions have had to face oppositions throughout the whole history of the world, even until today. The self-binding reaper was one of the triumphs of modern invention in the mechanical field, but it was riotously assailed as revolutionary and disastrous to industry by mobs of agricultural laborers who saw their occupation vanishing. Yet the broad prairies of the Great West have been brought under cultivation, and homes and employment have been created for millions, by the improvement in agricultural machinery. The typesetting machine was opposed because one would do the work of several hand compositors, and many men would be discharged, but newspapers have multiplied and enlarged by its introduction, and the whole craft has ultimately benefited thereby.

In the volume presented herewith, it has been planned to put in the possession of the reader such an array of facts and information of genuinely educational character as would enable him to observe clearly the greatness of this industrial age and its tendencies. The methods and results of the great industrial and commercial undertakings of the world; the modern world of invention, discovery and scientific enlightenment; the more noteworthy works of nature which bear upon man and his achievements, and a mass of matter concerning the things we need to know in every channel of human activity and interest—these are the general contents of the volume in hand.

The work is not a history, though it contains much of historical enlightenment. It is not an encyclopedia, though it contains an encyclopedic volume of information. Instead of these it is a book that tells what is being done in the World's Workshops today, for reading, for reference, for education and for study. In it a mass of material has been so arranged by a natural classification as to be readily at hand for convenient use for any purpose. Under the general heading of The World's Workshop are included accounts of the great commercial, manufacturing, industrial and financial undertakings which have risen so rapidly of late years. Their interesting phases are explained and pictured and the great cities of the world contribute to these pages.

The triumphs of modern science, invention and discovery are shown in startling array, an evidence of the capacity of the human mind to encompass almost any achievement that genius suggests.

The works of nature, which outvie all the deeds of man, are an exhaustless field of inquiry and interest. Here such are selected as are commanding in their importance and of immediate interest at the present day for some special reason that brings them into prominence.

Then again, as a source of varied information of general scope, are included the multitude of subjects under the comprehensive heading, "Things we all should know," a treasury of facts sufficient to fill a whole volume, if in more expanded form.

With the assurance that this work will command and justify attention by its plan and execution, placing readily at hand as it does the information for which everyone is seeking in regard to the world, its conditions and its activities today, it is presented herewith to the reader.

It is unnecessary to suggest that in a work of such magnitude the editors have had recourse to extremely varied sources of information. Based on the fundamental purpose of having its facts brought up to the very latest possible moment, they had to be sought far and wide, sometimes in places little accessible to the usual reader. Encyclopedic as the work is in many features and characteristics, it is not from the encyclopedias that its matter could be culled. Those ponderous and valuable works are necessarily years behind their publishers' dates in the contents of the volumes, and except in the unchangeable things of the world—and there do not appear to be many such nowadays—they must be supplemented by later information at the very time they are issued, if the reader is not to be led astray.

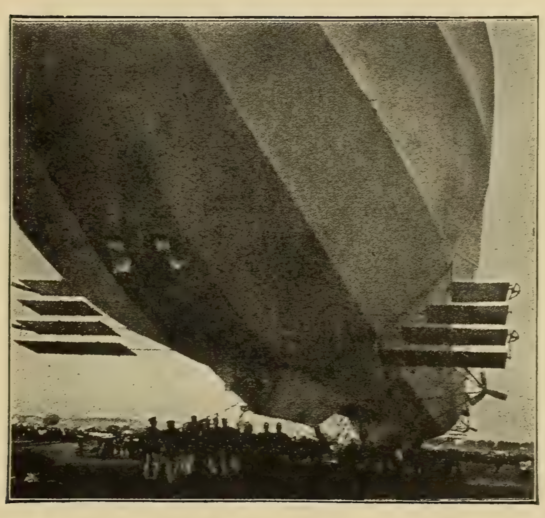
With the desire to occupy a field created for itself, and therefore peculiarly its own, the present work has kept timeliness in the foreground, and its pages are absolutely "up to date."

Whatever measure of success has been achieved in the effort to produce a worthy work must be credited in common to the liberal scope on which it was planned by the publishers, the able editorial and literary assistance rendered by the specialists who shared in the writing and compilation of it, and the generosity invariably shown by all who were approached in the search for information or photographs which were needed to assist the undertaking. It is a pleasure, no less than an obligation, to acknowledge these essential aids with the utmost cordiality. Rarely, if ever, has such a noteworthy collection of views of the world's industries and industrial processes been gathered within a single vo ume, and the series of illustrations in the other divisions of the work are no less str king in their variety and the freshness of the subjects chosen. Energy and liberality and courteous cooperation on the part of many from whom rare and valuable photographs had to be obtained after considerable difficulty and expense, united to make such elaborate illustration possible.

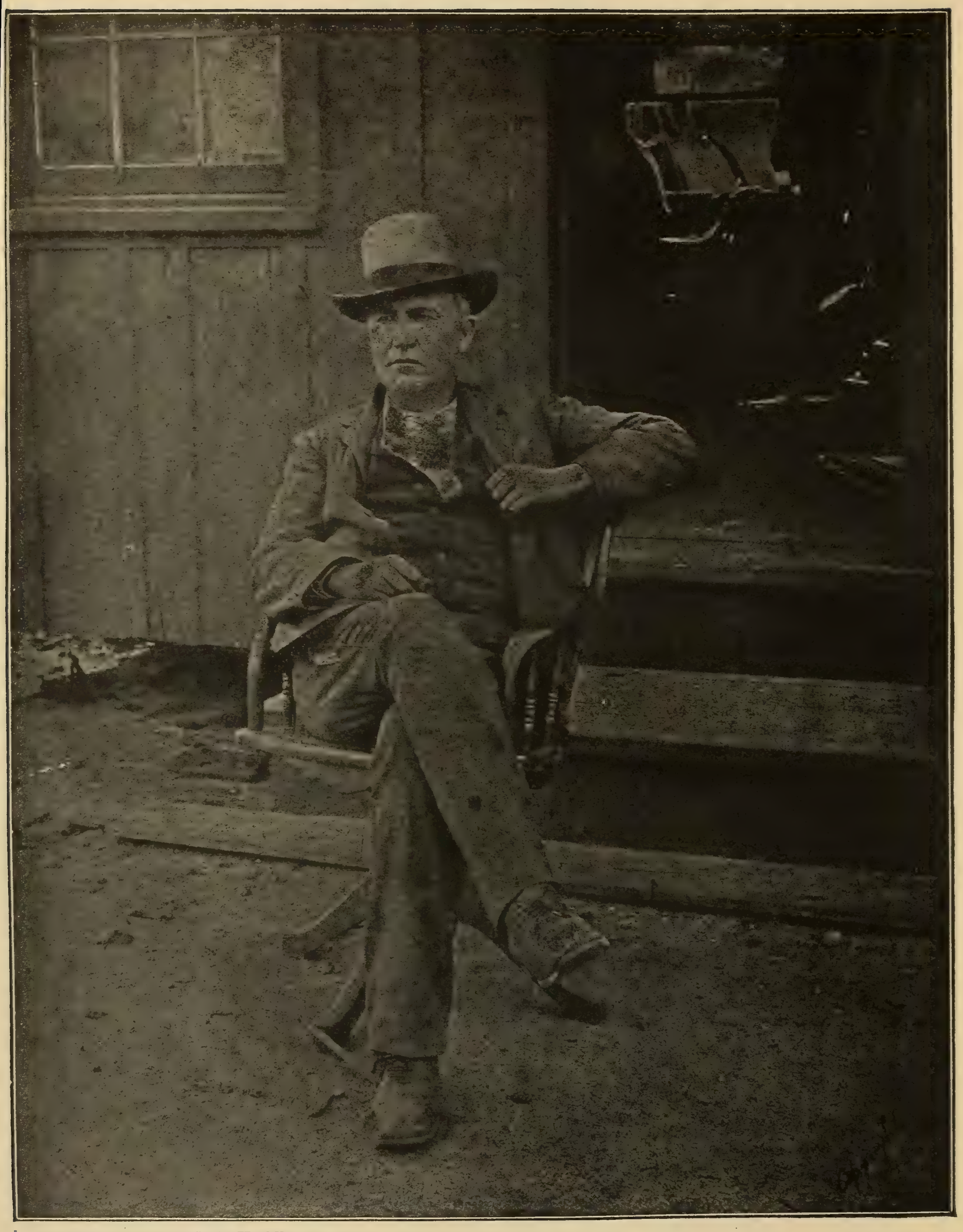
In like manner the search for new and interesting facts, which, indeed, had to precede the quest for illustrations, met a hearty response from the men who know things and the men who do things all over the world. Most of the facts herein contained have been gathered at first hand from the original sources of information, by travel, by research or by interview, and from such sources may be accepted as accurate within the limitations of human imperfection.

Where books or other printed matter contained facts that would serve in this connection they have been levied upon appreciatively for a share of their learning, adapted and modified to suit the present purposes. Such writings are properly included in the foregoing acknowledgments.

THE EDITORS.



ZEPPELIN'S DIRIGIBLE WAR BALLOON.



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THOMAS A. EDISON, THE WORLD'S MOST FAMOUS INVENTOR.

Photographed in front of his office at his Ogden, N. J., iron mines. This picture of Edison in his working clothes is very life-like, and the only one of its kind that has been taken.

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CONQUERING THE AIR.

Wright Bros.' Aeroplane in full flight. This photograph was taken when Mr. Orville Wright was establishing the world's record of over 38 miles in 1 hour and 14 minutes.

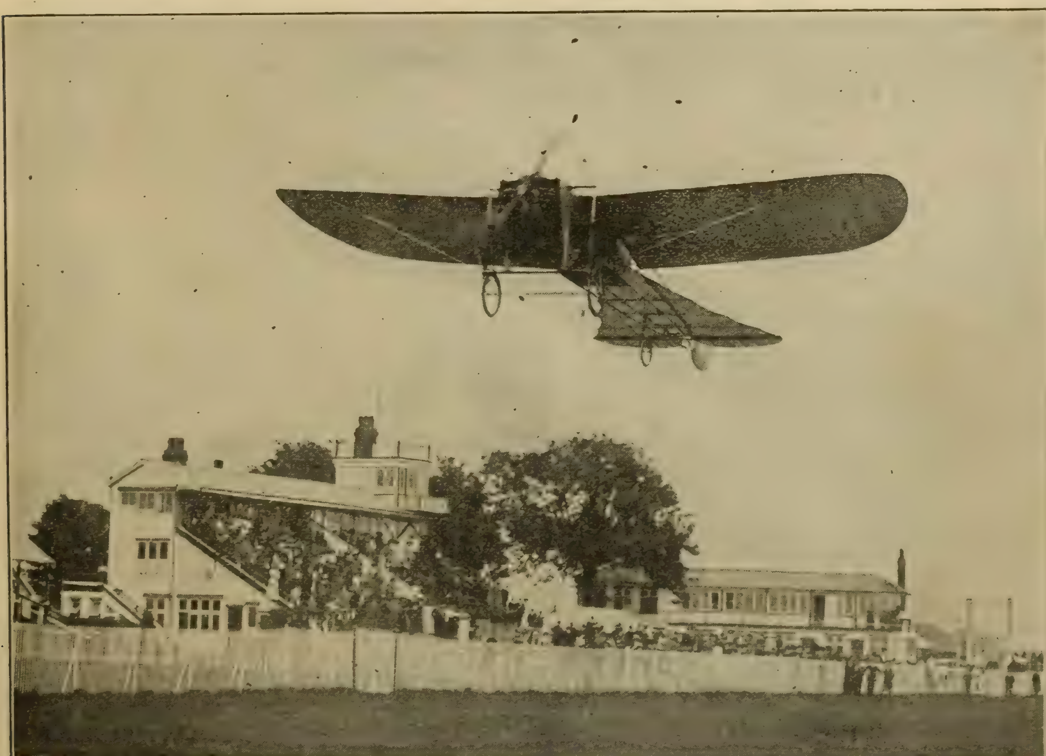
THE WORLD'S WORKSHOP

Wonderful Progress Made in the Entrancing Field of Invention and Discovery

FLYING MACHINES

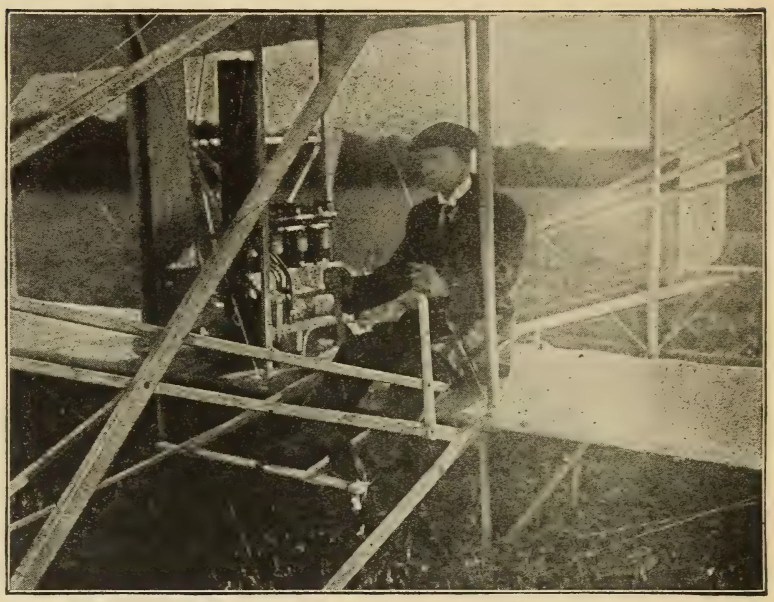
It is only a little over seven years since the first practical motor-driven flying machine was put in operation. In that comparatively short time remarkable advance has been made, not only in methods of construction, but as regards systematic operation as well, and what was at first regarded as simply an interesting scientific experiment of no particular commercial value, has been developed to a stage of assured usefulness.

It was on December 17, 1903, that Orville and Wilbur Wright, of Dayton, Ohio, astonished the world by the operation of a motor-driven aeroplane. On this occasion the machine, driven by one of the Wright



MOISANT (NOW DEAD) MAKING FLIGHT IN BLERIOT MONOPLANE FROM PARIS TO LONDON.

brothers, traveled 852 feet in the air in 59 seconds, an average of about 10 miles an hour. This was very slow compared with the speed of 60 and 70 miles an hour now being made, but it was enough to demonstrate the fact that the problem of aerial navigation in heavier-than-air machines has been solved in a practical manner. It was a radical departure from the old method of ballooning in which the aeronaut was at the mercy of the winds, and had no control of his movements. There is nothing wonderful in the fact that a bag of gas will sustain a certain weight in the air and be driven about by the wind until the buoyancy of the gas is lost. This was made plain by Joseph and Steven Montgolfier, of France, in 1783. But the idea that a machine many times heavier than the air, and absolutely without balloon attachment of any kind, could be made to float in the atmosphere, be raised and lowered, and steered in any desired direction at the will of the operator, was a seeming impossibility to the great mass of people.



WILBUR WRIGHT OPERATING A WRIGHT BIPLANE.

GLENN CURTISS, INVENTOR OF THE CURTISS MACHINE.

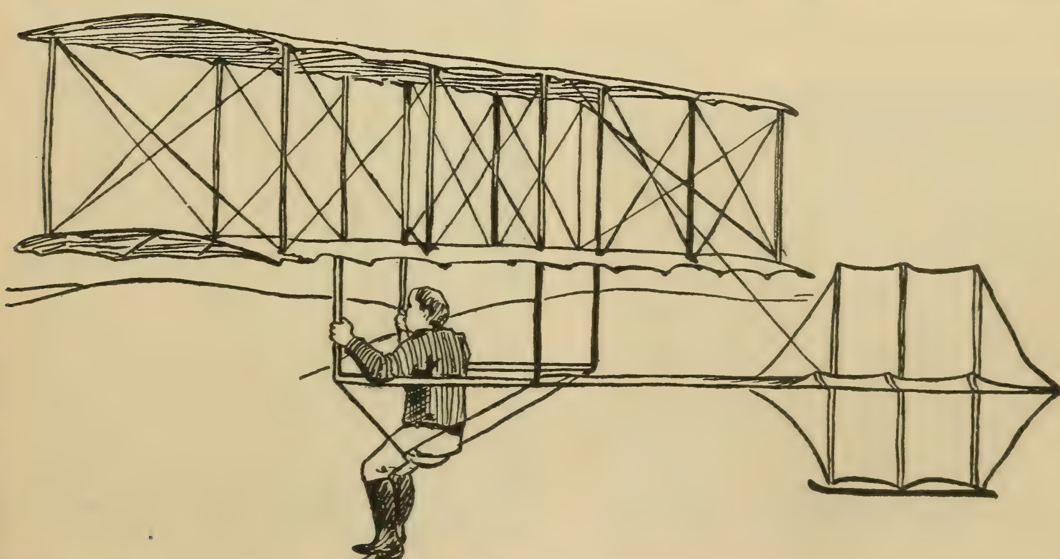
Experiments with the purpose of producing a practical heavier-than-air machine began in 1843, when Henson, an Englishman, constructed a steam-driven aeroplane. The motive power (20 h. p.) was deficient, however, and the machine did not work satisfactorily.

Scientists then turned their attention to perfecting a glider, without motive power, in order to determine the most adaptable form of construction, the effect of air currents, how best to maintain equilibrium, amount of surface area necessary to sustain a given weight, and similar problems. Between 1866 and 1902 glider experiments were made by such men as Wenham, Stringfellow, Renard, Phillips, Lilienthal, Pilcher, Herring, Avery, Chanute and others. It was the Chanute experiments, begun in 1896, which led directly to the adoption of the biplane form of construction and the warping of the wing tips, which were notable features in the first successful motor-driven Wright machine, and are still continued. Mr. Chanute, in 1898, placed the results of his experiments at the disposal of the Wrights, and continued to advise and consult with them in all their preliminary work, and even after they had demonstrated the practicability of a power-driven aeroplane. Commenting upon the death of Mr. Chanute, which occurred November 23, 1910, Wilbur Wright says:

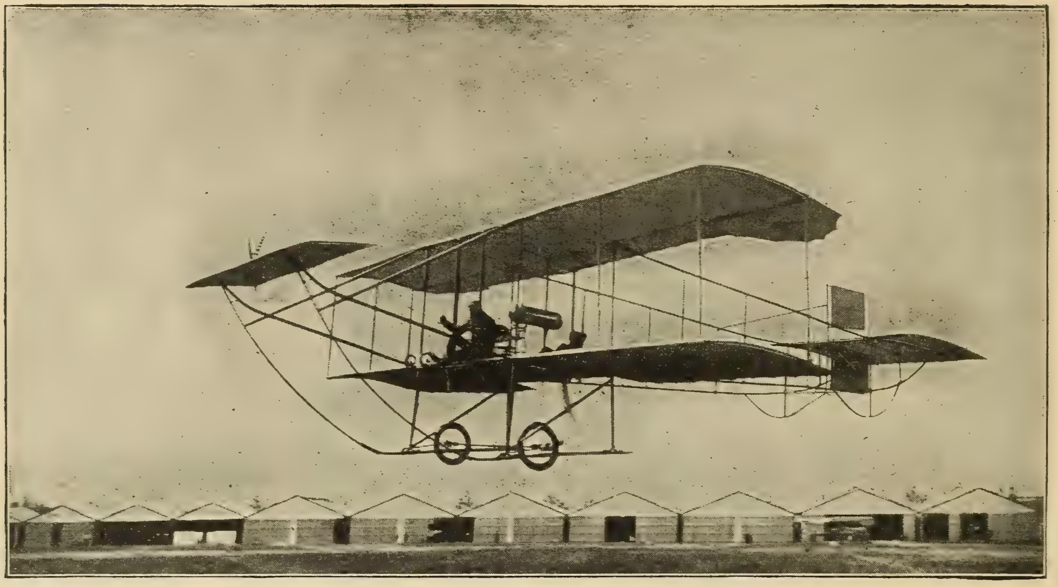
"By the death of Mr. O. Chanute the world has lost one whose labors had to an unusual degree influenced the course of human progress. If he had not lived the entire history of progress in flying would have been other than it has been, for he encouraged not only the Wright brothers to persevere in their experiments, but it was due to his missionary trip to France in 1903 that the Voisins, Bleriot, Farman, DeLagrange and Archdeacon were led to undertake a revival of aviation studies in that country, after the failure of the efforts of Ader and the French government in 1897 had left everyone in idle despair."

Aside from Henson's experiments in 1843, other power-driven aeroplanes antedate the Wright, but none of them were successful. Sir Hiram Maxim constructed a machine in 1888 with a surface area of 3,900 square feet, a veritable monster alongside of the modern machines with surfaces of from 110 to 500 square feet. Maxim's aeroplane was equipped with a steam engine (the gasoline engine was at that time undeveloped) and weighed complete about 7,000 pounds. It met with disaster on the first practical test.

In 1896, Professor Langley, of the Smithsonian Insitution, obtained a grant of $5,000 from the United States government, and constructed an aeroplane with a 27 h. p. steam engine with a speed of 12,000 r. p. m. On the second trial the machine collapsed and fell a total wreck into the Potomac



GLIDER, THE FORERUNNER OF THE PRESENT FLYING MACHINE.



LEGAGNAUX, FRENCH AVIATOR, MAKING FLIGHT IN SOMMER BIPLANE.

river. Mr. Manley, the assistant of Prof. Langley, who was the pilot of the machine, was killed.

In September, 1908, the Wright machine had been so far perfected that Orville Wright took it to Washington to compete for the government prize of $25,000. This amount of money was offered for a machine that would have a speed of 40 miles an hour in still air, carry fuel for a flight of 125 miles, and two people with a combined weight of 360 pounds. On this occasion he fell just short of the requirements, making 36 miles in 57 minutes 31 seconds, and on

FIRST EXPRESS BY AEROPLANE.

MLLE. DUTRIEUX, SUCCESSFUL WOMAN AVIATOR.

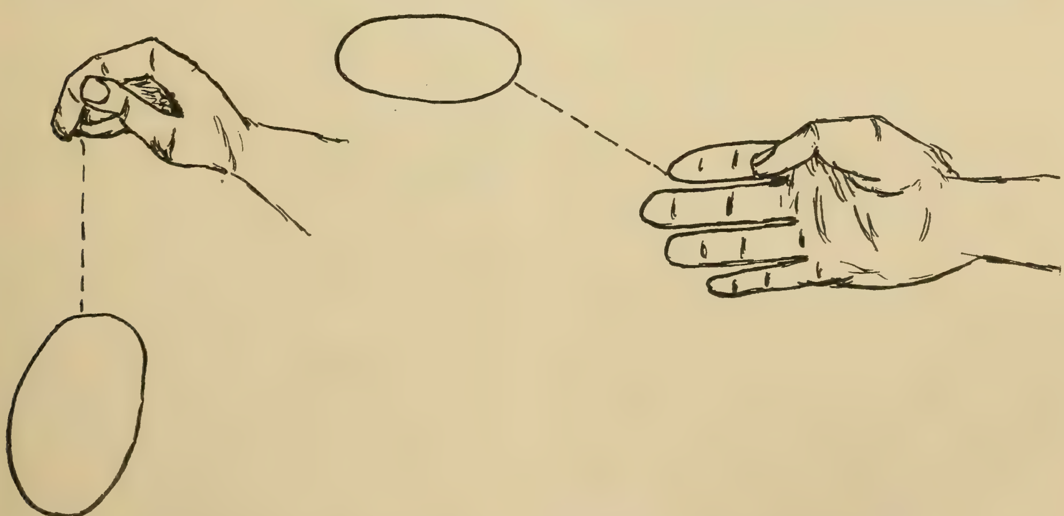
a second trial $38\frac{1}{2}$ miles in 1 hour, 2 minutes, 15 seconds.

On July 30, 1909, under new conditions, Orville Wright made another trial. This time he was successful, making a speed of over 42 miles an hour, carrying an army officer as a passenger. The government paid him $25,000 for the machine, and $5,000 as a bonus for exceeding the speed limit.

CONSTRUCTION AND OPERATION.

It is comparatively easy to construct an aeroplane so far as the theory of construction is concerned, but the application of the theory calls for great care in the selection of material, exactitude in shaping and putting the various parts together, and the utmost nicety in proportioning the various parts so as to secure stability and ample weight-sustaining surface.

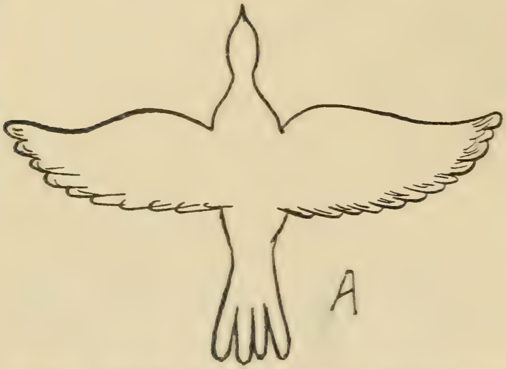
Every professional aeroplane builder has his own ideas as to the total surface area, and dimensions of plane timbers, etc. The Wright machine as originally put together consisted of two superimposed planes, each 40 feet in length and 6 feet in width. For each plane there are two main longitudinal beams of spruce wood, about two inches wide and $1\frac{1}{2}$ inches thick, the advancing edges of the beams being beveled to an edge to reduce the resistance to the wind. These beams are held together by struts of spruce, about $1x1\frac{1}{4}$ inches, in cross section and 5 feet long, and connected to the beams rigidly by means of aluminum sockets or angle braces. One of these struts is laid at the extreme ends of each frame, and others placed about $4\frac{1}{2}$ feet apart. The intervals between the struts are filled at distances of one foot, with the ribs which carry the cloth covering. These ribs are also of spruce, but are slightly curved, and considerably smaller in cross section than the struts, being usually $\frac{1}{2}x1$ inch. They are cut one foot longer than the struts, so the rear end will project over the rear beam, and thus afford a larger surface area. When the main beams of both planes have been joined by the struts, and the ribs put in place and clamped down, metal sockets are fastened to each beam exactly over the place where the end of the strut meets the



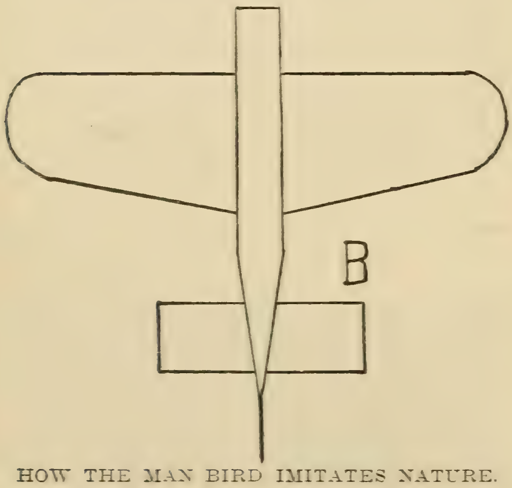
SIMPLE ILLUSTRATION OF THE PRINCIPLE OF SUSTENTATION.

A cardboard dropped from the hand will fall to the ground. The same cardboard, when thrown from the hand will remain suspended in the air so long as it has sufficient momentum.

beam. Into these sockets are fitted the stanchions. These are round pieces of spruce, about 1½x1½ inches in cross section, and 4 feet in length. Their office is to spread the planes apart vertically, and at the same time help to hold them rigidly together. When the stanchions—there are just as many of these on each beam as there



MODEL FROM WHICH AEROPLANES ARE COPIED.



HOW THE MAN BIRD IMITATES NATURE.

are struts—are in position on the lower beams, the upper plane beams, which have also been fitted with sockets, are placed over the upper ends.

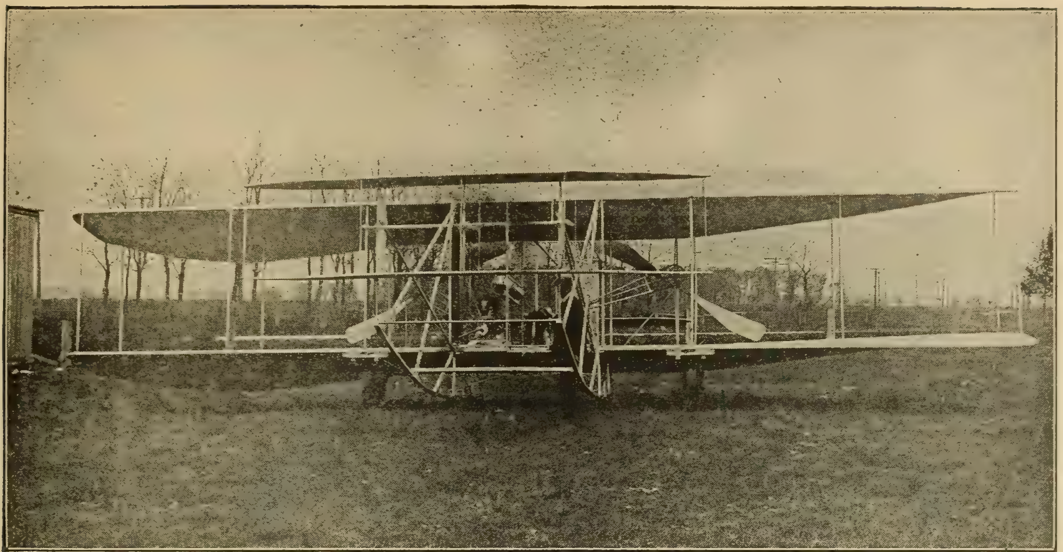
Before bringing the two surfaces together each plane is covered with cloth. This may be muslin or silk. The cloth, which should be one yard wide, is cut into strips a trifle over 6 feet in length. One end of the cloth is glued, wrapped around the front beam and tacked to it with small copper tacks, and then stretched tightly backward over the ribs, being fastened to the latter at spaces of one inch with copper tacks. After the cloth is in place it is treated to a coat of light-bodied varnish which tends to make it air tight. The various sections are then tightly braced with guy wires.

Equipment with motor and propeller depends upon the personal tastes of the aviator, the general object being to get an extreme high speed combined with the maximum of lightness. Four-cylinder motors developing 50 h. p., have been constructed as light as 90 pounds, but the average is about 150 pounds.

Successful operation of a flying machine calls for a combination of coolness, nerve, and technical skill, especially in an understanding of air currents and a knowledge of what to do in case of emergency. A few daring operators will make ascensions when the wind is blowing from 35 to 45 miles an hour, but the more conservative ones decline to start when the wind is moving at more than 25 miles, and prefer it to be less than that. The aviator's greatest danger lies in being struck by a gust or contrary current which will disturb the equilibrium of his frail craft. When this occurs it must be righted—restored to an even keel—immediately. This is done by manipulation of movable auxiliary planes known as stabilizing surfaces. On some machines this manipulation is effected by means of hand levers, in others by foot levers, and in still others by automatic devices.

FUTURE OF AIRSHIPS.

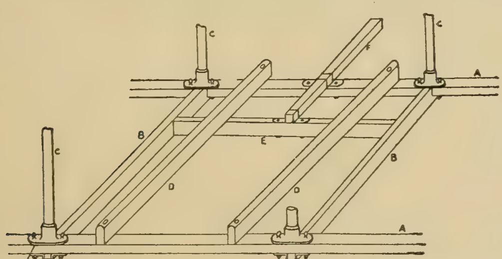
It is now well settled that the airship has a useful future. Whether it can be made of service as a common carrier for passen-



FRONT VIEW OF WRIGHT BIPLANE, SHOWING CURVATURE OF PLANE TIPS.

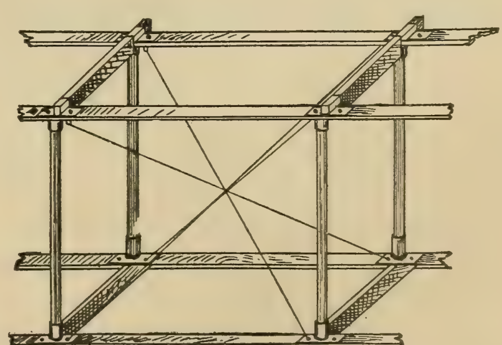
gers and freight is problematical. The consensus of opinions among expert aviators is against it. But there is an ample field for its use aside from commercial traffic. In war, scientific exploration, sport and pleasure the flying machine has an assured future. It will be especially valuable in scaling hitherto inaccessible mountains, in spying out an enemy's fortifications, in crossing and making observations of deserts, and in carrying messages from beleagured towns. Flying machine races are already popular and attractive, and no less a personage than former President Roosevelt, who made an ascent with Arch Hoxsey, at St. Louis, in November, 1910, gives strong testimony to the pleasurable sensations of a ride skywards.

So far as known only one attempt has been made to utilize the flying machine in a commercial way, and this was more for purposes of demonstration and advertising, than for practical results. On November 7, 1910, P. O. Parmalee, using a Wright biplane, carried 10 bolts of silk from Dayton, Ohio, to Columbus, Ohio, a distance of 58.3 miles in 59 minutes. This is the fastest



MANNER OF PUTTING GLIDER FRAMEWORK TOGETHER.

AA, main beams; BB, struts; DD, arm pieces; E, cross beam to hold rudder beam; F, rudder beam; G, socket for stanchion.

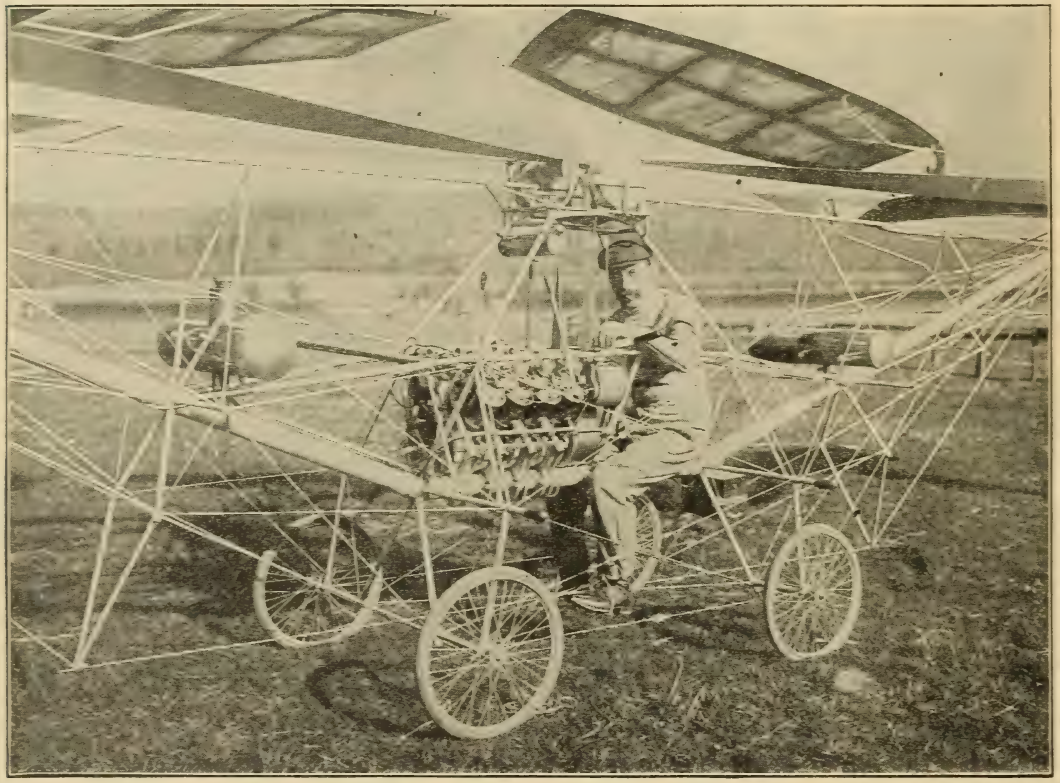


GENERAL PLAN OF WIRING FRAME.

time ever made in an American aeroplane, but it did not establish the freight-carrying possibilities of the machine. The load was very light—70 pounds—and it is well known that there is a limit to the weight-sustaining power of flying machines.

RECORDS MADE BY AVIATORS.

When we consider that ten years ago the propulsion of a flying machine through the air at a speed of 10 miles an hour was considered remarkable the fact that these machines are now moving at the rate of 70 and 75 miles an hour, is seemingly miraculous. The records to date (January 1, 1911,) are as follows:



HELICOPTER MACHINE AS MADE BY PAUL CORNU.

THE WORLD AT LARGE.

Distance and Duration.—Maurice Tabuteau, on M. Farman machine, with Renault motor: at Buc, France, 362.66 miles in 7 hours, 45 minutes, an average of about 45 miles an hour without a stop.

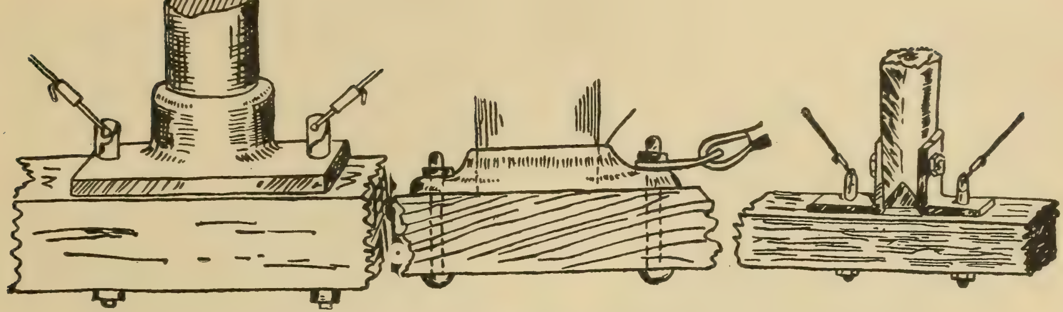
Speed.—J. Radley at Lanark (Great Britain) on a Bleriot monoplane with Gnome motor: one mile in 47:2-5 seconds, a rate of 75.95 miles an hour.

Altitude.—Arch Hoxsey, at Los Angeles, Calif., on a Wright machine with Wright motor, 11,474 feet.

AMERICAN RECORDS.

Distance and Duration.—A. L. Welsh, at St. Louis, Mo., on Wright machine with Wright motor: 120 miles in 3 hours, 11 minutes, 55 seconds.

Speed.—Alfred Le Blanc, at St. Louis, Mo., on Bleriot monoplane with Gnome mo-



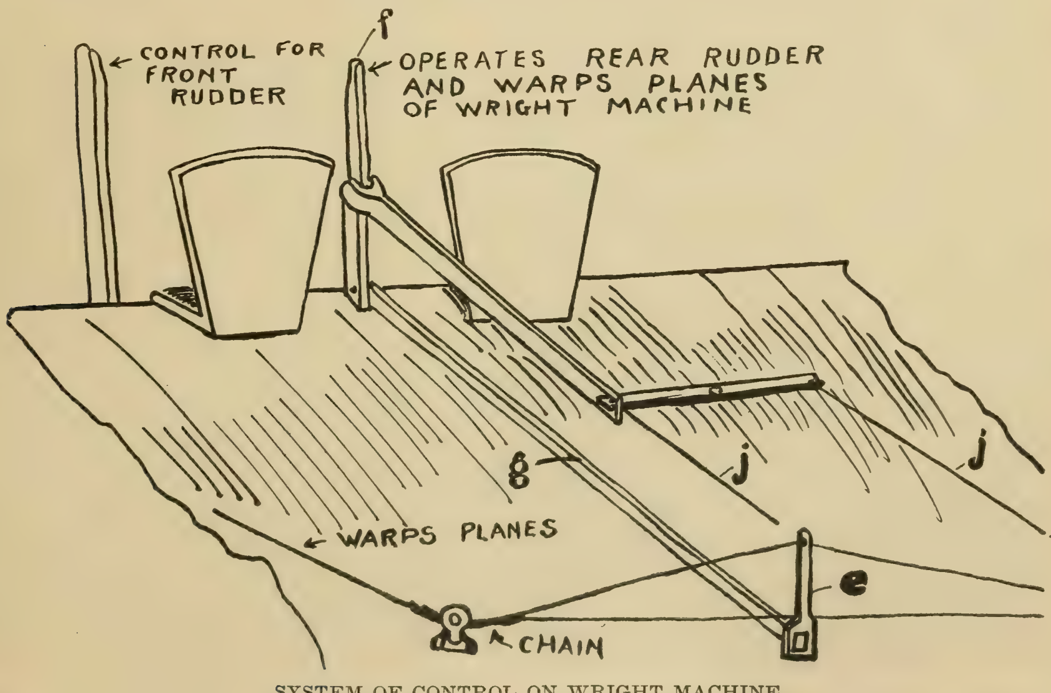
VARIOUS METHODS OF ATTACHING STANCHIONS AND GUY WIRES.

tor: one mile in 53 seconds, a rate of 67.8 miles an hour.

Altitude.—Arch Hoxsey, as given above.

Cross-Country, None-Stop.—Arch Hoxsey, from Springfield, Ill., to Clayton, Mo., on a Wright machine with Wright motor: 89⅝ miles.

While not constituting a record, another notable performance was that made by Walter Brookins, less than 20 years of age, when on September 29, 1910, operating a Wright biplane, he flew from Chicago to Springfield, Ill., a distance of 187 miles, in actual flying time of 5 hours, 45 minutes, an average of about 33 miles an hour, most of the distance being made against a head wind of 15 miles an hour. Brookins' longest continuous flight on this trip was 88 miles, being 1⅝ miles short of the record. His reason for descending at the 88-mile point was that it was a convenient place at which to obtain fuel and oil supplies.



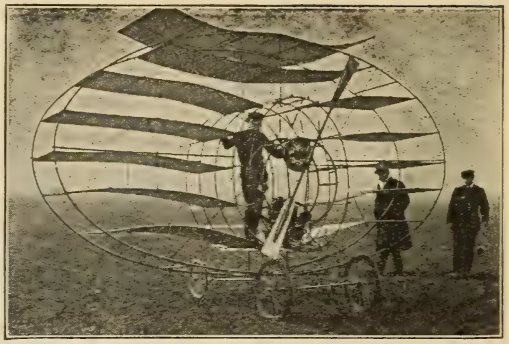
SYSTEM OF CONTROL ON WRIGHT MACHINE.

The various altitude records made in 1910, starting with 3,445 feet (which was considered remarkable at the time) and ending with 11,474 feet, are as follows:

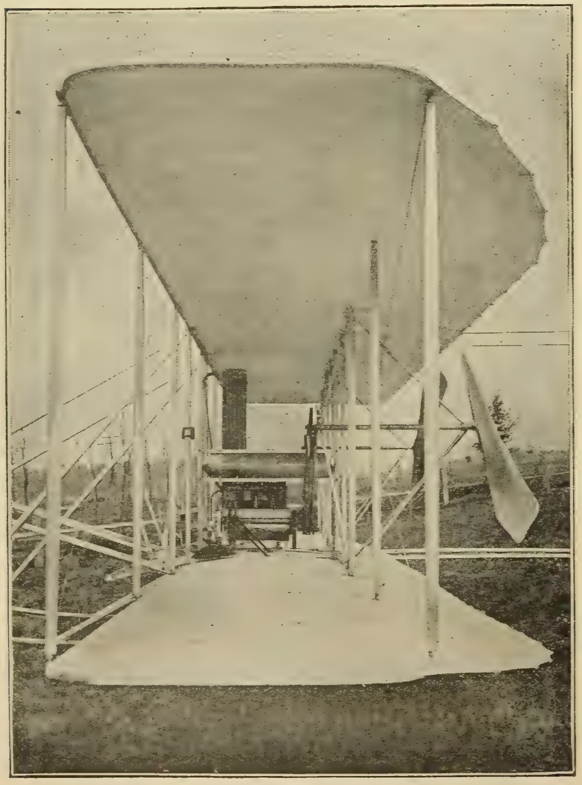
Date.	Place.	Aviator.	Altitude.
Jan. 7	Bethany Plains	Latham	3,445 feet
June 17	Los Angeles	Paulhan	4,164 feet
Jan. 10	Indianapolis	Brookins	4,384½ feet
June 13	Indianapolis	Brookins	4,503 feet
July 7	Rheims	Latham	4,541 feet
July 9	Atlantic City	Brookins	6,175 feet
Aug. 11	Lanark	Drexel	6,750 feet
Sept. 3	D'Eauville	Morane	8,471 feet
Sept. 8	Issy	Chavez	8,792 feet
Oct. 1	Mourmelon	Wynmalen	9,186 feet
Oct. 30	Belmont Park	Johnstone	9,714 feet
Nov. 23	Philadelphia	Drexel	9,970 feet
Dec. 9	Pau	Legagneux	10,498 feet
Dec. 26	Los Angeles	Hoxsey	11,474 feet

SUCCESS OF FOREIGN AVIATORS.

While American aviators were gaining fame by the construction and operation of biplanes (two-surfaced machines) foreign aviators were equally busy in the successful production and operation of monoplanes (one-surface machines). Of these Santos-Dumont and Louis Bleriot are in the front rank. The former has built and operated the smallest flying machine in the world—La Demoiselle. It has a surface area of only 110 square feet, and yet Santos-Dumont has made some remarkable flights in it. The Bleriot machine is somewhat larger, having 160 square feet of surface area. It was with this machine that Bleriot, on July 25, 1909, won world-wide fame by crossing the English channel from Calais to Dover, making an average speed of 45 miles an hour. Since then monoplanes have fast come into public favor and now there are nearly a dozen different makes in use. Even Glen H. Curtiss, the American aviator, who has hitherto adhered strictly to the biplane, has recently produced a monoplane machine with which he expects to attain extreme speed.



NEW FORM OF FRENCH AEROPLANE.



VIEW OF WRIGHT BIPLANE FROM END.

DIRIGIBLE BALLOONS.

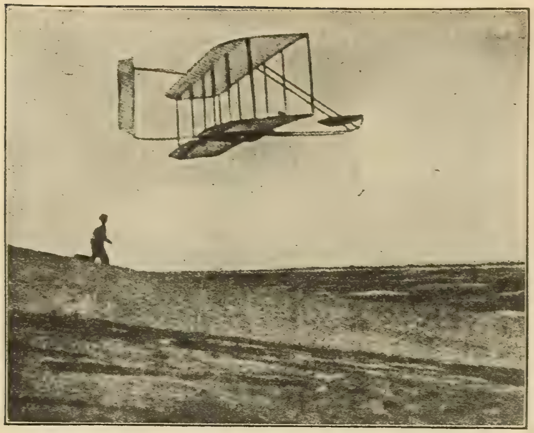
Great progress has also been made in recent years in the manufacture and operation of dirigible balloons. Foremost in this work—in the magnitude of his creations, at least—is the veteran, Count Zeppelin, of Germany. He has been building balloons on novel lines since 1898, an enterprise in which he has spent all of his private fortune as well as $500,000 subscribed by the German people, and met with many disheartening disasters. Accident followed accident, and even the best and largest of his airships was finally destroyed.

FIRST AEROPLANE COLLISION IN THE AIR.
During an aviation meet at Milan, Italy, M. Thomas, in an Antoinette monoplane, ran into Capt. Dickson in a Farman biplane. Both men were seriously injured.

The Zeppelin design includes an aluminum framework embracing seventeen gas-tight compartments. Over this framework is a gas-tight envelope of linen and silk. Over this again is a larger envelope of the same materials, the air space between the two bags acting as an insulator and preventing rapid changes of temperature from affecting the gas. The Zeppelin II, the largest of Count Zeppelin's balloons, up to the building of No. 3, was 448 feet long, 42 feet in diameter, held 446,000 cubic feet of gas, and was equipped with two motors of 220 h. p. On May 31, 1909, Count Zeppelin and a crew of nine men made a continuous flight of nearly 900 miles in 36 hours. All the Zeppelin dirigibles are built on the same plan — a cylindrical, cigar shape. But No. 2, as well as No. 3, was completely wrecked. Undaunted by the numerous disasters Count Zeppelin, with the aid of the Crown Prince of Germany, is now (January 1, 1911) planning to construct another large dirigible.

ARCH HOXSEY AND WALTER BROOKINS, PUPILS OF THE WRIGHT BROTHERS.

Major von Parseval, of Germany; Major



EARLY WRIGHT GLIDER IN FLIGHT.

Gross, of Prussia; the Lebaudy brothers, of France, and Clement-Bayard, are other foreigners who have also attained more or less success in the operation of dirigible balloons. The British government is using a dirigible in military maneuvers, and is having two more constructed.

In the United States the government purchased in 1908 the dirigible constructed by Capt. Thomas Baldwin, and is using it in the army signal service.

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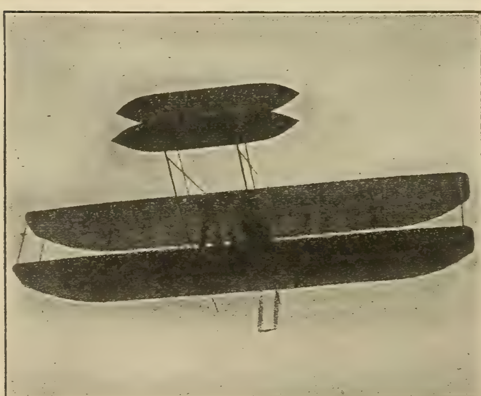
FATALITIES AMONG AVIATORS.

In the three years ending with December

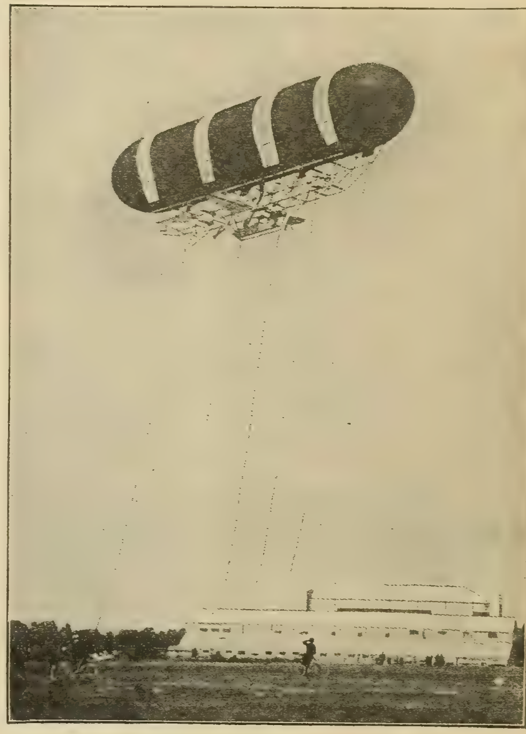


ASCENDING.
Wright Aeroplane rising high in the air like a bird.

31, 1910, forty-five lives were lost in flying-machine accidents, most of them through the collapse of a machine owing to the breaking of some vital part, defect in which might have been detected by careful inspection before flight. The fatality list is as follows:

1908.

Sept. 17—Selfridge, T. E. . . . . Washington



BRITISH WAR BALLOON.

1909.

Sept. 7—Ena, Rossi . . . . Rome
Sept. 7—Lefebvre, E . . . . Jusivy-Sur-Orge
Sept. 22—Ferber, Louis F . . . . Boulogne
Dec. 6—Fernandez, Antonio . . . . Nice

1910.

Jan. 4—Delagrange, Leon . . . . Bordeaux
April 2—Le Blon, H . . . . San Sebastian
May 13—Michelin, Chauvetto . . . . Lyons
June 2—Zoesly, Aindau . . . . Budapest
June 4—Popoff, M. . . . . Russia
June 17—Speyer, E . . . . San Francisco
June 18—Robl, T . . . . Stettin
July 3—Wachter, Charles . . . . Rheims
July 12—Rolls, Capt. C. S . . . . Bournemouth

July 13	Erblech, Oscar, and four companions	Germany
July 25	Kinet, Danial	Ghent
Aug. 3	Kinet, Nicholas	Brussels
Aug. 30	Vivaldi, Lieut	Rome
Sept. 7	Van Maasdyk, A.	Arnheim
Sept. 25	Poillot, Edmund	Chartres
Sept. 27	Chavez, G	Alps
Sept. 28	Haas, H	Metz
Sept. 29	Plochmann	Mullhausen
Oct. 7	Macievich, Capt	St. Petersburg
Oct. 23	Madiot, Capt	Douai
Oct. 25	Mente, Lieut	Magdeburg
Oct. 26	Blanchard, Fernando	Issy
Oct. 27	Saglietti, Lieut	Centosello
Nov. 17	Johnstone, Ralph	Denver
Dec. 3	M. Camerara and passenger	Rome
Dec. 4	Archer, Walter	Salida, Colo.
Dec. 5	Cammarota	Centosello
Dec. 21	Grace, C. S.	English Channel
Dec. 26	Brown, Frederick	Havana
Dec. 26	Piccolo, Senor	San Paulo
Dec. 28	Leffort, Alexander	Paris
Dec. 28	Paulla, Marquis	Paris
Dec. 29	De Caumont, Lieut	St. Cyr
Dec. 31	Moisant J. B	New Orleans
Dec. 31	Hoxsey, Arch	Los Angeles

Many of these fatalities were directly induced by the daring of the aviators. In order to win fame and money they took chances which were death inviting.

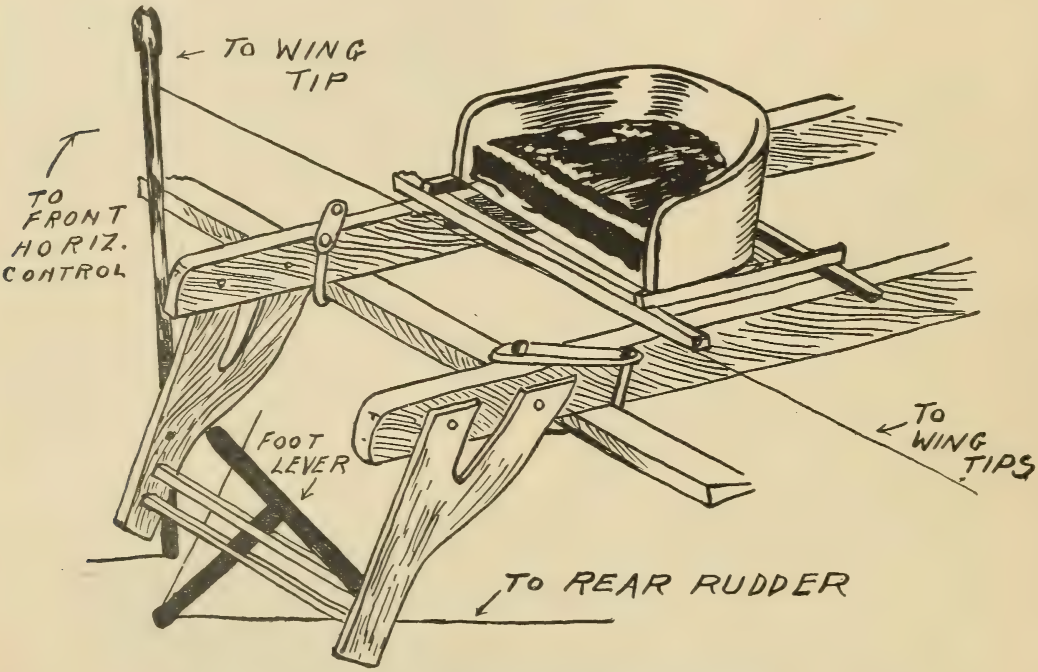
THE INCENTIVE TO RISK.

The question is often asked, "why should aviators willingly and knowingly attempt feats which are extra hazardous?" An answer may be found in the accompanying table showing the money winnings of well-known operators in 1910:

Paulhan	$82,052	Glenn Curtiss	16,600
Latham	60,614	Cattaneo	16,090
Morane	52,780	Aubrun	14,660
Rougier	52,300	Moisant	13,550
Chavez	49,233	Comte de Lambert	12,480
Grahame-White	48,700	Brookins	11,900
Leblanc	32,800	Metrot	11,200
Farman	23,390	Wagr	11,050
Johnstone	19,108	Simon	10,080
Legagneux	17,900	Olieslaegers	10,200
Van den Born	17,740	Drexel	10,100
Dickson	17,230	Hamilton	10,000
Effimoff	16,711	Bleriot	8,400

GERMAN WAR BALLOONS IN PRACTICE NEAR BERLIN.

Forty-three others won amounts ranging from \$7,708 (Hoxsey) to \$1,034 (Baroness de Laroche). These forty-three divided \$135,731, an average of over \$3,386 to each contestant. To establish a record or perform some daring feat brings fame, and fame brings money. Walter Brookins, a young pupil of the Wright brothers, was paid \$10,000 in September last (1910) for making an exhibition flight from Chicago to Springfield, Ill., in a little over seven hours.



SYSTEM OF CONTROL ON FARMAN MACHINE.

WIRELESS TELEGRAPHY

A Triumph of Modern Discovery

Today the traveler on a transatlantic steamship, far out in midocean, can write a message to his friends at home, hand it to an operator who sits at the side of a simple instrument in a cabin of the vessel, and for a few cents a word it will be transmitted across the intervening space, over the stormy sea, to a receiving station on shore, and thence by land telegraph wires to its destination, all with the speed of electricity.

It is only forty-three years since the announcement was made to an incredulous world that the Atlantic cable was a success and that telegraphic messages could be sent under the ocean from America to Europe. Many people remember the enthusiasm with which this amazing achievement was greeted, when the conviction was established that it was really true. Today the world is still enjoying the results of new scientific discoveries that are constantly being made, and the ones that seemed most marvelous when they were first announced, become commonplace after a few years have passed. Most conspicuous of all the recent discoveries in science, and farthest reaching in its possible ultimate effect upon our material affairs, is the successful system of wireless telegraphy, developed and established by the genius of the young inventor, Marconi. It was a triumph when his experiments resulted in communication at will without wires over distances of 250 miles. But hardly had the public become accustomed to this fact, when the announcement was made upon the authority of the young inventor himself, verified by unmistakable evidence, that on December 12, 1901, he had received signals across the Atlantic by this same system of wireless telegraphy. Wonderful as it was, the world has become so accustomed of late years to scientific discoveries which, but a short time ago, would have seemed extravagant and impossible claims, that this announcement was promptly received as an accepted fact, incredulity existing hardly anywhere. The interested public

GUGLIELMO MARCONI IN WORKING CLOTHES.

had long before learned that Mr. Marconi's announcements were never made until he was sure of his facts, and consequently people did not need to be reassured when this greatest wonder of all was announced. It was a red letter day in the history of scientific progress, that winter day in Newfoundland, and yet it was the direct result of a logical, persistent and patient effort on the part of Marconi, the result of years of preparation, study, and experimentation, leading directly to the goal of his ambition.

MARCONI AT HIS RECEIVING INSTRUMENT.

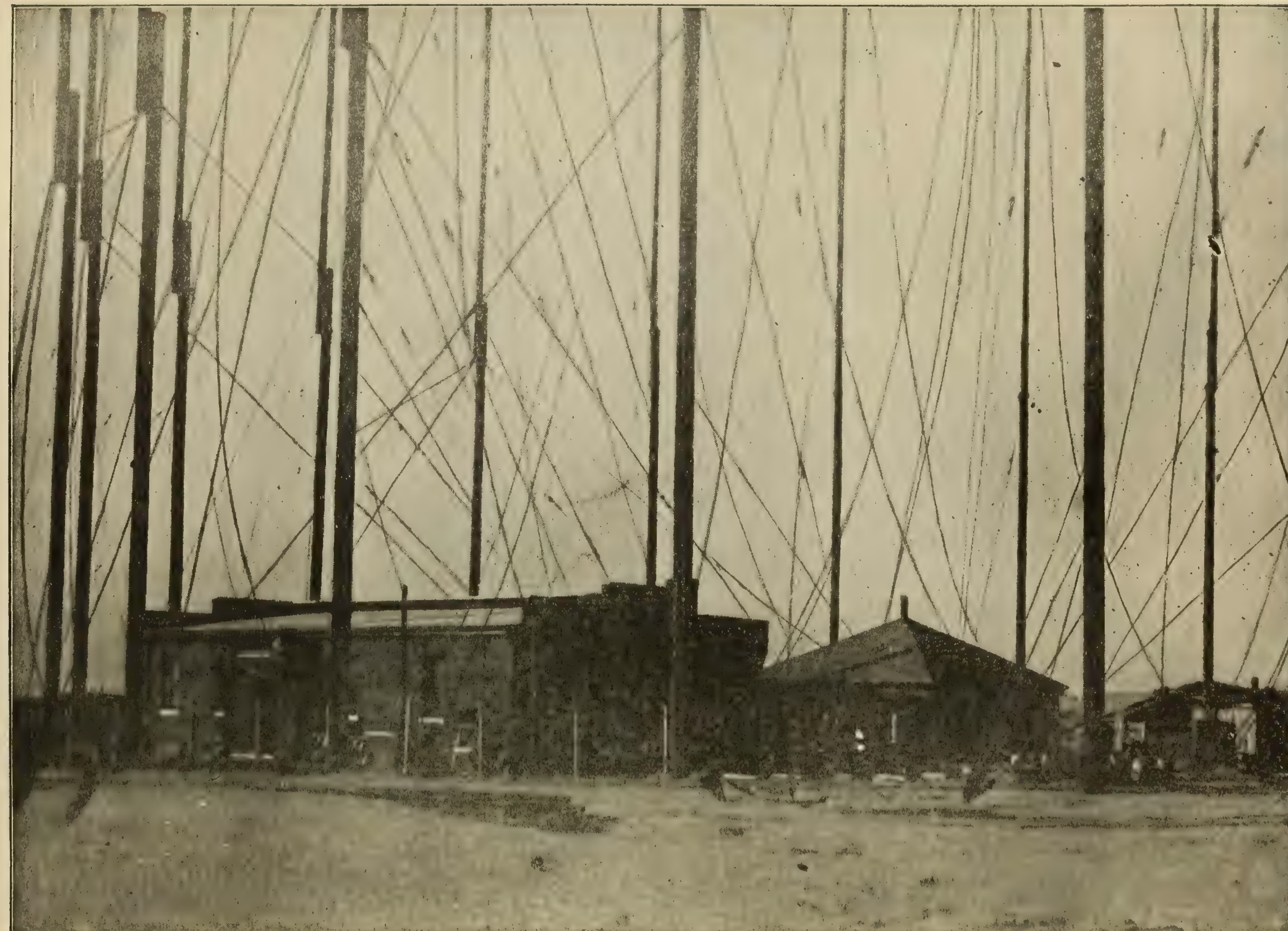
Let us examine the process by which messages are thus transmitted through space without the aid of connecting wires through which they may pass. Those of us unfamiliar with electrical apparatus are accustomed to consider only such electrical streams as take their way along wires. But there are a great many other electric streams unconfined by wires, which can be quite as telegraphic as if they kept to paths of copper and steel. Discoveries suggesting this fact were made as long ago as 1842, and others looking in the same direction have followed. Marconi makes no claim to being the first to experiment along the lines which led to wireless telegraphy, or the first to signal for short distances without wires. But in spite of his prompt acknowledgment to other workers in his field it has remained for Marconi to perfect a commercial system and put it into practical working order over great distances.

The two first essentials in wireless telegraphy, as Marconi has developed it, are the vertical wire, which he suspends in the open air to catch his messages, and the "coherer," which by its exquisite sensitiveness makes it possible to register the messages as received. Electrical waves cannot be seen, but electricians have learned how to incite them, to a certain extent how to control them, and have devised cunning instruments which register their presence. These waves have long been utilized for sending messages through wires. Marconi started with the assumption that inasmuch as electrical waves may pass through the ether which fills all space as readily as through wires, if these waves could be controlled they would evidently convey messages as easily as the wires. So he had to make an instrument which would produce a peculiar kind of wave, and another apparatus which would receive and register this wave at a distance from the first.

The transmitter which resulted from his experiments is an apparatus from which a current generated by a battery and passing in brilliant sparks between the two brass balls is radiated from a wire suspended on a tall pole. By shutting off and turning on this peculiar current the waves are so divided as to represent dots and dashes, and spell out letters in the ordinary Morse alphabet of telegraphy. The waves which come from the transmitter are received on a suspended wire, elevated either by a mast, a kite, or a balloon. This wire is exactly similar to the one used in the transmitter, but by the time the waves have passed over a long distance they are so weak that they could not, of themselves, operate an ordinary telegraphic system. It is here that Marconi utilizes the coherer as the final essential in the invention.

The coherer is a little tube of glass, about two inches long and as large as a small lead pencil in diameter. It is plugged at each end with silver, the plugs nearly meeting within the tube. The plugs are separated by a small quantity of nickel and silver filings, finely powdered. Under ordinary circumstances the filings are jumbled together like the particles of a sand heap, and in that state they form a poor conductor. The moment, however, that they receive an electrical wave they cling together tightly as a solid conducting bridge,

MARCONI'S ASSISTANTS PREPARING TO RAISE THE KITE WHICH SUPPORTED THE RECEIVING WIRE.
(Marconi approaching from the left, indicated by an X.)



MARCONI WIRELESS TELEGRAPH STATION.

At such stations on the Atlantic coast, one of which is at Poldhu, Cornwall, the southwestern extremity of England, one in Nova Scotia, and one at Cape Cod, Massachusetts, the messages are received and transmitted and the experiments carried on. The masts are 210 feet high, and twenty of them are used in a fully-equipped station.

that carries a current from a local battery to a receiving telephone or a telegraphic sounder of common pattern. If it is connected at one end with the suspended wire, and at the other end with the Morse instrument, there is a dot or a dash printed, according to the signal that has been sent by the transmitter, miles away. Then a little tapper, actuated by the same current, strikes against the coherer, and the particles of metal are jarred apart, or decohered, becoming instantly a poor conductor, and thus stopping the strong current from the home battery. Another wave comes through space, down the suspended wire, into the coherer, there drawing the particles again together, and another dot or dash is printed. All these processes are continued rapidly until a complete message is picked out on the tape.

In these early experiments Marconi believed that great distances could not be obtained without very high masts and long suspended wires, the greater the distance the taller the mast, on the theory that the waves were hindered by the curvature of the earth. But his later theory, substantiated by his experiments in Newfoundland, is that the waves follow around the earth, conforming to its curve, and it is not necessary, therefore, to erect masts to a great height. In the experiments of December, 1901, the transmitting station in England was fitted with twenty masts 210 feet high, each with its suspended wire, though not all of them were used. A current of electricity sufficient to operate 300 incandescent lamps was used.

Marconi landed at St. Johns, Newfoundland, December 6, 1901, ostensibly to communicate with the Cunard liners, traversing the North Atlantic Ocean, just along the Grand Banks. The dangers of the Newfoundland coast in the vicinity of Cape Race are well known to mariners, and it was supposed that his motive was to safeguard that coastline so that ships might be located when well at sea and kept in touch with as they approached there, thus reducing to a minimum the dangers of disasters. The Cunard vessels, like nearly all other Atlantic liners, are fitted with his apparatus.

CABOT MEMORIAL TOWER.
Loaned by Newfoundland Government for Marconi's experiments.

Marconi brought with him an apparatus for the receiving of messages, but not for the sending of them, so no specially important experiments were expected by those not in his confidence. For elevating his long receiving wire he brought a balloon and some kites, which, with his other apparatus, he removed to Signal Hill to begin work. The Newfoundland Government placed at his disposal the Cabot Memorial Tower, recently erected on Signal Hill, where his appliances were immediately stored.

On Wednesday, December 11, he sent up his balloon, only to see it break away and sail off toward Labrador. The rest of his experiments were performed with wires hanging from kites, these kites being about nine feet square, and possessing a considerable lifting power. They were built of bamboo and silk, after the Baden-Powell model. By the time he had lost his fourteen-foot hydrogen balloon and one of the kites the wind died down sufficiently to permit a test, even though not under the most favorable conditions. Thursday, the 12th, was a blustery day, and it required the combined strength of the inventor and his assistants to hold the kite at the elevation of 400 feet, which was desired.

Before leaving England Marconi had given instructions to his assistants there for the transmission of a certain signal at a fixed time each day, beginning as soon as they received word that everything in St. John's was ready. The transmitting station was at Poldhu, Cornwall, the southwestern tip of England. Marconi cabled his assistants when to begin sending signals, and on that bleak winter's day, on the barren summit of Signal Hill, were received the distinct signals across the 1,800 miles of the great Atlantic. Again the next day the signals were repeated, and the experiment was an assured success. The storminess of the day and the consequent impossibility of maintaining the kite at a fixed elevation were handicaps difficult to overcome with the incomplete apparatus at hand. Nevertheless, there was no room for doubt that a signal had been actually transmitted from England to America without wires.

The reception which this wonderful achievement won, when after two days of self-restraint Marconi announced the fact, was memorable. The world wondered and awaited details. Edison accepted the fact as soon as Marconi issued a signed statement. The governor of Newfoundland reported the achievement at once to King Edward, and, most significant of all, the Atlantic Cable Company, which possessed a special charter and exclusive rights for telegraphic service in Newfoundland, demanded the cessation of experiments as an infringement upon its rights, a demand to which Marconi and the Newfoundland Government had to bow. After that the inventor made two or three journeys back and forth across the Atlantic to direct experiments and commercial negotiations, and a station for his transatlantic service was decided upon, to be located near Sydney, Cape Breton Island, Nova Scotia. Newfoundland thus lost for a time the distinction of being the scene of Marconi's further experiments. In addition to this receiving station there is a large one at Cape Cod, on the Massachusetts coast, and these two, with the Lizard station in Cornwall, will complete a triangular service conveniently located for commercial use in the transatlantic system.

Shortly after the transmission of these first signals from Cornwall to Newfoundland came the news of the transmission of entire messages for a distance of 1,551 miles. Marconi was crossing the Atlantic on the steamship Philadelphia, and he exchanged messages with his assistants on land for that distance. The officers of the vessel signed and certified the messages as they were received, and the last remnant of incredulity was banished. The messages were clearly registered on the tape, and inasmuch as the receiver of the Philadelphia was not specially constructed for long distance work the achievement was considered all the greater.

Marconi's faith in his invention is boundless. He modestly but firmly maintains that what he has done is nothing with what he hopes to accomplish in the future. When the world throbbed with the surprise of his exploit, and the cables were loaded with congratulatory messages, he manifested no elation, but calmly declared that he never doubted his ability to employ the magnetic waves across the Atlantic. "When I am able," said he, "to send a message from Cornwall to New Zealand across the Isthmus of Panama, the only land that intervenes, then I shall count that I have accomplished something. The force I shall generate shall be sufficient to send the signals the whole way. And there is an even more difficult proposition which I intend to tackle, more difficult because it involves transmission over land, with all the diversities of the different countries. I shall not rest until I have inaugurated wireless telegraphy between London and Calcutta, overland."

The imagination is overwhelmed in the effort to look forward to the possibilities of a perfected wireless telegraphy system. The $400,000,000 invested in cable systems in various parts of the world would in large measure be lost. The cost of messages would be much reduced by this system. An Atlantic cable costs between $3,000,000 and $4,000,000, while wireless telegraphy stations can be built and equipped on both sides of the Atlantic for less than $150,-

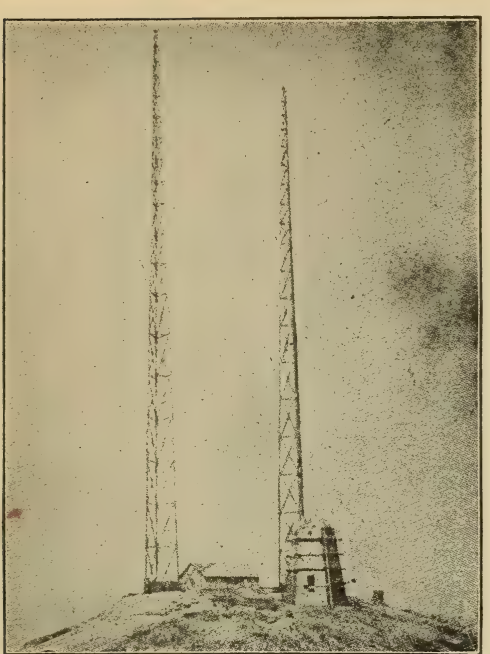
SIGNAL HILL, ST. JOHN'S HARBOR, NEWFOUNDLAND.
Showing the Cabot Memorial Tower from which Marconi conducted his experiments.

000, with a very small charge for maintenance. With all vessels and lighthouses equipped with apparatus, it should be possible to avert collisions at sea and wrecks on shore. In times of warfare generals may signal over the heads of the enemy where they could not possibly string telegraph wires or send couriers. The steamships in midocean would be in touch with the news of the day. It is little wonder that Lloyds, the chief marine exchange of the world, has contracted for fourteen years' use of the Marconi patents.

A general impression prevails that wireless telegraphy is still largely in the uncertain experimental stage, but as a matter of fact it is actually in wide commercial use. Most of the ships of the great navies of Europe, and all the important ocean liners, are now fitted with the wireless instruments. It is being used on many light ships, and the New York Herald receives daily reports from vessels at sea, communicating from a ship station off Nantucket. Though it is not generally known, messages are now received in England at the rate of 12½ cents a word for transmission to vessels that have already sailed from port.

The one remaining element of doubt which has been suggested as to the practical uses of a world-wide system is dismissed by Marconi with the assurance that he already has proved that he can overcome it. This is the question of whether or not messages can be clandestinely read by those for whom they are intended; in other words, if privacy can be assured by a system in which the signals radiate with equal force in every direction from the point of transmission. Marconi has found that he can so harmonize the transmitters and receivers or "tune" them, so to speak, so that they will respond to their own mates but not to others. By this system all the ships of a fleet can be provided with instruments tuned alike, so that they may communicate freely with each other without danger of the messages being read by the enemy. Great telegraph companies would have their instruments tuned to receive their own messages and no others. In one of Marconi's English experiments he had two receivers connected with the same wire, and tuned to different transmitters. Two messages were sent, one in English and one in French. Both were received at the same time, on the same wire, but one receiver rolled off its message in English, the other in French, without the least interruption.

With the progress of science as rapid as it is in these years at the beginning of the century one should be prepared for anything, however startling. Impossibility is a word to be avoided. Already wireless telephone systems are contemplated as a natural development to follow the wireless telegraph, and even these are hardly more wonderful than the phonograph with its manifold developments, the sending of pictures by telegraph, the moving picture machine under its various names, and a host of other scientific marvels which might be mentioned. Incredulity is no longer a safe frame of mind, and after the achievements of Marconi still less will we feel inclined to disbelieve any statement of invention or discovery.



WIRELESS STATION, MT. TAMALPAIS, CAL.

While the limit of accurate transmission of messages is generally fixed at 250 miles, there have been occasions on which a distance of 1,000 miles or more has been covered. Operators of the wireless system explain this on the ground of atmospheric conditions. When these conditions are favorable messages may be transmitted for almost any distance; when the atmospheric conditions are unfavorable 250 miles is about the limit within which satisfactory service may be had.

So practical and valuable has the wireless system become that the United States government has provided that beginning July 1st, 1911, all ocean-going vessels carrying 50 or more passengers, must be equipped with wireless apparatus and carry competent operators. The system is now in general use on the great lakes.

AUTOMATIC TELEPHONES.

Much more wonderful, from a mechanical standpoint at least, is the automatic telephone system, which eliminates the services of the "hello" girl in making connections between the phones of subscribers. Speed and certainty in service, and absolute secrecy in communication, are the advantages claimed for this system in addition to a great saving in the expense of operation.

Each phone is fitted at the base with an immovable disk, on which are raised numerals from 1 to 0. Over this disk is a movable metal circle numbered and perforated so that when the holes come exactly over a number on the lower disk it may be readily seen. Suppose a subscriber wishes to call phone No. 739. He slides the movable circle around so that the perforation numbered "7" comes exactly over the same numeral on the stationary disk. Next he moves the circle so the "3's" match, and then repeats the operation with the "9's." This makes a connection automatically at the central exchange and the subscriber is at once placed in communication with the number wanted. If the number should be busy when called an automatic signal announces the fact. Replacing the receiver on the hook cuts off the connection automatically when either subscriber "hangs up."

These phones have been in use successfully for a number of years and the service is being extended. Several thousands are now being operated in Chicago. Among the other advantages claimed for the automatic service is that of absolute certainty in getting the number wanted. If it is not obtained at the first effort it is because the phone desired is busy, and not because some operator has made a wrong connection.

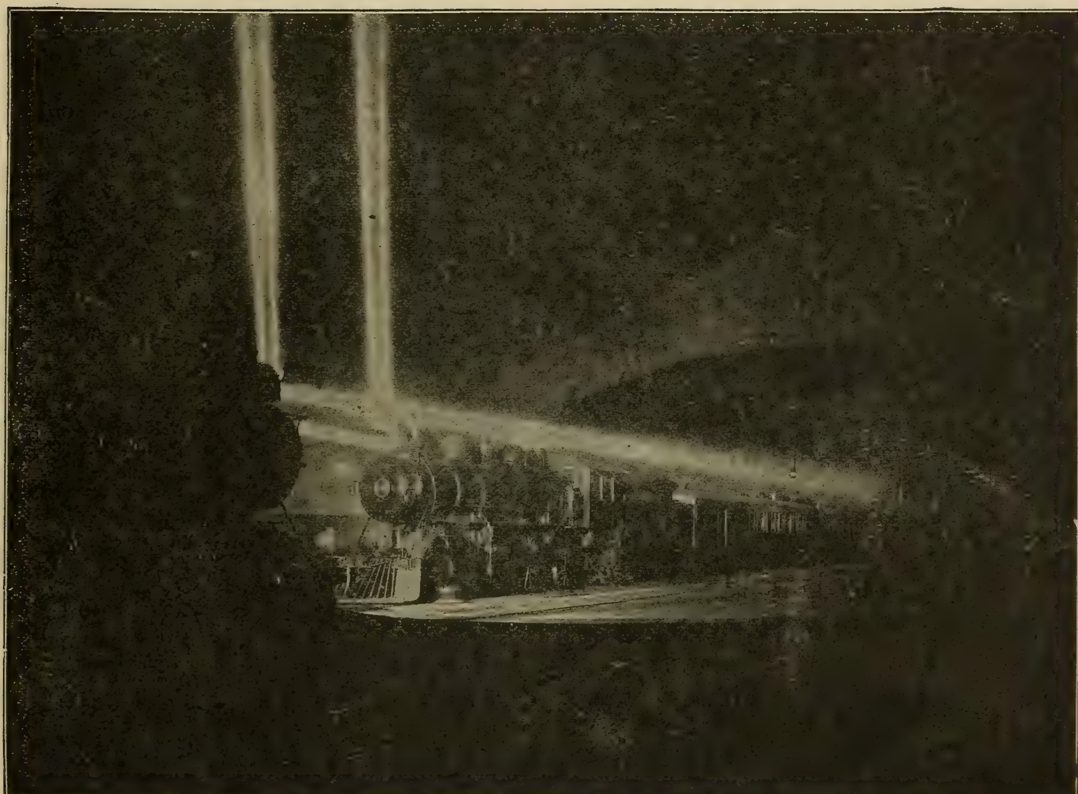
NEW STATION BUILDING OF CHICAGO & NORTHWESTERN RAILWAY IN CHICAGO.

THE WORLD'S GREATEST INDUSTRY

THE RAILWAY

The combined length of the railways of the United States amounts to nearly 200,000 miles, and of the whole world to approximately 500,000 miles. The increase is at the rate of about 10,000 miles a year the world over. If the actual cost of construction and equipment, the production of the materials out of which the lines are built, the employees engaged in railway, operation, and the interests which depend for their prosperity on the railway are considered, it may be safely said that the railway is the greatest industrial factor in the world today.

The most able financial organizations, the most skillful executives, and the most ingenious inventors, are devoting their attention to the construction, operation and



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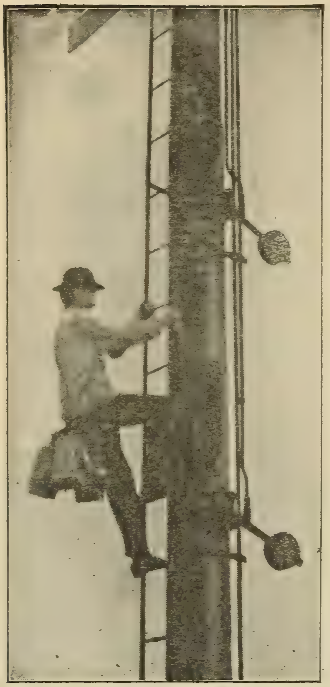
SPECIAL TRAIN H. R. H. PRINCE HENRY OF PRUSSIA IN CHICAGO MILWAUKEE & ST. PAUL RAILWAY STATION AT MILWAUKEE, MARCH 4, 1902.

(Photo taken at 9 p. m. by the light of the searchlight headlights. This is the latest device for averting collisions, as the piercing rays can be seen for many miles along the track and flashing against the sky.)



Carrying night lanterns to the top of a railway signal post.

perfection of railway systems. Improvement in the modern railways over those of only a few years ago is conspicuous. Old roads are reconstructing their lines and new ones build with the utmost care to assure the permanency of their tracks, the economy of their administration and the comfort of their travelers. Heavy steel rails have supplanted the light ones of iron; rock ballast is used where earth formerly sufficed; steel bridges span streams and the old wooden culverts are burned at the roadside; curves are straightened, grades are reduced, tunnels penetrate the mountains where trains formerly surmounted the summit by slow climbing. All this contributes to the safety, ease and speed of the journey, but it likewise reduces the cost of maintenance and operation, so that the railway companies find direct as well as indirect profit from their increasing expenditures. The elevation of tracks through cities, thus eliminating grade crossings, and the perfection of various block signals and safety switch systems, help to give additional safety to traffic and make high speed possible.

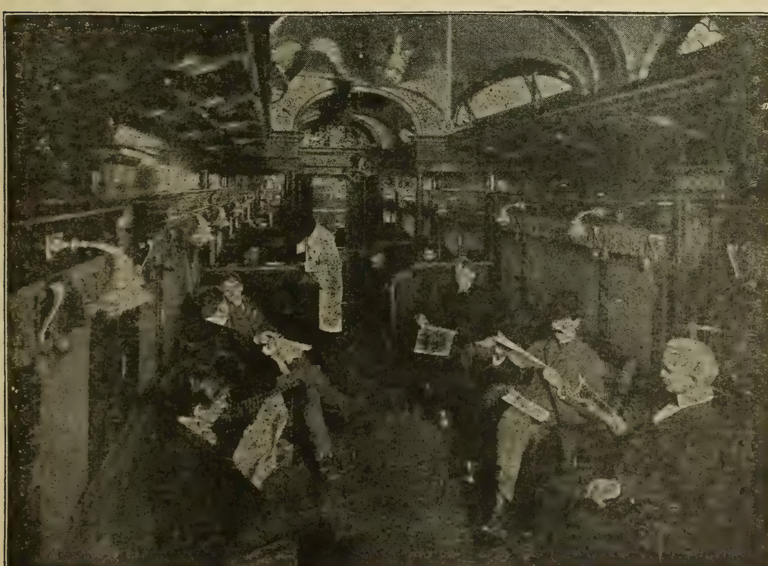
THE TRACK WALKER.

Rails, ties, switches and signals must be watched carefully to guard against accidents, and such patrol duty is one of the most important functions in railway service.

Train equipment has improved with the increase in travel, and today the railway journey may offer comforts and luxuries at a moderate price, which are hardly to be found in any but the homes of the wealthiest. A modern transcontinental train is in fact a luxurious home, with all the details of a splendid clubhouse or hotel available, while one races across plains and mountains at high speed. Such trains, equipped with palace sleeping cars, dining cars, drawing room and observation cars, a library, barber shop, café, card room, music room, electric lights, and vestibules excluding the noise and dust as one passes from one car to another, with waiters, porters and a lady's maid ready to serve the passengers with everything demanded, add enticement to the prospect of a journey, where formerly the destination itself was the only reward.

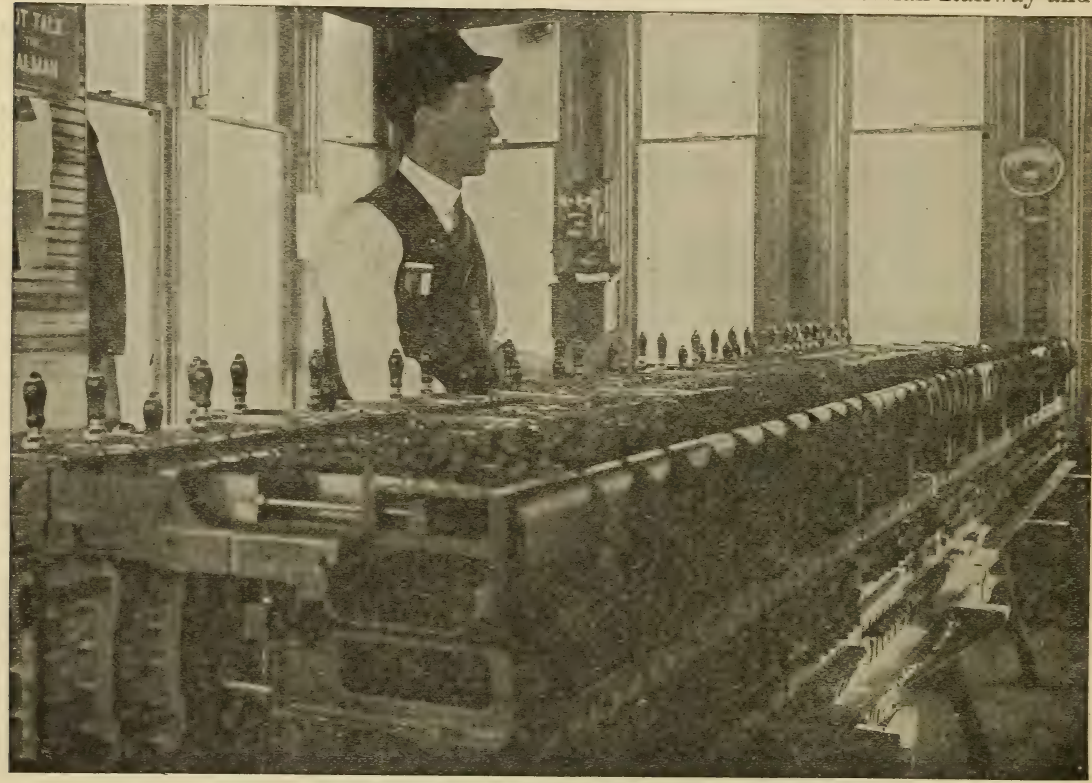
It is not alone in the United States that railway construction is advancing rapidly and luxurious facilities for travel are provided. All over the world the same spirit of energy rules and the effort to connect remote lands by these arteries of commerce never ceases. On our own continent, our neighbors to the north and the south are active. One transcontinental line crosses Canada, a second is advancing rapidly, and a railway to Hudson's Bay promises completion within a few years. The Mexican Republic has seen the construction of nearly 10,000 miles of railway within the last few years, and the country is traversed in every direction by lines which are extending rapidly.

ALL ABOARD!



SOLID COMFORT IN THE LIBRARY CAR.

Surveys have been completed for an intercontinental railway, to connect North and South America by way of the Isthmus of Panama. In South America the Andes Range has been a difficult obstacle for transcontinental lines to overcome, but already the mountains have been penetrated from the Pacific coast by several lines, and a railway from ocean to ocean is a thing of the near future. The heart of the continent is penetrated by numerous lines in Argentine and Brazil, lines which afford an outlet for the immense production of the interior, and novel journeys for the inquiring traveler.



OPERATOR IN THE SIGNAL TOWER.
(Showing mechanism by which switches and signals are controlled.)

In Asia the whole political and military situation has been affected by the construction of the Trans-Siberian railway, built by the Russian Government. Extending all the way from the European provinces of the empire as it does, across the whole of Asia, to a terminus on the Pacific Ocean, it provides a speedy route by which armies may be shifted to any scene of threatened difficulty at the will of the Emperor. Except for its course across Northern Manchuria, in order to obtain a shorter route to the sea, the entire line is within the dominions of Russia, and Manchuria itself is so entirely dominated by Russian authority as to be virtually at the disposal of the railway.

On the Pacific the Siberian Railway and this connecting line, the Chinese Eastern Railway, have one terminus at Vladivostok and another at Port Arthur. The former is a Russian city, with an impregnable harbor on the coast north of Korea. Port Arthur was acquired by negotiations with the Chinese, and situated as it is at the gateway by which Peking must be approached, it becomes a sentinel port whence the Russians can watch their own interests. The entire length of this wonderful railway from the Ural Mountains to the Pacific, is nearly double that of an American transcontinental railway, or more than 6,000 miles, and it was constructed at a total cost, including all incidental expenses, of nearly $250,000,000. From a European port on the Atlantic, Havre for instance, it is, therefore, possible to go by continuous connecting lines of railway a distance of nearly 10,000 miles right across two continents, or almost half way around the world. The Siberian line was not begun until 1891, and the completion of it in eleven years across the steppes of Siberia, the great rivers which flow through Asia into the Arctic Ocean, the mountain ranges and the wilderness, is the most noteworthy achievement in the history of railway construction.

Transcontinental trains on the Siberian Railway are equipped as our own railways are in America, with sleeping cars and dining cars of Russian patterns. In addition they have bathrooms, a gymnasium and a church car, which travels with the train at times, where priests hold services for the benefit of the faithful while they are speeding through the heart of Asia.

Russia has yet another railway, extending eastward into Asia from the Caspian Sea, about 1,000 miles south of the Siberian railway and roughly parallel with it. It has been completed for a distance of about 1,500 miles, and thus reaches nearly to the western boundary of the Chinese Empire. At its terminus, this line is less than 500 miles from the northern terminus of the British railways in India, and if this gap could be traversed there would be continuous rail communication between Western Europe and Calcutta. The great mountain range called the Pamirs intervenes here, however, and the connection will have

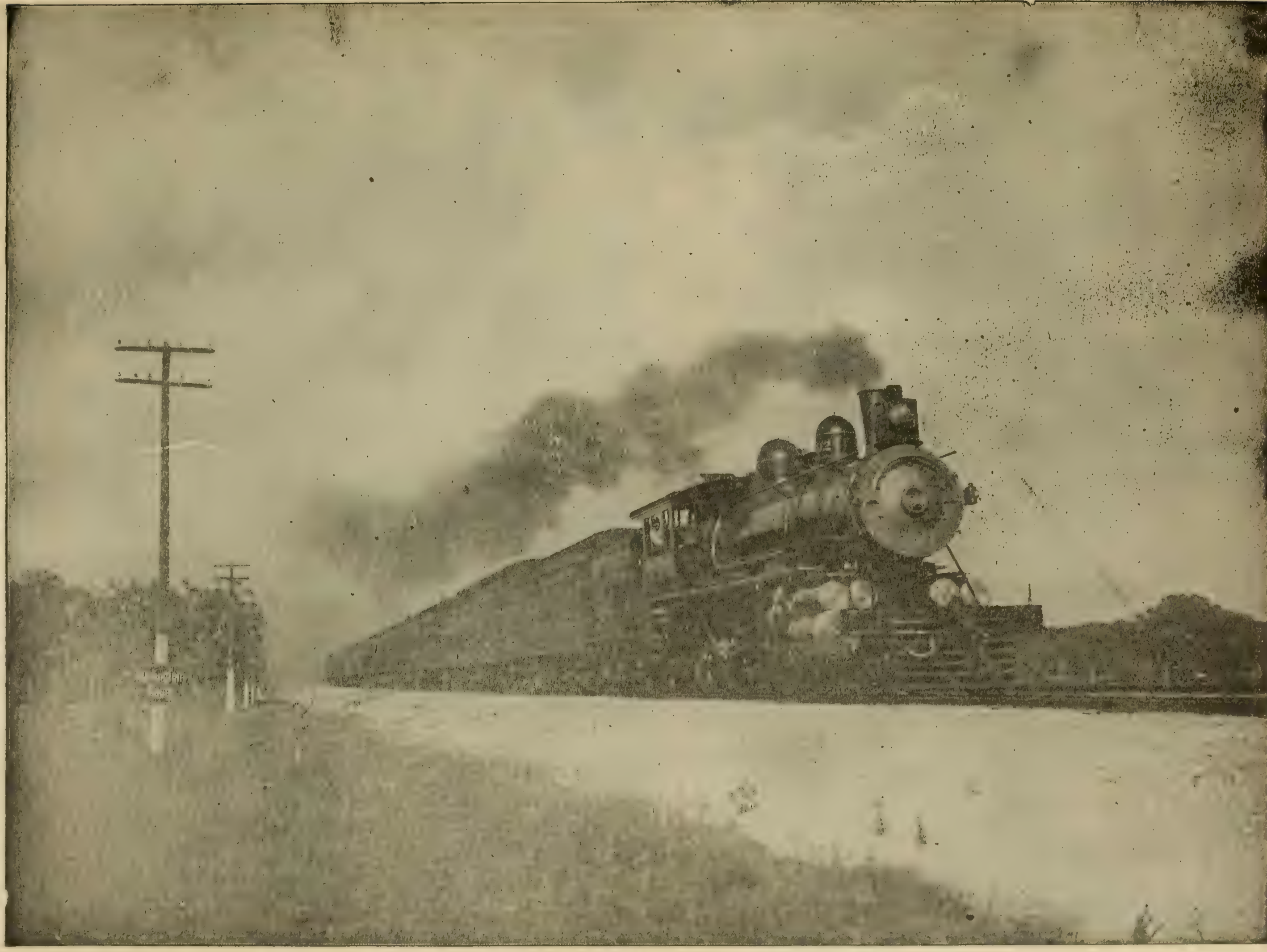
IN THE DINING CAR.

to be made some day by an easier route, but little longer, across Afghanistan. It is the purpose of Russia to connect this railway with the Siberian line by a northeastern extension, and perhaps, some day also, to build directly across the Chinese Empire to the Pacific Ocean at Shanghai.

Africa is not falling behind in the matter of railway construction. Already the line of the Cape to Cairo Railway is sufficiently advanced to make a striking impression when one studies the map. From Cape Town northward it has been completed nearly to the Zambezi River, and from Cairo it extends up the Nile to Khartum, whence construction is steadily advancing. The gap is still a long one, but the surveys are made, capitalists are interested, and it promises to be not many years before the traveler can find a through train of palace cars by which he may travel the length of the Dark Continent from the Cape of Good Hope to the Mediterranean. This is a distinctly English enterprise, and except for the comparatively short crossing of German East Africa, the line traverses British territory all the way until it reaches the practically British province of Egypt. In Western Africa, the French never halt in their explorations of the Sudan, into which they are steadily pushing their railways southward from Algeria. Before many years Timbuctoo will be a way station between Algiers and Dahomey, and we may visit the oases of Sahara in palace cars.

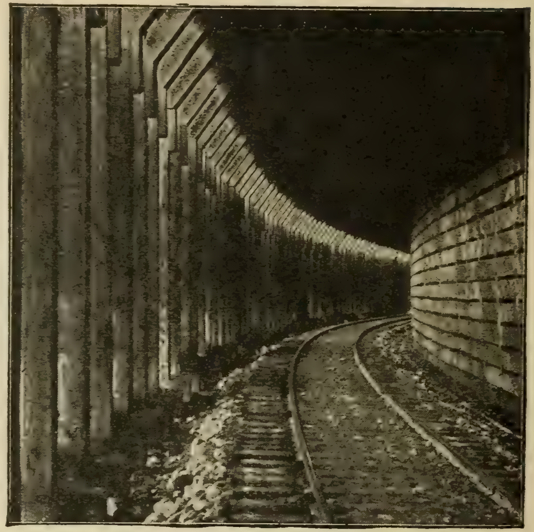
Australia, with its immense expanse of interior desert, is not yet traversed or encircled by a railway line. The capitals of the more populous states of the new Commonwealth, from Adelaide to Brisbane, are connected by rail, and many short lines extend from ports around the coast toward the interior of the continent. From Adelaide a telegraph line extends northward across the continent to Port Darwin, where it connects with the submarine cables to Asia and Europe. A railway line has been

RAILWAY CONSTRUCTION IN THE MOUNTAINS.

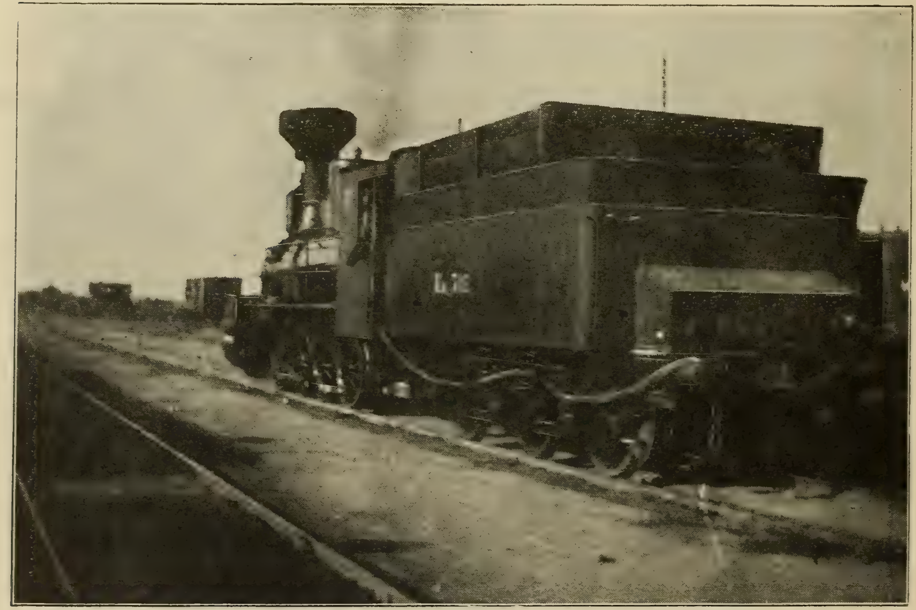


TRANSCONTINENTAL EXPRESS RUNNING SIXTY MILES AN HOUR.

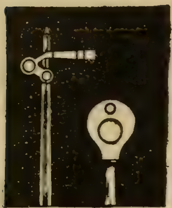
This train took its own picture, by opening the lens of the camera, that had been made ready, as it ran over the connecting mechanism on the track built from Adelaide northward as far as Oodnadatta, 800 miles into the desert, but a train service operated once every three weeks each way has not been sufficiently profitable to encourage the extension of the line. From this desert to Brisbane in the far northeast, there is consequently continuous rail connection for some 3,000 miles. What the future may bring to this great undeveloped land of possibilities hardly realized can not be predicted, but it is certain that Australian energy will not fail to multiply railway lines as fast as industry would be profited thereby. The three northern continents are crossed by railway lines. The three of the south are yet to be traversed.



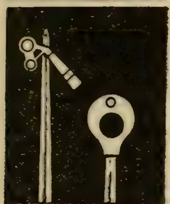
INTERIOR OF A RAILWAY SNOWSHED IN THE MOUNTAINS.



TYPICAL RUSSIAN LOCOMOTIVE IN URAL MOUNTAINS.

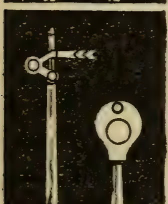


Home signals showing "Stop."



Home signals showing "Clear" or "Proceed."

Distant signals showing "Clear" or "Proceed."



Distant signals showing "Proceed" with caution to next signal.

Signals showing two blocks in advance are "Clear."

Home and distant signals showing "Stop."

Home signal showing "Clear" or "Proceed" but distant signal, showing second block in advance occupied and to be approached with caution.

ELECTRIC BLOCK SIGNALS.

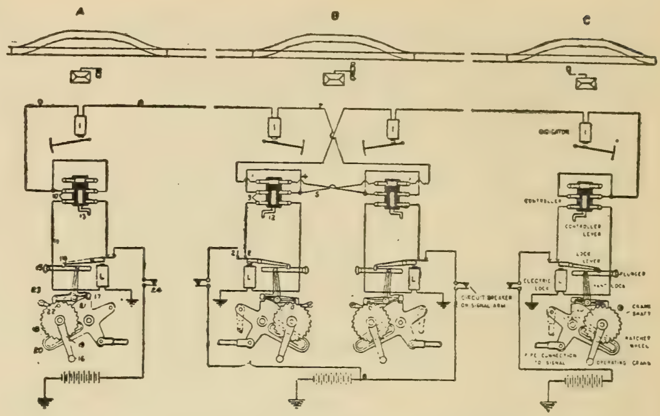
It is the aim of every railway operator to reduce, or abolish entirely, the risk of accidents, especially those caused by train collisions. One of the latest devices introduced for this purpose is an electric block signal system by which it is made practically impossible for a train to leave a station unless the track ahead of it is clear, provided, of course, that the engineer obeys orders. ''Popular Electricity'' describes the new system as follows:

Fig. 1 shows diagrammatically, a typical layout and wiring between block stations. (A), (B) and (C) represent the three block stations on a single track road, and all trains approaching or entering the blocks (AB) and (BC) are governed by the train order signals in front of each of the stations.

Supposing a train wishes to move from (A) to (B); the operator at (A) must ask the operator at (B), by means of the bell code, to unlock his machine so that he (A) can turn his signal to ''proceed'' position.

No train being in the block and the opposing signal at (B) being at ''stop,'' the operator at (B) so manipulates his unlocking key as to close an electric circuit from a battery at (B) through the interlocking key, held in its proper position, and the coils of an electromagnet at (A). This action releases a hand lock, which is moved to unlock the signal crank, allowing the operator at (A) to clear his signal. After the train has entered the block and has been so reported, the signalman at (A) must return his signal to the danger position. In doing so the lock on the operating crank is forced home, thereby compelling the operator to obtain another release in order to again clear the signal.

The positions of the various signals as interpreting the condition of the track, and the automatic orders given by them to the engineers, are shown in Fig. 2. On the left-hand end of the movable cross arms are red and green lights so the position of the cross arms may be seen at night just as readily as in the day time.



METHOD OF WIRING BETWEEN BLOCK STATIONS.

For allowing the operators to communicate with each other, a bell code is generally installed between block stations, operators conveying information by pressing a push button a prescribed number of times, which rings an electric bell a like number of times. This is a very simple circuit, and generally installed independent of the station instrument circuits.

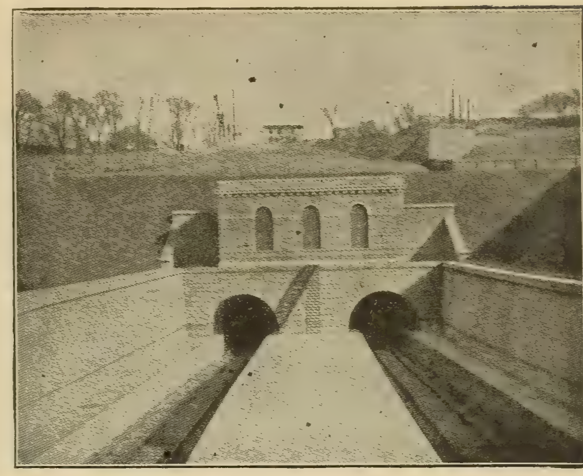
CHICAGO & NORTHWESTERN DEPOT.

One of the monster new railway stations of the world is that erected in Chicago in 1910, by the Chicago & Northwestern Railway Co. It stands facing Madison street, between Canal and Clinton, has a frontage of one entire city block, and is four blocks in depth (13 acres in all), running from Madison to Kinzie streets, the intervening streets being crossed by viaducts. The cost of the structure is placed by the railway officials at $20,000,000. It has a capacity of 1500 trains a day. All trains enter and leave the terminal on elevated tracks. Every conceivable comfort and convenience to meet the wants of 250,000 people daily has been provided, including restaurants, stores, bath-rooms, rest-rooms,

FIRST ALL-STEEL CAR TRAIN IN OPERATION.
The newest invention in railroading—will not break to pieces and cannot take fire.

and similar features in addition to those ordinarily found in modern railway depots.

In 1906 the Pennsylvania railroad eastern terminus was at Jersey City. In that year the trains of this company landed 140,000,000 people in Jersey City, virtually all of whom were carried across the Hudson river by ferry boats to New York. In September, 1910, the company opened a mammoth station located in the central part of New York City, and began to move its trains through tunnels constructed under the Hudson river, Manhattan island, and the East river. By the use of this tunnel system passengers, instead of being ferried across the Hudson river, are landed in the New York station, while those bound for points on Long Island may continue on through the tunnel under the East river. The new station building is 740 feet long, 430 feet wide, and of an average height of 69 feet, the maximum being 153 feet. The tunnel system, which is 5.3 miles in length, consists of four separate bores or tubes through which the trains pass. This monster work, begun in 1903, was all com-



TWO OF THE NEW JERSEY ENTRANCES TO PENNSYLVANIA TUNNEL UNDER HUDSON RIVER.

MONSTER NEW STATION OF PENNSYLVANIA RAILWAY IN NEW YORK.
This picture shows only one-third of length of structure.

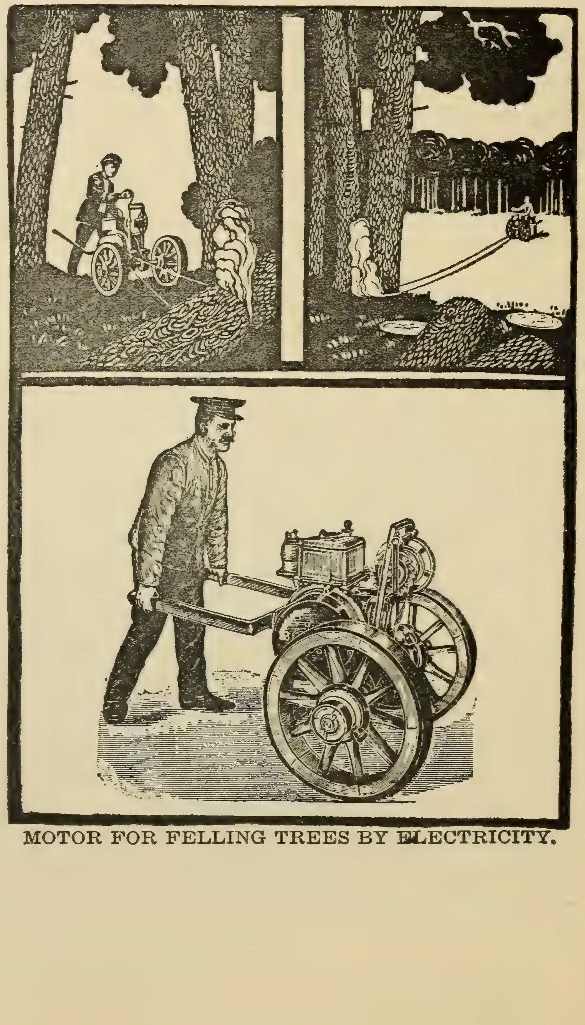
pleted and in use on September 8th, 1910. No official figures as to the cost of the tunnels and station are obtainable, but the outlay represents an investment of many millions of dollars.

TREE CUTTING BY ELECTRICITY.

Hugo Gantke, a German manufacturer, has presented a new method of felling trees which promises to supersede the old methods of chopping and sawing. As described in "Popular Electricity" Gantke uses a fine steel wire which is wrapped partly around the stem and is pulled back and forth by cables attached to an electric motor-driven drum. The friction of the wire which is moved to and fro 1,500 times per minute, heats it red hot so that it literally burns its way through the trunk in half the time it would take two men to saw down the tree. In doing so, the heat carbonizes the severed ends, leaving them protected against easy rotting in case they are left on the ground for some time. If the tree is to fall in a certain direction, this can be insured by notching the trunk with an axe. However, time is usually saved by simply placing the motor at a safe distance (100 to 150 feet) and letting the tree fall wherever it will. A new steel wire is used for each cut, the cost in Germany ranging from one-fifth to one-half cent each, according to the length and nature of the wood, which is less than the cost of filing and setting saws or of sharpening axes for the same work. Besides, the cutting can be done flush with the soil, or as much below ground as the root structure will permit, thereby saving the work of grubbing in many cases.

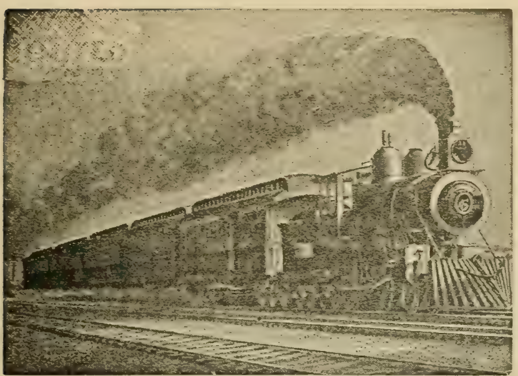
The motor equipment is mounted on a two wheeled cart and as it weighs only 570 pounds, it can easily be managed by one man even for trees measuring as much as ten feet in diameter.

Where no source of electric current is available close to the forest, it can be supplied by a portable gasolene and dynamo outfit from which the current is led to the sawing motor by a flexible cable.



MOTOR FOR FELLING TREES BY ELECTRICITY.

GREAT RAILWAY CONSOLIDATIONS



ACROSS THE CONTINENT.

One of the most noteworthy conditions of the present day is the tendency toward enormous consolidations of American railway lines in the control of a few individuals. Within the limits of the United States we have approximately 200,000 miles of railroads, and practically half that stupendous property is in the possession of five little groups of men, who direct it from their offices in New York.

It has taken less than seventy-five years for the railway systems of the United States to grow from that first inadequate little wooden track with its lonesome locomotive of 1829 to this mileage which is sufficient to make a single track extending eight times around the world. The increase of railway mileage in the United States at this time is nearly twelve miles a day. For every five miles of railway in the country there are twenty-five men at work, one locomotive, and eight cars. The number of railway employees increases at the rate of 240 new men every day. These American railways carry more freight than all the ships of all the oceans of the world, added to one-half the traffic of the European railways. One-fifteenth of all the labor in the United States derives its support directly or indirectly out of the railway industries. When we add to these facts the recollection that the success of almost every great American industry depends upon the railways in some way or other, whether it be manufacturing, commerce, or farming, it becomes apparent what vast importance railway problems have to all of us and to the prosperity of the country at large.

There is nothing new about the tendency toward consolidation of railway lines, except the rapidity and the magnitude of the recent achievements in that line. From the day when railways first began to be constructed smaller lines have been combined to establish greater ones, with the invariable result of improved service, and, at the same time, opposition to the combination. Half a century ago passengers had to change eight times between Albany and New York, and as many more between Albany and Buffalo, even though there were railways connecting through the entire distances. And yet the consolidation of these little lines, which now seem almost ridiculous to us, met with distinct opposition, both popular and legislative, when the first moves were made, just as is the case now in regard to the greater consolidations of today.

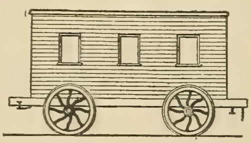
It seems fair to say that there is no essential evil in consolidation of railway systems as a principle. Such consolidations manifestly make for economy of administration and for convenience and harmony of service in the connecting lines.

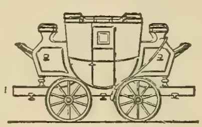
These things and the reduced rates which should naturally follow are all to the public benefit. As a matter of fact, except for short periods and in specific instances, there has never been but little real competition between railway systems. They might compete in quality of service, but clandestine pools have usually protected them from the cost of a fight among themselves.

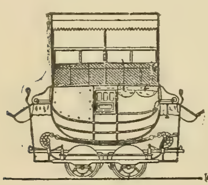
The real question, therefore, that comes from Americans in connection with the railway consolidation is whether the benefits of such union are enjoyed by the public, or are to be retained entirely as the sources of increasing wealth and power in the hands of the controlling syndicates. In the latter case it would seem as if the syndicate managers were preparing for the inevitable result of public ownership. In the former case the public may rest as contented with the present relations as it has been in the past.

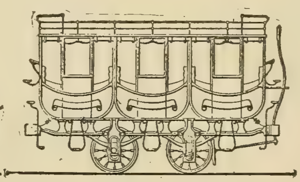
Five great syndicate interests, dominated in each case by one or two conspicuous men, control the five most important groups of railways in the United States. In addition to these, there are certain important independent lines, still outside of syndicate control, which are continually the subject of speculative rumor as to how or when they shall be absorbed.

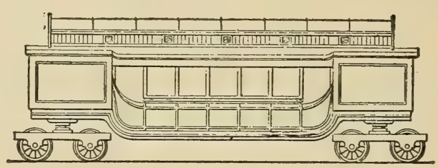
The most conspicuous of these groups, headed by the men who are today the most conspicuous, is the Morgan-Hill system, headed by J. Pierpont Morgan, the New York banker,

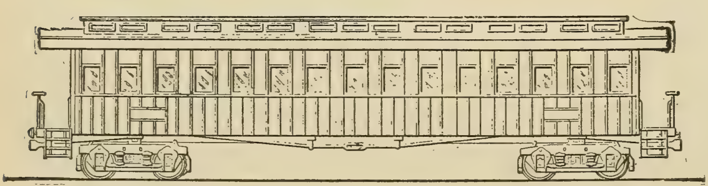

1825—First English Car on Record.

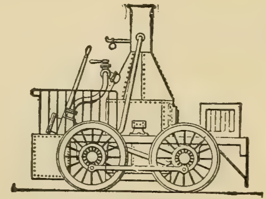

1829—Coach Body Car, the "Experiment." Stockton and Darlington R.R., England.

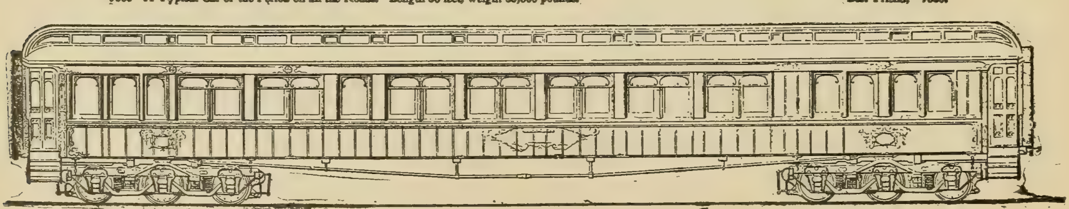

1830—The "Ohio," a Double Deck Coach Body Car, designed by Mr. Imlay for Baltimore & Ohio R.R.


1831—A Triple Body Car on the Camden & Amboy R.R., designed by Mr. Green. Drawn by horses and the "John Bull."


1836—The "Victory," also by Mr. Imlay. First car with raised roof. First car having toilet compartment and bar.


1865—A Typical Car of the Period on all the Roads. Length 50 feet, weight 35,000 pounds.


"Best Friend," 1830.


Late Sleeping Car. Length 72 feet, weight 100,000 pounds.

PICTORIAL HISTORY OF CAR BUILDING.

and James J. Hill of St. Paul, the northwestern railway magnate. The mileage which this combination controls measures a total of 37,500 miles, including two transcontinental lines from St. Paul to the Pacific coast, by the famous "merger" that brought on the attack made by the governors of the northwestern states and by the president of the United States in the federal courts to determine the validity of such union. The roads included in this system are the Northern Pacific, the Great Northern, the Chicago, Burlington and Quincy, the Erie, the Lehigh Valley, the Philadelphia and Reading, the Hocking Valley, the Southern Railway, and the Mobile and Ohio.

None of the other groups approaches this one in mileage, although in importance, wealth and profits they may not fall behind. The Vanderbilt system has a total of some 20,000 miles, including all of the New York Central lines, the Lake Shore and Michigan Southern, the Michigan Central, the Chicago and Northwestern, and the Big Four, with a host of tributaries, thus including three distinct lines between New York and Chicago.

The Pennsylvania system, with mileage approaching 15,000, now includes the Baltimore and Ohio, in addition to all of the lines formerly identified with the Pennsylvania, including the Fort Wayne, the Vandalia, and the Panhandle.

RAPID TRANSIT IN A GREAT CITY.
The Manhattan Elevated Railway in Upper New York. Height above ground nearly 100 feet.

The Gould-Rockefeller system, in which the Sage interests are also involved, includes the Missouri Pacific, the Wabash, the Iron Mountain, the Texas and Pacific, the Missouri, Kansas and Texas, and the Denver and Rio Grande, with a total mileage of nearly 17,000.

The Harriman-Kuhn-Loeb system, with

a mileage of 22,000, includes the Union Pacific, the Southern Pacific, the Oregon Short Line, the Chicago and Alton, the Illinois Central, and the Kansas City Southern. In addition to these syndicate systems of railways there still remain, as has been said, a number of independent systems with a total mileage of some 37,000, of which the Santa Fe, the Rock Island and the Chicago, Milwaukee and St. Paul are the most important. It is more than possible that several of these, particularly those of the southeastern states, will find a final refuge in the Morgan-Hill system or in some other syndicate organized for the purpose.

Says a recent student of this picturesque situation: "A strip of land hundreds of miles wide, beginning at the Washington ports in the northwest and sweeping east to the lakes, is practically an industrial fief of Mr. Hill and Mr. Morgan. In Mr. Harriman's hands, in some measure, is the prosperity of California and the southwestern states, as well as of a broad strip up the Mississippi Valley, a fertile band through the prairie states, and all the habitable land reaching west from the Rockies to the coast. The central Atlantic states live to the rhythm of the New York Central and the Pennsylvania Railroad. It is true that one can go from Boston to San Francisco, from the Gulf to St. Paul, and travel not a mile on the roads of the railroad giants, but only through a very narrow path and for the most part within view of competing syndicate lines on either side. When it is remembered, furthermore, that Morgan men are directors in Vanderbilt roads, Hill men in Pennsylvania roads, Gould men in Harriman roads, and that every other possible interweaving of common control exists throughout the great groups, the lines of demarkation melt away."

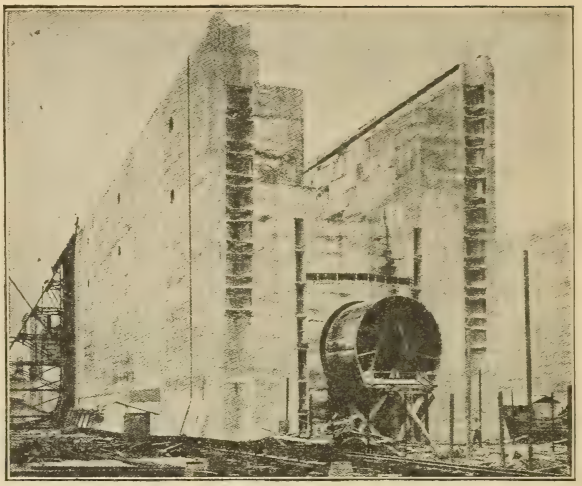
And yet, within twenty years, the average rate of freight has decreased from a cent and a quarter a ton for each mile to a little over seven mills, and the tonnage has quadrupled. The passenger rate has likewise gone down, and passenger traffic is growing 15,000,000 a year. With all these picturesque conditions in effect the situation becomes a puzzling one, and it will be of the highest interest to watch the course of events for the next few years. Whether or not we are to return to a system of individual competitive roads, whether railways will be a private monopoly or a government monopoly, can only be known after the period of adjustment has passed and the public has taken its own hand in the settlement of the proposition.

BUILDING OF THE GREAT PANAMA CANAL

As a preliminary to the construction of the Panama canal, connecting the waters of the Atlantic and Pacific oceans, the United States government in 1902 bought for $40,000,000 the rights of the French company which held a franchise for the work, but which had virtually abandoned operations. In 1904 it acquired from the Panama republic control over a strip of country, reaching from Colon on the Atlantic coast, to Panama, on the Pacific, and averaging about 10 miles in width. This strip, which cost the United States $10,000,000, is known as the Canal Zone. Within its limits the Americans are in control, administering the laws and exercising undisputed police powers.

When completed the canal will be about 50 miles in length, counting the deep water entrances at each end. The actual length

MAMMOTH CUT AT CULEBRA. GREATEST EXCAVATION ON PANAMA CANAL.



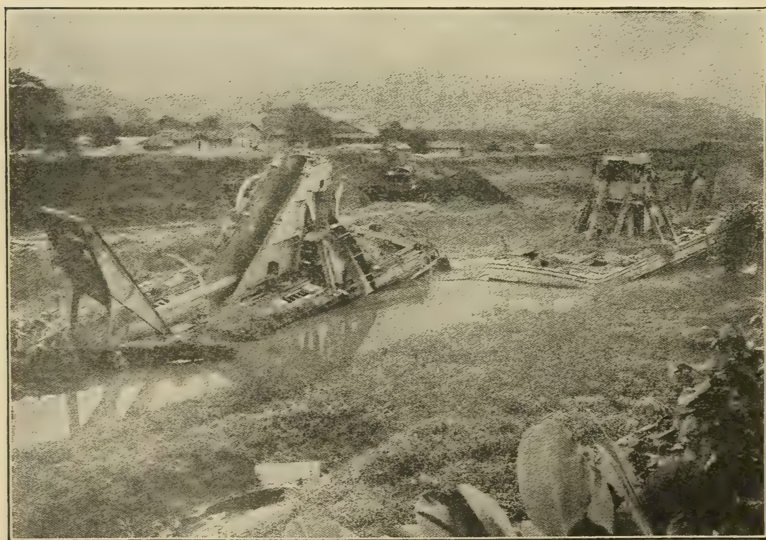
SOLID CONSTRUCTION OF GATUN LOCKS.

of the canal proper is 40½ miles. In bottom width the canal varies, the minimum being 300 feet at the Culebra cut and the Pedro Miguel lock, and the maximum 1,000 feet from the south end of the Gatun locks to mile 23.50, a distance of about 16 miles. The minimum depth is 41 feet. The extreme width of 1,000 feet is occasioned by the utilization of the River Chagres and Gatun Lake as a part of the route.

The purpose in the construction of this gigantic waterway is to afford a short cut for ocean commerce between the Atlantic and Pacific, doing away with the long, expensive journey via Cape Horn, or through the Straits of Magellan, just as the Suez Canal shortens the ocean route to India by eliminating the passage around the Cape of Good Hope.

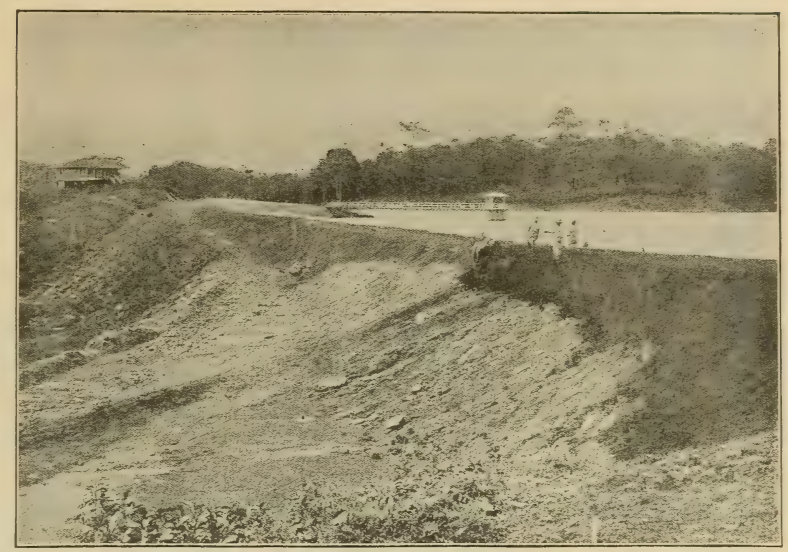
Since the actual work of construction was earnestly begun in 1904, a total of 123,958,967 cubic yards of earth and rock had been excavated up to December 1st, 1910, of which 31,608,242 cubic yards were taken out in the year ending on the last-mentioned date. Government engineers estimate that there remains 58,578,799 cubic yards to be excavated, and that the entire work will be done, and the canal ready for operation by January 1st, 1915.

The work to date (December 1st, 1910) has cost $255,093,269.32. When completed the total cost will be $325,201,000, which includes $20,053,000 for sanitation, and $7,382,000 for administrative expenses. These figures represent the cost of construction. To them should be added the $40,000,000 paid to the French company, and $10,000,000 paid to the Republic of Panama, making the grand total approximately $375,000,000.



COSTLY DREDGES ABANDONED BY THE FRENCH ON THE PANAMA CANAL.

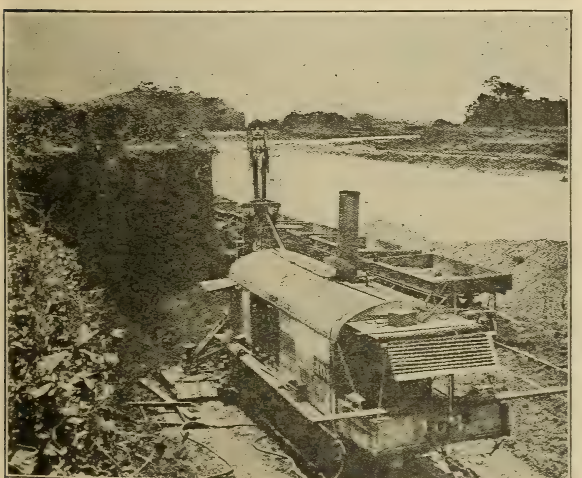
There are two great engineering works of unusual interest in connection with the construction of the canal. One is the Gatun dam and locks at the Atlantic end; the other is the Culebra cut, between Bas Obispo and Pedro Miguel. The main part of the canal will be 85 feet above sea level, and to reach this from the Atlantic end a monster dam, and a series of these locks have been constructed. The crest of the dam is 9,045 feet long, and 1,900 feet wide. It is 115 feet above sea level. It is estimated that about 2,300,000 cubic yards of concrete will be required in the locks and spillway.



AGUA CLARA RESERVOIR AT GATUN, PANAMA.

The Culebra section runs through a formidable hill or mountain of earth and rock formation. In order to get this part of the canal down to the 85 foot level it has been necessary to excavate 84,186,724 cubic yards of material. Of this, 49,293,193 cubic yards had been taken out on June 30th, 1910, leaving 34,893,531 yet to be removed at that date.

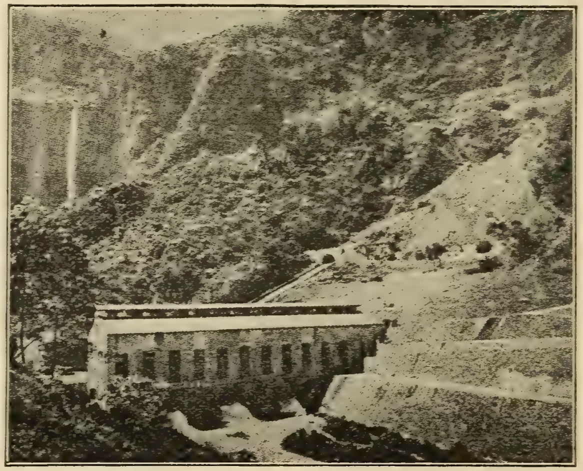
The average cost of dredging, including general administration expenses, has been: Atlantic division, 28.31 cents per cubic yard; Central division (including the Culebra cut), 68.34 cents per cubic yard; Pacific division, 31.74 cents per cubic yard.



EXCAVATION AT EAST MAMEI, PANAMA CANAL.

In the month of October, 1910, there were approximately 45,000 employes on the Isthmus on the pay rolls of the Commission and of the Panama railroad, about 5,000 of whom are Americans. There were actually at work on November 30th, 1910, 36,650 men, 29,690 for the Commission, and 5,960 for the Panama railroad company. Of this vast army the skilled labor is from the United States, while the laborers are mostly natives. The extreme heat, the malaria and the mosquitoes, make it an unhealthy place for northern laborers. Of the 29,690 men working for the Commission, 4,646 were on the gold pay roll, which comprises those paid in the United States currency, and 25,044 men on the silver pay roll, which comprises those paid on the basis of Panama currency or its equivalent. Those on the gold pay roll include mechanics, skilled artisans of all classes, clerks and higher officials, most of whom are Americans; those on the silver pay roll include principally the common laborers who are practically all foreigners. Of the 5,960 Panama railroad employees, 830 were on the gold pay roll.

In his message to Congress, delivered December 5, 1910, President Taft advocated the fortification of the canal so as to enable the United States to defend it in case of war. Foreign nations oppose fortification but, as the work is entirely an American one, it is probable that provision will be made by this country for its defense.



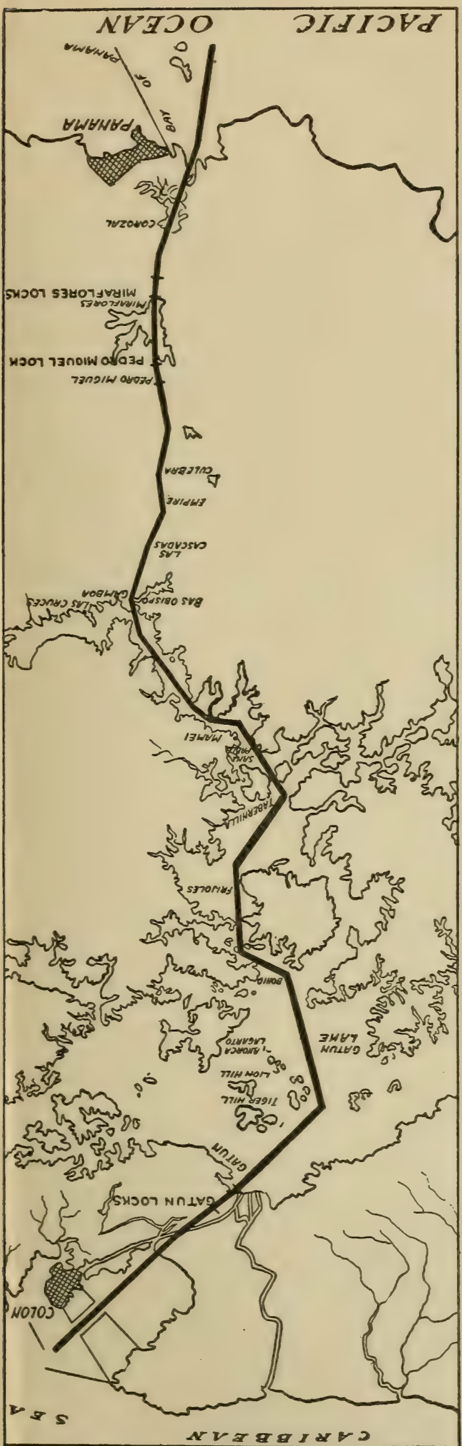
POWER HOUSE OF NECAXA SYSTEM.

LARGEST OF POWER PLANTS.

One of the largest power plants in the world—if not the largest—is located at Necaxa, Mexico, ninety-six miles northeast of the City of Mexico. Here, in the rugged mountains, and against seemingly impregnable obstacles, modern engineering experts have constructed a power plant producing 250,000 horsepower of energy. The waters of the Necaxa river are held in check and a reservoir of 50,000,000 cubic feet capacity, formed by a stone and concrete dam 1,300 feet wide and 194 feet high. From the level of this reservoir the water is conducted through monster pipes, or penstocks, to the power house 1,400 feet below the level of the dam.

In this power house three 7-foot streams of water, given terrific force by their mad downward rush of 1,400 feet, operate immense dynamos which generate the 250,000 h. p. of electrical energy already referred to. This energy is carried, in the form of a 60,000 volt current, through big copper cables, to Mexico City.

In this latter city, 95 miles away from the plant, the power thus supplied furnishes practically all the motive force required in a community of 500,000 people. It runs all the electric lights, the various trolley lines, operates elevators, and machinery in general. But this does not begin to exhaust the power supply of the Necaxa plant, and a large amount of energy is furnished to operate heavy mining machinery in the mining camps of El Oro and Pachuca. As has been true of many other large power projects, the demand for power from this plant has grown faster than the plant could be enlarged. The construction has occupied seven very busy years and is not yet completed, though enough power is now being developed to supply all the needs of a population of more than half a million. At



OFFICIAL MAP OF PANAMA CANAL SHOWING GATUN LOCKS AND CULEBRA CUT

first it was planned to develop 50,000 horsepower but it was soon seen that this would be inadequate. Before the original power house was completed it was necessary to change the plans and provide for one much larger than was originally intended. Now it furnishes 250,000 horsepower, and the engineers have a plan whereby the capacity may be duplicated by the establishment of another power plant further down the mountain side where water which has once turned the turbines will be made to do duty over again in a similar capacity.

BUSIEST CANAL IN THE WORLD.

Another canal of great importance from the commercial viewpoint is the Sault Ste. Marie, which connects the waters of Lakes Superior and Huron. It affords a safe passage for vessels around the St. Mary's falls. Official records show that seven times as much freight goes through the Sault Ste. Marie canal in six months, almost exclusively American tonnage, as the entire world sends through the Suez Canal in a year. This freight consists principally of iron ore, coal and grain. Of iron ore alone 39,594,944 tons have been taken through the Sault Ste. Marie canal in one season of six months, many of the vessels carrying cargoes of 10,000 tons each. This means a saving of $160,000,000 in freight tolls. During the same time 93,135,775 bushels of wheat were transported, the freight saving being $6,250,000. At a conservative estimate 80,000,000 tons of freight pass through the canal every six months. Loaded in 30-ton cars this would require 2,666,666 cars, the combined length of which would reach around the world. To haul these cars in trains of forty cars each would take 66,666 powerful mogul locomotives, and entail the services of not less than 330,000 train men.

A "WHALEBACK" IN THE GREAT CANAL LOCK AT SAULT STE. MARIE, MICH.

LAKES-TO-THE-GULF WATERWAY.

As a forerunner to a deep waterway connecting the great lakes with the Gulf of Mexico, the people of Chicago have constructed a drainage canal from that city to Lockport, near Joliet, Ill., a distance of 28.05 miles. The maximum dimensions of this work are: Bottom width, 202 feet; top width, 290 feet; depth of water, 22 feet; maximum flow through narrowest channel, 300,000 cubic feet per minute. This great work, which was begun September 3d, 1892, has cost to date (January 1st, 1911) about $60,000,000.

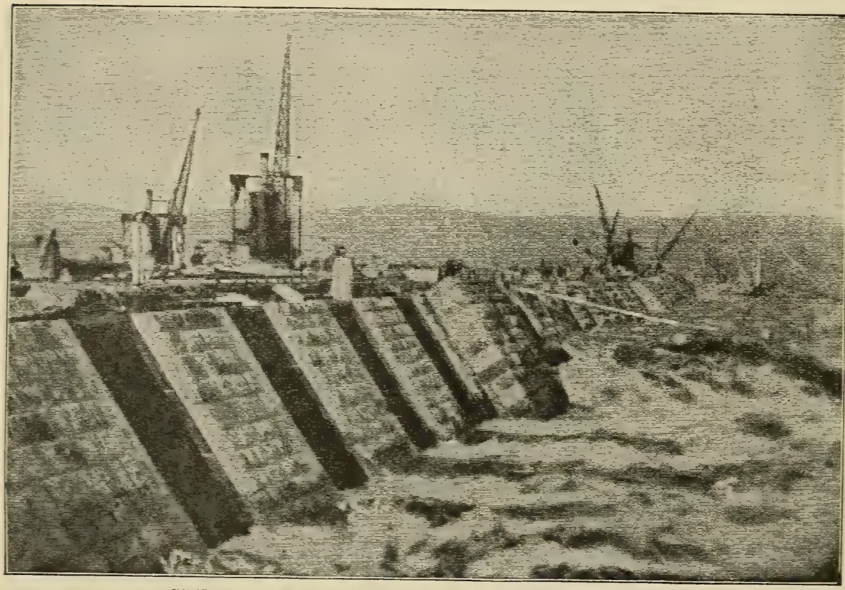
Previous to the construction of the canal, the sewage-laden waters of the Chicago river, carrying the offal and refuse of a city of 2,000,000 people, emptied directly into Lake Michigan, from which all the drinking water for the city is obtained. The drainage canal reverses the flow of the river, and sends the sewage-laden waters southwestward, via the Desplaines and Illinois rivers, to the Mississippi.

It has been the hope of the projectors of the drainage canal, and they are still working hard to this end, to make it the starting link in a great lakes-to-the-gulf waterway. It is urged that by use of the new canal and improvements in the Desplaines, Illinois and Mississippi rivers, it will be possible to send vessels of large size direct from Chicago to all the ports of the world and avoid the present expensive transfer of cargoes. With this object in view the canal has been so constructed that comparatively slight changes will make it capable of caring for a flow of 600,000

DAM AT LOCKPORT, ON THE CHICAGO DRAINAGE CANAL.

cubic feet of water per minute. It is estimated that $27,000,000 will complete the work from the end of the present drainage canal to St. Louis, a distance of 328 miles. This amount the Federal government is asked to appropriate. It is claimed that the investment of this amount would be justified by the amount of commerce between Chicago and St. Louis alone, leaving out of question the tonnage to and from the world's ports via the Gulf of Mexico. Now that the Panama Canal is well on the way to completion, it is argued that the construction of a lakes-to-the-gulf waterway would result in an immense saving to the American people in shipments to and from Oriental ports.

All of the $60,000,000 invested in the construction of the Chicago drainage canal has been raised by the taxation of property in a district containing 185 square miles, 142 of which are within the limits of the city. The tax rate is one-half of one per cent annually, although for the five years from 1895 to 1899 provision was made for a special rate of 1½ per cent. On this showing argument is made that the raising of the $27,000,000 or $30,000,000 needed to complete the work by the Federal government would not be felt by the people of the country at large, and that the investment would be a profitable one, direct benefits being obtained in the lower freight rates which consumers would pay.



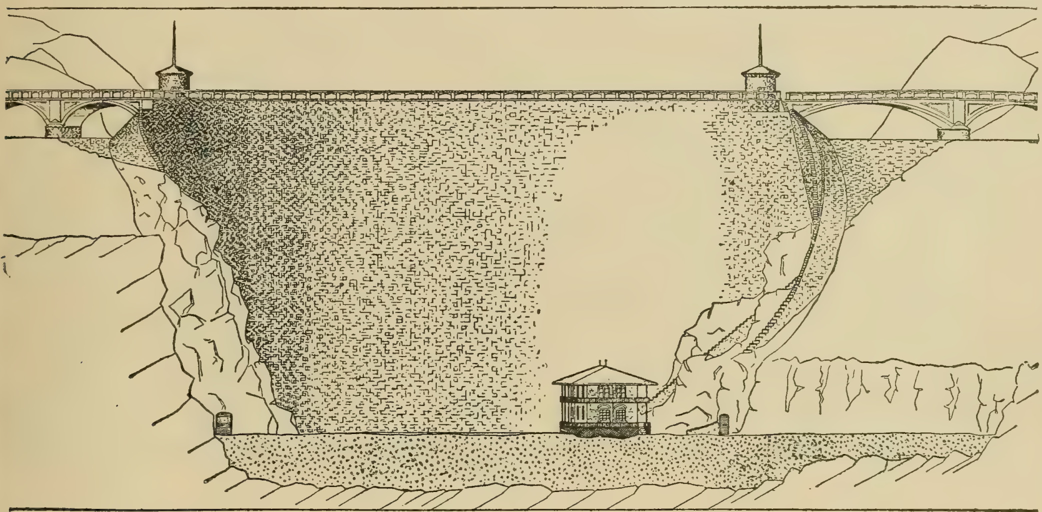
GREAT DAM ACROSS THE NILE—UPPER EGYPT.

MAKING A NEW RIVER BED.

Until recently Lime Kiln Crossing, in the lower Detroit river, has been known as the "Hell Gate of the Lakes." It has always been a serious menace to navigation because of the numerous submerged rocks, many of them coming within two feet of the surface. The United States government has expended millions of dollars in efforts to blast away these rocks, but as fast as the course was deepened the size of vessels was increased, so the danger of running on the submerged rocks remained as great as ever. C. H. Locher, a contractor, is now at work on a project which promises to do away with the difficulty. This has involved the construction of an immense coffer dam, the pumping dry of the river for a distance of eight miles, and the removal of the rock bed for depths varying from 8 to 20 feet. The total cost of the work will be $8,000,000, but a safe waterway will be provided for vessels of 24-foot draft.

MOVING TWO MILES OF RIVER.

Picking up a two-mile section of a river of fair size and moving it bodily to a new location half a mile distant, may appear to be an impossible feat. It has been accomplished, however, in the case of the Grand Calumet river, at the new steel manufacturing town of Gary, Ind. The United States Steel Corporation wanted to erect a plant on a certain tract of land, but the river was in the way. So the company's engineers simply moved the river out of the way by diverting two miles of it to a new channel half a mile distant, at a cost of about $500,000.



ELEVATION OF SALT RIVER DAM—HIGHEST IN THE WORLD.

LARGEST DAM IN THE WORLD.

In connection with the Salt River (Arizona) irrigation project, Uncle Sam has built the largest dam in the world. It is a mass of masonry 270 feet high from foundation to parapet, and contains 300,000 cubic yards of rock work. It impounds more than a million acre-feet of water, enough to cover one million acres with water one foot deep. The water forms a lake 25 miles long, and from one to two miles wide. The work cost between $3,000,000 and $4,000,000. The masonry is 165 feet thick at the bottom of the dam, and 16 feet at the top. In order to divert the waters of Salt River while the dam was being constructed a tunnel 500 feet long was cut through the solid rock on one side of the canyon. The country in the immediate vicinity of the dam is so rough that a seven-mile wagon road which had to be built in order to get supplies in, cost $25,000 a mile, which is about as much as first-class railway construction costs for grading, rails, track laying, culverts, etc.

THE "ONE-RAIL" RAILWAY

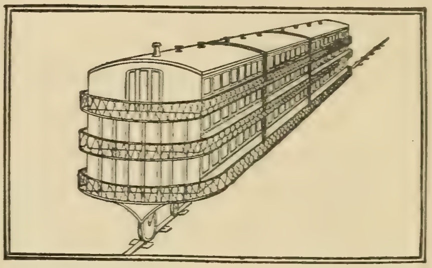
Louis Brennan, an English inventor, astounded the scientific experts a short time ago, with his demonstration before the Royal Society. Brennan is no ordinary dreamer, for the British government paid him $550,000 for his patent torpedo, and is now spending $25,000 building a monorail car 12 ft. wide, under the direction of the war department. Indeed the inventor predicts the railway car of the future will be several times as wide as now, and two or three stories high. It will travel upon a single rail, and cross rivers on a single steel cable if conditions do not favor the use of piles or piers. The propelling power may be steam, electricity or gasoline. If Brennan's expectations are realized his system will revolutionize the operation of railways throughout the world.

Monorail systems are not new, but heretofore the cars have either been suspended, or held in poise by guide wheels on each side of the carrying rail.

The secret of the Brennan system is the use of a gyroscope within each car. He has studied this mysterious piece of mechanism for 30 years and is said to be one of only three men in the world who really understand it. He says:

"The characteristic feature of the system of transportation is that each vehicle is capable of maintaining its balance upon an ordinary rail laid upon ties on the ground, whether it be standing still or moving in either direction at any rate of speed, notwithstanding the center of gravity is several feet above the rail and the wind pressure, a shifting load, centrifugal action, or any combination of these forces may tend to upset it.

"Automatic stability mechanism of extreme simplicity, carried by the vehicle itself, endows it with this power. The mechanism consists essentially of two flywheels rotated directly by electric motors in opposite directions at a high velocity, mounted so that by their gyrostatic action their stored up energy can be utilized. These flywheels mounted on high-class bearings are placed in air exhausted cases, so both air and journal friction is reduced to a minimum, consequently the power required to keep them in rapid motion is extremely small.



CAR OF THE FUTURE. THREE STORIES HIGH. MONO-RAIL. (ONE-RAIL SYSTEM.)

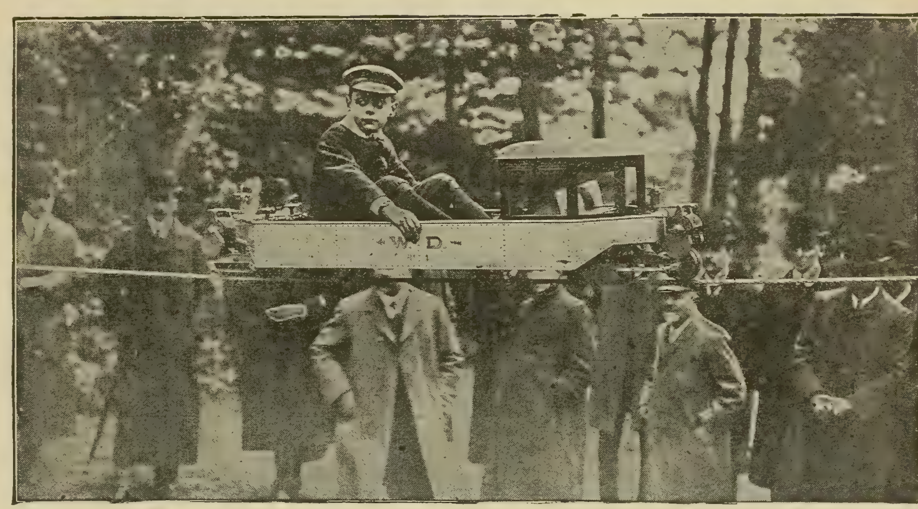
"The wheels are placed in a single row beneath the center of the car and are carried on bogies or compound bogies, which are not only pivoted to provide for horizontal curves in the track but for vertical ones also. By this means the cars can run upon curves even of less radius than the length of the vehicle itself, or on crooked rails, or on rails laid over uneven ground without danger of derailment.

"The motive power may be either steam, petrol, oil, gas, or electricity. I use petrol (gasoline) and an electric generating set carried by the vehicle itself to supply the current to the motor's stability mechanism.

"Everything points to a great economy resulting from making the cars wider in proportion to their length than on ordinary railways. Therefore it has been decided to make an experimental coach 12 ft. wide. Brakes capable of being operated by pneumatic or manual power are provided for all wheels.

"The rail only requires to be of the same weight as one of the rails of an ordinary line in order to carry the same load on the same number of wheels in each case. The ties also only require to be one-half the usual length.

"The bridges would be of the simplest possible construction, a single wire hawser stretched across a ravine or river being all that is necessary for temporary work. Strange to say, the lateral swaying of the hawser does not disturb the balance of the cars, and the strongest winds will fail to blow them off. In other cases for bridge building a single row of piles with the rail on top suffices, or a single girder carrying the rail may be conveniently used.



BRENNAN'S MONO-RAIL—SIX-FOOT MODEL OPERATED ON IRON HAWSER.

"The speed can be from twice to thrice that of ordinary railways, owing to the smoothness in running and the total absence of lateral oscillation."

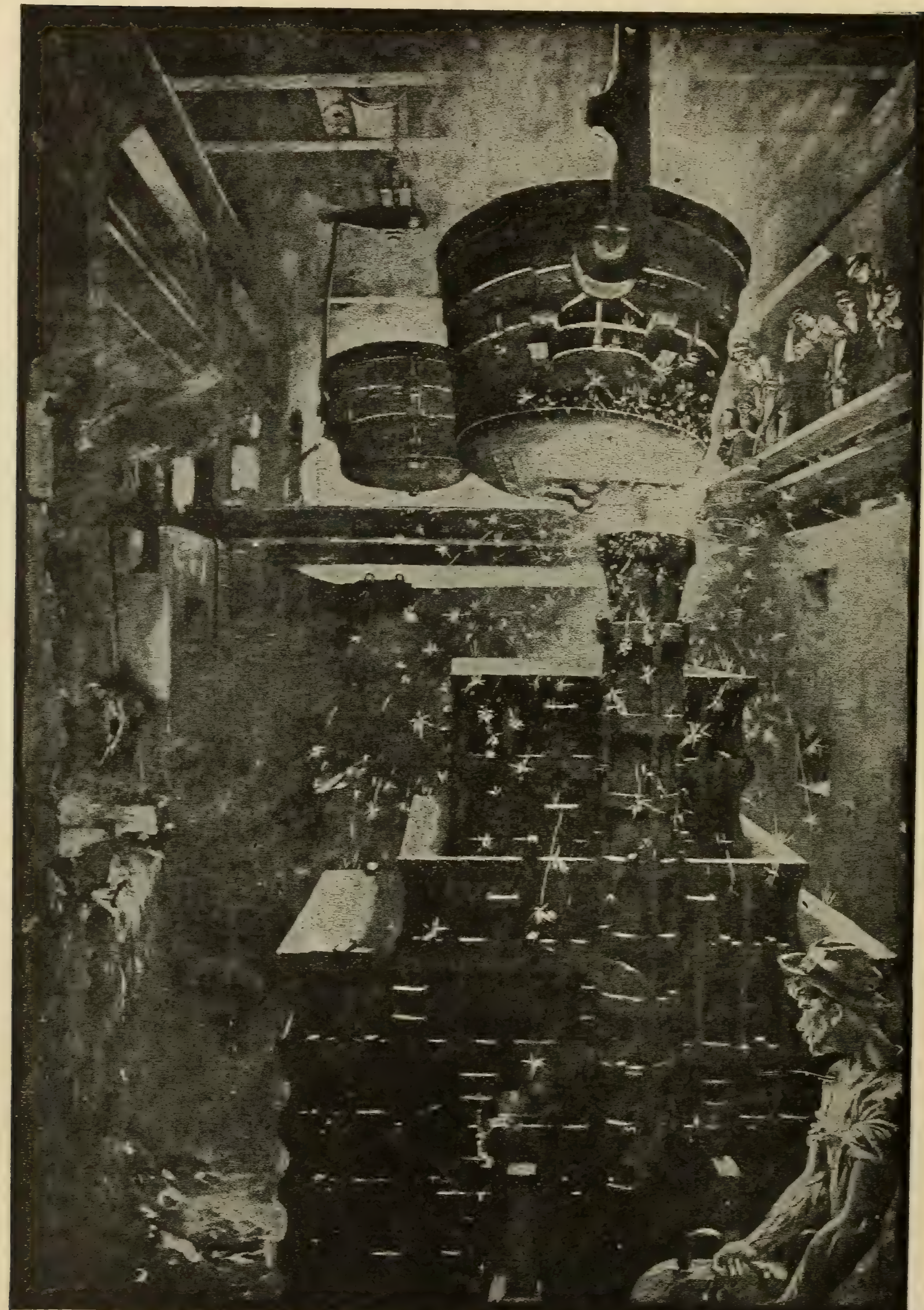
Sir Hiram Maxim, while admitting the success of the demonstration, pronounced the apparatus "a highly scientific toy," but does not believe the same results will follow when the system is applied to actual practice with standard size cars operating out of doors, and states:

"I think his plan to keep the carriages from tipping by the action of the gyroscope will be beset with a great many difficult problems, so difficult, in fact, as to make the whole scheme absolutely impracticable.

"It is quite safe to say that if Brennan's trains were running east or west and there was a strong wind from the north, the wind would exert considerable force on the train in the same direction, and I think that, under these conditions, the plane of the gyroscope would gradually yield, capsizing the train.

On the other hand Brennan operated his small car with one side greatly overloaded, and claims that in proportion to size of car and its unbalanced load, any wind pressure short of a hurricane would be no more severe test to a car of ordinary size. What can be done under actual working conditions will remain a question until the government makes the test. Until then the subject will continue to be one of absorbing interest to engineers and scientists, some of

In 1910 two mono railroads were in operation, one near London by Mr. Brennan, and the other in Germany.



MAKING A STEEL CASTING.

The molten metal is discharged through an orifice in the great kettle, swung over the molds, and flows in a fiery stream to the place prepared for it.

IRON AND STEEL INDUSTRIES

Steel is the material from which this industrial age builds its marvelous machinery, its great buildings, its railways and its steamships. Steel, it is, upon which our multi-millionaires have built their fortunes, fortunes which excel all wealth in the history of the world. The steel trust, it is, the formation of which has done more than any other single influence to draw the attention of the public at large to the enormous consolidations of capital for the dominance of the industrial world, not alone in America, but all over the globe. So it becomes of prime interest and importance to observe the progress of the industry and its products from the mine to the consumer.

There is a wide distance between the primitive miner and molder of prehistoric times, with his rough furnace, his rude appliances, and the customers of his neighborhood, and the remarkable organization of mines, transportation facilities and manufacturing plants which now unite to form the great iron and steel interests. The United States Steel Corporation, as the trust is officially entitled, with its capital

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ORE DOCKS AT ASHTABULA, OHIO.

of $1,100,000,000, is by far the greatest organization in the world. And yet it does not include by any means all the branches of the industry in America and the foreign fields, in which other great organizations exist. Organized by J. Pierpont Morgan as prime mover, and including such stockholders as Andrew Carnegie, John D. Rockefeller, Marshall Field, and other national characters, the very volume of its capital and the diversity of its interests has made it world-famous. Its president, Charles M. Schwab, has been reputed to receive $1,000,000 a year salary, although it may be doubted whether this information is accurate. The functions of this corporation include the mining of iron, the transportation of it to its own mills of many different kinds and in many locations, and the manufacturing of it into almost every product of iron and steel that is demanded on a large scale, particularly railway rails, structural steel, bridges, armor-plates, tin, sheet steel and tubes. It is readily seen that the ramifications of such an industry become world-wide.

The processes of iron mining, where ore is produced on a large scale, differ materially from those of coal mining or the mining of other metallic ores such as gold, copper, lead or zinc. The most noteworthy iron region of the United States is that around Lake Superior, in which the three states of Michigan, Minnesota and Wisconsin yield more than two-thirds of all the 16,000,000 tons of iron ore produced annually in this country. Michigan alone contributes nearly 6,000,000 tons of the product, and Minnesota follows with nearly 4,500,000 tons. Alabama is the third state in production, yielding more than 2,000,000 tons annually, and then follow in succession Virginia, Pennsylvania, Wisconsin and Tennessee, ranging from 860,000 tons

BIRD'S-EYE VIEW OF A GREAT PENNSYLVANIA STEEL MILL.

down to 535,000 tons. The dozen other states where iron is found commercially do not yield a total product, among them all, of more than 1,000,000 tons. Comparing this product in the United States with that of the world, which amounts to something more than 63,000,000 tons a year, we find that our country produces more than one-fourth the total, and more than its nearest competitor, which is Great Britain, with about 13,000,000 tons. Germany follows closely upon Great Britain, but no other country except Spain even passes the 5,000,000-ton mark.

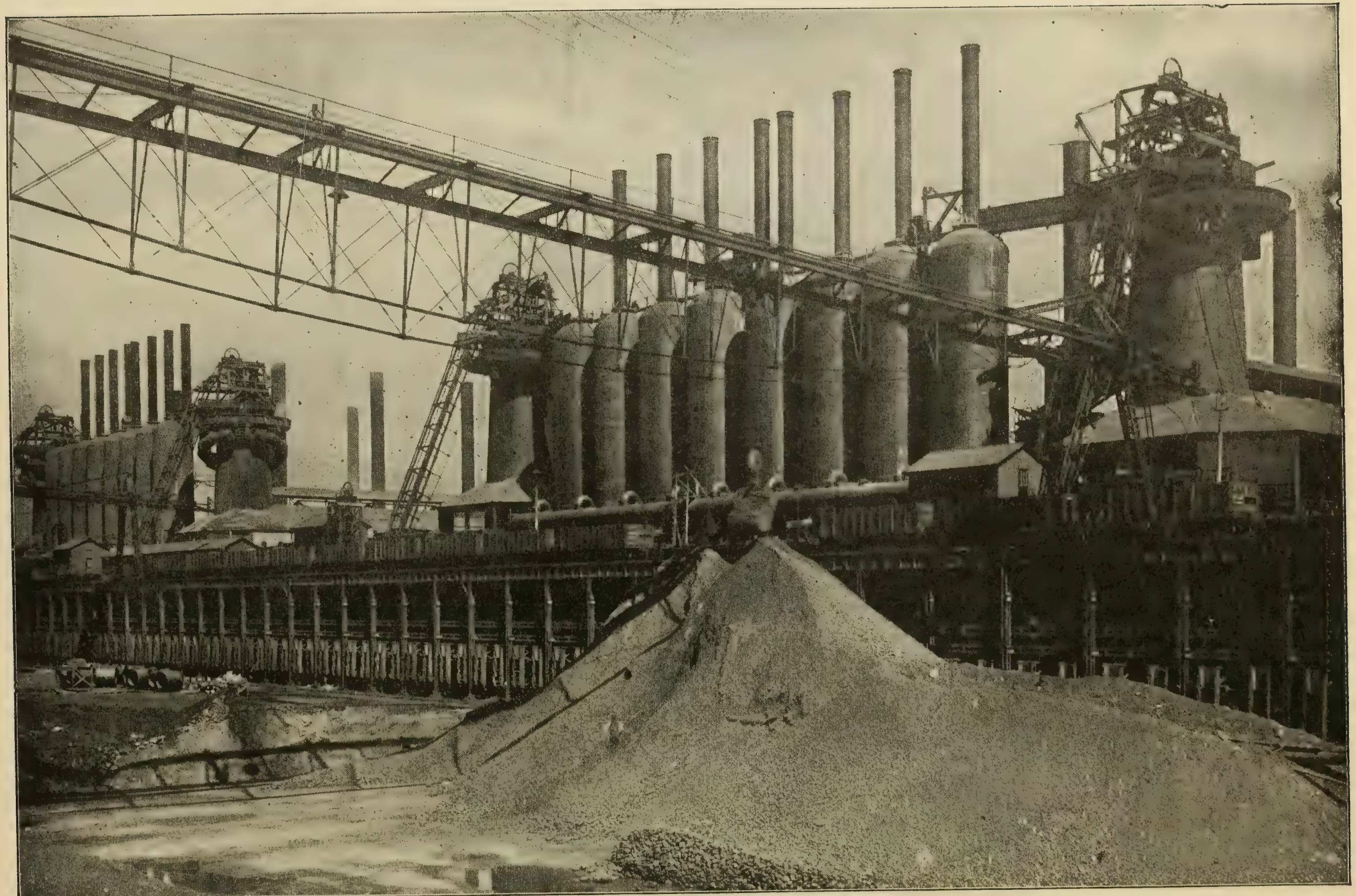
The remarkable iron ranges of the Lake Superior region are peculiarly available because of their proximity to the great lakes, by which the product may be shipped directly and cheaply by large steamers to the manufacturing regions of Ohio and Pennsylvania, where abundant coal is found and where great mills have been built. Three distinct iron ranges in Michigan are recognized, all in the upper peninsula, and trending nearly east and west. These are the Marquette, Menominee and Gogebic ranges. The first shipments of ore from these deposits were made in 1856. Bessemer, Ironwood, Hurley, Republic, Champion, Ishpeming, Negaunee, and other towns in this part of the state and in the edge of Wisconsin have become famous the country over for the remarkable mineral wealth they have yielded. Escanaba, Manistique, Marquette and Ashland are the shipping ports on the great lakes, from which this product is sent.

Two iron ranges in Minnesota, the Vermilion and the Mesaba, lying north of Duluth, furnish the iron from this state. The most important mining points are Ely, Tower, Virginia, Hibbing and Biwabik. Their shipments are made from Duluth and Two Harbors.

Most of the iron ranges of the Lake Superior region can be worked by stripping off the surface deposits and useless vegetable mould, and worthless mineral substances, and then digging the available ore from the open pits. This becomes quarrying rather than mining, as the word is generally understood, but though it may lack some of the more picturesque features of mining operations deep in the earth, it is much more convenient commercially, and makes the cost of the product far less than it would be by way of shafts and tunnels.

The brown ore is carried down to the lakes from the mines in an almost endless succession of trains, and dumped on the ore docks or loaded directly upon vessels waiting for it. Scores of great cargo carriers ply from these ports on the upper lakes down to Lake Erie, carrying their store of Lake Superior iron ore for the Pennsylvania and Ohio furnaces. This single industry employs a very large proportion of the fleets on the great lakes. At the other end of their route they deposit the cargo once more upon the docks of the manufacturing town, or into the railway cars that are to carry it inland to smelters and blast furnaces. The processes of loading and unloading these cargoes between ship and train have become so perfected by the use of mechanical appliances, that thousands of tons may be handled within a very few hours.

The iron and steel industries of Pennsylvania so far lead all others, that a view of them will serve to characterize the whole country. Annually the Keystone State produces 60 per cent of all the steel of the United States, 50 per cent of the pig iron

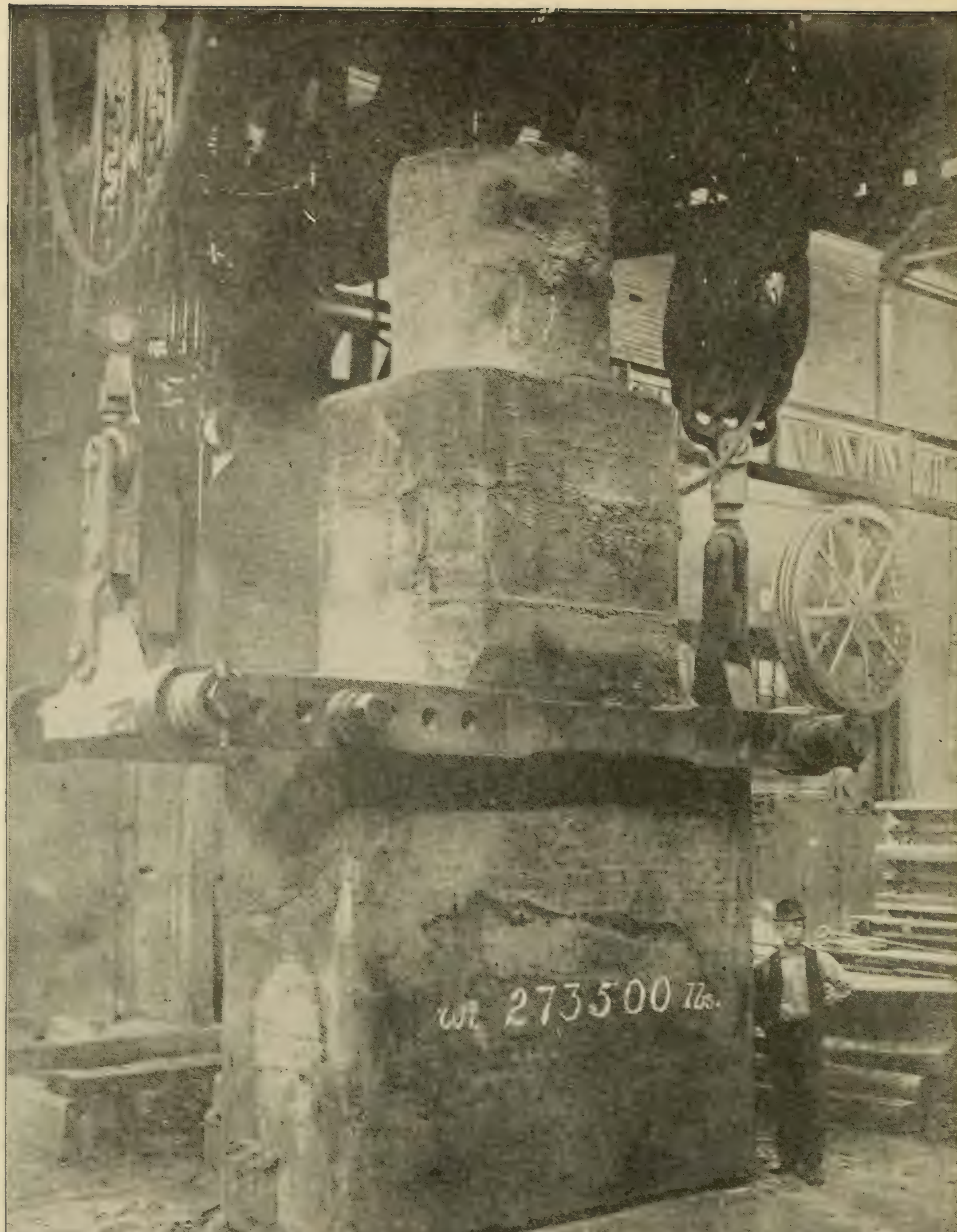


BLAST FURNACES OF A GREAT STEEL MILL.

and over 40 per cent of the tin plate. The output of pig iron annually approaches 5,000,000 tons, with a value of more than $50,000,000. The steel output is nearly 4,500,000 tons, and the total value is about $125,000,000. Blast furnaces, rolling mills and steel mills of every variety help to bring wealth to the state. The crude iron ore as it comes from the mines is taken through all the necessary processes, until it becomes the finished product, for use in complicated machinery, for bridge building, or for railway construction.

The ore as it comes from the mine is mixed with earth, rock, sand and other mineral substances which must be removed, and the first form it takes is that of pig iron, ready for the foundry. There is a melting room in which is a great cupola, cylindrical in shape, standing erect like a huge vertical boiler and lined with fire brick. A coke fire is started in the bottom of the cupola, and on top of the fire is dumped a mass of iron ore, alternating with lime and coke. There is a blast pipe below, through which a strong draught is driven, and a stack above from which the smoke and gases escape. The metallic iron melts out of the ore by the action of the heat, stimulated by the blast, and the lime takes up such impurities as cannot be removed by the heat itself. The metallic iron, melting, runs to the bottom of the cupola, where it accumulates in a liquid mass. The floor of the great room is made of sand, in which long troughs are marked, connecting with a main channel. When the iron is all melted in the cupola, a spout below is suddenly

STEEL "INGOTS" AND "BILLETS" READY FOR MANUFACTURERS' USE.



A 137-TON STEEL INGOT FOR A MODERN GUN.

This is the form taken by the steel when the first casting is made in constructing heavy artillery for battleships or coast defense. From this ingot the great weapon is turned and bored.

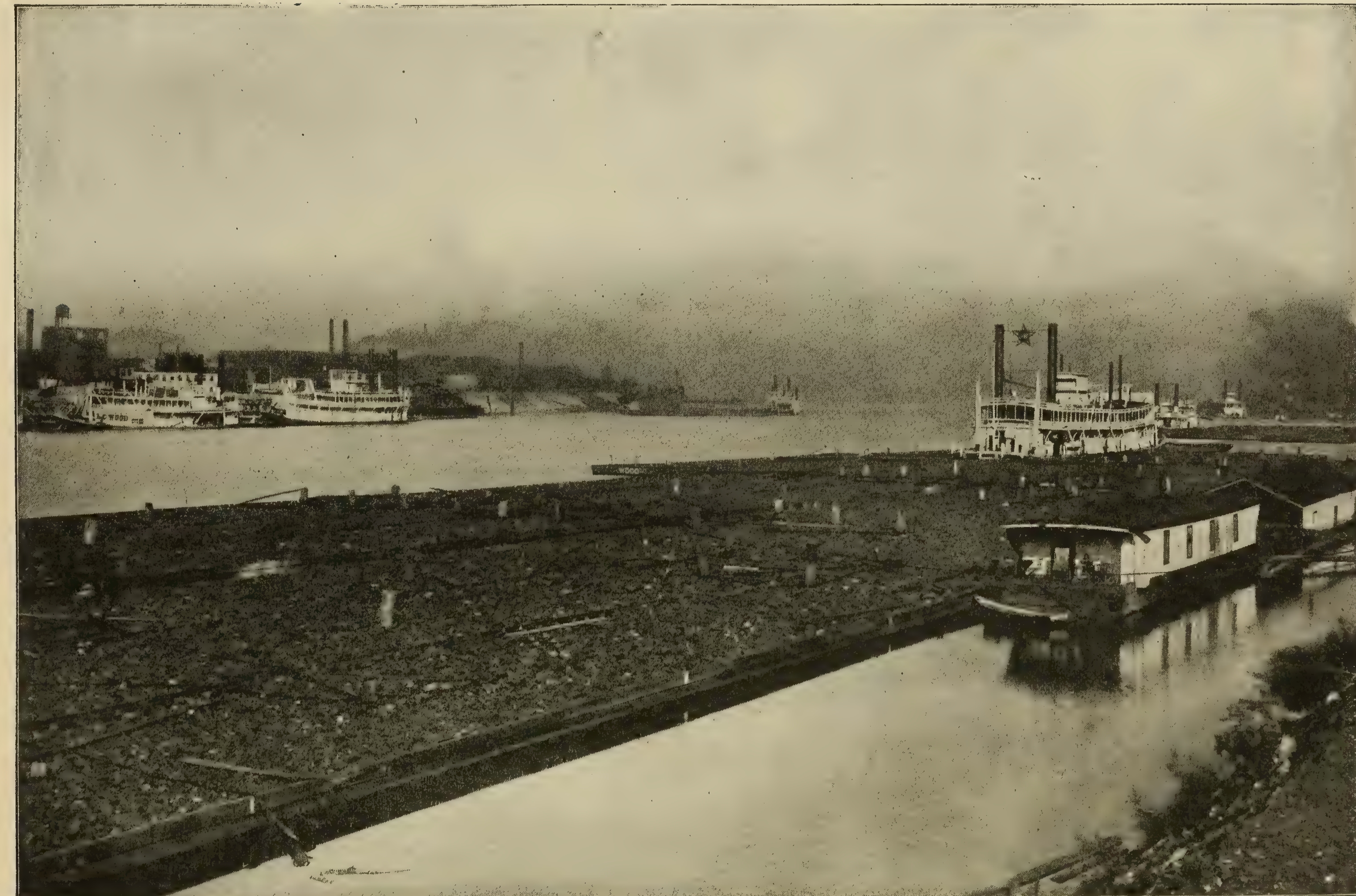
opened, and the molten mass flows out in a fiery stream. In these troughs of sand it cools gradually and is broken off into proper lengths for convenient handling. This is pig iron.

MAKING CAR WHEELS—MOLDS READY FOR POURING.

The most complete manufacturing plants, however, convert their iron into steel directly, without permitting the pigs to cool, thus saving a second heating. Little cars lined with fire brick receive the melted iron, and carry it to the top of another cupola, which is the steel converting crucible. This is an even hotter blast, with steady currents of air and sometimes oil used to get the desired heat. Carbon, manganese, and other chemicals that produce the different varieties of steel, are added here. When the process is complete to produce whatever qualities are desired, the contents of the cupola are received into molds on the floor until cool enough to handle. The lump of metal is now a steel ingot.

If it is intended for railway rails, the molds are picked up by cranes and tongs, and the ingot is delivered to a continuously traveling platform or bed, with projections sticking up from its chains. This passes it into the grip of a succession of great rollers, through which it is squeezed like a wet cloth through a laundry wringer, continually increasing in length and diminishing otherwise. At last it takes familiar shape, and in a few hours from the time it left the cupola, becomes the finished railway rail.

OPENING THE MOLDS.



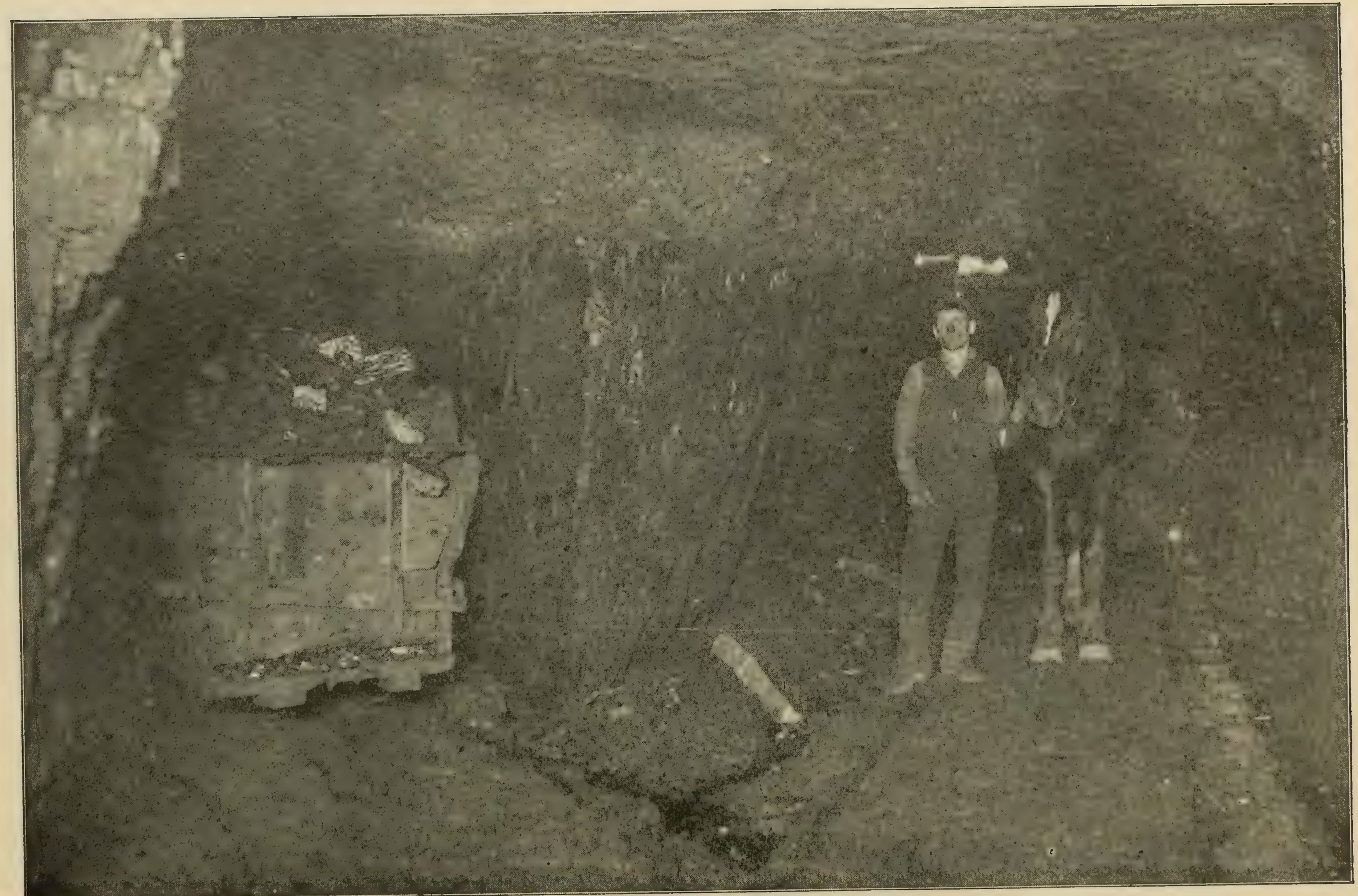
A FLOTILLA OF COAL BARGES ON THE OHIO RIVER BELOW PITTSBURG.

COAL MINING AND COKE MAKING

Deep down in the earth, thousands upon thousands of men are working day and night, mining the coal which is an essential factor in the whole industrial activity of the world. With all the new forms of power that have been devised by ingenious inventors of late years, it has not yet proved possible to eliminate or even to reduce the uses of coal. Electric power, except in those isolated instances where it is generated by a water-fall, requires, somewhere, that great furnaces and boilers shall be employed in the first instance. Electric light may partially supersede gas, and so reduce some of the coal consumption in this direction, but the coal must be burned to produce the power which drives the dynamos. The burning of wood for fuel has been greatly reduced, owing to the deforestation of large areas, and a resulting greater demand has been made upon the coal-bearing regions. The settlement of our immense prairie states, where cold rules through a long winter, has likewise shared in the stimulus to coal mining. And industrially, the enormous growth of manufacturing enterprises and the extension of railways has been a factor of prime importance in the coal trade of recent years.

COAL MINER WITH SAFETY LAMP.

Cautious scientists more than once have expressed alarm over the threatened exhaustion of the world's coal supply. And yet it appears true that the economical utilization of coal by improvements of power applications, will more than counterbalance the increased consumption of the essential fuel, and that after all nature will preserve a balance in some way. Great areas are known to exist where coal is plentiful, hardly yet touched by the miner's hand. Siberia and the Chinese Empire are noteworthy examples of this. Petroleum fields, yielding apparently limitless quantities of fuel oil, have been discovered in many parts of the world, and except on the shores of the Caspian Sea have been made use of hardly at all. Texas, the Mexican peninsula of Lower California, Central Siberia, the East Indies, and the mid-Australian desert, come into this category. Such natural forces, eternal and world wide, as the winds, the tides of the ocean and the



"DRIFT" AND "TUNNEL" IN A COAL MINE.

(Showing the tram cars loaded with coal ready to be taken out of the mine by way of the railway tracks.)

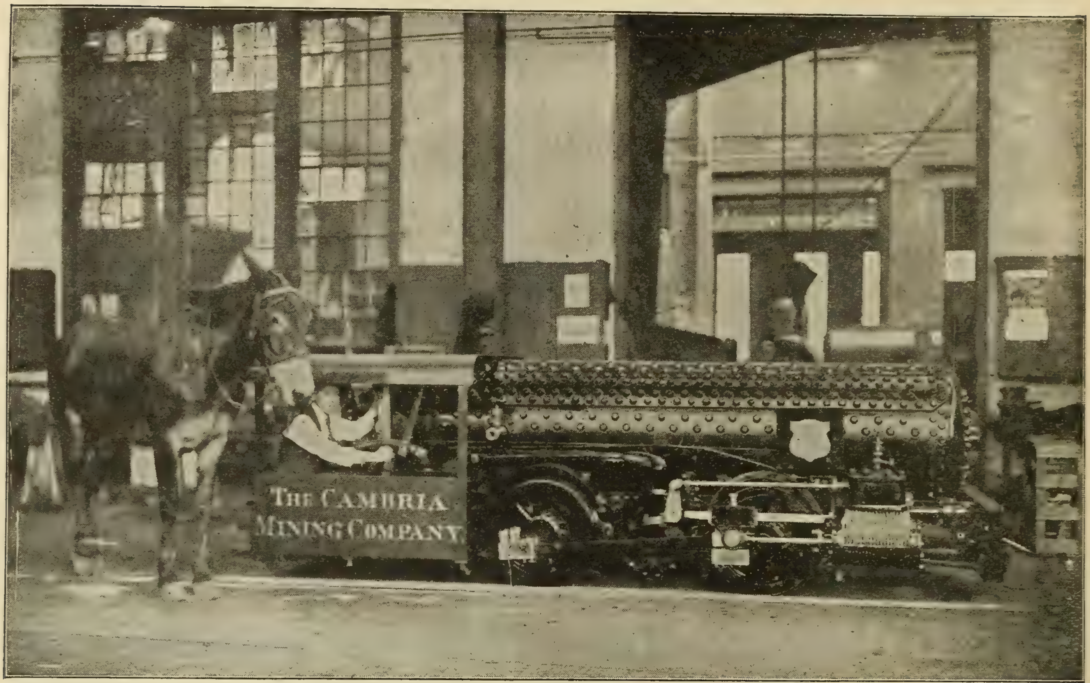
heat of the sun, are attracting the attention of great scientists as offering rich supplies of power for man's mechanical use as soon as science finds the way. Under such conditions as these, thus briefly outlined, it seems a needless anxiety to concern ourselves to-day with the possible exhaustion of the world's fuel supply in the course of a dozen centuries.

The first use of coal for industrial purposes in England was in the year 1234, if the records are truthful. After nearly 700 years, England still leads in the production and use of coal, being the only country exceeding the United States in the extent of the industry. The annual output of coal in Great Britain is more than 200,000,000 tons, while that of the United States is approximately 195,000,000 tons every year. Our American mines, being of more recent development, have not penetrated so deep into the earth as some in the old world. The deepest coal mine known is near Tournay, Belgium, extending 3,542 feet into the earth. The deepest coal shaft in England is in the Dunkirk mine of Lancashire, which measures 2,824 feet.

Pennsylvania so far leads all other states of the union in its production of coal that a description of the industry there will serve to characterize it throughout the country. Its total product is always more than half that of the entire American yield from all the mines, and exceeds annually 105,000,000 tons. So commanding is this industry in the Keystone State that the popular mind always associates the state and the product, and Pittsburg has gained the name of the Smoky City, thanks to the great manufactories and mines operating in its vicinity.

DOWN IN THE TUNNEL OF A COAL MINE.

Coal was discovered in the Schuylkill dis-



MOTIVE POWER IN A MINE—PAST AND PRESENT.
(The compressed air engine, by its additional strength and safety, is gradually displacing the mule in coal mines.)

trict in 1790, and thirty years later the first regular shipment was made to Philadelphia. Two kinds of coal are mined, anthracite and bituminous, or, more popularly speaking, hard coal and soft coal. The area from which the former is produced measures less than 500 square miles, and that of the soft coal nearly 9,000 square miles. But the former excels the latter slightly in tonnage produced, and by its greater value per ton exceeds the soft coal more than two to one in total value.

Let us now glance at the processes by which coal is mined in the heart of the earth, brought to the surface, and distributed to the market. Down deep in the earth stands a grimy miner. On his cap is mounted a small lamp, surrounded by a screen, which throws a faint gleam of light around him and permits him to see the walls of black against which his efforts are directed. The lamp was the invention of Sir Humphrey Davy, and protecting the flames as it does from direct contact with inflammable gases which are frequently found in mines, goes far to avert the danger of explosion. This Davy safety lamp has been a factor of prime importance in making possible mining operations in many places otherwise too dangerous to work. With pick and shovel the miner labors, breaking down the coal, and gradually enlarging the subterranean chamber in which he is working. At intervals blasts of giant powder and dynamite are used to loosen and shatter great masses of coal. When this is to be done, the miners retire to a distance and wait until the dust and gases scattered by the explosion have dissipated. Then they return to the face of the cutting which they have been working, and continue their toil.

Most mines are compelled to use both vertical shafts and horizontal tunnels or "drifts," in the course of their operation. If the first opening is in the side of a hill, a tunnel may extend far into the earth before the descent by a shaft begins. If, on the other hand, the mine to be opened is not located so as to be reached by a tunnel, a vertical shaft is sunk at once to the necessary depth. From the shaft the tunnels or drifts radiate in whatever direction the coal measures lie, and at different levels, so that work may be carried on in many places at the same time. Tracks are laid in all these tunnels or drifts, and on these, little tram cars run back and forth, to carry the coal to the surface. When they reach the shaft, they must be hoisted by powerful machinery on the outside.

In European mines, women and children are often employed to push these cars back and forth, but in the United States, horses and mules are used. Even these in some mines have been superseded by locomotives, operated by compressed air. Such locomo-

A GREAT COAL "BREAKER."

This is the building through which coal passes on its way from mine to railway car. By screens and chutes it is cleaned and sorted into various sizes for market.

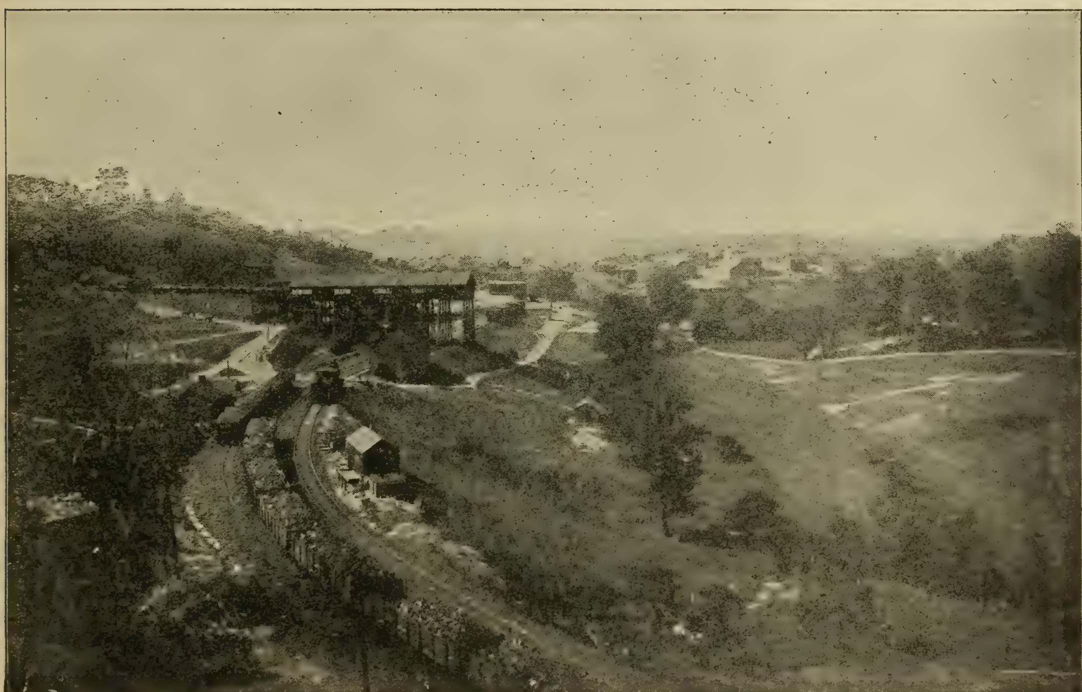
Copyright, by Detroit Photographic Co.

"BREAKER BOYS" OR COAL PICKERS IN A PENNSYLVANIA MINING TOWN.

These boys pick the slate and other impurities from the coal as it passes through the chutes and screens. They begin at an early age and reach manhood with but little schooling.

tives, to haul trains hundreds of feet under ground, must be very different from those we are accustomed to see on our steam railroads. One of the greatest dangers the coal miner has to guard against is the explosion of fire-damp, which can be set off by a single tiny spark. It would not be possible, therefore, to use an engine operated by steam, with a firebox. The driving machinery of these novel locomotives is not unlike that of engines of the more familiar type. The air supply is gained from great tanks carried over the driving wheels, in place of the ordinary locomotive boilers. The storage pressure capacity of these tanks is 600 pounds per square inch, from which 200 pounds' working pressure is maintained upon the engine cylinder. The supply of air can be replenished readily in the tanks, from nozzles connected with high-pressure pneumatic tubes placed at the points convenient for the purpose. Such a locomotive can draw long trains of cars, of which the mule can handle but one, and at much faster speed. It is thus that mechanical inventions are steadily improving the industrial processes in almost every line of business.

When the coal reaches the surface, either by tunnel or by shaft, it passes rapidly through a series of processes necessary to clean it, sort it into the various sizes or grades for the market, and bring it to the railway cars by which it is to be shipped to the place of sale. A great coal "breaker," as the peculiar structure is called where these processes are carried on, is a place of dust and noise, of rambling sheds, inclined

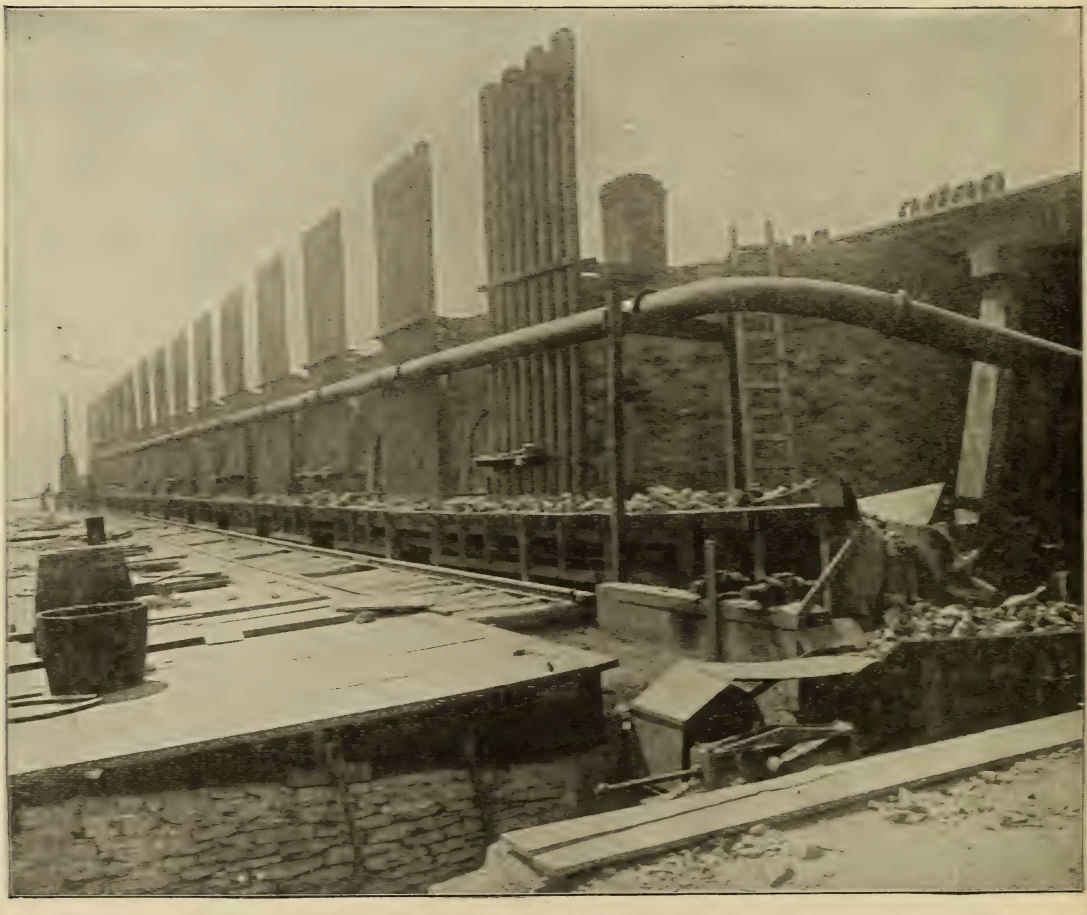


COAL FROM MINE TO MARKET.

(This illustration shows in striking manner a general view of a mine, including the entrance to the tunnel, the breaker, and the loaded cars ready for shipment, with the miners' houses in the background.)

planes, screens and chutes, a monster of architecture, but an important factor in the coal trade. The loaded cars right from the mines reach the breaker, high in the air, and are tilted so that they dump their cargo into chutes provided for the purpose. As the coal rattles down through the winding way provided for it, it passes over a succession of screens with meshes of various sizes. By this process it is sifted and sorted with mechanical precision until, finally reaching the bottom, each grade falls into the bins or railway cars provided for it, ready for the market.

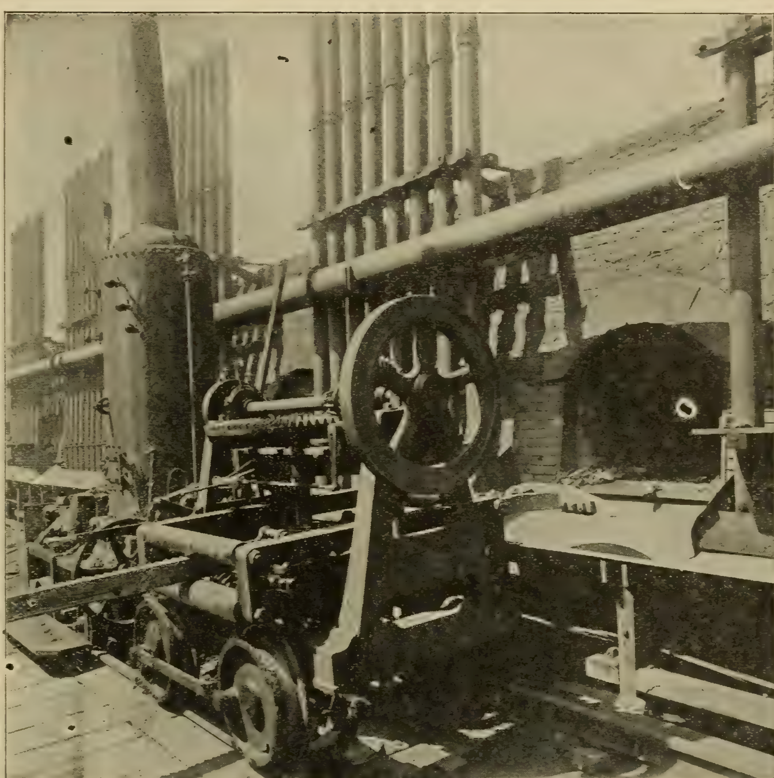
It is not enough to merely sort the coal into sizes. It must be cleaned as well, for few mines are free from slate and other impurities which would reduce the value of the coal if left untouched. As the coal passes through the breaker and over the screens, it is watched by keen-eyed, deft-fingered boys, who pick out and throw aside whatever pieces of slate or stone they discover. A "breaker-boy," as these



COKE OVENS.

(Far in the background men are seen with the apparatus which draws the coke out of the ovens. The product is then carried through the long trough by an endless belt and thence by another belt, shown in the foreground, to the shipping sheds.)

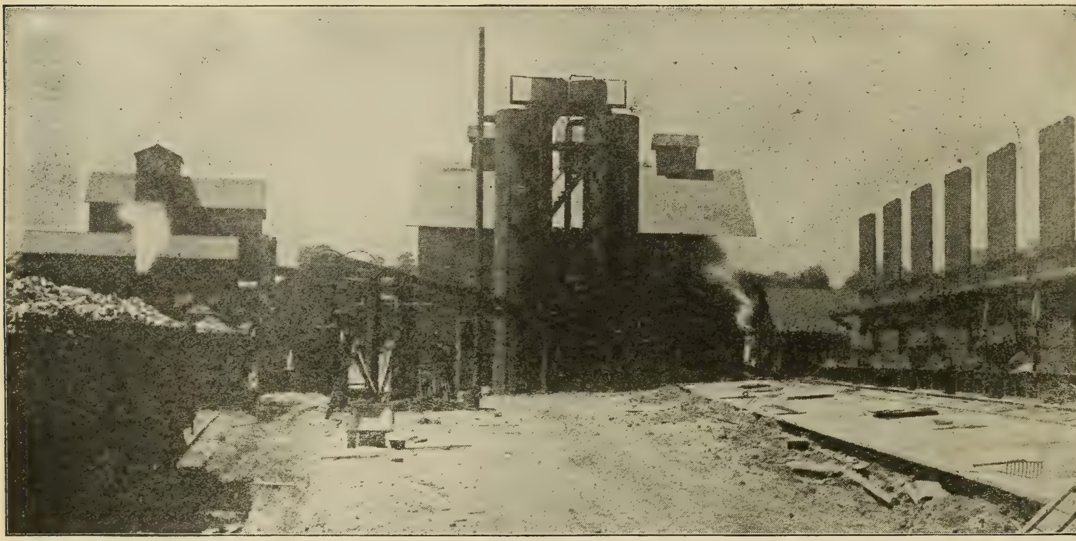
coal-pickers are called, is taking the first step in the life of a miner, and in every mining town there are numbers of such little fellows busily engaged and helping to earn the living for the household. The miners in many of our mining districts are foreigners, forming communities of their own and coming in touch but little with American manners of life and thought. Poor as they are, and beginning work at an early age, they have little opportunity to obtain more than the rudiments of an education. It is this element that forms one of the most difficult problems to deal with in our industrial and labor questions. The transportation of coal from mine to market is one of the most important and lucrative parts of the business of many great railways. In Pennsylvania, particularly, there are lines which are classified as "the coal roads" because this traffic forms such a dominant part of their entire business. There is a constant procession of coal trains between the mines and the large cities and manufacturing towns near them. Pittsburg and Allegheny are conspicuous examples of cities virtually built up by the fortunate combination of coal and iron areas convenient to them. Here, too, the Ohio River becomes an important aid in the traffic. Barges loaded with coal are lashed together, to form immense flotillas which are towed down stream on the Ohio, to such other markets as can be reached to advantage by that route. Ohio, West Virginia, Kentucky, Indiana, and indeed the whole of the Ohio and Mississippi Valleys, share in this distribution of the Pennsylvania product.



DEVICE FOR REMOVING COKE FROM OVENS.
(The rake-shaped fixture draws the charred coke out of the oven and into the trough, whence it is delivered as described in the accompanying view.)

A very large part of the Pennsylvania coal product is converted into coke for use in the steel mills and manufactories where it is needed. The coke furnaces thus become a feature of the coal industry, and they have grown to immense proportions because of the demand of the steel trade.

The mechanical appliances used in the manufacture of coke have been improved so that virtually all the work from the mine to the railway car with the finished product, can be carried on by machinery. The coke is drawn from furnaces where the coal has undergone the roasting or charring process, by ingenious mechanism which works like a great iron hand on the end of a long steel arm. This is carried on a heavy car, which runs back and forth on a railway track in front of the row of furnaces. An engine mounted on the same car, furnishes the power for this giant hand, which rakes the coke from the furnace into a long trough. An endless belt in this trough forms a carrier, connecting with another one of the same kind, by which the product is loaded directly into the cars for shipment.



LOADING COKE INTO CARS.

At the right are the ovens, with a trough in front through which the coke is carried by an endless belt. This discharges upon another belt on the incline in the background, and thus it is carried directly into the cars.

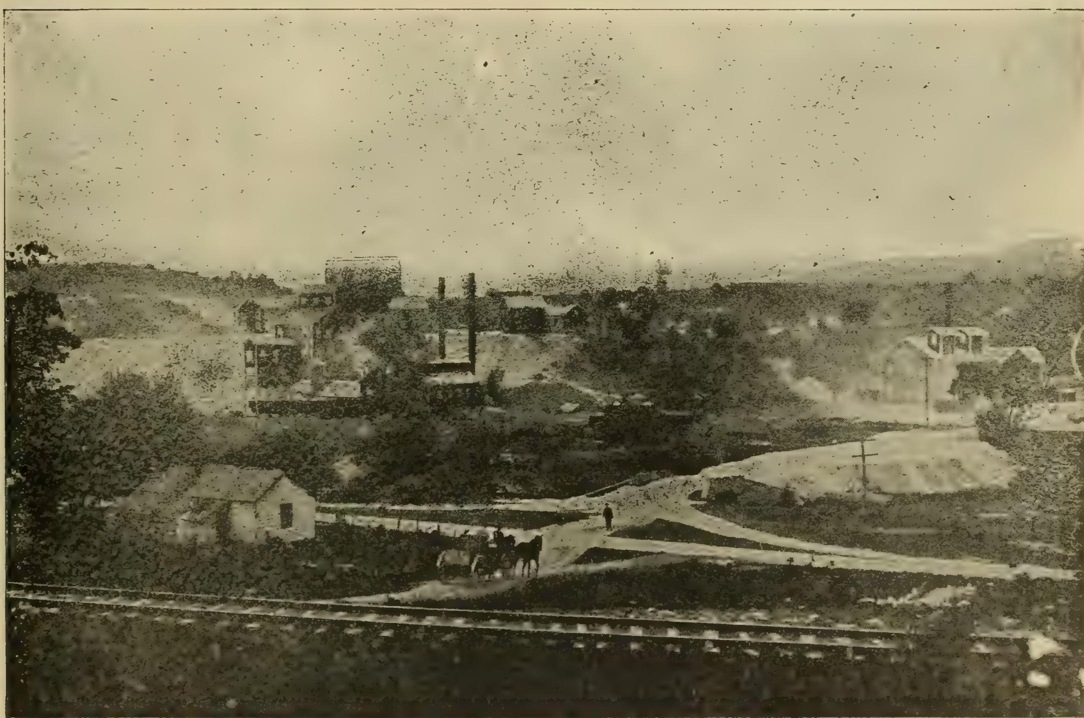
Pennsylvania, besides producing more than half of the total coal yield of the United States, furnishes virtually all of the anthracite or hard coal. Illinois is second in the production of bituminous, or soft coal, with more than 20,000,000 tons annually, and West Virginia is third. A large coal field exists in Georgia, where it is convenient to an iron-producing region. This condition, as in Pennsylvania, induces the development of a large coke district. Ohio, Indiana, Virginia, Iowa, Missouri and Colorado are other states in which the coal industry has reached large proportions, and in many other states of the union successful mines are in operation, important in their contribution to the local demand.

An important by-product of coal which is utilized in a multitude of ways, is coal tar, now so common that it has largely displaced pine tar. It is produced in the manufacture of gas, and from it we get the material used in every city pavement, as well as creosote, dyes, and various familiar medical remedies, such as acetanilid, etc.

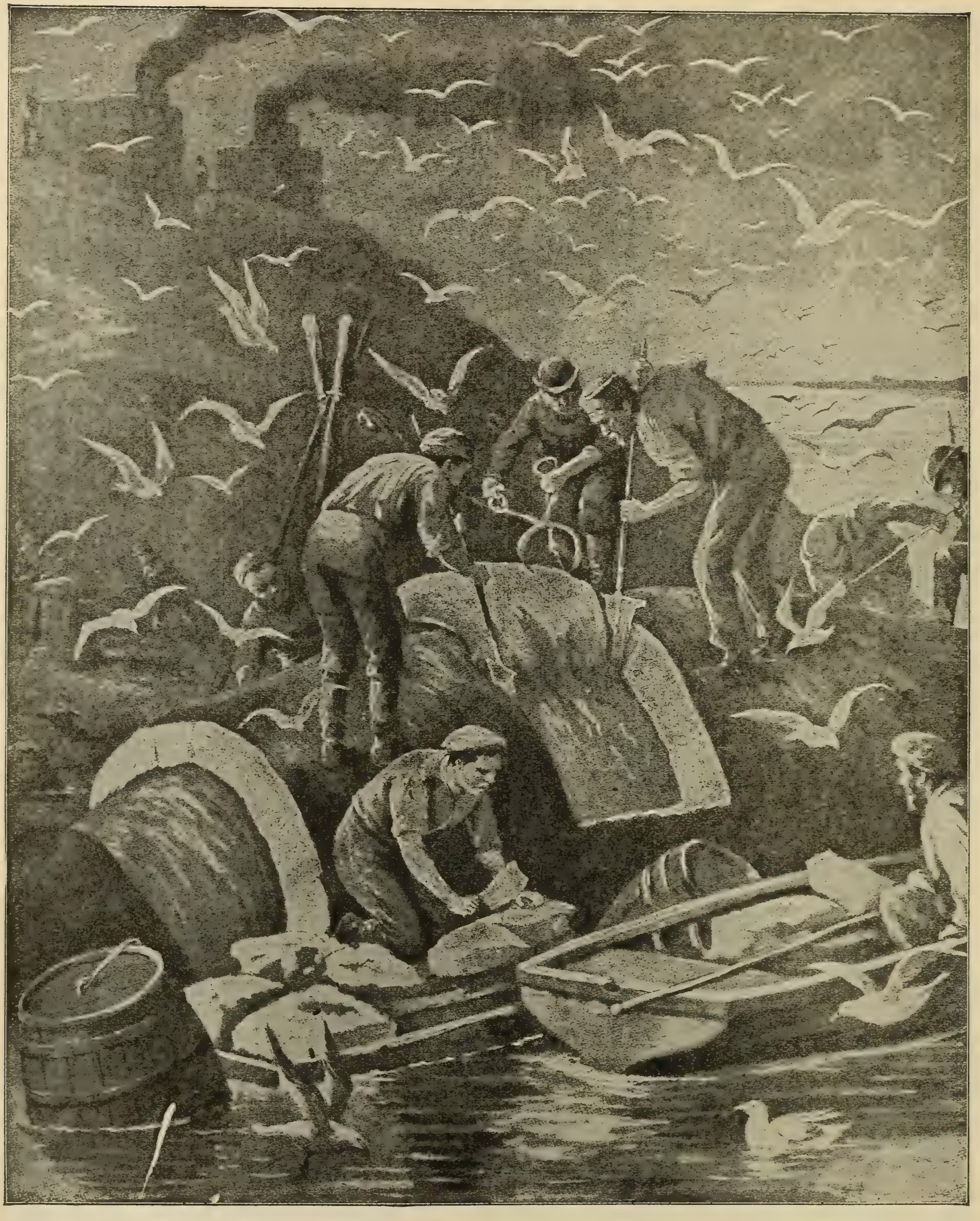
ZINC AND OTHER PRODUCTS OF THE MINES

Among the minerals entering commonly into domestic and industrial uses is zinc, which is produced in certain districts of the United States in large quantities. The State of Missouri is the location of the most important zinc mines of the country, which center about the city of Joplin in the southwestern part of the state. The development of zinc and lead mines within the last few years brought about the increase of the population of the place from 10,000 to 26,000, between 1890 and 1900. The zinc output here annually approaches 150,000 tons, with a value of considerably more than $3,000,000. Lead mines in the same vicinity yield about half that number of tons with about the same value.

The rapid increase in the demand for electrical appliances of all sorts has increased in like measure the value and the need of zinc which is used so much in electrical mechanics. This has resulted to the profit of the zinc miners, in like degree as the copper interests have profited from the same cause. The enormous copper mines of northern Michigan, Montana and Arizona have multiplied in the value of their output within recent years, thanks to the demands of electricity in its various uses. The annual production of copper in Montana approaches $30,000,000, and the other producing states named are not far behind. The total annual value of our mineral products equals $650,000,000.



A ZINC MINING SCENE.



STRIPPING BLUBBER.
Scene at a North Pacific Whaling Station.

THE "SOO'S" GREAT POWER CANAL

The largest power canal in the world is at Sault Ste. Marie, Michigan, and is used for the operation of gigantic iron industries. It provides for the reduction of 20,000,000 tons of iron ore at the very door of the mines.

In the water power development at the "Soo" is realized the utilization of the natural force inherent in the waters of Lake Superior. There they flow out over a sandstone ledge about a half mile long, half a mile wide, with a fall of 20 feet.

LAKE SUPERIOR GIVES THE "SOO" CANAL 200,000 HORSE POWER.

Lake Superior covers an area of about 36,000 square miles and is fed from a water-shed many times greater, the Sault Rapids being its only outlet. The quantity of the water discharged fluctuates, with the varying conditions of precipitation and evaporation, from about 3,600,000 to 7,000,000 cubic feet per minute, which, rushing over the Sault Rapids, represents an equivalent of from 130,000 to 260,000 horse power.

Just south of the western entrance to the United States Ship Canal lies the intake to the power canal, about 950 feet wide. The total distance of the constructed waterway is about 13,000 feet, the width from the expanded intake entrance gradually lessening to 200 feet, excavated to such a level that, when the full maximum power of the works is being used, water will flow at a uniform depth of 25 feet.

CONSTRUCTION OF THE CANAL.

The entire construction of the canal has been carried on with a view to the greatest efficiency in delivering the energy of the water, and it is everlasting in durability. Throughout the intake the sides of the canal are retained by timber cribs securely placed and framed, rendering the sides of the waterway smooth and permanent. The timber construction is continued to a point just below the water, and covered with masonry construction. The canal sides through the rock formation are channeled out vertically, its walls and bed being smooth. All defects in stratification are remedied by masonry construction, of which the embankments also consist.

The flow area of the canal differs with its different sections. The water will flow 25 feet deep through the entire canal, and will attain a velocity of four and a half miles an hour. This will deliver, approximately, 30,000 cubic feet of water every second to the turbines.

The conduit terminates at the power house, which performs the function of a dam, in which water wheels are so placed that the only escape for the water to the lower level is through them.

The equipment consists of hydraulic and electric apparatus. Each hydraulic unit is composed of four new 33-inch American turbines, arranged in two parts on one shaft. Each pair is housed in one case and discharges into one draught tube. The installation is of the horizontal, tandem type, the shaft and operating rigging penetrating the steel-plate bulkhead and coming out on the dynamo floor side. Each hydraulic unit, under normal conditions, equals 568 horse-power.

Involved in the construction of this canal were 1,250,000 cubic yards of rock and 3,000,000 cubic yards of sand excavated and dredged. This material was all utilized in reclaiming land under water, which is the property of the operating company. The material used consisted of 3,500,000 lineal feet of piles, 170,000 tons of concrete and monolithic blocks, 90,000 cubic yards of sandstone masonry, 32,000 square yards of dry sandstone pavement, 260,000 barrels of cement, used in all masonry, and 24,000 square feet of iron roofing.

LARGE TRACT OF NEW LAND MADE THROUGH EXCAVATION.

Two hundred and sixty acres of land were reclaimed during the construction, being filled in with the excavated material; 2,800 lineal feet of navigation docks were built; 22 miles of rails were laid and operated. The excavation was carried on with an equipment of eight steam shovels, 24 locomotives and 350 four-yard dump-cars, all work being carried on night and day, excepting Sundays.

The approximate cost of the entire right of way, canal, power-house, equipment, docks and appurtenant works, developing 57,000 horse power, is about $4,000,000.

THE WORLD'S STUPENDOUS GRANARY

Fifteen million barrels of flour is the annual output of the world's greatest granary, at Minneapolis. For some time this city of the Northwest has been recognized as the largest primary wheat market of the world, and also the greatest milling center.

Thousands of persons make annual trips to Minneapolis to see the great mills, and observe the process by which several trainloads of wheat are turned into flour in one day. But the methods of flour making have undergone so many radical changes within the past few years that men who were once experts in the business would now be novices.

GREAT INCREASE IN CAPACITY OF FLOURING MILLS.

The number of flouring mills in Minneapolis is no greater than it was 20 years ago, but the present annual output of 15,-

WHEAT FIELD, DAKOTA

000,000 barrels exceeds that of 20 years ago by more than 650 per cent, and this in the face of the fact that some of the larger plants manufacture, in addition to their flour product, immense quantities of the different kinds of breakfast cereals now so commonly used. The gain in capacity is due to the fact that most of the mills have been enlarged from time to time and equipped with the very best modern machinery.

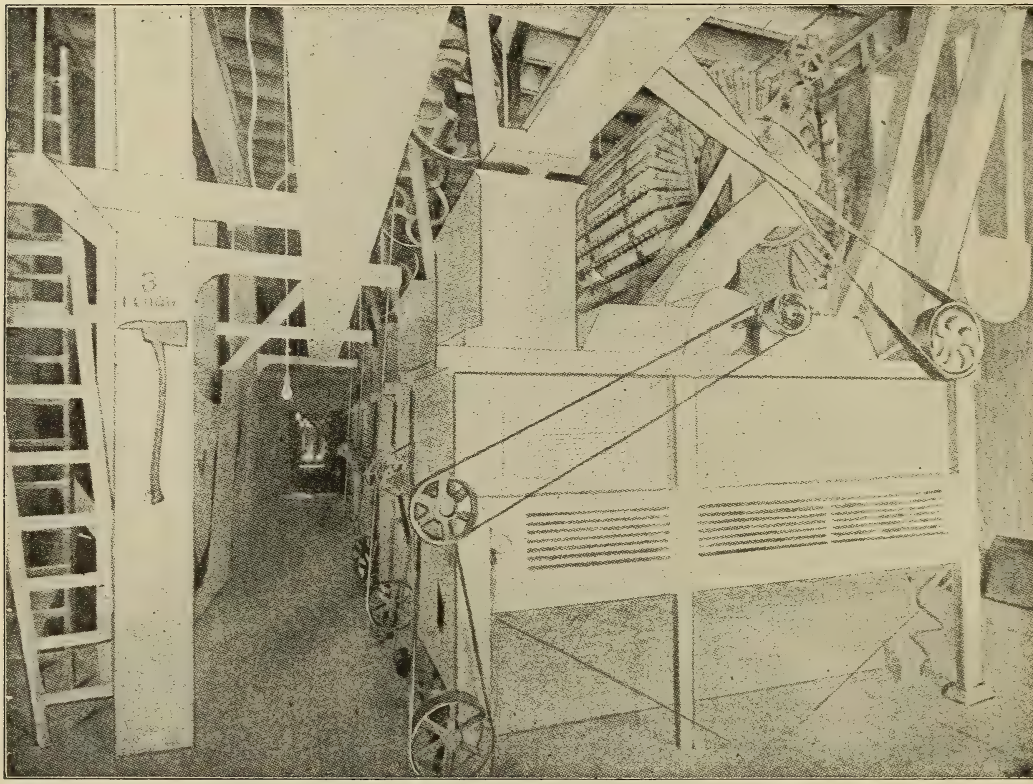
LARGEST FLOUR MILL IN THE WORLD.

As an illustration, the Pillsbury mill was constructed in 1880 with a daily capacity of 5,000 barrels, but it has been improved until its capacity is now 14,000 barrels. This is the largest flour mill in the world.

A MAMMOTH GRAIN ELEVATOR—"THE GREAT NORTHERN," AT DULUTH.

MECHANICAL PROCESS OF A GREAT FLOUR MILL.

The flour mills of the present are a wonderful triumph of scientific industry, and when in full operation one of them seems almost a thing of life. The wheat is shoveled by machinery from the car into a large pit, from which it is taken into the endless machinery of the mill. It is then hurried on, this way and that, through secret passages, from one side of the big mill to the other, now up, now down, through this machine and that, until finally every kernel is divided into as many component parts as the processes number, and each part drops into its own receptacle. It has been forced through all these by the mill's own machinery, without having been touched by human hands or seen by human eyes. No one is watching to see if it takes the proper course, or if any part of the machinery does its work; a lever is pulled which conducts a portion of the Mississippi upon a big wheel, and all the intricate machinery in the giant mill responds with a harmony that seems almost human.



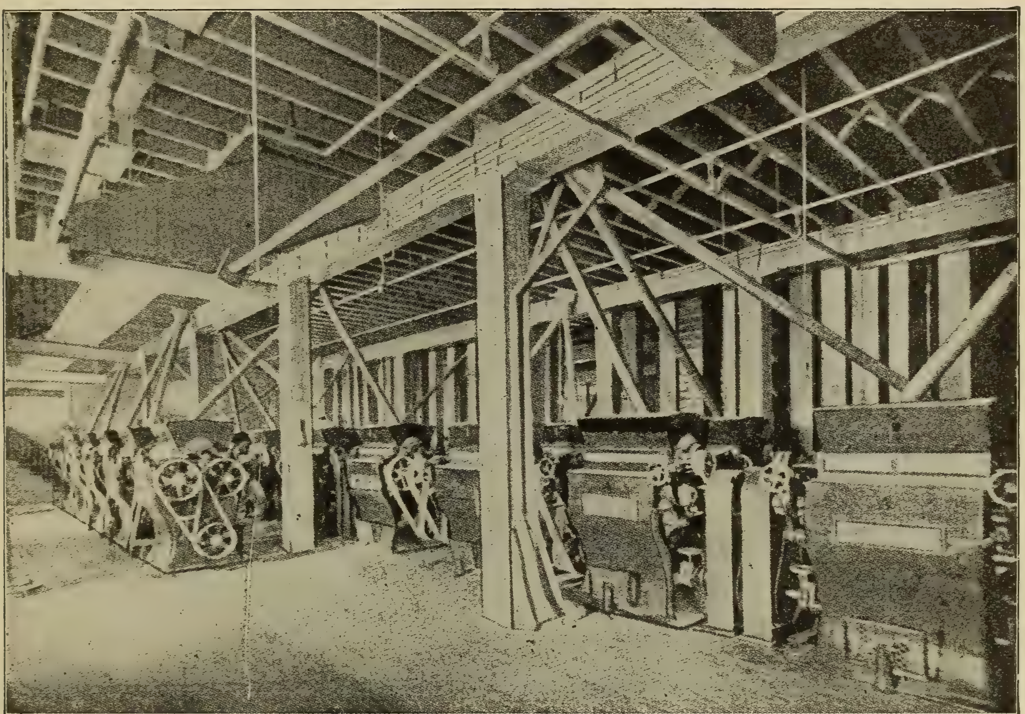
DUST COLLECTORS AND PURIFIERS, PILLSBURY "A" MILL.

DECREASE IN THE PRICE OF FLOUR.

Incidentally it may be mentioned that while the mills have been increasing their capacity and improving their processes the price of the product has been steadily decreasing. In 1880 the average profit on a barrel of flour was about 75 cents, while now the millers think themselves fortunate when they figure up their profits and find that about 20 cents is realized after all expenses have been paid.

It must not be inferred from this that

the business of milling has reached a crisis, or that the meager profits on a barrel of flour, as compared with those of the early days, have affected the milling industry. The price of flour has been reduced through natural causes, but the reduction has been, perhaps, more than offset by the increased capacity of the mills through the introduction of modern machinery. The lucrativeness of all the large manufacturing industries to-day depends upon the great volume of the output rather than upon the large percentages of profit.



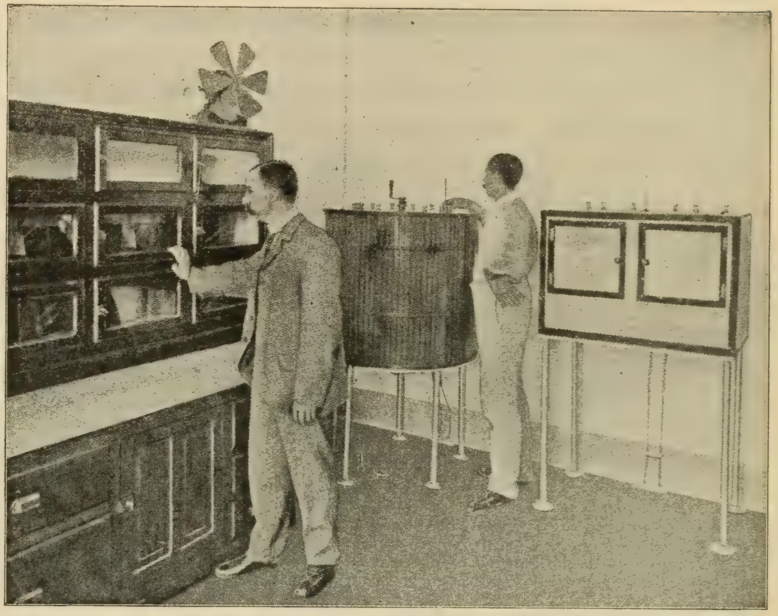
GRINDING FLOUR, PILLSBURY "A" MILL.

THE NEW MONSTER ELEVATORS.

Twenty years ago a car carried about four hundred bushels, but those now being built carry twelve hundred bushels. The building of new roads and improvements in methods of transportation have also reduced the price of grain carrying to terminal points in Minnesota nearly, if not quite, 66 per cent. But little more than ten years ago it cost twenty-six cents a hundred pounds to ship wheat from Minneapolis to Chicago; to-day the same amount is carried for ten cents. Twenty years ago it cost from 15 to 18 cents a bushel to ship wheat from Duluth to Buffalo; to-day a rate of three cents a bushel would be excessive. At that time a good cargo was 30,000 bushels; now those figures may be multiplied by ten. A great grain market, created and fostered by an extensive system like that at Minneapolis, has made a radical change in the problem of storage construction.

THE MODERN TERMINAL ELEVATOR.

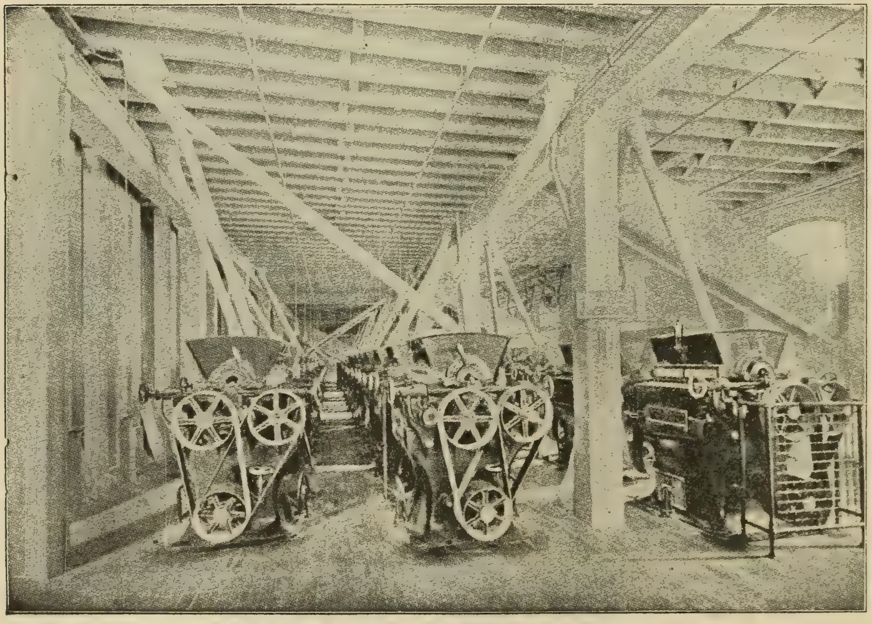
The modern terminal elevator, which is a child of necessity, has reached its present



By courtesy of the "Scientific American.
BAKING BREAD IN ELECTRIC OVENS.

development through as many evolutions, perhaps, as those of the modern flour mill. There has been no change in recent years in the methods of operating a terminal elevator, except that in some cases electricity has been substituted for steam as power, and that in a few instances, the grain is conveyed by pneumatic tubes instead of by cup-belts. But the shape and material of the structures have been completely revolutionized. Some years ago, in this process of evolution, steel began to supplant wood as building material, and the Great Northern steel elevator of Duluth, which is capable of storing more grain under one roof than any other elevator in the world, is made wholly of steel.

OUTSIDE STORAGE TANKS.



GRINDING FLOUR, PILLSBURY "A." MILL.

Cylindrical tanks for storage next began to be erected outside of and separate from the elevator, instead of the long bins in the elevator proper. Some are made of steel, some of tiling and some of cement. A wide, flat, rubber belt carries the grain from the upper story of the elevating plant, or working house, to the tanks, and discharges it through a hole in the roof. When grain is shipped from a tank it is conveyed from the bottom of the structure through a subterranean passage to the elevator pit on a belt similar to the overhead belt which carries it to the tank. From the pit it is elevated to the shipping floor and spouted to a car.

It is possible to keep grain making this circuit continuously, from the pit to the top of the "working house" by the cup-belt to the top of the tank by the horizontal belt, to the bottom of the tank by gravitation, and then to the elevator pit again by the underground passage. Somtimes, damp grain is treated in this way to dry it. A conveying belt is three feet wide, and the stream of grain which falls upon its surface is from six to seven inches in diameter. A six-inch stream will empty a tank of about five thousand bushels of wheat in an hour. Each plant consists of a dozen of these tanks, more or less, and their capacity is about 100,000 bushels each. These are much more expensive than the old-style houses, but the extra expense is offset in a few years' time by the saving in insurance. Being strictly fireproof no insurance is carried on the structure or its contents. Thus, while the mills have passed from the primitive to the modern era, and the methods of transportation have been improved, the elevators have kept pace with these improvements.

TESTING FLOUR, PILLSBURY "A." MILL.

STATE SUPERVISION OF TERMINAL GRAIN MARKETS.

In addition to the great industries already mentioned, Minnesota has a system of state supervision over the grain market at its terminal elevators, in which the grain dealers of the whole world are vitally interested. Other states adopt similar measures, but do not compare in efficiency with this big cereal state of the northwest. Certificates issued by Minnesota are accepted without question. In Illinois, the elevators are regulated by state commissioners.

THE GRAIN PRODUCTION OF THE UNITED STATES IN BUSHELS, FOR CERTAIN YEARS: PREPARED FROM GOVERNMENT TABLES.

	Indian Corn.	Wheat.	Oats.	Barley.	Rye.
1905	2,707,993,540	692,979,489	935,216,197	136,651,020	27,616,045
1906	2,927,416,091	735,260,970	964,904,522	178,916,484	33,374,833
1907	2,592,320,000	634,087,000	754,443,000	153,597,000	31,566,000
1908	2,668,651,000	664,602,000	807,156,000	166,756,000	31,851,000
1909	2,772,376,000	737,189,000	1,007,353,000	170,284,000	32,239,000

PILLSBURY "A" MILL. THE LARGEST FLOUR MILL IN THE WORLD. CAPACITY, 15,000 BARRELS DAILY.

From the following table, taken from the "Year Book of the Department of Agriculture," may be seen the relative food values possessed by various grades of flour, together with the refuse matter.

Components.	High-Grade Patent Flour.	Bakers' Flour.	Common Market Flour.	Flour of Small Mills.
Water	12.75	11.75	12.25	12.85
Proteids	10.50	12.30	10.20	10.30
Ether Extract	1.00	1.30	1.30	1.05
Ash	.50	.60	.90	.50
Moist Gluten	26.00	34.70	24.50	26.80
Dry Gluten	10.00	13.10	9.25	10.20
Carbohydrates	75.25	74.05	75.65	75.30

From the same authority are tabulated the following figures pertaining to a representative brand of self-raising flour.

Components.	Self-Raising Flour.	High-Grade Patent Flour.	Bakers' Flour.
Water	12.30	12.75	11.75
Proteids (factor 6.25)	10.10	10.50	12.30
Moist Gluten	27.00	26.00	34.70
Dry Gluten	9.65	10.00	13.10
Ether Extracts	.70	1.00	1.30
Ash	4.00	.50	.60
Carbohydrates	72.90	75.25	74.99

LUMBERMEN BOATING DOWN A MOUNTAINSIDE.

In British Columbia flumes are used to float logs from mountain tops to saw-mills. The men nail boards together and come down the same way, traveling sometimes a mile a minute.

LUMBERING IN AMERICAN FORESTS

The forests of the world have been the source of shelter and prosperity for countless millions, but never have they entered more fully into the industrial life of the people than they do to-day. In America alone the lumbering industry, with its branches, is recognized as one of the most important factors in our national prosperity. The forests began to serve us long before we were born, for to the trees before the coal age we owe the enormous deposits of fuel which we are even now digging from the mines, for use in great manufacturing enterprises, in our railway locomotives, and in our households.

But timber in its natural form is a source of wealth to any wooded country. It is an evidence of the increasing intelligence of mankind in this industrial age, that all the world over, influences are at work to promote the preservation of the forests and to put an end to wasteful extravagance in their destruction. Estimates have it that the forests of the world cover 1,201,000,000 acres of land. Russia leads the list with 485,000,000 acres, the United States comes second with 176,000,000 acres; Canada third, 174,000,000 acres; Brazil fourth, with 135,000,000 acres, and then in succession Scandinavia, Austria, Germany, France and Italy, down to the countries of less consequence in forestry. Since 1848 the French, who have been most industrious in this direction, have converted 9,000,000 acres of waste land into forest. Paris alone burns the timber of 50,000 acres annually, requiring a million acres of forest to keep up the supply.

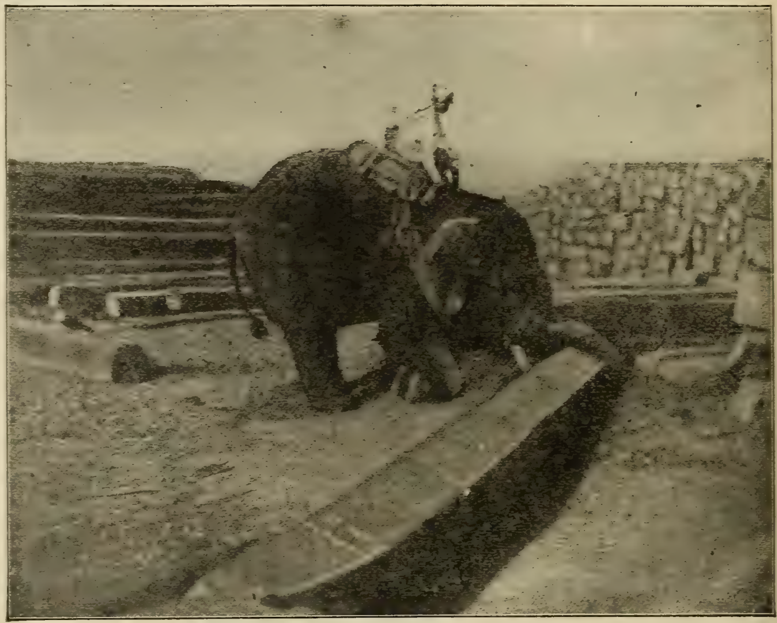
Forty billion feet of lumber is yearly used by the United States for the lumber and paper trade. This is equivalent to the product of about 4,000,000 acres of good virgin forest, an area equal to Rhode Island and Connecticut combined. This does not include the wood used for fuel, which is about four and a half times more. Four million feet is used for matches, the product of 400 acres of good virgin forest. About 620,000,000 cross ties are now laid on American railroads, and 90,000,000 new ties are required annually for renewals. There are now standing nearly 7,500,000 telegraph poles and 750,000 new poles are required each year for renewals. These figures do not include telephone poles and the poles required on new railway lines. The timber used for ties and poles each year is equivalent to the product of 100,000 acres of good virgin forest. The amount

LOGGING CAMP IN MICHIGAN.

Copyright, 1898, by Detroit Photographic Co.

RAFTING SAW LOGS THROUGH A DRAWBRIDGE—UPPER MISSISSIPPI RIVER.

of wood used in a single year for making shoe pegs is equal to the product of fully 3,500 acres of good growth hard wood land. Lasts and boot trees require at least 500,000 cords more. Most newspaper and packing paper is made from wood. The total annual consumption of wood for paper pulp is equivalent to more than 800,000,000 board feet of timber, equal to the growth of 80,000 acres of prime woods. It is manifest that with such enormous inroads upon the forest areas of the United States, the time might come when the country would be virtually denuded of trees, if no measures were taken to prevent such a disaster. The effect of that would be much more far-reaching than the mere termination of the fuel-wood supplies, and the supplies of wood for all the other purposes heretofore mentioned, for the denuding of a country means its certain reversion to a desert condition. It is the forests that shelter and preserve the rainfall, yielding the streams that flow down into the prairies of our agricultural states. If the Rocky Mountains, for instance, were to suffer the loss of their forests, the snows which cover them in the winter would melt rapidly during the first days of spring time, and would flow away in disastrous floods, destroying the farms below. Later in the season, when water was needed, there would be none, and farms would suffer perpetual drought. Under the forests' shade, snow drifts, however, melt gradually throughout summer, thus supplying never-failing streams for the watering of the thirsty crops in the valleys below.



ELEPHANT PILING TEAK LOGS, BURMAH.

Recognizing these facts, Americans with foresight and prudence have induced the government to establish forest reserves in the United States, where no timber may be cut except under the most rigid and exacting restrictions. There are forty-one of these forest reserves in the United States, created by presidential proclamations according to an act of Congress, and embracing a total estimated area of 46,410,209 acres. The greatest of these is in Oregon, in which state a single reserve includes 4,588,800 acres. California, Washington, Colorado, Idaho, Montana, Wyoming, Utah, South Dakota, New Mexico, Oklahoma, Arizona and Alaska are the other states and territories in which forest reserves have been established by national law. With this protection, in spite of the depredations that are sometimes committed by forest fires and vandal woodsmen, we may expect that some of these great forests will be preserved to posterity.

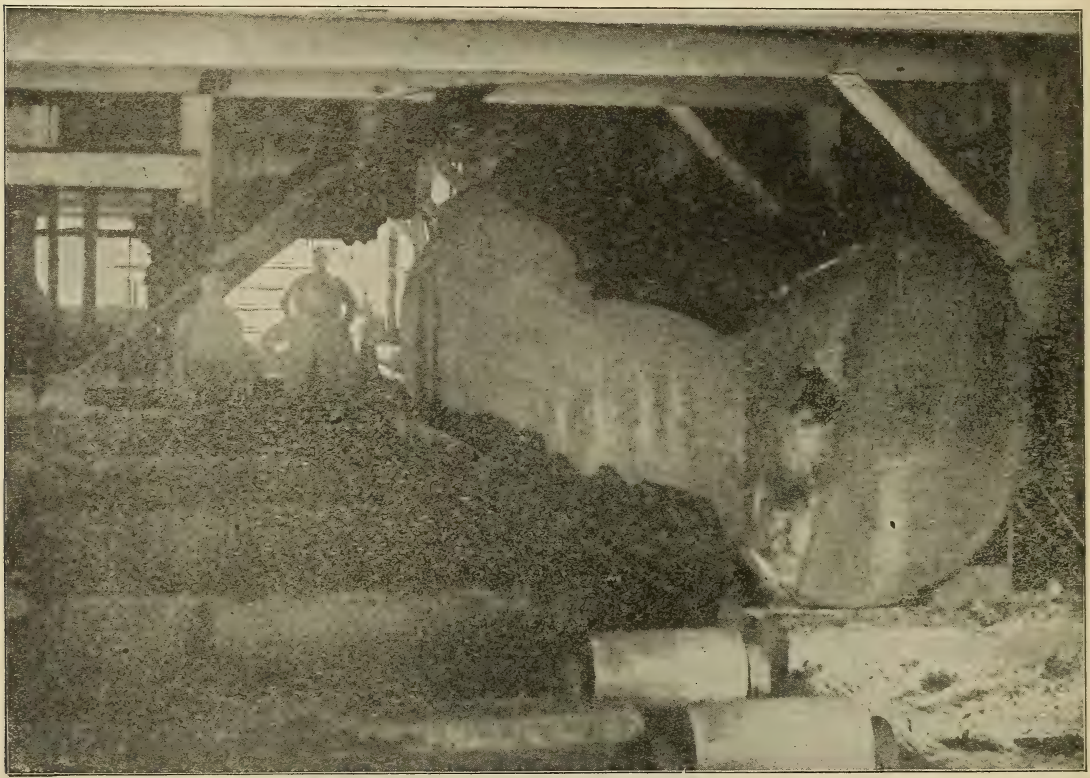
The forests of the eastern section contain large areas of both deciduous and evergreen trees, including maple, oak, chestnut, birch, hickory, walnut, beech, linden, elm and locust. Characteristic trees of the south are oak, long-leaf pine, magnolia and palmetto. The cone-bearing trees include valuable cypress, spruce, hemlock, cedar and larch. The forest areas of the Rocky Mountain ranges bear conifers, aspen and oak. The magnificent forests of Washington, Oregon and California are unrivaled. The trees, chiefly conifers or evergreens, include Douglas fir, yellow pine, sugar pine, and valuable redwood. The standing timber in the United States is estimated at 2,300,000,000,000 feet and the annual cut is 40,000,000,000 feet. Of this conifers constitute three-quarters and the oak and other hard woods the remainder.

In the early history of the country the chief lumbering interests were in Maine,

LOG JAM IN THE LUMBERING REGION OF MICHIGAN.

and the industry there remains very important, although far exceeded in later years by some of the western states. Michigan leads all other states in the lumber industry, with an annual production of nearly 5,000,000,000 feet of lumber and many other incidental products from the timber that is cut. The lower peninsula in Michigan contains the most extensive pine forests in the country, although the area now is largely reduced. Wisconsin and Minnesota are likewise leading states in the production of lumber and in the other forest industries. Georgia, Louisiana and other southern states produce large quantities of hard pine, and such other forest products as turpentine, pitch and tar. The lumber industries of the Pacific coast states are very great, with Oregon and Washington in the lead.

The work of the lumbermen in the northern forests begins in the winter, when hauling on great sleds becomes the easiest way to bring the logs out of the forest. The life in the logging camps of Michigan at this season is one of hard work and little idleness, but the men become strong in it, and return to the same employment year after year. The logs are hauled over the snow to the banks of the rivers, to await the thaw in the spring. When the ice breaks and the melting snows cause the streams to rise, the logs are picked up by the current and carried down stream rapidly toward their destination. This is usually a milling town at the mouth of the stream, where the logs



SAWING A BIG LOG IN AN OREGON MILL.

Copyright, by Detroit Photographic Co.

COTTON READY FOR EXPORT ON WHARVES AT SAVANNAH, GEORGIA.

are turned into lumber. It is at this time that the "log jams" or blockades occur, which call for such bravery on the part of the strong men who are urging them down stream, to break the jam and start the flow once more. On the larger rivers, the logs are sometimes lashed into huge rafts, and are towed by steamers to the milling towns. This is characteristic of the upper Mississippi and some of the larger rivers which flow into it.

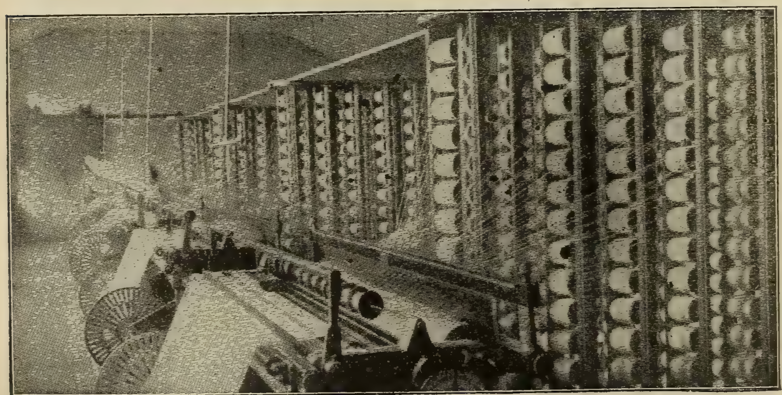
It is these lumbermen who have given to us the material from which millions of homes have been built, our furniture produced, our houses heated and a multitude of other important commercial and domestic necessities provided.

IN A COTTON MILL—TEARING RAW COTTON FROM THE BALE.

TEXTILE FABRICS IN AMERICA

As civilization advances, mankind takes more thought how to be fed and sheltered and wherewith to be clothed. No longer do rude garments of rough skins serve the purpose. Instead, if skins are utilized, they must be the finest furs of the rarest northern animals, cut according to the fashion of the current season and finished with skill and beauty. Wool from the sheep, the camel and the alpaca is sheared, woven and marketed all over the world. Fiber plants are cultivated and utilized most deftly for the making of such fabrics as appeal to the taste. Cotton is not the only vegetable fiber in use for thread, cloth and garments. In different countries, hemp, flax, jute, ramie, cocoanut-bark, pineapple fiber and other products are used locally for the production of cloth. The world over, however, cotton, wool and silk are the materials from which the garments of mankind are made. Linen is much reduced in favor, of late years, as cotton has multiplied. Silk, indeed, is the only fabric materially gaining on cotton and wool, and its advance is a natural one, justified by its beauty and explained by the increase of large trade with Japan, China and India, whence so much of the silk comes.

The United States is the leader in the world's cotton trade. This valuable product was first raised in the United States in Virginia in 1621, and was first ex-



COTTON WEAVING, FROM THE SPOOL TO THE CLOTH.

MAKING HOSIERY—INTERIOR OF A GREAT STOCKING MANUFACTORY.

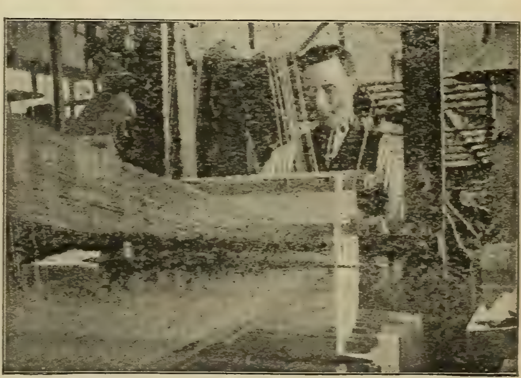
WEAVER AT THE LOOM.

ported from this country in 1747. Within the next fifty years the progress of the industry was steady, but the difficulty in separating the seed from the fiber was the cause of slow growth until, in 1793, Eli Whitney invented the cotton-gin. Since that time, the increase has been enormous and uninterrupted, except during the Civil War, when industry in the south virtually ceased. By this time the acreage annually planted to cotton in the United States approximates 25,000,000, and the annual production is above 10,000,000 bales, the annual value of the crop being about $325,-000,000.

SILK WINDERS AT WORK.

Egypt and India are the countries with the greatest cotton production after our own, but they fall far behind this country. All of our southern states produce cotton, with Texas standing at the head of the list, Georgia and Mississippi as close rivals next, and South Carolina, Alabama, Arkansas, Louisiana and North Carolina following in that order. The greatest cotton shipping ports and markets are Galveston, New Orleans, Mobile, Savannah, Charleston and Richmond.

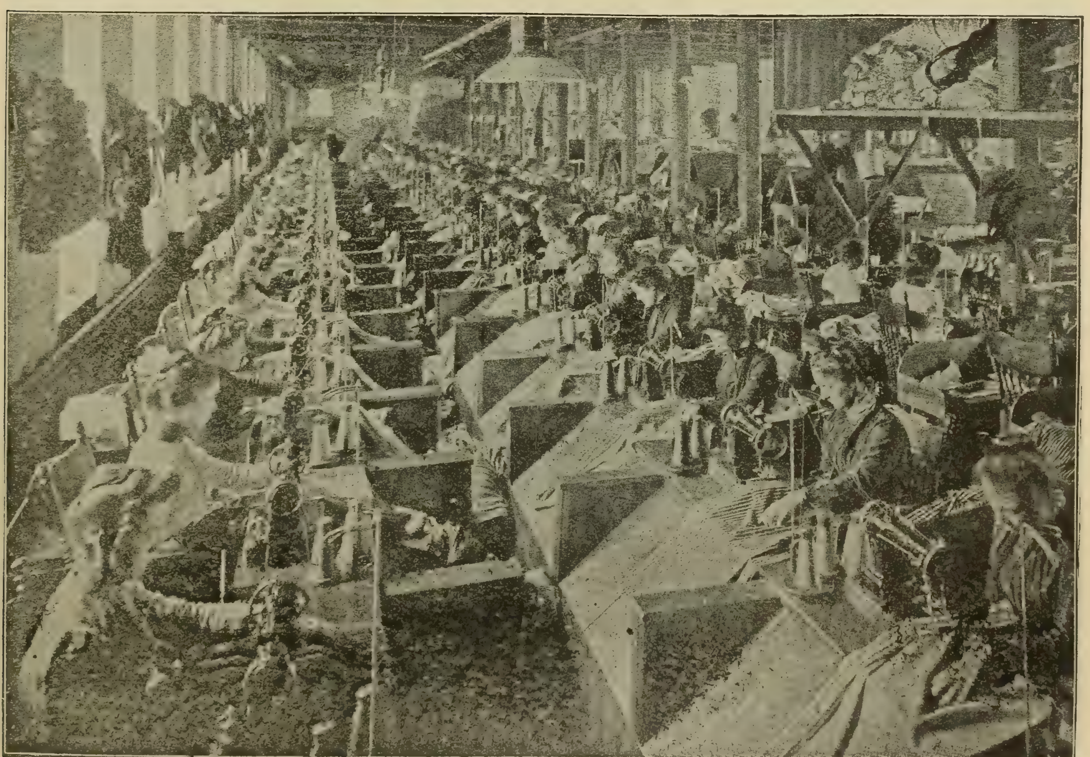
The manufacture of cotton in the United States has been growing rapidly in recent years. In 1890 the number of establishments for the preparation and manufacture of cotton and cotton goods was 2,641, and the capital employed was $366,000,000. For the manufacture of cotton goods alone, apart from mixed goods, there were 905 mills, with an aggregate capital of $355,-000,000, employing 222,000 hands. The annual cost of material used was $155,000,-000, and the value of the products $268,-000,000. Ten years later the showing was greatly increased, chiefly by the establishment of numerous important mills in the southern states themselves. The tendency indicates that the time has come to take advantage of the cheap labor of the south, and the proximity of the cotton fields, to operate more economically and evade surplus freight on raw material.



WEAVING VELVET IN A SILK MILL.

The New England states still stand at the head in the manufacture of textile fabrics. The first cotton mill in the United States was established at Beverly, Massachusetts, in 1787, and one of the first woolen mills at Newbury, only seven years later. Rhode Island is only second to Massachusetts in its cotton mills and likewise stands high in woolen and silk manufacture. Pennsylvania leads in the middle states in cotton and silk. New Jersey stands at the head of the list in the United States in silk manufacturing, with 257 factories, and a capital invested exceeding $20,000,000. There are 26,000 persons employed and an annual value of output of $43,000,000. Among the southern states, North Carolina, South Carolina, Georgia, Alabama and Mississippi have important cotton mills.

The wool clip of the United States approximates 270,000,000 pounds annually, from 36,000,000 sheep. It is in New England and the eastern states that our American woolen goods are chiefly manufactured. The value of the woolen manufactures of Massachusetts alone is about $75,000,000 a year. Nearly all the hemp from which our rope and other hemp products are made, comes from the Philippines, which have a virtual monopoly of the world's product. The development of textile industries is constant and there is an evident improvement apparent in the quality and the artistic beauty of the materials produced.

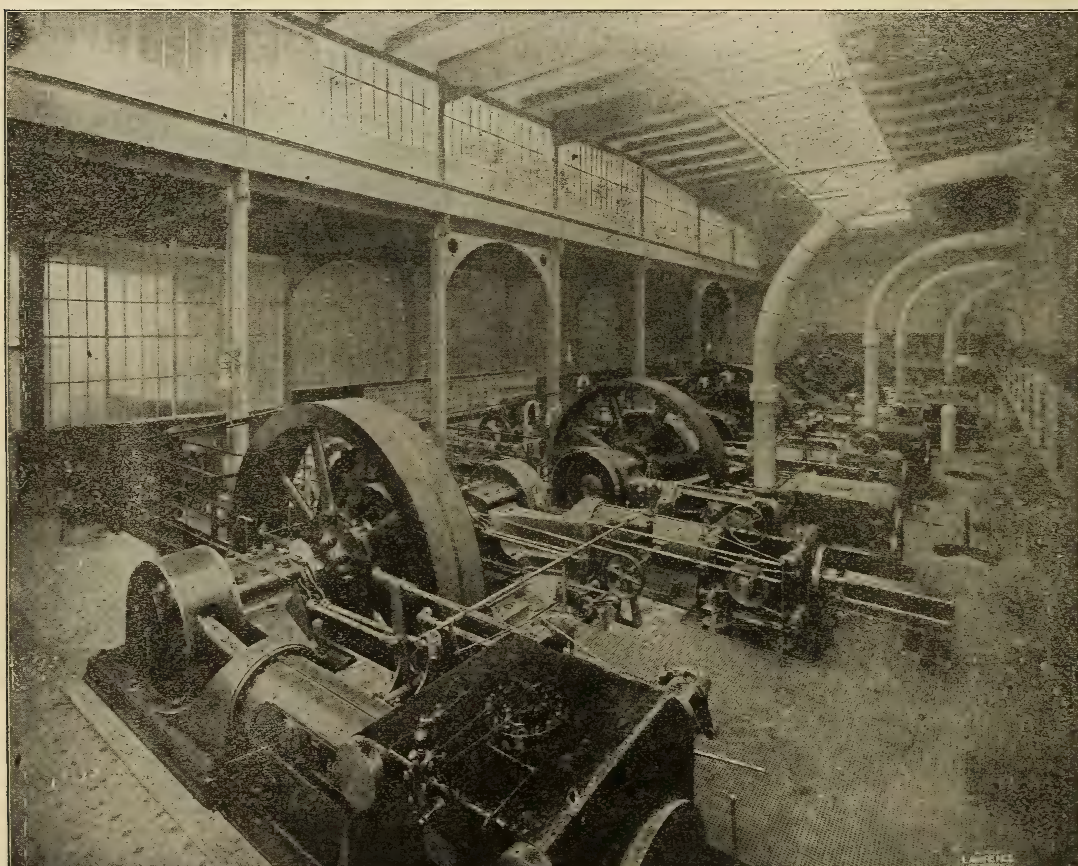


OPERATIVES IN A GREAT GARMENT FACTORY.
All these sewing machines are driven by electricity.

POWER: ITS DEVELOPMENT AND TRANSMISSION

It is a primary truth in natural philosophy that no machine can give off more power than is given to it—that something cannot be generated out of nothing. Logical experimenters have long ago given up the futile effort to discover or invent some process for perpetual motion. Instead, mechanical ingenuity has devoted its inquiry to the search for improvements in the application of power and in the mechanism of it. The most perfect engine that can be imagined would waste some of the power naturally developed, by the loss in friction. The ideal toward which inventors strive is the reduction of friction, so that as much as possible of the power actually produced shall be used for the purpose intended, with as little waste as possible in the mechanism of the engine itself.

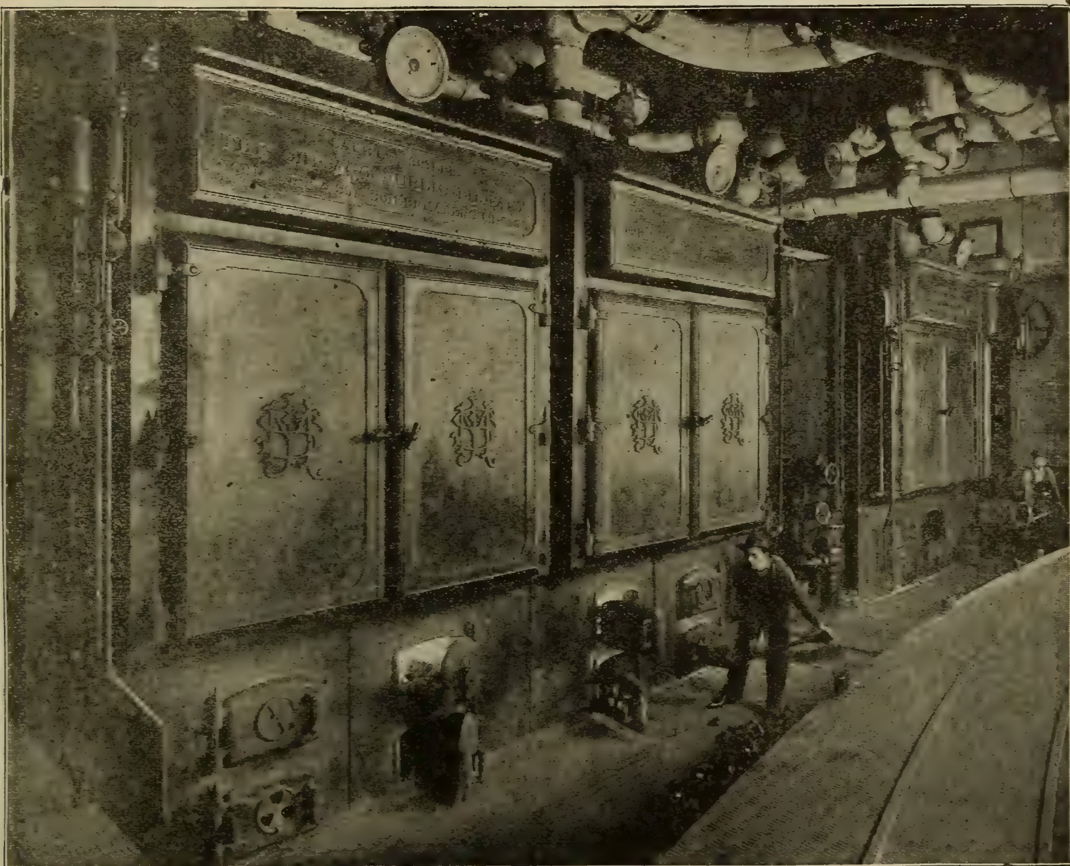
It is the enormous waste of power in transmission that is rapidly causing the cable-railways of city streets to be superseded by electric car lines. Electricity is one of the most economical of all powers to



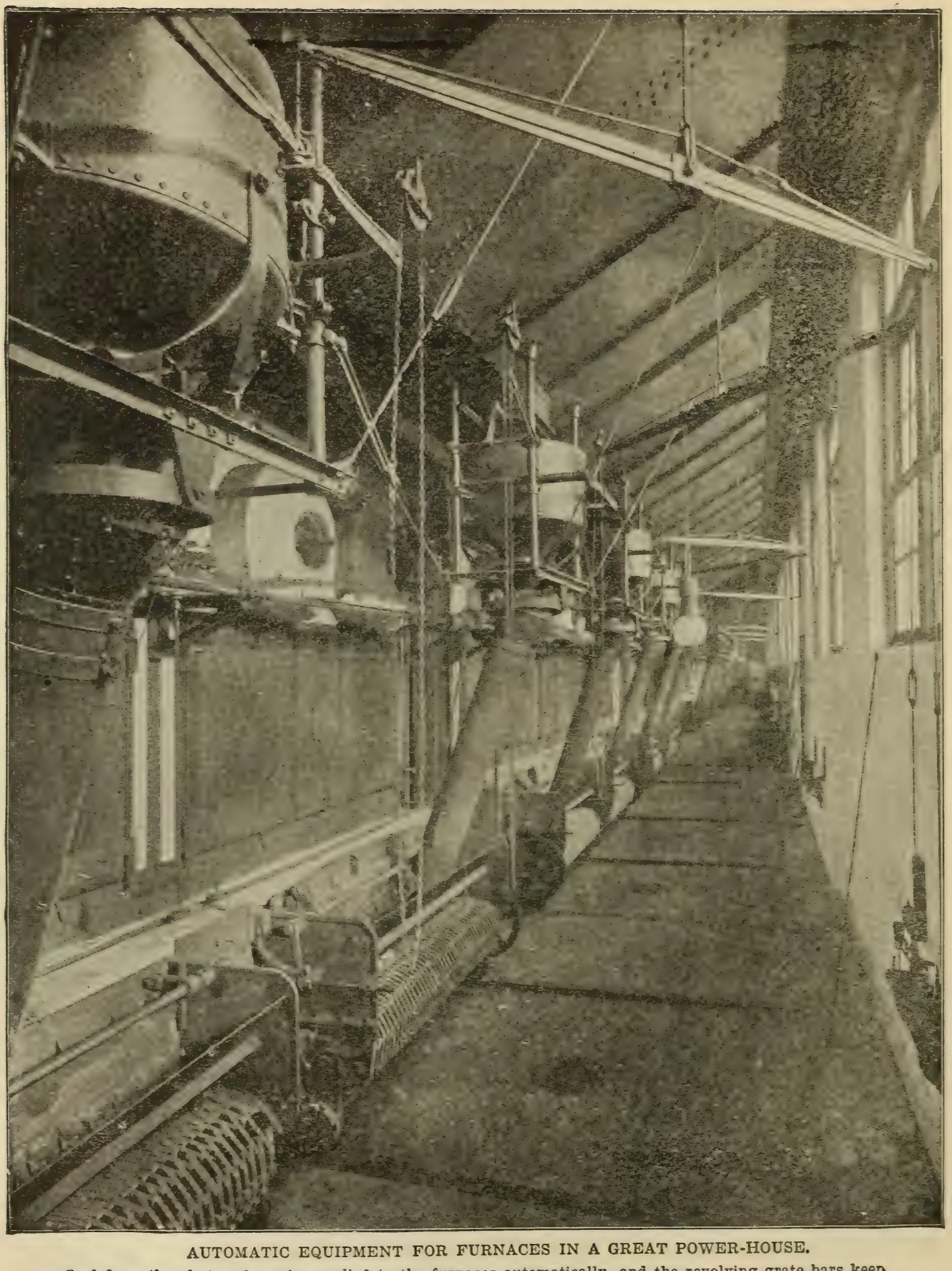
INTERIOR OF A CABLE-RAILWAY POWER-HOUSE.
Showing the cables passing over the wheels which move and stretch them.

transmit, because it is conducted through copper wires for long distances, with comparatively slight loss of the current. The cable system, novel and picturesque as it seemed when the idea was first put into use, requires engines and boilers sufficient to generate an immensely greater power than the actual demands of the cars in service, because so much of the power is used in drawing the cables themselves.

The cable railway of our city streets is operated as follows: In a narrow trench between the rails is a steel cable about an inch in diameter, resting on broad wheels over which it may be drawn as easily as possible. This cable extends in a great circuit from the power-house, throughout the length of the line, over a large pulley, and back by another parallel track of the line, to the power-house again, where it passes over the great wheels connected with the engines which give it its forward motion. In order to cause the cable to move onward continuously at a regular rate of speed, an intricate device for keeping it stretched must be used, which increases the friction. It is evident that the weight of such a cable several miles long, and the friction which it generates in passing over the succession of wheels and pulleys, must



FIRING BY HAND—FURNACE ROOM OF THE CHICAGO PUBLIC LIBRARY.



AUTOMATIC EQUIPMENT FOR FURNACES IN A GREAT POWER-HOUSE.

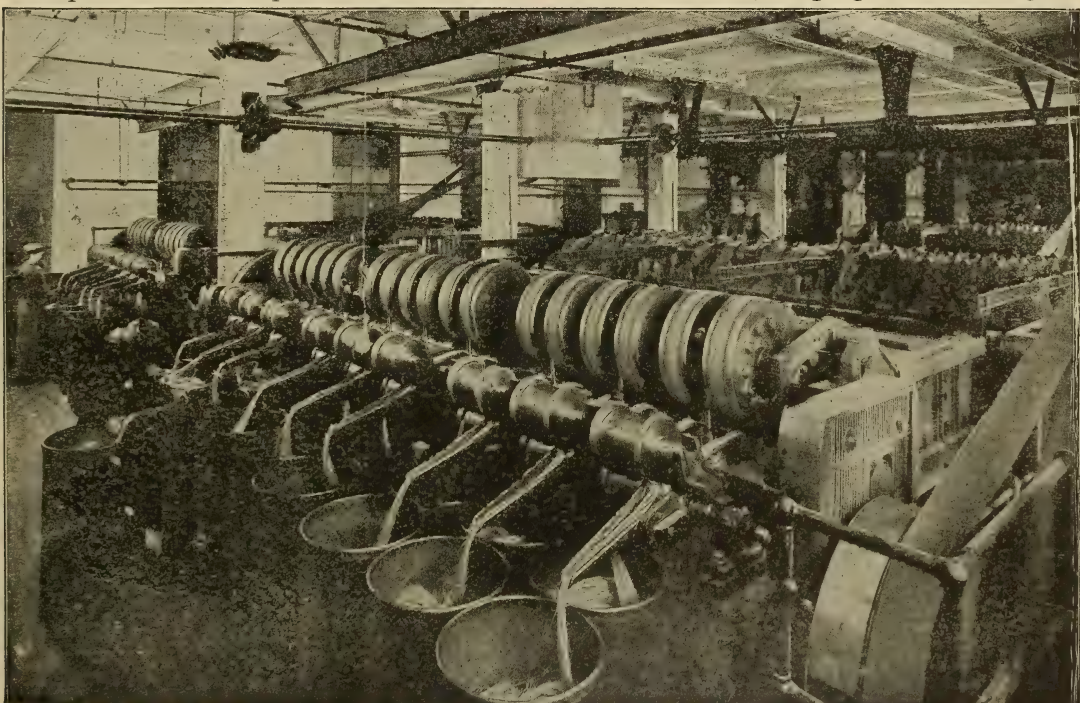
Coal from the chutes above is supplied to the furnaces automatically, and the revolving grate bars keep the fire in good condition.

require a great engine power to move it even were there no cars to be operated.

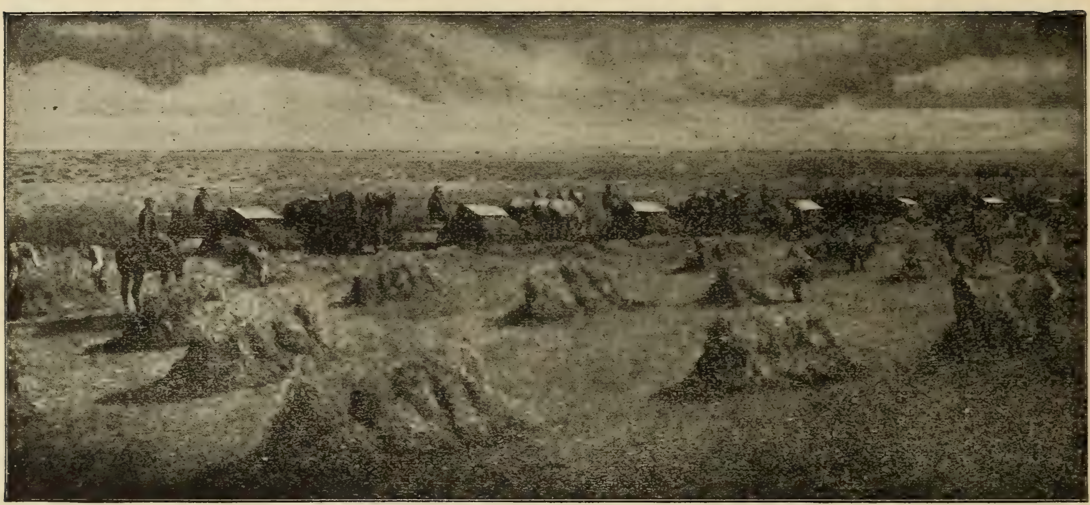
Between the rails of the street car track, over the trench in which the cable lies, is a slot, likewise continuous. Through the bottom of the street car a clutching or gripping device extends, operated by levers above. When it is desired to start the car, the gripman moves the levers, thus grasping the cable below, and when it is desired to stop the car he releases the cable by the reverse motion of the levers. The cable itself is all the time moving. It is the identical principle by which a boy with a sled operates, in winter, when he grasps the trailing rope behind a farmer's wagon and is dragged along the ground at will. The frequent jerks and shifting strains upon the cables as cars start and stop, wear out the steel wires rapidly, and help to make the system an expensive one to operate. And yet in many cities cable railways have proven of great value for years prior to the introduction of electric lines.

The immense power required for large manufacturing plants can hardly be realized by those who have not come in contact with such conditions. Great battleships and passenger liners in some instances have boilers and engines sufficient to develop 30,000 or 35,000 horse-power, or as much as the entire power required for all the machinery at the Chicago World's Fair of 1893. Great factories in some instances, too, require plants of almost as much magnitude. The battery of boilers such as one may see in a modern manufactory on a large scale is an impressive sight.

To some extent firemen have been eliminated in such institutions, by the invention of automatic appliances for supplying coal for the furnaces, keeping the fires in good



MAKING BINDER TWINE FROM MANILA HEMP.



HARVEST TIME ON A NORTH DAKOTA WHEAT FARM.

condition, and removing the ashes and cinders. Coal is dumped into bins above the furnaces, directly from railway tracks. Chutes carry the coal when needed from the bins to the firebox, where it is distributed by other automatic processes, and finally, automatic grate-bars, revolving upon axles at either end of the furnaces like an endless chain, keep the fires shaken down and the refuse removed as regularly and as perfectly as could be done by skilled firemen. Of course such a mechanical equipment requires the supervision of skilled engineers, but it is a great economy in labor for all that.

UP-TO-DATE METHODS IN FARMING

The methods of farming, that greatest of all American industries, have changed almost as much in late years as the methods in any of the mechanical and commercial industries. In the days when railways did not exist, and scientific farm implements had not been invented, the farmer was, indeed, but a farmer, living an isolated life, raising his own food, and consuming his own products in large degree, in virtual independence of his fellowmen.

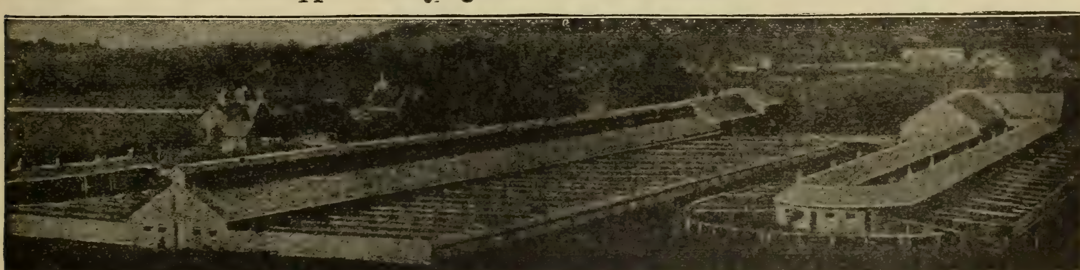
But now the farmer must be an intelligent business man as well if he is to make the highest success of his industry. It does not avail to buy expensive farming machinery, only to let it fall to destruction because it is given no care or protection from the elements. It is an extravagance to waste valuable pasture on inferior stock, which will bring but a low price in market, when good stock may be raised with greater ease and greater profit.

Agricultural colleges, established all over the United States, have educated thousands of young farmers in scientific methods of agriculture, with profit to themselves and their enterprise. Agricultural newspapers, circulating everywhere, form a medium of exchange of opinions and information, thus spreading the educational spirit. The Agricultural Department of the United States Government has become an immense factor in building up the agricultural interests of the country by scientific experimentation and intelligent, practical work. It is this

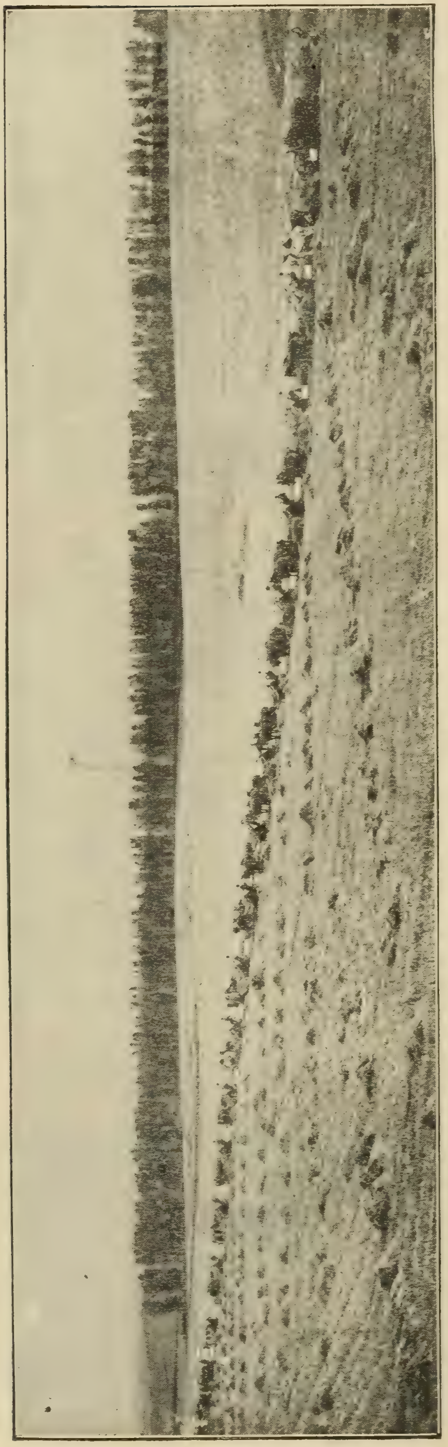
THRESHING MACHINES IN THE FIELD.

Agricultural Department that has been an active influence in preserving the forests and water supplies of the land, in reclaiming the arid and desert land in the west by irrigation systems, and in finding crops adapted for the soil.

Farming and stock raising are not left to the individual husbandman who cultivates his own ground. Like the industries of handicraft, that have grown into great manufacturing enterprises, the promise of wealth in agriculture has attracted men of large ideas and large wealth. On the plains of the southwest and northwest, immense herds of cattle and sheep are grazing, owned by great corporations or energetic millionaires. In the Mississippi Valley great farms have grown in the possession of capitalists, who conduct them as methodically as they would any other productive industry. In North Dakota, for instance, wheat farms of 20,000 acres are not uncommon. A farm of this size requires executive ability, economy of administration and attention to details in order to assure profit, just as truly as would a cotton mill or a coal mine. Batteries of reapers sweep across the wheat fields at harvest time. Platoons of harvest hands work in the fields. And yet even such an enterprise demands skill and intelligence and attention no more truly than does any one of our fertile farms, if the highest results are to be obtained from it for the owner.



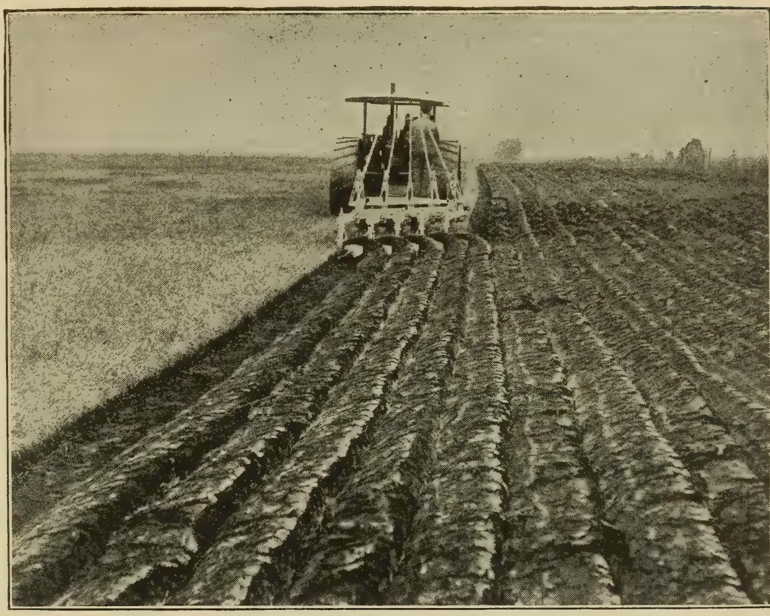
THE LARGEST POULTRY PLANT IN THE WORLD, IN THE STATE OF OHIO.
Annual production 100,000 chickens, 73,000 dozen eggs.



TWENTY HARVESTING MACHINES AT WORK IN ONE WHEAT FIELD IN THE NORTHWEST.

Few people realize the extent to which the efforts of the U. S. Department of Agriculture has improved farming, fruit-raising, and stock-breeding interests in the United States. Through the systematic work of the numerous experimental stations, and the issuance of a large amount of literary matter for gratuitous distribution, productions of the soil have been greatly increased, with a corresponding pecuniary benefit to the people at large, but more particularly to the farmers. The department now has in circulation something like 2,286 publications, treating of various subjects connected with the soil and its products, and the list is being added to continuously. Any person interested may obtain these publications without cost of any kind, even postage, by application to the senator or congressman representing the home district of the applicant, or by application direct to the Department of Agriculture. It sometimes happens, however, that the supply of documents at the disposal of the department may be exhausted. When this happens they may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., on payment of a small fee, generally about 15 cents for each publication.

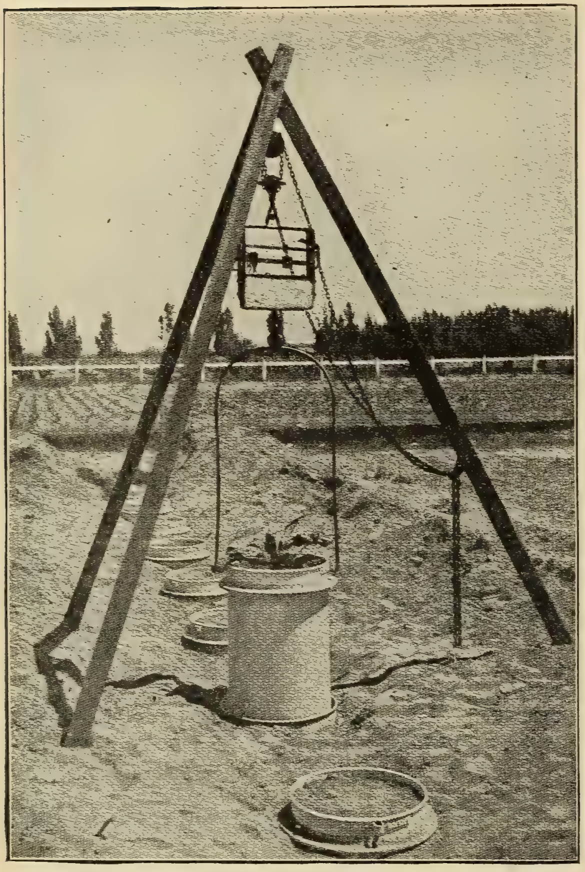
The list embraces pamphlets on the results of Irrigation, Methods of Raising Various Crops, Fruit Culture, Orchard Cultivation, Fertilizing of Soil, Dry Farming, Poultry Raising, Breeding and Care of Livestock, Injurious Insects and How to Get Rid of Them, Forestration, Butter and Cheese Making, Deer Raising for Profit, Road Making, Silos and Their Uses, and a lot of other subjects of vital interest to both farmers and consumers of food products. Each subject is subdivided into various topics, so there may be a dozen or more pamphlets treating of various phases of the same general subject. There are, for instance, thirty different publications covering the important subject of fertilization of the soil. An official list of all the publications issued by the department may be had on application as previously mentioned, and it is then an easy matter to order by number such as are wanted.



TRACTION PLOW TURNING FIVE FURROWS AT ONE TIME.

There is no doubt but that the work thus conducted by the Department of Agriculture has been of inestimable benefit to the country at large. One illustration will sustain this assertion. Two tracts of land immediately adjoining and of indentically the same soil, were selected and sown to wheat. One was cultivated according to the old methods, and the other according to the advice given by the department experts. The same seed was used. The first tract produced 25 bushels per acre, and the one cultivated by department methods 46 1-6 bushels per acre. With wheat at 90 cents a bushel this made a difference of $19.05 per acre in the financial returns. The difference in methods occupied three days of additional time, which gave the farmer $6.35 a day for his extra work.

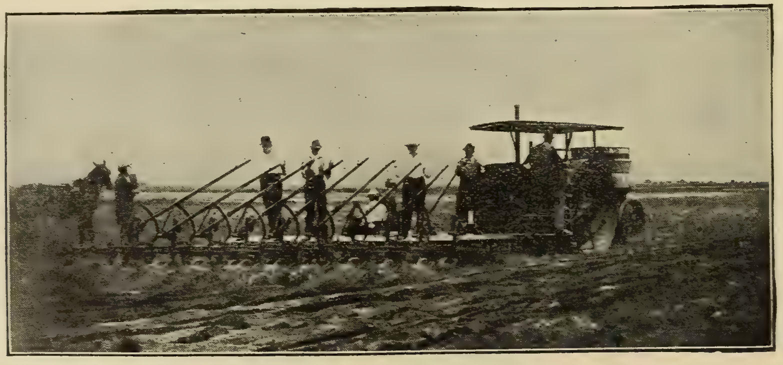
OPERATING A HARVESTING MACHINE IN EGYPT.



GOVERNMENT MOISTURE TANKS.
By lifting and weighing these tanks at regular intervals the amount of moisture necessary for plant growth is determined.

Some of the record yields may be summed up as follows: wheat, 46 bushels to the acre; oats, 80 bushels; potatoes, 300 bushels; alfalfa, 7 tons; corn, 89 bushels; barley, 60 bushels; apples, 1,000 boxes ($1,000); peaches, 1,500 boxes ($1,500); pears, 1,500 boxes ($1,500). Exact figures on cattle, hogs, poultry, etc., are not available, most of these being produced and marketed as side "crops."

Through the efforts of the Department of Agriculture the land owner has been shown how to make his land more productive in money returns, and at the same time to keep it in a condition of ever-increasing fertility, instead of exhausting it year by year. One secret of the increase in wheat yield from a general average af 13 bushels an acre to over 20, may be found in the new method of disk harrowing the stubble immediately after the harvesting of the crop. It was found that the stubble remaining on the ground absorbed a great amount of moisture. By disk harrowing this loss of moisture is prevented, and the ground put into much better condition for the following crop.



TRACTION PLOW TURNING TEN FURROWS AT ONCE.

BURBANK, "THE WIZARD"

Owing to his skill in creating new and valuable varieties of fruits, vegetables and flowers, Luther Burbank, of California, has well earned the title of "the botanical wizard," by which he is now widely known. Some of the wonderful results obtained by Mr. Burbank have been produced by the cross-breeding or hybridization of plants. In this way he produced the primus, or Logan berry, a cross between the raspberry and blackberry, thus securing an entirely new species of fruit which has brought large money returns to the berry growers of the west and northwest. Similar attempts to hydridize the straw·berry and raspberry failed. Another notable result of Mr. Burbank's experiments is the pomato, a cross between the potato and tomato. It took him five years to produce a plant which grows a fine white fruit, delicious in taste when eaten raw, preserved, or stewed like an ordinary tomato. In the same way Mr. Burbank has propagated new species of apples, plums, pears, peaches, flowers and even nuts, one of his triumphs in the latter class being chestnut trees which at eighteen months of age yield crops of large, succulent nuts.

MACHINE WHICH HUSKS AND SHELLS CORN, AND CUTS THE FODDER IN ONE OPERATION.

In addition to scientific cross-breeding, Mr. Burbank has made a long study of the effects of the "survival of the fittest" by careful propagation of the soundest, hardiest, and most productive plants. Taking for instance, an unusually beautiful flower, a notable specimen in a large field, he would reproduce flowers from the seed of this one specimen only, destroying the rest. The following season he would again select the seed from the finest plants, and so on through a succession of years until he had secured a perfect result.

The cactus, in its natural state armed with fierce spines and worthless to man or beast, has been transformed into a spineless plant bearing rich and nourishing fruit for man, and its stalks and leaves affording valuable food for horses and cattle.

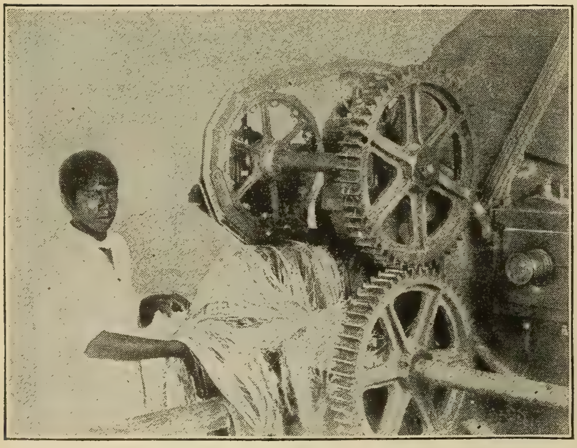
Mr. Burbank's object lessons have been worth millions of dollars to the farmers of the United States. Aside from the production of new species by cross-breeding, he has shown the farmers how they may largely increase the yield of their lands, raise a finer quality of crops, and get more money for them, merely by careful systematic selection of seed. It was formerly the practice to use any kind of corn for seed. Now the intelligent farmer selects only the finest ears and from these rejects the tip end kernels, and all others that are not plump and perfect. The result is much larger crops and a better grade of corn.

HOW BINDER TWINE IS SECURED.

An important item of expense in connection with the harvesting of small grains, such as wheat, rye, barley and oats, is the binder twine used on the modern harvesting machines for the automatic tying of the bundles. Formerly this twine was made almost entirely of a fibre obtained from a species of banana tree, grown in the Philippines, and known to the trade as "manila." Recently, however, the McCormick Harvester Co. has introduced a new binding twine which, owing to its relative cheapness, and the ease with which it is secured, has come into almost general use. This new twine is known as sisal. It is made from the fibre of the leaves of the henequen plant, which is extensively grown in Yucatan. The underleaves are cut off and passed through a machine which squeezes out the juice and other worthless material, the clear fibre being delivered at the other end of the machine. This fibre is then hung out in the sun to dry, and afterward spun into twine.

PLANT FROM WHICH TWINE IS MADE.

DRYING THE SISAL FIBRE IN YUCATAN.



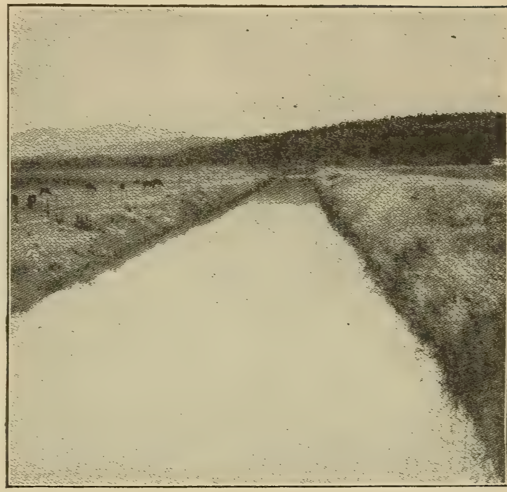
MACHINE FOR SEPARATING SISAL FIBRE.

IRRIGATION

Irrigation projects, planned and paid for by the United States government, in the arid and semi-arid states, have brought under cultivation fully 500,000 acres of hitherto waste lands, and when fully completed will make productive 2,700,000 acres. These irrigating works will cost $70,000,000, an average of about $30 an acre. This cost is repaid to the government, by the settlers who take up the lands, in ten annual installments, after which the settlers own the irrigation plants and are under no expense except that of maintenance.

The district in which irrigation projects are either completed or well under way embraces Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Washington and Wyoming.

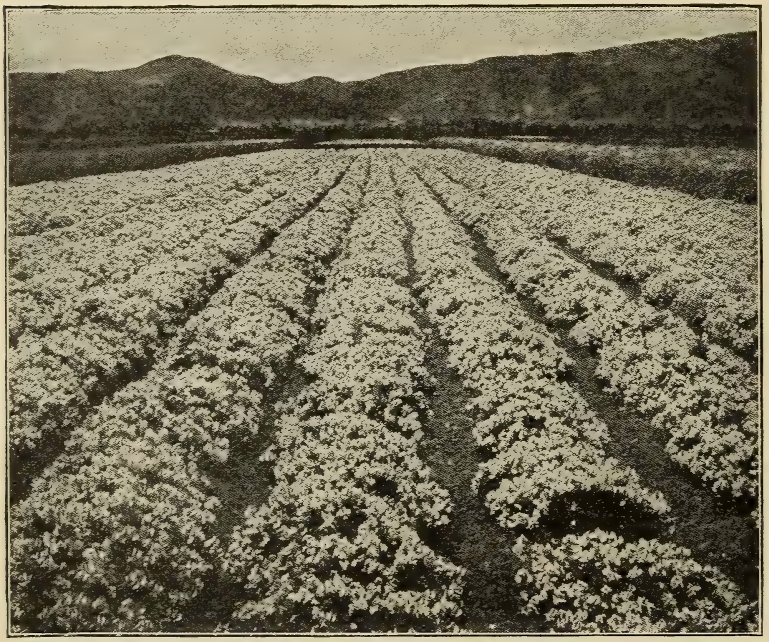
There are several methods of providing water for irrigation purposes. One is by direct diversion of a stream through lateral ditches. This system requires that the stream be on a level, or slightly above, the land to be watered. Another is by pumping the water from wells, or from streams, into reservoirs. In this latter case there is the objection to the cost of pumping, unless motive power can be obtained by means of a waterfall. The most common source, and the cheapest in the end, is by the building of dams, which back up the water, forming huge reservoirs from which it is fed into a main canal. From this canal the flow of water into lateral ditches is regulated by means of "gates." This is the method used almost exclusively in government irrigation works. From the lateral ditches the settler cuts his own cross ditches.



MAIN LATERAL FOR SUPPLYING FURROWS.

IRRIGATING A POTATO FIELD.

There is no set rule as to the amount of water to be delivered to the land owner. It depends upon the requirements of the locality, the nature of the soil and kind of crops cultivated. A sandy or loam soil will need more water than a clayey soil as it will soak away faster. Alfalfa needs more moisture in its early stages than almost any other crop. In Montana, Wyoming, and Idaho, as well as in parts of other states, water is usually delivered in continuous streams which for an average-size farm seldom exceed 80 miner's inches, or 2 cubic feet, per second. The supply ditches for the farms are accordingly small, except for the large holdings.



MILE LONG ROWS OF IRRIGATED PEAS.

In Utah, New Mexico, Arizona, California, and to some extent in other states and territories, water is delivered to the user during short periods of time, with long intervals between when the supply is entirely shut off.

In the citrus orchards of California the size of the streams delivered varies from 30 to 60 miner's inches. (In southern California 50 miner's inches are equal to one cubic foot per second.) At Riverside, where the soil is a clay loam, the usual allotment is 30 inches for forty-eight hours once a month, or 30 inches for seventy-two hours every six weeks on a 10-acre tract. Around Pomona, where the soil is sandy, the usual head is from 50 to 60 inches, the larger head being for a shorter time.

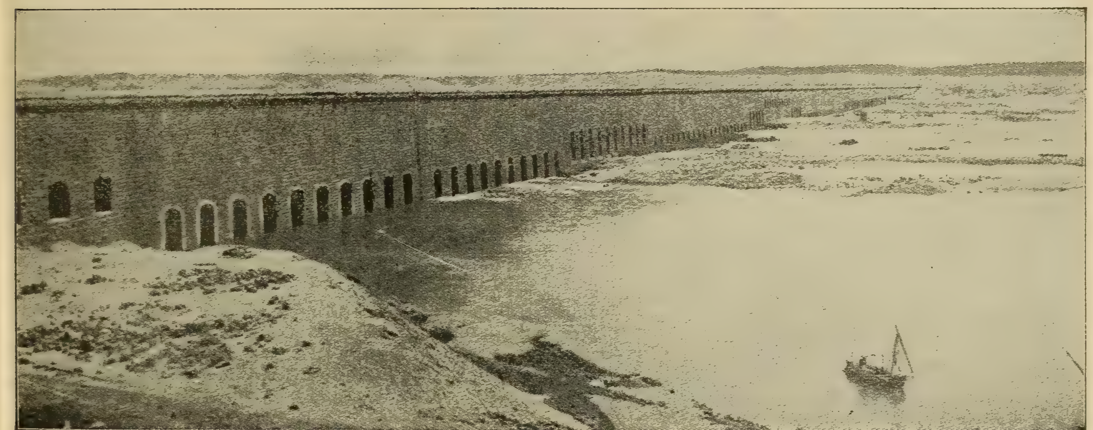
On the diversified farms of Utah and Colorado the supply ditches vary in capacity from 50 to 150 miner's inches.

Recent investigations made by the U. S. Office of Experiment Stations have shown that the quantity of water which plants use forms but a small part of that which is diverted from streams for irrigation purposes. Large volumes are lost by absorption and seepage in the earthen channels of canal systems. Similar losses occur in the ditches which supply farms, and a large part of the remainder is wasted in irrigating crops. The farmer is chiefly concerned in lessening the waste of water in his supply ditch and on his farm. In localities where water is scarce, the supply ditch should be made watertight. This may be done by lining the channel with cement concrete, cement plaster, asphalt, heavy crude oil, or clay puddle. Flumes or pipes may also be used as a substitute for an earthen ditch.

Plants will usually indicate by a change in color or by their general appearance whether they need water or when they have been over-irrigated. Most field crops turn to a darker green when in need of water, and the leaves and stems show a tendency to droop or curl. The lower leaves assume a pale yellow. A crisp or dead appearance in the lower leaves is one of the best indications that a plant needs water. Grain which has suffered from drought may mature, but the straw will be small and short and the kernels will be shrunken and inferior in quality. Alfalfa and similar crops have the appearance of cured hay. Where field crops are over irrigated the color of the foliage becomes a yellowish green and the plants have a sickly appearance. These indications vary with the quality of the soil, so that it is impossible to lay down fixed rules to govern the number or frequency of irrigations. Only close observation for a number of years on the same farm will enable a person to tell by the appearance of the plants whether they need water or not.

IRRIGATION OF THE NILE REGION

BARRAGE AT ASSIOUT—2,750 FEET LONG



SOUTH OR UPSTREAM SIDE OF THE DAM AT ASSOUAN, FROM WEST BANK.

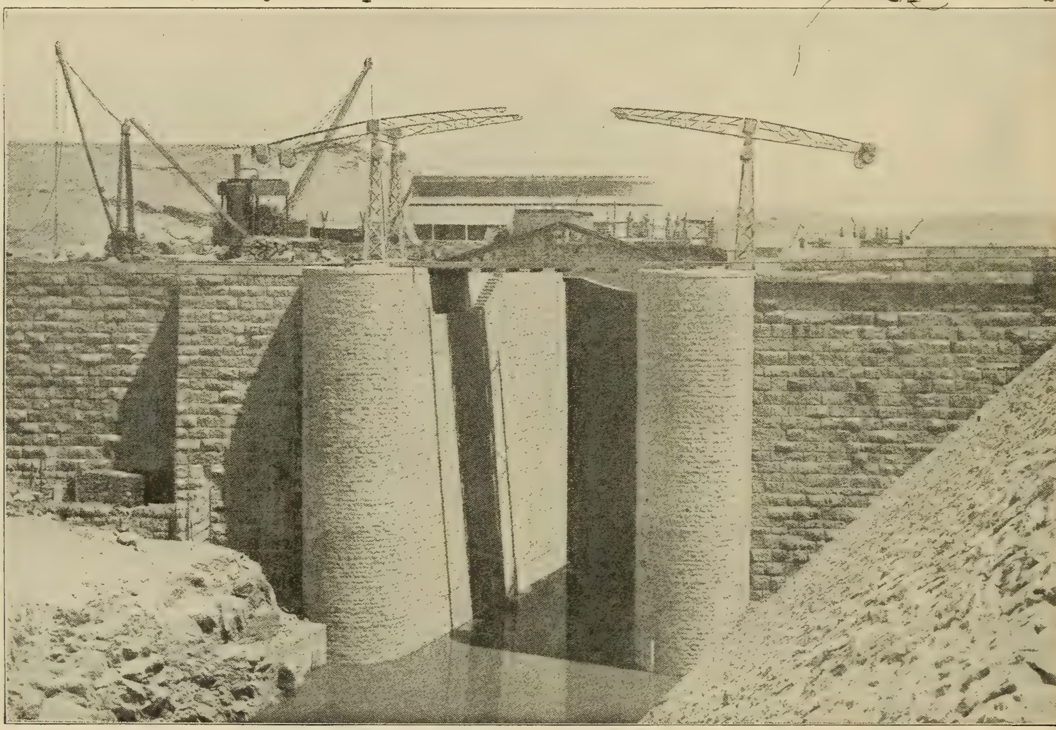
Total length, 1¼ miles; maximum height above foundation, 130 feet; difference of water level above and below, 67 feet. Total weight of masonry, over 1,000,000 tons.

The monumental dam at Assouan, which is by far the greatest achievement of its kind in ancient or modern times, forms a reservoir in the Nile valley capable of storing 1,000,000,000 tons of water, practically creating a lake more than 140 miles long. The foundation stone was laid by the Duke of Connaught on February 12, 1899. At times fifteen thousand men have been employed, and work has gone on day and night. At other times, when the Nile was in flood, labor had to be suspended for several weeks.

One gains a clearer idea of the magnitude of the task by recalling the first step taken; that was, to divert the channel and excavate in the rocky river-bed a trench one hundred feet wide and as many feet deep, in which to lay a concrete foundation for the massive piers.

At its best, and controlled, the Nile is very generous, as befits the majesty of its three thousand miles. Joseph the Israelite drew some of his prosperity from it. One of the irrigation canals he planned for Pharaoh's people is still in use. But in most moods the Nile is a sullen and inconstant stream, and even in the days when Egypt was the granary of imperial Rome there seems to have been no comprehensive attempt to govern it.

Napoleon had a faint perception of the thing that needed to be done when he suggested a dam near Cairo. That, he realized, would double the cultivable area around the river's mouth. In the earlier portion of the 19th century two barrages were actually built at that spot by a French engineer—badly built, however, and useless until, of recent years, the British reconstructed them. This work consists, in effect, of two brick arched viaducts crossing the Rossetta and Damietta branches of the Nile, having, together, 132 arches of 16-feet-four-inches-span, which were entirely closed by iron sluices during the summer months, thus heading up the water about 15 feet and throwing it at a high level into the six main-irrigation canals below Cairo. In the summer months the whole flow of the Nile is arrested and thrown into the aforesaid canals.

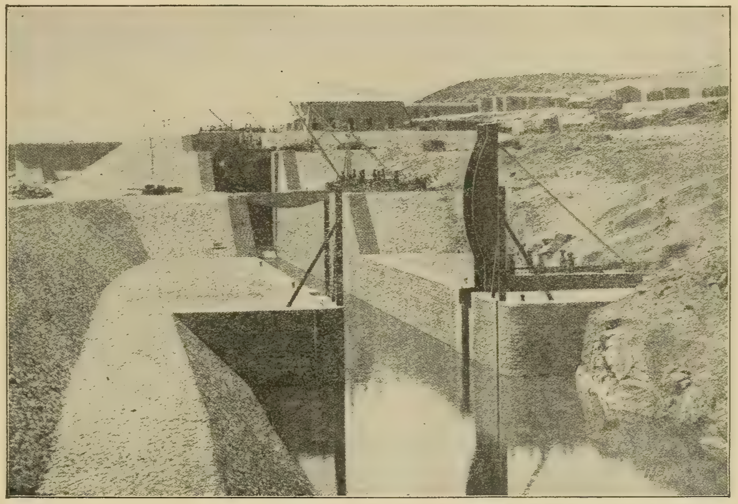


THE GREAT DAM AT ASSOUAN.
Entrance to locks of navigation channel from the south.

The most important of the works constructed to enable the water stored up in the great reservoir to be utilized to the greatest advantage is the barrage across the Nile at Assiout, about 250 miles above Cairo, which was commenced by Sir John

Aird & Company in the winter of 1898, and completed in 1902. In general principle this work resembles the old barrage at the apex of the delta; but in details of construction there is no similarity, nor in material, as the old work is of brick and the new one is of stone. The total length of the structure is 2,750 feet, or rather more than half a mile, and it includes 111 arched openings of 16 four-inch spans, capable of being closed by steel sluice-gates 16 feet in hight.

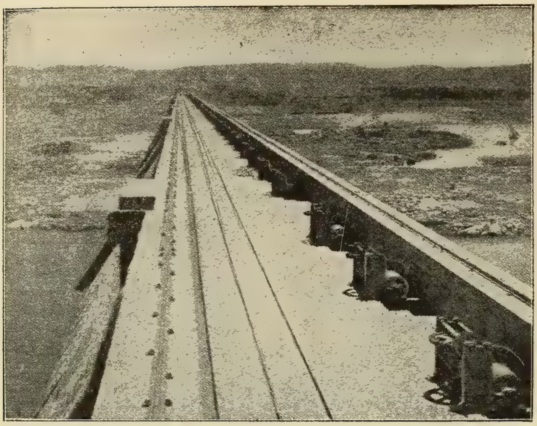
The object of the work is to improve the perennial irrigation of lands in Middle Egypt and the Fayoum, and to bring an additional area of about 300,000 acres under such irrigation by throwing more water at a higher level into the great Ibrahimick Canal, the intake of which is immediately above the barrage.


THE NAVIGATION CHANNEL ENTRANCE LOCKS FROM THE NORTH.

The total length of the dam is about a mile and a quarter; the maximum height from the foundation is about 130 feet; the difference of level water above and below, 67 feet; and the total weight of masonry over 1,000,000 tons. Navigation is provided for by a "ladder," of four locks, each 260 feet long by 32 feet wide. As with the case of Assiout, the difficulties in dam construction are not in design, but in the carrying out of the works. When "rotten rock" in the bed was discovered, Sir Benjamin Baker frankly reported to Lord Cromer that he could not say what the extra cost and time involved by this and other unforeseen conditions would be, but that, however bad the conditions, the job could be done. He was told to go ahead with the work.

The first channel was successfully closed on May 17, 1899, the depth being about 30 feet and the velocity of the current about 15 miles an hour. In the case of another channel, the closing had to be helped by tipping in railway wagons themselves, loaded with heavy stones and bound together with wire ropes, making a weight of about 50 tons—this great mass being necessary to resist displacement by the torrent. These rubble dams were well tested when the high Nile ran over them; and on work being resumed in November, after the fall of the river, water-tight sand-bag dams, or "sudds," were made around the site of the dam foundation in the still waters above the rubble dams, and pumps were fixed to lay dry the bed of the river.

This was the most exciting time in the early stage of the operations, for no one could predict whether it would be possible



LOOKING TO THE EAST ALONG THE TOP OF THE DAM.
Regulating gear for sluices to the right.

to dry the bed, or whether the water would come pouring through the fissured rocks in altogether overwhelming volumes. Twenty-four 12-inch centrifugal pumps were provided to deal if necessary with one small channel; but, happily, the sand bags and gravel and sand embankments staunched the fissures in the rock and the interstices between the great bowlders covering the bottom of this channel, and a couple of twelve-inch pumps sufficed.

ARMY OF WORKERS.

The masonry of the dam is of local granite, set in British, Portland-cement mortar. The interior is of rubble set by hand, with about 40 per cent of the bulk in cement mortar, four parts of sand to one of cement. All the face work is, of course, rock-faced ashlar, except the sluice linings, which are finely dressed. The maximum number of men employed on this dam was 11,000.

OLD SYSTEM OF IRRIGATION.

The old system of irrigation was little more than a high Nile flooding of different areas of land or basins surrounded by embankments. Less than a hundred years ago, perennial irrigation was first attempted to be introduced by cutting deep canals to convey the water to the lands when the Nile was at its low summer level. When the Nile rose, these canals had to be blocked by temporary earthen dams, or the current would have wrought destruction. As a result, they silted up, and had to be cleared of many millions of tons of mud each year by enforced labor, much misery and extortion resulting therefrom.

Moreover, the old canals and the dams at the delta barely touched the surface of Egypt's irrigation problem, the problem of avoiding drouth and making waste lands fertile. The great dams at Assouan and Siut, "inaugurated" in the summer of 1903, go to the bottom of things in more than one sense of the word.

At Assouan, near the First Cataract, nearly six hundred miles from Cairo, the Nile is a mile wide. The dam is a quarter-mile wider, a great granite wall that rises ninety feet above the

EARLY IRRIGATION IN EGYPT.
Most primitive methods of farming prevail.

level of low Nile, and is sixty feet wide at the top.

When the river is in flood, its waters gush through one hundred and eighty massive sluice-gates. In autumn the sluice-gates are closed until the reservoir thus formed is full, ready to be distributed through canals and ditches over the agricultural land on either side. In April and August, when the water is most wanted for the crops, the supply in the lower river is increased from the reservoir.

THE DAM AT SIUT.

At Siut, about half-way between Assouan and Cairo, is a subsidiary dam a half-mile wide, with more than one hundred sluice-gates. Broadly speaking, the two reservoirs add $400,000,000 in land values to the region covered by their operation.

OLIVE CULTURE ON AN EXTENSIVE SCALE

THE WORLD'S BIGGEST OLIVE ORCHARD.

The United States has no rival as far as climate and other resources are concerned. In the West India Islands which we have acquired, in Samoa, in the Hawaiian Islands, and in the Philippines, can be produced every tropical product that has a commercial value. Hereafter, we may grow our own spices and tropical fruits, our coffee and our hemp, and numerous other peculiarly tropical productions, which are not produced in the United States proper.

RESOURCES OF THE UNITED STATES IN CLIMATE AND SOIL.

In our own country, between the Atlantic and the Pacific, from British America on the north, to Mexico on the south, we have such a variety of resources from the soil and the mountains, from the forests and the plains, as to make us almost absolutely independent of the world's markets, if by chance we should be isolated from them. It is true that no part of the United States is in the tropics, yet in Southern California and Florida the balmy climate makes the cultivation of most of the more important tropical plants possible.

In Southern California is located the largest olive orchard in the world. There are also others that outclass the olive groves of the Mediterranean in size. Only in a limited area of central and southern California, and in New Mexico and Arizona, can the olive be produced, in this country. It is quite certain, therefore, that there will not be an over production.

ORIGIN OF THE OLIVE IN CALIFORNIA.

Olive orchards in Italy are looked upon as perpetual fountains of wealth. It is more than a hundred years since the first of these orchards was planted by the Spanish mission fathers of California, who did so much to influence the early industries and life of that state when it was a part of Spanish Mexico. The success of their olive-tree cultivation proved the adaptability of the climate, and ever since that time the industry has been steadily growing. From the olives that are grown in California is produced from 24 to 31 per cent of oil. They are richer and more palatable, when pickled, than are the imported green olives from Italy. The demand for ripe olives is steadily on the increase, and in the year 1902 it was about 30 per cent more than in the preceding year.

THE OLIVE TREE MORE VALUABLE WHEN OLD.

The older the olive tree becomes, the more valuable it is to its owner, because of its prolific bearing. The wood of olive trees is highly prized by cabinet makers, for it is exceedingly hard and susceptible to a high polish.

THE WORLD'S BIGGEST OLIVE ORCHARD.

This mammoth enterprise is located at Sylmar, twenty miles from Los Angeles, California, in a beautiful amphitheater in the Sierra Madre mountains.

The ranch contains more than 120,000 trees. There are 1,200 acres under cultivation, covering an area whose greatest length is three miles and whose breadth is two and one-half miles. Each acre contains 110 trees, and it is estimated will produce 2,000 gallons of olives yearly for the next 20 years. This amount will make 250 gallons of oil, which, at $2 per gallon, will make the revenue $500 per acre. There are forty miles of roads within the ranch. Two hundred and ten thousand dollars has been invested in the orchard and $15,000 in the factory. The crop of 1903 is valued at $225,000.

TEN TIMES LARGER THAN SPAIN'S GREATEST.

Although the olive tree has been cultivated for more than 4,000 years, and olives have formed a staple food of some of the oldest races of earth, yet the young orchard at Sylmar is ten times as large as the largest olive orchard in Spain or the Holy Land.

One hundred and fifty men are employed in gathering the olives in harvest time, which is throughout the months of November, December, January, and on into February. The olive berries frequently weigh down the branches until they touch the ground. Two hundred pounds is a good average day's pick, at an average wage of about $1.50 per day.

The Sylmar ranch was planted about 1894, and the trees yield about 50 pounds of olives each. An olive tree does not come into bearing until it is four or five years of age. As the trees are supposed to live 4,000 years, indeed, some of the trees on the Mount of Olives, in the Holy Land, are known to be over 3,000 years old—an olive orchard may be reckoned on permanently.

BILLOWY EXPANSE OF SILVER GRAY.

The big olive orchard at Sylmar presents a vision of surpassing loveliness. As far as the eye can reach it is one sweeping, billowy expanse of silver gray. The olive trees themselves are not unlike willows in their graceful, somewhat drooping, silhouette. The trees are arranged in orderly rows, and near at hand one sees the peculiarly beautiful shade known as olive green, which becomes a silver gray whenever a breath of wind discloses the under side of the leaf. In the distance the perspective reduces the size and assembles the trees, producing an effect much like a waving field of grain.

The earth on the surface is always carefully pulverized, and, consequently, the water has been drawn up by capillary attraction. There is a strong underground seepage from the surrounding hills.

MAMMOTH SICILIAN OLIVE TREES.

In Sicily, olive trees have been known to attain enormous size, one having grown to the dimensions of 26 feet in circumference, with an expanse at the top of fully 150 feet.

Italy produces, annually, 70,000,000 gallons of olive oil; Spain, 23,000,000, and the United States, about 7,000,000.

The olive berry always grows on new wood, and, in order to increase the yield, the tree is "cut back" and new wood springs out, which bears fruit the second year. It is said that the roots of the olive tree extend as far into the earth as the branches rise above the soil.

GATHERING THE CROP.

The olives are carefully gathered in canvas buckets made for this purpose, and are brought to the factory in spring wagons, to keep them from bruising. The berries are gathered when ripe, although "ripe" olives are frequently "green" in color. After they reach the factory the olives are graded into "ones," "twos," or "threes," according to size. They are then put into a solution of one pound of lye to ten gallons of water. This takes out the bitterness. Here they remain a week to ten days. Then the lye is soaked out by fresh running water, and if they are for table use they are put into a solution of brine, where they remain permanently until bottled up or shipped away.

The olives to be used for oil are gathered from the tree a good deal riper than those used for the table. The oil is extracted by a series of "crushers" and hydraulic presses, which are composed of materials that will not absorb odors, stone and metal being used as much as is possible.

CRUSHING AND PRESSING.

In Italy the olive fruit is crushed and pressed by a simple process. A platform of strong masonry is made about 40 inches high and ten feet long, the surface of the top being slightly hollowed. At the center a strong, vertical, wooden axis is erected, to which is affixed, at right angles to the platform, a millstone about 12 inches broad and weighing about 1,600 pounds. By means of a shaft and yoke beam, a donkey, or ox, slowly moves the stone around. The olives are emptied into the mill trough and crushed to pulp, one attendant constantly turning the mass over with a shovel. In half an hour about 200 pounds can be thus crushed. The thick pulp is then put into soft flat rush baskets, each having only a small aperture in the top, and these are arranged in the press in layers, one above another, up to 15, mouth upwards. Wooden boards are then laid across, and then comes the strong cross beam of the press. To this is attached a strong wooden screw, worked by a lever in the hands of six or eight men, first slowly, then faster, and finally screwed home. The oil flows readily, and runs through a shoot into a hogshead below, filled up to four-fifths of its capacity with water, so that as the oil runs in, the heavy impurities may be deposited and the soluble matter taken up by the water, leaving the oil to collect on the surface. The pulp is thus passed through the mill, two, three or four times, and the final residue, amounting to about 70 per cent of the original fruit, is mostly sold to the large oil works, where it is worked over again. Formerly, it was disposed of to the bakers for heating their ovens.

HOW RUBBER IS MADE TO-DAY

But two centuries have elapsed since rubber was known only as a curiosity; to-day it is in common use in nearly every industry and household.

THE PROCESS OF KNEADING.

The system by which crude rubber is brought down to merchantable condition, is a simple method of kneading by steam rollers. First the crude rubber is soaked in hot water for several hours. After this operation, it is cut up into pieces of convenient size and run through a washer, which is a machine equipped with heavy corrugated steel rollers. Here it passes through and through until it is crushed and mangled, all the time being washed clean of bugs and other impurities, that get into the rubber tree. The rubber is very sticky and after the washer has completed its work, one sees nothing but a sticky mass in long sheets. These are allowed to dry and then are run through heavier rollers.

THE PROCESS OF MIXING.

After this process the rubber is run through the "mixers," which consist of large hollow steel rollers having steam pipes inside of them, to furnish heat in the operation of mixing, and also a set of water pipes by which the rubber may be cooled when necessary. Through the rollers the rubber passes. So adhesive is it that it sticks fast to the rollers and has to be constantly cut off by means of a sharp knife, and thrown back, for another rolling. Great power is needed for this process because the sticky mixture retards the rollers. When the kneading is all but completed, a coloring compound is added to the mass to give it the tint desired in certain kinds of uses for which it is intended.

THE PROCESS OF COMPRESSING.

After this, the rubber is run through four polished steel rollers, one above the other, and here it gets its proper thickness. These rollers or "calenders" are used also for crushing the rubber into cotton ducking, for making rubber cloth, etc.

Manufactured rubber goods are made by this method of compression instead of by melting and pouring into molds.

THE PROCESS OF VULCANIZING.

Charles Goodyear discovered the process of vulcanizing rubber, a process which consists in changing the chemical composition of rubber by heat, whereby its sticky and

YOUNG RUBBER TREE.

elastic properties are removed and the rubber is given greater durability. This process consists in submitting the rubber to a great pressure under heat, by means of hydraulic presses. Generally, about 2,000 pounds are brought to bear, and the presses are connected with steam so as to secure the desired heat.

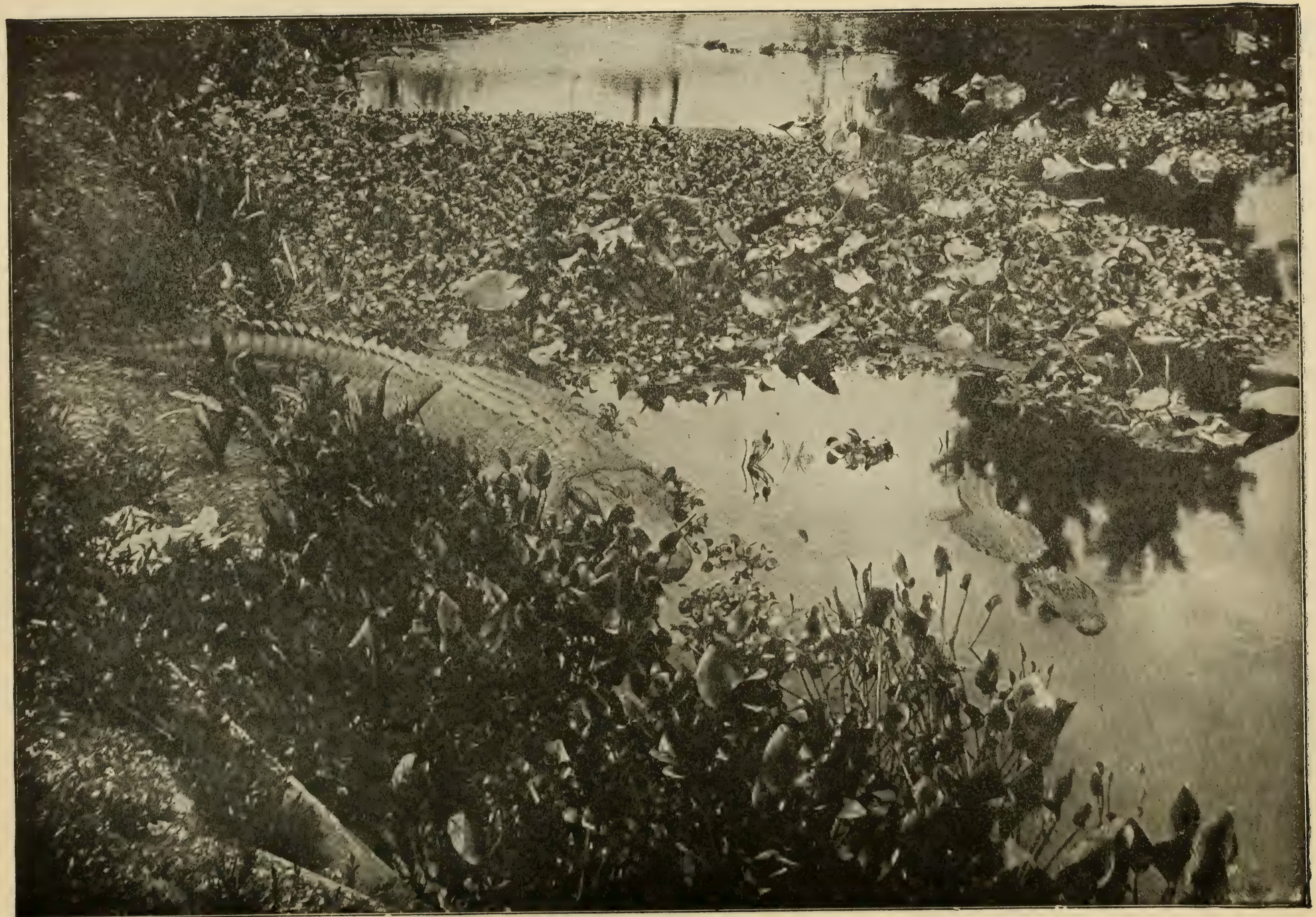
ODD METHOD OF VULCANIZING RUBBER BELTS.

An odd method is employed to vulcanize rubber belts. A stretcher is used to take the stretch out of the belts. This is made up of two sets of heavy clamps, and a great hydraulic ram which exerts a pressure of 2,000 pounds to the square inch. In this manufacture, the belting has already been made by pressing the rubber into the cotton duck. This is now cut into strips of desired length, and the strips are laid, one over the other, until the thickness of the desired belt is obtained. Then a strip of thin, pure rubber is wrapped about the several folds. The whole belt may then be put into a steam press and vulcanized.

RUBBER HOSE.

When rubber hose is made, a rubber tube is first slipped over a mandrill, and cotton-duck stripping is wrapped about it until the desired thickness is attained. Then, a thin sheet of rubber is rolled about it all. This is covered with strips and sent to the vulcanizing press. The press consists principally of an iron pipe which is thrust into the hose. Steam is admitted to the pipe and the hose is heated. When the process is over, compressed air is blown between the hose and the pipe to remove it. Firemen's hose, with its cotton outside, is made by drawing a rubber tube within the cotton tubing, and then the whole is charged with steam.

RUBBER TREE IN U. S. BARRACKS, KEY WEST, OVER 100 YEARS OLD.



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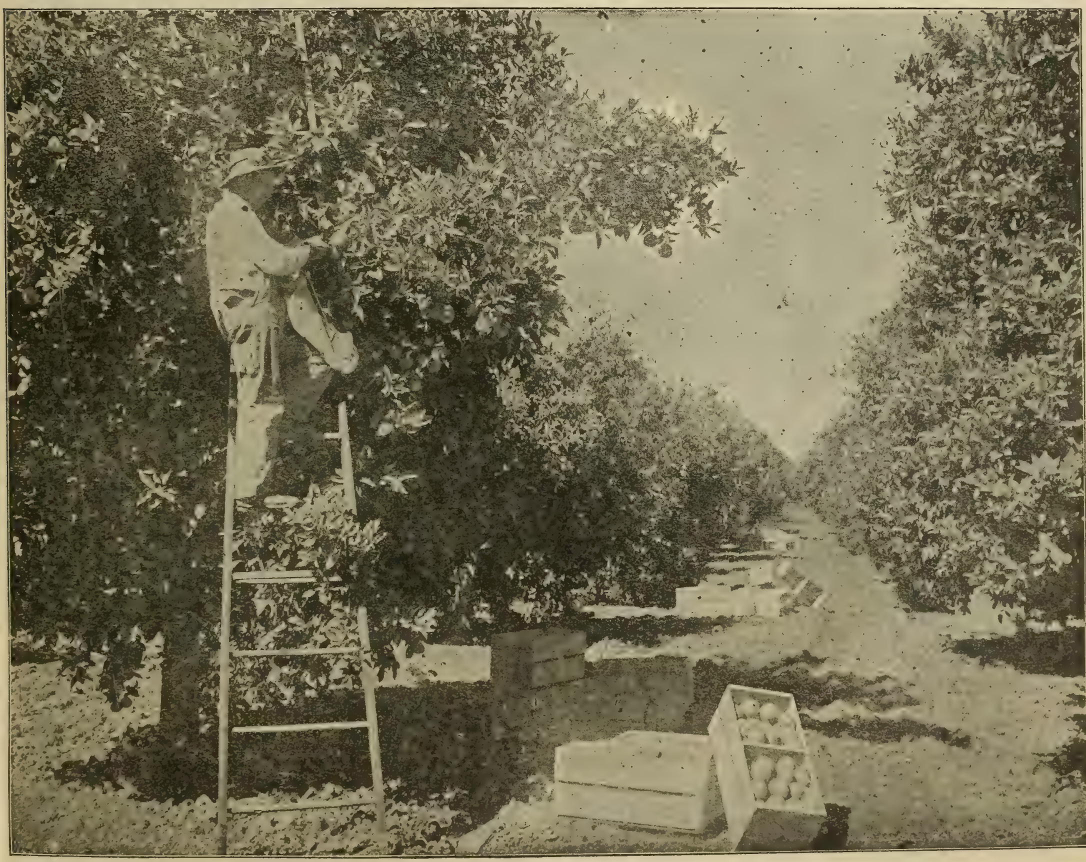
ALLIGATORS ON THE INDIAN RIVER, FLORIDA.

ORANGE GROVES AND THEIR PRODUCTS

Thanks to the semi-tropical climate of our favored southern states, particularly Florida and Southern California, we are enabled to have a current supply of luscious fruits and vegetables of subtropical character which only a few years ago were considered as genuine delicacies of some rarity, instead of being commonly found in the markets as they are now. In addition to these newly developed regions of our own country, commercial enterprise of late years has placed Central America, Jamaica and certain others of our neighbors in the Caribbean Sea under tribute, for still further tropical delicacies, and now the volume of trade in such foods has become very great. Bananas, for instance, come to us in immense shipments, the year round, from Honduras by way of New Orleans, and from Jamaica by way of Philadelphia and Boston. Our pineapple supply is chiefly from the West India Islands, although Florida sends an increasing crop northward every year, and the Hawaiian Islands have begun to contribute their quota by way of the Pacific coast.



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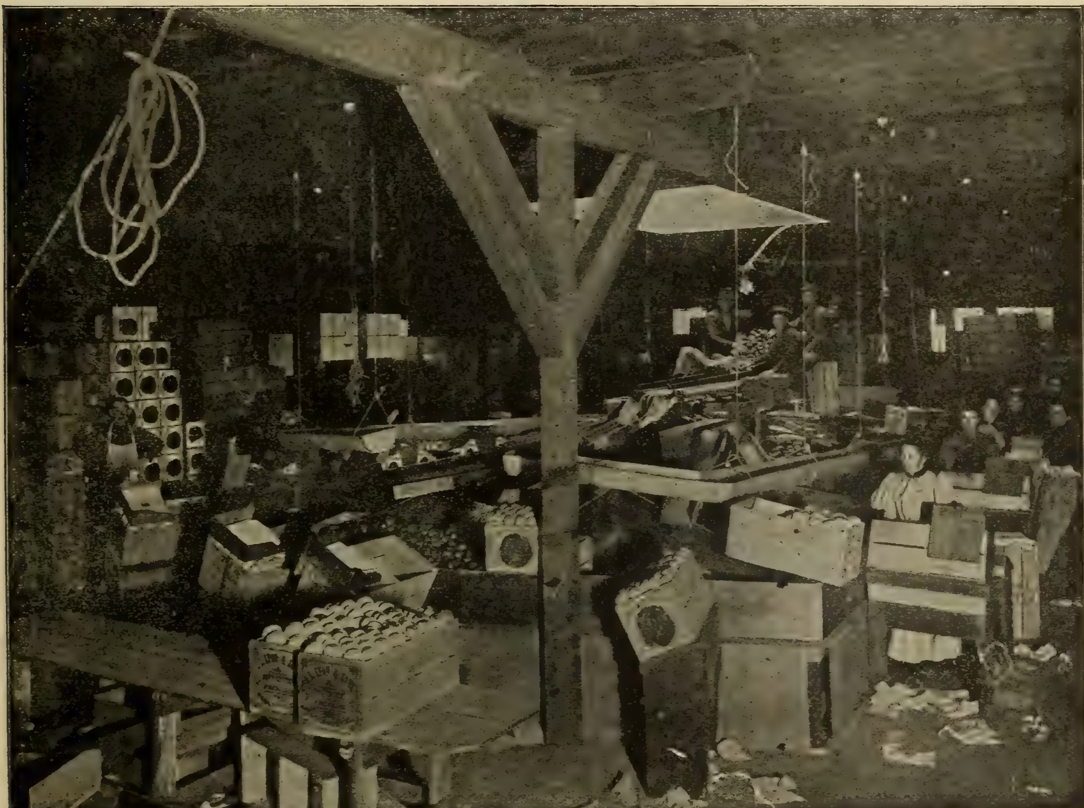
PICKING ORANGES IN A CALIFORNIA GROVE.

The orange production of the country is multiplied many times since the possibilities of California began to be realized. Florida still supplies large quantities of the choicest fruit from the Indian River orchards, but the area devoted to the industry is not increasing greatly. In California, however, the increase is very rapid and even young readers can surely remember within their own knowledge a time when the golden fruit was by no means as commonly seen in every town and village as it is now. Although we usually associate the orange groves of California with the southern part of the state, as a matter of fact they are by no means confined to this vicinity. Central California indeed, from Sacramento north, has some of the choicest and largest of the orange orchards, and the production in that part of the state rivals if it does not exceed, the more famous regions around Los Angeles and San Diego.

It is difficult to imagine any horticultural scene more beautiful than an orange grove in full bearing. Citrus trees have a foliage of a peculiarly brilliant green and the golden fruit itself, glittering among the leaves, brightens the picture with a vivid color which justifies the admiration and interest always excited. Oranges are shipped east from California every day in the year, the smallest number of carloads in any one day being perhaps half a dozen, in the months of September and October. The annual harvesting of the crop begins about the middle of November, and is at its highest from January to March. In those months the average shipment is over 250 carloads a day, and the industry affords employment to a small army of pickers and packers. It is one of the corner-stones of the prosperity of the state. The product averages about half a carload to the acre of bearing trees throughout the state, and as the trees grow older this average increases. The groves vary in size from ten acres to forty, the latter area being all that one man can take care of with the help of one farm hand. Less than ten acres can not be depended upon for a sufficient income, though there are instances of five-acre tracts that have, through careful cultivation, yielded large returns. The land costs all the way from $100 to $300 an acre, bare of trees. An orange orchard in good bearing is worth approximately $1,000 an acre, and the chances are that it will have cost its owner a large part of that sum, in investment, interest and period of waiting. But the returns from the industry justify that high valuation. The majority of the well-managed orange orchards produce a profit annually of from $125 to $175 an acre.

The citrus fruits were introduced into California more than a century ago, by the Spanish mission fathers who brought them from Mexico and Spain. If they could return to-day to the scene of their labor, they would see a wonderful change in the industry. Cultivation for export was not attempted until early in the seventies, and even as late as 1886 the total export product was only 150,000 boxes, or 500 carloads. In the years from 1885 to 1895 a vast amount of planting took place and the trees are now all coming into fruitfulness. The crop of 1900 was 18,000 carloads, or 6,000,000 boxes, of which about 85 per cent was oranges and 15 per cent lemons. The oranges are largely marketed through mutual associations, formed to share the expense of maintaining agencies in the eastern markets, and to obtain the most favorable prices for them. These associations are organized in the different orange-producing districts, and they have warehouses where the crop is received, sorted and packed for shipment. The wagon-loads of fruit are poured into hoppers from which inclined tin troughs extend in various directions. The oranges are sorted by size, automatically, as they are shaken over the hoppers and fall through holes into the troughs, much as coal is screened for shipment. The small oranges roll gently down the incline to one box, those of the next size to another, and so on till the sorting is completed and each box is filled with fruit of uniform size, carefully wrapped by the deft-fingered girls who find profitable employment in this work. Thence the boxes are delivered to the railways for shipment, and ultimately they find themselves in the town and city markets throughout the country, ready for any purchaser.



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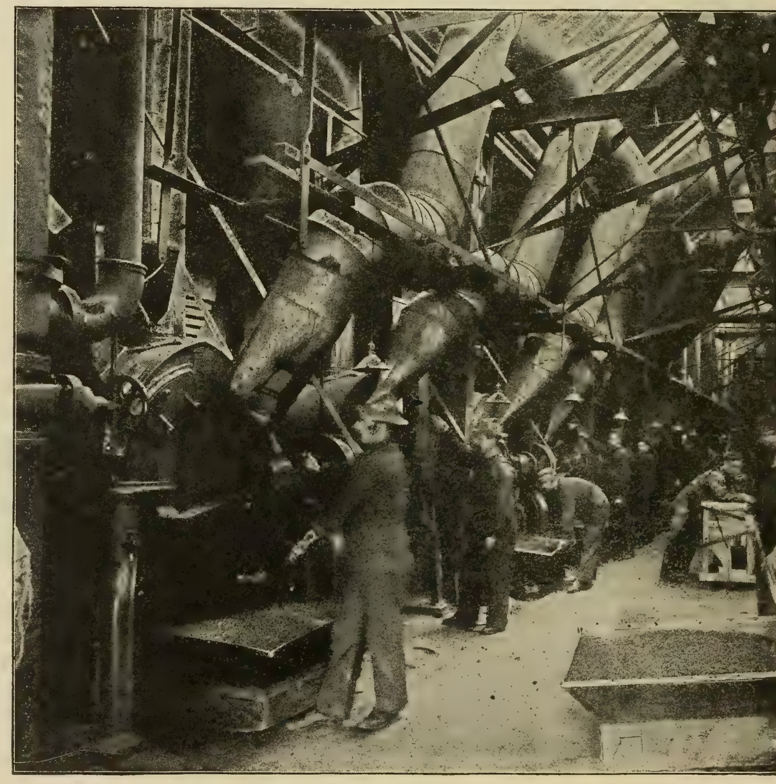
SORTING AND PACKING ORANGES FOR SHIPMENT.

COFFEE, TEA AND CHOCOLATE

The tropics and the orient have given to mankind three beverages now of world wide use. Coffee, tea and chocolate are known in every land, and varying in popularity each has its loyal adherents. Here in the United States coffee very much exceeds the others in popularity, with tea second and chocolate far in the rear. England is a nation of tea drinkers, with little favor given to coffee. In fact critics declare that it is hard to get a cup of good coffee in Great Britain. The English retort with, perhaps, equal truth, that it is difficult to obtain a cup of good tea in the United States. Holland is the country where the best chocolate is found, thanks to the Dutch colonies of the East Indies, where there is a large production of the bean from which it is prepared. France offers coffee as its favorite beverage, with chocolate and tea following in succession. It is in France that adulteration of coffee has been carried to the highest extent, and sometimes even in the best restaurants it is hard to trace the real coffee taste in the beverage offered. The Russians are the greatest of all tea drinkers, obtaining their supply chiefly by caravans into Siberia from the Chinese provinces where the best crop is produced. The Russian samovar or tea urn is perpetually alight in every household of the empire, and tea is served not only at every meal but to every caller between meals and at all sorts of surprising occasions. Even a business call at bank or office is almost certain to bring the offer of a glass of scalding tea, to be taken while the errand is explained.

The range of coffee culture extends over almost the whole of the tropical belt of the globe. The plant seems to bear greater climatic extremes than most members of the vegetable kingdom, and thrives in localities differing as much as thirty degrees in aver-



LARGEST COFFEE-ROASTING PLANT IN THE WORLD.

age temperature. It is interesting to note that in many countries where the Coffœa Arabica, the coffee of commerce, has been introduced, indigenous varieties of the coffee plant have been discovered. In Brazil, for instance, at least sixteen species are found growing in a wild state. The limit of average productiveness is about thirty years. After that time the trees may continue to live and grow, but they yield little or no fruit. In Java coffee trees planted nearly a hundred years ago are said to be in existence, being now some forty feet high with trunks a foot in diameter, but they grow entirely wild and produce no berries. On an average trees are replaced on the plantations every twenty years, and this process of replanting goes on constantly.

COFFEE YARD NEAR JALAPA, MEXICO.

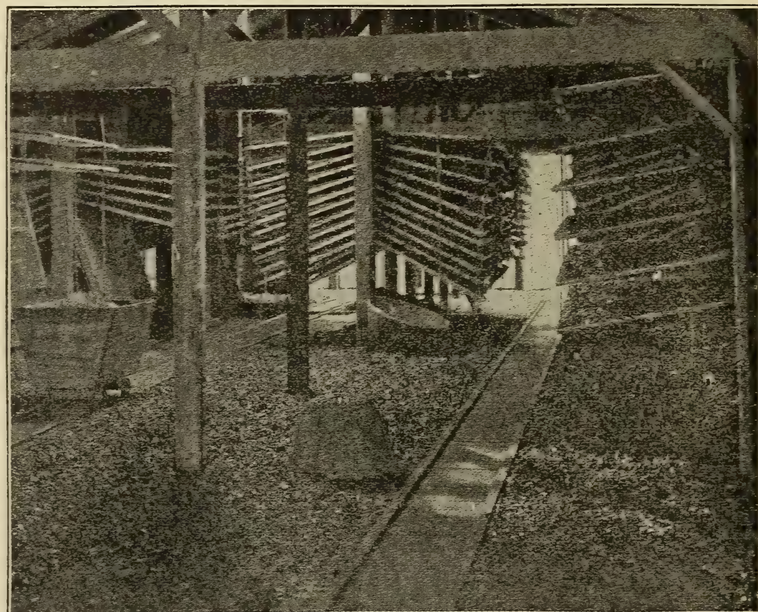
Coffee grows best on the uplands, usually on mountain sides, at an elevation of from 1,500 to 4,500 feet above the level of the sea. The trees are raised from seeds in nurseries, and transferred to their final positions when about a year or eighteen months old. The plants are usually set at intervals of eight or ten feet. They begin to bear at the age of three or four years and at six years may be said to be in full bearing. Taking one year with another, a tree in full bearing produces from two to three pounds per annum. The average diameter of the trunk in full-bearing trees is about the size of a man's wrist. They bear a profusion of dark green glossy leaves, and the fruit or berry forms on the woody stems usually at the base of these leaves.

The berry, when ripe, is red in color, and much resembles a large cranberry or medium sized cherry The two beans lie within, face to face, and surrounding them are five successive layers of skin and pulp, covering and protecting the beans. Picking begins in Java in January and lasts for three or four months. The chief part of the Ceylon crop is gathered from April to July. A small crop, chiefly young coffee, is picked from September to December. In Brazil they commence gathering crops in April or May, and work continues until September. Women and children are largely employed in gathering the fruit, carrying it from the trees in baskets to the place where the preparation of the berry for market commences.

After the berries have been gathered, the first operation to which they are treated is called "pulping." This means to remove the outer covering of skin and pulp from the beans themselves. The berries may be treated while in the soft state, or they may be permitted to dry, after which the dried husk is removed by a machine. When this process is chosen, the berries are spread upon drying-grounds of stone, mortar or cement, where they stay until the heat of the sun prepares them for the machine. It is a similar machine, differing only in details, which is used when the berries are to be treated in the soft state. Successive cleansings, washings and dryings finally bring the coffee into a condition for shipment to the markets, thousands of miles from the plantations where it is raised.

Coffee as a commercial staple is naturally inseparable from coffee as a popular beverage. Amsterdam was for many years the center of the coffee trade, owing to the fact that nearly all the coffee of commerce came from the Dutch East Indies. With the rise of coffee cultivation in Brazil, the West Indies, Central America, Mexico, Ceylon, India and Liberia, the Dutch lost their control of the trade, and New York became one of the most important coffee ports. The United States consumes more than one-third of all the coffee exported from the producing countries. Out of a total annual world production of 750,000 tons, the United States takes about 280,000 tons annually, of which nearly three-fourths is the product of Brazil.

In Abyssinia and Ethiopia, where the coffee plant is found both wild and in a cultivated state, coffee seems to have been used as a beverage from time immemorial. In those remote regions the Arabs are said to have first tasted the fragrant draught, and to have brought some of the precious beans into their own country toward the beginning of the fifteenth century. The Mohammedan pilgrims who flocked annually to Mecca tasted the delicious beverage, and carried back coffee beans in their saddle-bags to all parts of the globe professing the faith of Islam. Coffee overran Egypt and reached Constantinople, where in 1554 the first coffee house in Europe was established. Nearly one hundred years later the first coffee house in London was established, in 1652, by the Greek servant of an English merchant who had brought some



DRYING TEA IN CEYLON.

coffee with him from Smyrna. Within a few years Marseilles, Paris and London had numerous cafés, and coffee drinking was becoming common in England and France. During the eighteenth century it spread all over Europe, although the enormous prices of the berry restricted the practice to the wealthier classes.

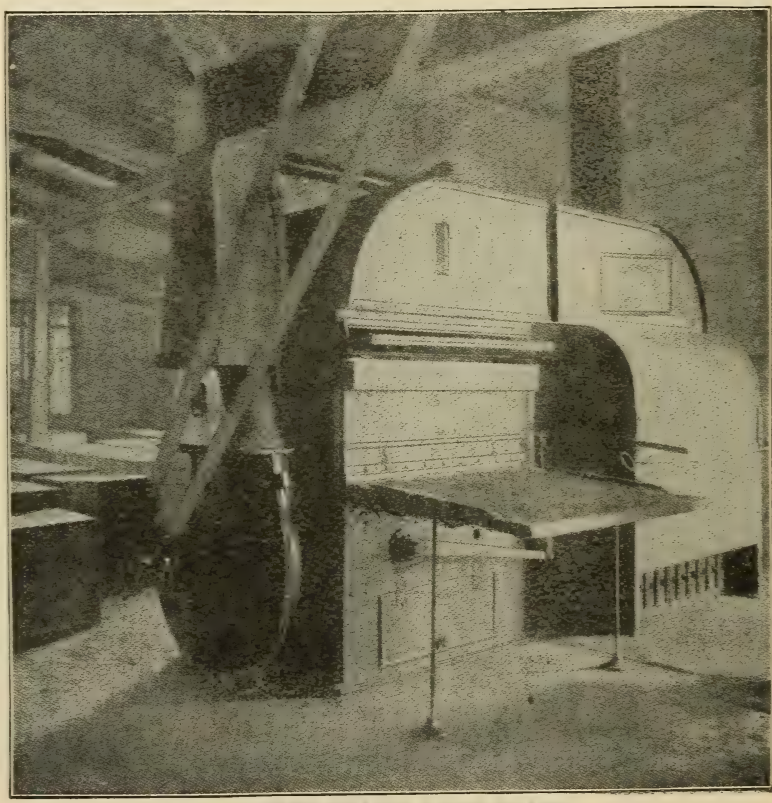
For more than fifty years after the introduction of the beverage into Europe, Arabia still furnished the entire coffee supply of the world, a necessarily very limited quantity. Then the Dutch, early in the eighteenth century, appeared in the market with the product of Java, and a few years later the culture extended to the West Indies and spread with wonderful rapidity. Next Brazil entered the field, overtaking all rivals, until now more than one-half of the coffee consumed in the world issues from her fields. Java holds second rank in the list of coffee producers, Ceylon follows third, and southern India, Central America, Sumatra, Porto Rico, Mexico, Liberia and Arabia contribute to the world's supply.

The western hemisphere does not contribute commercially to the tea product of the world, although in our own southern states certain experiments have been made which suggest that good tea could be cultivated, even though it might not be highly profitable. Japan, China, the island of Formosa, India, and Ceylon are the principal tea producing countries. The tea plant is a species of camellia, bearing a thick and glossy leaf which when green has no tea flavor, or rather has a flavor very unlike the cured leaf known to us as tea. There is considerable variety in the mode of cultivating, but the prevailing system is to plant in rows about six feet apart. Three or four plants are planted together in hills which are about three feet apart, and usually as they grow larger they fill nearly the whole original space left between the hills, thus making an almost continuous row. The plants are raised from the seed, and take from three to four years to mature sufficiently to yield the first crop. After that they are picked continuously for many years.

GATHERING TEA IN CEYLON.

During the winter and early spring, in the districts yielding the best variety of tea, the plants are covered with mats which serve the double purpose of protecting them first from cold which might injure the plants, and later from the sun which tends to make the leaf tough and injures the delicacy of the flavor. The first picking, which is considered the best, takes place in Japan the last of April or the beginning of May, the second about a month later, while the third, which is often omitted, particularly when prices are low, takes place usually during the month of July. Left to themselves the plants would probably grow to a considerable height, but they are pruned and trimmed down so that they are seldom more than three or four feet high. This results in a large number of small branches, producing small and tender leaves, which are the only ones sought for, although in rapid picking different sized leaves would naturally be taken, together with a considerable quantity of stems and other trash. Immediately upon being picked, the leaves are taken to the buildings for the curing processes. The flat baskets in which the tea is brought from the fields are placed over the steaming apparatus for a few seconds, the steam permeating the mass and wilting the leaves. This gives them the dark green color, and enables the leaf to be rolled and doubled up, so that there is less liability to crumble when fired. They are then thrown upon large paper pans beneath which a gentle coal fire is maintained. They are toasted here for several hours, during which they are constantly rolled and stirred with the hands, so as to make the leaf as compact as possible. The tea is then placed in large baskets to await the sorting process.

The dried leaves are spread on a smooth tray before the sorters, who with a pair of chop-sticks dexterously pick out the stems and coarse leaves which are thrown aside as refuse. In the finer qualities they also separate the large from the small leaves, the latter being most highly valued. After the



DRYING TEA BY A HOT BLAST.

DELIVERING SUGAR BEETS AT THE FACTORY.

tea is thus sorted it is sifted to extract the dust and broken leaves, and packed to be sent to the market.

At the shipping ports, where tea is prepared for export, there is a second process of toasting or refiring the tea, and an additional cleansing, after which it is packed in chests lined with lead which is soldered and closed so as to be air tight. Then after nailing the boxes, covering them with matting or rattan, and labeling them, the tea is ready for the ships which carry it to the American or European markets.

The methods followed in China are almost the same as those of Japan. In some sections artificially flavored teas are produced. Flowers are gathered from the jasmine, and scattered over the tea, which absorbs much of the fragrance and is highly favored by epicures. The brick tea, which goes overland to Russia by camel trains, is an inferior quality, composed of the dust and siftings, mixed with other tea of ordinary variety. This is consumed by the Russian peasants. An enormous quantity of the finest grade of tea is taken by the connoisseurs of the same country, who are considered to be the most exacting of all the world in their choice of tea. Chocolate is produced in several of the West India islands, in Peru, Bolivia and Ecuador, and the Dutch East Indies. It is a product of the cacao tree, which bears a large pod in which the coarse beans are formed out of which chocolate is made. These beans are dried, roasted and ground. Cocoa is a modified preparation from the same substance. Porto Rico is the chief island of the Caribbean where chocolate is produced, and here is the principal source of the American supply. Students of health and diet of late years have recognized that chocolate is one of the most valuable food products, and not merely a stimulating beverage of doubtful value to the health like tea and coffee. Explorers and travelers now carry chocolate in condensed form as a valuable part of their commissaries. Soldiers find it in their rations, and invalids prize it as a food.

BEET SUGAR AND CANE SUGAR

When the Nebraska farmer drives into the factory yard with his ton of beets, he brings with him about 280 pounds of pure sugar secreted in the roots. Nature has been busy all summer with her apparatus of sunshine and rain, taking the elements of carbon, hydrogen and oxygen from the earth, air and dew, putting them together, and storing up the sweetness in the little sacs she has made for the purpose in the beet-root; and the great piles of brick and mortar, the groaning engines and the roaring furnaces, the pumps and pans of the sugar mill have been devised to extract sugar from the root.

The older method was to grate the sugar beet to a pulp, press out the juice containing the sugar, clarify it a little, and boil away the water, leaving the crystals behind. But in this way from forty to eighty pounds of all the sugar in the ton of beets went to waste, for no press, however strong, could squeeze out all the juice, and the sugar would lie hidden away in the little particles of pulp. So the crude method has been superseded by a more perfect one, with the result that greater factories have grown, farmers have planted larger fields of sugar beets, and the industry has become a factor of importance in national politics.

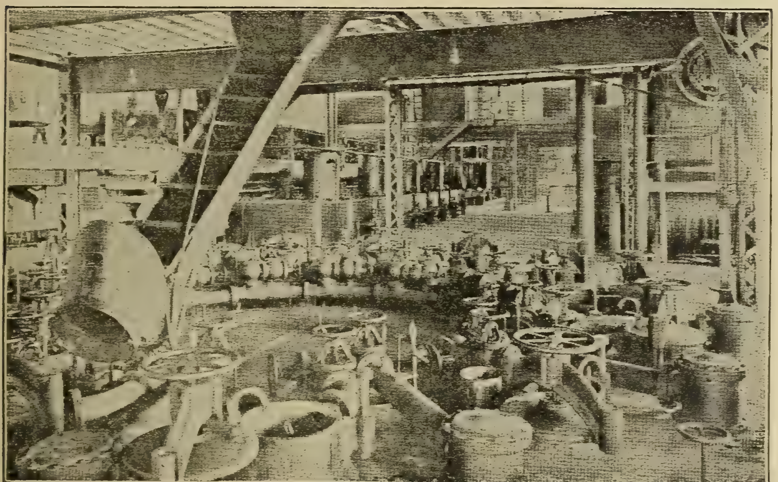
When the beets are brought in by the farmers, they are dumped into long trenches, V-shaped at the bottom, from ten to twenty feet wide and from six to ten feet deep, either covered with sheds or simply open ditches. At the bottom of each of these is another ditch, reaching downward, with perpendicular sides twenty to thirty inches deep, and having a curved bottom eighteen inches wide. This is a sort of flume, through which water will flow. All the ditches slope toward the factory, and meet in one larger ditch near it. Before the beets are thrown into the larger and upper trench, the smaller one is covered with short boards, laid across to prevent the beets falling into it. In these trenches or "silos" the beets are kept until needed. In warm weather they are covered with canvas or straw, and in cold weather with soil. When they are wanted in the factory, a stream of water is let into the upper end of the bottom ditch. The loose boards covering it are raised, and the beets are allowed to fall into the swiftly-running stream below, and are floated along to the houses. The water serves the double purpose of carrying and washing the beets.

At the end of the ditch the beets are caught by buckets arranged upon the rim of a large revolving wheel, which lift them out of the dirty water and deposit them in the washing machine. This is a large, wooden, auger-shaped affair, lying horizontally in a round iron tank through which clear water is flowing. The revolving auger pushes the

SCREW ELEVATOR AT A BEET SUGAR FACTORY.

beets forward, rolling and tumbling in the water, and finally deposits them clean, in the elevating apparatus which carries them to the very top of the building. Here they are deposited into an automatic weighing machine which weighs half a ton of them at a time, and drops the beets into a slicer, a large wheel covered with knives, which revolves among the beets and cuts them into long, thin, diamond-shaped slices.

Immediately below the slicer, and upon the second floor of the factory, is a group of wrought-iron tanks that look like upright steam boilers, each large enough to hold



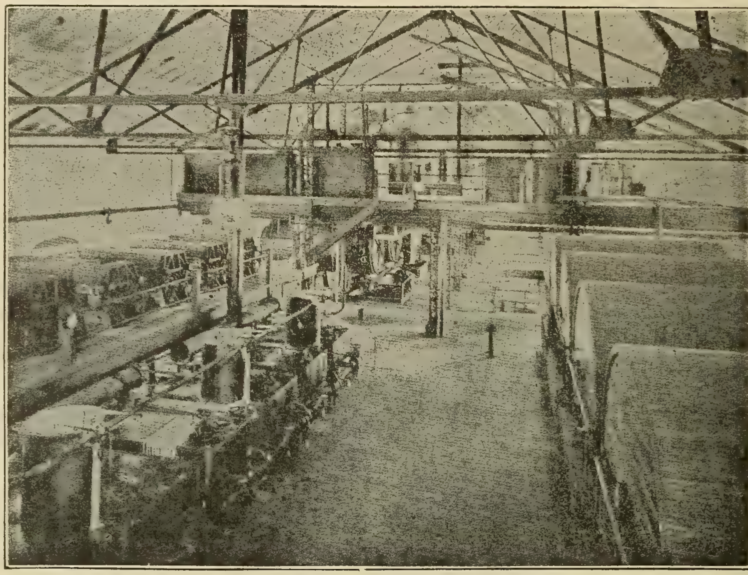
DIFFUSION BATTERIES.

about 3,000 pounds of the slices. These communicate with each other by means of large pipes. The first is filled with slices and water is then let in from a tank above. This is allowed to stand while the second tank is filling. Then the valves are opened into the next tank, containing fresh slices, and fresh water running into the first tank under pressure, forces the water which has already absorbed some sugar, on into the next tank, where it becomes richer. And so on from tank to tank it progresses, always tending to coax the sugar outside of the beet into the water. By a repetition of this process from tank to tank, the water gradually absorbs the sweetness from the beets and exhausts them of all the sugar to within one-tenth of one per cent. The exhausted slices are dropped from the tanks, and run through great rotary auger presses, and the partly-dried pulp is then shipped away for cattle feeding.

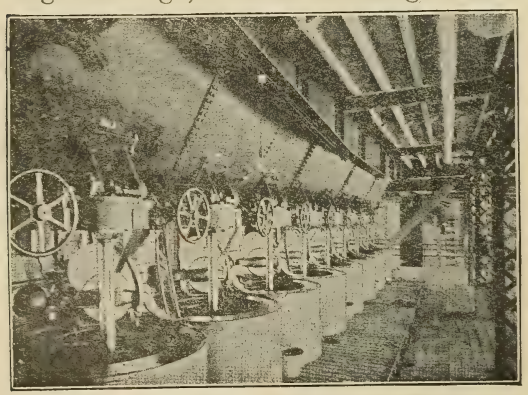
The apparatus just described is called the diffusion battery, and when once started, fresh slices are supplied and juice is drawn off almost continuously. The juice is of a chocolate brown color, containing much organic matter not sugar. It is run from measuring tanks into tall, cylindrical vessels holding about 2,000 gallons. Here a thick lime solution is added, which takes out the coloring matter and other organic matter. Next comes a succession of boiling, filtering and clarifying processes, after which the fluid has become a moderately thick syrup ready to be boiled down to sugar. The boiling process is a delicate one, which must be handled with care in order to get the best results. The syrup is pumped up into vacuum pans, large cylindrical bodies, some ten feet in diameter, with oval top and bottom. Great copper steam pipes are coiled inside, and a large air pump with an eighteen inch cylinder keeps up the high vacuum and removes the evaporated water so that boiling down goes on rapidly, and at a very low temperature.

The sugar-boiler watches the mass through glass windows set in the sides of the pan, and when the small grains begin to appear, "feeds" them by adding fresh syrup until they are of the required size. When the grade is right and the water is evaporated sufficiently, the steam is shut off, the pump stopped, a valve is opened at the bottom of the pan, and the whole mass is allowed to run into the tanks below.

The syrup now looks about like dark molasses thickened with granulated sugar, and is so stiff that it will just run. This mass is drawn off into large whirling drums called centrifugal machines. These have their sides perforated with small holes, and are lined with gauze. The sugar rises up along the sides of the drums as they whirl, as water will in a revolving pail, and the molasses is thrown out of the holes in the sides, while the sugar too large to get through, remains sticking to the gauze. The sugar is washed by directing a spray of cold water and air against it as it whirls, and a little bluing is added to give brilliancy. The machine is then stopped, and the sugar, which is now white and moist, is dropped from the bottom of the machine, and conveyed to a large horizontal revolving cylinder heated by steam and called the "granulator." It is here dried, and the fine dust of sugar contained in the granulator is drawn out by a suction blower. The sugar passes through screens at the end of the granulator, which removes the large lumps, and thence to the bags for market.

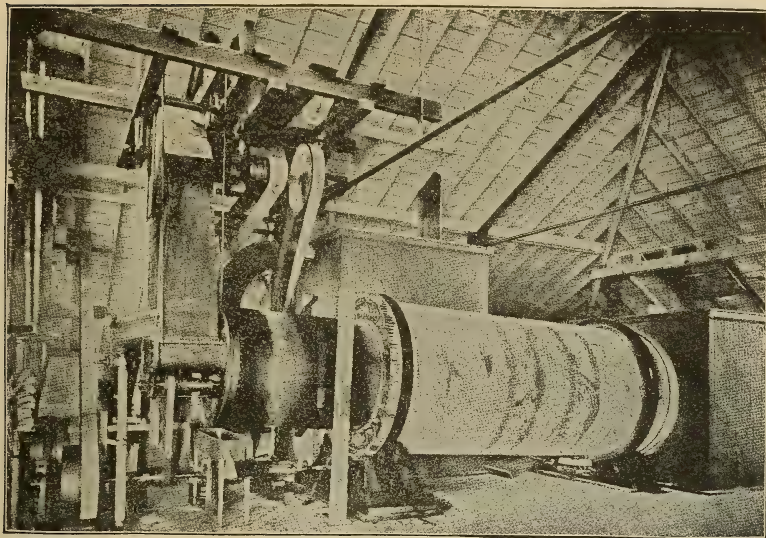


CARBONATORS IN A BEET SUGAR MILL.



THE CENTRIFUGALS.

The molasses thrown off at the centrifugals is mixed with fresh syrup and boiled again, or is boiled alone and passed through the centrifugals, and the brown sugar resulting is refined by mixing with fresh syrup. A careful chemical control is kept upon the whole house. The laboratory has been called by one of the principal manufacturers, the heart of the factory. Here



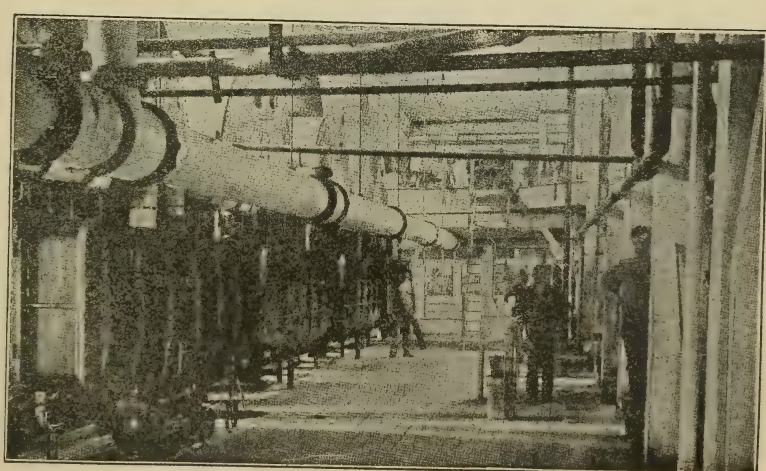
SUGAR DRIER.

er than Cuba, China, Germany or any other country can possibly produce it.

The Louisiana sugar plantations produce less than one-fifth of all the sugar consumed in the United States, which is the chief reason for the rapid stimulus of beet-sugar production. In our Louisiana cane fields the harvest begins early in October. The negro field hands first strip the cane of its leaves with the dull side of the knife, and then the tops are cut off as far down as the experienced cane cutter pleases and the maturity of the cane will permit. For while the sugar planter wants every inch of cane which will yield up sugar, he doesn't want to grind and handle an inch more than is necessary. The field hands begin work at daybreak, and cut enough cane during the day to keep the mill supplied for the suc-

everything is tested — beets, juice, syrups and boiled sugars. Every pound of sugar entering the house is known from analysis and every loss is located and accounted for. In the laboratory are tested also the coal, the limestone, and the coke, the amount of ash in the raw sugar, and the value of soils and fertilizers. The factories run day and night, seven days in a week, stopping only to clean up or in case of an accident. And the sugar rolls out from each factory at the rate of thirty, fifty or one hundred tons a day.

If a Michigan chemist realizes his expectations, saw mills in the pine forests of the north may become active competitors of the Louisiana sugar plantations. He declares that he can make granulated sugar out of sawdust, and that he can do it cheap-



DEFECATING PANS.

ceeding day and night. The cane is first weighed while on the wagon, and then dumped in the cane-shed, which is an open, heavily built wing of the sugar house. From the shed to the mill extends a traveling platform or conveyor. Colored women pick up the cane and spread it on the moving slats which carry it to the mill to be crushed. The roller mill is a ponderous piece of machinery, massive in all its parts, for sugar cane has a tough, hard skin, and cannot be crushed by tender methods. Sometimes nine rollers in succession are used to complete the crushing process. In the intermediate stage the crushed cane is called bagasse. When it is squeezed almost dry it is carried to the boiler room, for fuel, or it may be used for fertilizer.

When the cane is crushed, the juice runs down, a greenish, sticky liquid, through a strainer, to a vat from which it is dumped to the clarifiers. Lime and heat are used in this process, just as in making beet sugar. The juice is boiled in a succession of open kettles, first to a syrup and then to sugar, being frequently skimmed of the impurities which rise to the top in the form of a scum, and are usually made into rum. When the tests show that the proper density has been reached, the heavy syrup is dipped into cooling-vats of wood, where the sugar is crystallized. Of late years vacuum pans and centrifugal machines have been introduced in the largest cane-sugar factories, like those used in beet-sugar making.

Enormous quantities of sugar are made in Cuba, Porto Rico, and the other West India Islands; in the northern countries of South America; and in the Dutch East Indies. Hawaii, too, has a large sugar industry. Germany and France are leaders in the beet-sugar industry; Russia and Austria are active in the same direction, and our own American farmers and sugar-makers are united in the development of the industry in this country.

CUTTING, STRIPPING AND HAULING SUGAR CANE.

AUTOMOBILES AND THEIR DEVELOPMENT

The age has arrived when the horse as a means of power for general traction is well on the wane. While it is not intended by this statement to convey the idea that the time will come when horses will no longer be used to draw vehicles, nevertheless the development in the past decade of the automobile, or automatic vehicle, has attained such success that it is no longer a mere experiment. Today, upon the streets of any of our cities may be seen horseless carriages, trucks, wagons and fire engines, while in the country the traction engine and the automatic plow are gradually coming into use.

Industrial science affords no more complex problem than the construction of a carriage which contains within itself all the elements of swift and safe transit for persons and goods. The development of the automobile has been slow until a comparatively recent date. Briefly, and to avoid ancient history, let us take up the story of the horseless vehicle in its nearly perfect form.

The principal motive powers for the motor vehicle to-day are electricity, gasoline and steam, although there are several chemical and other agents, such as compressed air, which are in occasional use. In general, however, it may be stated that the last named have been dropped.

The relative merits of the three systems now generally in use may be summarized as follows:

THE ELECTRIC MOTOR.

The greatest difficulty that is presented in the problem of driving a carriage by electricity is that of the storage battery. For many years a great number of scientists have busied themselves striving after improvements in the method of storing electricity. The result of these experiments has shown that weight is a serious handicap. Nevertheless, so convenient is the electrical method that the electric motor probably is the most successful, in its particular sphere, now in use on automobiles.

A FASHIONABLE AUTOMOBILE.

The mechanical arrangement of the average electric automobile consists of a battery, or series of batteries, in which is stored sufficient electrical fluid to serve for a several hours' run. These storage batteries must be filled at some power station when run down, an operation that takes some time. It is customary in the large cities, on automatic "bus" lines, to have a wire connection at the regular station of the "bus," whereby the batteries may be kept constantly supplied. From the storage batteries run connecting wires to a motor usually located on the rear axle of the vehicle, or in the hubs of the rear wheels.

By the ordinary method of levers, the power is imparted to the motor, or thrown off at will. Very effective brakes, of necessity, make up a part of the complete automobile. The best equipped machines can come to a full stop from a high rate of speed in a very few feet. The steering gear is usually attached to the front wheels, and is operated by a horizontal lever near the front seat. However, some cabs steer by the rear wheels. The most up-to-date machines are equipped with electric lights and bells.

THE GASOLINE MOTOR.

The motive power of the gasoline automobile is derived through the constant explosion of gasoline and air combined in proper quantities, which in turn operates a piston and a fly wheel, and finally the wheels of the carriage. The greatest advance in this style of pleasure automobiles has been made in France, and from that country some of the best machines in present use in this country have been imported. The mechanical arrangement of the gasoline motor embraces a tank for gasoline, a device for admitting air to the gasoline, a mixer or carburettor, an electric "sparker" which ignites the mixture under pressure, by means of which the explosion which drives the piston is produced. The usual method consists of four cycles. The spark first ignites the gasoline, and this explodes, driving forth the piston, which, in turn, recedes, driving out the spent gases, thus preparing the cylinder for exploding the next intake of gasoline and air. A corresponding operation is in process in the other cylinder, both being connected with same crank shaft. A water jacket is one of the essentials of this machine, to prevent too high a temperature resulting from the constant explosions. Tremendous speed has been attained with this style of machine, a record of over eighty miles per hour having been made.

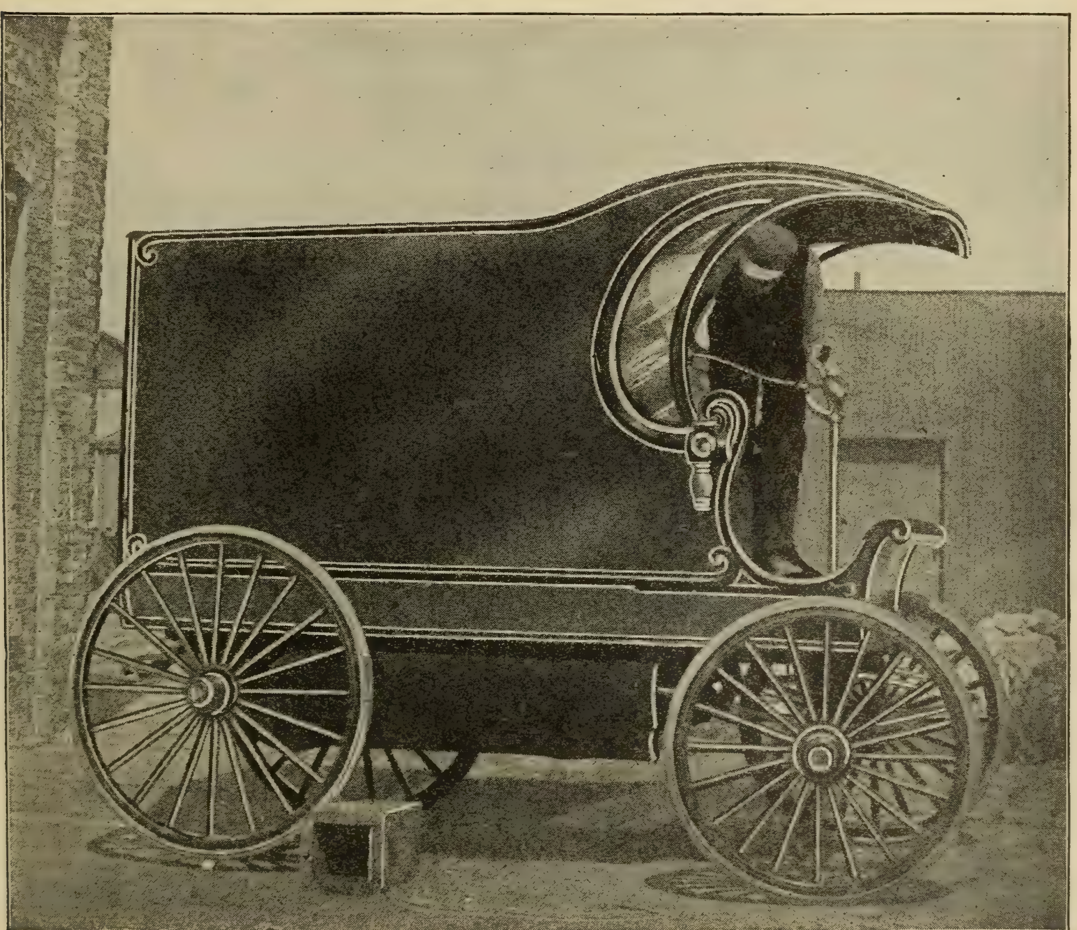
By courtesy of the International Harvester Company of America.

AUTOMOBILE MOWING MACHINE.
At Work in a Field.

Some of the difficulties attached to this method are the seeming impossibility of readily regulating the speed from high to low gear; the constant jar and racket due to the exploding gasoline; the disagreeable odor that follows the machine; the serious difficulties arising from the delicate adjustment of the sparking apparatus, and accidents occurring from starting the fly wheel by hand. All of these defects, however, have been obviated in the latest improvements. Some of these machines cost as high as $10,000.

THE STEAM MOTOR.

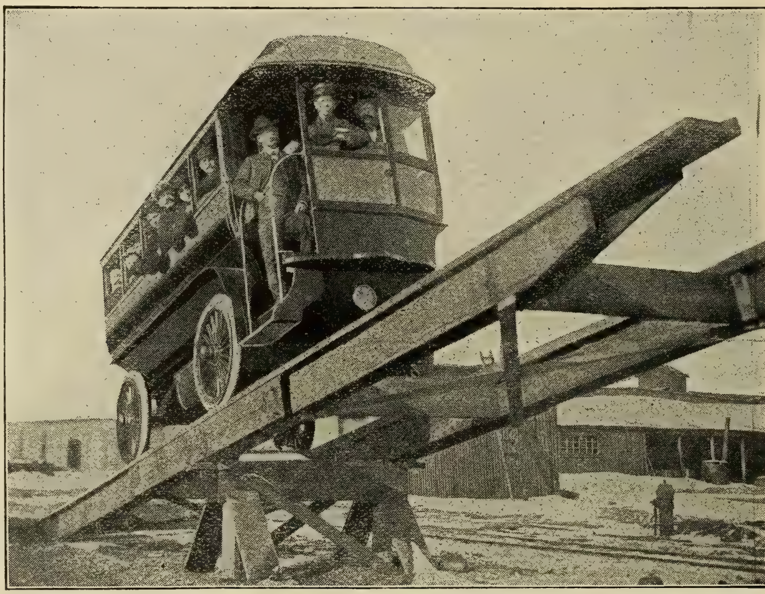
The steam machine is operated by a simple steam engine, the steam for which is generated by heat from oil or gasoline. Among the chief points in favor of this method are its comparative freedom from vibration or jar, its comparatively noiseless operation, and the universal knowledge of its propelling power.



By courtesy of the Chicago Motor Vehicle Co.
BACKING THE WHEEL OFF A TWELVE-INCH BLOCK ONTO AN EGG, CRACKING THE SHELL WITHOUT SPILLING THE CONTENTS, AND THEN MOUNTING THE BLOCK.
A Demonstration of Perfect Control.

This vehicle is equipped with a burner, a boiler, cylinders and a chain connecting the fly wheel with one of the axles of the wagon. As in the gasoline method, fuel for trips of over a hundred miles can be carried easily.

Self-propelling vehicles are built in scores of patterns. Some of the heavier drays use compressed air for motive power. In Paris the fire department is equipped with an electric automobile, and in other cities the chiefs use light vehicles in running to fires. The Chicago Motor Vehicle Company is operating a very successful gasoline street car. Ambulances, ammunition wagons, bicycles and light railway hand cars are driven by light gasoline engines. Many feats of cross-country riding, mountain-climbing and the like have tested the astonishing capabilities of the automobile.



By courtesy of the Chicago Motor Vehicle Co.
CLIMBING A 25-PER-CENT GRADE LOADED.

Motive power for farm purposes is receiving more and more attention. The latest departure is an automobile mower which is just being put on the market by the Deering Harvester Company of Chicago, or, to be more accurate, the International Harvester Company, of which the Deering is now a part. Their experiments began in 1894 and they succeeded in getting one of the machines ready for exhibition at the Paris Exposition, where it attracted much attention. In competition it worked perfectly, running at any speed and turning even more easily than a team of horses.

The mower is equipped with ball and roller bearings and is propelled by a motor which consists of two six-horse power gasoline engines mounted tandem on a large pipe six inches in diameter and five feet long. The rear end of this pipe is secured to the mower frame in the place of the ordinary draft tongue and the front end is supported by a steering wheel. The machine is guided by the wheel which the operator holds in his left hand. The levers at his right are for operating the cutting bar.

Although this motor is designed for the mowing machine it can be used for other purposes. By taking off the cutting apparatus it can be made to draw loads, grind feed, pump water and do many other useful things.

RACING AUTOS.

The greatest speed thus far attained by an automobile is two and one-fifth miles in a minute. At Ormonde Beach, Florida, on a straight course, Barney Oldfield, drove a 200 h. p. Benz car at the rate of 132 miles an hour, the time being verified by official timers. This terrific speed was maintained only for one minute, but it was enough to show that under favorable conditions, there is practically no limit to the speed of the modern high-class racing automobile. It will be impossible, of course, to sustain this extreme speed for any considerable time or distance, as it would be too severe a tax on human endurance, to say nothing of the strain upon the mechanism of the car itself. As all of the distance contests take place on circular courses, many of them with sharp turns, and continuing for from 200 to 415 miles, the average speed in such races is necessarily considerably less than that made by Oldfield in his straightaway dash at Ormonde. The greatest sustained speed made in a long-distance race in America (415.2 miles) is 70.28 miles an hour, which is fully 15 miles an hour more than the sustained speed of the fastest railway train on the run of 500 miles between Chicago and Buffalo.

ALCO CAR, WINNER OF VANDERBILT CUP, 1909-1910.
Harry Grant, Double Winner, at Wheel.

EXTREME SPEED IN RACES.

David Bruce-Brown, driving a Benz car, set a new American long-distance race record at Savannah, Ga., November 12th, 1910, when he won the Grand Prix, 415.2 miles, with a sustained speed of 70.28 miles per hour for the entire distance. V. Hemery, also driving a Benz car, covered the long route at exactly the same rate of speed, but Bruce-Brown won on a handicap allowance. The fastest lap (17.2 miles) was made by Hemery in 13.50, a rate of 78 miles an hour. The day before the race Bruce-Brown, in a practice spin, covered 74 miles in an hour.

On October 1st, 1910, Harry F. Grant, driving an Alco car, won the Vanderbilt Cup race, 278.08 miles, on the Long Island (N. Y.) course, maintaining a speed of 65.18 miles an hour for the entire distance. His fastest lap was made at the rate of 80.25 miles an hour, while eleven other drivers made laps at from 79.69 to 70.22 miles an hour. The general roughness of the course, however, made it impossible to maintain such extreme speed for any considerable distance.

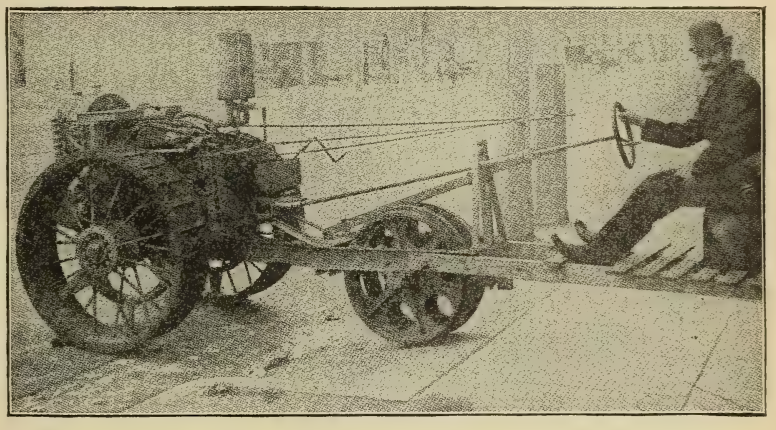
THE MODERN CHARIOT RACE.

Photographed on the Grosse Pointe race track near Detroit, when Alexander Winton of Cleveland drove his automobile ten miles in eleven minutes and nine seconds. Mr. Winton is ahead, nearest the fence.

GAS ENGINES—THE NEW POWER

Gas engines, so-called, but erroneously, have largely replaced steam power engines, and are put to many uses, especially on farms, for which steam motors have been found too unwieldy or expensive. The gas engine proper can be used only in localities where a constant and economical supply of illuminating gas can be obtained, which necessitates close proximity to permanent gas works. What are commonly known as gas engines are in reality gasoline motors, the motive power being obtained by explosions of a mixture of gasoline and air in the cylinders. They are portable, and may be used anywhere, independent of the source of fuel supply. The gasoline is carried in tanks attached to the engine. From the tank the gasoline flows to a carburetor in which it is mixed with air (without air gasoline has no explosive force), and then injected into the cylinder in the form of a highly explosive vapor. This vapor is ignited by an electric spark and an explosion results immediately on top of the piston head. This drives the piston downward and sets in motion a fly wheel, the revolution of which tends to bring the piston head back into position to receive another explosion. This process is repeated about 500 times a minute in each cylinder, so that with a motor of two or more cylinders there is a practically continuous series of explosions. The horsepower of the motors is governed by the diameter of the cylinder bore, the length of the piston stroke, and the number of cylinders coupled to one crank shaft.

Gasoline motors of this description are widely used for a large variety of purposes. They were originally designed for the propulsion of automobiles and their greatest use today is in this line. Next comes the motorcycle, an ordinary bicycle equipped with a gasoline motor. Aside from these uses the gasoline motor is fast coming into favor for a multitude of other purposes. Farmers are adopting it for threshing grain, cutting grass, sawing wood, pumping water, plowing and harvesting land, seeding grain, making butter, etc. In many parts of the country the gasoline motor is superseding the horse and ox in farm work. The farmer has learned that a motor does not require feeding, except with gasoline and lubricating oil, is practically tireless, ready to work twenty-four hours or longer at a stretch, and has a power capacity many times greater than that of flesh and blood.



FARM TRACTOR THAT DOES THE WORK OF SIX HORSES.

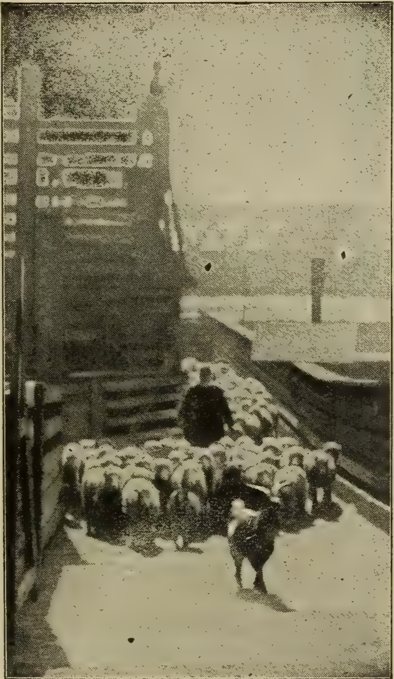
BIRD'S-EYE VIEW OF THE LARGEST PACKING PLANT IN THE WORLD.

THE WORLD'S GREATEST MEAT MART

THE CHICAGO STOCK YARDS

IT IS a recognized fact that the world's greatest meat mart is located at Chicago. There are other great stock yards and packing houses at Kansas City and Omaha, but they do not begin to compare with the stock yards in Chicago.

The Union Stock Yards are located 4½ miles from the very heart of Chicago. Into these yards run 26 railroads that center in the metropolis of the west. The total area is a trifle over 600 acres, three hundred of which are paved with vitrified brick tiling, which makes the surface most substantial. Running through the pens are 25 miles of streets and alleys, 38 miles of water troughs and 60 miles of feeding troughs. In addition to these there are over a hundred miles of water, sewer and drainage pipes. The total cost of the yards up to the date of this publication is in the neighborhood of $50,000,000.



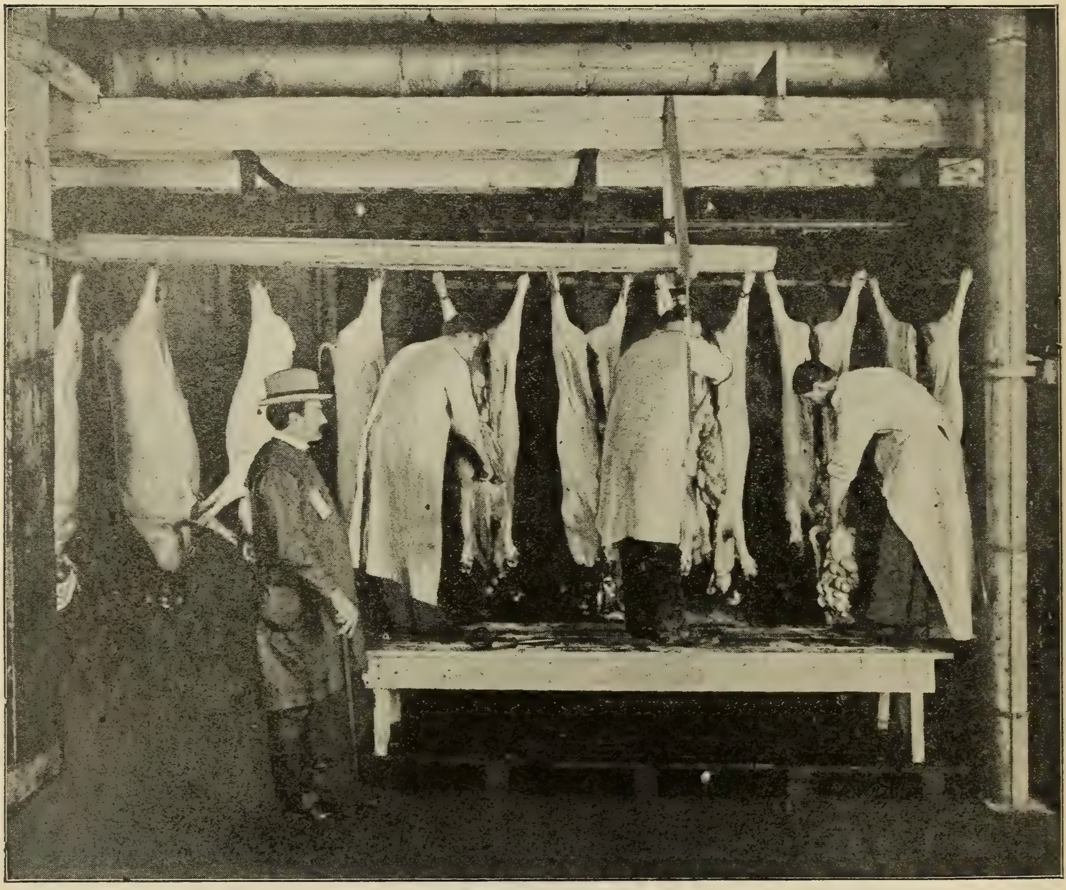
Courtesy of Armour & Co.
DECOY GOAT LEADING SHEEP.

The stock yards were built in 1865, and the first day's receipts of cattle, sheep and hogs numbered a trifle over 300. At the present writing, it is not an uncommon thing to see 20,000 cattle, 30,000 sheep and 45,000 hogs in the yards at one time. The annual receipts of live stock are approximately as follows: 2,900,000 cattle, 155,000 calves, 9,325,000 hogs, 3,600,000 sheep, and about 130,000 horses and 10,000 mules. To bring this stock into market requires nearly 400,000 cars, which would make a train almost long enough to reach across the continent, from New York to San Francisco. In the yards there are about 15,000 pens, of which 8,000 are roofed in for sheep and 3,000 pens, or "double decks," for hogs.

200 MILES OF RAILROAD TRACKS.

Inside the yards are grouped nearly a score of separate packing houses, all doing an enormous business. There is also a big office building known as the "Exchange Building," which accommodates nearly 300 commission firms, the general offices of the stock yards company, a bank, and a branch of the Bureau of Animal Industry, of the United States Department of Agriculture. Surrounding the yards is a network of tracks comprising a total mileage of nearly 200 miles.

If the visitor to Chicago wishes to witness a busy scene, let him or her go to the stock yards between 5 and 9 o'clock any week-day morning, and they will see a great horde of people flocking to their daily work. Inside the yards alone there are regularly employed 33,410 men, women, boys and girls. The early morning is devoted to the unloading of the live stock. After this is accomplished begins the sale. Soon after the sales are made, the stock is weighed to the purchaser, and if it is to be



GOVERNMENT INSPECTOR.

reshipped, is again loaded into cars and forwarded to its proper destination.

GOVERNMENT INSPECTION OF MEATS.

When the cattle, hogs and sheep are in the pens, the government inspectors step in and make a thorough inspection of all live stock received. Condemned animals have a tag fastened in their ears. These animals are slaughtered under the direction of the Bureau of Animal Industry, and, if the meat is found to be diseased, the carcass is condemned and goes into the tank. In addition to this inspection, the Government keeps a man in every packing house in the yards, whose duty it is to inspect all animals slaughtered, and so thorough is the work done that an animal can be traced from the time it arrives at the yards until it reaches the retail butcher's shop.

PORK TESTED BY THE MICROSCOPE.

Pork that is to be exported is subjected to a rigid microscopic inspection, and if found to contain disease of any kind, the carcass in which the disease is found is ordered "tanked" at once. All this work is done by a corps of expert microscopists, under the direction of the chief of the Bureau of Animal Industry. Tiny bits of

SECTION IN COOLER.

meat are cut from each carcass that is to be exported, and after being placed in a tin box, are labeled, and later, taken to the microscopic department, where an inspector (usually a woman) cuts the meat into jelly with a tiny pair of scissors, after which the pulpy mass is placed between two pieces of clear glass, pressed together, and then subjected to a powerful microscope. If the meat is diseased, the microscopist

FILLING PAILS WITH LARD.

SKINNING SHEEP.

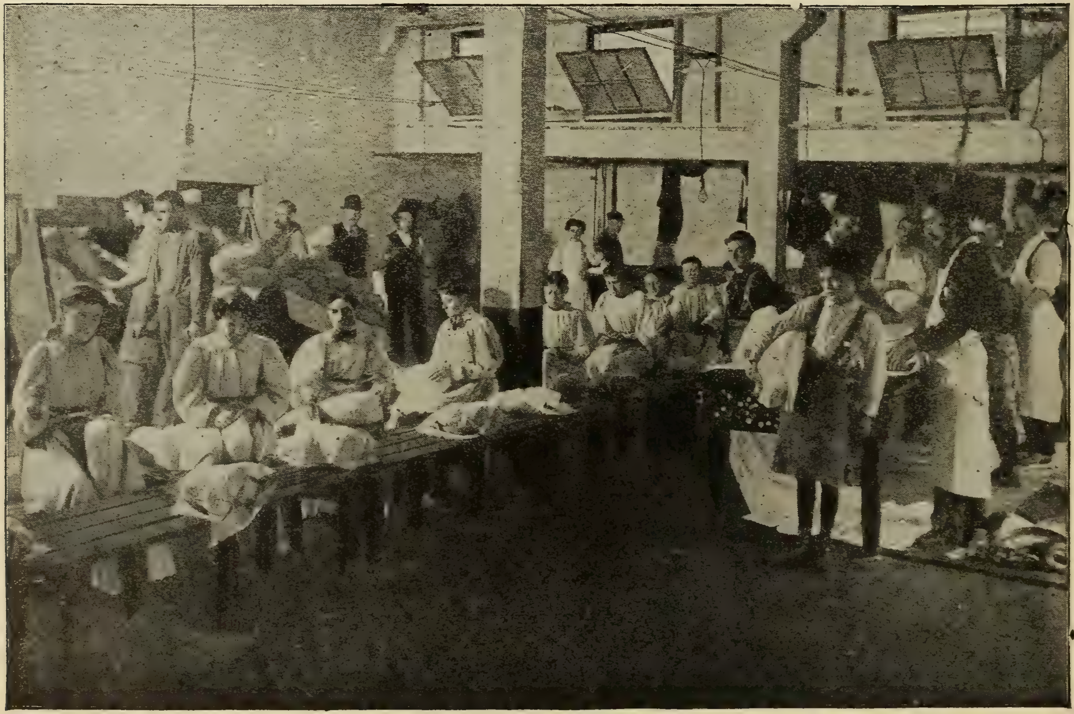
will immediately discover it, and that carcass will be condemned. In Chicago, there are 90 inspectors at work during the whole year.

PROCESS OF SLAUGHTERING AND DRESSING.

In the great packing houses that abound within the yards, there is a familiar jest, that everything of the animals slaughtered except the squeal of the pigs is saved, and this is to-day literally true, for, that which once was loss is now made into various things. So complete is the utilization of that which was once waste, that the profits of a big packing house on its by-products amount to a small fortune each year. Let us follow the process of a typical packing house from beginning to end. The buyers of the concern purchase such cattle as are wanted for the day, which are driven from the pens over long runways, to the pens of the packing house, which is located near the slaughter house. Some of the packing houses have fat steers trained to lead the other cattle to the foot of the gangway, there to turn and leave them, while the victims go on to their fate. From the gangway there is an incline which leads into a small stall, or pen, directly opposite the killing floor. Above, on small platforms, the "knockers" run along, and with a small sledge-hammer, strike the cattle upon the head until they fall to the floor, stunned. Then the doors open automatically, and a

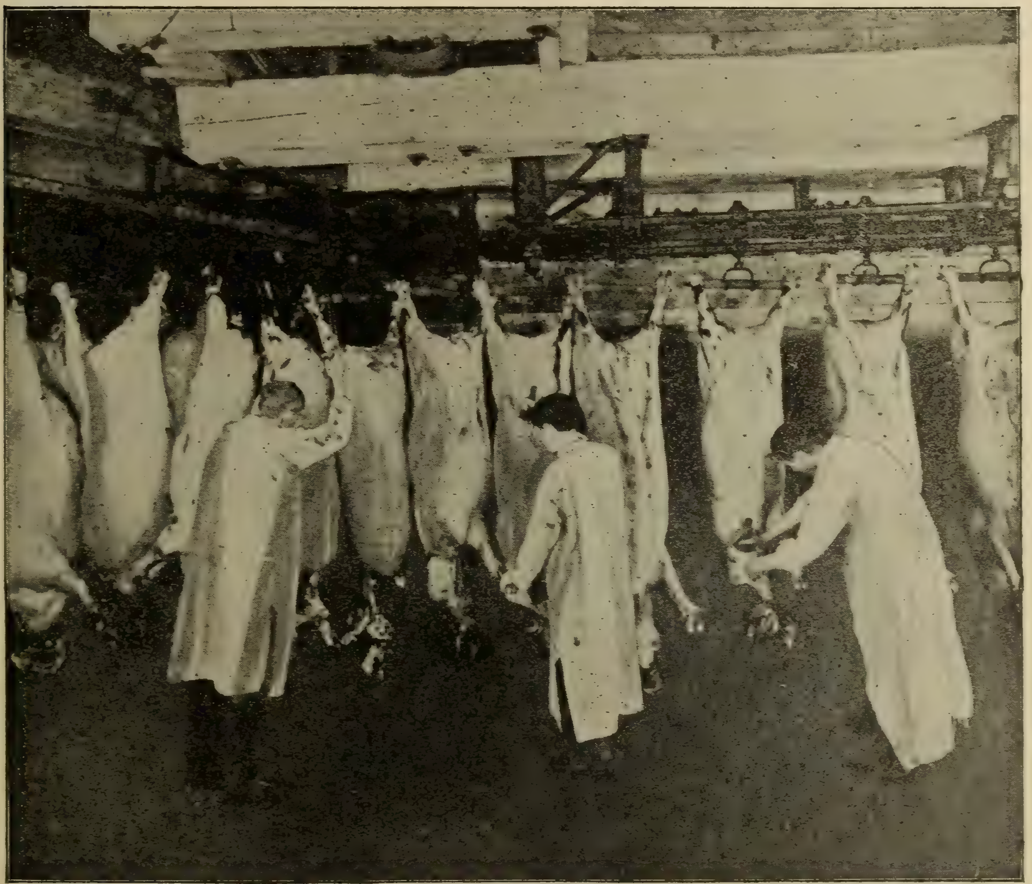
LOADING INTO REFRIGERATOR CAR.

SCALDING HOGS.



SEWING HAMS FOR EXPORT. By courtesy of Armour & Co.

moment later, the animal is dangling by the hind foot at the end of a long chain, which suspends the carcass high enough for the butcher to cut its throat. The heads are removed at the same time the carcass is drained of blood, and then in quick stages the hoofs, shanks and entrails are removed.



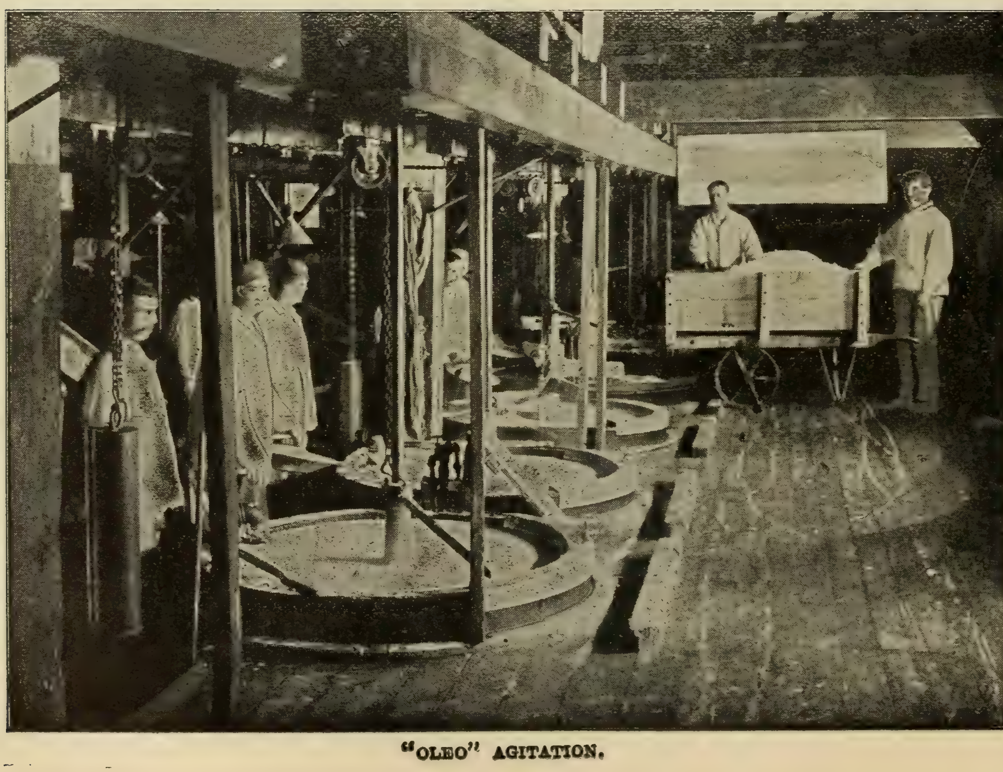
ROUGH FINISHING.

The carcass is split down the backbone. It travels along on an endless chain, or trolley, is washed, and later taken into the great coolers to be chilled.

NOTHING WASTED.

Everything that pertains to a slaughtered beef is sold and put to use. The horns become the horn of commerce; the straight lengths of leg bone go to the cutlery makers for knife handles; the entrails become sausage casings and their contents make fertilizing material; the livers, hearts, tongues and tails, and the stomachs that become tripe, all are sold over the butchers' counters of the nation; the knuckle bones are ground up into meal for various uses; the blood is dried and sold as a powder for commercial purposes; the bladders are dried and sold to druggists, tobacconists and others; the fat goes into oleomargarine, and from the hoofs and feet and

PACKING MINCE MEAT

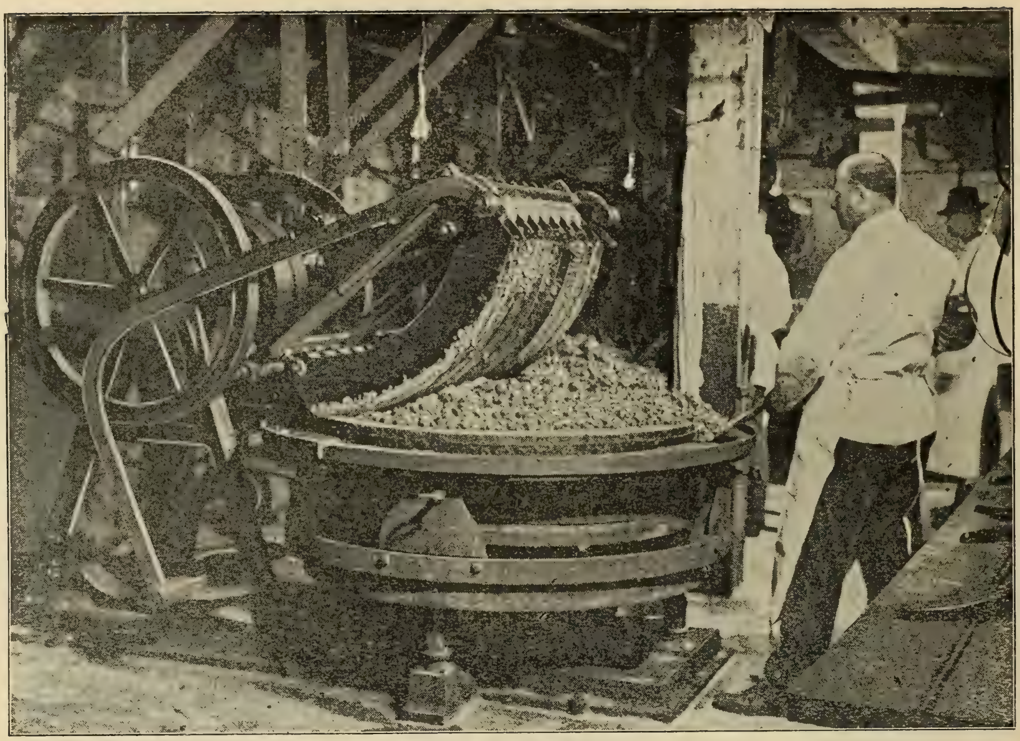


"OLEO" AGITATION.

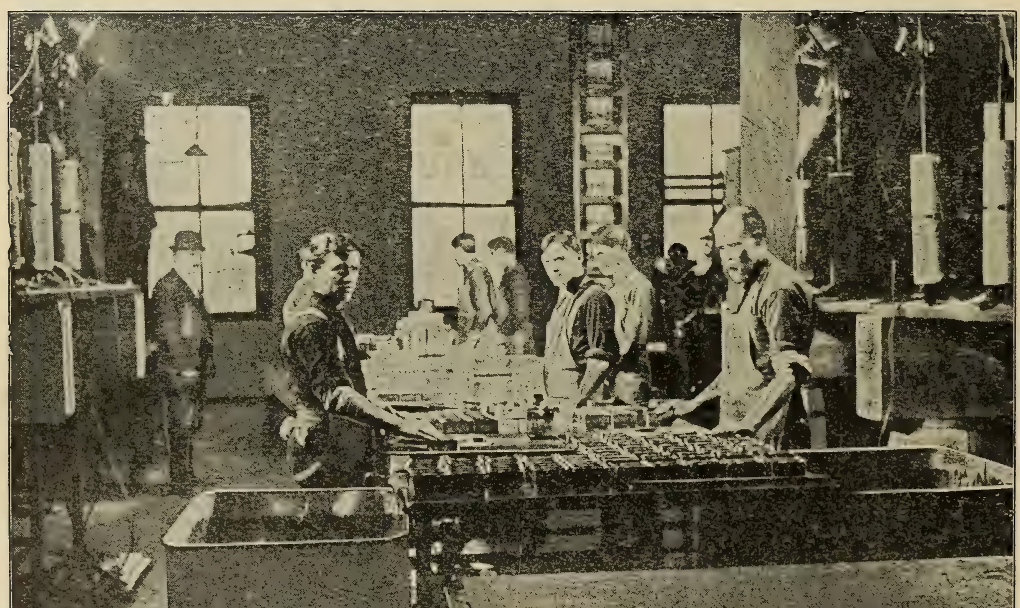
other parts, come glue and oil and fertilizing ingredients.

Directly above the slaughter houses is a series of rooms full of bones and horns. The bones are boiled to get the fat of the marrow as well as to clean them. Then they are dried and shaken about until they are smooth and clean as cotton spools. The knuckle bones are cut from them, and one room is filled with the ground-up pulver of these parts. The white and pretty bones are shipped to Connecticut, England and Germany, to be worked into knife handles, fan handles, tooth-brush handles, backs for nail brushes, sides for pen knives, and into button-hook handles, shirt studs, cuff buttons, and so on, ad infinitum. What is to become of the horns is still more astonishing. By heating them and then tapping them skillfully, the operators loosen the soft cellular filling which solidifies and strengthens each horn. The substance around this, between it and the inner surface of the horn, goes for glue; the rest

SKINNING CATTLE.



SAUSAGE ROCKERS.



CANNING DEPARTMENT. By courtesy o: Armour & Co.

is ground up into bone meal. The horns are then sent to makers of horn goods, who, by cutting each horn skillfully and then pressing it between heavy rollers, manage to spread each into a flat ribbon. In this shape, it can be used in a thousand ways. The artificers who do this work cut each horn spirally, so that it becomes a tight curl capable of being straightened out. By immense pressure the curve is taken out of it. Good horns sell for $100 per ton.

SLIDING ONTO RAIL.

REFRIGERATION.

The refrigerating and cooling rooms are kept at a temperature of 36 degrees, yet, when the meat fresh from the slaughter is railroaded into such a room, the animal heat in it warms the room for a considerable time, and fills it with steam as with a fog. As soon as it is cool, the sides of beef become firm, hard and almost appetizing. Everywhere, except at the actual scene of slaughter, these houses and their work are clean and above criticism.

HOG KILLING AND DRESSING.

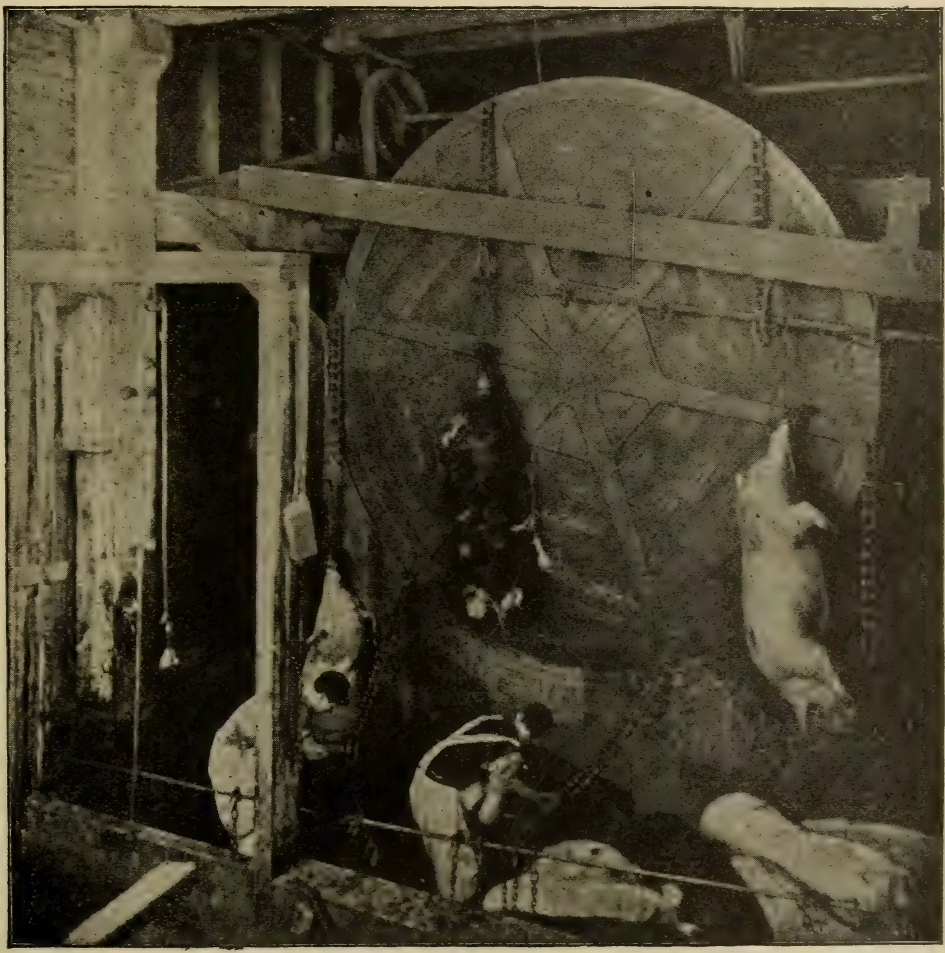
The killing of hogs is done in a much more peculiar manner than the slaughtering of cattle. The hogs are run into a catching pen, from where they are caught up and forced upon a revolving wheel, where the butcher stabs them to the heart, and death is practically instantaneous. From the wheel the dead body swings along, to be loosened over a vat of scalding water, into which it is plunged. Here the bristles are loosened. Then a great rake scoops out a hog, and it falls upon a runway, where

THE CATTLE PENS.

TAKING OUT LEAF LARD.

a chain that is hooked to its nose pulls it through a steam scraper. The knives of this machine are set at every angle, and miss no part of the hide on the body.

When out of reach of the scraper a number of men pass the body along, to remove every bristle and speck that was missed. Then the body is washed with a hose, and its head is almost cut off. Next it is disemboweled. Then the lard is removed, the head is cut off, the tongue taken out, and the body is split and passed along to the cooling room. The blood is turned into albumen for photographers' uses, sold to sugar refiners or transformed into fertilizing powder. The bristles go to brush makers, shoemakers and upholsterers. The fat is valuable in many forms, the intestines become sausage casings, livers, lungs and hearts are made up into sausage meat, and parts of the meat of the heads made up into headcheese. The feet are canned or pickled, or worked up in the lard tanks.



HOISTING ON REVOLVING WHEEL.

SHEEP KILLING.

The method used for killing sheep is similar to that heretofore described, except that they are suspended two by two on hooks that run along a continuous trolley line. As each pair passes the succession of men in waiting, a new step in the process is completed. The killer sticks the knives into their throats at the rate of 25 per minute, and the animals continue to pass through the hands of specialists at that rate of speed, until the carcass appears at the end of the trolley, spread apart with wooden braces, and ready for the refrigerating room.

SHEEP KILLING.

One of the big packing houses, in 1901, did a business of $160,000,000, which is astonishing when one thinks that there are a score or more which do an enormous business. The markets for the products of these American packing houses, of which those of Chicago are but the largest of many great ones in western cities, are found the world over. It would be hard for any European power to go to war without patronizing the American packing houses for their meats and supplies. During the Spanish-American war the United States government drew on them heavily, and when England was fighting the Boers the American packers did an enormous business.

RUMPING AND BACKING.

KILLING "KOSHER" CATTLE.

For Jewish customers, meat must be dressed with especial religious rites.

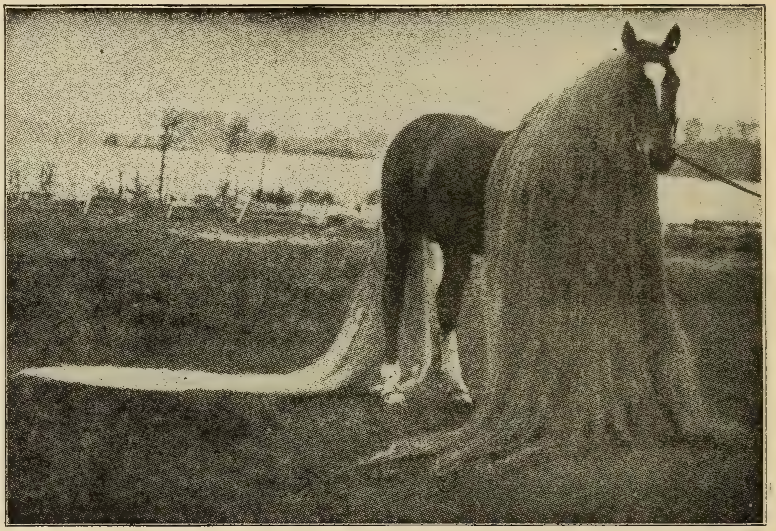
In closing this article it is proper to mention a peculiar feature of the yards, viz., the killing of cattle intended for the Jewish markets. For this purpose a "Kosherman" is in attendance, who, as a steer is thrown upon its back, with legs bound, takes a razor-like knife and makes a stroke forward and a half stroke backward upon its throat. After the carcass is dressed it is hung up, and remains thus about four days, the rabbi washing it carefully each day. He then officially marks it as fit for consumption by those of his faith.

PUTTING UP SAUSAGES.

No country in the world, unless, possibly, South America, breeds mules so extensively as the United States, or regards their usefulness so highly. Their value in some sections of the country is manifested in the statement of a veterinary periodical, that 100 mules were sold not long ago in Scott county, Kentucky, at $177 each.

The perfection to which mule breeding has attained in this country, so far as development in size and strength is concerned, is shown by a recent advertisement offering

By courtesy of the Lawrence Photographing Co.
THE GREATEST HORSE MARKET IN THE WORLD.
DEXTER PARK PAVILION, UNION STOCK YARDS, CHICAGO.



THE LONGEST TAILED HORSE IN THE WORLD.

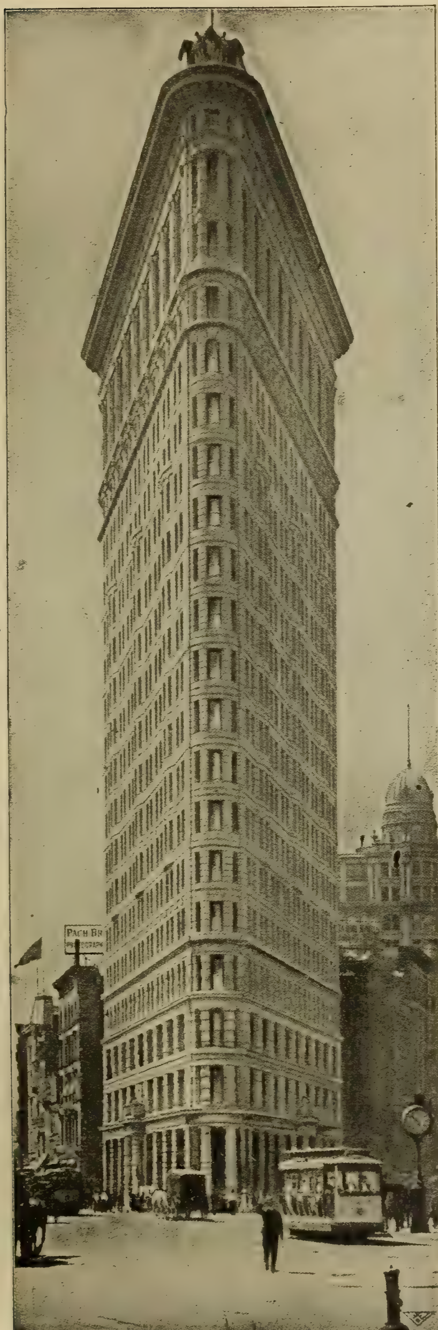
This remarkable animal was bred in Lexington, Ky., and attracts great attention at stock shows in Europe. His tail is 19 feet long, mane 12 feet and forelock 8 feet. He is a chestnut and stands 15½ hands. The last selling price for the horse was $20,000.

for sale two black mules, three years old and 17 hands and 3 inches high. It is not uncommon in Pennsylvania and New Jersey to see teams of mules on heavy work which stand 16 and 17 hands in height.

In no other part of the world are mules of this size bred. In most countries large animals of this species are not regarded with favor, 14 hands being deemed the proper limit. The mule will do double the amount of heavy road hauling and work on the farm that is possible for the average horse, requires but two-thirds the food and half the attention demanded by the latter, and can be depended upon, as a rule, for more than double the number of years of service.

SCENE ON A MULE FARM.

CONSTRUCTION OF THE "SKY-SCRAPER"



FLATIRON BUILDING, NEW YORK CITY.

Great has been the progress in building in the last decade. Time was when a ten-story office building would have been deemed an affront to Providence. But with the invention of the modern elevator and the rapid advance of land values in great cities, architects and contractors began seriously to study out methods for accommodating great numbers of tenants in individual buildings. As long as buildings had to be constructed solely of brick and masonry there was a definite limit to their height, for, as the height grew so grew the weight of the walls and further altitude had to be sacrificed when it became impossible to fit the walls to carry the height without undue expenditure.

At the junction of Fifth avenue, Broadway and Twenty-third street, New York, stands a unique structure, probably the strongest ever erected. It is known as the "flatiron" building, and is the cumulative result of all that is known in the art of building. It is equipped with every convenience that human ingenuity could devise.

BUILDING WALLS FROM THE UPPER STORIES DOWNWARD.

Suddenly there appeared an engineer who solved the problem by propounding the idea of building steel structures after the fashion of gigantic bridges set on end, and to hang the walls on—that is, to make the girders and beams support the floors and walls, instead of making the walls support everything. This was called Chicago construction, because it originated with a Chicago man. Building under this method each floor is absolutely independent so far as the walls and partitions are concerned, for the walls have

MONADNOCK BUILDING, CHICAGO, ILL.

The largest office building in the West: 17 stories high, covering an entire block, facing four streets. Architects, Messrs. Holabird & Roche; builders, The Geo. A. Fuller Co. Sixteen hydraulic elevators. Original cost $2,800,000. Occupants, 7,000 (equal to the population of a small town). 24,000 people carried by elevators each day. **12 horizontal tubular boilers 1,800 horse power, all equipped with smokeless furnaces.**

nothing but their own weight to carry in the height of each story. It is no uncommon thing on "Chicago-construction" buildings for the contractor to begin his exterior work on the third, fifth or ninth story, leaving the first to be enclosed after every other floor has been walled in and plastered. This method of building is diametrically opposed to the old-fashioned solid-masonry construction, which begins at the very bottom with the foundation and rises to the roof, with the piers, exterior walls and partition walls going up together. The contractor, building a sky-scraper according to "Chicago construction," shoots the steel frame-work up as rapidly as possible, so as to get the roof on to protect the interior from the weather. With the frame-work up, he puts in the hollow tile partitions or builds the walls to suit his convenience. This method of building set all traditions, rules and time-honored customs of architects and builders at naught, for it ignored massive foundations, heavy piers, the use of thick walls to carry weight, and solid partition walls running from the foundation to the roof.

When new tenants moved into old-fashioned buildings, the rearrangement of spaces to meet the tenants' requirements frequently necessitated expensive alterations, for the partitions could not be moved without substituting some other form of supports for the floors above. Chicago's architectural engineers concluded that columns starting from the foundations could carry the floors as well as partitions, and would thus permit any arrangement of a floor without interfering with the construction.

High buildings required monstrous foundations and very thick walls under the solid masonry style of construction. The limited areas in the cramped business districts of the cities made it impossible to build 16-story buildings under old-fashioned methods because the builder could not get "spread" for his foundations, and the original soil of Chicago was not adapted for carrying weights on small areas.

THE ARCHITECTURAL IRON WORKER.

This style of new building developed a new craft—that of the architectural iron worker—who is a mixture of a bridge builder and a sailor. He must be a rigger as well as an iron worker, and must be able to tread the beams high in the air with the confidence and nerve of a tight-rope dancer. The building up of the great structures in the business center provided another source of wonder and admiration for the gaping crowds that watched the daring workmen riveting together angles and beams hundreds of feet in the air. Many sailors left the lakes and became iron workers, and the craft grew until it became one of the largest and strongest of unions.

OLD AND NEW STYLE FOUNDATIONS.

In solid masonry construction the foundations are made of heavy stones piled on each other so that they are broad at the base and somewhat pyramidal in form. On the foundation the massive piers rise, well-nigh filling up all the space in a basement. Under present methods of construction a basement, so far as room is concerned, is as valuable as the other floors, for the slender columns shoot up from the foundations, occupying comparatively little space. In "Chicago construction," the foundations are made of steel railroad rails or beams.

MASONIC TEMPLE, CHICAGO.

The largest building ever attempted by a charitable or social organization. It is twenty stories in height (265 feet), and has a west frontage of 170 feet and a north frontage of 114 feet The first three stories are constructed of Wisconsin granite, and above them the material is gray fire-brick.

HAVEMEYER BUILDING, NEW YORK CITY

First a bed of concrete is laid, and on this is placed a layer of rails or beams set side by side. On this bottom layer another layer of rails or beams is laid, crossing the lower members of the foundation at right angles. On top of the rails a cast-iron plate is laid. This is the shoe for the steel column.

THE COLUMNS.

The column is always made of wrought steel shapes and it is of uniform size for each of two stories, diminishing in size as it nears the roof. The floor beams are carried on the columns and the entire frame-work is riveted together with hot rivets, just as a bridge is. Architectural engineers say that if it were possible to upset a building of the "Chicago-construction" kind, the whole structure would tip over like a box and would not fall into pieces as a solid-masonry building would. An earthquake might rattle down some bricks, or loosen some partitions, but, according to claims made by Chicago builders, it would not throw down a Chicago skyscraper.

THE AUDITORIUM, CHICAGO.

Containing the largest auditorium in the world, also Auditorium Hotel.

Copyright, by Detroit Photographic Co.

TYPICAL NEW YORK "SKY-SCRAPERS."

The two great edifices here pictured are the tallest office buildings in the world and of all structures are surpassed only by the Washington Monument, the Eiffel Tower and one or two Cathedral spires.

FIREPROOFING.

Every piece of exposed steel work is completely surrounded with some fireproof material, such as blocks of tile, terra cotta or brick, and air spaces are left between the fireproofing material and the metal, for dead air is one of the poorest conductors of heat known. The hollow tile arches, placed between floor beams, are covered over with thick concrete, and this concrete is fireproof. The partitions are of hollow tile, which is not only light as compared with brick, but is fireproof as well; and it is said that buildings of "Chicago construction" are as nearly fireproof as it is possible to make them. The average thickness of the walls of a modern skyscraper runs from 16 to 18 inches, the walls carrying about the same thickness from the ground up. This is a radical departure from the old-fashioned construction, for the walls of the lower floors of 15 stories of solid masonry would have to be at least three and a half feet thick, and would drop off about four inches for every two floors above the third. This thinness of walls in Chicago buildings has its disadvantages from the point of view of the architect, for it gives a "skimpy" look to the building, but to the ordinary man they are simply wonders.

By courtesy of Lawrence Photo. Co.

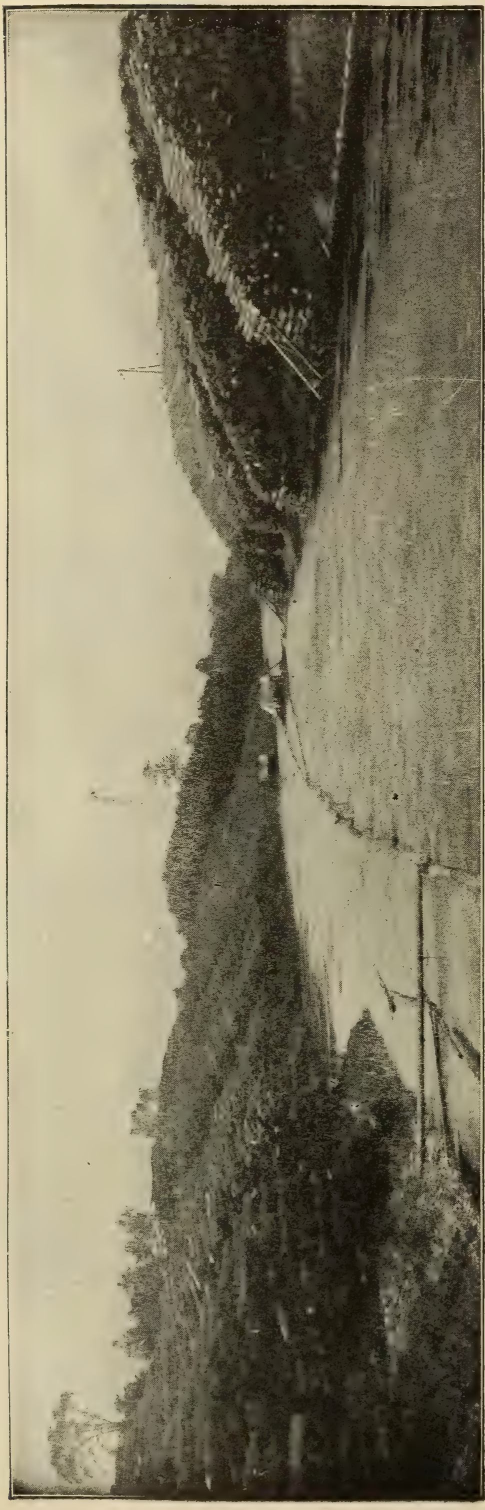
CHICAGO POSTOFFICE.

PAPER, ITS HISTORY AND HOW IT IS MADE

In the earliest times it was realized that the information of the world must be perpetuated, if true progress were to be obtained, otherwise each generation would have to learn for itself as its forefathers had done, without having the advantage of the experience already gained. So at first primitive man used the only tablets at his command and engraved strange hieroglyphics upon stone, to tell what was desired to be preserved. In the height of Egyptian civilization obelisks, pyramids and slabs of stone took the place of the ruder tablets. Later clay and terracotta were used for the making of tablets, and great libraries were even formed, portions of which are still preserved, to give us the history of the Chaldeans, the Babylonians and the Assyrians. As time passed other materials were introduced, plates of metal, skins and bones of animals, ivory, wood and wax being used.

It was Egypt that gave us the real forerunner of paper, and, indeed, the name itself, by a material made from the graceful water plant of the Nile, the familiar Egyptian bulrush or papyrus. Out of the pith of its stems were made sheets of a material not much indeed like the paper of to-day, but the pioneer of paper manufacture. Rolls of this material were made into books, and a large amount of the history and literature of the time was thus preserved for the use of students of to-day. The Chinese, about the same time, were independently learning to make paper from rice and silk. The first rival of papyrus was parchment prepared from the skins of sheep and goats

SORTING RAGS FOR FINE BOOK PAPER IN A PAPER MILL.



THE RAW MATERIAL OF THE DAILY NEWSPAPER.

Spruce logs waiting to be floated down to the pulp mills, where they are to be made into printing paper.

It grew in favor, owing to the partial exhaustion of the papyrus beds on the Nile, and because the Egyptians wanted to hold a monopoly and raised prices of their product beyond all reason. The next step forward was the invention of paper as we have it to-day.

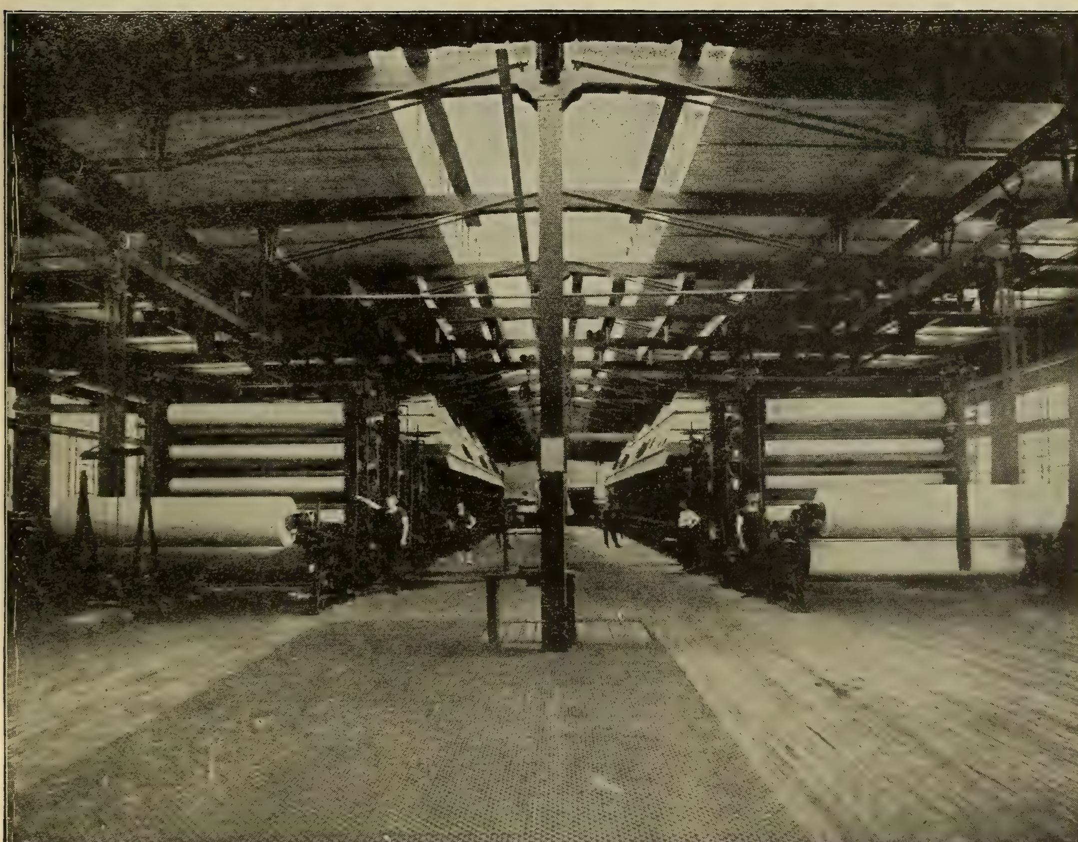
Like a great many other inventions of present value, the first European knowledge of paper-making came from the Chinese. They had been making paper for more than 1,000 years when, in 1189, the art was introduced into France, the first country of Europe where it was made. The Arabs had learned the art from the Chinese, and from them it passed to western Europe through the Crusaders who visited the Moslem countries. The Dutch were the next Europeans to make paper, and the English followed, about the time of the discovery of America. Long before this, however, the Saracens had introduced paper-making into Spain, whence it had reached Italy.

The first paper mill in America was established at Germantown, Pennsylvania, in 1690, by a paper-maker from Holland, one of the owners of the mill being the printer who some years later gave to Benjamin Franklin his first employment in Philadelphia. During the early history of paper making, rags were the only material used. The scarcity of rags was so great that the mills had to continually appeal for them by advertisements and solicitation, and the paper mills in the thirteen colonies grew in number so rapidly that the scarcity of material caused much inconvenience.

Before the most recent modern processes of paper-making had been invented, the production was much more expensive and slower. Everything was done by hand, and it took three men a day to finish 4,000 small sheets of paper, while from the beginning to the end the process required about three months. This is a striking contrast to the conditions of the present, when by machinery paper can be made from the tree as it stands in the forest within twenty-four hours. But little hand-made paper is used in America, except for special purposes. But all Bank of England notes are printed on linen paper, made by hand, with but two notes to a sheet.

The better and more expensive grades of paper are still made from rags, gathered and shipped in great quantities from all parts of the country and indeed from all over the world. China is one of the most important of the rag markets. They come to the factories in all conditions of filth, and the processes of sorting and cleaning are of the utmost importance to the perfection of the product. The mills making the highest grade bond paper, and that used for our paper money, use nothing, however, except new rags fresh from the mills or from garment factories where the trimmings are saved for the purpose.

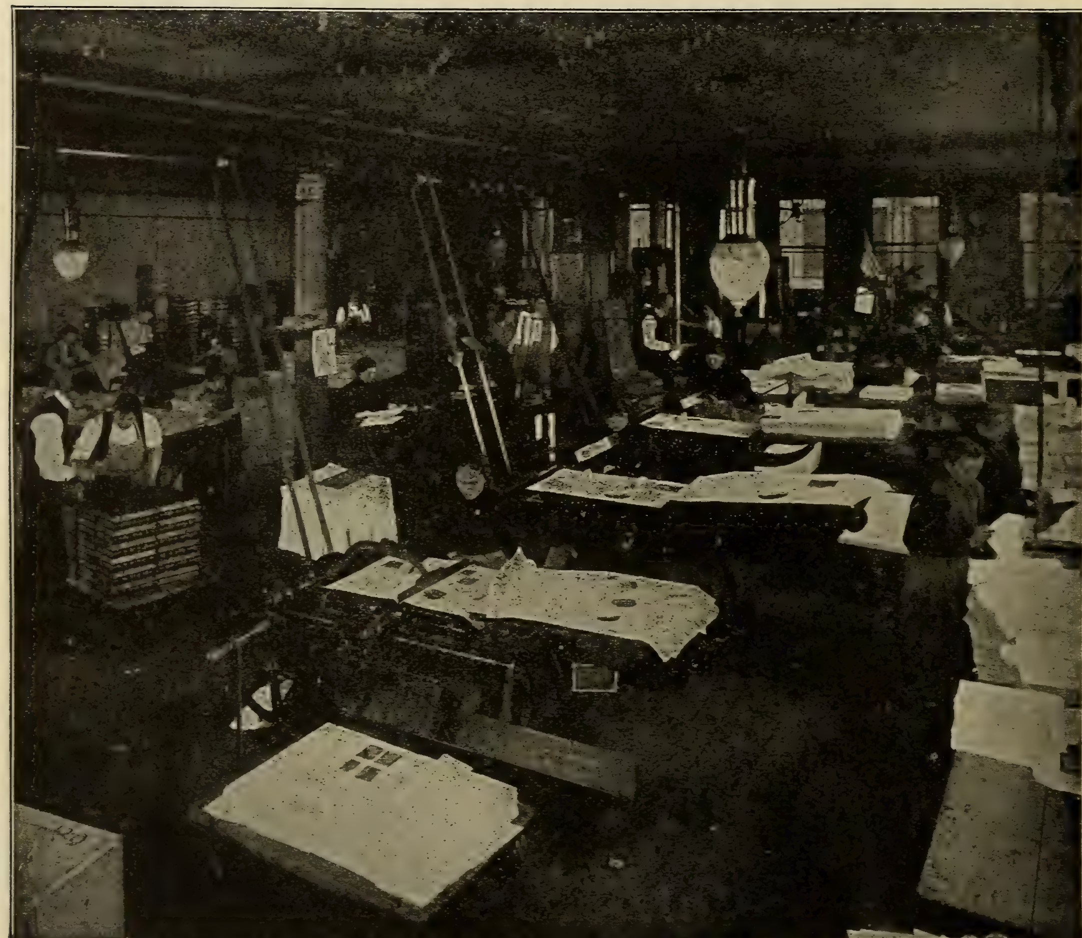
When sorting and cleaning are done, the rags are chopped into small pieces, boiled for a day under steam pressure, and finally treated with chemicals for an additional cleaning and bleaching of the resulting pulp. By this succession of processes the



INTERIOR VIEW OF A GREAT PAPER MILL.

dirty rags from the streets come forth a mass as white as milk. The pulp is drained and dried to a proper consistency, and finally passed through a great machine which converts it into the paper itself. By the flow of pure water the liquid pulp is spread out evenly over a wire cloth into a sort of web of damp paper, which is delivered on an endless belt of moist felt. Successive squeezings and scrapings dry the paper, smooth it and give it strength. From this point the additional processes are merely those for finishing different grades of the material. The surfaces are given a gloss or polish, or a rough or antique finish, according to the purpose for which it is intended.

Although the more expensive papers are made from rags, the great bulk of what is used in books, magazines and newspapers comes from wood pulp, the newest development in modern paper manufacture. The different fibers used in paper-making, whether of wood or rags, do not differ greatly after their mechanical and chemical treatment is finished. When the logs are



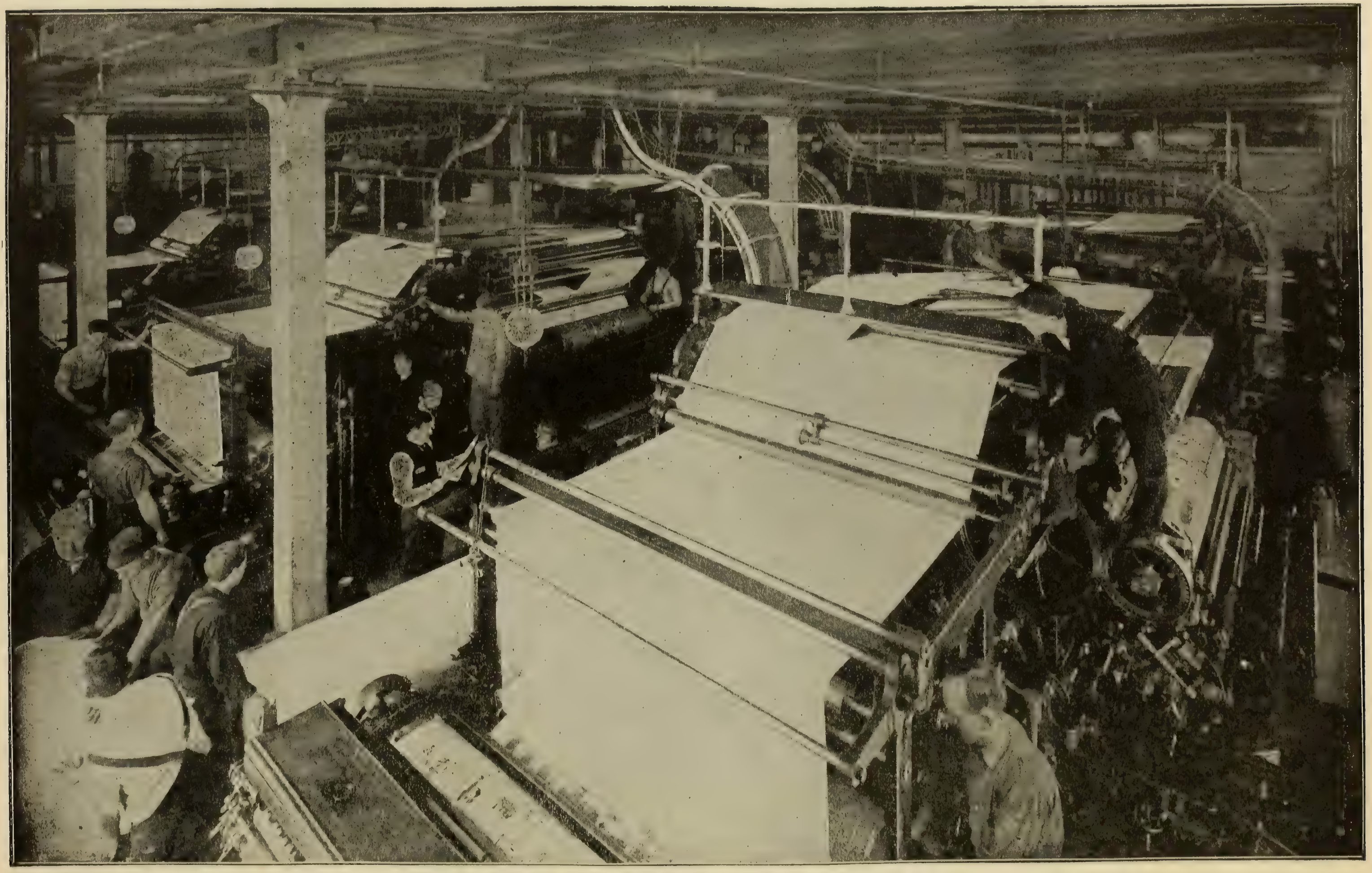
AT WORK IN A BOOK BINDERY, FOLDING MACHINES IN THE FOREGROUND.

cut in the forests, the bark is stripped from them and they are sent to the factory. Here they are sawed and split into small blocks, after which they are ground to a powder which becomes a pulp when diluted with water. This pulp, chemically treated to bleach it and to remove all resinous and foreign matters, then passes through processes similar to those by which paper is made from rags.

All of the paper from which our greenbacks and bank notes are made comes from one mill. It is made from the finest new, clean linen rags, and there is a special attachment on the machine by which the silk threads always seen in our paper money are introduced. It is forbidden to make such paper for private use, under the same penalties that apply to counterfeiting.

Paper fills an important place in many mechanical arts, and there are various novelty papers made which have important uses. Paper made with a quantity of asbestos fiber is used for fire-proofing purposes; tar paper is used for covering roofs and lining walls; photographs are made up-

TRIMMING AND MAILING MAGAZINES IN A BINDERY.



PRESSROOM OF A GREAT METROPOLITAN NEWSPAPER.

The peculiar curved troughs or channels, rising from the presses to the ceiling, are the carriers through which the completed papers are hoisted automatically to the delivery rooms above.

on paper rendered sensitive by a chemical process; carbon paper, transparent paper, stencil paper, gunpowder paper, safety paper for bank checks, and other familiar forms are but developments of the ordinary paper products. Sand and emery papers are prepared by coating a sheet of paper with glue, and then sprinkling sand or emery dust upon the surface. Car wheels, lumber, buckets and tubs, and many articles of common use are made from paper pulp.

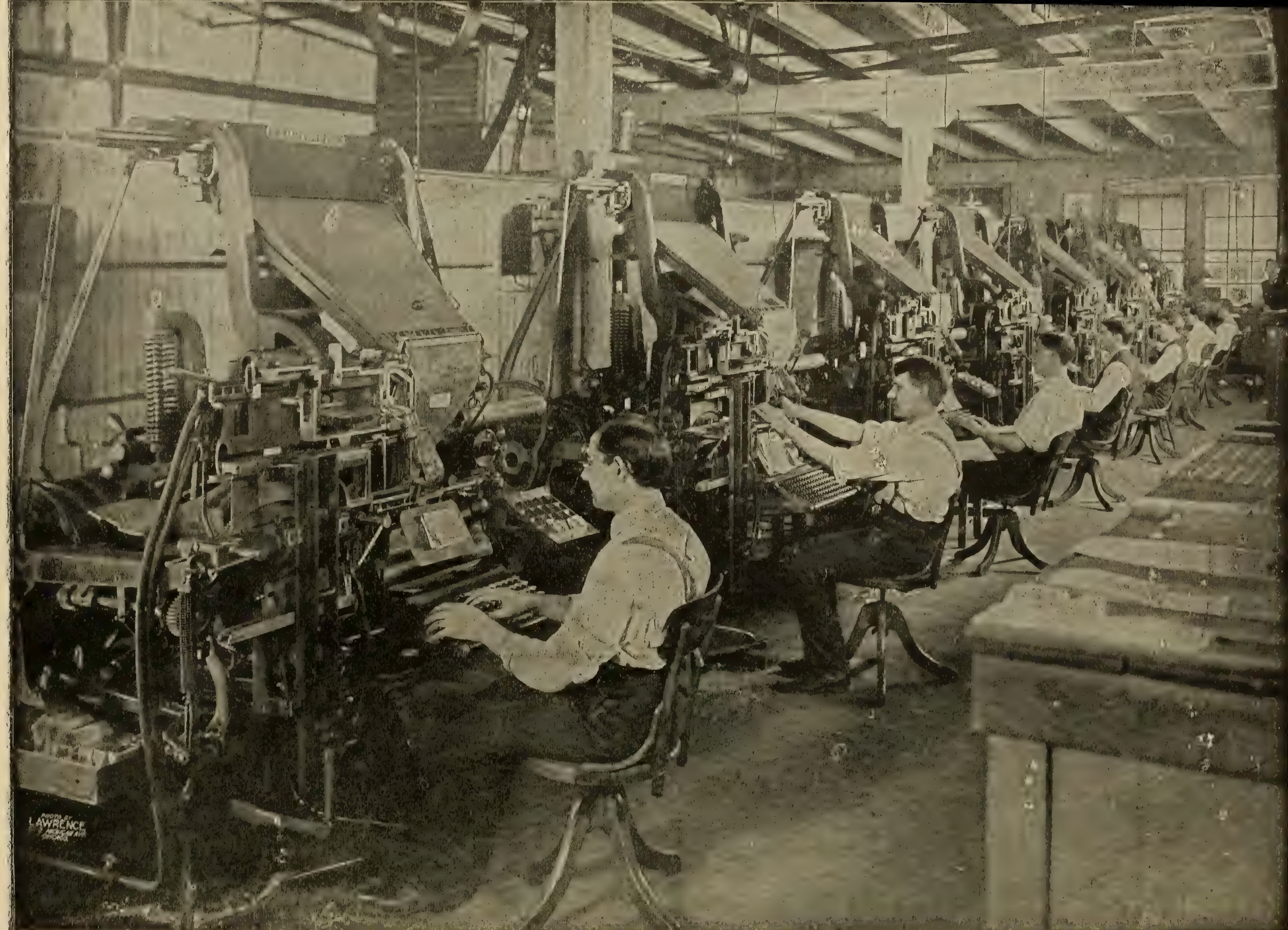
The United States leads in paper-making, producing about one-third of all that is used on the globe. The city of Holyoke, Massachusetts, is the greatest paper center in the world for expensive papers of linen. The cheaper grades of paper, from wood pulp, are made in great quantities in the mills of Maine, Canada and Wisconsin, convenient to the forests which provide the material.

HOW A GREAT NEWSPAPER IS MADE

Like the industries and the affairs of the world which it records, the modern newspaper has grown to a magnitude and an influence never dreamed by the pioneers of the press. Perhaps not changed greatly in the smallest towns, where the newspaper proprietor may embody in himself all the editorial and mechanical labors of his office, in the city it is a very different institution.

In order that the morning paper may be read by its thousands of subscribers at their breakfast tables, sometimes hundreds of miles from the place of publication, hundreds of employees must work in one department or another to produce and circulate the printed pages. In fact, the work of producing the paper begins long before the time of its publication, and enlists the energy of men who may be far away. The material equipment of presses, machinery and type comes from great factories where the highest mechanical ingenuity is employed to perfect the processes. The paper mills must turn out miles of broad, white ribbon, which, when printed and folded, becomes the morning paper. Back of the manufacturers and the paper mills come the miners, who toil deep in the earth to produce the metals, and the lumbermen of our northern forests, who cut and raft the logs from which the paper is made. Correspondents the world over keep a multitude of telegraph operators busy, transmitting the important facts of the day to the office from which the paper is to issue. Railways run special trains to insure prompt distribution of the finished journal, and by the time the newsboys, the clerks in the business office, and the editorial staff itself are added to the list of participants, the number who from the beginning to the end have shared in making the paper, which the reader buys for a cent, is an astonishing one.

In order to carry on all these manifold operations harmoniously, and without delay at a critical time, a great newspaper must be organized with the utmost care. The business, the mechanical and the editorial departments have their distinct functions, all of prime importance. It is the business department that does the work of securing subscriptions and advertisements, circulating the paper to subscribers, collecting bills and paying expenses. It is a self-evident fact that a carelessly managed business de-



LINOTYPE COMPOSING ROOM IN A DAILY NEWSPAPER OFFICE.

One of these machines will set as much type as half a dozen hand compositors. They are used in almost all large printing establishments.

partment could soon destroy the most ably edited publication.

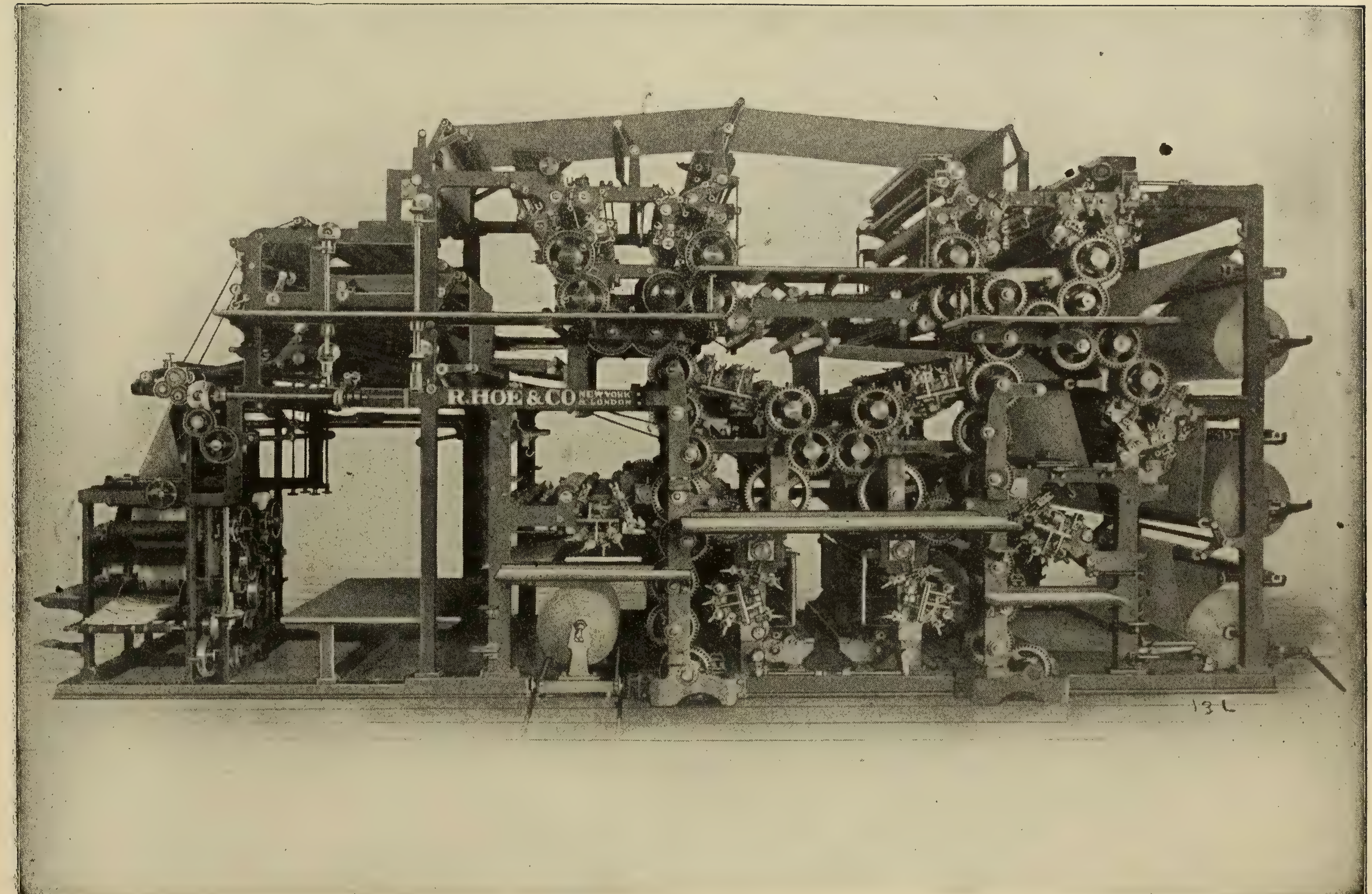
The mechanical department receives from the editorial staff of writers and artists, the articles they have written and the pictures they have drawn, and, from the business department, the advertisements which have been received for publication. Out of this material the finished product is made, by the various processes of type-setting, zinc-etching, stereotyping and printing.

The editorial department is the one first thought of by the reader, for from this department come the various articles of news, criticism, opinion and fact that go to make up the printed sheets.

The editorial staff of a newspaper is directed by the managing editor, who is himself, like the business manager and mechanical superintendent, responsible directly to the publisher. Under the managing editor are the numerous out-of-town correspondents, who send matter by mail and telegraph; the city editor and his reporters, who gather the local news and write it; the special writers who furnish dramatic criticisms, sporting news, literary or musical notes and the like; and the copy readers, who give final revision to all this matter after it has been written, in order to be sure that the style and policies of the paper are conformed with, that errors are guarded against, and that nothing libelous is included. The artists, too, report to the managing editor or city editor, because their work, while pictorial, must conform to the general style of the paper.

Once the manuscript has been prepared and finally revised, it goes to the composing room, into the hands of the mechanical department. Except in the smaller offices, the old method of setting type by hand has been done away with, by the invention of a mechanical device called the Linotype machine. By this machine one type-setter can accomplish as much as five or six hand compositors, with a higher average of accuracy. The Linotype, invented and perfected by Ottomar Mergenthaler, is a cumbersome and complicated apparatus, but it achieves its purpose with what seems almost human deftness and skill. The operator sits before the keyboard, not unlike that of a typewriter. The upper part of the machine is a magazine of molds or matrices, each in its own box, and carrying at one end the form of a printed letter. In another place there is a quantity of molten typemetal, kept heated by a gas flame. As the operator taps the keys indicating the letters he desires to use, each matrix slips from its box in proper order and falls into place in a little tray made for the purpose. When these have assembled, to the length of a full line of type, an arm controlled by a lever lifts them to a set of clamps, where an impression is taken from them in the proper quantity of the hot metal. This is the line-of-type, cast in one piece, which gives the machine its name. The matrices are carried up to the magazine again by another arm, and by an ingenious device each is distributed to its proper place once more.

When the article has been put in type in this fashion from the manuscript, an impression is made from the type, called a proof, and this is sent to proof-readers, who examine it for errors which must be corrected. When the type has accumulated sufficiently to be classified, or made up into the page of the paper, this is done, and the entire page sent to the stereotyping room. The printing of great papers is not done di-



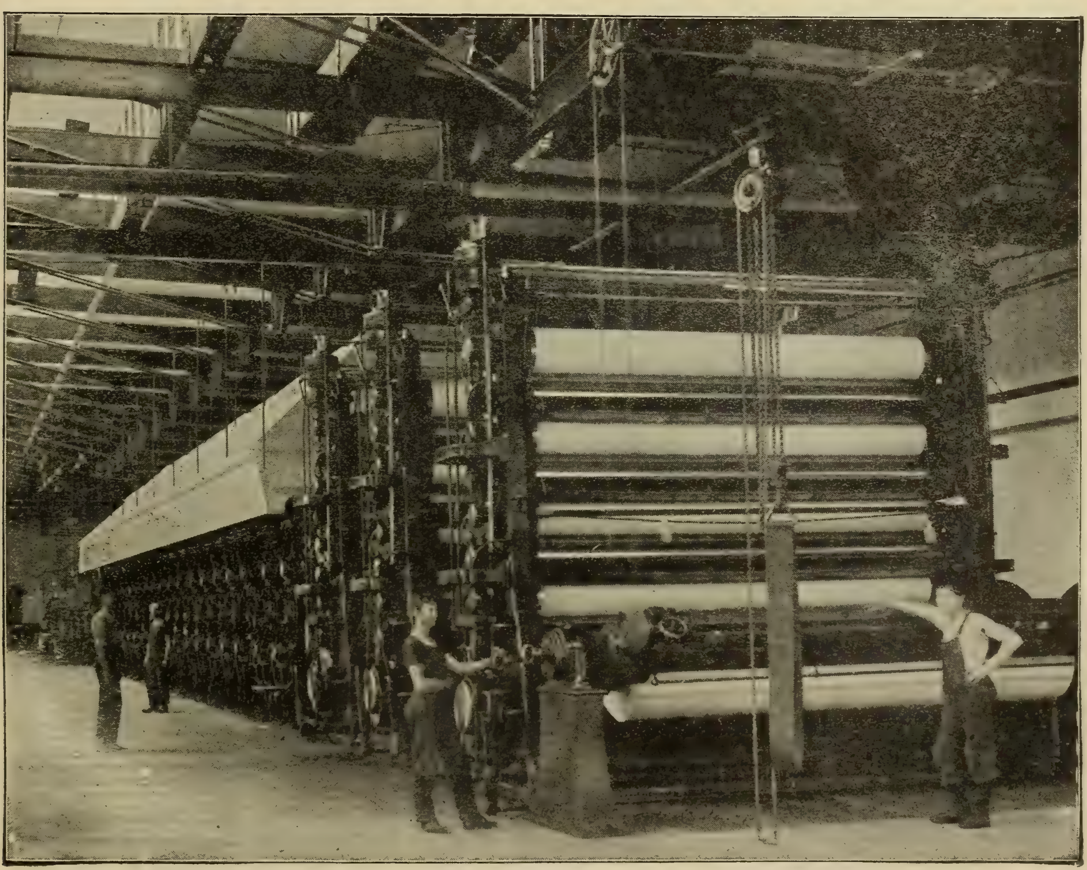
OCTUPLE ROTARY COLOR PERFECTING PRINTING PRESS.

This is the latest development of modern printing machinery as used in the greatest newspaper offices. It will print, cut, fold and paste 48,000 complete 16-page papers every hour with the cover pages printed in four colors. It is the largest printing press that has ever been constructed, and costs $60,000.

rectly from the type cast. The size of the editions requires that several presses should be at work simultaneously, in order to issue the paper in time. Duplicate plates are therefore made from the type pages, by the process of stereotyping, as many as are necessary for the number of presses used. These stereotype plates are not flat, but curved into a half circle, so that they may be clamped on to the cylinder of the press used for printing.

The pictures drawn by the artists are reproduced by a photographic process, which transfers the picture to a sheet of zinc, that is then treated with nitric acid to bring out the artist's lines. After such an engraving is finished, it may be placed in the page of type and stereotyped like the type itself.

The perfecting printing press of the newest design and largest size is one of the most interesting pieces of mechanism to be found anywhere. The curved metal plates, or "turtles," from which the printing is done, are locked in place; the rolls of paper like great bolts of ribbon, perhaps six feet wide and five miles long, are hung in place on the press; the ends of the strips of paper are woven through the labyrinths of rollers, cylinders and wheels of the machine, an electric button signals the starting, and the clamor begins. Then from the further end of the press begin to fall the folded newspa-



MACHINE FOR MAKING WHITE PAPER FOR NEWSPAPERS.

pers, printed, pasted, even addressed if they are intended for the mail, at a rate of 24,000, 48,000 or even 96,000 an hour. Truly a battery of half a dozen such presses, multiplying the printed pages for a myriad of readers, should be a more effective force in the world than a battery of artillery thundering against an enemy.

HOW BOOKS AND MAGAZINES ARE ILLUSTRATED

The great increase in book and magazine illustration, made possible by the improvement of mechanical devices, has brought about the establishment of important business concerns, devoted entirely to the making of pictures. Various processes are employed in publishing houses for the illustration of the books, magazines and newspapers which they produce, but the most effective and artistic of these for general purposes is that employed in the volume herewith presented. It is a photo-engraving process, producing what is known as half-tones.

It was found that by photographing the picture or object desired for reproduction, through a fine screen of muslin or wire gauze, or lines scratched on a glass plate and then filled up with ink, the little squares in the screen would separate the rays of light according to the strength of the lights or shadows of the picture. Where the shadows are most intense the rays run together, so that the effect on the plate is of the black shadows running all together, but where they are lighter, the rays form little dots upon the plate, while in the high lights or white places it is still more dotted.

If you will take the magnifying glass and examine any half-tone engraving, you will see that the whole picture is made up of little cross bars. This effect of the screen

OFFICE OF A GREAT ILLUSTRATING AND ENGRAVING COMPANY.

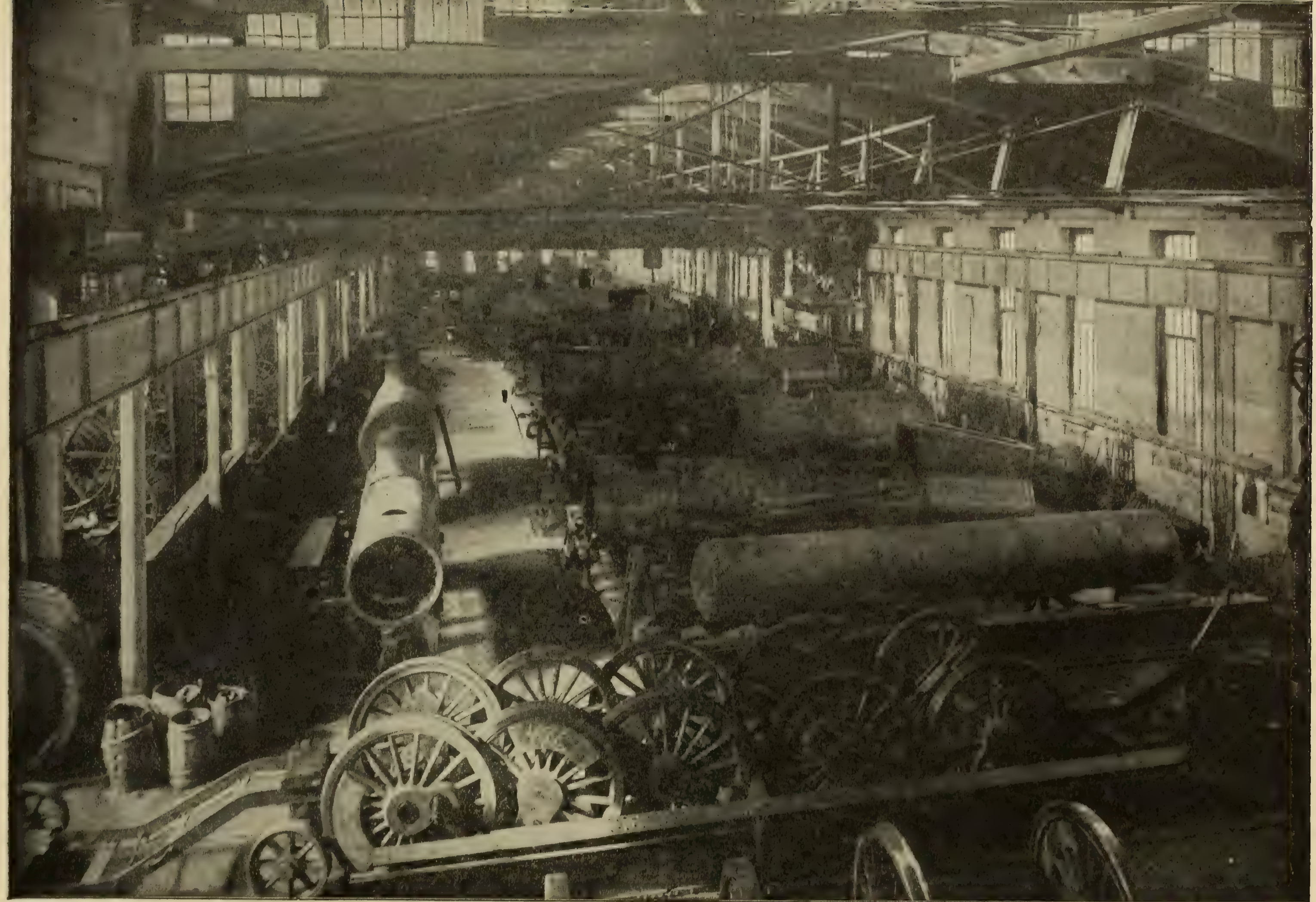
is called "stippling." The screen is placed just in front of the plate to be photographed upon, in the camera, and as the rays of light come in through the lenses they are diffused according to the intensity of the lights or shadows in the object being photographed. The screen is ruled in little bars, with lines from eighty to 150 to the inch. They are so small that they hardly appear as lines when the cut is viewed at a little distance, and by the process described they produce a picture upon a copper or brass plate almost a counterpart of the photograph.

The coarser line engravings used in newspapers are made with great rapidity by a process known as zinc etching. The artist draws in India ink the picture to be produced, making his sketch much larger than it is to appear in the paper. The process of engraving reduces the size and at the same time improves the work of the artist. This drawing is next photographed and developed by ordinary processes, and from the negative a print is made on a sheet of sensitized zinc, just as one would print an ordinary photograph on sensitized paper. The zinc plate is treated by a developing process that shows up the lines of the picture, and after this it is given a bath in nitric acid that eats away the exposed surface of the zinc plate and leaves the photographic lines standing out. Repeated eatings by acid, and retouching by skilful engravers, with sharp tools, bring the plate to final perfection, after which it is mounted on a metal base and is ready to be used in printing.

Colored pictures are made by a process similar to that of the half-tones, with some additions. Three plates are made of the same subject, which are used respectively with three different inks, red, yellow and blue. Such colors combined in proper proportions, by printing one on top of another, will give any shade or color desired. One plate is arranged for printing the blue, another for the red and another for the yellow. Each picture must go through the press three times for these colors to be put on, one at a time, and of course the work must be very accurate so that the successive impressions will be in the right place. When the work is finished, however, if this is done properly, there is a remarkable colored picture produced, with artistic effects, and yet at great speed and moderate expense.

Not merely mechanical processes, but genuine artistic ability as well, must be employed to obtain such results. The one to whom this work is given, carefully studies the subject to be printed, as to its color, and the proper combination of inks to produce the desired colors is decided. The first plate of the three is then arranged for printing in blue. All that portion which is to appear in heavy blue has a heavy surface left on the engraving; the lighter shades are stippled more, eaten out by the acid or carved out by hand, according to the degree of intensity needed. That portion which needs blue in combination with one or both of the other colors is shaded in proportion. This plate, after being thus made ready, is marked near the edges with lines which aid in printing the next color, exactly on top of the first at the proper place.

Next the plate from which the yellow is to be printed is prepared in the same way, and the red plate completes these preliminaries. Proofs of each plate are taken separately and together to see if the right color scale has been worked out. If the final proof is correct, the register marks should exactly coincide, and the colors



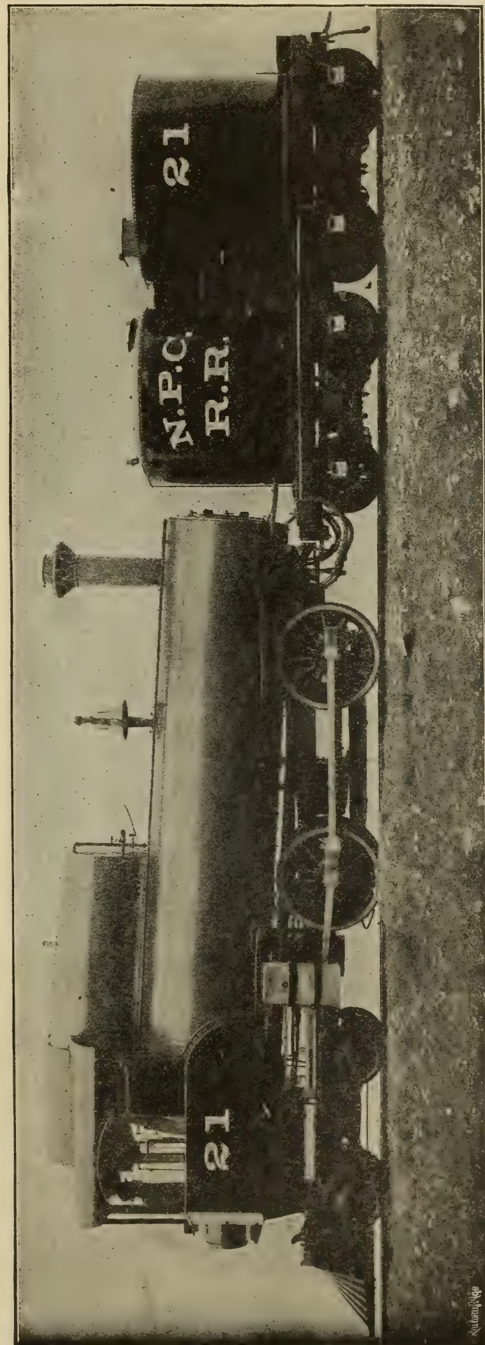
LOCOMOTIVE BOILERS IN THE PROCESS OF CONSTRU should blend so that they appear to be printed by a single impression. The completed work is a perfect colortype, resembling a half-tone photographic engraving in the natural colors.

The chromos of a few years ago are entirely superseded by the process thus described, which in addition to being much more satisfactory and artistic in its results, is more rapid and far cheaper. The new process has made it possible for beautiful pictures, colored as in nature, to be possessed by multitudes of lovers of beauty and art, at small cost, and house decoration is greatly aided thereby.

LOCOMOTIVES AND THEIR CONSTRUCTION

The modern locomotive, that draws trains of palace cars across the continent at a bewildering speed, has not many points in common with the "Rocket" and those other pioneer engines of the pioneer railways early in the century. Locomotives are getting larger and faster by a process of steady improvement in the mechanism and material. A score of great factories are busy turning out such engines for American railways, day and night, and with the great increase in railway mileage and traffic, it is almost impossible for the construction of train equipment to keep up with the demands of the roads. The locomotive trust, organized in 1901, with a capital of $50,000,000, includes all but two of the important American manufactories. These two, however, are among the largest, and one of them is perhaps the largest of all such works in the world.

American locomotives are used the world over. In Australia, New Zealand, India, South America, South Africa, Manchuria, Russia and Siberia, the American traveler finds himself drawn over the rails by an American engine. The American factories,



AN OIL-BURNING LOCOMOTIVE.

with characteristic adaptability, turn out locomotives of every type from the monster mountain-climbing giant of 120 tons for the Rockies or the Sierra Nevadas, to the smallest engine for a mine or a sugar plantation. Making locomotives according to regular designs and patterns, so that the various parts of it are as interchangeable as the parts of a watch, these great factories can supply a demand with surprising rapidity. The greater locomotive works can turn out complete engines all the year round, at the rate of from two to five a day. If the order be for one of a regular type and size, they can deliver it out of the stock room as promptly as a grocer can deliver a barrel of sugar. For a test of speed, locomotives have been built out of the parts into the completed machine, ready for the track, in twelve hours.

It is this facility that has enabled the American builders to get into the world markets with such great rapidity, in competition with the English, French, Belgian and German builders who have hitherto monopolized the trade. Even such Australian, Russian and South African railway managers as believed the European locomotives to be superior could not overcome the temptation to buy the American machine, promised for shipment and delivered in three months or less, when the European competitor demanded one or two years. Even the English railways themselves have begun to buy American locomotives, apologetically explaining that it was promptness of delivery which compelled their choice.

Generally speaking, English locomotives, and consequently English trains, have the better of us in speed. There are various reasons for this. One is that the English roads early adopted the principle that there must be no surface crossings, either of other railways or of wagon roads, so that they avoid many delays and halts which American trains must make. Then, too, the English lines are invariably double-tracked, a policy which rules only on the richer American roads, in the most thickly populated districts. Then there are no such long runs in the British Isles as we have in America. The through trains between London and Glasgow or Edinburgh, a distance of not much more than 400 miles, and between London and Liverpool, less than 200 miles, are the ones making the longest runs. They have no such thing as our transcontinental lines to maintain.

The London Transport of May 10, 1901, printed figures showing the relative speed of English and American express trains. For distance up to 100 miles, the English trains average 41 miles an hour and the American trains, 42 miles. It is fair to say, though, that the average for this country is brought up by the great speed of the trains between Philadelphia and Atlantic City, otherwise it would fall slightly below that of England. For a distance of 100 to 250 miles, the average in both cases is about 40 miles an hour. For long distances English express trains average 43.3 and American 35 miles an hour. All countries have their speed records of exceptional runs and we do not fall below others in this. Speed up to seventy and eighty miles an hour is no longer uncommon, while for short distances on straight track some trains have actually achieved the marvelous speed of 112 miles an hour. It is to the American locomotive builder that the credit must be given for the machines that race over the track at such an amazing speed.

BLACKSMITH SHOP IN BALDWIN'S LOCOMOTIVE FACTORY.

MAKING LOCOMOTIVE SPRINGS.

THE AMERICAN INDUSTRIAL INVASION OF EUROPE

The American industrial invasion of foreign lands has reached such proportions as to disconcert and even alarm many thoughtful men abroad, who see their countries being exploited for American profit and their opportunities utilized by American energy. American industrial pioneers are entering the activities of Europe, Asia and Africa, in competition with the English, French, Germans and Belgians, who have believed themselves to be safe in their monopoly of their respective fields of endeavor.

Even in London, an English builder, manufacturer, engineer or promoter finds his American rivals at every turn. Great American manufactories are establishing branches in England, and in some instances actually buying out their former English competitors. In 1901, the British match-manufactories were absorbed by the American match trust, a fact which greatly disturbed English students of commercial and industrial conditions.

A striking achievement was made a year later by an American builder, who practically completed in ten months a huge work that the most enterprising of British contractors declared could not be done in less than five years. He shook the traditions of British bricklayers, carpenters, builders and theorists to their foundations. The London Times devoted one of its ponderous editorial columns to a lesson to the British workmen, based on this American contractor's success, and other papers all over the British Isles took up the refrain.

The British Westinghouse Company, which was to supply the electric fittings for most of the underground railways that American capitalists were building in London, found it necessary to erect one of the greatest electrical plants in the world at Manchester. Being to all intents and purposes a British company, they were naturally very anxious to give the British contractors the job of building it. A Manchester company got the contract for foundations, and a London company for the steel work, both these contracts being allotted in May, 1900. Neither of the concerns could "see their way" to saying when the work was likely to be done. The foundation people thought the matter over and finally began the work in July. In November the foundation of one of the largest buildings was in such condition that the steel work could be begun, and then the London contractors arrived on the scene and the work proceeded in an eminently dignified way.

Meanwhile the capitalists were making things hum, extending their systems right and left, pushing through plans for the electrification of old-fashioned steam lines with such rapidity that it made the old-fashioned stockholders dizzy to think about, and pouring huge hurry-up orders on the Westinghouse Company.

At the gait things were going the new plant would not be ready in time to fill the orders, and the great enterprise would be delayed, at a cost that might be disastrous. George Westinghouse promptly took a hand in it, and told the contractors that the whole group of buildings must be ready in two and a half years. The contractors threw up their hands in holy horror. It couldn't be done in less than five. No man on earth could do it in less than five.

The situation was serious, for it was beginning to look as if even two and one-half years was going to be too long to wait. Then somebody called to mind the doings of an American contractor named Stewart, head of the firm of J. C. & A. M. Stewart, of St. Louis, Pittsburg and New Orleans, who had taken in hand the principal building of the Pittsburg Exposition when it had burned down three months before the day the show was to open. Stewart had it up again and finished ahead of time. His rush work on some grain elevators was so striking that a novel had been based upon it. He had restored the Galveston system of docks and storehouses in forty-five days from the time they were destroyed.

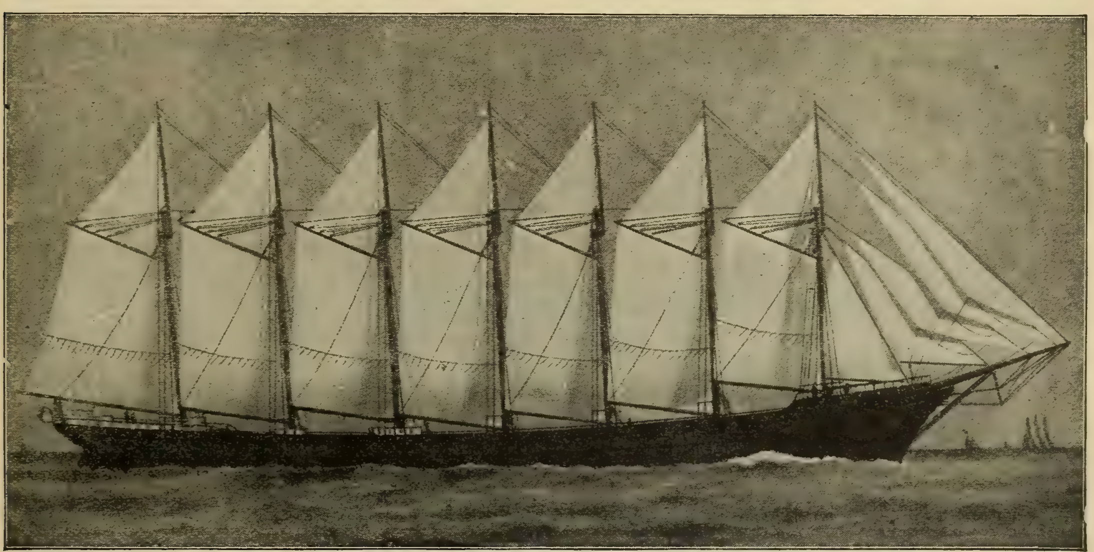
The Westinghouse people told Stewart they wanted him to take the Manchester job, and finish it in fifteen months. The agreement was signed in Pittsburg, and the contractor took the first steamer for Liverpool. He had never been in England before, and did not know what was waiting for him. He landed on January 24. One week later his best two men got four hours' notice to start for England. One of them was in New Orleans and the other in Toledo, O., but they both caught the Teutonic two days after. Before they could reach England, however, Stewart was hustling home aboard the Oceanic. The two men stopped at Queenstown, hired a tender and went out to meet the Oceanic, and had a bundle of minute instructions as big as a log of wood tossed to them. The next day they were at the Manchester works, and things had begun to happen.

Three weeks later, Stewart, who had been collecting some of his good men, and buying American appliances for handling work, was back in Manchester. He brought ten young Americans, whom he had trained himself, and with them he sailed into the biggest fight of his life. For the next few weeks he and his little band got about four hours' sleep per night. They "rushed" things all day and spent half the night in discussing how they were to be rushed the next day. Stewart slept in a little hotel within a hundred yards of the work. His two men slept on the plans in the office. They were working every morning at six.

When the American took charge of affairs at Manchester there were 236 men on the job. In four weeks there were 2,500. Stewart had an advertisement in each of the largest provincial papers, saying that carpenters and bricklayers were wanted, and they came in from all over the country. As soon as a man came in he was set to work. He got a fair trial, and if he was no good he was discharged. Every morning Stewart and two of his men made a complete tour of the work, and all three took note of how things were progressing. Every gang of men that didn't get ahead fast enough had an American foreman placed behind him. Every day's work was carefully measured and compared with the record of the day before. If there was no improvement the contractor found out why.

Before going any further, it may be well to give a few rather striking figures that tell better than any technical description could, what sort of a job the American contractor had tackled. The plant as it was completed is the biggest in the world ever built at one time. When Mr. Stewart was asked with what one could compare it, he mentioned the Westinghouse factories at Pittsburg and the General Electric Company's plant at Schenectady. It consists of nine immense buildings, the office building, machine shop, box-factory, power-house, steel-foundry, iron-foundry, brass-foundry, pattern-shop, and dipping and drying-shop. The cost of the buildings was about $7,500,000. Twelve million feet of lumber were used, and 5,000,000 bricks, 750,000 feet of glass, and 40,000 square yards of paving, or enough to pave a street three miles long. About 4,500 men were employed.

Putting up this building was a fight from the start. No sooner was one obstacle overcome than another popped up. In the first place, the sub-contractors would not put on enough men. They had ten men on the job where a hundred have been used in America, and when Stewart insisted on the force being doubled or quadrupled, they wailed that they could not look after so many men. So they put the men on and Stewart did the "looking." Sometimes they wanted to back out of their contracts, saying that they couldn't buy the material and make any profit; so Stewart went out and bought it for them. When they said they couldn't get some little job finished, he told them that there was $100 extra in it for them if they did, and somehow the job was done on time. When bulldozing worked best he bulldozed and held their "penalties" over their heads; when they seemed like to stand out he cajoled.



THE FIRST AND ONLY SEVEN-MASTED SCHOONER IN THE WORLD.

This steel craft is not only the largest fore-and-after ever built, but it is the largest sailing vessel of any kind in the world. It is 388 feet long at the water line, 50 feet wide and carries 8,000 tons of cargo with a crew of only 16 men. Built in Boston, 1902.

The railway terminus was not far from his works, and the contractor built a line from the depot to the grounds and ran a section of it into every building. Two hundred and fifty carloads of stuff were coming in every day, and Stewart's little engine was kept breathless, shunting it where it belonged, but the supplies were not enough to keep pace with the work. The fault was the contractors' again. They notified the American that they had shipped goods, whereas the men he sent flying to look them up found the stuff piled up in their yards. He insisted on his advices being sent by telegraph, and, insisted, too, that every shipper supply the car numbers in which the stuff was sent, a demand that never before had been made in England. He had his men all over England following the cars. They called on railway superintendents and asked why cars did not get along faster, and kept hammering at the officials until they did something.

In dealing with his men he had first to fight their prejudice against him because he was a "damned Yankee." The more they saw of him, though, the better they liked him. He made a policy of keeping every promise he made them. If he said he would pay a man extra for a job, the man got his pay. If he threatened to "fire" a man if he didn't do better, the man was fired. He paid his men two cents an hour above the union wages. He allowed them "walking time"—half an hour in the morning to get to the works. He kept a supply of hot water to be served out to them for their tea. When they did a job especially well, he treated them all to free beer. The union rules of England did not allow him to pay the men that did the most of the work the best wages, but he got around that by keeping only the best men and discharging the rest.

And he made them work as they had never dreamed of working before, and as none of the men who had been blaming the British laborer for the decadence of British trade had ever dreamed they could work. One reason was that Stewart is a practical man himself. He studied under his father, who was an architect, and then went out and worked at other trades. He can lay a brick and can cut stone and do carpentering, as the men have discovered.

The way in which he shook up the bricklaying part of the job is a fair specimen of the things he did to the men's long accustomed ways. When the work first began, bricks were being laid as they are laid everywhere in England, at a rate of about 400 a day. There were no steam "hoists" for sending the brick up to the scaffolding, and the men were using stiff mortar. Under the new regime automatic "hoists" were set to work in a jiffy, and soft mortar was supplied to the men.

Stewart explained to the men personally how, by using the American mortar, they could lay enough with one stretch of the trowel for six or a dozen bricks, and lay the bricks themselves by a light pressure of the hand and a light tap with the trowel, instead of by repeated hammering to force the brick into the stiff mortar. He told them to their horror and amazement that bricklayers in America laid 2,000 bricks a day and thought nothing of it. He had hardly got the words out of his mouth, however, when one of the men contradicted him bluntly. He said he had been in America and he knew how bricks were laid there. Stewart, looking, as usual, as if he had just come out of a men's furnishing shop, with glossy derby, natty business suit, and patent leather shoes, was standing on the ground and talking to the men on the scaffolding above. He jumped for the ladder leaning against the building, and in four steps was standing on the scaffolding beside the man who had contradicted him. He rolled up his sleeves, and, filling a trowel with mortar, he laid four complete rows of bricks with a deftness and dispatch that made the men's eyes stick out of their heads. Then he went on, but left an overseer behind him to see that the men worked faster and faster. Little by little he got them along, until, finally, they, too, could and did lay 2,000 a day. Yet the London County Council, the governing body of the metropolis, reported recently that the average of bricklayers on municipal works was "over" 330 a day.

The "boss" got just as striking results with the other men as with bricklayers. When he arrived the carpenters were averaging 500 feet of timber a day, and they finally averaged 1,000. The steel workers were doing their riveting by hand, and the union tried to make trouble; Stewart insisted that automatic riveters be used. In the beginning the men disposed of from ten to fifteen tons of steel a day; they learned to use up 100 tons. Their first rate of riveting was fifty rivets a day; long after it was from 200 to 300.

The work as originally ordered was done in ten months from the time the American "hustler" took hold, but the company made certain changes in the plans and extended the undertaking so that several months'

NEW YORK DOCKS.
Ocean Freight Vessels that carry our goods to foreign ports.

additional work were required. Mr. Stewart had an experience which, while financially profitable and a valuable lesson to his English rivals, was trying to his own powers of endurance. Various liberal offers were made to him by important London institutions, urging him to stay and continue similar work in their behalf, but he declared that it was too big an undertaking for one man to revolutionize a whole country. "Mr. Westinghouse made it a big object for me to come over here," he said, "and I am going back from $30,000 to $40,000 better off than when I came, but I said to him when the work was done, 'you have had the best five years of my life, but you have had that all in one.' "

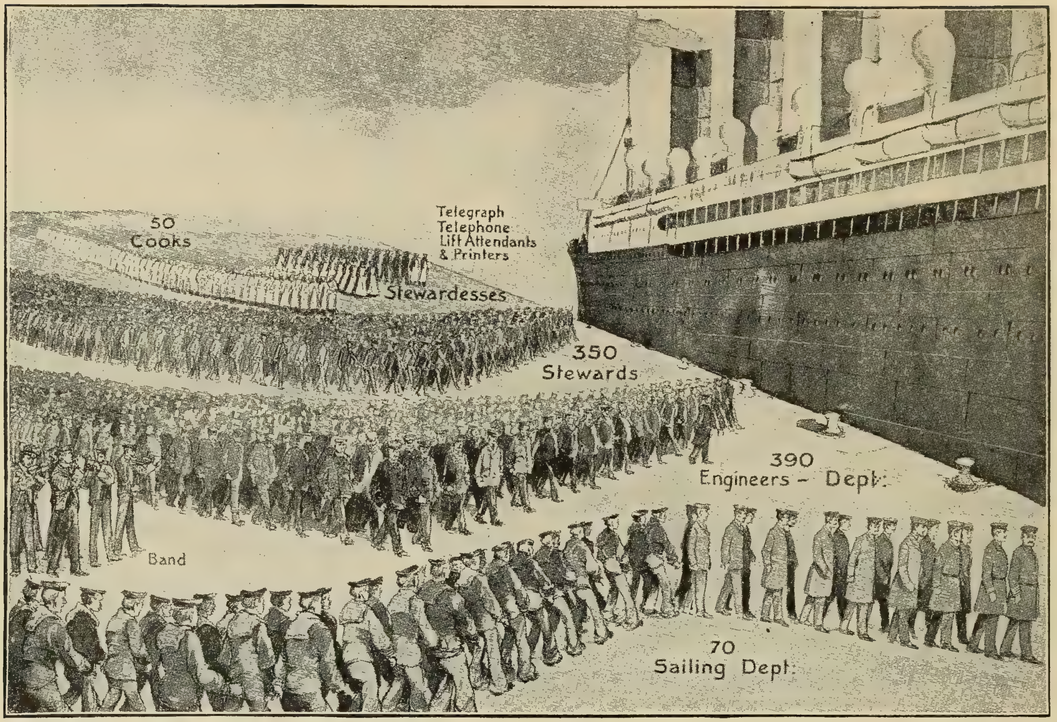
EAST RIVER DOCKS, NEW YORK.—Vessels from foreign ports unloading cargo.

GIGANTIC OCEAN STEAMSHIPS

Few people realize the great progress that has been made in ocean transportation, especially as regards the size of the ships and the care and comfort of passengers. Until the launching of the White Star steamship "Olympic," at Belfast, October 20, 1910, the Cunarders "Lusitania" and "Mauretania" were the largest vessels afloat. These were twin ships, each 790 feet long, 88 feet in width, 45,000 tons displacement and 37½ feet draught. Their proportions were regarded as Titanic. Then came the Olympic, which is 882½ feet in length, 92½ feet in width, and 66,000 tons displacement, the greatest monster that has yet ridden the deep. Beside the Olympic, the Great Eastern, which was discarded in 1889 as being too big and unwieldly, was a pigmy. The Great Eastern was only 692 feet in length and of 12,000 tons displacement. There are few modern ocean passenger steamers which do not exceed the Great Eastern in size and the Olympic is much larger in every way. The Cunard line has awarded to Brown & Co., of Clydebank, a contract for the building of a steamer which is to be 1,000 feet in length and of 90,000 h. p. It will dwarf the Olympic almost as much as the latter dwarfs the Great Eastern of 1889.

For a steamer like the Lusitania, which is now of the second class, it requires 6,600 tons of coal to supply the boilers for one trip. Such a ship carries 500 first-class, 500 second-class, and 1,300 third-class passengers. The crew, consisting of sailors, engi-

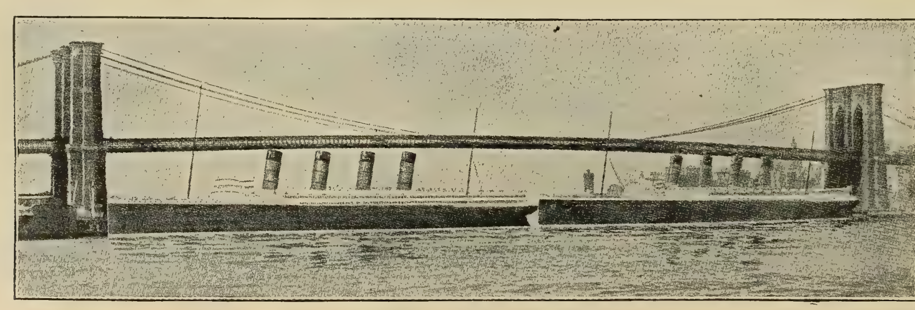
THE MODERN OCEAN LINER IS LONGER THAN THE GREAT AUDITORIUM AND ANNEX HOTELS COMBINED.



CREW REQUIRED TO OPERATE AN OCEAN PASSENGER STEAMER.

neers, firemen, stewards, cooks, and other attendants, numbers 860. On one voyage (one way) across the Atlantic, which is made in less than six days, the amount of food consumed is something enormous. The official figures are: 40 oxen, 130 pigs, 80 sheep, 2,000 chickens, 150 turkeys, 350 ducks, 90 geese, 10 calves, 200 pheasants, 800 quail, 200 snipe, 250 grouse, 250 partridge, 400 pigeons, 20 kegs oysters, 10 boxes fresh herring, 12 barrels smoked herring, 84 boxes haddock, 36 boxes bloaters, 1,500 lbs. salmon, 60 boxes kippers, 45 boxes fresh fish, 325 lbs. turtles, and fresh vegetables in proportion.

The celebrated Marshall Field & Co.'s retail store in Chicago is the largest establishment of the kind in the world. The Olympic is twice the length of this mammoth store.

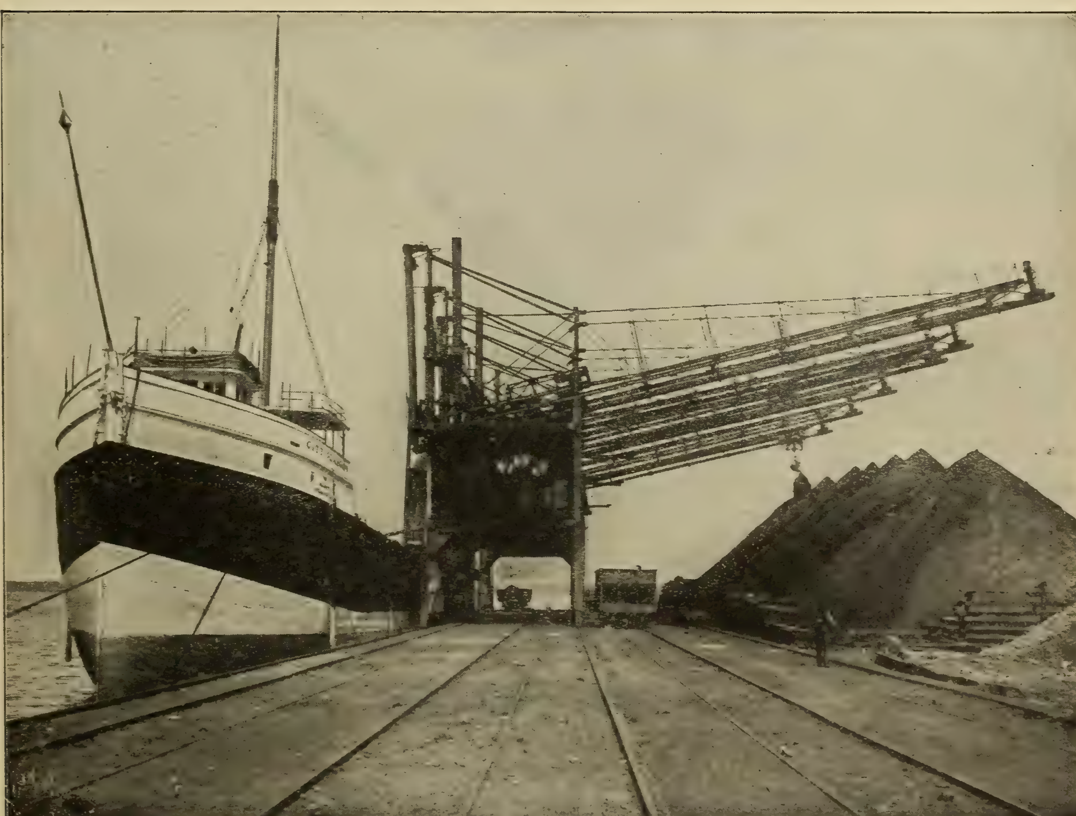


TWO MODERN OCEAN STEAMERS FILL THE SPAN OF BROOKLYN BRIDGE.

SHIPPING ON THE GREAT LAKES

From the Atlantic Ocean to the very heart of the American continent, by way of the St. Lawrence River and the Great Lakes, there is a commercial route over which traffic passes throughout the eight months of open navigation every year, so immense in its magnitude that it never fails to astonish those who consider it for the first time. From Niagara Falls to the sea this route is virtually uninterrupted for more than 1,000 miles, except by the short canals which are necessary to pass around the rapids of the St. Lawrence. Niagara Falls, however is an obstacle difficult to surmount, and although the Welland Canal, connecting Lake Erie and Lake Ontario, makes it possible for vessels to continue their journey, yet in practice not a great deal of the trade is carried through uninterruptedly.

From Buffalo to Duluth at the head of Lake Superior, and Chicago at the head of Lake Michigan, however, the travel routes are unbroken. Indeed there is no interruption in direct navigation among all the ports of the upper lakes, except that at Sault Ste. Marie the United States Government has built a great canal lock, the



IRON ORE DOCKS ON LAKE ERIE.

largest in the world, by the aid of which vessels overcome the twenty-one-foot difference in level between Lake Superior and its lower neighbors.

By way of Lake Superior, Lake Michigan and Lake Huron come the immense shipments of agricultural and lumber products from the numerous ports around their shores. From the Lake Superior region come the huge cargoes of iron ore and copper from northern Michigan, Wisconsin and Minnesota. Duluth and West Superior, at the head of this greatest lake,

ENTRANCE TO CHICAGO RIVER FROM LAKE MICHIGAN.

This is a bird's-eye view of the city freight yards of the Illinois Central Railway at Chicago. The tract thus occupied lies at the mouth of the Chicago river, and the docks and elevators are convenient for an exchange of freight with the railway. Michigan avenue is the street at the extreme left, and in the distance appears the boulevard leading north along the lake shore to Lincoln Park.

IRON MINE IN THE LAKE SUPERIOR REGION.

also ship immense quantities of grain from the wheat fields of the northwest. It was at the shipyards of West Superior that those peculiar craft, the "whalebacks," known to all lake men as the "pigs," were built, and in them are carried millions of tons of grain, ore and coal every season. There is no trouble in finding return cargoes for vessels on the Great Lakes, whichever way they sail. The great wheat, lumber and ore carriers from Lake Michigan and Lake Superior discharge their cargoes at Detroit, Cleveland, Erie or Buffalo, and return laden with coal or manufactured products, so that there is a constant exchange between east and west, with profit to all interests concerned.

Few people realize that the traffic on the great lakes of North America is one of the largest industrial enterprises in the world. The commerce of such a port as Chicago is as great as that of New York. The volume of traffic passing up and down through the great canal connecting Lake Superior and Lake Huron at Sault Ste. Marie, is greater than that passing through the Suez Canal, and the traffic passing the city of Detroit on the Detroit River is much greater than the ocean traffic at the port of New York City.

For a few months in the winter all this navigation system is closed by ice, and traffic is halted until the ice breaks up in the spring. It is evident, therefore, that the date of opening navigation is of great importance to the immense interests involved. So regular is the season, that steamship owners are able to calculate in advance about what time the first vessels may pass through the narrow channels connecting the different lakes. But sometimes all rules fail. In the spring of 1901 navigation was closed by ice later in the season than it had been for fifty-seven years, or virtually since the trade of the lakes grew to important proportions. The April ice jams forbade communication between the upper and lower lakes until well into the month of May, a whole month later than the average date of opening. Of course, every day's delay meant great loss to vessel owners and those who were dependent upon shipments by water, and the total loss in this month of delay reached an enormous figure.

There are three places that are watched for the signs of opening navigation. These are, respectively; the St. Mary River, which connects Lake Huron with Lake Superior; the Straits of Mackinac, connecting Lake Michigan and Lake Huron, and the St. Clair River, connecting Lake Huron with Lake St. Clair, just above Detroit. The last of these being the farthest south, is usually the first to open, and when vessels find a channel through the straits of Mackinac, that is usually considered as a signal that navigation from the upper to the lower lakes is once more free. In 1901, however, although the Straits and the "Soo" were open to free navigation almost as early as usual, it was not possible to go from Lake Huron into the lower lakes. A succession of northeast winds carried the great ice floes of Lake Huron into the southern extremity of the lake, where they packed and jammed instead of melting and scattering in open waters, as they would have done under other circumstances. The current of the lakes flowing into the St. Clair River at this point aided the winds in blocking up the narrow channel, and the result was that a solid mass of ice accumulated at the foot of Lake Huron, perhaps fifteen by twenty-five miles. The jam extended into the St. Clair River, which is about thirty miles long, and for weeks that stream was packed solidly with the great cakes of ice.

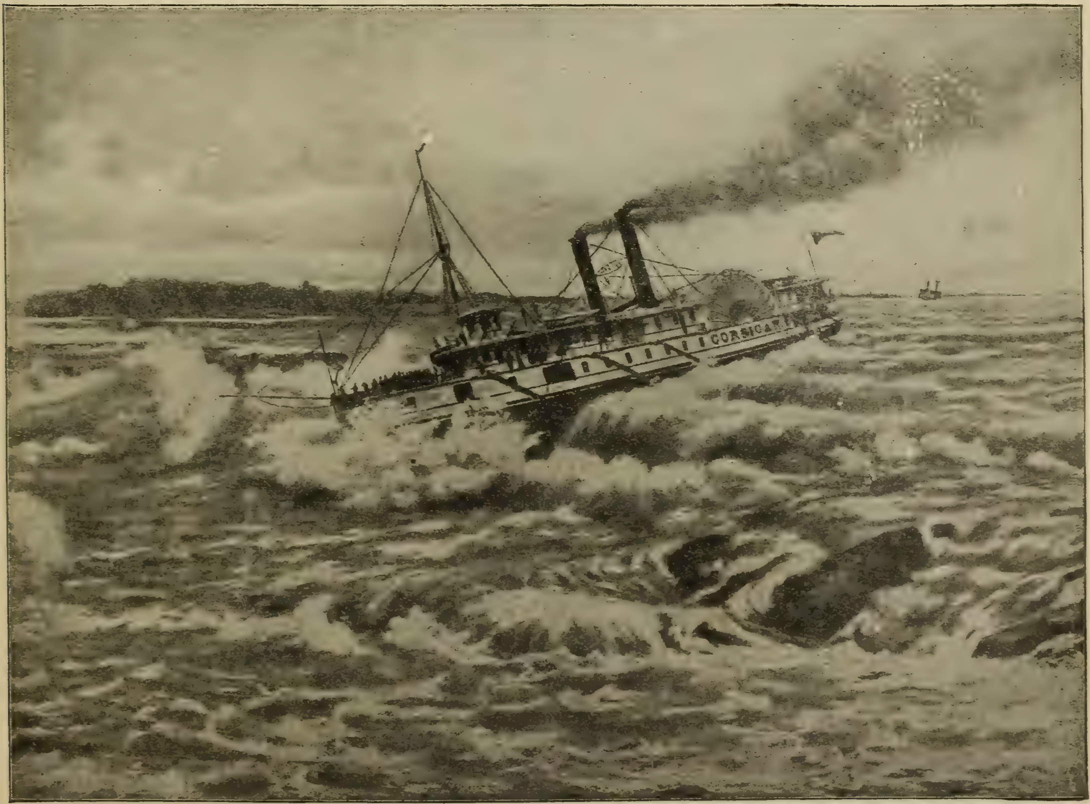
All the vessels which had sailed from ports on Lake Michigan and Lake Superior were blocked by ice jams above, and all those from the lower lakes were held at Detroit, unable to go farther up stream. It was not until April 29 that one boat got through to Detroit from the upper lakes, and two days later fourteen came through. After that the jam packed solidly again, and it did not finally open until the 8th of May. In the St. Clair River itself, and in the narrow canal which extends from the mouth of the river into deep water in Lake St. Clair, the ice cakes had actually filled the stream from top to bottom until a great dam was formed. Above the jam the water rose, but below fell so far that in Lake St. Clair and the Detroit River navigation was greatly embarrassed by the shallow water.

Although the commercial loss by this unfortunate delay was great, the people who lived on the St. Clair River and in Detroit and other neighboring cities had some recompense in the picturesque and interesting conditions that existed. On shore the season was almost summerlike, with flowers, grass and foliage as far advanced as ever in early May. Excursionists by the hundreds came out on the electric cars that run along the river bank, wearing their summer suits and straw hats, to see the marvelous masses of ice that were blockading the commerce of the lakes. Scores of great vessels were held captive for from one to four weeks, some of them above or below the ice jams, and others in the very midst. The latter experienced all the sensations of Arctic exploration, cut off from shore as they were, except when they sent men to make perilous trips back and forth over the ice for provisions.

When the jams finally began to break, and the glacier-like masses began to race down stream again, the vessels held in their clutch were at times in great danger. Docks along the shore were torn to pieces, vessels were dragged from their moorings and in some instances badly damaged, and others were left aground. Altogether the conditions were memorable, and those who had occasion to deal with the lake traffic at that time earnestly hope that nature may play no more such tricks upon them.

AREA OF THE GREAT LAKES OF THE UNITED STATES.

	Superior.	Michigan.	Huron.	Erie.	Ontario.
Greatest length in miles	390	345	270	250	190
Greatest breadth in miles	160	84	105	60	52
Greatest depth in feet	900	1,800	1,000	204	412
Area in square miles	32,200	22,400	23,000	10,000	6,700
Drainage in square miles	85,000	70,040	74,000	39,680	29,760
Height above sea-level in feet	600	578	574	564	234
Latitude, degrees north	46° 45′	40° 15′	43° 20′	41° 20′	43° 10′
	48° 50′	46° 55′	60° 10′	42° 50′	44° 10′
Longitude, degrees west	84° 30′	84° 40′	80° 10′	78° 35′	76° 20′
	92° 15′	87° 08′	84° 30′	83° 10′	79° 50′
Boundary lines	300	None	220	200	160
United States shore line in miles	955	1,320	510	370	230



PASSENGER STEAMER SHOOTING THE LACHINE RAPIDS ON THE ST. LAWRENCE RIVER.

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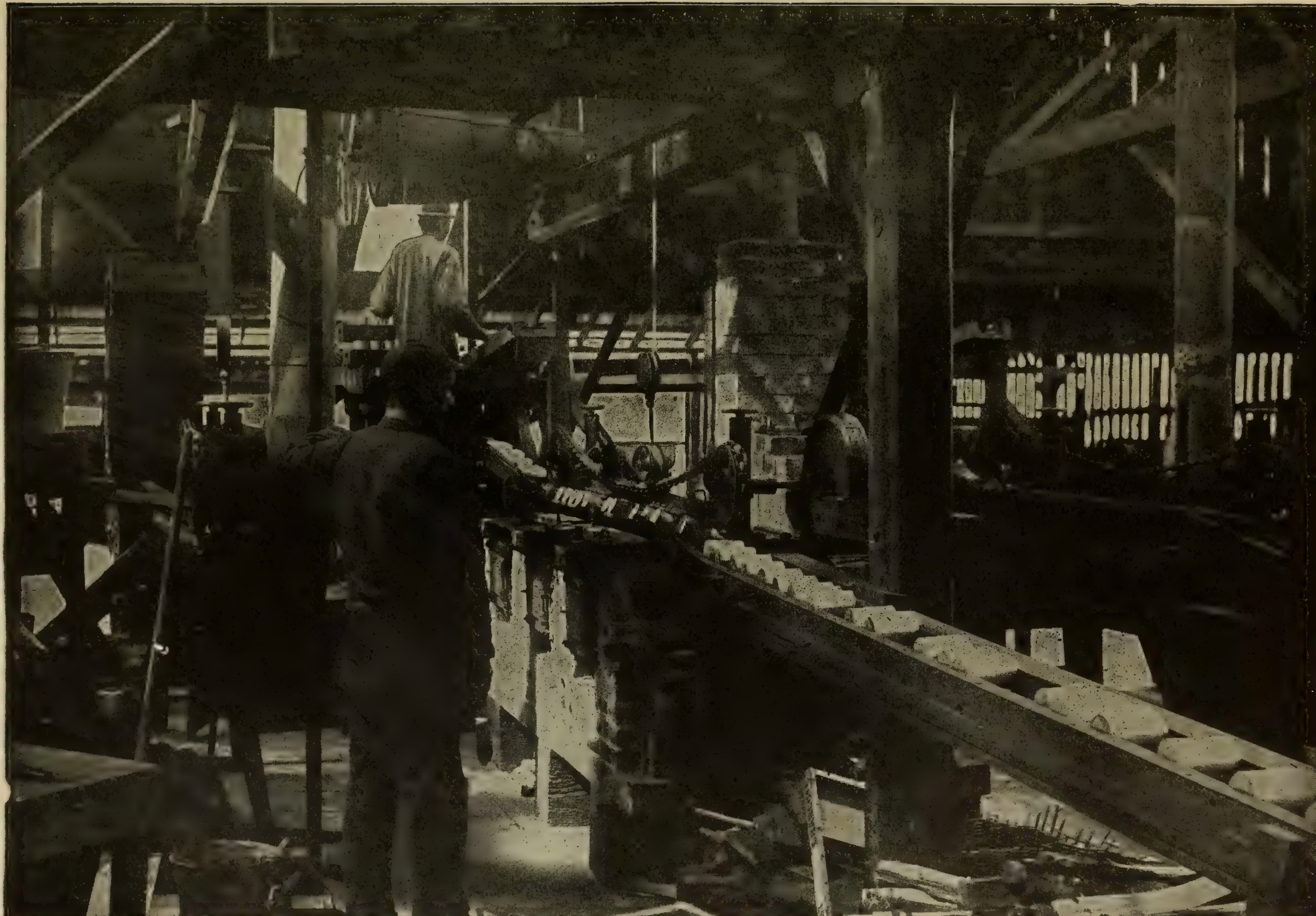
ALONG THE WATERFRONT, NEW YORK CITY.

Showing passenger steamers from the Tropics lying at the docks, with Brooklyn Bridge in the background.



MAKING TIN CANS BY MACHINERY FOR A GREAT SALMON CANNERY.

LAUNCHING OF THE NEW AMERICAN BATTLESHIP, THE MAINE.

Here at Cramp's great shipyards in Philadelphia was built the successor of that unfortunate vessel which was destroyed by an explosion in Havana harbor just before the outbreak of the Spanish-American war of 1898. It is a splendid ship, far greater than its historic predecessor, with 12,500 tons displacement, 16,000-horse power, 20 big guns and a speed of 18 knots an hour.

PROGRESS IN METHODS OF NAVAL WARFARE

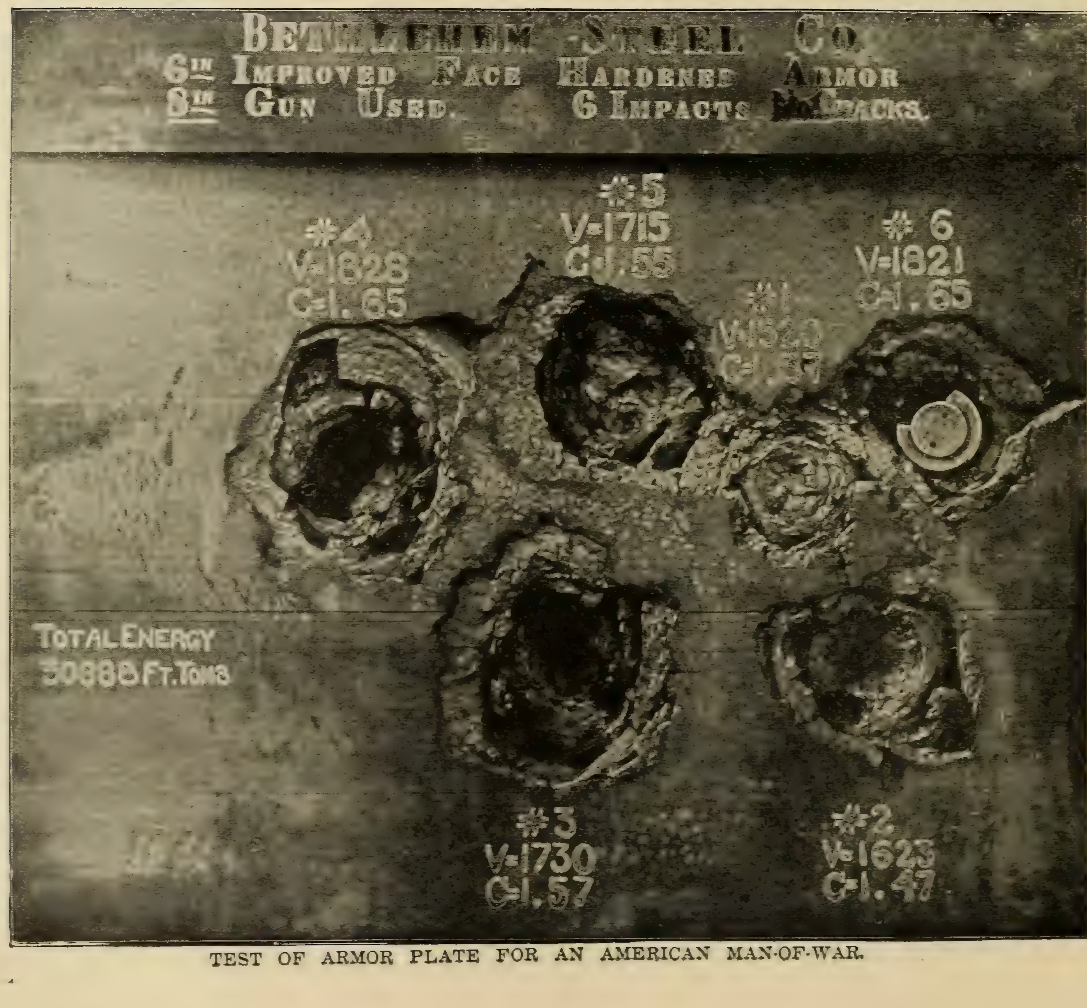
If it be true that the most certain way to put an end to warfare is to make war more terrible, we should include the Krupps, the Gatlings and the Maxims in the list of our true promoters of peace. Improved artillery, rifles, armor plate and explosives have been devised of late years with a rapidity not second to industrial inventions.

The world's naval wisdom received a surprise and a shock when Ericsson's little iron-sided Monitor fought its duel with the ponderous Merrimac, ribbed with railroad iron. American ingenuity, both north and south, had grappled with the problem of invulnerable warship construction, ignoring absolutely all other naval architects of the world and their cumbrous lore. Slow-going conservatism had to be abandoned, and the old wooden hulks then constituting the navies of the earth's great powers were doomed to the scrap heap.

Since that time there has been a constant rivalry between the ship-builder and armorer on the one hand, and the gun, gunpowder and projectile manufacturer on the other hand. Every improvement in armor plate has been met by a further advance, either in the gun, the projectile, or the propelling charge of the gunpowder. An armor-maker would announce the production of a steel plate which no existing cannon could penetrate. Then the projectiles

LAUNCHING OF THE "CONSTITUTION," FAMED IN AMERICAN HISTORY.

were made conical, and with a sharp point, having a fine temper, and the gun was rifled to give the projectile rotation and true flight, and the guns were made to load at the breech instead of the muzzle, adding greatly to the rapidity and facility of fire. Another inventor then came forward with a method of hardening the surface of the plate, by a process bearing his name. A Harveyized plate is so hard that it cannot be scratched with a file or cut with a cold chisel. Nickel was put in the plate, adding still more to its hardness and toughness. Then smokeless powder was produced, developing much greater energy than its black predecessor, and made to burn with accelerating combustion, and with it projectiles could be hurled with such velocity that the energy of their impact could not be resisted by the plate, and the gun had to be lengthened and strengthened forward to meet the new demands upon it. The limit in the weight of armor plate was soon reached. Twelve inches in thickness came to be about the maximum for the belt of the strongest warship, for she could not carry thicker and float. The projectile was still more improved, being made of the finest forged steel

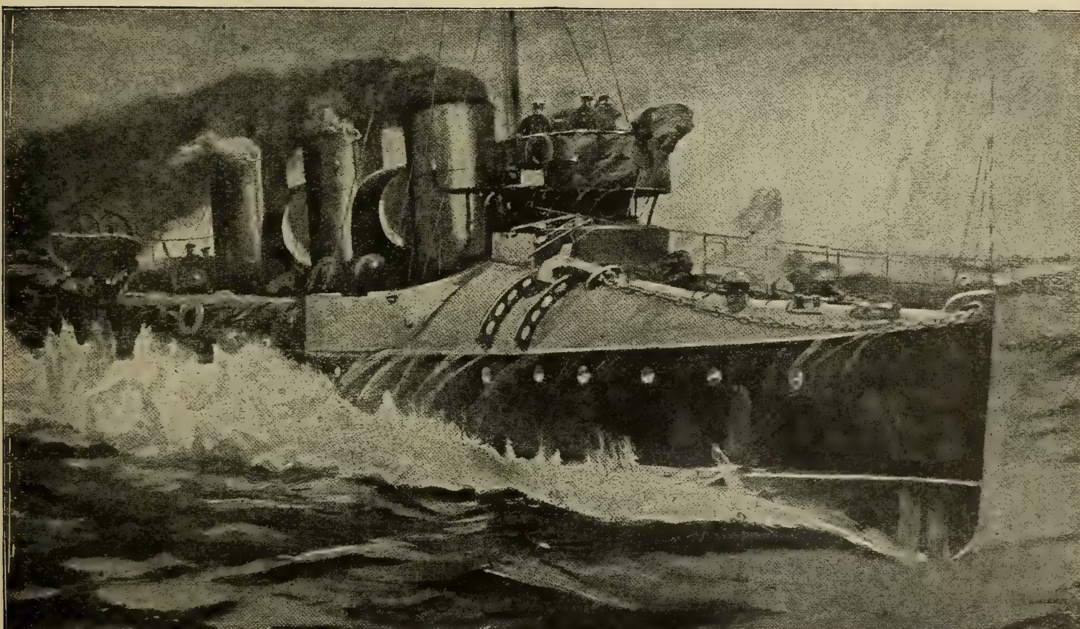


TEST OF ARMOR PLATE FOR AN AMERICAN MAN-OF-WAR.

and tempered with great skill. Then came Kruppized plate, and the projectile was again turned aside or smashed upon its surface. Lastly a soft nose made of mild steel was placed on the point of the armor-piercing projectile, and the gunner could again laugh at the thickest Kruppized plate that could be carried by the battleship.

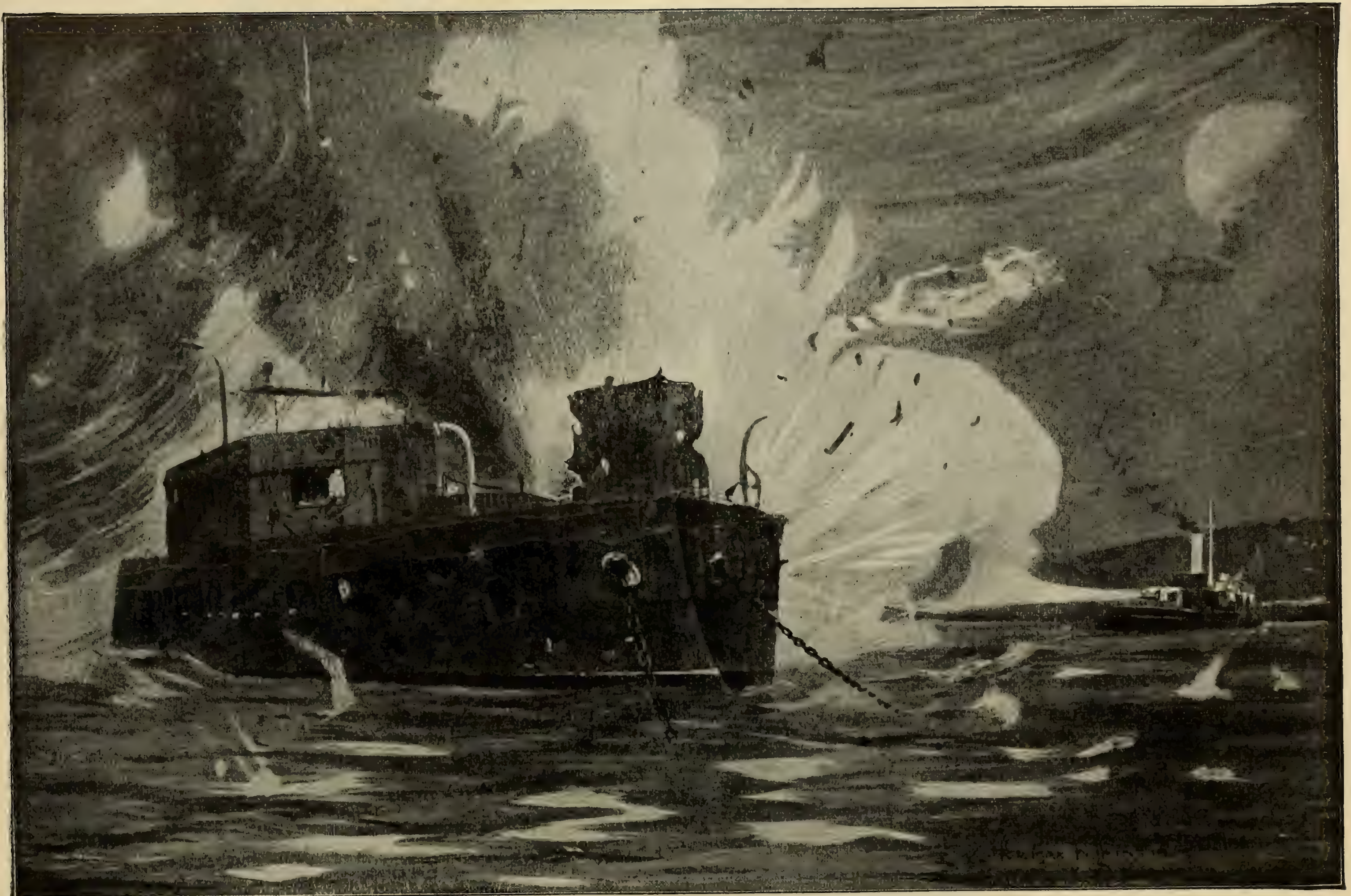
Contemporaneous with this work, the high-explosive manufacturer and inventor have been busy, but so burdened has been their work by popular misunderstandings of the nature of the high explosives, that they have had a much stronger barrier in the form of prejudice and ignorance to get through than has the gun manufacturer in keeping ahead of the armorer.

There was such a wholesale dread entertained by even rational investigators, and some inventors themselves, of high explosives, that they chose rather to theorize than to learn by experiment. It was believed by many that high explosives must of necessity be very ticklish, and that their sensitiveness must be in direct proportion to their explosive power. The word dynamite was sufficient to cause a person of average information to seek safety in flight from its vicinity. It was generally believed that if high explosives could only be thrown in any considerable quantity from guns they would destroy anything they might hit, or if they should strike in the water anywhere near a warship it would be sent to the bottom. But it was thought that guns must be constructed in some peculiar way, and a propelling means especially adapted to lessen the shock be employed for throwing some special kind of bomb, in order to get the dynamite out of the gun very gently.



THE FASTEST SHIP AFLOAT.
The British torpedo-boat destroyer "Viper," steaming at 38 knots, or more than 43 land miles, an hour.

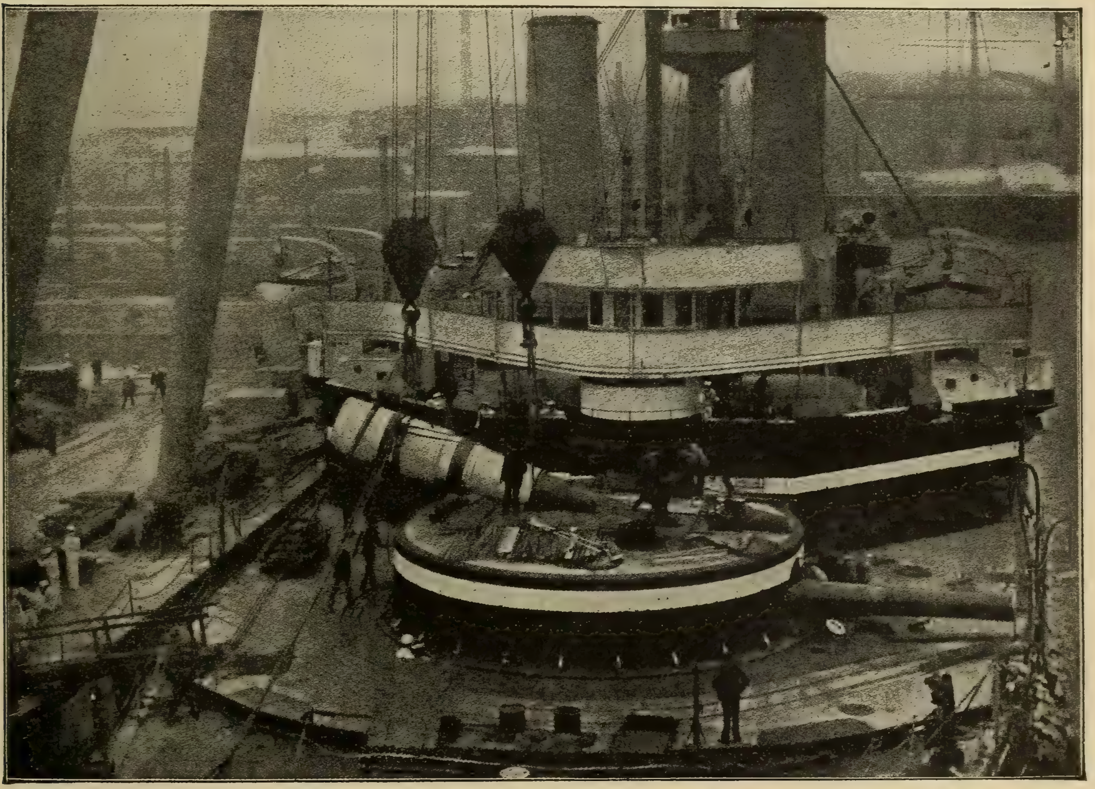
The most notorious of these freaks in ordnance is the so-called pneumatic dyna-



PRACTICAL EXPERIMENTS WITH NEW ARMOR AND PROJECTILES.
Gunnery practice against an obsolete battleship by our North Atlantic Squadron.

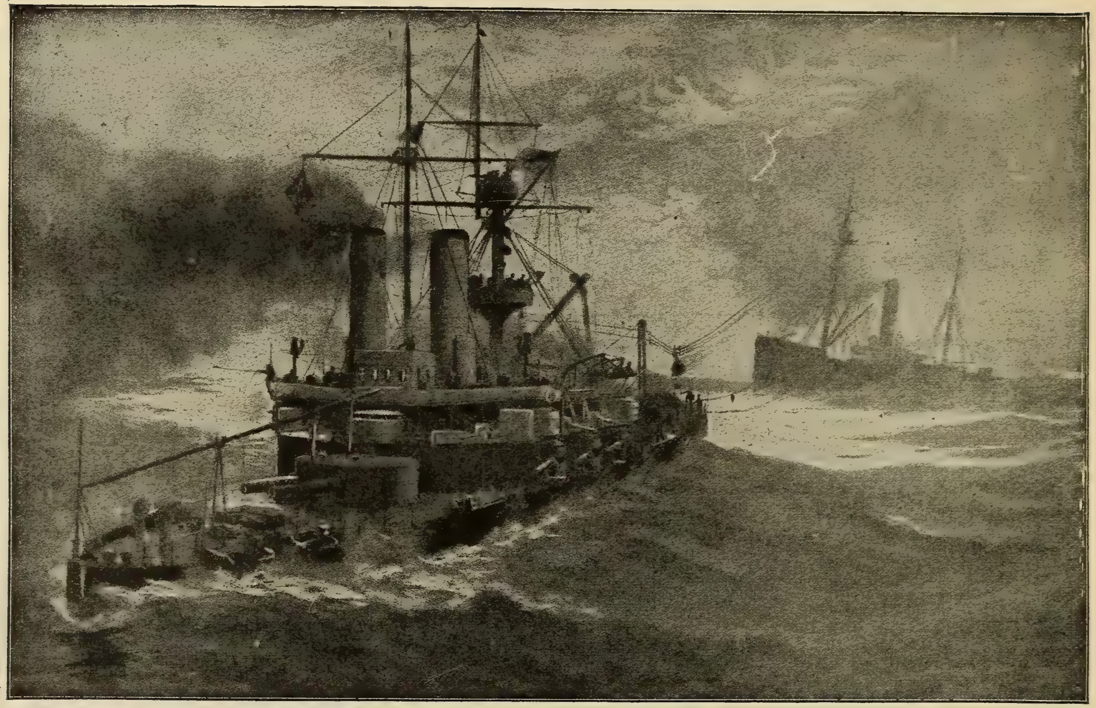
mite gun, a battery of which guns was erected at Sandy Hook and protected at great expense, and a similar battery was put up at San Francisco. The expense of these outfits was enormous, and absolutely to no purpose whatever. Their range is limited to about a mile and a half. The projectile has no power of penetration whatever, and must necessarily go off on impact outside of an object, should the gunner be so lucky as to hit anything with it; but the angle of fire is so high, and the range so short, that the question of hitting an enemy's battleship with one of these weapons can be no longer seriously considered. A fleet of modern battleships could lie with perfect safety within close gunshot of these batteries and bombard them out of existence, and it would be impossible for the pneumatic guns to get a single shot within half a mile of any of the battleships.

In 1899 Gen. A. R. Buffington, the Chief of Ordnance of the United States Army, determined to thoroughly investigate the subject of high explosives, and he arranged that the Ordnance Board, with headquarters at Sandy Hook Proving Ground, New Jersey, should carry out a line of experiments in such a thorough and efficient manner as to settle once for all what known high explosives were the most suitable for use in the service, and also to test thoroughly,



PLACING A BIG GUN ON BOARD A BATTLESHIP.

This extraordinary gun, 36 feet 8 inches long, has a range of 14.000 yards, or eight miles. It fires a shot weighing more than half a ton with a charge of 650 pounds of powder.



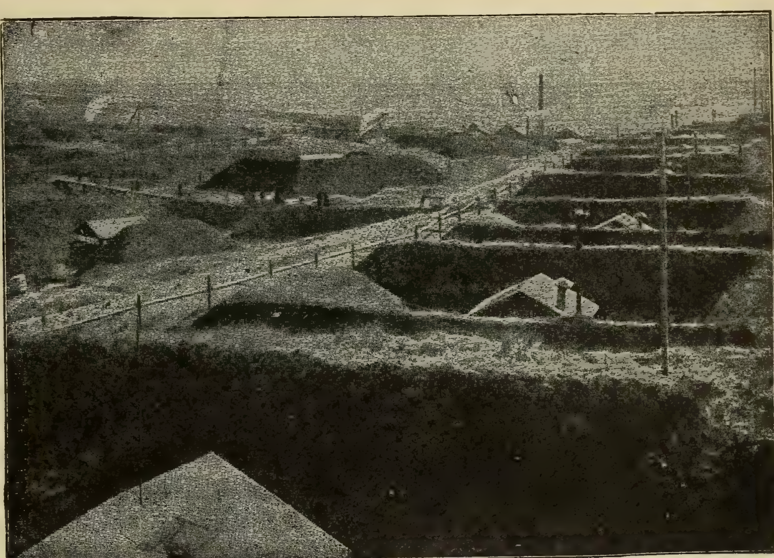
COALING A BATTLESHIP AT SEA.

and without partiality, any and all new high explosives which might be submitted by different inventors and manufacturers, provided they appeared to offer sufficient merit to warrant investigation.

MAXIMITE, THE NEW EXPLOSIVE.

Maximite, which was adopted by the Government, satisfactorily stood every test to which it was subjected. It is very inexpensive of manufacture; has a fusion point below the temperature of boiling water; cannot be exploded from ignition, and, indeed, cannot be heated hot enough to explode, for it will boil away like water without exploding. It is, therefore, perfectly safe to melt over an open fire for filling projectiles, in the same manner that asphalt is melted in a street caldron. Should the material by any chance catch on fire, it would simply burn away like asphalt, without exploding. When cast into shells, it not only solidifies into a dense, hard incomprehensible mass on cooling, but it expands and sets hard upon the walls of the projectile like sulphur, that is to say, in the same way as water does in freezing.

Hiram Maxim, the inventor of this explosive, describes its effects as follows, and adds his opinions on the tendencies of modern warfare: "When a shell filled with it strikes armor-plate, the Maximite does not shift a particle, and it is so insensitive that it not only stands the shock of penetration of the thickest armor-plate which the shell itself can go through, but it will not explode, even if the projectile breaks upon the plate. In one experiment a six-pounder projectile, filled with Maximite, fired against a thick plate, entered the plate about half its length and upset—that is to say, shortened nearly two inches and burst open at the side, and some of the Maximite was forced through the aperture and the projectile rebounded from the plate about 200 feet and struck in the front of the gun from which it was fired, and all without exploding. Some lyddite shells—that is to say, shells charged with picric acid, the high explosive adopted by the British Government,—filled in the same way as was Maximite, into the same kind of projectiles and fired at a thin plate an inch and a half in thickness, all exploded on impact. So insensitive is this high explosive that melted cast iron may be poured upon a mass of it without causing an explosion. The writer has repeatedly made this experiment. When a projectile, however, charged with Maximite, is armed with a proper detonating fuse, such as that used in these experiments, the invention of a United States Army officer, it is exploded with such terrific violence that a 12-inch armor-piercing projectile was broken into at least 10,000 fragments; 7,000 were actually recovered. This armor-piercing projectile, weighing 1,000 pounds, was filled with seventy pounds of Maximite, armed with a fuse, and burned in the sand. After exploding, the sand was sifted to obtain the fragments. There were other high explosives tested with Maximite, which also produced remarkable results. Had not Maximite been invented, the Ordnance Board would still have in its possession a high explosive developed by the Army Department itself, far superior to anything that has ever been employed in any other country, and the work of that Board for the last two years would have still been highly rewarded. Maximite has been adopted for the sole reason that it fulfills the largest number of the highest requirements sought for by the Ordnance Board."



FACTORY FOR HIGH EXPLOSIVES SHOWING EARTHEN WALLS, TO PROTECT AGAINST DISASTERS.

Not since the lesson taught by Ericsson's Monitor has anything been accomplished in military science more pregnant with meaning than these results at Sandy Hook. They have demonstrated that nothing whatever can be made to float with armor which will be capable of withstanding the destructive effects of Maximite shells thrown from modern high-power guns, which are capable of penetrating the thickest Kruppized plates, to explode into a battleship.

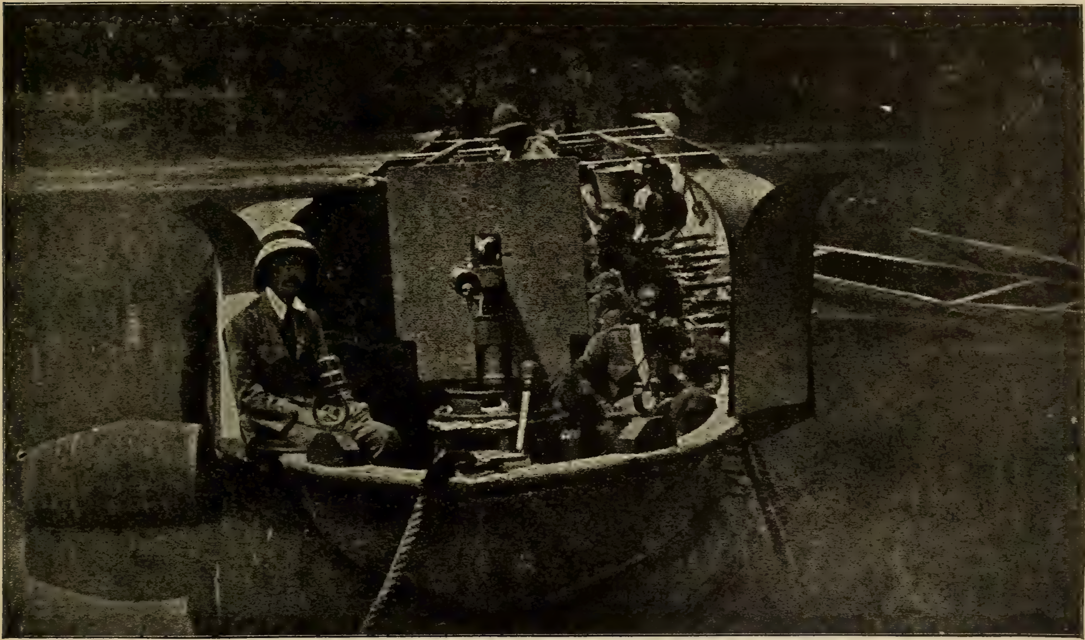
Should the United States now become involved in war with any other great power, we should be able to throw these high explosive projectiles through the thickest armor of our enemies, to explode inside their warships, while they, in turn, would be able to penetrate our armor with solid shot, or, at least, with projectiles carrying no bursting charge whatever.

Mr. Maxim also says: "The moral taught by these new developments is that the ponderous battleships must go and be replaced by the small, swift torpedo boat or torpedo gunboat and cruiser, and practically unarmored, as no protection whatever can avail against such missiles. There must be no sacrifice of mobility for cumbersome armor. While Maximite places this government far in the lead of any other power in its weapons of offense and defense, it will, as well, save this government many hundreds of millions of dollars which should otherwise have been expended in the building of unwieldy battleships, for which other powers have squandered fabulous sums, and which must soon be recognized as obsolete. The competition between the great powers for naval and military supremacy is about as keen as it could be in an actual state of war, and the drain upon their resources is enormous, and the burden year by year is growing heavier. It is problematical whether England, France or Germany would prove the stronger in the event of war, and it is equally problematical which can longest endure the ever increasing drain upon its resources as a measure of insurance in the event of hostilities. And there is another problem—and one of vast concern—and it is whether these stupendous preparations are altogether wise on present lines; but no power dares to deviate too far from the main course pursued by the other powers for fear of making an irreparable mistake, and so big battleship building still goes on, with a sort of half-awakened consciousness that these craft will prove a source of weakness rather than of strength.

"Along with the ponderous, armor-clad battleship, we have seen developed means for its destruction, so that to-day it holds no higher place with respect to invulnerability in face of these means, than did the wooden hulk of a half century ago in the face of the weapons then used. Indeed, it is probable that the modern battleship, costing five or six millions of dollars, will be in still greater danger of being sent to the bottom in a modern naval engagement than was the wooden craft of Nelson's time.

"Let us consider what will be the chief forces that will oppose the battleship and oppose one another in the next great naval engagement. First, there will be the torpedo boat and the torpedo boat destroyer, capable of traveling at a speed double that of the battleship, armed with Whitehead automobile torpedoes, which launched below the water lines will run beneath the surface as straight as an arrow to deal the battleship a fatal blow below its armored protection. There will also be the submarine boat, similarly armed, which has already shown itself capable of stealing upon the battleship wholly unobserved, to deal it a deadly blow, even in the glare of noon, as well as at the dead of night. And there will be another form of torpedo craft, armed with automobile torpedoes, which will run upon the surface of the water like an ordinary torpedo boat, but at railroad speed, and which will dive to a semi-submerged position when coming within the range of the enemy's guns. Half a dozen torpedoes will be launched by it in a moment, and the little boat will be endangered only by the huge vortexical gulf down which the battleship takes its plunge to the bottom of the sea.

"Now that a high explosive has been developed, which is capable of withstanding the shock of penetration of the hardest steel wall of the biggest armor-clad, to explode in vital parts, the battleship has another and most formidable antagonist. By means of this invention the destructiveness of the present high-power gun is enormously increased. There will be two systems of guns and projectiles employed—the one the present quick-firing, high-power cannon, throwing armor-piercing projectiles carrying relatively small bursting charges of high explosives, to explode on the interior of the warship, or within the armor, to rip it from the sides. The other will be the torpedo gun, throwing aerial torpedoes carrying half a ton or more of high explosive at high velocity, to explode and crush the walls of the battleship or demolish its superstructure, or, if falling in the water, to crush in the sides below the armored belt. Each of these systems will have its advantages over the other, and will also have its disadvantages. While the large quantity of explosive carried in the aerial torpedo will be capable of working wide destruction when landing fairly on the mark, yet the quick-firing cannon, with equal range, and able to fire many times as fast, with projectiles capable of penetrating the strongest armor, to explode inside, will remain no mean rival to the torpedo gun, and any and all other forms of attack.



ARMORED BOAT FOR RIVER SERVICE IN CENTRAL AFRICA.

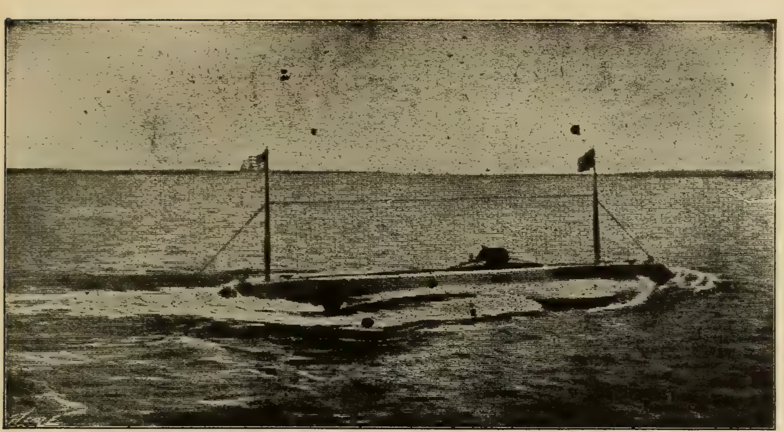
NAVAL BATTLES IN THE FUTURE.

"The first and most important lesson which will be learned from the next great naval battle will be that armored protection will not protect, and the fight will soon be a duel between battleships at long range, aided by various forms of torpedo boats, and light unarmored cruisers, throwing high explosives; and these latter will be the factors which will determine the fight. The heavy armorclad will be discredited, and then will be a wild scramble by the nations in the endeavor to make up for the lost time wasted on its construction, and light and very swift unprotected war vessels will be constructed, depending for their safety upon their speed, and upon their own ability to strike death-dealing blows. These are the true principles which must, sooner or later, be recognized.

"The British Government now proposes building still larger and heavier battleships and, of course, enormously more expensive. Within the next decade, and sooner, in the event of the great war, this will be learned by the British War Office to be a great mistake. The writer pointed out some years ago that the introduction of gunpowder was long opposed on grounds which, according to twentieth century ideas, are supremely ridiculous. To us moderns nothing could be more apparent than the superiority of firearms over bows and arrows as weapons of war. A few years hence, the present panorama of the nations will appear ludicrous, vying with one another for naval and military supremacy, and exhausting their treasuries in the construction of huge battleships, a dozen of which will be sunk by a torpedo fleet costing no more than one of them. Such battleship destroyers are now an accomplished fact, and lie under the eyes of all the world to-day, but are not seen. Their merits are told into ears that are as deaf as death. It is like knocking at the doors of an empty house for admission. Only the issue of a great naval battle can bring the torpedo fleet into proper recognition.

"When firearms were first introduced, the foot-soldier was clothed in armor, which was constantly increased in weight and thickness to resist improved weapons, until it became so ponderous and unwieldy as to sadly interfere with mobility. It was found impossible, however, for the soldier to carry armor thick enough to protect him against missiles hurled by gunpowder. As a result, all the armor was discarded. The modern war vessel has now entered upon a similar phase of its evolution, and for exactly the same reason that the soldier was obliged to discard his armor, so will armor have to be sacrificed in the coming war vessel, and the most practical means of defense will then be found to consist in the very means which serve best for offense."

The naval authorities of most of the maritime powers have studied with great interest the progress of experiments in submarine craft. Inventors for years have been endeavoring to perfect vessels that could be submerged and still propelled and controlled with safety to their occupants. This series of investigations has been encouraged by the governments with some spirit of rivalry as to which country should first obtain such a practicable craft. In our own country the vessel known as the Holland, named for its inventor, has achieved remarkable success and has been adopted by the government as a worthy adjunct to our coast defense. The vessel travels at fair speed on the surface, may be submerged for several hours without discomfort or danger to its crew, and can travel slowly under water, so that it may advance clandestinely upon an enemy with-



THE "HOLLAND" AT FULL SPEED ON THE SURFACE.

marine craft are operated on the same general principle, being sunk by admitting water to tanks provided for the purpose, and raised to the surface again by the buoyancy of these tanks when the water is pumped out.

For warfare in the interior of uncivilized countries, the light-draft armed vessel also has been brought to a high degree of adaptability. The British in Africa use what they term an armored canoe, although the word canoe is a misnomer. It is a heavy steam launch, covered with boiler iron, and with shields to protect the men and the rapid-firing machine guns which it carries. Such a boat can penetrate the African jungles by way of the rivers and can assist in campaigns against savage tribes who could with difficulty be reached at all by the trails through the forests. The United States, like other powers, utilizes light-draft gunboats for service in the rivers and archipelagoes of the Asiatic coasts, and the Pacific islands where such service is needed. The rivers of China and Korea, at the time of native attacks on foreigners, have been the frequent scene of such operations.

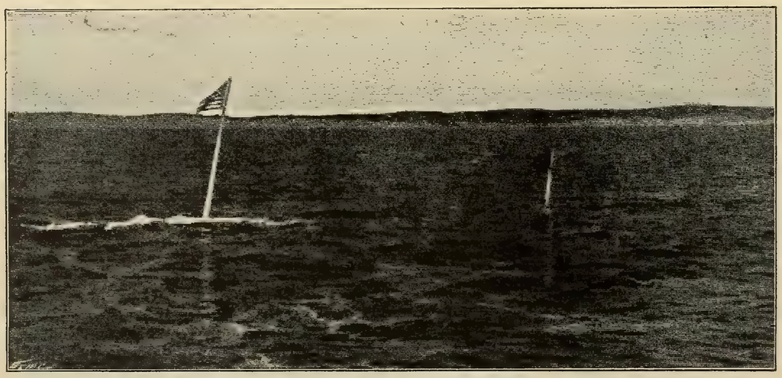
In order to still more facilitate the operations of warships at sea, a device has been invented by which the fighting craft may take coal without making port. Wire cables are strung between the masthead of the battleship and the collier, and upon these cables iron baskets are hauled back and

out danger of discovery. For launching torpedoes against the side of a battleship without danger to the attacking party, such craft have every advantage. They have not been perfected yet to a degree that enables them to make long voyages, but the present success is sufficient to promise great improvements in the future.

THE SUBMARINE VESSEL.

The French experiments have been successfully achieved through the skill and genius of Gustave Zádé, an inventor of Toulon, who has built two interesting craft of which the latest, named for himself, is the most successful. This latter boat is 147 feet long and is propelled by electric motors with storage batteries. The hull is cigar-shaped, with very sharp ends, and the speed is eight-and-a-half knots an hour below, and fourteen knots above the surface. A crew of ten men is carried, with compressed air, stored in tanks, enough to last them while below. Torpedoes may be discharged from an opening in the bow of the boat. This vessel has been operated in deep and shallow water with remarkable success, and has made trips up to seventy miles without difficulty. All of these subforth until the coal is transferred. This is an application of the trolley system by which ore and coal are conveyed from mines to cars for shipment, where valleys and hills intervene. Experiments with this method of coaling have been made in the American navy and in the British navy, and in moderately rough weather forty tons per hour have been taken aboard a battleship from a collier. With practice it is believed that this speed can be greatly increased, and such embarrassments as hampered the American navy in the Caribbean during the late war will be eliminated.

The improvements in the appliances of warfare thus briefly indicated are typical of others upon which students of the arts of war are engaged. In these ante-millennium times, war is occasionally a necessary contingency, and when it comes we want the best tools we can get to fight with. It is a crime for a nation not to be prepared for war, a crime against those who will be called upon to defend her in time of war. It is a crime for a nation not to be abreast of the times in arms and equipment. At best war is cruelty, but it is not only often a necessity but unavoidable, and, once engaged in, should be made as destructive as possible, in order that it may be brief as possible, thus minimizing the evil in the aggregate.


SUBMARINE BOAT "HOLLAND" DIVING.

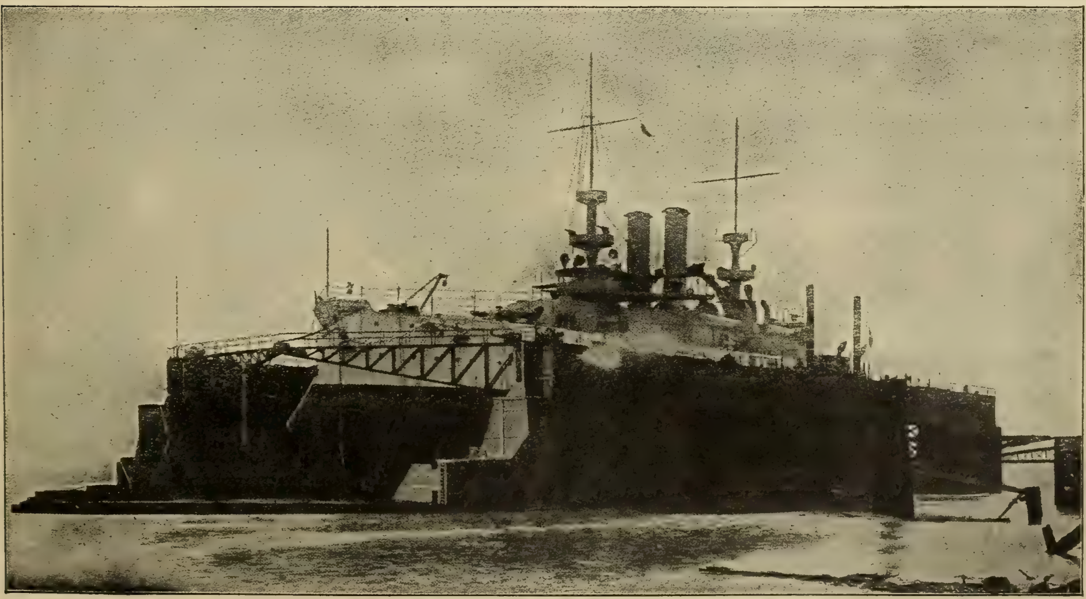
The approximate dates of the completion of the new battleships and cruisers of the United States were given by the Secretary of the Navy at the beginning of 1902 as follows: battleships: Maine, October, 1902; Missouri, March, 1903; Ohio, May, 1903; Virginia, May, 1904; Nebraska, July, 1904; Georgia, July, 1904; Rhode Island, July, 1904. Armored cruisers: Pennsylvania, January, 1904; West Virginia, February, 1904; California, August, 1904; Colorado, January, 1904; Maryland, February, 1904; South Dakota, August, 1904.

With the completion of the above, the navy will have seventeen battleships and eight armored cruisers. The total number of warships of all kinds under construction at the same date was fifty-nine, including besides those mentioned, nine cruisers, four monitors, twenty-five torpedo boat destroyers, nine torpedo boats and seven submarines. In addition to these, the navy in commission at the same date included eleven men-of-war of the first rate, meaning above 8,000 tons; fifteen of the second rate, or between 4,000 and 8,000 tons, and about eighty of less size, including monitors, cruisers, gun-boats and torpedo boats. The best calculations therefore credit the United States with being fourth among the powers in naval strength, surpassed only by England, France and Russia, and followed by Germany, Italy and Japan.

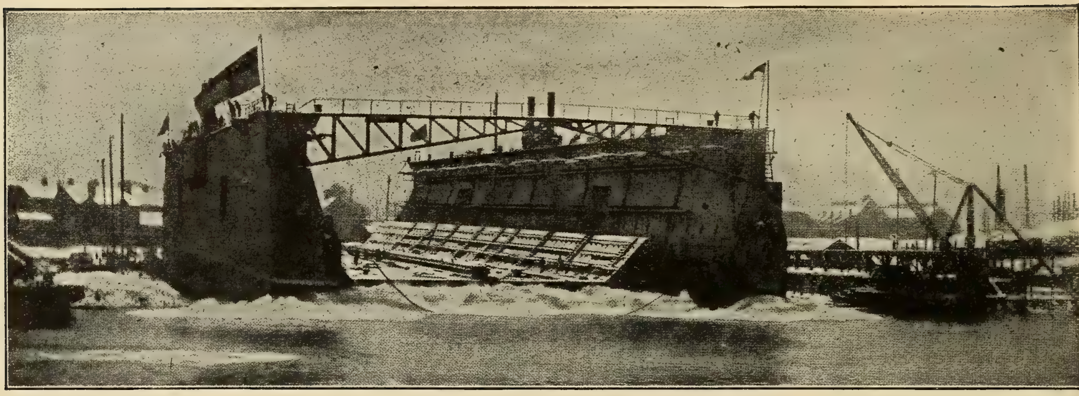
FLOATING DOCKS FOR MEN-OF-WAR

The immense increase in the size of men-of-war in the last few years has compelled the rapid increase of repair and supply and equipment stations wherever such vessels are to sail. The navy without proper equipment would be as bad as no navy at all, and so every country has found it necessary to seek a favorable location for coaling stations all over the world. In time of war, the fighting ships of the hostile powers are limited in their privileges in neutral ports. For instance, they are permitted to take on board only sufficient coal to enable them to steam to the nearest port of their own country, and that privilege can not be duplicated at a later time during the progress of hostilities. Powerful and threatening as a great battleship is, there can be nothing more helpless than such a craft either out of coal or disabled for want of some facility of repair.

The prime requisite for well-equipped navy yards is a dock in which even the largest vessels may rest while they are being overhauled. There are two types of such docks, the drydock which is built on land, with gates by which the water may be admitted and released at will, and floating docks, for use where the other type is not available. Like other powers, the United States has found it necessary to extend its docking facilities, and the great structure pictured herewith is the newest one of all. This floating dock is located at Algiers, across the Mississippi River from New Orleans, although such craft may be taken from port to port at will. In the illustra-



FLOATING DOCK SHOWING BATTLESHIP ILLINOIS IN PLACE.
This dock was built by the Government for use at New Orleans.



LAUNCHING A GREAT FLOATING DOCK.
This dock was constructed at Wallsend-on-Tyne, for use in Bermuda.

tion, the new battleship Illinois is seen in the dock high out of the water.

In spite of the great size of the floating dock, the method of its use is simple enough. The general shape of the peculiar structure, if it were cut right through to show a section, is that of a great letter U, but on the outside it is rectangular, the curve of the U occurring only on the inside. The great bottom and sides of it are hollow, and under ordinary circumstances it floats high on the water. When it is desired to take a vessel into the dock, the great pontoons, which are enclosed in the bottom and the lower part of the sides, are pumped full of water, so that it sinks to whatever depth is required to permit the admission of the ship. With the end gates open, the ship is now moved cautiously into the dock, and braced in place, after which the water is pumped out of the pontoons. As the dock rises, of course the vessel rises with it, until at last it is entirely uncovered and ready for whatever repairs are necessary. In order to release the ship from this position, the same process is reversed. In the picture, one obtains a striking view of the bottom and bow of the Illinois and its projecting "ram." The peculiar trusses extending from the side of the dock to shore are hinged at each end so that although the dock may rise and fall with the tide or the weight of vessels, it still maintains its position in reference to the shore. Another new floating dock which came into service for the American navy is the one at Havana, which was built at Birkenhead for the Spanish Government in 1887, and cost nearly $600,000.

The other illustration shows the launch of a new floating dock constructed in England for use in Bermuda. This dock is 545 feet long, the side walls are fifty-three feet high, and the total width of the structure is 130 feet, with 100 feet between the walls. This dock is capable of lifting out of the water a ship 17,500 tons in weight, and drawing thirty-two feet of water. This dock cost $1,150,000, of which $175,000 measured the cost of towing it across the Atlantic Ocean to Bermuda.

THE FIRST CABLE ACROSS THE PACIFIC OCEAN

Now that the political and commercial sway of the United States extends far into the Orient, it is necessary to connect the nation with its remote dependencies by steamship lines and submarine cables under our own control, so that communication may be uninterrupted at all times. Steamship lines, in fact, are already established between the Pacific coast of the United States and our island possessions of Hawaii, Samoa, Guam and the Philippines. In order to accomplish the other purpose, Uncle Sam is about to spend 9,000,000 good American dollars for copper wire, gutta percha, jute yarn, tar, and steel wire. When this money has been spent and a fleet of ships and a thousand electricians and engineers have finished their work, the Philippines and the United States will be within half a minute's talking distance of each other.

The cable which will establish this communication will be the first to span the Pacific, and almost triple the length of the longest submarine wire ever laid. From San Francisco to Manila, with stops at Guam and Honolulu, the distance is nearly 8,000 miles.

The making of this great stretch of cable is a colossal task. About 22,740 tons of material will be required—1,980 tons of copper wire, 12,000 tons of steel wire, 2,300 tons of jute yarn, 4,300 tons of compound and tar, and 1,260 tons of gutta percha. This means a total weight greater than that of forty-eight locomotives of standard size.

Most people know in a vague, general way that the submarine wire is about an inch thick, and that it resembles, more than anything else, the underground cable which in some cities operates the cable cars. Few people, however, have any idea of the inner construction or of the ingenious processes by which the delicate copper wires that carry the electric current are so protected that they lie for years and years on the oozy bed of the ocean, and do their work with practical immunity from breaks, accidents or interruptions of any kind.

The cable is composed of three parts: the copper strand; the hemp, tar and rubber casing which protects them from the water, and the heavy steel binding that acts as a shield against rocks, wreckage, the keels of ships, and the sharp teeth of ocean monsters.

The first step in the making of a submarine cable is the preparation of the copper wire. After the wire has been weighed and tested it is taken to the winding drums. Here it is rapidly reeled around large, spool-like devices called bobbins. From the winding room the wire goes to the stranding room. Here the seven wires are twisted together and united on the cable stranding machines.

The thin metal threads which are destined to flash under the water messages for which, perchance, a world will wait breathless, are now ready for their first sheathing. This consists of insulating material, jute being usually employed.

In applying the jute water is used, and as the least moisture would render the cable useless, a very careful and thorough system of drying is employed. The jute-covered wires go through vacuum drying-boxes,

MACHINES FOR BRAIDING WIRES INTO SUBMARINE TELEGRAPHIC CABLES.

which evaporate the last vestige of moisture. From the drying-boxes the wire passes to caldrons filled with insulating material. Here the wire is allowed to steep until the covering has become so thoroughly impregnated that there is no chance of any of the electric current leaking out, after the cable has finally been consigned to its watery resting place. The first stage of the work is now completed.

Next comes the making of the gutta percha jacket. Despite its great cost, gutta percha will be used in the Pacific cable, for it has been found to give a better result than any other form of casing. From time to time cable manufacturers have utilized various rubber compounds as substitutes. These all have to be vulcanized by heating and kneading with sulphur or some sulphuric preparation, to deprive the rubber of its adhesive qualities. Even at their best none of the rubber compounds has been found to equal gutta percha.

In preparing gutta percha the mass of the crude material is first heated and kneaded by a special process, till it becomes plastic. The softened, pliable heap is then taken to the press, where it is to be united with the copper cable wire. By the use of suitable nozzles the gutta percha is deftly pressed around the strands in the form of a seamless jacket. Here again the greatest care is taken to have the covering air-tight and moisture-proof; for the least drop of water finding its way into the wire would produce disastrous results.

Now the cable, consisting, at the present stage of its construction, of the copper wire strands and jute and gutta percha coverings, passes over rollers, partly through the open air and partly through a long tank containing water. The purpose of the latter is to harden the gutta percha. The cable is then subjected to a final rigid test, and if the insulation is perfect it passes to the armaturing department. The second stage is finished.

The third and final process is administered by the armaturing machine. To this powerful contrivance is allotted the task of putting on the shield of steel wire. The big machine works with an almost human intelligence and handles the heavy ropes of steel wire as deftly and as easily as a sewing machine manipulates threads of cotton. Over the metal casing is spun a protecting fibre, which is then impregnated with insulating material. It is the purpose of this insulated fibre to protect the armature from the destroying effects of the earth and water. After being drawn through a bath of lime water, which destroys the adhesiveness of the impregnated fibre, the cable is wound upon large wooden rolls and is ready to be taken on shipboard. In so far as human genius can make it so, the cable is protected against any injury from the elements or the denizens of the deep.

Much of the work preliminary to the laying of the cable has already been done. The United States ship Nero has taken probably a thousand soundings to determine the depths and character of the bottom from our western coast to the Philippines.

Four vessels, each having cable tanks forty feet in diameter and holding about 1,000 miles of cable, will do the work of handing over the wire to old Neptune's embrace.

When the cable is finished, a greater step toward the pacification of the Filipinos than the despatching of regiments of soldiers will have been taken. Through ready communication the natives can more readily be made to understand the character and purposes of the American people. The convenience the cable will be to the business man and the impetus it will give to the transpacific commerce are almost past computation.

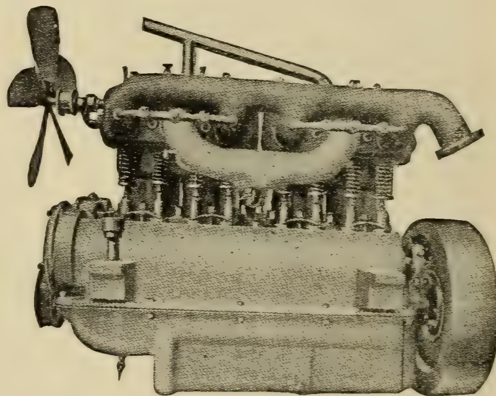
At the present time, if a San Francisco merchant wants to communicate with Auckland, New Zealand (the most expensive place in the world to reach by wire), the message transmitted must travel across the United States from San Francisco to New York, then to London over one of the Atlantic cables, and then be forwarded successively over the lines of the Eastern Telegraph Company and the Eastern Extension Telegraph Company to Suez, Aden, Bombay, Singapore, Adelaide and Sydney to Auckland. In short, to send a message between two points only 8,000 miles apart it would be necessary to pass over 26,276 miles, or more than the circumference of the earth.

But when Uncle Sam gets his cable this will all be changed.

"ACID BLAST" HALF-TONES.

Great improvement has been made in the reproduction of pictures by the "half-tone" process for book, periodical and newspaper illustrations. The half-tone is an exact reproduction in the form of a metal cut, generally copper, of a photograph or drawing. Every detail is reproduced by photography and the use of acids. By this process it is possible to make, at a nominal expense, exact copies of pictures, which, if reproduced by hand, would cost hundreds of dollars. One great trouble with the ordinary plan of making half-tones is the difficulty of etching them deep enough in the metal to give a sharp, clear, impression and withstand the wear of long runs on the printing presses. This is now overcome by the "acid bath" process, in which a spray of acid is projected against the metal by mechanical means. This insures fine, deep plates, which print much better than those made in the ordinary manner. Most of the illustrations used in this volume are made by the new "acid blast" process. It is somewhat more expensive than the ordinary work, but the more satisfactory results justify the additional outlay.

In etching a half-tone—that is, eating out the superfluous metal after the photograph is made so as to get the desired forms



MODERN MOTOR FOR AUTOMOBILE.

and light-and-shadow effects—it is customary to give each plate about three acid baths or "bites." The first, lasting from 30 to 60 seconds, secures the minimum results desired. The plate is then washed and dusted with an acid-resisting powder which protects the parts which are deep enough from further attack. Two more "bites" are then given in the same way, which completes the mechanical work. When extra fine pictures are desired, such as those used in The World's Workshop, the work is given a finishing touch by hand experts going over each plate carefully with engraving tools and remedying any possible defects.

NEW YORK IN A BLIZZARD.

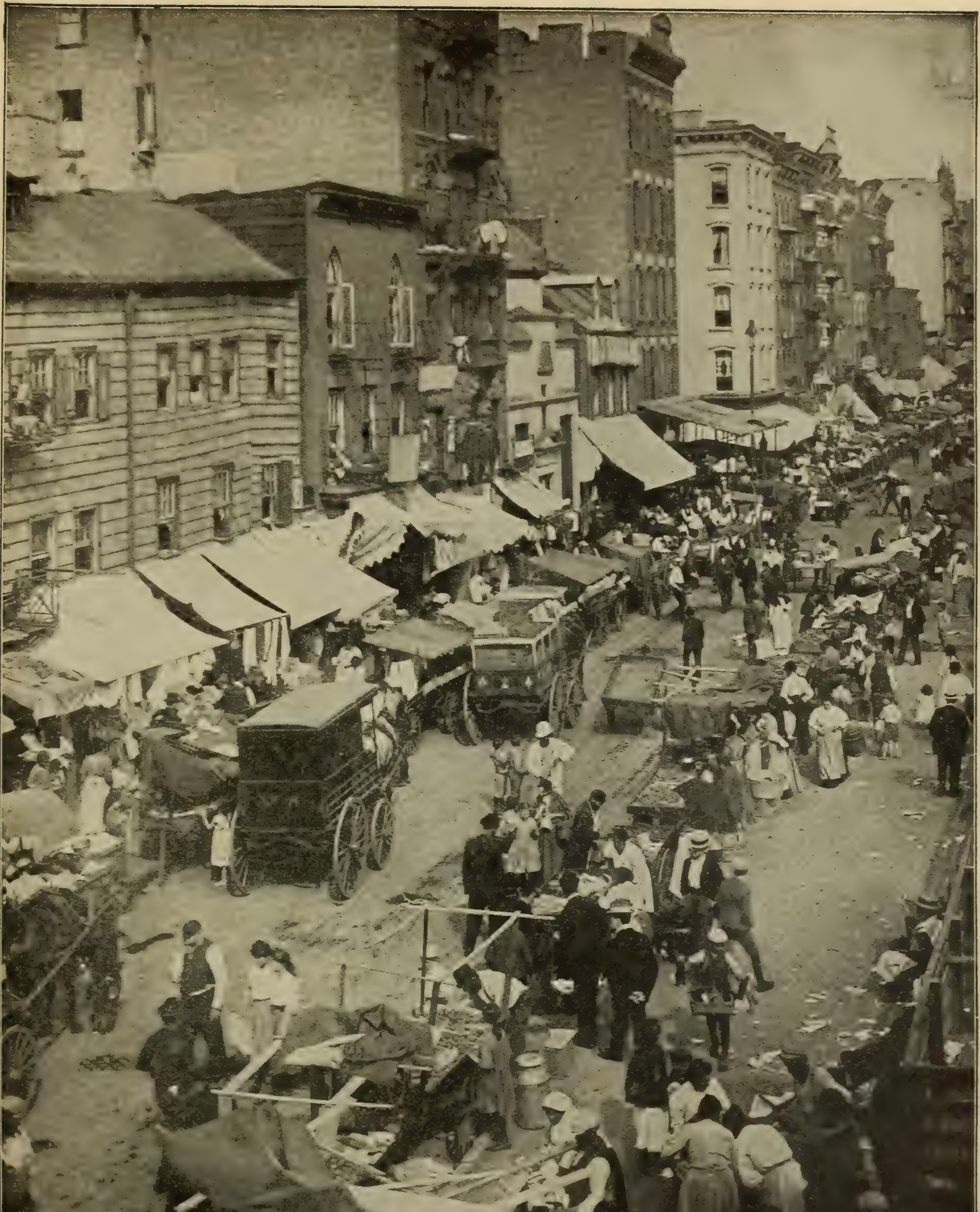
(A scene on Broadway, with city traffic blocked during the continuance of the storm.)

PHASES OF STREET LIFE IN A GREAT CITY

Street and household life in a great city has an unfailing interest to the observer, whether he be a student of social conditions or merely a seeker for entertaining novelty. Street crowds in a metropolis on the most ordinary shopping days are so great as to suggest a holiday or a parade to the stranger from a smaller town. And yet the flow of the stream of humanity is unceasing, and the procession of wheeled vehicles is never interrupted, except at the street crossings, where pedestrians and drivers are alternately given the right of way at the behest of the vigilant policeman. To thread one's way through such a crowd in the heart of the city becomes almost a sixth sense, and while the unaccustomed stranger may be bewildered by the roar and the confusion of traffic over the noisy pavements, and the multitudes which jostle him at every step, so that his progress is halting and slow, the resident passes from street to street or office to store, almost without noticing these things which are so familiar to him, and, reaching his destination without delay, does not realize the crush through which he has passed. Upon the shopping streets of the great city the big stores display their wares in glittering array in decorated windows, or heap them enticingly upon racks at the edge of the sidewalk itself. Not the least pleasure of a stroll down a shopping street is found in the study of these window and sidewalk exhibits. Beautiful fabrics, millinery, books, china, jewelry, furs, pictures, furniture and the other offerings of the merchants are arranged to the best advantage to attract the unwary, and such a street in a metropolis today is hardly second to a great international exposition, so carefully selected are the goods and from such widely diverse markets of the world do they come.

Once out of the business district of the city, and passing through the more crowded residence portions, another evidence of the multitudes who dwell in such a center of population may be seen. "Blue Monday" is just as regular in its arrival in the city of a million as it is in the small village, and the freshly washed garments of the household need sun and air for drying in like manner. Without beautiful lawns and ample grounds around them as have the more favored quarters in the less crowded communities, the people of the tenements must utilize what facilities they have. The essential and practical clothesline is made the subject of household ingenuity. The narrow back yards between the tenements are criss-crossed with an apparent tangle of lines, some high in the air and stretched to telegraph poles, or from house to house between fourth-story windows. The glimpse of such an area thus decorated, on a city washday when the sky is clear and the bright sun has encouraged the outdoor drying of the fresh linen, is peculiarly novel, and suggests forcibly the crowded fashion in which people in the city must live.

The immigrants who come to America generally choose to settle in communities in the cities, forming streets and even whole districts of their own nationalities. In New York and Chicago Russian, Jewish, Polish, Italian, Chinese and other special quarters have been established, where they preserve their European customs and afford interesting street sights for strangers.



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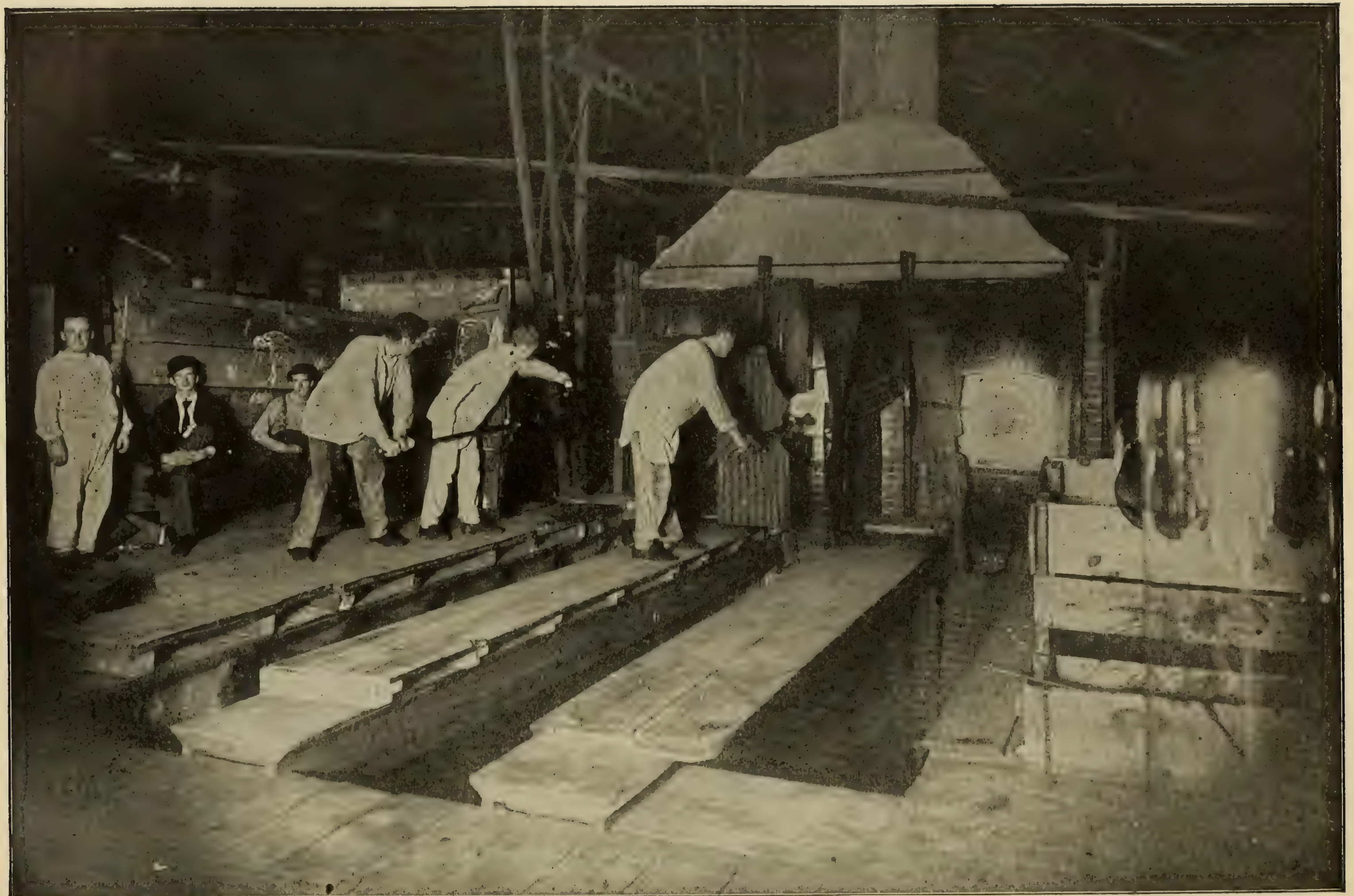
STREET SCENE IN THE JEWISH QUARTER OF NEW YORK CITY ON A BUSY MARKET DAY.



WINDOW GLASS MAKERS AT THE MELTING FURNACE.

GLASS AND ITS USES

Without glass in its various forms, the modern household would be quite at a loss. Glass enters into so many of the essential conveniences of life, of the commonest sort, that we no longer think of it as a luxury, but as a prime necessity. Windows, dishes, bottles, lamp chimneys, mirrors and ornaments are among the first uses that come to mind, all entirely ordinary to us. And yet there are lands and tribes where glass is unknown, except as it is brought to them by traders from the outer world. The wild races of the Pacific Islands and Central Africa, like the Eskimos of the far north and the American Indians, knew nothing of glass until the white men taught them its uses. They were not slow, however, to see the value of such material, and trinkets of glass or small mirrors have been among the most effective articles of trade in the dealing of explorers with these people.

Glass was first made in England by Benedict, a monk, in 674, but at that time it was recognized only as a novelty, and not of any special value. The first use of it in England for bottles was in 1557, and in the same year the first window glass was made there. More than one hundred years later, in 1673, the first plate glass was made in Lambeth, England.

Now there is no house so mean that it does not have glass in use in many forms. The decorative value of the material is great, and there is no more interesting display of the finer fabrics of the world than can be seen in the illuminated windows of a great city shopping street, extending for miles, and forming a crystal wall behind which the choicest fabrics are displayed. The incandescent electric light, too, requires the transparent bulb of glass to enclose it, so that we owe our brilliant light to the same common substance.

Glass factories have grown to immense proportions, particularly in the eastern states, where coal and natural gas are readily at hand for the immense quantity of fuel and the necessary mineral substances required in the manufacture. Pennsylvania and Indiana are among the states which lead in glass production. In the former state there are thirty glass factories, with an invested capital of more than $15,000,000 and an annual value of products of more than $9,000,000. Indiana has about twice as many factories, with a corresponding output. The employees in the glass factories of this state number 10,000 and their annual wages amount to nearly $5,000,000.

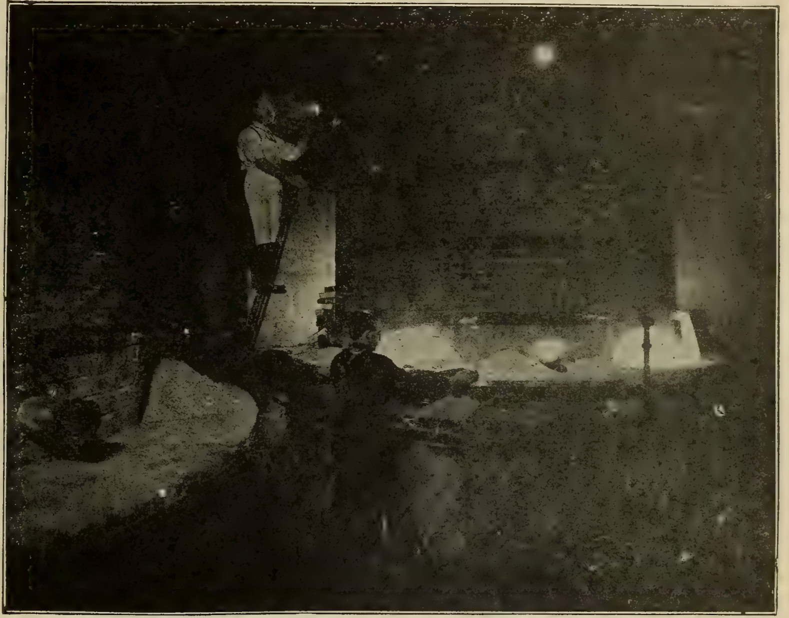
In the countries where glass is not known, the same substitutes are still used that were employed hundreds of years ago. Sheets of mica, bits of skins and other such makeshifts are made to answer the purpose, or else the windows are left wide open. In the Arctic regions, indeed, thin sheets of ice are fitted into the walls of the snow houses, and the light penetrates through them. For bottles, wooden or earthen vessels are used. But in the civilized countries to-day, glass is so cheap and so common, thanks to the improved methods applied to its manufacture, that no one is denied its use. It is in this cheapening of the necessities that are of universal use that modern industry makes one of its most conspicuous successes.

GLASS-BOTTLE BLOWERS AT WORK.

THE WORK OF THE POTTER

From the earliest times of primitive civilization, men have made utensils for domestic use out of clay, first molded into proper shape and then hardened by heat. The most primitive races to-day make rude dishes roughly fashioned and poorly baked, and through all the progress of civilization the utility of this kind of wares has been recognized. Now some of the most artistic minds are busily engaged in creating new designs, more beautiful and more serviceable. The work of the potter and the porcelain maker has become more than a mere mechanical craft, and is recognized as an art in the best sense of the word. In the finer grades of china, pottery, porcelain and the kindred wares, European makers have excelled Americans until recent years, when the products of the Rookwood workers at Cincinnati have been recognized as worthy to rank with any in the world. French china, largely produced at Limoges from the great Haviland factory, is perhaps the best known modern ware in the American household. Wedgewood, majolica, royal Worcester, Dresden and other varieties are likewise well known in this country. The plainer products of coarser ware, either in white or decorated china, are produced in large quantities by great potteries in New Jersey, Pennsylvania, Ohio, and some other states.

Oriental wares brought from China and Japan, are becoming better known all the time as our trade with the Far East increases. Indeed it was the country of



NIGHT SCENE IN A POTTERY.

China itself that gave to the most common ware its general title. Japanese and Chinese dishes are peculiarly attractive in their artistic decorations and their graceful form. One of these wares, known as Satsuma, is held in high esteem by connoisseurs, and collectors visit Japan for the purpose of searching for treasures of this sort.

Roughly speaking, all earthen ware passes through the same processes. The clay itself is properly mixed to the needed consistency, and then molded by hand or machine to the desired form. It is then

ARTIST DECORATING POTTERY.

decorated and glazed, after which in great ovens or kilns it is subjected to a high degree of heat, and this burning hardens the clay and makes permanent the decorations and the glaze. It is the variety of clay, the artistic ability devoted to the forming and decorating of the object, and the quality of the glaze or final finish, which regulate the beauty and the value of the product. As interest in household art has increased within the last decade, there has been a marked increase in the public appreciation of choice plastic wares, and this is resulting in a gradual improvement in what are now offered for use in the household, for decorative or practical use.

HOW PIANOS HAVE MULTIPLIED

There is no more conspicuous evidence of the manner in which all people profit by improved industrial and commercial methods, than is shown in the business of piano manufacturing. It is but a few years since a piano was a genuine luxury, to be found in the households of none but the rich, or those who made professional use of their musical talents. To pay $1,000 for a piano meant nothing exceptionally fine in the instrument under the old regime. The piano manufacturer might be himself musician, designer, workman, business manager and salesman of his factory.

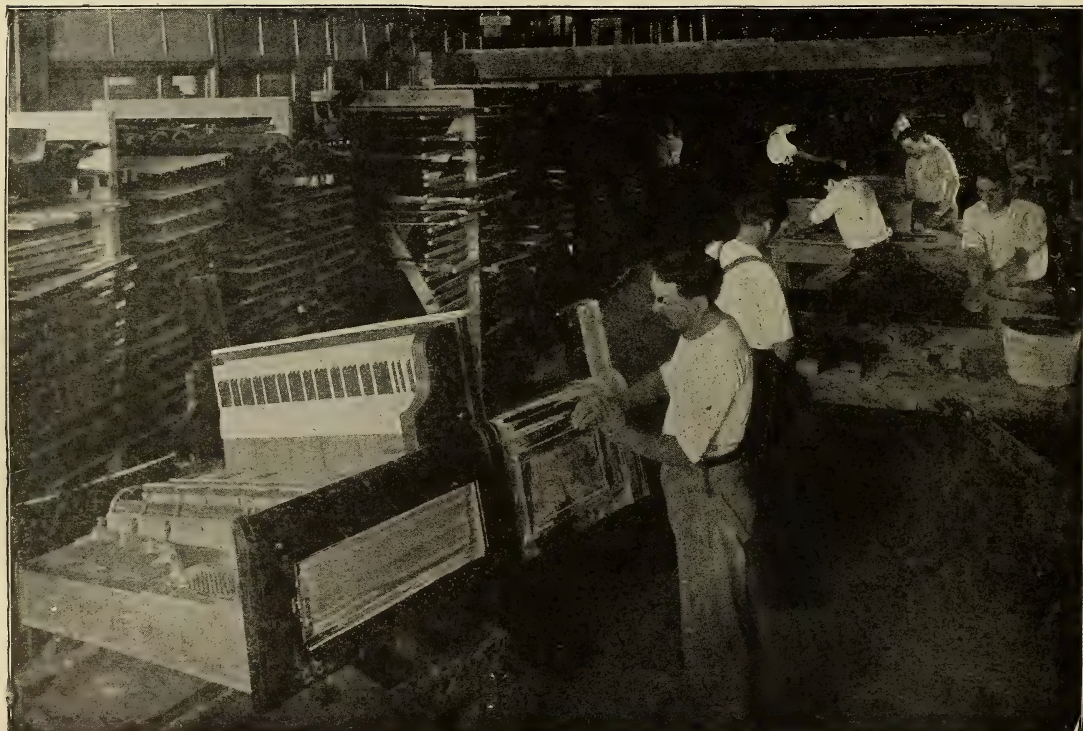
To-day all this has changed. The improved methods of wood-working and metal-working devised by skilful inventors, have made possible the construction of the ordinary piano at a cost to the manufacturer of hardly one-tenth what it was a generation ago. The methods of distribution have improved no less than those of manufacture. The result is that now almost every well-to-do household has its piano, perhaps not as perfect an instrument in every instance, with as true an identity as were the finest of those older ones which were all the product of skilled hand labor, and yet, it is believed, showing a higher average degree of excellence than ever before. It is true that there are still $1,000 pianos, but they are far superior to any of the former day, while the ones that cost such a sum years ago can be duplicated now or excelled for a fifth of that amount.

Piano manufactories are great industrial institutions, employing hundreds of laborers and turning out thousands of instruments a year. There is hardly a village that does not have its piano store and music teachers, and the widespread use made of this most popular instrument, in the most enchanting of arts, is a manifest evidence of the advance of culture and prosperity in the industrial age.

MAKING GRAND PIANOS, SHOWING INTERIOR CONSTRUCTION.

Pianos, too, have changed in form as well as in price. Two generations ago the grand piano, with its great triangular bulk, was first choice. The square piano, imitating the form of the spinet or the harpsichord and the older forms of the keyed, stringed instruments, was next in favor, and was the resource of those who could not find money or room for the larger instrument. As the square piano improved it became more popular, and until twenty years ago was one commonly seen in most households. To-day the square piano has almost vanished. The upright has taken its place as a better instrument, far more convenient in form, and economical of space in the room. The grand piano with its greater size, strength and volume of tone, must retain its place for professional use, but it is safe to say that 900 out of every 1,000 pianos made in the great factories of the United States, are of the form known as the upright.

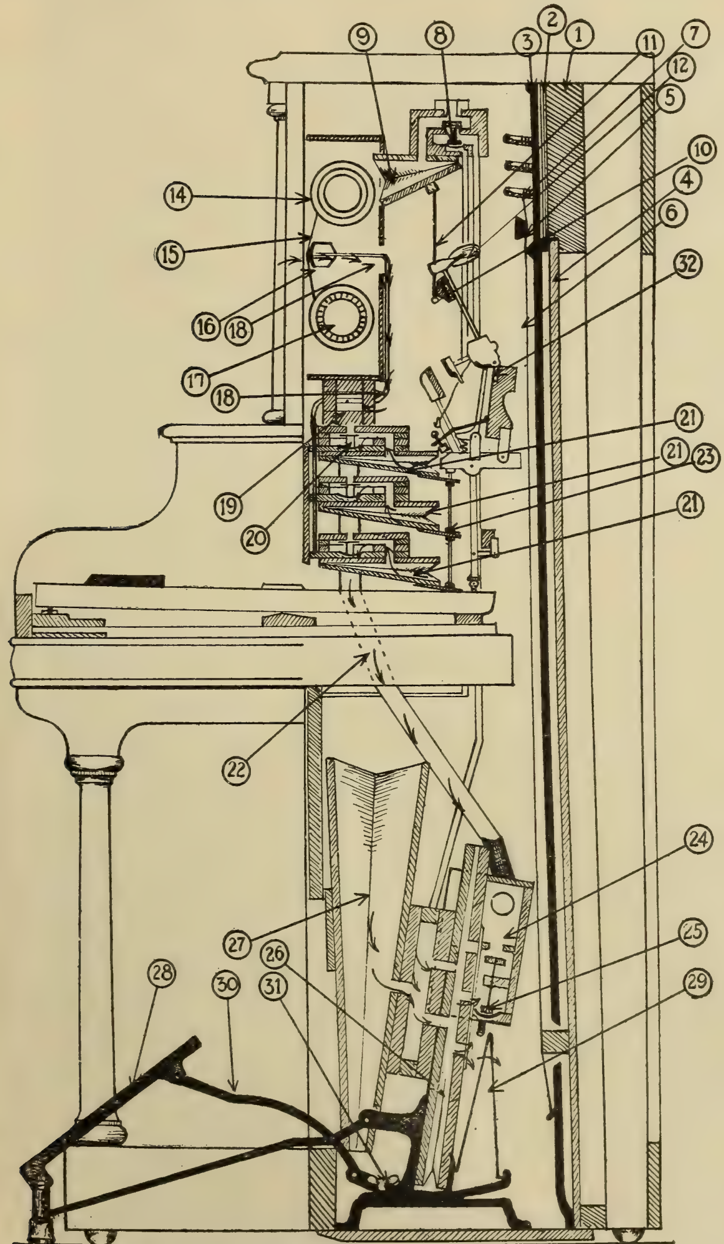
American pianos, like other American products, are finding their way far afield. Those makes which are best known in this country as reliable and popular instruments, are recognized likewise in England and upon the continent of Europe. Some American manufacturers, indeed, in order to enter the European market to best advantage, have established selling agencies and even factories across the Atlantic, where their goods are produced and sold, to be another item in the American advance in the industrial and artistic world. Such enterprising manufacturers seek for the best materials and the best markets the world over. Good pianos must be constructed out of good materials. It is not merely the beautiful veneered and polished case, but the strength of the frame and volume of the tone, that tell the story, and in these details American piano manufacturers admit no superior.



FINISHING CASES OF UPRIGHT PIANOS.

THE WONDERFUL SELF-PLAYING PIANO

Modern mechanical genius has made it possible for a person without musical training, or even a knowledge of musical notes, to play the piano acceptably; to reproduce at sight, and without hesitation, the most difficult and involved of musical compositions. This is accomplished by means of a roll of stout paper in which the notes of the score are perforated, and a pneumatic device, acting through these perforations, causes the piano keys to be struck in proper order. All that is necessary is to "pump" the foot pedals just as is done in the old-fashioned melodeon. The pressure of the foot on the pedals, causes a suction or vacuum in the pumper bellows, and air rushes in from the openings in the tracker bar and motor to fill this vacuum created. The air is admitted through a series of holes in the tracker bar—one hole for each of the notes to be played. These holes are closed—air tight—by the paper music roll and opened for each note, as it is to be played, by the perforations in the music roll passing the tracker opening. The air then rushes in and in its course to the pumper pedals, exhausts the pneumatics, which, through the piano action, strikes the hammers. The combination of holes in the tracker bar, thus act the same in playing the piano as would a musician's fingers.



INTERIOR MECHANISM OF PIANO PLAYER.

SCENE IN THE REMARKABLE SALT FIELD IN SOUTHERN CALIFORNIA.
Salt cones ready for the mill after the Indian laborers have washed it.

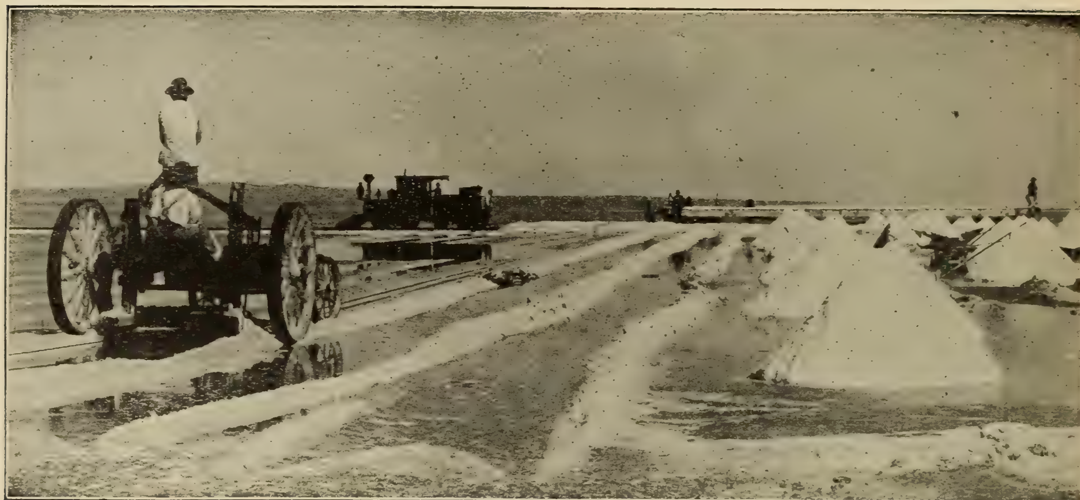
SALT AND ITS PRODUCTION

It would be difficult to name anything more universally required by mankind than the common, cheap and simple substance which we call salt. Indeed, not only mankind, but animals as well, find it essential to their health and will undergo any difficulties necessary to obtain it. Fortunately for the world there is nothing more generally found and nothing cheaper. The ocean, which occupies approximately three-fourths of the surface of the globe, holds inconceivable quantities of salt, carried into it by the rivers which it receives, and absorbed from the salt beds upon which it rests, and this supply in the greatest of storehouses is never diminished by evaporation. On land, underground and surface deposits of salt alike are found the world over, and great inland bodies of water are saturated with this simple substance, which they are ready to yield at the demand of the salt-gatherer. Salt is obtained in ways that differ as widely as do the localities where it is found. Perhaps the most picturesque and interesting of all the salt gathering industries is found in our own country, recently developed, but already taking an important place in the production of salt for the market.

Away down in Southern California in the middle of the Colorado desert, about 100 miles from the ocean and eighty miles from the Mexican boundary line, is the little station of Salton, on the Southern Pacific Railway. It lies between the San Bernardino and the San Jacinto ranges of mountains. Between these ranges the valley sinks to a level some 400 feet below the level of the sea, making it the most depressed spot in the United States. In this remarkable depression, a short distance to the south of Salton, is a field of crystallized salt some 300 feet below the level of the sea and more than a thousand acres in extent. Here the company owning the tract employs a number of laborers in the gathering of salt for the market, by methods genuinely unique.

GATHERING SALT IN MEXICO.

The salt itself exists as a crust over the surface of a marsh. It is constantly supplied by salt springs which flow from the



A DRY SALT SEA IN THE DESERT.

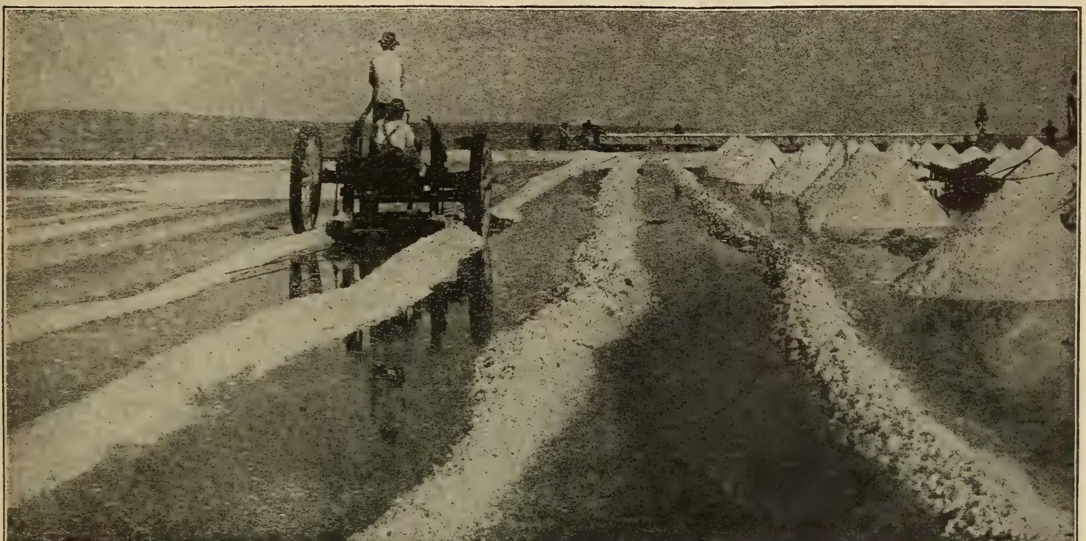
surrounding hills draining into the basin, where they rapidly evaporate, leaving the deposits of almost pure salt. The salt crust thus formed varies in thickness from ten to twenty inches.

The process by which the salt is collected is simple in the extreme. The crust is plowed by a salt-plow, resting on four broad-tired wheels and managed by two men. A railway track runs across the salt field at either end at right angles to the direction in which the plowing is to be done and a locomotive works back and forth on this line. From it steel cables are carried around pulleys and then hooked on to the plow, and the locomotive tugs away, drawing the peculiar implement the full length of the field. The heavy steel share makes a broad furrow but a shallow one, leaving parallel ridges on the crust on either side. Between the wheel tracks the brine is exposed that seeps from the underlying salt springs. Laborers with hoes work the salt in the water, to separate the earthen particles that have adhered to it, and when this is done they stack up the clean salt in conical heaps ready to be hauled to the mill. The water in which this washing process goes on is itself so saturated with salt that it can absorb no more, so that there is no loss by the washing.

The surface of this remarkable field of salt is snow white, and its brilliancy in the clear light of the California sun is so dazzling that laborers have to wear dark glasses to protect their eyes. These laborers are either Japanese or Indians, for no white man can stand the intense heat. For weeks at a time the temperature averages 140 degrees, and the uninterrupted sunshine reflected from the dazzling white surface produces a glare that is almost intolerable. Even the Japanese laborers confine their work to the sewing of the sacks in which the salt is packed. The field work and the work in the mill are done entirely by Indians of the Coahuila tribe.

In order to supply additional water for washing the salt, the company sunk an artesian well to a depth of 900 feet. Even this is still strongly alkaline, but it is the only source of water for domestic purposes. The air, laden with impalpable particles of salt, stimulates an intense and painful thirst which the workmen find it impossible to quench with the lukewarm water of the artesian well.

Out of this field of 1,000 acres of virgin salt, not more than ten acres are worked at this time, and yet from such a small portion about 700 tons of salt can be plowed and shipped daily. As fast as the crust is removed a new crust forms almost immediately after the plow has passed on. The drying and milling works are at Salton. After the salt has drained in the conical mounds in the field, it is loaded on flat-cars and hauled to the works. Here it passes through a mill which grinds it to powder and then it is sifted and packed into sacks for the market, in which it is recognized as of the best quality.



AT WORK IN THE SALTON SALT DEPOSITS.
Indian laborers plowing, and, in background, loading salt on flat cars.

Under certain atmospheric conditions this salt field displays remarkably perfect examples of the phenomenon known as the mirage. Beautiful flowering fields, sylvan lakes and towering cities appear in most deceptive form. The effect of moonlight on the white expanse is singularly weird and beautiful.

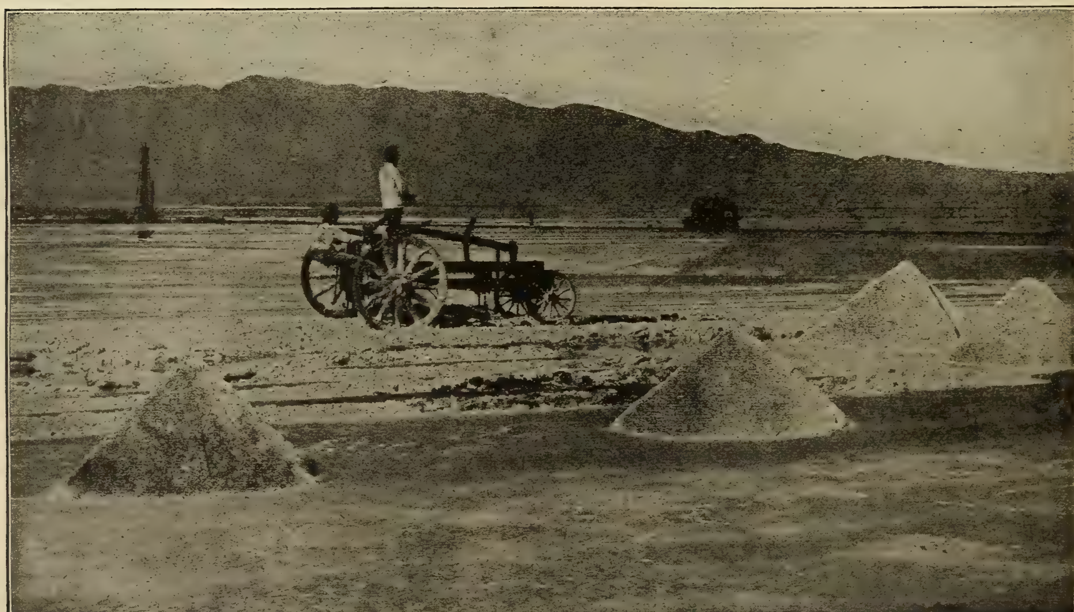
The salt deposits of the ocean itself are utilized as a source of commercial supply in many countries, and particularly in the islands of the sea where other supplies do not exist. Even on our American coasts, however, the business possibilities of this industry are not neglected, and in the neighboring islands of the West Indies many people obtain their living by gathering salt. The process is to prepare a series of shallow pools near the ocean and below the level of high tide. Channels are cut by which the ocean water can enter these pools, and the channels are then dammed up so that the water cannot flow out when the tide recedes. After evaporation has left the ground white with dry salt, it is raked into heaps and hauled to the place of shipment, while a new period of evaporation is passing in the refilled pools.

In New York, northern Michigan, southern Kansas, southwestern Ontario and several other regions of North America, there are underground deposits of rock salt of great value. The usual process by which this salt is obtained involves the boring of wells deep into the strata of salt. These wells fill with water, either from the surface drainage or underground springs, or are pumped full, and the water dissolves the salt until it is saturated and becomes a brine. Then it is pumped out and evaporated in great kettles. In several European countries there are mines of rock salt, extending far underground, which are worked by shafts and tunnels in the earth, just as coal or iron mines would be. Austria and Russia have mines of this character, and they are considered among the most interesting of all the underground industries.

Mexico in several places has salt deposits similar to those in southern California, although none so extensive. Indeed, there is hardly a country in the world which does not contain salt deposits of some sort, even if in some instances they are no more than flowing springs impregnated with this important substance.

When we say salt we mean, usually, chloride of sodium or common table salt. This, however, is but one of many soluble salts contained in the ocean and in the salt seas of the world. Even in fresh river water some mineral salts are present. Of these a part may be removed by various means during the journey of the river, but the rest remains to be concentrated at last in the basin in which the river comes to an end. Of course in most instances the ultimate outlet of the rivers is the ocean and when this is not the case whatever outlet is final is sure to be salt.

There are not very many salt lakes in the world, or lakes without an outlet. North America has one such important



PLOWING FURROWS IN THE FIELD OF SALT.

lake, the Great Salt Lake of Utah, into whose basin drain a number of rivers included between the Rocky Mountains and the Sierra Nevadas. Asia has two or three of the same character, notably the Caspian Sea, which is the largest land-locked body of water on the globe, and nearly five times as large as Lake Superior. Lake Balkash, the Sea of Aral and the Dead Sea are others in the Asiatic continent, the latter being one of the few at a lower level than that of the salt deposit in southern California.

It would be easily possible indeed for this American salt field to become another Dead Sea. It lies far below the level of the ocean, as has been said before, and the Colorado River, which carries a considerable stream, is several hundred feet above it and not far away. In the summer of 1891, indeed, there was a flood in this river and a large area near Salton became a lake of considerable depth. When the river flood subsided, however, so that the supply of the lake was cut off, the rapid evaporation from its surface soon carried away the water, and left it in its former condition.

The saltness of the sea is evidence of its power of transportation if not of destruction, for at least a very large part of the salt is brought down into the sea by rivers. This, however, must be uniformly distributed by diffusion or by currents, for ocean water is practically the same composition in all parts of the globe. True, it is a little more salt in warm regions than in cold, but this difference is due to the greater amount of evaporation. For a time, also, it is more brackish, at any rate near the surface, in the neighborhood of the mouth of a large river. That the mineral substances must be mainly if not wholly brought down in solution by the rivers, is proved by the fact that every sheet of water for which there is no outlet is salt. Evaporation cannot remove the salt constituents, which are present in greater or less degree in every stream, so they remain behind and the water very slowly but very surely becomes more salt.

There was a time, as is proved by the character of the fossils which are found in beds high above the present level of the water, when the Dead Sea was but slightly brackish. The ocean, also, may be more salt at the present time than it was when the world was young. It would become much more so if countless millions of minute organisms were not ever drawing from it the supplies which are needed in the construction of the solid parts of their bodily frames.

The Dead Sea is recognized as the most fully impregnated with salts of all the bodies of water in the world. Less than 74 per cent of its entire bulk is water, and more than 26 per cent is of salts held in solution. Chloride of sodium, however, or common salt, is not the dominant salt, chloride of magnesium being 16 per cent of the total bulk of the sea, while common salt is but 3½ per cent. Our own Great Salt Lake, in Utah, stands at the head of all in the amount of chloride of sodium in solution, with nearly 12 per cent dissolved in it.

It is this large proportion of salt in the water which gives to the Dead Sea and the Great Salt Lake their extraordinary buoyancy. In these bodies of water it is absolutely impossible for the human body to sink, and difficult to swim, so dense is the saline fluid.

INTERIOR OF A GREAT CITY BANK.

FINANCIAL METHODS OF TODAY

In addition to the production of raw material and the manufacture of it into goods for the market, and the distribution of these goods by railways and great mercantile concerns, the industrial world is compelled to recognize a multitude of middlemen, whose functions are of the highest importance in the present business organization. These are the financial concerns and agencies of various sorts that deal in credit, providing money when it is needed, at a profit to themselves, and in general sharing in the processes of sale and collection. Roughly speaking, banks, chambers of commerce, boards of trade and stock exchanges include the men who control these details of industrial activity. They are strongest in the financial centers and great markets of the world, where business concentrates, and they are a factor always to be reckoned with.

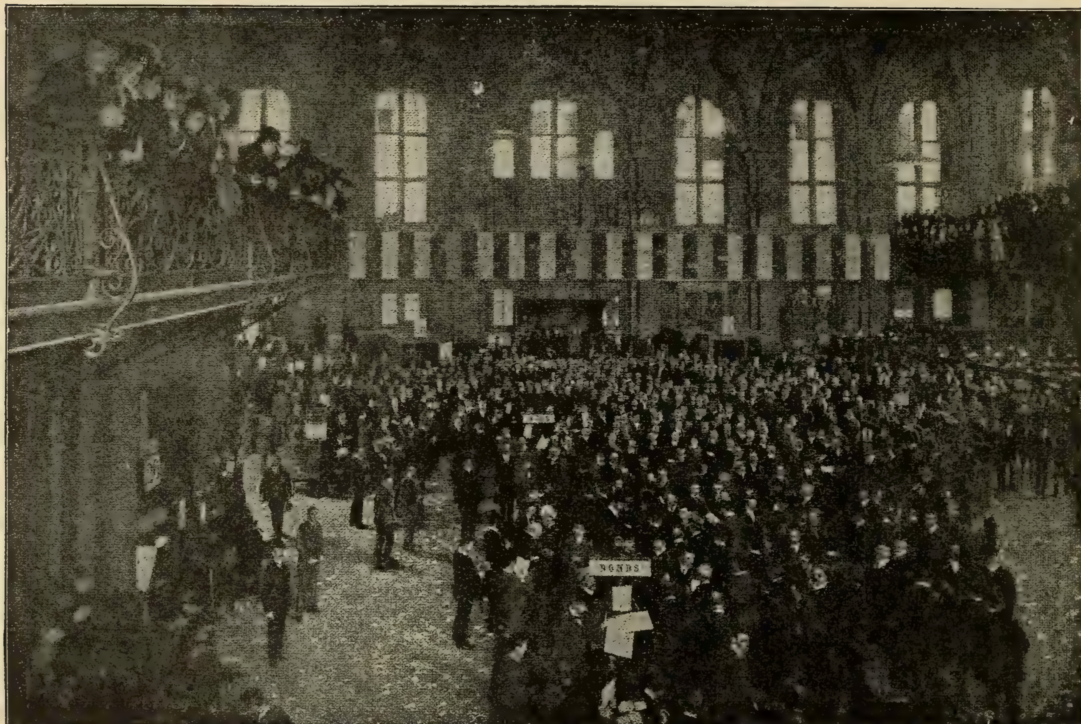
Banks, generally speaking, are purely financial in their dealings, affording places for the deposit of money, and lending to their customers at interest. Chambers of commerce and boards of trade operate chiefly in commodities, such as grain, wheat, cotton, coffee and the like. Stock exchanges deal in financial securities, such as stocks and bonds of railways, mining

BANK OF ENGLAND AND ROYAL EXCHANGE, LONDON.

This is the financial center of the world. The Bank is the building on the left and the Exchange is the pillared structure on the right. The Mansion House, residence of the Lord Mayor, is opposite the Bank, not shown in the illustration.

companies and other corporations. Owing to the intimacy of trade and communication between the various markets of the world, the importance of these controlling organizations continually grows, and the condition of the market in any financial center responds rapidly to influence throughout the world.

banks are gaining in this country at a startling rate of speed. At least one bank in New York City has a capital of $25,000,000 and a surplus of $15,000,000, while two others in that city and one in Chicago exceed $15,000,000 in capital and surplus. With deposits in their vaults ranging from $50,000,000 to $125,000,000, and connec-

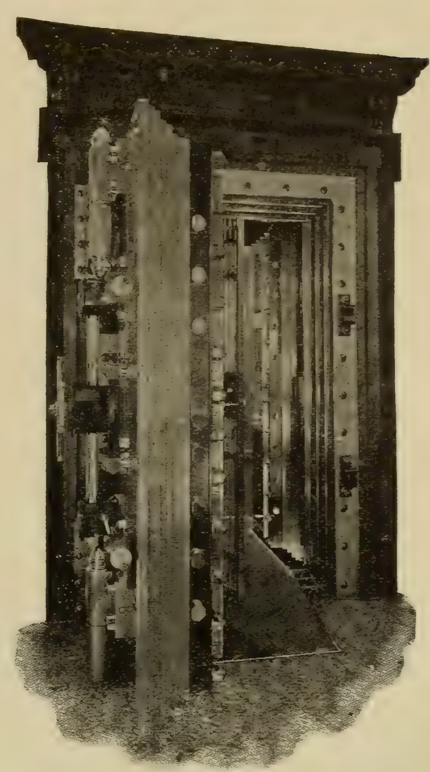


"WALL STREET," THE FAMOUS NEW YORK STOCK EXCHANGE.

This [illegible] the last photograph taken of the old Stock Exchange where so many financial "panics" have occurred, before it was torn down to make way for a splendid new building.

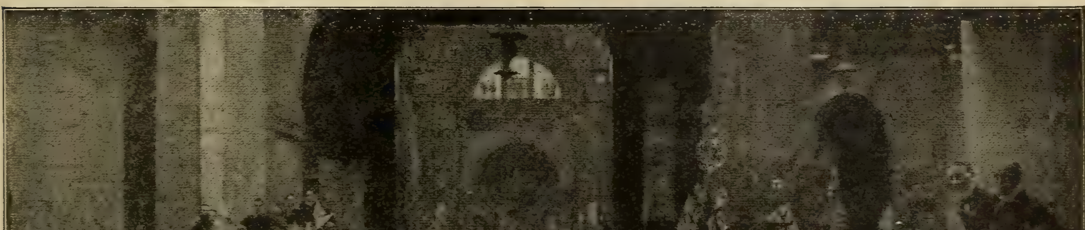
tions with smaller city and country banks all over the United States, it is apparent that the financiers who control such great institutions exert wide influence upon the business affairs of the nation. The significant thing in this enormous capitalization of city banks, which was not even dreamed of five years ago, is that it is a reflection of the gigantic strides of America toward the commercial supremacy of the world,

Banks are growing in size and influence with great rapidity, the tendency being toward the consolidation of such institutions in cities, with immense capital and far-reaching connections. The Bank of England, the Bank of France, the banking houses of the Rothschild family, and others in Europe, far surpass anything we have in America. Along with the growth of trusts and industrial organizations, however, New York looks forward to the proud eminence of being the financial center of the world. This greatest of American banks has been an important factor in many of the recent colossal combinations or "Morganizations," engineered by J. Pierpont Morgan and other financial giants.

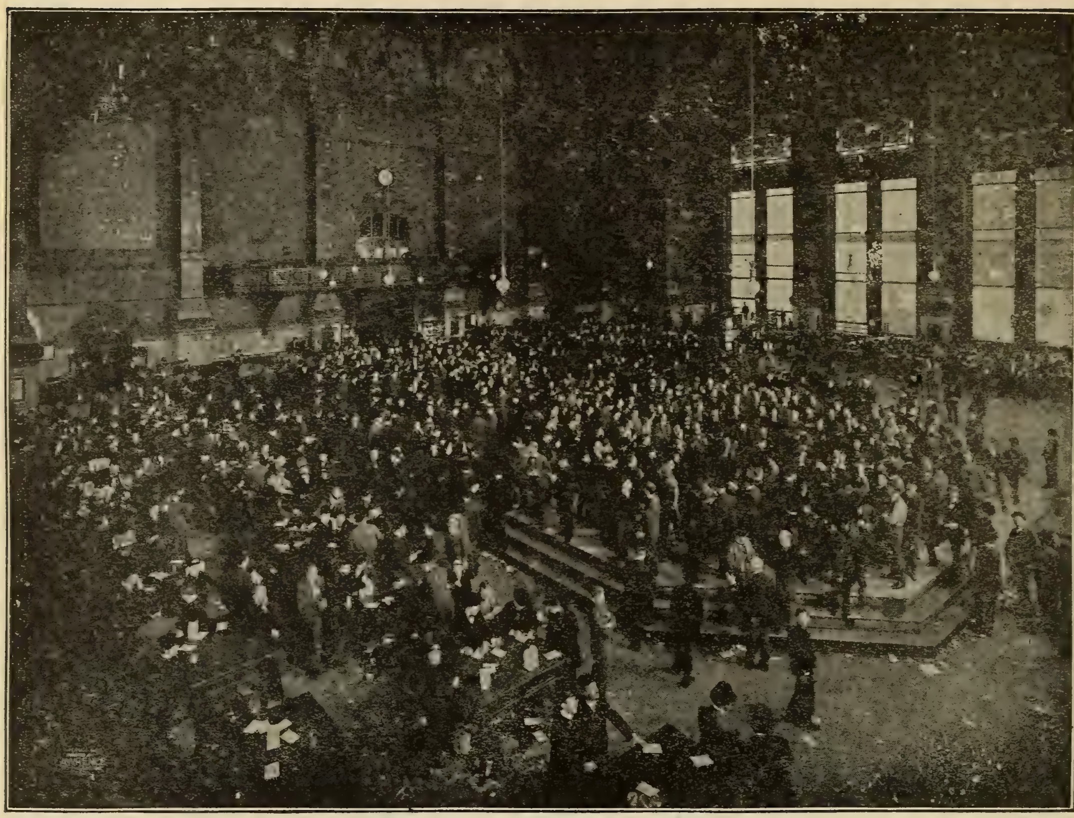


BANK VAULT DOOR OPEN.

The method of trading that has grown up in boards of trade and stock exchanges is full of technicalities that puzzle the visitor. In an excited state of the market, the confusion is bewildering. Traders are shouting their sales and purchases into each other's ears, or frantically waving their hands high in the air, with one or more fingers extended to signal what they mean, according to a code that is well understood. Of course the actual transfers of stocks or provisions are very great, and still this phase of the business is far exceeded by mythical dealings in "futures." When a sale is made for a future delivery at a given price, this does not at all imply necessarily that the goods are to be delivered. Instead, when that date comes around, if the actual market price of the commodity is higher than the contract price, the one who



"THROGMORTON STREET," THE LONDON STOCK EXCHANGE.
This photograph was taken during the British war in South Africa, on a day of great public excitement.



THE CHICAGO BOARD OF TRADE.
The octagonal rostrums, with steps leading to them, have depressions in the center, at the floor level, and these are the "pits" which figure in all accounts of trading.

has sold simply pays to the buyer the difference between these two figures. If the contract price is lower than the current market price, the buyer pays the difference to the seller, and the deal is thus closed.

It is this condition that justifies the familiar charge that such deals are but bets as to what the price will be at a certain time in the future, the loser to pay his loss. "Puts" and "calls" are privileges to deliver or to claim a certain commodity at a certain price in the future. The one buying the privilege to deliver to another, or to demand from him under such circumstances, is in effect betting that the price will fluctuate in the interval in such a way as to give him a profit.

Traders are divided into two general groups known as "bulls" and "bears." Any man holding a commodity and wishing to sell it, or holding a future privilege to call for it at a fixed price, naturally desires to see the price of this commodity rise, and devotes his energy to hoisting the price in any way possible. He is therefore known as a bull. The bear, on the other hand, is the one who wishes to buy a commodity, or who has an outstanding contract to deliver at a fixed price at a future time, that which he has not now in hand, and his interest therefore is to depreciate the price. It is this condition that makes the eternal quarrel between the two elements on the market, although, of course, they are continually shifting in identity as their trades change.

There is little essential difference between the so-called "bucket shops" and the boards of trade themselves. The former make deals of smaller size, and probably a smaller percentage of their trading is for actual delivery of the commodity dealt in.

"Margins" are the sums of money deposited with a broker to guarantee a given trade. If the commodity were bought outright, of course, the whole purchase price would have to be paid, but when it is merely bought for speculation, to close the trade whenever the price justifies, that is not necessary. If, for instance, a buyer instructs his broker to purchase 10,000 bushels of wheat, he may deposit $200 to guarantee the trade. The purchase of the wheat is entered on the books, and as long after that as wheat rises on the market, the purchaser is making a profit and could sell out again, or close the deal at any moment, withdrawing his deposit and the increase. If, however, instead of rising, the wheat falls in price, as soon as it has fallen two cents a bushel, the $200 deposit is exhausted, and the margin is "wiped out" or lost. In the event that the purchaser wishes to protect his deal still further, he may continue to deposit margins as long as he likes, to see them continually lost if the price continues to fall. There are a multitude of other details and technicalities in stock exchange and board of trade dealings, but these are the essential ones and should be sufficient to show that such institutions offer little profit to the stranger, who is not on hand to direct his own investments. Many systems have been invented by which to "beat" the markets, but no successful one has been devised.

WHERE OUR MONEY IS MADE

The United States Government, under the constitution, reserves for itself the right of issuing all metallic money for the nation, and the great mint at Philadelphia is a place of peculiar interest to every curious visitor who wishes to see how money is made.

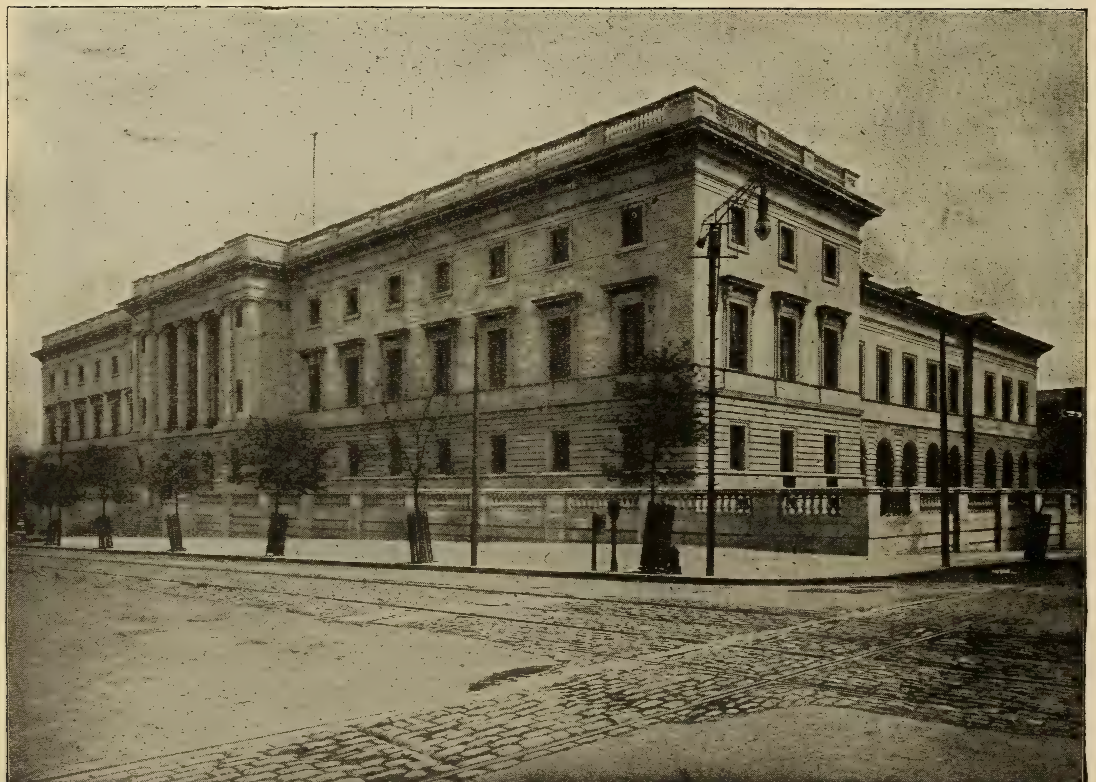
When the bullion is received at the mint from the mines and other sources throughout the country, it is melted in crucibles and molded into ingots not unlike pig iron or steel right from the foundries. In this form copper, silver and gold do not show their value, but appear uninteresting in the extreme. Repeated processes of refining and alloying to the proper degree of fineness gradually bring the precious metals

BANK VAULT DOOR CLOSED.

into more sightly form, although it is long before they take on the final polish.

For silver dollars, for instance, long strips of the metal are molded to the proper thickness and proper width. They are passed through a press which first stamps out discs of the metal of the proper size and shape for the finished dollar. These discs undergo a polishing process, and then great hoppers of them are placed over the coining machines, from which they trickle out a stream of shining dollars. A single motion of the machine turns out the coin from the discs. Two dies, one for each side of the coin, meet with irresistible force and stamp the designs upon the metal, while at the same time the milled edges are formed by the encircling pressure. The coins then are given their final polishing, after which ingenious automatic scales weigh them, separating the ones that are too heavy or too light from the perfect ones, to be returned to the melting pot for another coining process. But few people are so indifferent to the enticements of money that they fail to be impressed at the sight of gold or silver dollars, pouring in a continuous stream from the coining machines in the mint.

The old mint at Philadelphia, from which hundreds of millions of dollars of coin were turned out during the nineteenth century, has been supplanted by a splendid new building, equipped with the most modern machinery, and doubly effective for the convenience of its arrangements. There



THE NEW UNITED STATES MINT AT PHILADELPHIA.

are mints also at Denver, New Orleans, and San Francisco, and government assay offices at New York, St. Louis, Deadwood, Helena, Boise, Carson, Seattle and Charlotte, N. C.

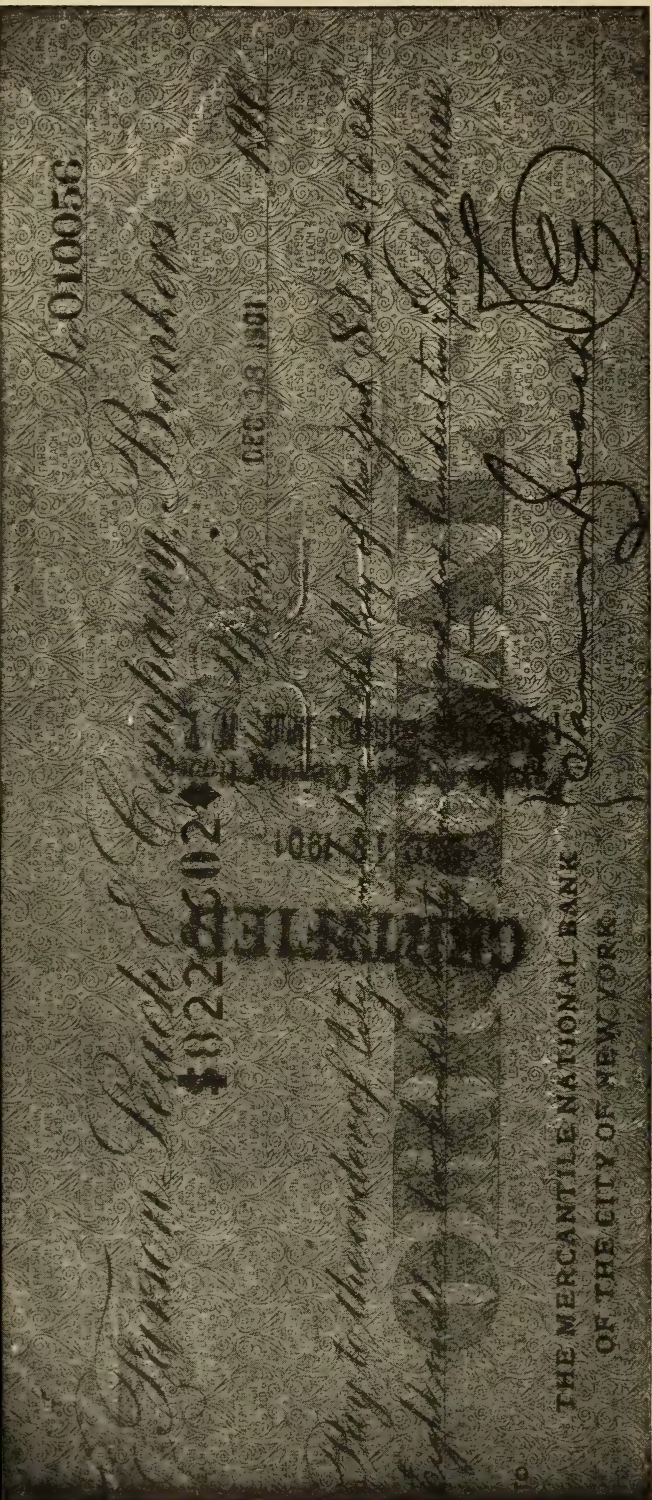
The assay office is practically an outside agency for a mint. It receives the bullion, ascertains and pays its coinage value less any bullion charges that may be made for the service, and ships it to one of the mints. The equipment and organization of a mint are expensive, and it is cheaper to concentrate coinage operations in a few institutions than to multiply mints. An assay office renders practically the same service to the mining industry that is rendered by the mint. The New York assay office receives the bullion upon precisely the same terms as a mint, but the others make a special charge of one-eighth of one per cent in addition to mint charges.

Gold bullion that is of standard fineness, and requires no treatment to fit it for coinage, is received and coined without charge. If it contains base or other metals which must be removed, a refinery charge is made, and if it is above the standard an alloy charge is made. The law provides that these charges shall equal, but not exceed, the cost of the service. The total number of pieces of coins struck by the mints of the United States in 1901 was approximately 185,000,000, and the value about $140,000,000. This exceeded any record before made by any government.

HAULING INGOTS OF SILVER BULLION IN THE PHILADELPHIA MINT.

EIGHT MILLION DOLLARS IN ONE CHECK

The largest financial transactions are not settled by a transfer of coin, or even paper money, from hand to hand. The very weight and bulk of the money required makes that impossible. Instead bank checks are used for settlement of great obligations,



MADE FROM PHOTOGRAPH OF ORIGINAL CHECK FOR OVER EIGHT MILLION DOLLARS THAT WENT THROUGH BANK AND WAS PAID.

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and the money called for can be transferred at will from bank to bank, according as the customer desires. The check reproduced herewith is believed to be the largest ever drawn in any American transaction, if not in the world. It calls for the sum of $8,229,602.81, and was made by the Chicago banking firm of Farson Leach & Company, in their New York branch office, in settlement of a purchase of municipal bonds issued by New York City. The check was passed through the New York Clearing House, where the daily balances are adjusted between the banks, and it took the usual course of business papers.

If the amount of money represented by this check were paid in silver dollars, it would weigh about 300 tons, and would require a train of fifteen heavily loaded freight cars to carry it. In gold it would make eighteen tons, and one car would be sufficient. It is hard to conceive such a sum of money. Invested in ordinary dwellings, at an average cost of $2,000 each, this is enough money to build 4,100 houses, or as many as comprise the ordinary American city of 20,000 inhabitants.

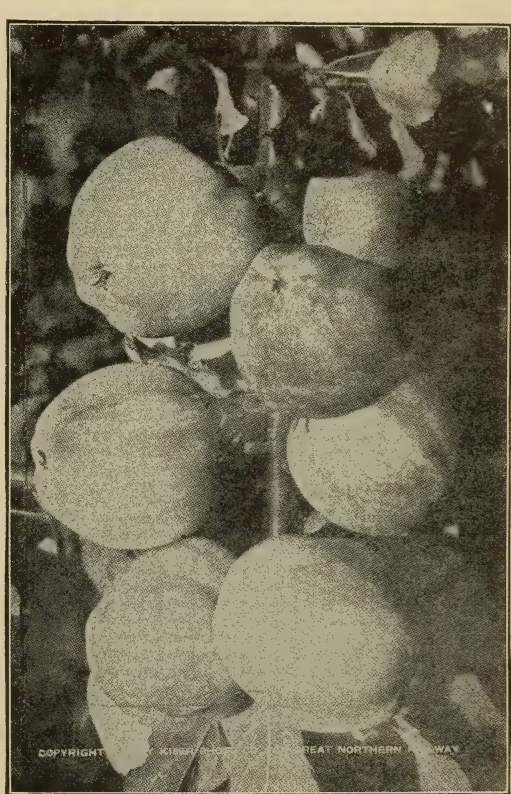
RICE A PROFITABLE CROP.

One marked result of the reclamation of formerly worthless southern lands—worthless because they were too swampy and wet to cultivate—is the growing of highly profitable crops of rice. Arkansas, Louisiana and Texas are now great rice producing states. In the former crops of 80 bushels, selling at from $1 to $1.05 per bushel, are produced to the acre. Rice is a water crop. During the growing stage it must be kept almost totally submerged, only the heads of the plant showing above the water. At the same time there are seasons—seeding and harvest—when the land must be dry enough so that men, horses and machinery may be used on it. This can only be done by controlling the flow of water, which is one of the features of the reclamation systems. A few years ago improved lands in the rice belts sold at from $30 to $40 an acre, including the buildings. These same lands are now hard to buy at any reasonable price because the growing of rice returns an annual profit of from $60 to $75 an acre, or about double what the land could be bought for in 1900.

KILLING THE ORCHARD PESTS.

The yield of orchards and gardens is largely increased by the spraying of the trees and plants with chemical solutions, a process which destroys the injurious insects and fungi, and restores the trees to a healthy condition. There are many well-authenticated instances in which entire orchards which had been virtually killed, so far as bearing fruit is concerned, by the ravages of insect or fungous pests, have been brought back to a profitable bearing stage by intelligent spraying. Various solutions are used for this purpose, the chemicals employed varying according to the nature of the tree or plant, and the kind of pest to be destroyed. Those in most common use are as follows:

Fungicide—for rots, blights, mildew and similar fungous troubles—Bordeaux mixture, copper sulphate (blue vitriol) 5 pounds, quicklime 5 pounds, dissolved in 50 gallons of water.



HOW APPLES GROW IN IRRIGATED ORCHARDS.

Insecticide—for insects that chew—Paris Green 1 pound, quicklime 2 to 3 pounds dissolved in from 150 to 300 gallons of water.

Contact Insecticide—for sucking insects and San Jose scale—lime 15 pounds, sulphur 15 pounds, salt 15 pounds, water 50 gallons.

There are various methods of applying these sprays. In small orchards and gardens they are frequently applied with hand pumps, and even with sprinkling pots. When used on a large scale, however, recourse is had to specially built spraying machines equipped with a gasoline (or similar) motor by means of which the solution is driven in minute particles and with considerable force into every part of the affected object, thoroughly saturating the bark and branches, and drenching both sides of the foliage.

PROTECTING THE PEOPLE'S FOOD.

Adulteration of foods and food products, as well as many medicinal preparations, had become such a bold and dangerous evil that in 1906 the Congress of the United States adopted a Pure Food act which was approved by the president and became law on June 30th of that year. The act is very comprehensive and sweeping in its provisions. It prohibits the adulteration, wrong labeling, or misrepresentation of any food or other article taken into the human system. It applies, not only to ordinary foods, but to all medicines, liquors, confectionery, canned goods and similar articles. These various products must be free from all harmful adulterants, and when put up in packages or containers the actual weight must be accurately stated. In the case of medicinal preparations the name and quantities of ingredients like alcohol, opium, morphine, cocaine and similar drugs must be plainly given. Liquors and all manufactured articles must be labeled in the same manner. Every violation of the law is treated as a separate offense, punishable by a fine of $500, or one year's imprisonment, or both. Any person handling, receiving or shipping adulterated goods is also liable to a fine of $200 for the first offense, and $300, or one year's imprisonment, or both, for each subsequent offense.

Administration of the law is under control of the Department of Agriculture. This department maintains a bureau of chemistry under the supervision of Dr. H. W. Wiley. Here all suspected articles are tested and, if found to be in violation of the law, are reported to the Department of Justice for legal action. Convictions have been had in many hundreds of cases, and the most dangerous forms of adulteration are being prevented and the offenders forced out of business. In addition to the infliction of a fine and prison sentence, all articles found to be adulterated are to be confiscated and destroyed, and this latter provision is liable to make the offense so costly that the number of people willing to incur the risk is growing smaller every year.

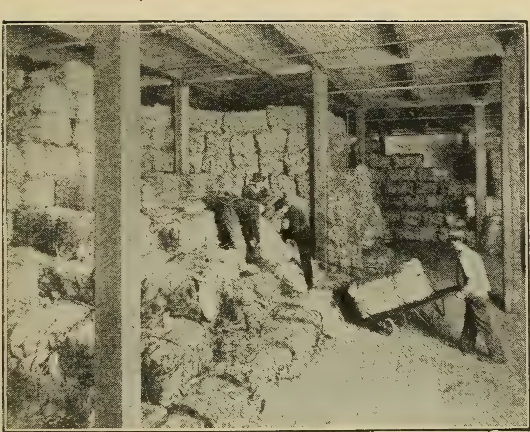
Many of the developments made by the Department of Agriculture are startling. Before the adoption of the pure food law nearly every article manufactured for food, medicinal or similar purposes, was adulterated, and frequently with dangerous ingredients. The cheaper forms of confectionery were largely made of mineral substances such as terra alba, barytes, talc and chrome yellow; most of the cough syrups and soothing syrups had some form of opium as a base, liquors were largely made from chemicals, and even eggs, butter and cheese were all adulterated.

HOUSE CLEANING BY SUCTION.

One of the most ingenius devices of the present day is the pneumatic suction cleaner. Equipped with a small, easily carried metal tank, within which is a motor operated by attaching a wire to an electric light tap, the modern housewife cleans her carpets, rugs and other furniture by simply passing a suction hose over the surface. This contrivance draws the dirt into the machine where it is caught in a bag from which it may be readily emptied as required. There is no dust to settle in the room after the cleaning is done, and the hard manual labor of handling the old-fashioned broom is avoided.

WORLD'S PRINCIPAL PRODUCTS.

Official reports prepared by the United States Department of Agriculture place the wheat production of the world at 3,251,000,000 bushels yearly, of which the United States produced 695,443,000 bushels in 1910. The second wheat-growing country



MANNER OF STORING SISAL IN BALES.

is Russia, with 513,000,000 bushels. France is third, with 329,000,000.

Corn—World's production 3,360,000,000 bushels. United States, 3,125,713,000 bushels, or virtually the entire crop. Austro-Hungary was second with 165,000,000 bushels.

Cotton—World's production 19,569,000 bales. United States, 11,649,000; British India, 3,891,000; Egypt, 1,383,000.

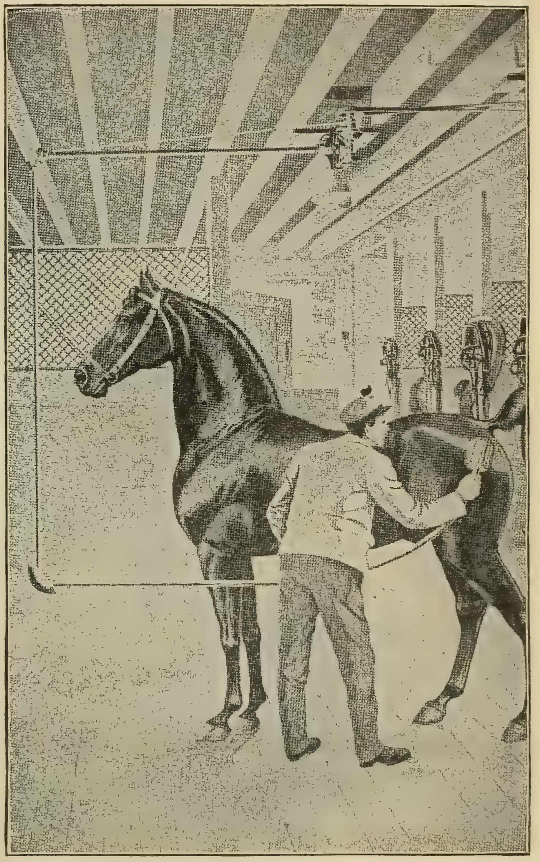
Tobacco—World's production, 2,281,000,000 pounds. United States, 984,349,000; British India, 450,000,000; Russia, 206,000,000.

Swine—World's production, 145,300,000 head. United States, 55,965,000; Germany, 22,238,000; Russia, 11,701,000.

Cattle—World's production, 428,300,000 head. British India, 91,285,000; United States, 72,715,000; Russia, 37,531,000.

Sheep—World's production, 577,400,000 head. Australia, 87,652,000; Argentina, 67,212,000; United States, 56,315,000.

Horses—World's production, 95,200,000



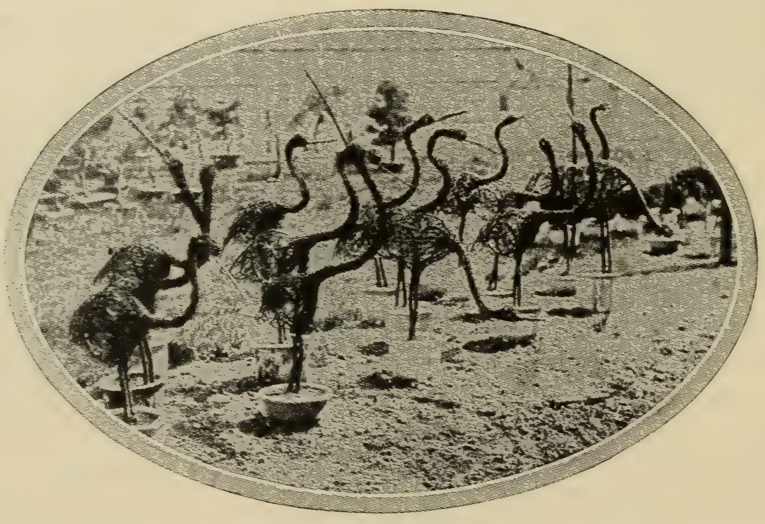
CLEANING A HORSE BY ELECTRICITY.

head. Russia, 23,899,000; United States, 23,577,000; Argentina, 7,531,000.

In giving these figures only the product of the three countries ranking highest is recorded. The difference between the world's product and the total of the three countries given may be accounted for by the smaller products of the other countries.

RUBBER GROWING IN MEXICO.

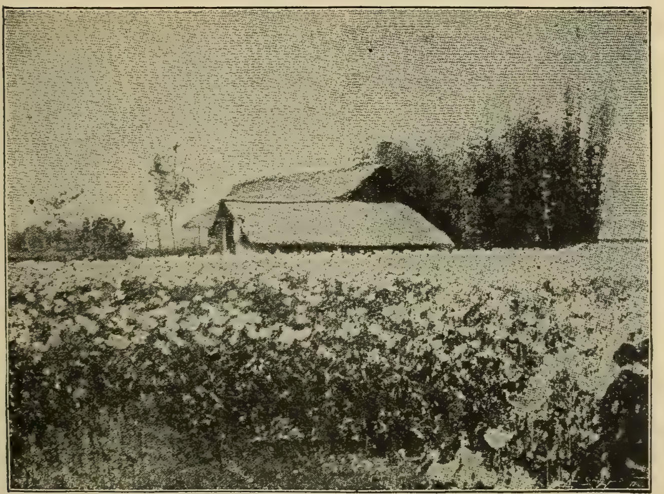
Previous to the advent of the automobile, and the application of rubber-tired wheels to vehicles generally, the world's supply of rubber was obtained from wild trees in the forests of Ceylon, Malaya, and South America. In the preparation of commercial rubber the sap is drawn from the trees and evaporated either in the sun, or by artificial heat, until a hard, gummy mass is left. This is pure rubber. The process as conducted by the natives is wasteful and the supply uncertain. Owing to the ever-increasing demand, and the necessity for a regular supply, rubber-producing trees are now being cultivated, and commercial rubber produced in a systematic, intelligent manner in Ceylon, Malaya, Brazil and Mexico. One feature of this cultivation is the planting and care of the Castilloa Elastica and Hevea Brasiliensis. The latter is native to the River Amazon basin in South America, while the former thrives in the rubber belt of tropical Mexico, Central America, and the far East. With systematic plantation methods improvements in the handling and preparation of the sap, or "milk," have been introduced and the output is being largely increased. New York merchants are buying from the rubber district of Mexico alone—which embraces the states of Tabasco and Chiapas—over 300,000 pounds of pure rubber every year. As little or no rubber is used in the pure state in which it is imported, being utilized merely as the basis of a compound, it will be seen that 300,000 pounds means a greatly larger amount of what is known as rubber when put into form for consumption.



THESE ARE NOT BIRDS—MERELY BUSHES TRAINED BY JAPANESE GARDENERS.

OPIUM AND ITS PRODUCTION

Opium has done much to soothe pain in its various medicinal uses, and has put into a dreamy stupor many a devotee of its insidious fumes. Its effect in international affairs, however, has been far from soothing. English, French and Chinese blood has been shed in battle, and the diplomats of those three countries have used all their skill in settling the questions which have been raised over it. In the politics of Eastern Asia the opium question has been of admitted importance because of its commercial value to the tax collecting powers. In French Indo-China it has long been contended that this drug is the chief cause of difficulties with the native races, and that the famous pirates on whom the French made war were simply honest merchants whose affairs were interfered with by the opium monopoly. It has always been charged against Great Britain that the war with China some forty years ago was incited only by the British desire to establish the opium trade which has become the curse of the Chinese empire, and peace was permitted only when the Chinese yielded to the admission of the opium against which they had struggled so long.



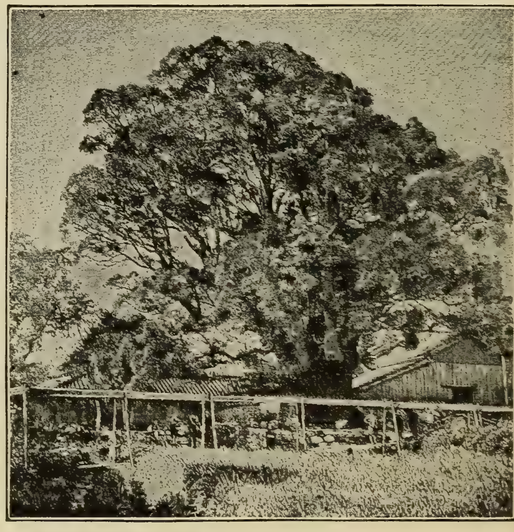
FIELD OF WHITE OPIUM POPPIES IN BLOOM.

Opium, as every one knows, comes from the poppy, of which many varieties flourish in our own flower gardens. The nature of the soil and the climate have great influence on the chemical qualities of the various plants, which are found in Persia, China, and more especially in India, where for a long time the English government has monopolized its culture as in France the government monopolizes the culture of tobacco. In all the immense and fertile valley of the Ganges, nothing is asked of the earth except the poppy. The districts of Patna and Benares are distinguished by the richness and abundance of their harvests. At the season's blossoming the air is saturated with a soft, enervating perfume, and nothing equals the monotony of an Indian landscape when the dried petals of the flower detach themselves and cover the soil. The product of this culture in the province of Bengal alone is estimated at 15,400,000 pounds which represents a value of $30,-000,000.

Opium is extracted from the matter which exudes from the green, unripened capsule of the poppy. This matter is gathered in little globular particles of amber color, by means of a special instrument. It is put into earthen pots, carefully covered, and transported to the laboratories of the English government, where it is massed into balls about the size of a Dutch cheese. These masses are covered by the petals of the plant, which have been reduced to powder in order to prevent their adhering to each other. After being dried methodically, the masses are packed and sent to Calcutta, the market which supplies all Asia.

From this raw opium is made the finished product which is used by smokers. The process is a very delicate one, and only the Chinese know how to get the very best results. The raw opium is brought from Calcutta to the place of manufacture, to the opium-boiling establishments. The ordinary place of this kind contains four large boilers and 160 small furnaces, with basins constructed of masonry, in the form of a long bench. First the balls of opium are cut in half, and from the inside the raw opium is taken with the fingers. That which remains attached to the envelope of petals is afterwards secured by placing it in the boiling water. These preparations completed, the opium is placed in the basins with water, where it is boiled for two hours and constantly stirred until it reaches the necessary consistency, which nothing but long practice can determine. The worker seats himself on the ground, his basin between his knees, and with the aid of a small instrument works and kneads the mass before him, over and over.

The mass is now spread over the inner surface of the basin, which is tilted so that the direct heat of the fire is radiated against it. Under this influence, the external surface of the opium loses part of its moisture, and then becomes softer. The basin is then taken from the fire, and the cold air operating on the surface of the mass hardens it suddenly, while the part below the surface retains its paste-like consistency. The worker seizes the hardened crust and detaches it from the rest of the mass. The basin is then exposed to the fire again and a second crust is detached and sometimes even the third one. These crusts are then broken and placed in the basins full of water. In about twenty-four hours all the solid parts of the opium are separated and the liquor is filtered and evaporated at the fire to a sufficient consistency. After being exposed to the air the extract is put into copper vessels where it is left long enough to undergo fermentation which removes from it the acrid principles and permits it to acquire all of its necessary properties.



A CAMPHOR TREE.

The opium now presents itself in the form of a cake, brown in color like molasses, and exhaling an aroma difficult to describe. The precious drug is put into small metallic boxes of various sizes and at last is ready for the market at a price ranging from twenty dollars a pound upward, according to quality, taxes and import duties in the countries where it is consumed.

Of course its high price and the restrictions placed about the production and sale of the drug, account for the widespread theft and smuggling of it, with which all countries have to contend. It has its distinct value in science, but except for the medical and surgical uses to which it is put, it would be better if this insidious decoction of the innocent poppy were blotted out of existence.

TOBACCO RAISING AND CIGAR MAKING

Of all the contributions which the western hemisphere has made to the world since the voyages of Columbus, probably no product has gained more universal use than tobacco. It is declared that there is no other luxury in the world for which so large a sum of money is annually paid and, indeed. it has been taken out of the list of luxuries and has become a necessity to many millions of people. It has therefore become in an industrial sense one of the most important products of agriculture and commerce.

An exploring party searching for strange things in Cuba, reported to Columbus on his first voyage, that they saw people who carried fire brands and perfumed themselves with herbs which they carried with them. On the second voyage the habit of snuff taking was observed. Tobacco chewing was noticed by the Spaniards on the South American coasts in 1502, and, as exploration advanced, it was found that tobacco smoking was common all over the new

CUTTING TOBACCO ON AN AMERICAN PLANTATION.

world, dating from time immemorial, and that it constituted an important factor in all tribal negotiations and religious ceremonies.

Francisco Fernandes, a Spanish physician, was sent by Philip II. in 1558 to ascertain the natural products of Mexico, and it was he who first took the plant to Europe. Jean Nicot, the French ambassador to Portugal, sent some tobacco to Catherine de Medici, and his name has been commemorated in the scientific name of the tobacco plant, Nicotiana. At first it was supposed to possess almost miraculous healing power. It went to Europe through Spain, but its use was introduced by the English. Ralph Lane is said to have been the first English smoker, and through the example and influence of Sir Walter Raleigh, the habit spread among the gentlemen of Queen Elizabeth's court.

There are many species of nicotiana, but those of which the leaves are used for smoking are few in number. These with but two exceptions, one a native of New Caledonia and the other of Australia, all are of American origin. The tobacco plant flourishes over wide areas, but is best suited for regions having a mean temperature of not less than forty degrees, where early autumn frosts do not occur, and where there is neither excessive moisture or drought. Tropical climates develop the finest qualities, where there is no excessive moisture. The tobacco plant absorbs its food from the soil very rapidly and leaves it in an exhausted condition. This makes liberal fertilization necessary and the character of the fertilizer exercises a wonderful influence over the quality of the tobacco.

There is a saying in our own southern states, that the cultivation and saving of a successful tobacco crop requires fourteen months every year. This is justified by the fact that actual work on the crop begins by January first, and continues with little intermission till March or even May of the following year. In addition to the actual cultivation, it involves a warfare on pests from the start.

About the first week in January the planter goes into the thick woods where there is a good southern exposure and picks out a place for the plant bed. Then the negroes set to work clearing the required space. After the square is thoroughly cleared it is covered with fertilizer and then the seed, which is like a quantity of ground black pepper, is sown over the ground and whipped in with a brush. Forty days' time is required for it to sprout. A little while after the seed is sown, the bed is covered with a flimsy cotton cloth to guard against the frequent changes of weather at that season and keep off the pests which would destroy young plants. Early in May the plants are large enough for transplanting into the field, which must be put in the very nicest order for their reception. The weather has much to do with success here, for it is only in a wet spell that sprouts will survive transplanting. The cultivation proper is not the most exacting part of the undertaking. The plowing or hoeing must be well, and even nicely done, but it extends over a period of only about six weeks.

When the plant is six weeks old it is topped to ten or twelve leaves, and almost immediately false leaves or "suckers" start at every joint, beginning at the bottom. As these detract from the proper growth of the leaf, it is necessary to go over the crop each week until cutting time, and pull off every new sucker that has been put out. As many as three successive sets of suckers will start at the base of every leaf.

The most picturesque feature of the whole season is the worms. Where does the worm come from? Who ever saw one in a country where tobacco was not raised? But let a man go to Alaska and get a good crop of tobacco under way and some morning when he goes out to look the prospect over he will be greeted by the tobacco worm. A great many of the worm's brethren, also, and their progenitors, the tobacco fly, will be there. He is a big worm, and if he were to make his appearance suddenly on the floor of a house in a region where tobacco is not known, he would have possession of the place very quickly. But his appearance does him injustice. He is not as dangerous as he looks, and his only bad habit is tobacco. If left alone he would ruin a crop in two weeks after his arrival. But the little negroes do not leave him alone. They take him familiarly between a thumb and forefinger, and end his career at once. Planters offer a bounty of so much a dozen for worms taken from their fields, and a much greater reward is paid for the capture of the tobacco fly from whose eggs the worms hatch. There is no very great number of tobacco flies. A very few, say a dozen or so, would plentifully supply a whole plantation with worms, and so the early destruction of the fly goes a long way toward abating the pest. To accomplish this an occasional "jimson weed" is allowed to grow in the field, and when these are in blossom a small amount of cobalt mixed with honey is placed in the flower. As the fly feeds on the blossom, a very small amount of the cobalt is fatal to him.

CUTTING TOBACCO IN CUBA.

In about ninety days after the planting, the tobacco is ready to cut. When ripe the green is dappled over with slightly yellow spots. For cutting, a strong knife is used. A large number of sticks about three feet long are then distributed over the field. One man holds the stick, while another cuts the plant, splits it near the base, and hangs it on the stick. Five to seven plants are placed on the stick, which then is laid on the ground to be taken up into the wagon following, and hauled to the barn.

The tobacco barn is a tightly constructed log building, about twenty feet square and almost as high. There are two furnaces inside, which are arranged to be fired from the outside of the building. There are sets of horizontal poles across the interior, from which the sticks of green tobacco are suspended. The barn holds about 800 sticks, probably the yield of a little less than an acre of ground. When it is full, the door is closed, and the fires are started, to be kept going night and day for four days. Beginning with a very low heat, it is increased to about 100 degrees by the end of the first twenty-four hours. Too sudden heat blackens the stems, and otherwise affects the color injuriously.

Beginning with the second day, the temperature is increased about a degree an hour, until 125 degrees is reached. It is held at this temperature for from eight to twelve hours, after which the thermometer is started up again, until 180 is touched, and the heat is held at that until the stem of the tobacco is thoroughly "killed." Then the fires are drawn, and a quantity of water is thrown in upon the ground, the vapor from which puts the now brittle leaf in condition to be handled without injury. Then the tobacco is taken out and stored away and the barn is ready to be filled again.

Firing or curing is a delicate and difficult task to do properly. It is necessary to replenish the fires and observe the thermometer every hour. Burning a barn and its contents on the third or fourth day is not infrequent. The heat becomes so intense that a spark sets it off with almost an explosion. Tobacco cured thus in closed barns is much lighter in color than that dried in the sunlight or in the open air. The lighter and evener the color, the higher the price it brings in the market.

After the curing is all done, comes a long-drawn-out task in which the men, women and children all participate—that of stripping the leaves from the stem and tying them into bunches or "hands." This task is not continuous, as often for two or three weeks at a time the leaf is too dry to handle. When the air is moisture laden it becomes as soft and pliable as a kid glove. As the stripping is done, the leaves are sorted by color into as many as seven different grades. When there are ten or a dozen leaves of one color and grade, they are secured by placing the stems together, wrapping an extra leaf tightly around them, and drawing the end between the other leaves. This is now called a "hand," and is the form in which tobacco is marketed.

It is now ready for "bulking" for fermentation. For this purpose it is piled or stacked upon the floor of the barn or dry house. Fermentation is quickly set up, and the temperature steadily rises to about 130 degrees. Care must be taken to prevent over-heating, and to secure uniform fermentation. This is accomplished by taking down and restacking, putting the top to the bottom, and the outside into the middle.

It requires from three to five weeks to complete this process, depending, of course, upon the quantity in the mass, and the atmospheric conditions. The leaves should now have a fine brown color, and can be left in the mass until the following summer heat sets up what is termed the May sweat, when it is necessary to give it careful attention again.

The net yield in money to the planter varies greatly. To insure success the closest attention is necessary at every stage of the work. A storm just before cutting-time sometimes damages the crop one-half. A bad job of curing, on the other hand, would take away nearly the other half. If the soil is very rich it is likely to add to the weight, but it more than counterbalances that gain by detracting from the quality. One Virginia or North Carolina "cropper" or renter, if he has a couple of boys and can depend on the rest of the household on demand, will undertake the cultivation of eight to ten acres. With fair luck he will make 500 pounds to the acre, which should bring him approximately $75 per acre.

BALED TOBACCO IN THE WAREHOUSE.

Tobacco is grown in a dozen states in this country, and is divided in a general way into "seed leaf," which is grown in the Connecticut River Valley and Ohio; "bright leaf," the characteristic product of Virginia and North and South Carolina; "white burley," peculiar to Kentucky, and "shipping leaf," which has a wide range of country to grow in. The processes everywhere are much as they have just been described.

The "hands" are pressed into hogsheads for shipment to the warehouse, by means of a simple screw press, set in a frame of heavy timbers. In each of the big tobacco markets, Louisville, Cincinnati, St. Louis, Richmond, Clarksville and Henderson, are great buildings with broad, open floors, the tobacco warehouses which are characteristic of the place. The hogsheads of tobacco are rolled in upon these floors, and the cask itself is removed, leaving the mass of tobacco still retaining the form of the hogshead into which it has been pressed. The inspector sticks an iron hook into the tobacco and removes a sample. Three samples are taken from each hogshead and are tied together, sealed, marked with the name of the owner, the weight, and the warehouse number of the hogshead. Then the bundle is laid on top of the cask. The auctioneer who sells the tobacco passes the bundle of samples around the crowd of buyers, and when each has examined it sells the hogshead to the highest bidder. The purchased tobacco then is sent to the warehouse of the buyer, to be made into cigars, cigarettes, plug or fine-cut chewing tobacco, or smoking tobacco.

A great improvement has been made in the processes of tobacco growing in Connecticut and Florida, by the introduction of cloth shelters over the entire growing crop. Posts are set all over the field to be planted, and over these stringers and galvanized wires are stretched. Then a great canopy of cloth is spread over the field, the whole preparation costing about $250 an acre. In these tented tobacco fields the plants are immune from insect pests, from the changes of climate, from the effects of the direct sun, and from many other difficulties which the planter ordinarily has to face. The coverings are strong enough to stand any ordinary wind, and the plants are not lashed and torn by the storms. Within the tents a continuously tropical climate exists. The leaves grow more luxuriantly, and the plants increase to great size. The tobacco with which these experiments have been made is the Sumatra product, for which this country has been sending annually the sum of $6,000,000 to the Dutch East Indies. The Sumatra wrapper is considered essential for cigarmaking, and the great profit produced by this successful experiment promises to keep this money at home instead of spending it for the imported product.

Hundreds of millions of cigars and cigarettes are burned each year, and the making of them supports an immense army of workmen, who supply the tools, boxes and labels and who roll the fragrant cylinders. The cigarmaking business is one of the few which holds at bay the labor-saving machine. Numerous efforts have been made by sanguine inventors, who saw fortunes in a practical machine, but the hands and fingers of the cigarmakers, aided by the simplest of tools, continue to roll and shape the tobacco leaf into the finished product ready for the smoker. Few trades require less in the way of tools than the cigarmaking industry. Give the skilled workman a hard maple board on which to roll his cigars, a knife, some paste and tobacco leaf and he is well-equipped. But, like most trades where the fingers are the principal tools, the cigarmaking business must be learned from the very beginning. From three to five years are required to make a skilled workman out of a boy, and sometimes men cannot learn the business at all.

Cigar manufacturing may be divided into two general divisions, hand and mold-making. There is considerable difference in a technical way between Spanish and American methods, but the difference comes in minor details, which would not be noticed by the casual visitor to a cigar factory. The fact is, nearly all ordinary cigars are made alike, whether the cigar box has a New York brand, a Key West label, or a Havana mark. The better class of cigars are the hand made, and most of the cheap grades are mold made. In either case the beginning is the same.

The tobacco leaf is moistened, stripped, separated into its grades, and "booked." This work is done by boys who are learning their trade, or by girls. The strippers tear the leaf from the thick middle stem, and if the leaf is to be used for wrappers or binders, they place the spread-out leaves, one over the other, into a book. Before the leaves are stripped they are moistened by being dipped in water, and laid away over night between damp cloths in a box. In spreading the leaves out for examination and stripping, some skill is required, for the stripper must know by the feel of the leaf just how much stretching and smoothing it will stand before tearing. This is a trick of the trade which can be learned only by experience. The stripper does more than this, however, for she separates the leaf into the various grades, and boys are set to work stripping, because they thus not only learn how to handle the leaf, but learn the fine distinctions between "wrappers," "binders" and "fillers."

The filler is the core or the body of the cigar; the binder is the leaf which is wrapped around the filler, and the wrapper is the outside of the cigar. The best-looking, largest and smoothest leaves are used for wrappers. The stock which does not quite fill all the requirements for a wrapper is used for binders, and the filler is stock which does not come up to the binder standard. This difference is not so much a difference of quality as of appearance, for the same bunch of tobacco leaf which is taken from a bale will be divided into three classes.

The cigarmaker works seated before a table on which is his "board," blade and tobacco leaf. A cloth pocket extends the length of the table, with its open top just above the workmen's knees. The scraps and bits of leaf cut off by the workman are thrown into this pocket, and the three grades of leaf are spread on the table in little heaps, each grade separate. The board on which the cigarmaker trims the leaf and rolls the cigar is made of blocks of hard maple, glued and dovetailed together to make a solid block about a foot square. The wood is cut across the grain, so that the surface of the board is made up of the cross sections of the smaller blocks of maple. The binder-stock is moist enough to bear the working and handling without crumbling. The binder-stock is more moist than the filler, and the broad leaves to be used for wrappers are so moist that the leaf feels silky to the touch and is elastic.

UNPACKING TOBACCO FROM THE BALES IN A CIGAR FACTORY.

The workman makes a bundle of tobacco leaf for the filler, arranging the bits so that the tips of the leaves are toward the butt of the cigar, or that end which is lighted. He lays the tobacco in the hollowed palm of his hand, so that the bits lie parallel, and packs them together so that the bunch is solid but not tight. This bunch he lays in the center of the trimmed leaf he has selected for the binder, and with a dexterous combination of twist and roll he wraps the binder around the filler and then puts the wrapper on. The tool he uses for trimming the leaves to shape is called a blade. It has no handle, and resembles the blade of a meat-chopper used in a kitchen when the cook makes hash for breakfast. The edge of the blade is curved, and the cutting is done by rocking the blade over the leaf on the board. Knives with handles are used for the same purpose. The blade is also used to roll the cigar when the wrapper is put on, and the rolling not only gives the cigar a more cylindrical shape, but puts a sort of polish on it.

In cutting the wrapper the cigarmaker endeavors to leave out the thick veins. The wrapper is cut or trimmed twice, once to give a narrow strip, and the second time for the "head." The head is not cut out until the wrapper is on the body of the cigar and the workman is ready to twist the point. Then he cuts the wrapper in such a way that it will twist up to the point, but before the point or head is made, he puts on some gum to hold the point in place. The cigar is then cut to the right length, rolled, and laid to one side finished. The process just described is generally called the "German hand-made" process. It is the one commonly used in the smaller shops in Chicago.

Mold-made cigars call into use wooden molds which press the "bunches" to shape, ready for the wrappers. The molds are made of two pieces of wood in which cigar-shaped recesses are cut. Less care is used in bunching the filler and wrapping on the binder, for the mold gives the shape. The partly made cigars are placed in the molds and squeezed for an hour or so in a press. Then they are turned half way round in the molds and pressed again, and when taken out are "rolled" and cut to length. Two hundred and fifty cigars are a good day's output for one workman on hand-made goods, but 500 cigars have been made in one day by one cigarmaker working with molds.

Spanish handmade cigars are made without binders, for the workman spreads out each leaf of the filler in the palm of his hand and twists them to shape and puts on the wrapper almost in one motion.

After the cigars have been laid neatly in rows in the cigar box the lid is closed over them and the box is put in a little screw press, which jams the cigars down snug enough to permit the lid to touch the wood, for the cigars more than fill the box. Then a number of boxes are placed in a larger press, a board is laid over the top row, the screw is turned down upon the board, and all of the boxes are kept in the press over night. Then the lids are tacked down and otherwise fastened, and the cigars are ready for the "trade."

HOW TRUNKS ARE MADE

Travelers need more than trains and steamships to make their journeys pleasurable. They must have their baggage with them, and thanks to the assaults made upon it in transit by their eternal enemy, the baggage master, they must see to it that trunks and valises are strong enough to stand the shocks to which they are submitted. It has been suggested that the men who make trunks and the "baggage smashers" who apparently attempt their destruction, represent two great industries in a state of mutual antagonism like that which exists between the makers of armor plate, the builders of hundred-ton guns, and the inventors of high explosives.

The trunk-maker selects for the body or box of his trunk, sheets of thoroughly seasoned basswood. This may be used solid, or in veneers glued with the grain of alternate sheets at right angles. For the best trunks the veneers are used, and are glued together so strongly that it is almost impossible to separate them. The nails used in fastening the box together at the joints and angles are of steel wire, coated with gum to increase the holding power.

After the box is completed it next receives a covering of strong canvas or duck, pressed upon hot glue with a heavy roller. This adds strength to the wood, and keeps it from splitting, besides giving an elastic surface for additional durability. After the glue has dried, the canvas is painted whatever color desired.

The next process is to put on the hardware, the defensive armor which contributes additional strength at corners, edges and joints, where reinforcement is necessary. Strips of tough steel and angle-iron are used for this, and the nails of Swedish iron are all clinched. Next hickory strips are nailed on to the body the long way of the trunk, not merely to strengthen the box, but to act as skids upon which it may slide with its heavy load when dragged over a truck by the baggage man. The successive corner clamps, handles, hinges and the other fittings are heavily riveted, and the lid is put on with the utmost care. This calls for the most expert workmen, for the lid must be opened and closed easily, and yet when closed and bolted must be as strong as the solid body.

The lid is not fastened to the trunk until after the trunk lining and lid lining have been put on. Various fabrics are used for linings, such as linen, grass-cloth, duck, cambric, flannel and velvet. After the lining is completed, the lid joined to the trunk, and the lock set in place, the outside of the trunk is varnished and it is ready to receive its trays. The trays are made of basswood, thin and light, but bound with fine steel clamps which are hidden under the lining. They are constructed with great care, for they, too, must withstand twists, strains and hard usage. When the trays are in place the trunk is ready to travel.

Probably the strongest trunk made is the raw-hide trunk. This is produced at con-

INTERIOR OF A TRUNK FACTORY.

siderable expense and by not many manufacturers, the name being a synonym for the highest grade. The first raw-hide trunks made in the west were built out of buffalo hide for a Chicago wholesale house twenty-five years ago, and those identical trunks are still on the road, packed with dry goods samples.

Trunks are made out of basswood, tin, sheet iron, sole leather, canvas, split leather, willow, rattan, paper and pine. The commercial traveler is the trunk-maker's best customer. These traveling representatives of wholesale houses use trunks to carry all sorts of things. A trunk was made recently to carry an iron safe for a sample. A musical instrument house in Chicago orders trunks large enough to hold a complete organ, and traveling men for a stove house carry full sized samples of their goods in trunks. The large trunks for bicycle salesmen have become an important part of the product. Theatrical companies likewise are among the best customers of the trade.

Valises and traveling bags of various sorts, of which the dress suit case is the most recent and popular form, are likewise made in great number at the trunk factories. The finest leathers are used and in the more expensive grades such traveling bags are fitted with silver and cut glass toilet utensils and all the equipments of a lady's boudoir.

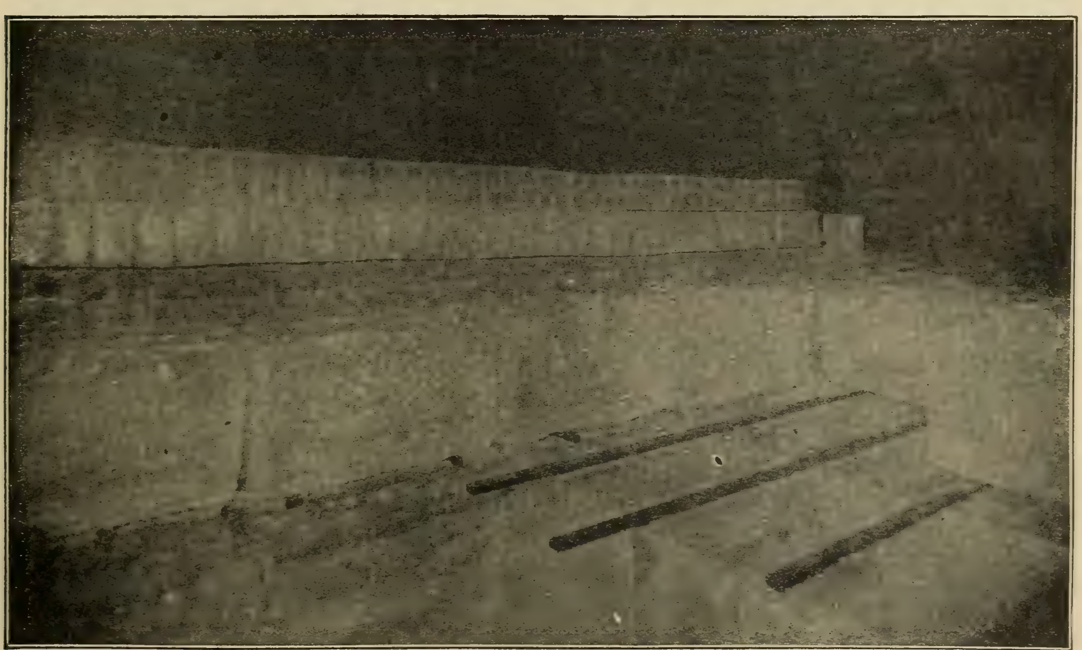
For making high grade trunks and valises, high grade labor must be employed. It is declared that expert workmen in such occupations are paid the highest wages earned by any mechanic or bench laborer in any manufacturing line in the United States.

MAKING VALISES AND TRAVELING BAGS IN A TRUNK FACTORY.

ICE

Artificial and Natural

There is no article more intimately associated with our genuine comfort in the hot, trying weather of midsummer, than ice, which is now so universally distributed as to be recognized as no longer a luxury but a necessity. Ice is an essential factor for health and comfort, particularly in the cities, where people live crowded together, and the refreshing conditions of rural life are not at hand. The result of this wide use of the transparent blocks of frozen water is that for its preparation and distribution an immense industry has grown up, so important as to have its influence upon municipal politics and state legislation, and so profitable as to make fortunes for those who are engaged in it. In our northern states, nature by her own processes will make ice in the winter, enough to serve for the summer, if it is properly preserved, but in the southern states of our own country, and in the tropics, nature's gifts do not take this form, and man must provide cold things for himself. So it is that inventors have devised simple machines which by chemical and mechanical processes produce ice at little cost, whether it be on the equator or not. So excellent is the ice thus frozen that great ice-manufacturing companies have been established in the northern cities as well, competing in price and quality with those companies which distribute nature's own product.



ARTIFICIAL ICE IN STORAGE.

It is an old scientific trick to freeze water in the fire, by wrapping a small bottle with a rag soaked in ether or chloroform. The heat of the fire evaporates the volatile ether so quickly that the ether sucks the heat out of the water and freezes it. This is practically what the icemaker does, only he uses ammonia or sulphurous oxide, instead of ether or chloroform, and works on a big scale with large pumps, steam engines, and miles of iron pipe.

At ordinary temperatures ammonia is a vapor or gas. The ammonia which is bought at a drug store is really ammonia water, for it is a water in which ammonia gas has been dissolved or absorbed. The icemaker uses ammonia gas, sulphurous oxide—which is the choking, suffocating fumes given out when sulphur is burned—or ammonia water, according to the system he employs. Anhydrous ammonia is ammonia without water in it, and the icemaker who uses ammonia, buys anhydrous ammonia.

The whole story of artificial icemaking can be told in a paragraph, for it is simply permitting pure liquid ammonia to evaporate or expand inside of iron pipes which are coiled in tanks filled with salt brine, which gives up the heat required by the ammonia in evaporating, and thus lowers its temperature below the freezing point. The fresh water is in smaller cans which are surrounded by the brine, and is frozen, for the brine does not freeze even at zero.

But to do all this, expensive, heavy and special machinery must be employed, and the combination of steam-boilers, pumps, condensers, tanks, pipes and other machinery gives a complicated appearance to an artificial ice plant which is confusing.

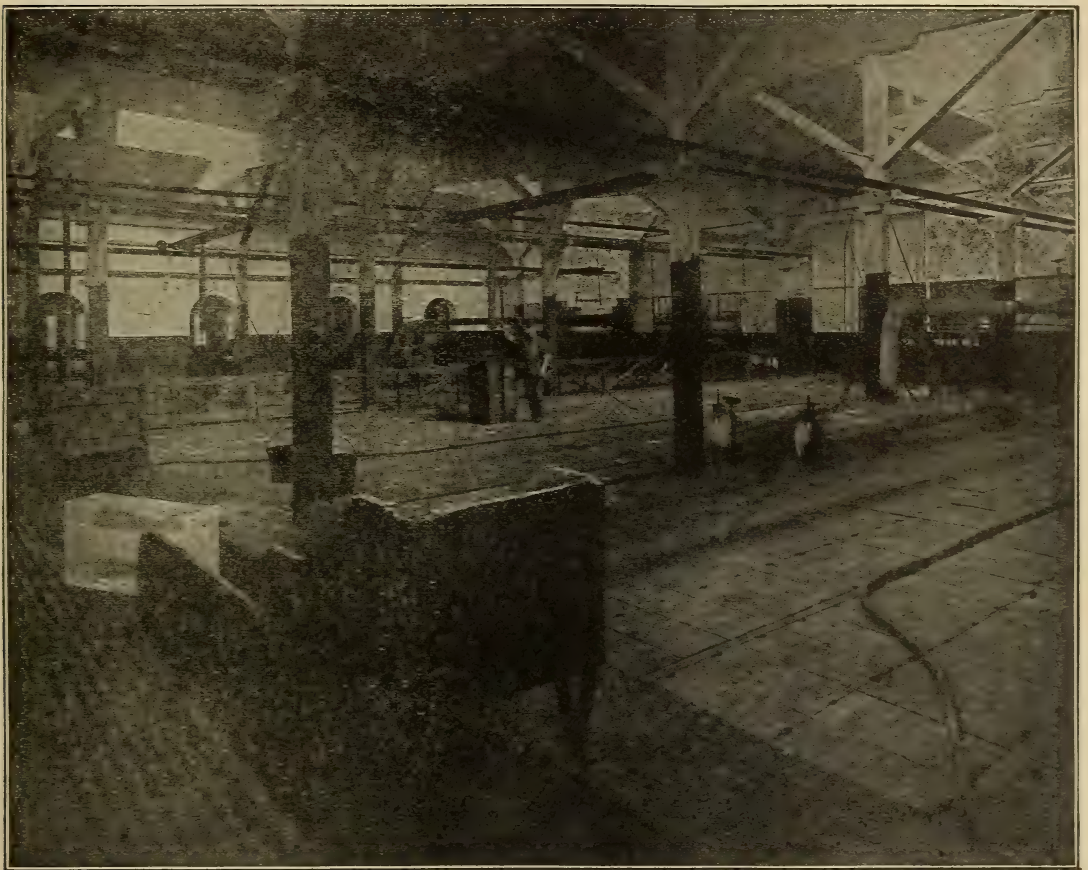
The great pump is the principal piece of machinery in the ice-making establishment. It performs a double office, for with one stroke of the piston it sucks in the anhydrous ammonia gas, and with the next compresses the gas to a liquid, for the anhydrous ammonia is used over and over again, first as a liquid, then as a gas, freezing water, and back as a liquid again. The ammonia gas is liquefied not only by pressure but also by cold. In an ice-making plant both are used. The pump forces the gas into the condenser, which is a series of coils of small pipe over which water is constantly flowing. The gas, pressed into the smaller pipe, turns to liquid ammonia. As it condenses, the liquid ammonia flows into a storage tank through small pipes leading from the condenser. All this time it is under pressure which forces it along, so that the liquid ammonia flows from the storage tank, which is placed in a horizontal position, into two large vertical cylinders, and from there into the expansion coils, which lie in the bottom of the expansion tanks. The pipes of the expansion coils are much larger than the pipes which make up the condenser, and the liquid ammonia expands and evaporates as it moves along, keeping the salt water or brine in the freezing tanks at a temperature of 18 degrees or colder.

All this time the big pump is pushing the liquid ammonia along, and sucking the ammonia gas back again, so that the ammonia, whether gas or liquid, is moving around, condensing, expanding, freezing, condensing again, expanding again, freezing again, and so on.

In making artificial ice the manufacturer wants pure water. To be certain that the water is free from sediment, typhoid germs and other impurities he filters and distills the water before it is frozen. In some ice works the water is filtered once before it is distilled and twice afterward.

The freezing tanks are made of iron. They usually are set below the floor, for the purpose of facilitating the handling of the ice. The tanks are about 50 feet long, 20 feet wide and 4 feet deep. The cans in which the distilled water is frozen are 44 inches by 22 inches by 11 inches in size. The pipes which contain the anhydrous ammonia go back and forth across the tank between the cans, and the salt water brine is kept in motion by an agitator somewhat like a screw propeller. This gives the brine an even temperature. It requires from forty-eight to sixty hours to freeze the water in one of the cans.

The cans are covered while the water is freezing, so that the whole process of freezing is really going on under the floor, for the covers are the plates of the floor. Over the freezing tank is a traveling crane, with a block and tackle for hoisting the cans with the frozen blocks out of the tank. The cans are lifted so that when they are clear of



FREEZING TANK ROOM IN AN ICE FACTORY.
The tanks are shown in the floor, each with rings by which they are lifted.

the tank they tilt upside down. They are then carried by the traveling crane to the head of a gangway which runs into the icehouse. Here streams of tepid water are directed upon the can. In a few moments the ice holding the cake to the can melts, and the block of artificial ice slides out of the can and down the gangway. The can is then taken back, filled with water, and dropped into the tank again.

Where shafts or tunnels go through quicksands artificial refrigeration is sometimes used to freeze the treacherous material. The anhydrous ammonia plant is on the surface or at the mouth of the tunnel, and from it brine chilled to zero is sent through pipes to the place of working. Pipes are driven ahead of the work into the quicksand, and the circulating brine freezes the loose ground into a hard cylinder. The work is then carried on through this frozen material, which shuts out the quicksand until the brick is laid in.

Fortunately nearly every city and town has some lake or river near by where ice can be cut in winter. The lakes of Michigan, Wisconsin and Minnesota, filled with pure water as they are, furnish a large quantity of the ice used in Detroit, Chicago, Milwaukee, Minneapolis, St. Paul and the other smaller cities within their territory. During the winter season busy scenes may be observed at these lakes, which are the favored resorts of multitudes of summer visitors in vacation time. Their frozen surface is alive with men and teams cutting the ice, rafting it to shore, and turning it over to the sleds that haul it to the railway for shipment to the ice houses.

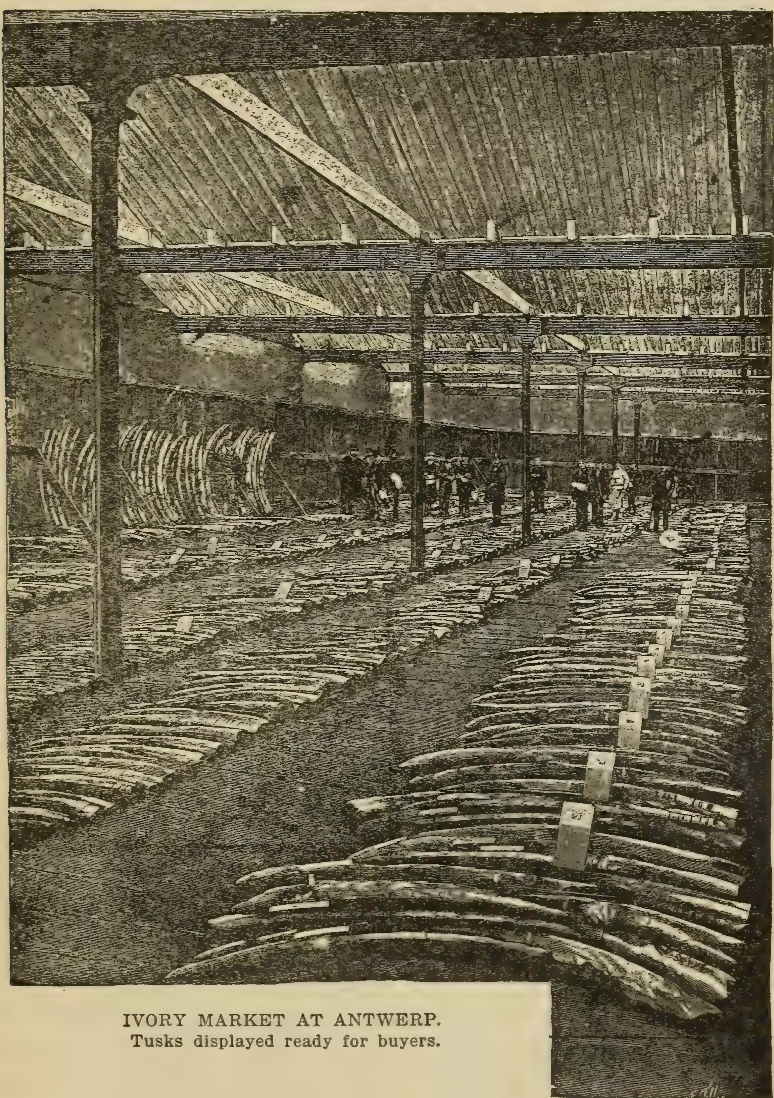
There was a time when people were more careless about the health conditions of the food and its surroundings than they are now, but it has come to be so clearly recognized that many of our bodily ills come from carelessness in the sanitation of our houses and in the freshness of our food, that people now scrutinize these details with great care. Ice made from impure water is no longer acceptable for our refrigerators or our drinking water. Laws have been passed protecting the public in this matter, and their rigid enforcement has assisted materially in reducing typhoid and kindred diseases.

IVORY, HOW OBTAINED AND USED

Every ivory billiard ball in use in the world is said to have cost the life of a human being. And still the demand for ivory, not only for the manufacture of these simple spheres for a popular game, but for a multitude of other uses in decorative and toilet articles, continues, with the price so high that the trade still goes on in spite of its disastrous cost in human life.

Most of the heavy expense has been paid in the jungles of central Africa, where a man does not count for half as much as a humped ox or a trained ape. For nature has built an effectual barrier about her cultivators of billiard balls—the elephants—and he who would penetrate it must take his life in his hands.

In the first place she has provided an atmosphere of great heat, reeking half the year with moisture, in which lurk the germs of a hundred unnamed diseases, and rent for two seasons with sudden storms accompanied by heavy rains. Then there is the barrier of a rank and tangled vegetation, through which no roads but those of the jungle-folk have yet pierced. The huge trees conceal fierce wild animals, poisonous snakes, and insects whose stings mean death at the end of the days of suffering. Impassable morasses, lakes, broad rivers and mountain ranges are also numerous,



IVORY MARKET AT ANTWERP.
Tusks displayed ready for buyers.

and yet more dangerous are the jealous savages, who have learned enough of civilization to distrust it, and who know that a man never protests against robbery after he is dead.

So the elephant is given a chance to grow a little before the harvesters of the ivory crop can reach him. When he has trumpeted for a few score of years, and his tusks have made him a power in the herd, some native hunter spies him as he thrashes through the jungle or wades in a morass. Then a great number of the bravest warriors gather and build a huge inclosure of vines, into which the elephant one day walks. From the surrounding trees come a shower of arrows, and perhaps a bullet or two from an ancient gun obtained at a hundred times its value from some wandering trader. The elephant charges about trumpeting, but on every side the barrier holds him in. At last he falls, overcome by numbers. Then his great tusks are packed away, and a row of naked natives carry them for days through the jungle, until they are placed in the king's treasury as a part of the wealth as well as the currency of a nation.

After a time traders from England and from other countries appear, and the tusks are bartered for bright nothings, old-fashioned and shop-worn fabrics, food, whisky and firearms. There is another long period of transporting the precious ivory on the backs of natives, with the constant danger of attack from hostile tribes and the treachery of friendly ones. At last it is aboard ship, and after weeks on the sea it arrives at the great ports where it is sold to carvers and manufacturers.

The best ivory comes from Africa. Some of the tusks are from eight to ten feet long, and often weigh 170 pounds. The Indian elephants' tusks are much shorter and of less weight, and the great demand has reduced the supply to such an extent that it is now rare to find a large tusk. Indian ivory is not so good in quality as that from Africa. Much of the ivory used in Russia and other parts of Europe is found in northern Russia and Siberia, in the remains of prehistoric mammoths. Where the skeletons have been always frozen in the earth, the ivory is as good as the ordinary Indian product, but much of it has been injured by exposure to the weather. Tusks have been found which were more than 12 feet long and weighed upwards of 200 pounds.

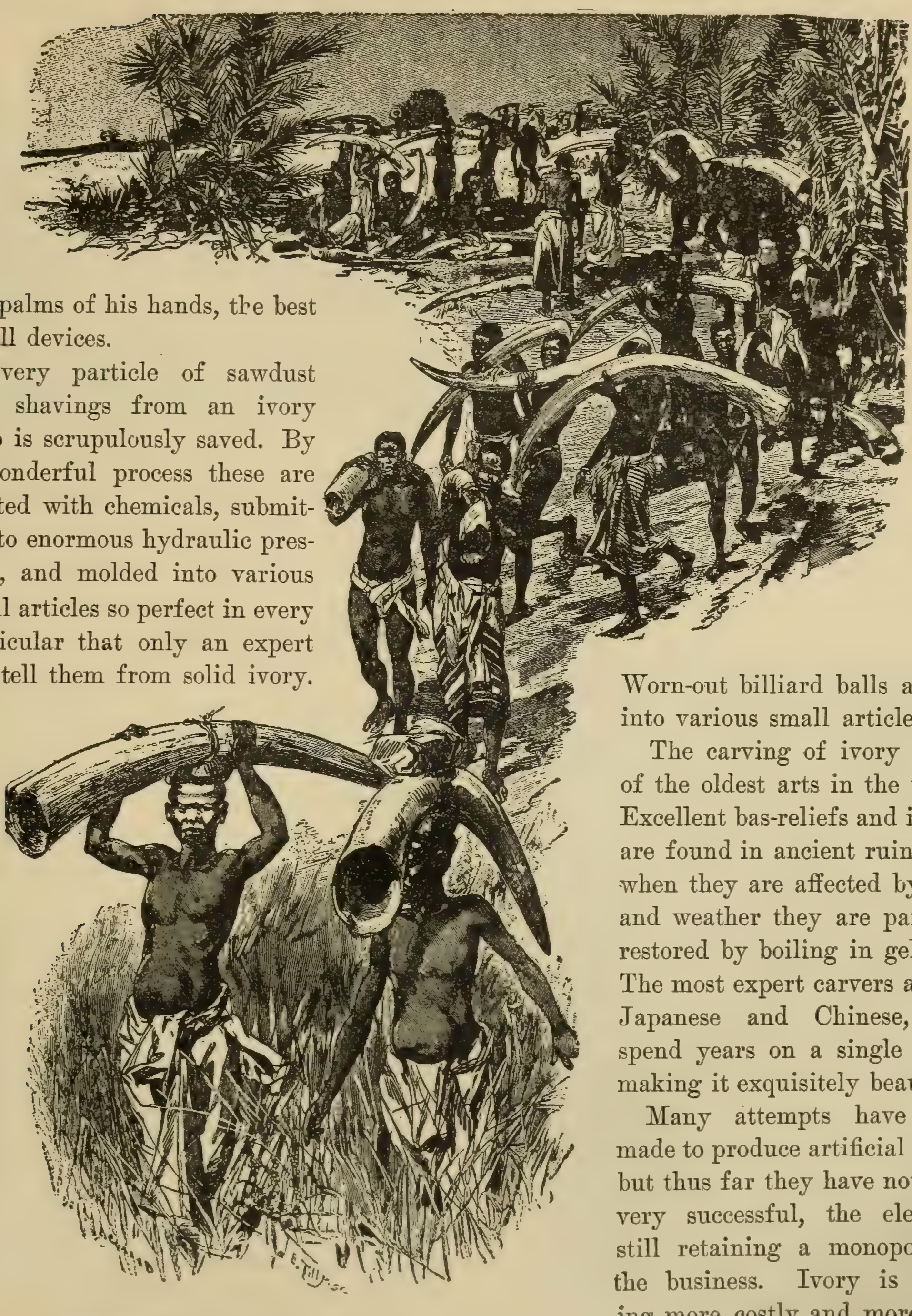
The value of ivory rests mainly in its toughness, its elasticity, and its quality of taking a high polish. It is filled with millions of minute holes which give it an elasticity which no solid object could ever have. In effect ivory is the same substance as the dentine of the teeth, and it is unlike bone in having no channel for the passage of blood. The teeth or tusks of the narwhal, sperm whale, walrus, and hippopotamus are also used as ivory, but the quality is usually poor.

Great skill is required in buying tusks, for the external appearance is most often deceptive. The inside may be full of abscesses and cracks, and sometimes the core is filled with pieces of stone and chunks of iron by the tricky natives and no less tricky dealers.

When at last the tusk reaches the manufacturer of billiard balls it is again examined very carefully for flaws, and even if the smallest crack is perceptible the ivory is used for some other purpose. If the tusk is found to be perfect and of about the right size—a little larger in diameter than the ball is to be—it is sent out to the workroom. Here workmen measure the tusk into the proper distances to be cut into blocks. It is then sawed into lengths of two and a half to three inches, according to the size of balls to be made, and the turners take the blocks in hand. In order to save the corners of the blocks the turner cuts a ring at each end and slowly deepens it until a rough ring drops off. This is subsequently finished into a martingale ring like those used on expensive harness. Two rings come from each billiard ball block. The remaining ivory is now almost round, and after a few more shavings are taken off it is laid aside to dry for about six months, for "green" ivory is rather soft, and there is always a likelihood of some shrinkage.

When it has been seasoned it goes to the workman again, and with still more delicate chisels he pares it down smooth and exactly round, a task requiring much skill and care. Then the ball is roughly polished by means of an ingenious little machine, after which it is treated to a rubbing with chalk and chamois skin, and finally with plain, soft leather. It is now bright, shiny, and to one who doesn't know about such things, perfectly smooth. But a workman spends much time rubbing it with the palms of his hands, the best of all devices.

Every particle of sawdust and shavings from an ivory shop is scrupulously saved. By a wonderful process these are treated with chemicals, submitted to enormous hydraulic pressure, and molded into various small articles so perfect in every particular that only an expert can tell them from solid ivory. Worn-out billiard balls are cut into various small articles.



BRINGING IVORY FROM THE AFRICAN JUNGLES TO THE COAST FOR SHIPMENT.

The carving of ivory is one of the oldest arts in the world. Excellent bas-reliefs and images are found in ancient ruins, and when they are affected by time and weather they are partially restored by boiling in gelatine. The most expert carvers are the Japanese and Chinese, who spend years on a single piece, making it exquisitely beautiful.

Many attempts have been made to produce artificial ivory, but thus far they have not been very successful, the elephant still retaining a monopoly of the business. Ivory is growing more costly and more rare from year to year, and it is only a question of time when the sources of supply will fail.

Until a few years ago London and Liverpool were the two great ivory markets of the world, but they have been outstripped of late by Antwerp. This is on account of the development of the trade in the Congo Free State, which is a colony of Belgium. The Antwerp market was opened less than ten years ago. The stock offered there for sale is remarkable not only for the great number of tusks, but also for the enormous size of some of them. Among those sold lately was a pair weighing nearly 350 pounds. A few days before the opening of the market the tusks, all laid out and numbered in lots, are placed on public exhibition in some great hall, as represented in the accompanying illustration, and the buyers come here to select what they want and bid for them.

The world's consumption of ivory is very large. The annual average quantity used is about 1,500,000 pounds. Taking into consideration the fact that in the wholesale markets such as Antwerp and London ivory costs on an average $1.75 a pound, an idea may be had of its importance in commerce.

Unfortunately the future of this trade, which has caused streams of blood, is seriously threatened. The constant war waged upon the elephant on account of his ivory is bringing him nearer and nearer to extinction. The Congo Free State has occupied itself earnestly with this question, and has officially established a closed season and limited conditions, during which elephant-hunting is absolutely forbidden. It is also proposed to establish elephant farms in the Congo State, as has been done by the English with ostriches in South Africa.

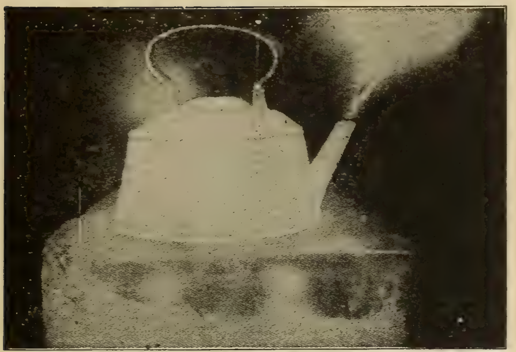
OSTRICH FARMS IN AFRICA AND CALIFORNIA

When the demands of fashion for plumes and the careless slaughter of the great birds began to threaten the extermination of the ostrich, clever business men in South Africa decided to domesticate the valuable producers of the big feathers, and raise them more carefully, for profit. So it was that a new industry was created. Eggs were obtained and hatched, the young birds carefully reared, and though the first experiments were carried on at a loss, it was not long before the milliners of the whole world were drawing their supply of plumes from the ostrich farms of Cape Colony and Natal. The trade now has reached such proportions that in a single year ostrich feathers to the value of more than $3,000,000 have been exported from South Africa. An illustration on page 420 in this volume shows a characteristic group of ostriches on one of these queer ranches near Cape Town.

When Americans saw the profit in ostrich farms, they promptly looked about to find a region in this country where the same industry could be established. In Southern California, Arizona and New Mexico they found favorable conditions, and now there are a score of large and profitable enterprises of the kind in operation in the southwest. The first birds and eggs were brought from South Africa, of course, but now they are bred here with entire success.

These ostrich farms produce a large part of the plumes used in this country. The feathers are plucked from the big birds once a year, the plumes bringing about $20 a pound. These peculiar ranches are places of great interest for traveling strangers.

LIQUID AIR—ITS WONDERFUL POWER



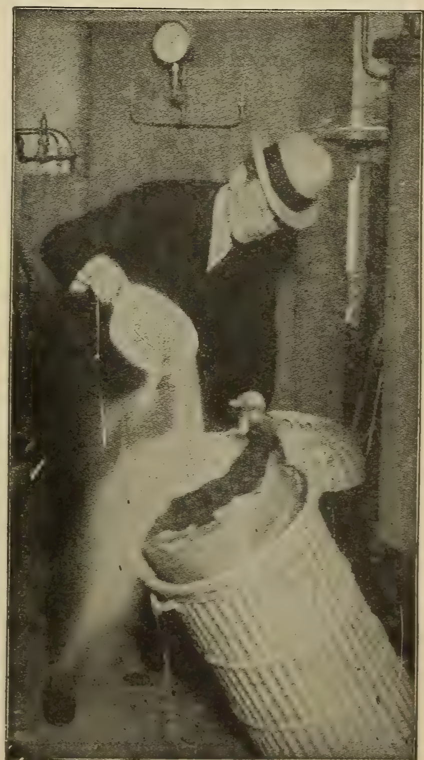
LIQUID AIR BOILING ON A BLOCK OF ICE.

To Charles E. Tripler, a scientist of New York City, belongs the credit for having made liquid air familiar to the scientific world, cheapened its production, and applied it to practical commercial purposes.

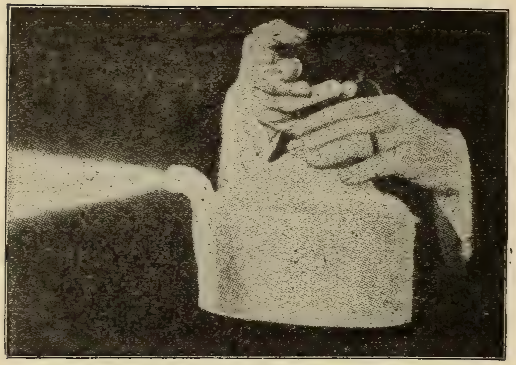
It seems almost a contradiction in terms at first thought, and yet scientists have been able to liquefy not only air but many other gases, while they can also turn solids into liquid, and the resulting liquid into gases. It is all a matter of temperature and pressure.

Tripler, however, was not the pioneer in experiments. Scientists had long observed that to compress a gas into a reduced volume, raised its temperature greatly. The heat thus resulting was to be generated by the pressure applied, but experiments soon proved it was not caused by the actual increase of the heat of the whole body, but rather by the concentration of the heat of the entire mass into the smaller space.

Later experiments showed that if this gas under pressure was cooled, and then allowed to expand to its former volume, it would fall greatly in temperature, and in practice a drop of 200 degrees was obtained. In 1877, the first real headway was made by scientists in their efforts to liquefy air. The first real success in these experiments was made by Raoul Pictet, who submitted oxygen gas to a great pressure, combined with intense cold, and produced a few drops of the clear liquid that soon evaporated into the air after a few moments of violent bubbling. In 1892, there was a like success with nitrogen, the other constituent of air. About the same time Prof. Dewar, of England, performed the same experiments, and then succeeded in producing a small quantity of liquid air, or rather a sort of slush of air, water and ice. His



PACKING LIQUID AIR FOR SHIPMENT.

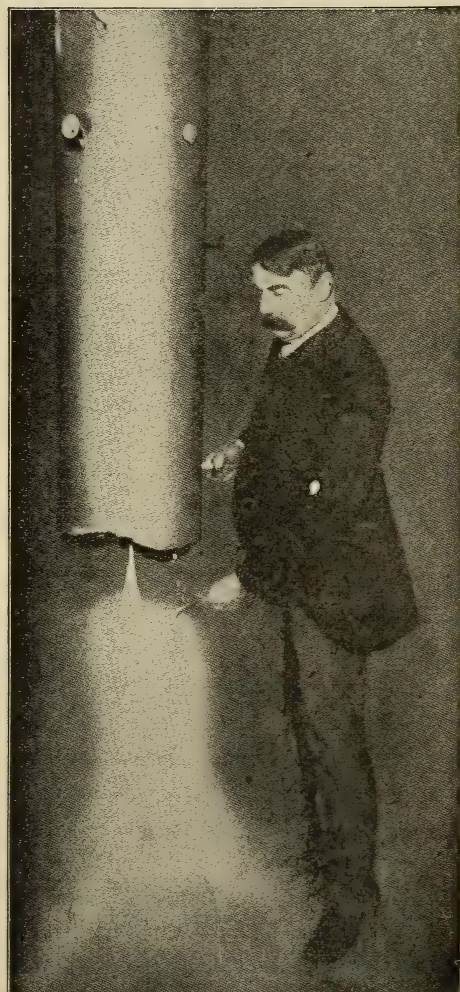


LIQUID AIR BOILING BY HEAT OF THE ATMOSPHERE.

experiments aroused the utmost interest among scientists, but the cost of the apparatus and processes, which amounted to $3,000 for this first ounce of liquid air, limited it to laboratory experimentation.

It was Prof. Tripler who discovered the means by which this wonderful product could be made with ease, at a cost of not more than 20 cents a gallon. Tripler's process comes as near being a practical form of the chimerical perpetual motion as can be conceived, as he utilized power generated by the liquid air itself to produce more liquid air, and as the production from a given quantity is in each instance a larger quantity, there is a constant increase of the power at command.

The apparatus for the manufacture of liquid air, in addition to the power plant, is an air compressor, and a barrel-shaped tank about 15 feet high, penetrated by a multitude of small pipes and valves, protected by felt and canvas to keep out the heat. This contrivance is so arranged that the expanding air, which constantly grows cooler, passes about the pipes containing the working material. Air is placed under a pressure of 2,500 pounds to the square inch, and cooled to about 50 degrees by being passed in pipes through running water. From there it is conveyed to the receiver through two different sets of pipe, one containing the air to be liquefied, and the other the air that does the work of liquefying, both under the same heavy pressure. By opening a tap in the receiver, the air from the latter pipe rushes up and around all the pipes in the barrel-like space, expanding, reducing the pressure, taking up the heat wherever any can be found,



DRAWING LIQUID AIR FROM THE LIQUEFIER.

growing warmer, and gradually rising to the top of the space.

While this process is in operation the air in the pipes has been gradually returning to the compresser, where it is again brought under pressure and cooled, only to be released once more in the receiver, there to absorb more heat from the confined air in the pipes. So rapid is this process that the temperature of the air goes down 100 degrees every time it is thus chilled, and it takes only fifteen minutes to produce the desired result. At the expiration of the fifteen minutes the faucet at the bottom may be opened, and the liquid air, at a temperature of 312 degrees below zero, begins to flow from the pipes.

Liquid air is of such an expanding nature that if confined it would explode. In order to preserve the product thus yielded, various devices have been prepared. One of the vessels used for carrying liquid air is a bulb of glass, which is surrounded by an outer vessel, of the same material, the two having a vacuum between them and joined by a common neck at the top. The vacuum thus produced delays the passage of heat, so that the evaporation of the liquid in the inner tube is reduced to a minimum. In a shipment of nine hours, air packed in the above manner, loses less than one-third of its bulk.

Liquid air is eleven and one-half times as powerful as compressed air, and yet it may be carried in a pasteboard box, while the heaviest steel tanks would be required to control as much energy in compressed air. In the meantime Prof. Tripler goes on experimenting with this wonderful air. Inventors of airships are seeking something that combines great power with lightness; submarine navigators want an economical motive power and air for the crews to breathe; deep-sea divers hope that some service may be rendered to their perilous profession by the use of casks of the liquid suited to their apparatus, and automobiles have been adapted to this power. By the use of liquid air, a rose may be frozen in its full form, or an egg may be made so solid that when broken, it will scatter like a powder. The surface of a frozen potato is as hard as stone and beautiful as ivory. Frozen butter may be pounded in a mortar until it is as fine as flour, and raw beefsteak will become pale and then break, like petrified wood. Mercury is frozen, and alcohol

ROSES FROZEN WITH LIQUID AIR RENDERED BRITTLE AS GLASS.

is made stringy and white by this air, and steel bars, when dipped into this liquid, may be burned as readily as a piece of dry wood.

ITS POSSIBLE USE FOR FUEL AND PROPULSION.

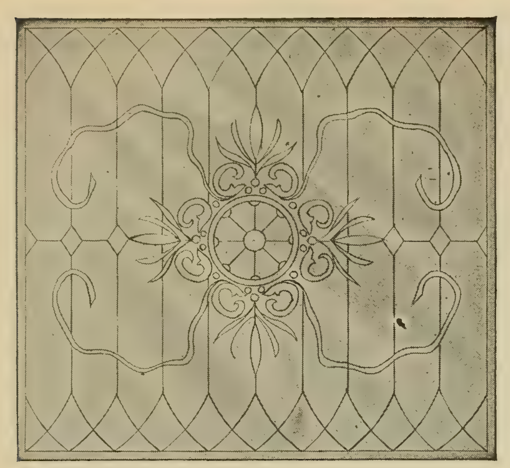
In the not distant future, liquid air may supplant some forms of fuel, for when mixed with any form of carbon, it burns rapidly or explodes. Thus it may be used in interior combustion engines,—for instance, the gas engine.

FULL RECOGNITION OF A GREAT DISCOVERY.

When, with its lightness and extreme potency, it shall be utilized in helping to solve the problem of practical aëronautics, and shall also be made to serve, with a suitable motor, in propelling submarine craft, while at the same time supplying breathing air to the crew, through compression in storage tanks, then, indeed, will be fully recognized the great significance of the discovery of liquid air.

DRIVING A NAIL WITH A HAMMER MADE OF MERCURY FROZEN BY LIQUID AIR.

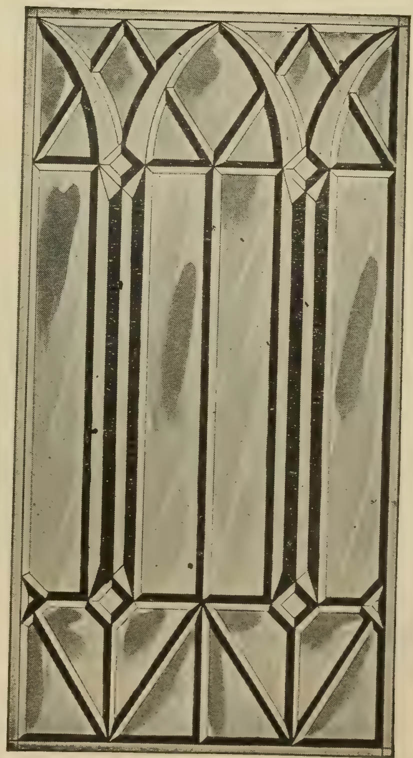
NEW PROCESS OF MAKING STAINED-GLASS WINDOWS



In a short article of this description, it is possible to give only the bare outlines of the art of making stained-glass windows. To begin at the beginning, when the exact shape and subject of a window is decided upon, a water color sketch is prepared to scale, and then the working drawings and cartoon in full size are made. The drawings are done either in monochrome, charcoal, crayon, pencil, or bister, in wash or in color or pastel, according to the taste of the artist.

The lead glazing lines are usually shown on the drawing, and for the guidance of the glass cutter a tracing of these lines is made on linen. Possibly, the most important, and certainly one of the most delicate functions in the making of a window, now follows—that of choosing the glass itself, for on this depends to a great extent the final artistic results, as will be presently explained. The artist stands by the cutter and chooses each tint, each sheet, and even indicates the particular part of each sheet most suitable for his purpose. For the color is not always even throughout the glass. What to an inexperienced eye looks like a flaw, a splash of different color, or a mass of air bubbles, is produced intentionally in the manufacture of the glass, and eventually adds to the beauty of the window. When the various pieces are chosen, they are cut to shape on the linen tracing. A tracer now marks on the pieces of glass the main lines of the artist's drawing. It is here that one may point out why stress is laid on the importance of the artist choosing his own glass, and not leaving it to the cutter.

A prevalent idea is that a stained glass window is produced by painting white or ordinary glass with various colors, but it



By courtesy of the American Art Glass Co., of Chicago.

is not so. It is in reality a Mosaic of colored glass, shaped by a pigment of one color

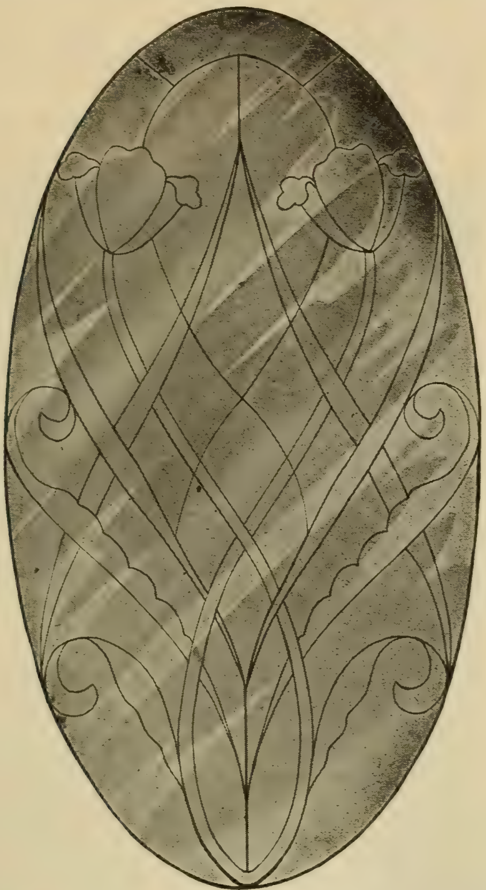
By courtesy of the American Art Glass Co., of Chicago.
STAINED GLASS WINDOW—REPRESENTING A HUNTING SCENE.

only, and with the exception of what is called staining, which will be presently explained, the color of the glass is in no way changed. The pigment used is chocolate-brown, in color, and is made of the same earths as the glass itself, with some iron or copper added to give opacity.

The next process is to stick onto a sheet of plate glass, with hot wax, all pieces, placed in their proper order and position and the whole is then covered with a fairly thick pigment, and, while still wet, stippled to let the light through. When the pigment has dried, the lights and half tones are picked out and brushed away, here and there a shadow is strengthened with more pigment, and the work is ready for diapering and staining. The diapers, or patterns, are either painted on in thick opaque lines, or the existing paint is etched out with points, to the required design (see illustration). Staining is painting the back of such portions of glass as may seem desirable with nitrate of silver, which, when sufficiently heated, changes to a brilliant yellow. It can be so manipulated as to give shades from pale lemon to deepest orange.

The pieces of glass are now all dismounted and carefully laid in flat iron trays, the bottom of which contains a layer of white dry powder; the glass is so arranged that no two pieces touch. The trays are then placed in a kiln heated by powerful Bunsen burners, gradually brought to heat and as gradually cooled. The pigment which, as was pointed out, is made of the same earths as the glass on which it is painted, has become, by firing, part and parcel of the glass itself; it is no longer paint, but actual glass.

It is now ready for the glazier who, by means of the design or cartoon, puts the



By courtesy of the American Art Glass Co., of Chicago.
ARTISTIC WINDOW.

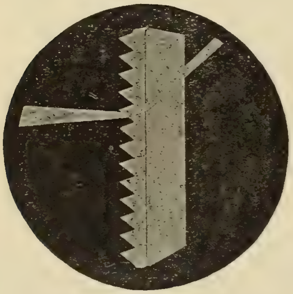
different pieces in their proper places, and joins them together by means of grooved leads, and solder. Around the outside edge of the design, in order to bind the whole firmly together, is fixed a stronger piece of lead than that used to join the pieces of glass.

Now follows a very dirty process—that of making the window proof against the weather. This is done by rubbing under the leads a cement made of whiting, oil, etc. The whole window on one side is smeared with this, but it is eventually all cleaned off, leaving a deposit under the leads which makes it water tight. Again the glazier takes it in hand and solders onto the lead cross-bars of galvanized iron at proper intervals. It is now ready for setting.

The stone mullions of a window to be fitted with stained glass are grooved on one side deeper than on the other. The glass is slipped into the deeper groove first and then pulled back into the shallow one in the mullion opposite. The iron bars, called tee bars, are set into the stone on each side of the window holding the glass in place. The space between the outer lead of the glass and the stone work is now carefully filled in with cement, to prevent the rain beating through, and then the window is complete.

LUXFER PRISMS AS LIGHT TRANSMITTERS

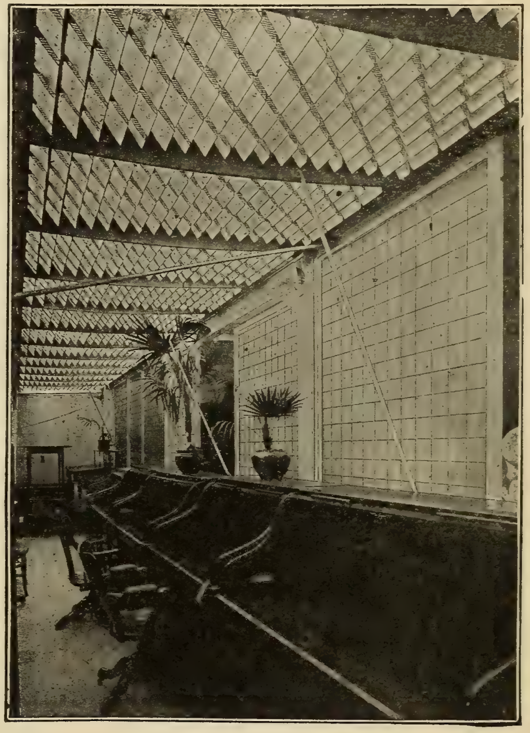
While some scientists have been busy with new inventions for the production of improved light from electricity and gas, others have given their attention to the more effective use of the light which is free to all, that of the sun, which is the ultimate source of all light. The Luxfer prism, invented by a Canadian investigator of the phenomena of light, J. G. Pennycuick, is admittedly one of the most noteworthy of contributions to practical optics.



HOW THE PRISM ACTS. Showing ray of light from above, deflected to a horizontal course as it passes through the glass.

Luxfer prisms are sheets of crystal glass having a smooth outer surface, and an inner surface divided into a series of small, accurately formed prisms. They can be united into plates of any size, to fit any window sash. The rays of light from without, that strike the smooth surface, penetrate it as they do any other glass. The prisms on the opposite surface, however, are set at such an angle that the light passing through them is refracted to a horizontal direction, and thus illuminates the room much farther from the window than is the case with ordinary, plane-surfaced glass. The dark corners are lighted, the gas and electric light bills are reduced, and all this without a meter to continually register the saving and bring in a charge for it.

These prisms and their modified forms are applied to use in a multitude of ways. Large stores have them placed in the transom frames above the front windows, so that the rear of the long rooms may receive ample light. The same prisms placed like an awning in front of windows in a narrow, shaded street, gather the scanty light from above and deflect it into the building so equipped. Sidewalks made of Luxfer prisms receive the direct light from the sky on the upper face, and turn or refract it into the basement of the building adjoining. It is said that more than five thousand prominent buildings throughout the United States installed Luxfer prisms within the first five years of their manufacture. This is noteworthy evidence of the fact that new inventions that are of genuine value are sure to find welcome.

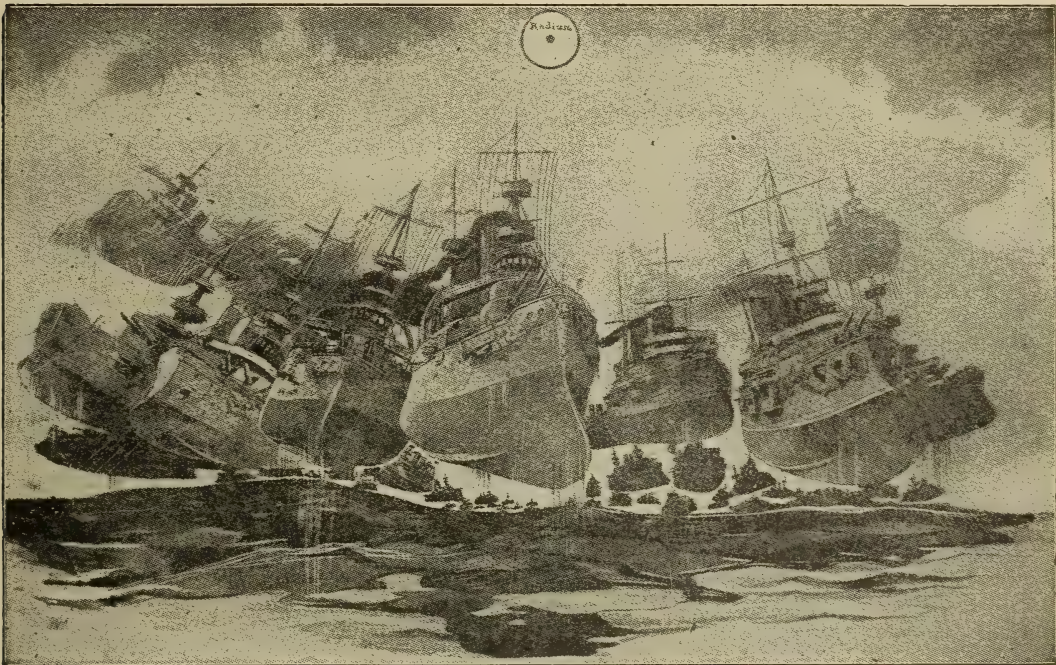


LUXFER PRISMS IN USE.
Illumination in a basement salesroom by means of prisms in the sidewalk.

MARVELOUS METALS RECENTLY DISCOVERED

RADIUM AND POLONIUM THROW OUT LIGHT THAT SHINES THROUGH IRON. WOMAN SCIENTIST'S ACHIEVEMENT. VALUE OF RADIUM $1,000,000 PER POUND.

A new metallic substance called radium has been discovered by a Polish woman, Madame Sklodowska Curie, who, with her husband, is engaged in scientific work in Paris.



RADIUM'S MIGHTY EXPLOSIVE POWER.
The power of an ounce of radium is sufficient (according to Sir William Crookes) to lift the entire British and French navies from the water.

Radium is a white crystalline powder, a combination of several metals, with an illuminating power that far eclipses the Roentgen or X-rays. Its rays travel almost as fast as sunlight and can pierce three feet of iron, burn through metallic cases and take photographs in closed trunks. Professor Curie, the husband of the discoverer, says that he would not venture into a room containing two pounds of radium, as it would probably destroy his eyesight, burn off his skin and even kill him.

Now, before scientists have finished marveling at the new and mysterious metal, the Polish woman has added another to her triumphs in chemistry, by the discovery of a still more wonderful element to which she has patriotically given the name of polonium, in compliment of her native country.

In a much higher degree than radium it possesses the property of shining in the dark and, like radium, this strange substance does not seem to exhaust itself or lose its luminous powers with the passage of time.

Polonium is extracted from pitchblende, a black mineral found in Bohemia and heretofore considered valueless, after uranium had been extracted from it. Uranium is most commonly used for imparting fine orange tints to glass and porcelain enamel.

As yet too little is understood of the marvelous properties of this new metal to predict just what its uses will be in medicine, surgery and other sciences; but it is not improbable that it may be found to perform the present functions of the Roentgen or X-rays far more powerfully and without their cumbrous apparatus.

VALUE, $1,000,000 PER POUND.

Its vast value, $1,000,000 a pound, must always keep it as a laboratory subject, but one that is pregnant with possibilities to the scientific world.

BUT TWO POUNDS OF RADIUM IN THE WORLD.

The total supply in the world is estimated at two pounds, which, if gathered together, would contain enough potential energy to swing the globe from its orbit. It projects invisible elections—or scientific particles of matter—at the amazing rate of 1,200,000 miles per second. It neither tests nor destroys anything, but a plate of radium one inch square would shine successfully for a million years.

RADIOGRAPH OF A MOUSE.

William J. Hammer, an electrical engineer of New York, has made a series of photographs and radiographs by the light of radium. Among them is a radiograph of a mouse, taken by laying the animal directly on the plate, which was then placed in the bottom of a trunk, wrapped in rugs and allowed to remain there twenty-four hours.

RADIUM'S UTILITIES.

The future uses of radium are likely to be various and important. In connection with the treatment of blindness and cancer, great and beneficent results are confidently expected. The extremely limited supply thus far available restricts its application to industrial purposes; but is understood that a small fraction of an ounce, properly employed, would probably furnish a good light for several rooms, which would last, without renewal, for a hundred years. Calculations have been made indicating that the potential force inherent in one gramme of radium will raise 500 tons to the height of a mile. An ounce would therefore be sufficient to propel a 50-horse-power motor car at the rate of 30 miles an hour around the world.

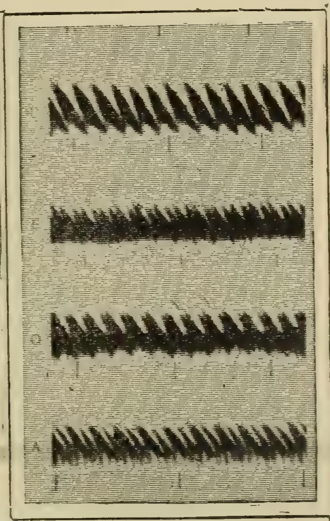
AN AMAZING TRANSFORMATION.

The most recent discovery in connection with radium, through the experimentations with radium is that a dense vapor is thrown off by it, which is gradually transformed into helium and afterward disappears. This antagonizes a basic idea in chemistry. The gas now found to emanate from it is measurable and weighable and can be bottled, but vanishes within a few weeks. It was at the moment of its disappearance that its spectrum was discovered by Prof. Ramsay to show the peculiar features of helium, which grew more manifest until the identity was established. This astounding transformation suggests the problem whether, if one metal can change into another of a different nature, a similar transmutation, under certain conditions, may not likewise affect many other substances in metallurgy. The latest prediction from scientific sources is that a species of radium will soon be obtainable from petroleum by certain processes now being pursued.

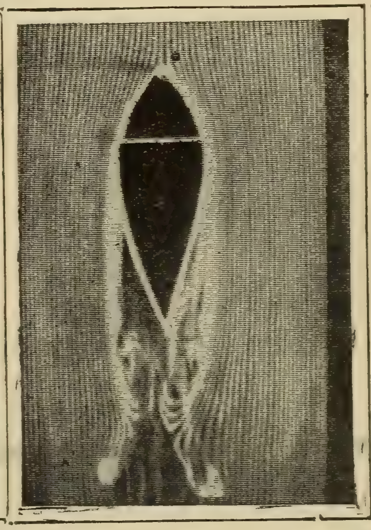
SNAP-SHOTS OF THE HUMAN VOICE

A French scientist, M. Marage, has invented a process by means of which it is now possible to photograph the human voice. The actual vibrations of the air, made in speaking the vowel sounds, can be recorded and made visible by an ingenious use of chronophotography, or the analyzing of motions by means of instantaneous photographs. Every one is familiar with an opposite and synthetic use of chronophotography,—the presenting of animated views of moving objects by means of the kinetoscope.

CHRONOPHOTOGRAPH OF THE MOVEMENTS OF THE JAW.



HOW THE VOICE LOOKS IN FORMING SOME OF THE VOWEL SOUNDS.



PHOTOGRAPH OF AIR CURRENTS PASSING A CURVED OBJECT.

M. Marage's scheme may be described as follows: the vibrations of the air set in motion by the voice are made to act upon the flames of acetylene gas, issuing from specially prepared burners. The flames, vibrating in unison with the sound waves, throw their images into a revolving mirror, which dissociates and causes them to appear in various forms, according to the sound. By means of the acetylene flames, which are photogenic, the vibrations are recorded on a ribbon of sensitized paper.

It has been found possible also to photograph the various functional movements of the body. Thus the motions of the lower jaw in the act of opening the mouth may be represented, as well as the movements of the ribs in respiration. Another ingenious use of chronophotography makes it possible to reproduce in visible form the action of air currents in their passage around an obstruction, as shown in one of the accompanying illustrations.

THE SOLAR FURNACE

POWER FROM THE SUN.

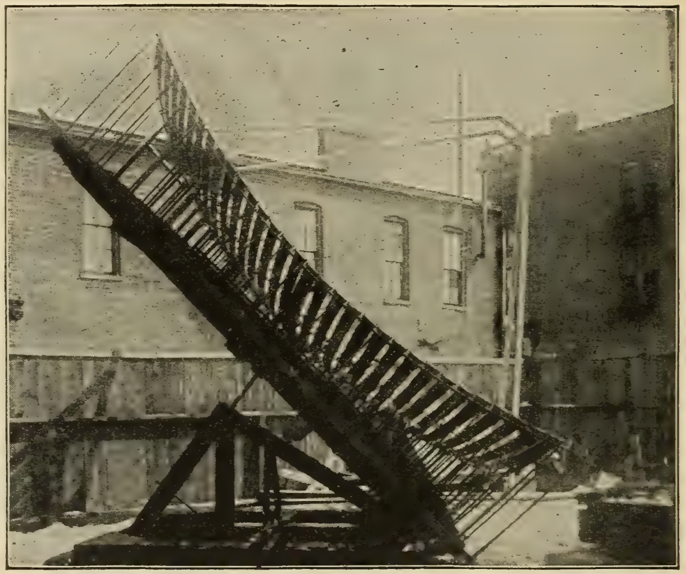
A wonderful new invention, running steam engines, smelting all kinds of ores and minerals, heating and lighting houses and cooking all kinds of food, either day or night, by heat of the sun's rays, without fire, fuel or expense, is the Solar Furnace.

STEAM ENGINES.

For running steam engines the sun's rays are concentrated by means of curved reflectors onto a specially built high-pressure boiler, the heat being so intense that the water is turned into steam very fast, two square yards of sunlight furnishing sufficient heat to develop one horse-power, the sunlight falling on a space 44 feet square, furnishing sufficient heat to run a 100 horse-power steam engine. Any engine can be used, but a specially built boiler is necessary. The reflector is mounted on a revolving base and moved by a clock-work attachment that keeps it in focus with the sun all day.

PUMPING PLANTS.

It is thought by some that the solar furnace will revolutionize the present irrigation system, especially in the Southwest, where water is scarce and fuel high. Any amount of water and fuel can be pumped from either deep or shallow wells; no fuel is required, and when a plant is once installed the expense is ended. On all pumping plants requiring over five horse-power, a steam engine is used, the steam being generated by the heat of the sun, as above stated. On plants of five horse-power or less, a "compression" engine with pump attached is used. No fire, fuel, steam, or water is used; nothing but sunlight and air. It is impossible for it to "blow up" or explode. It works automatically, and no engineer is required.

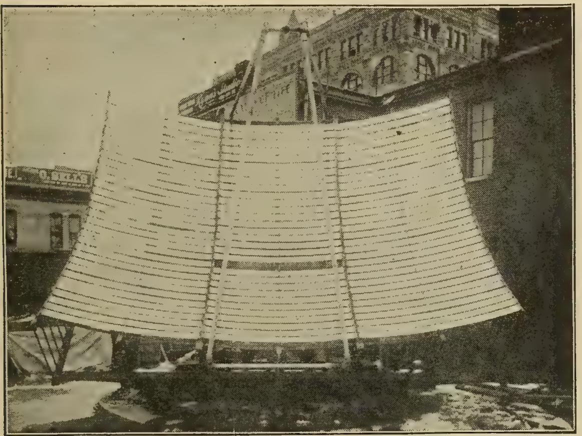


By courtesy of the Solar-Furnace and Power Co.
SOLAR FURNACE (SIDE VIEW).

A small plant may be made to pump sufficient water for a large tract by having a reservoir and running the pump every day when the sun shines, using the water only as needed.

SMELTING ORES AND MINERALS.

Any and all kinds of minerals can be smelted, or literally "burned up," if desired. A single yard of sunlight will melt silver, gold, glass or wrought iron to a liquid, while two yards square of sunlight will develop heat of over 25,000 degrees, or more than one hundred times as hot as boiling water.



By courtesy of the Solar Furnace and Power Co.
SOLAR FURNACE (FRONT VIEW).

HOUSEHOLD USE.

A small plant can be installed on the roof of the house at a cost of only a few dollars. Attached to the water hydrant it works automatically and carries steam down through pipes to the kitchen, where it is attached to a steam cooker cooking a dozen different kinds of food at the same time without fire, fuel or expense, and furnishing boiling water for the bath, the laundry and all other purposes.

STORING HEAT AND POWER.

Electric power is generated by a steam engine run by the solar furnace during the daytime and stored up in a storage battery to run machinery, and for heating, lighting, cooking and other purposes nights and cloudy days. The possibilities of the solar furnace are practically unlimited.

A TELEGRAPH MACHINE THAT PRINTS

Along with progress in other electrical devices has come the invention of a practical printing telegraph machine. For years effort has been expended to produce a contrivance that would print automatically from electrical impulses sent over a wire from a distance, but the devices have operated poorly. To be sure, the stock "ticker" serves its purpose in a measure, and when not out of order, is worthy of great commendation. The mechanism, however, is so complicated that the machine cannot be relied upon.

Now comes from Australia a man named Donald Murray, who with great ingenuity, has perfected a device which to-day operates in the offices of the Postal Telegraph Company in many cities, and before long probably will find its way over two continents. Labor saving is not so much the result aimed at and reached in this instrument as the tremendous saving in wire. When it is considered that a single copper wire from New York to Chicago costs $60,000, that it rents for $12,000 a year, and that the Murray system can, on one line, do the business of two or three, the saving may be imagined readily.

This device, the Page-Printing Telegraph, is a series of instruments which automatically receive upon a typewriter telegrams sent over a single wire. There are four main instruments for sending and receiving—two for each station. The sending instruments consist of a transmitting perforator and a modified Wheatstone transmitter. The receiving devices are a receiving perforator and an automatic typewriting attachment.

Upon receiving a message for transmission, the operator sends it through the perforator, which is much like a typewriter. This device punctures a tape with little dots at irregular intervals. The arrangement of these dots signifies certain letters. The perforator writes eighty-four characters. The tape is provided also with a central line of smaller punctures, which engage the teeth of feed-wheels in the machines, thus insuring a steady flow as they are drawn through mechanically. After the message has been perforated on the tape, the tape is fed through the transmitter. This instrument is so arranged that two small rods press against the tape, held in place by small springs. When the rods are even with the perforations they push through for a moment and then are withdrawn automatically. These rods serve to make and break an electrical current. This current is imparted to the wire, traveling as irregular impulses according to the spacing of the perforations.

These impulses pass as signals to the receiving station. The process of receiving the message is similar to that of its transmission, excepting that the latter is done by hand, whereas the former results from electrical energy. To aid in the receiving operation, there is a local electrical circuit. On this line are a punching relay, a governing relay, a vibrator, a receiving perforator and the automatic typewriter. The message arrives on the wire and the impulses are transformed into the local receiving circuit. Automatically, the punching machine perforates the series of irregular dots in the receiving tape. The tape is then fed into the typewriter, which is so arranged that the perforations cause the proper keys to be lifted and the message to be printed in commercial form.

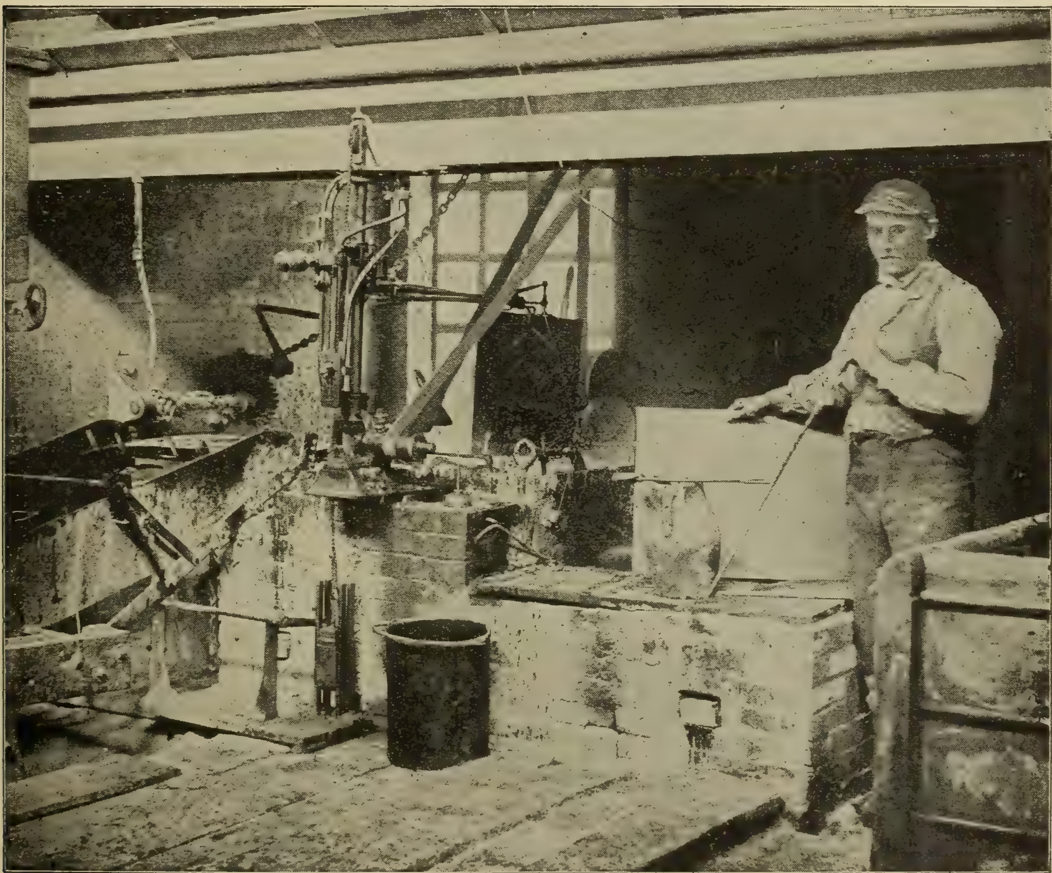
The speed of the system is remarkable. The ordinary Morse system permits of about 25 words a minute. Under similar conditions, the Page-Printing Telegraph transmits and receives about 130 words during the same interval. The perforators can receive messages faster than the typewriting machine can translate them in commercial form, but this is no drawback, as the tape at the receiving station can be torn at certain intervals and fed into several machines at once.

The design of Murray's skilfully contrived apparatus, filed November 28, 1899, in the United States Patent Office, indicates how striking is the contrast between its delicate simplicity of construction and its great importance to telegraphy. Since he perfected the instrument, however, the inventor has made claim for 37 distinct improvements on its various parts, which are now covered by three separate patents. The value of the invention in facilitating the operations of the Postal Telegraph Cable Company, to which the ownership of the patent was assigned, cannot be overestimated.

TIN-MAKING IN THE TWENTIETH CENTURY

Originally the method of tinning plates was the simple expedient of dipping them in a bath of molten tin and allowing the surplus metal to drain off; but about thirty or forty years ago, a Mr. Morewood, of South Wales, Great Britain, designed a tinning machine which has since revolutionized the tinning process. The system consists of placing at the surface of the pot a pair of very carefully turned steel rods, which seize the plate as it comes up and roll off the surplus tin, leaving a smooth and even coating of the metal.

Even this system has been improved, and to-day the rolls are submerged inside the tinning pots in the hot metal and oil baths, and as the plates pass through, while the coating process is going on, it leaves a uniform coating and a highly polished surface. In the manufacture of high-grade



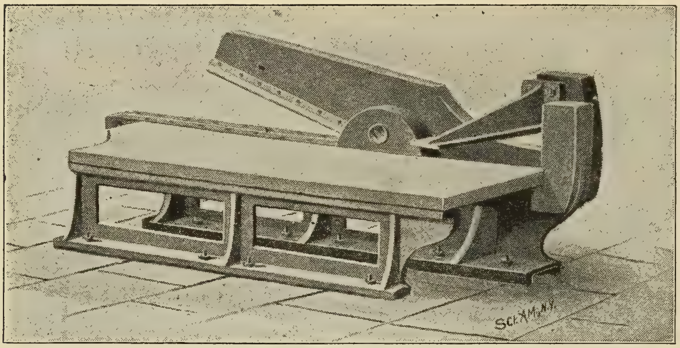
By courtesy of the Scientific American.

TINNING MACHINE.

With Bennett Magnetic Catcher for removing tinned plates as they come from the rolls.

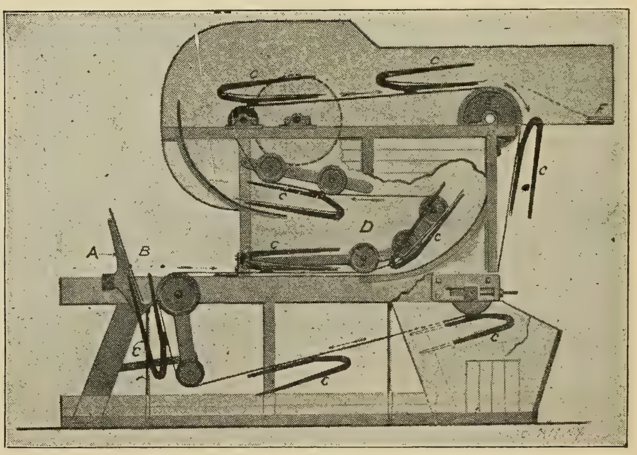
roofing tin, the hand process of dipping is still maintained.

In this hand-dipping process, known as the "MF Style," the plates pass through four or five different pots filled respectively with metal or palm oil. The plates made by this process resist attacks of the atmosphere more thoroughly than plates made in the "coke" tinning process. Recently, a new method of finishing has been introduced. In this method, the plates after coming out of the last old-style of "MF." tinning bath, are immersed immediately in an oily substance, the temperature of which is below the melting point of the coating metal, and an instantaneous and uniform settling of the coating metal is thereby effected on all parts of the sheets alike.



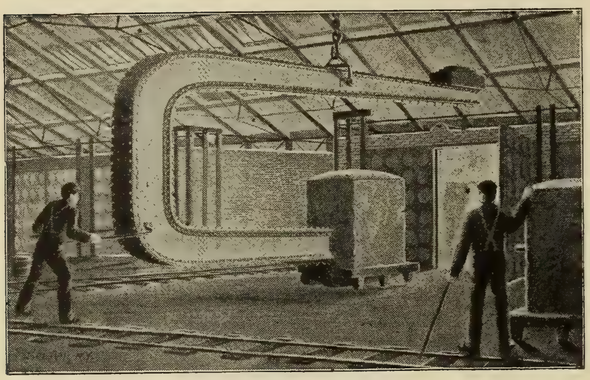
By courtesy of the Scientific American.
THE CUTTING AND DOUBLING SHEARS.

A sectional illustration of a modern tinning machine is herewith given, which shows very clearly its construction. The heavy cast-iron tin pot is carried in a brick setting, and the tin is kept molten by a furnace below the pot. In the bottom of the pot is about 14 inches of the molten tin, and above this on the discharging side are 12 inches of palm oil. The black plate is introduced into the tin pot through the hopper (A). This hopper holds a chemical fluid, the weight of which is less in specific gravity than the molten tin, and which in combination with the tin and iron, causes a galvanic action by which the iron and tin are quickly and thoroughly amalgamated. The tinner pushes the plate downward with a pair of tongs over the curved guide bars until it is seized by the first pair of rolls known as the "feed rolls" marked (B) in the picture. By these it is drawn through the molten tin into the upward curved hopper (C), in which are running two pairs of rolls (D D). The top pair is partly visible and partly immersed in the palm oil which covers the tin on this side of the machine. These rolls are held suspended in a machine frame and are regulated by means of screw-adjusted



By courtesy of the Scientific American.
THE BRANNER.

THE TIN HOUSE, WHERE BLOCK PLATES ARE COATED WITH TIN.

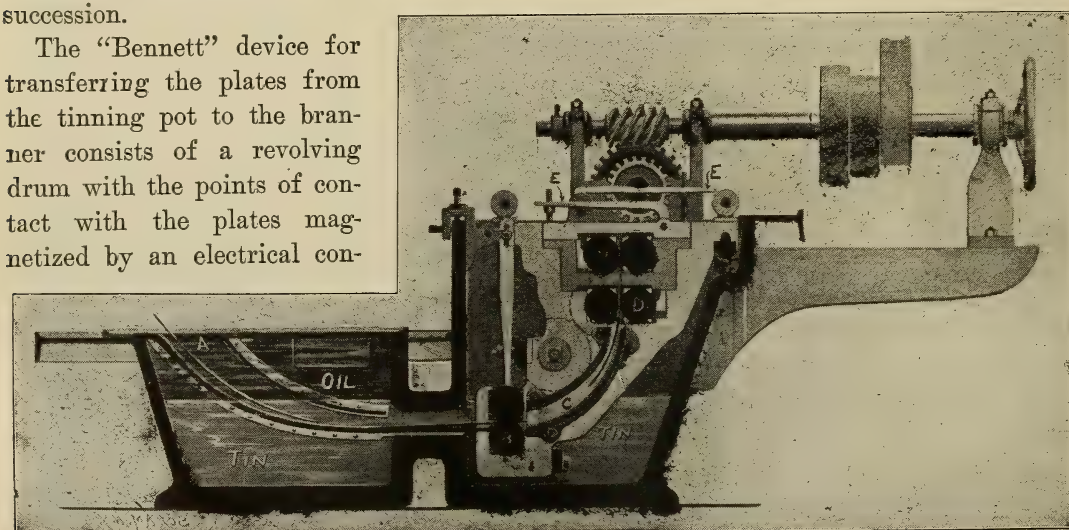


By courtesy of the Scientific American.
PLACING BLOCK TIN.

springs (E E). Upon the adjustment depends the thickness of the coating of tin given to the plate.

As the plates come out of the rolls they are picked up by a mechanical figure with arms and fingers, which stands above the finishing pot, taking the place of a man. It seizes the plates as they rise through the rolls, swings them sidewise, comes to a stop automatically, drops the plate into a branner, and comes back to its original point of action, repeating the operation in rapid succession.

The "Bennett" device for transferring the plates from the tinning pot to the branner consists of a revolving drum with the points of contact with the plates magnetized by an electrical connection. As the plates leave the tin pot, they have upon them a thin coating of oil which has to be removed. For this purpose they are put into a branner which is located conveniently at the side of the tinning machine. The branner consists of an inclosed wood and metal box, through which a series of carriers (C) are continually traveling on an endless belt. The plate (B), as it comes from the tinning machine, is placed in a rack (A), which is so located that the plate will be caught up by the traveling racks (C), and by them carried through the machine. The interior of the branner is filled with bran and slack lime and as the carrier travels, it forces the plate through the bran and lime, which cleans off the deposit of palm oil. After the plate has passed through, it drops into what is known as the "duster," where it is passed slowly through a rapidly revolving pair of sheep-covered rollers, which clean off the residue of the palm oil and impart a finish-



By courtesy of the Scientific American.
SECTIONAL VIEW OF TINNING POT.

ing touch or polish to the plate. There are three of these sheepskin rollers and by the time the plate has passed through the set, it shows the beautiful finish for which tin plate is noted.

POULTRY KILLING BY MACHINERY

Poultry-killing by machinery is the latest innovation made by the big packers at the Union Stock Yards, Chicago. In olden times the method used for slaughtering fowls was to catch them and wring their necks or chop off their heads with an ax or large cleaver. To-day that process has been superseded by one that, while it may not seem humane, is by far the most rapid method ever introduced for killing chickens, ducks, geese or turkeys.

KILLING 10,000 CHICKENS, 8,000 DUCKS AND 6,000 TURKEYS PER DAY.

THE FATTENING ROOM.

In describing this twentieth-century method of slaughter, let us begin at the time when the chicken or turkey reaches the packing house. The fowls arrive in car lots and are at once transferred to the "feeding-room," where they are kept for ninety days, to "fill out." Then, if at the end of that period they are found to be fat enough to slaughter, the killing is begun.

THE KILLING FLOOR.

From the feeding room to the "killing floor" there is a chute through which the fowls are "shot" into a cage which acts as a receptacle on the floor below. Standing directly in front of this cage is a man whose duty is to lift the birds from the cage and place them upon an endless chain, which runs directly in front of him. In placing the fowl upon the endless chain it is turned upside down, both feet being placed in small prongs, spread a sufficient distance apart to make picking possible.

Then a weighted tin can, which weighs about eight ounces, is attached to the bill of the fowl by a "snap." The bird is still alive.

This ends the man's duty at the cage, and the bird moves along to the next man, who sticks an awl into its gullet, which kills it. Then the blood drips down into the weighted can and later finds its way to the fertilizer works, where it is utilized. After this operation the bird continues on its way, passing en route 20 men, each of whom, in turn, removes a few of the feathers as it passes along. Eight of these men are stationed inside a great iron cage, and it is their duty to pick off the best feathers, which are saved and sold to pillow manufacturers.

When the fowl has reached the end of the chain it is taken off by a man and passed over to an inspector. Should there still remain any small feathers upon it, it is taken to a hook which projects from the wall, and there gone over by a "cleaner." At the conclusion of this operation, if the inspector is satisfied, it is placed upon the racks, and within a few minutes, is wheeled into the big coolers. This is what is known as the dry picking process.

THE SCALDING PROCESS.

There is also a scalding process, which is operated upon a similar plan, only that after the bird has been "stuck," it is drawn along on an endless chain, which carries it through a "scalding tub," where the feathers are removed. It then goes into a "cooling tub," and later, finds its way to the cooler.

So rapid is this method of killing fowls that in a day of ten hours, 10,000 chickens, 8,000 ducks and 6,000 turkeys may be slaughtered. The average wages earned by men in this department are $1.75 per day. It is not an uncommon thing for the packers to have 40,000 fowls in the "feed room" at one time. This enables the shippers to cool and pack to advantage.

GIGANTIC ICEBERG OF NORTHERN GREENLAND.

THE WIRELESS TELEPHONE

We have had the telephone for more than a quarter of a century in practical working use, and have begun to think of it no longer as extraordinary. In truth, however, the advances and improvements in the ordinary telephone since the first successful experiments were made, mark almost as great progress as did the original invention itself. Of very recent success are the experiments of Marconi with wireless telegraphy, an astounding and important advance over the ordinary system of telegraphy through wires. Now comes the announcement that an American inventor, unheralded and modest, has carried out successful experiments in telephoning and is able to transmit speech for great distances without wires.

The inventor is Nathan Stubblefield. The first public test of telephoning without wires was made at the Kentucky village where the inventor lived, on the first day of January, 1902, only a few weeks after Marconi's success in signaling across the Atlantic by telegraph without wires.

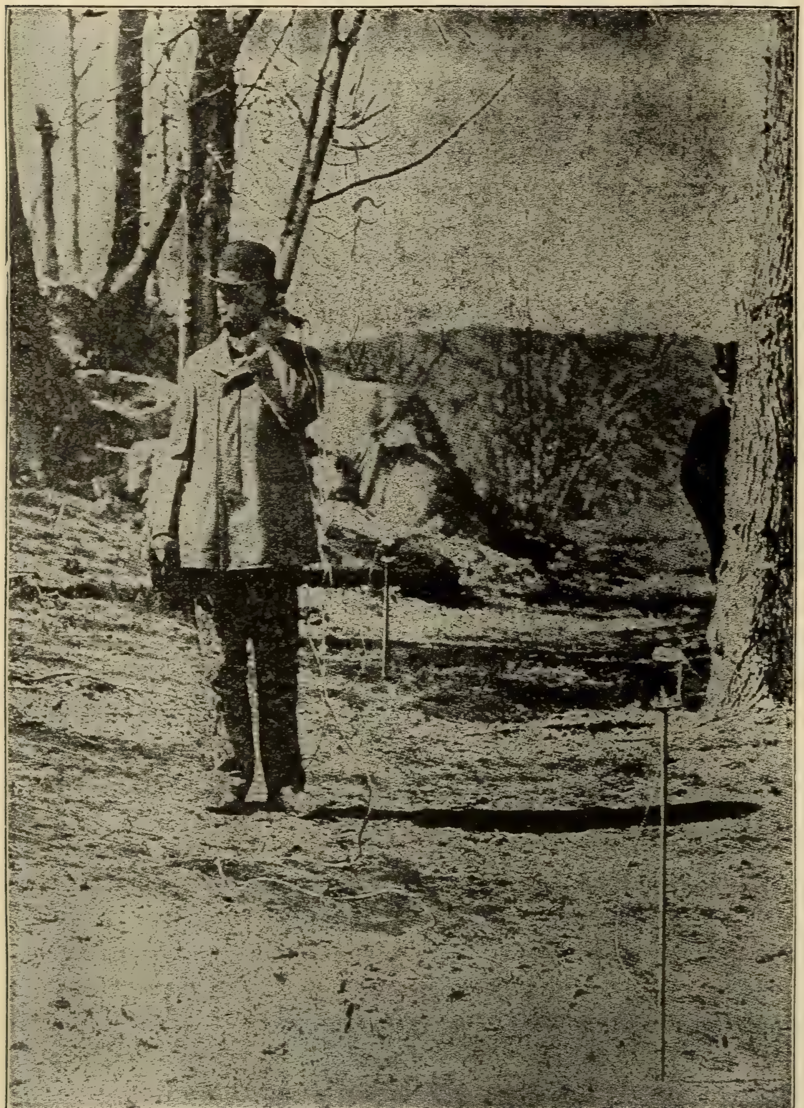
The next demonstration was made ten days later for a newspaper correspondent from St. Louis and the account of it was published in detail in that city. The investigator wrote as follows in regard to what he learned:

"Mr. Stubblefield has worked for ten years to discover an apparatus by which he could overcome the use of wires in telephoning, during which time he has become a technical electrician of high order. He has kept in touch with all the leading electricians, and is familiar with every important discovery in the field of electricity. Naturally he has been a close observer of the work of Marconi.

"The transmitting apparatus is concealed in a box. Two wires of the thickness of a lead pencil coil from its corners and disappear through the walls of the room, and enter the ground outside. On top of the box is an ordinary telephone transmitter and a telephone switch. This is the machine through which the voice of the sender is passed into the ground, to be transmitted by the earth's electrical waves to the ear of the person who has an instrument capable of receiving and reproducing it.

"We went into the cornfield back of the house. After walking five hundred yards we came to the experimental station the inventor has used for several months. It is a dry goods box fastened to the top of a stump. A roof to shed the rain has been placed on top of it; one side is hinged for a door, and the wires connected with the ground on both sides run into it and are attached to a pair of telephone receivers. The box was built as a shelter from the weather, and as a protection to the receivers. I took a seat in the box and Mr. Stubblefield shouted a 'hello' to the house. This was a signal to his son to begin sending messages. I placed the receiver to my ears and listened. Presently there came with extraordinary distinctness several spasmodic buzzings and then a voice which said: 'Hello, can you hear me? Now I will count ten. One—two—three—four—five—six—seven—eight—nine—ten. Did you hear that? Now I will whisper.'

"I heard as clearly as if the speaker were only across a 12-foot room the ten numerals whispered. 'Now I will whistle,' said the voice. For a minute or more the tuneless whistle of a boy was conveyed to the listener's ears. 'I am going to play the mouth organ now,' said the voice. Immediately came the strains of a harmonica played without melody, but the notes were clear and unmistakable. 'I will now repeat the program,' said the voice, and it did.



MR. STUBBLEFIELD RECEIVING MESSAGES BY WIRELESS TELEPHONE.

Note the two steel rods in the ground, which establish connection with the electrical currents of the earth, being connected by 30 feet of wire attached to the receiver.

"An examination of the station showed that the wires leading from the receivers terminated in steel rods, each of which was tapped with a hollow nickel-plated ball of iron, below which was an inverted metal cup. The wire enters the ball at the top and is attached to the rod. The rod is thrust into the ground two-thirds of its length. Another test was made after the rods had been drawn from the ground and thrust into it again at a spot chosen haphazard by the correspondent. Again the 'hello' signal was made by Stubblefield, and after a few minutes wait came the mysterious 'Hello! Can you hear me?' and a repetition of the program of counted numerals, whispers, whistling and harmonica playing.

" 'Now,' said Mr. Stubblefield, who carried under his arm duplicates of the ball-tipped steel-rods. 'I wish you would lead the way. Go where you will, sink the rods into the ground and listen for a telephone message.'

"Away we went, down a wagon track, through the wide cornfield. A gate was opened into a lane between the hedge that bordered the field and a dense oak woods. We pursued the lane for about 500 yards and struck into the woods. I led the way. Into the heart of the woods we walked for nearly a mile. In a ravine I stopped. 'How far are we from the house now?' I asked. 'About a mile,' Stubblefield answered. 'Place the rods where you will and listen for a telephone message.'

"I took the four rods from Stubblefield. Each pair of rods was joined by an ordinary insulated wire about 30 feet long, in the center of which was a small round telephone receiver. Two of the rods were sunk in the ground, about half their length, the wires between them hanging loosely, and with plenty of play. I placed a receiver at each ear and waited. In a few moments came the signal and the voice of Stubblefield's son. The voice was quite as clear and distinct as it was 500 yards from the transmitting station. The rods were moved here and there, but always the message came."

Nathan Stubblefield comes from a family distinguished in his locality. His father was a lawyer, much respected in that part of Kentucky. His brothers are merchants and leaders in the community. But Nathan Stubblefield is another type. He cares only for his home, his family, and electricity. He educates his children in person, and after seeing that his family is well provided for, spends the remainder of his substance in electrical experiments.

His son, Bernard B. Stubblefield, 14 years of age, has been for four years his father's sole assistant. He is a remarkable boy. His father has been his only educator, and the lad is now an expert electrician and reads abstruse works on electricity and technical electrical journals with the same zest that other boys read stories of travel and adventures. His father says of the boy that he would be able to carry out and finish this system of wireless telephony should the father die, so closely has he been allied with every step in its discovery and development.

"I have been working for this, ten or twelve years," he said. "Long before I heard of Marconi's efforts, or the efforts of others, to solve the problem of transmission of messages through space without wires, I began to think about it and work for it. This solution is not the result of an inspiration or the work of a minute. It is the climax of the labor of years. Of course I worked along the lines all the others are working. The earth, the air, the water, all the universe, as we know it, is permeated with the remarkable fluid which we call electricity, the most wonderful of God's gifts to the world, and capable of the most inestimable benefits when it is mastered by man. For years I have been trying to make the bare earth do the work of the wires. I know now that I have conquered it. The electrical fluid that permeates the earth carries the human voice, transmitted to it by any apparatus, with much more clarity and lucidity than it does over wires. I have solved the problem of telephoning without wires through the earth, as Signor Marconi has of sending signals through space. But

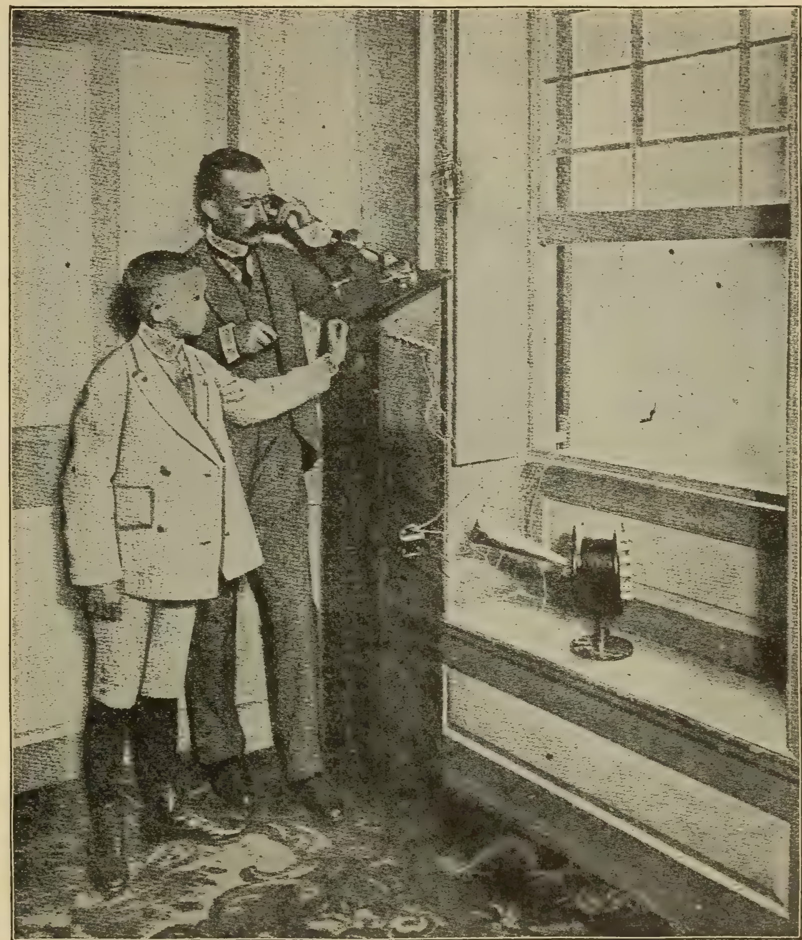
I can also telephone without wires through space as well as through the earth, because my medium is everywhere.

"As to the practicability of my invention, all that I claim for it now is that it is capable of sending simultaneous messages from a central distributing station over a very wide territory. For instance, any one having a receiving instrument, which would consist merely of a telephone receiver and a few feet of wire, and a signaling gong, could, upon being signaled by a transmitting station in Washington, or nearer, if advisable, be informed of weather news. Eventually it will be used for the general transmission of news of every description. I have as yet devised no method whereby it can be used with privacy. Wherever there is a receiving station the signal and message may be heard simultaneously. Eventually I, or some one, will discover a method of tuning the transmitting and receiving instruments so that each will answer only to its mate.

"I claim for my apparatus that it will work as well through air and water as it does through the earth. That it will convey messages between the land and sea, for instance, from lighthouses to ships, from vessels in any part of the ocean to vessels or their owners on land, if each carry my transmitters and receivers; it can be used on moving trains so that they may be spoken between stations and thus prevent accidents. There is no conceivable position or station in which they may not be used. The all-enveloping electricity, the medium of carriage, insures that. The curvature of the earth means nothing to me—it will not deter messages sent by my apparatus. I have shown what my machine will do through the earth by grounding the wires. I will say that it is not absolutely necessary to ground the wires. I can send messages with one wire in the ground, the other in the air, or with no wires at all. In fact, my first and crude experiments were made without ground wires. I have sent messages by means of a cumbersome and incomplete machine through a brick wall and several other walls of lath and plaster without wires of any description. The present method of grounding wires merely insures greater power in transmission. Several years ago I invented an earth cell which derived enough electrical energy from the surrounding source to run a small motor continuously for two months and six days without being touched. There was enough energy in the motor to run a clock and other small pieces of machinery or ring a large gong. This earth cell can be greatly magnified. Its discovery was the beginning of my experiments with wireless telephony. The earth cell was merely buried in the ground and connected by wires with the motor. The earth's electrical currents supplied it with power. The expense of my wireless telephony apparatus will not be great—not greater than that used for ordinary telephoning, minus the present enormous cost of wiring."

In May Mr. Stubblefield went to Washington and conducted a public test in the presence of a number of scientists and capitalists from New York and Chicago. These tests were made on board a steamer on the Potomac River and on land nearby. During the land tests, complete sentences, figures and music were heard at a distance of several hundred yards, and conversation was as distinct as by the ordinary wire telephone. Persons each carrying a receiver and transmitter with two steel rods, walking about at some distance from the stationary station, were enabled to instantly open communication by thrusting the rods into the ground at any point. An even more remarkable test resulted in the maintenance of communication between a station on the shore and a steamer anchored several hundred feet from the shore. Communication between the steamer and the shore was opened by dropping the wires from the apparatus on board the vessel into water at the stern of the boat.

An interesting article by Professor A. Frederick Collins, the well-known electrical scientist in the "Electrical World and Engineer," relates his observation of the demonstrations of wireless telephony and gives his opinion as to the practical value of the invention. He says in part:



NATHAN STUBBLEFIELD AND HIS SON TRANSMITTING MESSAGES BY WIRELESS TELEPHONY.

"There are many instances where an ordinary telephone cannot be employed. As an illustration let me cite a few cases: Two families lived only 1,500 feet apart, and where telephones costing $25 per pair would have answered the purpose, but owing to a railroad operating the adjoining properties, permission could not be obtained to stretch the wires; as an experiment the wireless telephone was tried, and with success. Another case was in the Thousand Islands, where a cable was laid from an island to the main land, at a cost of $2,000; here, again, a wireless telephone could have served the purpose at a cost not exceeding $200. A third case is in Narbeth, where the borough officials will not permit the Bell Telephone company to erect poles. Two physicians have had telephones in their residences for nearly a year, hoping that the Bell people would effect connection with their lines, one-fourth and one-half mile away. The contention was a matter of one narrow street. This distance could have been easily bridged by means of a wireless telephone; in fact, communication was established between one of the residences and the writer's laboratory, where three streets intersected the line of wave propagation, but as it took place under the surface of the earth, no one objected to it. But the most useful sphere of the wireless telephone, and the one which the writer has ever advocated, is its application to vessels in harbors. The wireless telephone is a first-hand instrument; it is simple, reliable, and it may be applied to any vessel at a comparatively small cost.

"The synchronization of wireless telephony is one of the knotty problems. It is this question that staggers the most sanguine; but if one had asked Professor Bell, in 1876, how any two of 40,000 subscribers might be put into instant communication one with the other, he, doubtless, would have found it difficult to even picture in his mind's eye the modern central station switchboard. It must be remembered that the wire telephone has had engaged in its improvement the brightest scientists, the most original investigators of the world for a period of over a quarter of a century, and this experience and application has brought the 'toy' to be one of the most potent factors of the commercial world. Would that a little of such applied energy could be put on the wireless telephone."

As an evidence that the practical value of the wireless telephone is recognized, the Gordon Telephone Company of Charleston, South Carolina, promptly ordered a complete equipment to connect that city with the sea islands along the coast. Only a year before, that company spent $25,000 in one winter to install and maintain its marine cables, and the president of the company estimated that an equally satisfactory service by wireless telephone would have cost but $2,500 to install.

The wireless telephone is practical—this has been amply demonstrated—but the opportunity for its satisfactory use is limited. Where there is a multiplicity of messages, as in an exchange, there is a liability of interruption and "mixture," messages becoming intertangled. The same is true as to the danger of interruption from wireless telegraph "waves." At the same time there are places and occasions when the wireless telephone system may be employed to advantage. One of these, for instance, is in speaking over a reasonable distance of water, where it would be difficult or impossible to stretch a wire, as from Key West, Florida, to Cuba. Ordinary telephonic communication by submarine cable between these points is not satisfactory, but the wireless phone has been found to work well when it has a clear field; that is, when there is no multiplicity of similar messages, or interruptions by wireless telegraph. The United States government has equipped many of its war vessels with the wireless telephone apparatus for communication at short distances, say from ten to fifteen miles, and, under favorable conditions, it has been found to work well. As a general proposition, however, it has no particular advantages over the wireless telegraph, aside from the fact that the voice of the speaker may be heard and identified.

SILK COCOONS, AND THE SILK INDUSTRY

The Illustrations in this article are furnished by the courtesy of Belding Bros. & Co.

The art of reeling, or producing raw silk, has been carried on in China for ages, and so well did the orientals guard the secret of silk culture that the nature of the fibre was unknown in Europe for more than a thousand years after silk fabrics had been introduced there. China still takes the lead in the production of raw silk; but large quantities also are obtained from Japan, India, France and Italy. Every silk article ever made or exhibited was originally in the cocoon condition, and the fibre had to be put through a great variety of processes before it was finally ready to be woven into fabrics. The idea is quite common that the silk threads or fibres as they come from the cocoon are ready for the weaving loom without further work or preparation, but the fibres, after coming from the cocoon, must be manufactured before they can become of any value.

THE SILK MOTH AND THE SILK WORM.

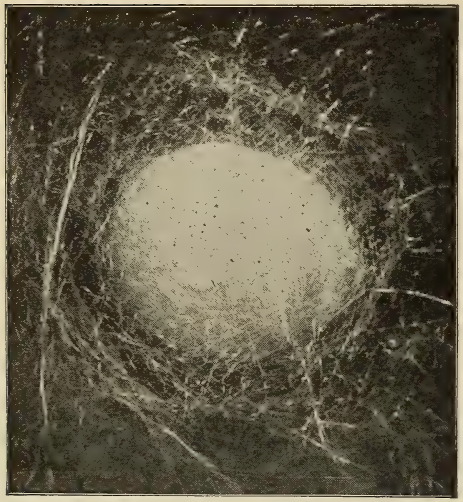
The little bright colored silk moth deposits from 400 to 600 eggs, and then disappears and soon dies. The eggs, on being exposed to a temperature of 65 or 70 degrees, hatch rapidly, each one producing a short brown worm, which, with a ravenous appetite, feeds upon the leaves of the mulberry tree, consuming double its weight daily. In five weeks, it attains its full growth, having increased 8,000 times in weight. It is then three inches long, and as thick as a large, lead pencil.

THE SILK COCOON.

The worm now seeks a convenient place

FEEDING THE SILK WORM.

to begin the formation of its cocoon, which is to protect it in the changes incident to caterpillar life. Having selected a site, it ejects from two small tubes near the mouth, a liquid, gummy substance which adheres to whatever may be within reach; thus anchored, the next move of the body in the opposite direction draws out the silked fibre. The worm then turns over and over toward the center of the cocoon, and pays out the silked cable as it goes, until it has spun itself almost to death, and has built



COCOON—END VIEW.
(Enlarged.)

around itself a cocoon of silked thread about a quarter of a mile long.

Thus imprisoned, the insect remains, if undisturbed, for about 15 days, when the end of the cocoon is moistened, and it emerges in the form of a moth. This, however, causes the fibre of the cocoon to be badly tangled and twisted, so that it is necessary to kill the insect before it comes from the cocoon. This is done about eight days after the cocoon has been finished, by exposing it to the direct rays of the sun at a temperature of 100 to 125 degrees.

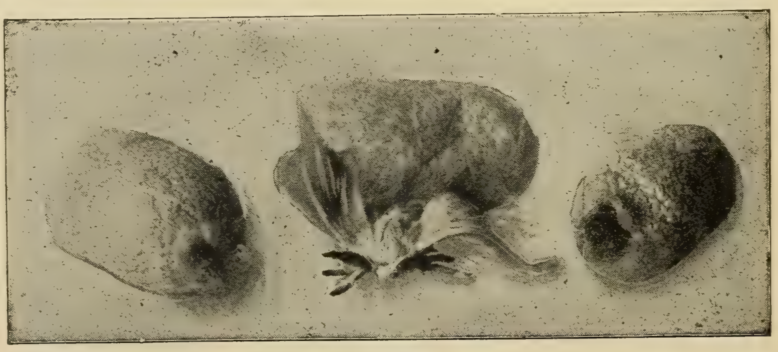
REELING THE COCOON INTO RAW SILK.

The cocoons are now ready to be reeled into raw silk. This is a very important operation, as everything depends upon the reeling, and the quality of the silk will be good or bad, according to the manner in which it is done. In silk countries the making of the cocoons is carried on as a separate business, distinct from the raising of silk worms, the cocoons being sold outright to the reeling establishments, which are known as "filatures."

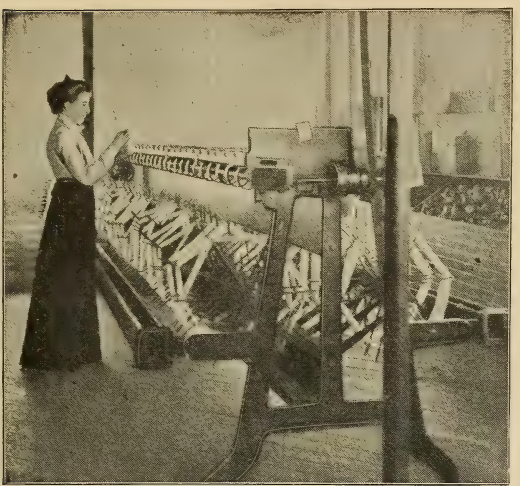
If the reeling has been indifferently performed, the silk may not sell for more than $4 a pound, but if well reeled it may bring $6 to $7, and even more, depending upon the demand at the time. It is also a peculiar fact, that of two reelers, each reeling half a pound of cocoons of the same quality, one will be able to obtain but 6 or 6½ ounces, and another will obtain 8 ounces.

The filaments of the cocoon are cemented together with a gum, and to dissolve this gum requires the aid of hot water. The cocoons are placed, from 6 to 10 at a time, in a basin of hot water, and sunk by the aid of a whisk broom below the surface, where they are allowed to remain from two to three minutes. This softens the gum and loosens the fibre; then, moving the whisk broom very lightly over the cocoons, the ends of the fibres will adhere to it and are easily found.

The ends of the fibres from each cocoon in the basin are then collected together to form one thread, which is passed through a



MOTH.



RAW SILK.
First Process, Winding.

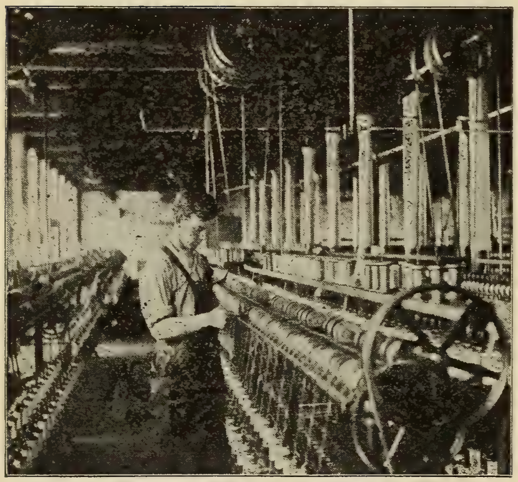
guide eye and tied to one of the barbs of the reel, and the reeling begins.

The reels are usually turned by hand, although, occasionally, electric power is used. The reel must be so far away from the basin that the gum of the fibres has a chance to dry and cool before it passes onto the reel, otherwise the fibres would become firmly cemented together. It is also important that the reel should be moved at a certain uniform rate of speed. The whole operation is tedious and necessarily expensive, as five ounces of well-reeled silk represents about ten hours' labor by an expert reeler.

The reels are usually about 70 inches in circumference and have a traverse rod which properly distributes the thread over a surface two or three inches wide. So fine are the fibres which come from the cocoons that they are almost invisible to an inexperienced eye, and the reeler does not depend upon seeing them, but gets notice of a broken subdivision by discovering one of the cocoons at rest on the water, while the others are still in motion.

This rupture must be instantly repaired if a uniform thread of raw silk is to be obtained. A supply of cocoons is kept close at hand so that as fast as the fibre in one is exhausted, another is put in its place. The ends are joined by a dexterous movement of the reeler, who carries the end of a reserve cocoon fibre to a point just below the guide eye, where the natural gummy substance found on the silk, assisted by the movement of the reel, causes adherence to the main thread.

Thus no tying of knots takes place in a single fibre of the silk while reeling, although in case of a break in all of the fibres, which is not common, a fresh start must be made, and a small knot is made, hardly perceptible in the after stages which the silk passes through. The skeins of raw silk are reeled from one to several ounces, as desired, and, on being removed from the reels, are dried and neatly packed into books or bundles weighing from 5 to 10 pounds. These books are then packed and sold in bales containing 133 1-3 pounds each, which is the way in which the raw silk reaches this country.



THE TWISTING PROCESS.

SPINNING IN THE FACTORY.

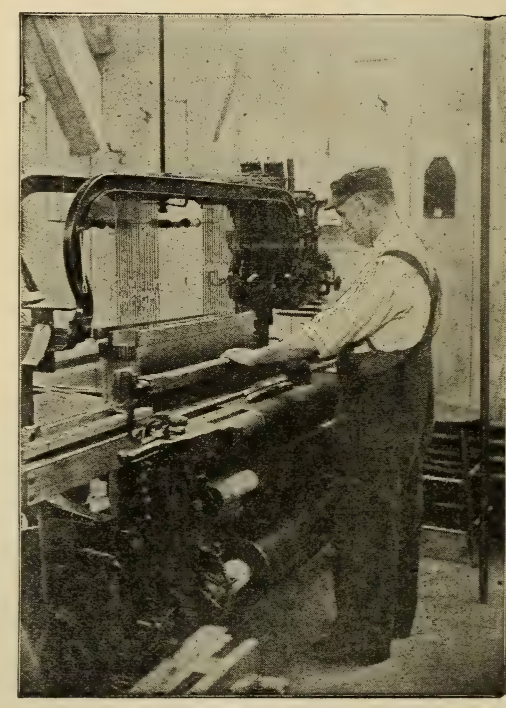
On reaching the factories where the manufacture of this raw silk is carried on, the skeins are soaked in tepid soapsuds for several hours to soften the gum, after which they are placed on light "swifts" and wound off onto bobbins. This makes the raw silk soft and pliable and gives a certain lustre to it. These bobbins are placed upon pins projecting from the bobbin board of a doubling frame, and from two to ten threads, or even more, are drawn off collectively onto one bobbin, which is next placed upon a rapidly revolving spinning-frame spindle. The threads, while being drawn from the bobbins to the spindle, are given the requisite amount of twist. These spindles revolve so rapidly as to appear to be motionless, a speed of 10,000 revolutions a minute not being at all unusual.

The thread is now drawn from the spindles and doubled and twisted, and for some purposes is again doubled and twisted, so that in an ordinary three-cord sewing silk it is quite possible to have 200 or even more of the original, gossamer threads which came from the cocoon, and the lightest grades of thread contain, at least, from 75 to 80 of the fibres.

DYEING AND SPOOLING THE SKEINS.

The next operation is reeling the silk into hanks of skeins for dyeing, which is one of the most important of the various processes, and requires experience as well as knowledge. After being dyed the thread is wound on spools, as desired, this operation being performed with great rapidity and accuracy by automatic machinery.

The silk cocoons vary in color from a delicate white to a dark yellow, depending to a great extent on the food of the worm and the locality in which it grew.

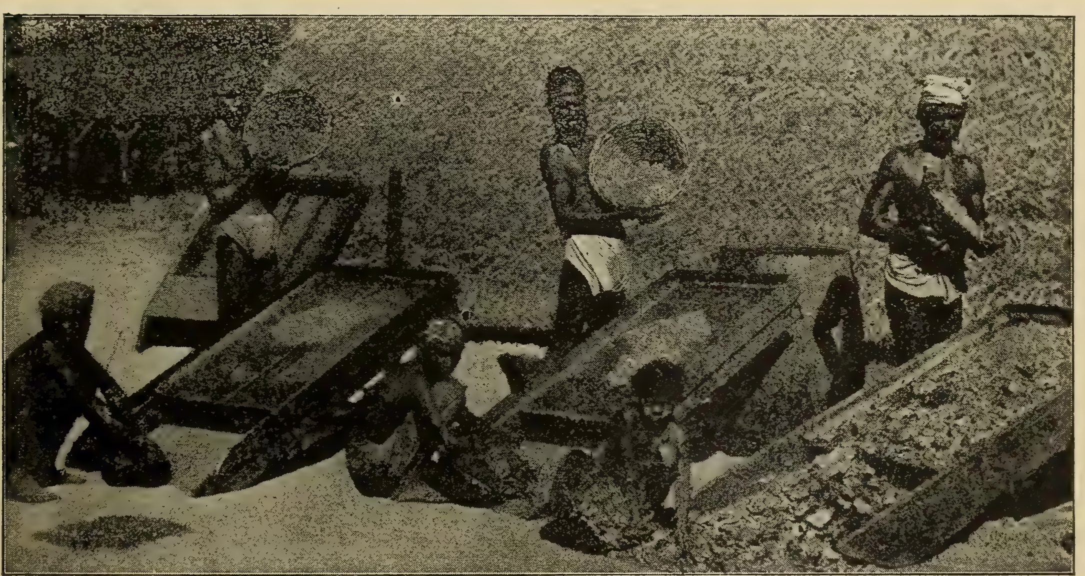


WEAVING SILK.

MAKING LEAD PENCILS

COMPOSITION OF THE LEADS.

The "leads" of lead pencils are made of a mixture of German pipe clay and "black lead", which is not lead, but graphite. But the first pencils were made of real lead and the name has clung to "lead" pencils ever since. Graphite, or plumbago, is a nearly pure form of carbon and most of the pencils made in this country use the graphite mined at Ticonderoga, Vermont, where the only graphite mine of any consequence in the United States is located.



SORTING OUT GRAPHITE (PLUMBAGO).
For making Lead Pencils.

GRAPHITE.

The graphite is taken in the lump from the mines and carried to the reducing mill, where it is ground or pulverized in stamp mills under water. The fine particles of graphite float away with the water through a number of tanks, collecting at the bottom of these reservoirs. It is packed in barrels in the form of dust and sent to the factory, where tens of thousands of lead pencils are turned out every day.

The pulverized graphite is so fine that it really is dust; it is dingy in color, and smooth and oily to the touch. It is divided into various grades of fineness by floating it on water from one tank to another. The coarse dust sinks to the bottom of the first tank, the next finer, to the bottom of the next and so on down the line, the finest powder, for the finest pencils, settling in the last tank.

GERMAN PIPE CLAY.

In another series of tanks the German pipe clay, which is mixed with graphite to secure the different grades of hardness, is graded in the same manner by floating. The finest clay is mixed with the finest graphite, and the hardness of the pencil is secured by increasing the proportion of clay in the mixture. For medium grades seven parts, by weight, of clay are mixed with ten parts of graphite.

PROCESS OF MIXING.

The mixing is done under a grinding mill similar to that used in mixing paint, and water is added to facilitate the mixing. The grinding stones are about two feet in diameter and only the upper one revolves. After the graphite and clay are ground together the mixture is put into canvas bags and the water is squeezed out under hydraulic press, leaving the mass the consistency of putty. This plastic material is placed in the forming press, which is a small iron cylinder in which a solid plunger or piston works up and down. A steel plate having a hole the size and shape of the "lead", is put under the open end of the cullender, and the plunger, pressing down, forces the graphite through the hole, making a continuous thread or wire of graphite.

As long as this thread is moist it is pliable, but it becomes brittle when dry, so it is handled rapidly. It is cut in three-lead lengths, straightened out, and then hardened in a crucible over a coal fire. The leads when taken from the crucible are ready for the wood.

DIFFERENT KINDS OF WOOD FOR PENCILS.

Pine is used for cheap pencils, an ordinary quality of red cedar is used for better pencils, and nothing but Florida Key cedar is used in the best.

CUTTING CEDAR STRIPS.

The sawmills at Tampa, Florida, cut the cedar blocks about seven inches long, and these are sawed into strips wide enough for six pencils; but as pencils are made in halves, each strip is thick enough only for a half pencil. When these strips are received in the factory they are run through a machine which cuts in each one six grooves, round or square, and at the same time smooths the face of the wood.

FILLING THE STRIPS WITH LEAD.

The filling of the strips is done by girls. The first one takes a grooved strip of wood in her left hand and a bunch of leads in her right. She spreads the leads out fan shape, and with one motion fills the six grooves with leads. Next to her sits another girl who takes the filled strip, and quickly and neatly lays on it another grooved strip, which has just been given a coat of glue by a third girl.

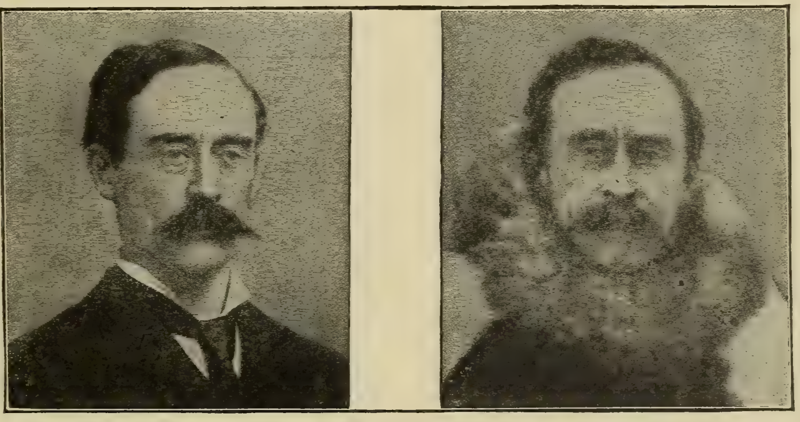
THE FINISHING PROCESS.

The filled and glued strips are piled up and put in a press to dry. The ends of the strips are evened off under a sandpaper wheel, and then the strips are fed into a machine which cuts out the individual pencils, shapes them and delivers them smooth and ready for the color polish in six streams. The coloring is done in liquid dyes, after the pencils have been sent through the varnish machine. Then follows the stamping, finishing and counting. This latter work is done by quickly filling a board having 144 holes in it, thus counting out a gross of pencils.

THINGS WE ALL SHOULD KNOW

Man's Hunt for the North Pole

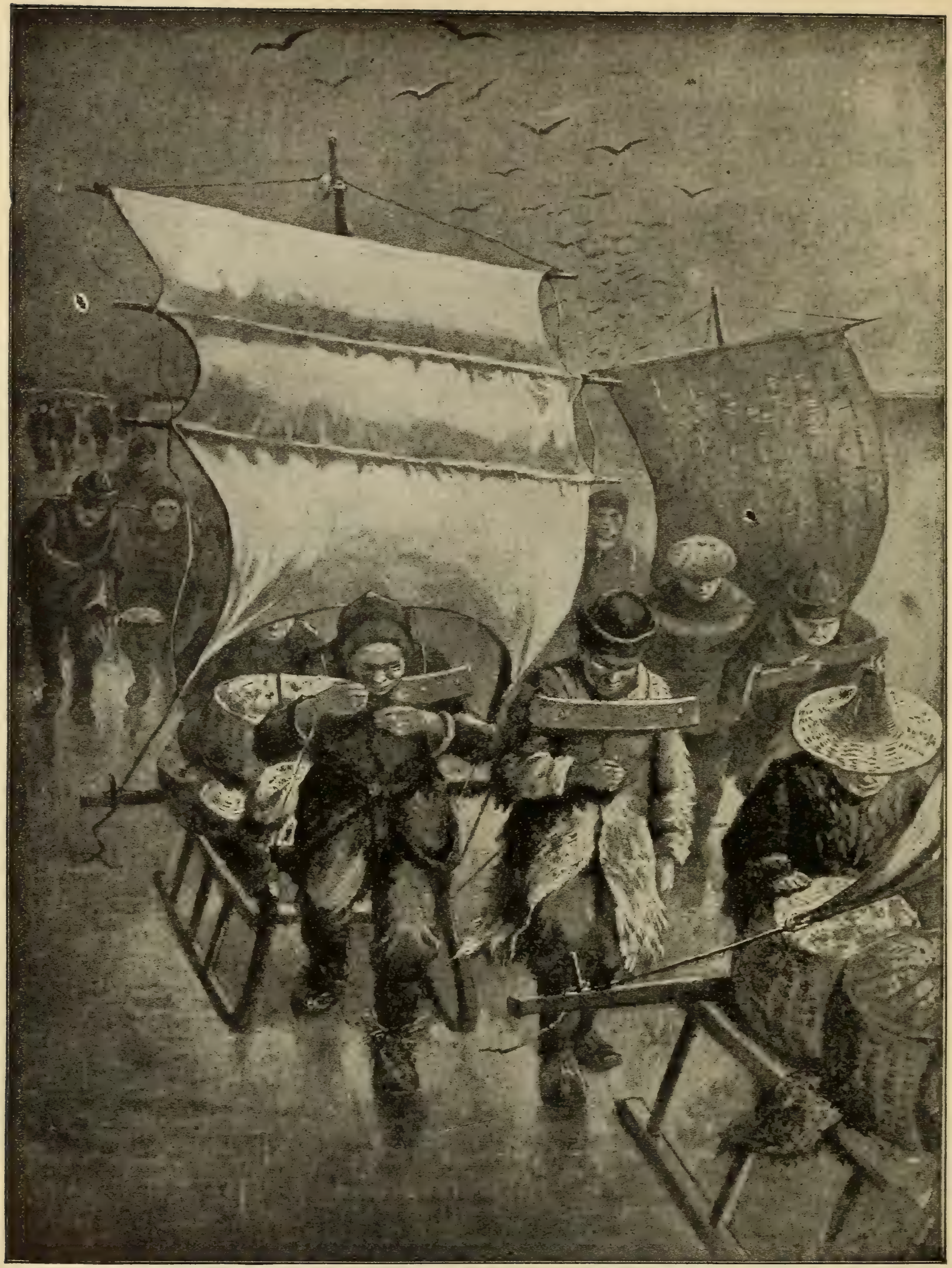
Organized search for the North Pole began in 1585, when John Davis entered Baffin's Bay, and penetrated the Arctic Circle. Since then there has been a long procession of adventurous explorers, the journeys of many of whom were attended with great loss of life and intense suffering. The most disastrous of all these expeditions was undoubtedly that of Sir John Franklin, made in 1845, and on which the leader and his entire party of 130 men perished. Another disastrous expedition was that made by Lieut. A. W. Greely, U. S. A., in 1881-84, in which twelve men lost their lives.



LIEUTENANT PEARY IN CIVILIAN AND IN EXPLORING GARB.

It was on September 1st, 1909, that Dr. Frederick A. Cook startled the world with a message from the Shetland Isles, stating that he had discovered the North Pole on April 21st, 1908. Dr. Cook started on his voyage July 3rd, 1907, from Gloucester, Mass., on a fishing trip to Labrador, as the guest of John R. Bradley, of New York. It was not until Mr. Bradley returned to his home in October, 1907, that the world knew that Cook had pushed on northward in an effort to reach the Pole, parting from Bradley at Etah, Greenland. Nothing more was heard from Cook until the following spring when Francke, a returning member of the party, brought a letter written on March 7, 1908. At that time Cook had been on the trail for only two weeks and had not made much progress. Eighteen months later announcement was made by Cook that he had located the Pole at latitude 90. On his return to this country Cook was feted and lionized, and made a great deal of money by the delivering of lectures. His description of the trip, with its privations, hardships and sufferings, was thrillingly dramatic.

Just five days after the world had been informed of Cook's claim, a similar message was received from Lieut. Robert E. Peary, U. S. N., who had also been making



SAILING SLEDGES ON THE GRAND CANAL OF CHINA.

In winter as in summer the Chinese waterways are the chief arteries of traffic. To assist his progress the ingenious Chinaman rigs up a sail in the manner pictured.

a hunt for the Pole. Peary's message was sent from Indian Harbor, Labrador, September 6th, 1909. In subsequent messages he gave the date of his discovery as April 6th, 1909, nearly a year later than the date set by Cook. A bitter controversy between the partisans of the two explorers began. Neither voyager had anything in the way of documentary proof to submit in support of his assertion, and the matter was finally taken up by the Danish Geographical Society at Copenhagen which, after examination of the data submitted by Cook, reported adversely on his claim. Cook then dropped out of sight for nearly a year and was not heard from again until December, 1910, when he published an article in an American magazine admitting that he was not positive he had reached the Pole, and if he had there was no way of proving it.

According to the map drawn by Cook he made his way from Annatok, his base of supplies, across Ellesmere Land to Nansen's Sound, and then directly north across the ice to latitude 90. Returning, he came south to Ringnes Land and thence southeast to Baffin's Bay by way of Jones Sound. After leaving the Bradley vessel at Etah Cook traveled almost exclusively by sled and on foot.

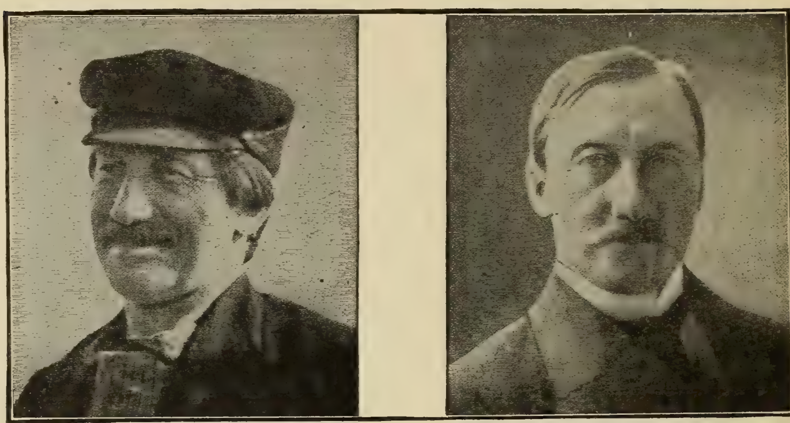
Peary left New York, July 6th, 1908, on the specially prepared steamer Roosevelt, going direct to Sydney, Nova Scotia, and from there to Etah, which was reached August 16th. From Etah his course was different from that selected by Cook. He made his way to Cape Columbia, on the northern coast of Grant's Land, considerably to the northeast of Nansen's Sound. From Cape Columbia the party worked its way northward to latitude 89.57, from which point the final dash to the Pole was made. Peary reports that the objective point was reached on April 6th, and that the party, consisting of Peary, Henson, the negro cook, and four Eskimos, remained there thirty hours. Observation showed the latitude to be 90. The temperature was 32 degrees below zero.

Both parties suffered intensely, but there was only one fatality. Prof. Ross Marvin, of Cornell University, was lost in latitude 86.34 by his sled sliding into an open "lead" or fissure in the ice.

Leaving out the last expedition of Cook and Peary, eleven notable attempts have been made to reach the North Pole since 1800, all of them ending in failure and intense suffering, and many of them in great loss of life. Arranged in chronological order these may be enumerated as follows: Beechey, 1818; Perry, 1819; Von Wrangell, 1820; Franklin, 1845; Kane, 1853; DeLong, 1881; Greely, 1881-84; Nansen, 1888; Peary (accompanied by Dr. Cook), 1891, 1893, 1898, 1905, 1909; Andree (balloon), 1897; Cook 1891, 1907.

While most of the polar expeditions have been made northward, numerous explorations, including those of Borchgrevink in 1900; Capt. Ruser in 1901; Capt. Bruce in 1903, and Capt. Shackleton, H. M. N., in 1907, have been made in an effort to locate the South Pole. Of these the most successful was that of Shackleton, and yet he only reached latitude 88.23 south, but this was 340 miles further south than any of his predecessors. While Antarctic exploration has its share of danger and suffering, and the cold is fully as intense as that in the North, there has been no similar loss of life. This is all the more remarkable from the fact that there is absolutely no animal life in the extreme south, and explorers can not get supplies of life-saving food as Arctic explorers do by shooting wolves, bears, and other animals. If Shackleton reached latitude 88.23, as seems to be well confirmed, he was within 100 miles of the South Pole. That he was compelled to turn back before reaching the goal, was because of lack of food supplies.

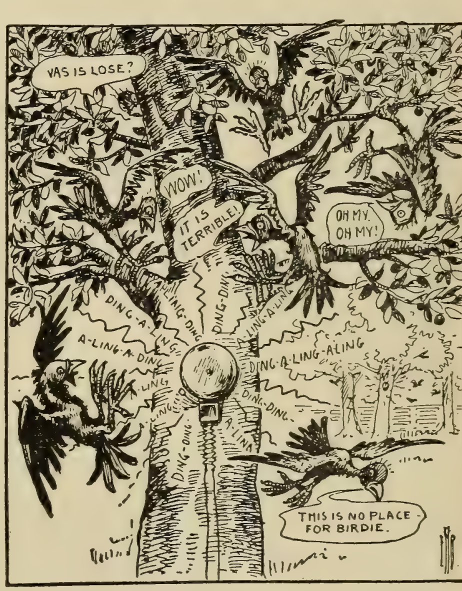
Two interesting facts have been demonstrated in connection with North and South Pole exploration. Both Cook and Peary agree that the immediate vicinity of the North Pole is composed of a great field of rough ice in fantastic shapes, but whether this ice covers land or water is unknown. In the vicinity of the South Pole there are vast stretches of ice-covered ocean, with comparatively small areas of land. Both the North and South magnetic Poles have been reached, but the true geographical Poles for which explorers have searched for centuries, are as yet undiscovered so far as actual records show.



DR. COOK IN DENMARK AND IN AMERICA.
At the left hand the explorer is shown as he appeared on landing at Copenhagen. On the right he is seen as he looked on landing in America.

ELECTRIC "SCARECROWS."

For many years farmers have used fantastic lay figures of various kinds to frighten away crows and other depredatory birds from their growing crops of grain, but none of them has been wholly satisfactory. An Austrian schoolmaster has lately patented an electric gong system which effectively scares away the birds. This consists of a clock, which at irregular intervals makes connection with electric gongs fixed in various positions in the orchards and grain fields. The noise made by the gongs serves as an effective "scare crow" and frightens off whatever birds may have invaded the field.



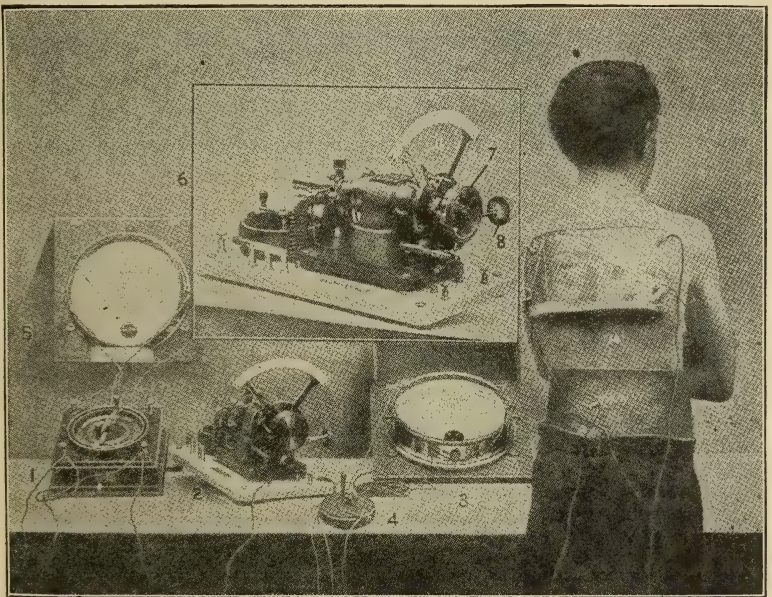
AN ELECTRIC "SCARECROW."

ELECTRIC RAILWAYS.

Although it is less than 25 years since the first Electric Railway was operated in Richmond, Va., there are 1,500 lines today. During the year 1910 these lines carried 10,000,000 people. This only includes the lines running between cities and towns.

BRINGING THE DEAD TO LIFE.

Dr. Louise G. Robinovitch, whose home is in Paris, but who passes part of her time in New York, is credited, by reliable authorities, with power to restore human life by means of electricity applied with apparatus of her own designing. She has interested the New York Edison Company in her experiments, and has given several demonstrations in the presence of the company's experts. One case in particular is cited.



ROBINOVITCH APPARATUS FOR RESUSCITATING THE DEAD.

A woman far gone with the ravages of morphine eating, was admitted to Ste. Anne Asylum, Paris, where she was deprived of the drug. One day she died—at least the physicians pronounced her dead. All the ordinary means of resuscitation were employed without avail. Twenty minutes after the physicians had abandoned their useless efforts Dr. Robinovitch's apparatus was applied. Within thirty seconds the complexion of the "corpse" began to change, finally assuming a natural color. There was a quick, sharp sigh, and the woman's eyes opened.

"Oh! I feel so cold in the back!" she cried, with a shiver. It was the wet pad of cotton in the electrodes at her back.

A devout little nurse dropped a bottle of aromatic spirits she had been holding and crossed herself. "Back from the dead!" she exclaimed and the look in her eyes was half horror, half astonishment. Dr. Robinovitch had expected skepticism on the part of the male physicians. One, witnessing this "reawakening," asked: "I wonder have you brought the soul back too?" The woman, in her hour of triumph, merely smiled.

Where actual death has set in to the extent of making chemical changes in the body, resuscitation is impossible. The more advanced physicians, in view of the Robinovitch demonstrations, now maintain that evidence of these chemical changes is the only real proof of death. In hundreds of cases Dr. Robinovitch has demonstrated to physicians that animals, such as rabbits, which had been shocked to death by electricity, could be restored to life by an application of the same power. It is now broadly claimed that in cases where criminals are electrocuted by the means ordinarily employed and life can be restored if the application is made quickly enough.

WAR ON FLIES AND MOSQUITOS.

Medical science has developed the fact that the common house fly and the mosquito are great purveyors of disease. The fly visits putrid masses, the germs of typhus and similar fevers attaching to its feet. It then invades the home through open windows and doors and leaves some of these disease germs wherever it alights, frequently on the food which is later taken into the human system, germs and all. The mosquito performs its deadly work in a different manner, but the results are even worse. Where the fly merely deposits the germs of disease and trusts to chance for their being swallowed by human victims, the mosquito makes its work sure by inoculating its victims with the virus of disease, such as yellow fever, for instance, by biting them. This has been decisively established through scientific experiments by experts. notable among whom is Dr. John B. Smith, state entomologist of New Jersey. Consequently, the command has gone out, "Swat the flies! Swat the mosquitos!" and it is being obeyed. Vigorous war is being made against both pests, but more has been accomplished in the suppression of the mosquito, than of the fly. This is mainly because the breeding places and habits of the mosquito are better known, and more strenuous war has been made against the pest than in the case of the fly. But the war on the latter has been started, and has begun to show results.

Mosquitos breed in stagnant water. Water is an absolute necessity to their existence. If fish can be introduced into these stagnant pools the mosquito will soon disappear, as the fish feed greedily upon the young "wrigglers," which, if left alone, develop rapidly into poison-bearing "skeeters." Draining the stagnant pools will kill off the pests; so will opening ditches which admit a current of water; burning the vegetation is another remedy, as is spraying the stagnant waters and banks with solutions of permanganate of potash, or kerosene oil. All of these means of extermination are being used with good effect, and the number of mosquitos is growing less year by year. Left alone the pest breeds with wonderful rapidity. In one small pool at South Cape May, New Jersey,

OFFENSIVE WEAPONS OF POISONOUS MOSQUITO.

Dr. Smith took out 10,636,704 "wrigglers," an average of 5,616 to the square foot.

The extinction of the house fly is a more difficult proposition. It has no known, or favored, breeding places which may be systematically attacked. It reproduces itself in countless swarms anywhere and everywhere. Thus far the people have had to content themselves with a more general use of screens on windows and doors, and various fly-catching devices, such as sticky paper, fly traps, etc.

REMEDY "NO. 606" AND ITS USE.

If the expectations of the medical profession are realized, "Remedy No. 606," introduced by Prof. Paul Erlich, of Germany, will be of inestimable value to the human race. It is known as "606" merely because that is the official number of the experiment as conducted by Prof. Erlich at the Royal Institute for Experimental Therapeutics at Frankfort-on-the-Main. Physicians designate the preparation as salvarsan. Its office is to overcome, or cure—this latter word is tabooed by ethical physicians—the ravages of blood diseases of syphilitic origin. Until the introduction of "606" there was no course of treatment known to the medical profession by which the desired results could be obtained in all instances. Even now there are some prominent physicians who deprecate the universal use of "606," but the more advanced of practitioners, having confidence in Prof. Erlich's skill, and with the lesson of the wonderful results obtained at Frankfort before them, accept the verdict as to its efficacy without question.

Salvarsan, or "606," is a yellow, sulphur-colored powder, the chemical formula of which is $C_{12}H_{12}O_2N_2As_2$. This powder is mixed with a normal solution of sodium hydroxide, a thick alkaline fluid resulting. This fluid is in turn treated with acetic acid to remove the excess of alkalinity. A light yellow-colored sediment is precipitated, the supernatant fluid being the celebrated "606." This is injected in average doses of 0.5 gm. The remedy has been used with gratifying results in many of the leading hospitals of Europe, under the supervision of eminent physicians, including such famous men as Citron and Wechselmann.

It was Prof. Erlich who suggested and carried to success improvements in the preparation of diphtheric anti-toxin, with the result that only a fraction of an ounce is now required for treatment where formerly it took from five to seven ounces.

GREAT INCREASE IN EMBEZZLEMENTS.

The record of embezzlements, forgeries, and bank wrecking for the past year shows a material increase over 1909, being in round numbers about $25,000,000, as compared with $8,000,000 in 1909 and $13,000,000 in 1908. These losses, as reported by telegraph, were distributed as follows:

Banks	$15,000,000
Public officers	2,000,000
Forgeries	2,500,000
Agents	1,000,000
Loan associations	2,000,000
Miscellaneous	2,500,000

The figures given will approximate the total losses. Many embezzlements are incorrectly reported. Some cases are settled in full, there being no criminal intent, and in many cases alleged embezzlers are declared guiltless by the courts.

GENEROUS GIFTS BY AMERICANS.

Extraordinary liberality was shown by Americans in their monetary gifts to religious, charitable, educational, and similar purposes in 1910. The total amount of these gifts was $141,604,538. Of this amount $97,492,407 represented gifts and $44,112,131 bequests. These sums have been distributed as follows: To charities of various kinds, $56,229,243; to educational institutions, $61,283,182; to religious institutions, $12,654,433; to art museums, galleries, and public improvements, $9,536,680. A significant feature of this report is the rapidly decreasing amount given to libraries ($1,911,000), which a few years ago occupied a conspicuous place in these records. During the year women gave $8,743,722 to charities, $6,433,250 to schools and colleges, $3,025,500 to museums and galleries, $2,432,270 to religious institutions, and $148,000 to libraries. The largest individual contributor was Andrew Carnegie, with a total for the year of $19,664,325, making a grand total to date of $179,500,000. John D. Rockefeller stands next with 1910 gifts of $16,039,000, grand total to date of $135,000,000.

OUTDOOR CURE FOR CONSUMPTION.

In Chicago, and elsewhere in the United States, organized effort is being made to combat pulmonary tuberculosis (the white plague) and anaemic conditions generally in children by the means of outdoor schools. The results have been so encouraging that it has received the endorsement of prominent physicians and is to be greatly extended. A few months in the open-air school transforms weak, puny children with tubercular tendencies, into robust youngsters. These schools, as a rule, are located on the roofs of handy buildings, or on specially constructed open porches or balconies. While book lessons are taught there are frequent intermissions devoted to dancing and other forms of calisthenics. No matter how cold the weather may be the school routine is not interrupted, the children retaining their hats and wraps while at study, and the frequent exercises tending to keep the blood in circulation and warm the body. One of these schools, under roof, but with the windows removed so the fresh air may circulate freely, is conducted by the Chicago Board of Education in connection with the Graham public school in that city. The results in the improvement of the physical health, and mental calibre of the pupils are said to be marvelous.

Sleeping outdoors, preferably on a roofed balcony, so as to be protected from rain, has also been found to be of wonderful benefit in cases of pulmonary tuberculosis. The fresh air seems to arrest the progress of the ailment, and replaces the diseased lung tissue with a healthy growth. Those who have tried this simple remedy speak strongly in praise of it, and their improved looks verify their assertions. It is admitted even by the most ardent advocates of the treatment, that to be of benefit it must be resorted to in the early stages of the disease, or at least before it has advanced to the incurable stage.

FATALITIES TO HUNTERS.

During the year ending Dec. 31, 1910, there were 219 people killed and 232 injured while on hunting expeditions in various parts of the United States. The largest number of deaths (42) was in Wisconsin. Maine comes next with 33, Pennsylvania with 31, and Michigan fourth, with 26. Montana, Missouri, Nebraska, New Jersey, Oregon, Rhode Island and West Virginia are the only states in which no fatalities occurred.

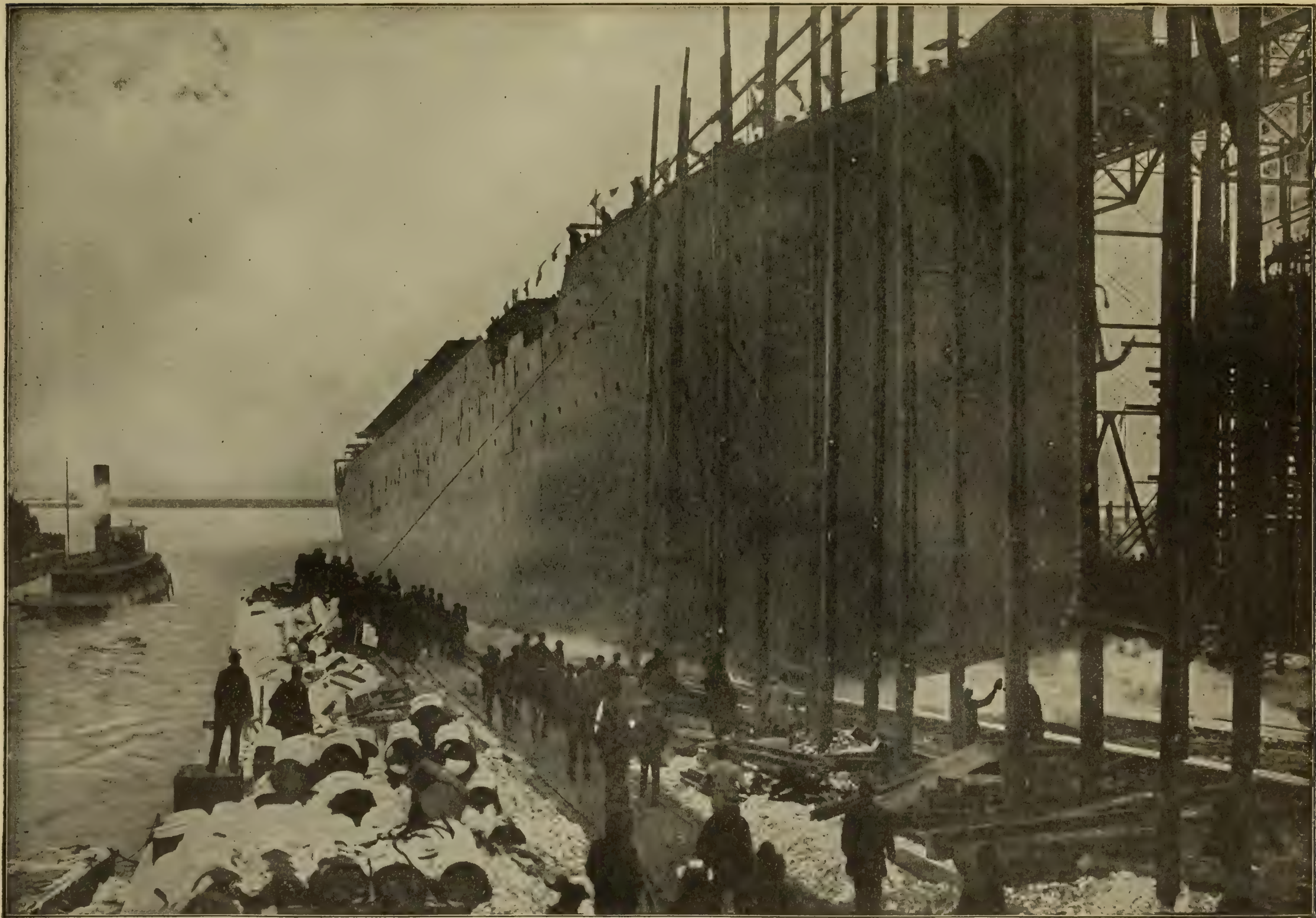
EPIDEMICS AND WAR LOSSES.

The loss of life by epidemics in Europe shows a large increase over the last two years, being approximately 150,000, as compared with 5,000 in 1909 and 50,000 in 1908. The two principal sufferers were Russia and Italy, which together lost about 102,000 victims by cholera.

The wars of 1910 were mostly short lived and not destructive. One thousand five hundred and fifty were killed in Africa, 20 in Corea, 1,060 in China, 45 in India, 550 in Syria, 1,800 in Arabia, 2,103 in Albania, 113 in Morocco, 300 in Portugal, 11 in Persia, and 200 in Tripoli. The battle losses in Mexico, Central and South America, as the outcome of revolutions, were as follows: Mexico, 2,653; Nicaragua, 2,406; Honduras, 116; Brazil, 400, Uruguay, 500. The total for the year was about 13,000, as compared with 68,000 in 1909 and 22,000 in 1908.

HAGUE PEACE CONFERENCE.

Two sessions of The Hague Peace Conference have been held—the last in 1906—with the purpose of securing universal



LAUNCH OF THE "KROONLAND," CRAMPS' SHIPYARDS, PHILADELPHIA.

This is a passenger and freight steamship for Atlantic service, 560 feet long and with engines of 10,000 horsepower.

peace among the nations of the world, but little of practical value has been attained. In this body every civilized country in the world is represented. The delegates from the United States at the last session were:

Hon Seth Low, Hon. Standford Newell, Hon. Andrew D. White, Frederick W. Hulls, Capt. Alfred T. Mahan, U. S. N., and Capt. William Crozier, U. S. A.

The idea, which originated with the Czar of Russia so far back as 1899, was to stamp out the possibility of war by decreasing, or at least not increasing, military and naval armament, and its attendant burdens of taxation, but thus far no real progress has been made. It was desired to substitute a system of international arbitration for the settlement of quarrels between nations, and thus eliminate entirely, or greatly reduce, the possibility of actual hostilities. Despite the two conferences the various nations, especially the more powerful ones, have gone on increasing their war forces, and the desired end seems as far from attainment as ever. As an illustration of what might be accomplished in this direction, the case of the Treaty of Ghent between the United States and Great Britain, was cited. Under this compact the border line between the United States and Canada is unfortified by either country, and no war vessels are maintained on the great lakes.

In its inception Andrew Carnegie was an ardent and liberal supporter of The Hague Peace Conference policy, and contributed generously in money to secure the desired results. That he has begun to lose confidence in the ability of the conference to bring about universal peace is evidenced by the fact that, on December 13th, 1910, Mr. Carnegie started another universal peace movement, contributing $11,500,000 to the cause. The interest of this fund, amounting to $575,000 a year, he placed at the disposal of a board of twenty-one trustees of his own selection, "to be used in any manner they may deem best, so long as it will tend to lessen the chances of war among the nations."

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THE WORLD'S GREAT DISASTERS.

The first ten years of the Twentieth Century were marked by an unusual number of appalling catastrophes. First came the volcanic eruption of Mt. Pelee in 1902, by which 30,000 lives were lost, and the entire city of St. Pierre, Martinique, wiped out of existence. Then came the horrible Iroquois theater fire in Chicago, in which nearly 700 people were killed. Next came the San Francisco earthquake disaster in 1906, and then the Italian seismic horror of 1908, which has been described as the most appalling and terrible in the annals of history.

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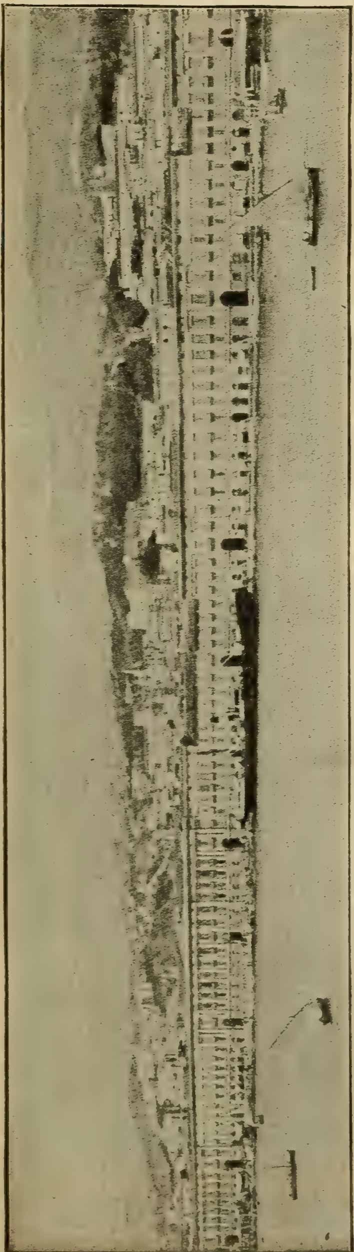
ERUPTION OF MT. PELEE.

On May 8, 1902, the city of St. Pierre, metropolis of the French island of Martinique, in the Caribbean sea, southeast of Porto Rico, was wiped out of existence by an eruption of Mt. Pelee, a volcano, which was supposed to be extinct. For several days the volcano had given signs of unrest, but nothing serious was anticipated, until a short time before the actual outbreak, and it was then too late for the bulk of the people to escape. It was just before eight o'clock on the morning of Thursday, May 8, that the lava and gases of the crater of Mt. Pelee burst their bounds and bore destruction to the fated city. Within thirty seconds 30,000 persons were killed, and the streets of St. Pierre were heaped with dead bodies. Within ten minutes the city itself had disappeared in a whirling flame vomited from the mountain. The volcano, whose ancient crater for more than fifty years had been occupied by a quiet lake in which picnic parties had bathed, discharged a torrent of fiery mud, which rolled toward the sea, engulfing everything before it. The city was no more.



MESSINA, THE DAY BEFORE THE EARTHQUAKE.

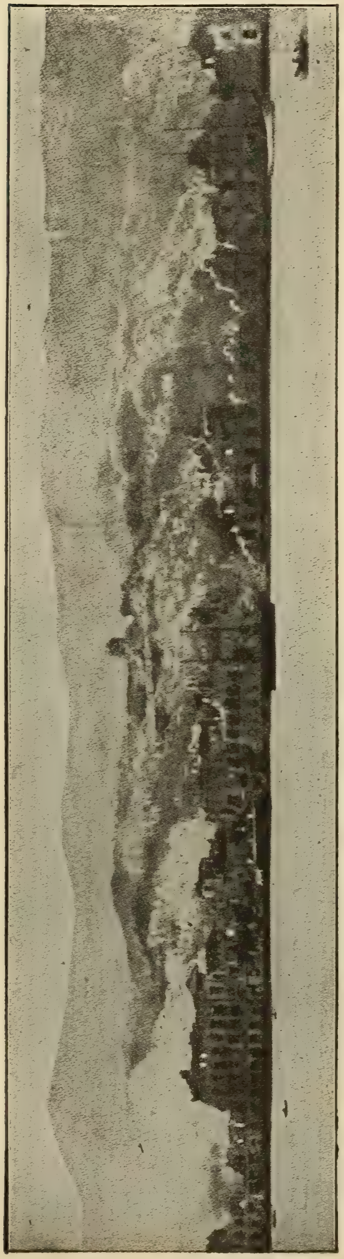
St. Pierre was destroyed by one all-consuming blast of suffocating, poisonous, burning gases. Death came to the inhabitants instantly. It is not merely true that no person inside the limits of the town escaped, but it is probably a literal fact that no person lived long enough to take two steps toward escape. The manner of the annihilation of St. Pierre is unique in the history of the world. Pompeii was not a parallel, for Pompeii was eaten up by demoniac rivers of lava, and lava became its tomb. But where St. Pierre once stood there was not even a lava bed. The city had gone from the earth.

SAN FRANCISCO EARTHQUAKE.

About 5 o'clock, on the morning of April 18, 1906, the people of San Francisco were awakened by a terrific earthquake shock which destroyed many buildings. Following this fire broke out which raged for three

DEATH AND RUIN EVERYWHERE.

days, destroying a large part of the city, and making nearly 40,000 people homeless. Many lives were lost. The exact number will never be known, as in the excitement many bodies were buried without formal permit or record. Over 500 bodies were taken from the ruins by the firemen, police and soldiers. The money loss has been placed at $200,000,000. The earthquake shock destroyed the water mains, and deprived of an adequate supply of water, the firemen could make no headway against the flames. Water, even for drinking purposes, was hard to get. The fire did not stop until it had burned itself out, although many buildings were dynamited in the hope of checking the flames. The work of rebuilding the city began almost before the ruins had cooled off, and the San Francisco of today is a handsome, solidly constructed, modern city.



MESSINA, THE MORNING AFTER THE EARTHQUAKE.

THE ITALIAN EARTHQUAKE.

Early on the morning of Monday, December 28th, 1908, the southern part of Italy, and the eastern part of Sicily, was visited by a terrific earthquake, lasting 23 seconds, which completely annihilated everything within its zone. Following immediately after the great shocks came an

SEA FRONT OF MESSINA, SHOWING WRECKAGE.

enormous tidal wave that hurled itself with resistless fury against the already stricken city of Messina completing the work of destruction in the lower part of the town. Almost immediately afterwards fires broke out in many places and turned the vast sepulchre into an actual inferno. The suddenness of the shock was responsible for the huge death roll. Thousands were killed in their beds before they could realize what was happening. Others were killed by falling debris or shattered under masonry that toppled into the streets as the earth continued its quivers and even long after all pulsations had ceased. It required an army of 25,000 men to rescue the living entrapped in the ruins, and to bury the dead. It is estimated that 100,000 people were killed in less than half a minute in Messina and the immediate vicinity.

At Reggio, on the mainland of Italy, just across the straits from Messina, only 5,000 out of a population of 50,000 escaped. Bagnara, Cannitello and other towns suffered in proportion. Relief was rushed to the stricken region as promptly as possible, the entire civilized world responding to the cry for help with generous contributions of food, clothing and money. But, promptly as this relief was furnished, there was a lamentable amount of suffering from hunger and exposure. For weeks searching parties dug amid the ruins, and made many remarkable rescues. In one instance two girls and a boy who had been entombed in the ruins for eighteen days, were taken out alive. More than $10,000,000 was raised for the relief of the sufferers, of which the people of the United States contributed $3,600,000. The total loss of life has never been officially reported, but conservative estimates place it at between 250,000 and 300,000.

FINANCIAL DEVELOPMENT OF UNITED STATES IN 1910

	1909.	1910.	% Inc.
†All bank clearings	$164,195,488,940	$162,000,000,000	*1.3
Value of all farm products	8,760,000,000	8,926,000,000	1.9
Railroads earnings, gross	2,608,176,609	2,835,374,081	8.7
Deposits in all banks	14,035,000,000	15,283,400,000	8.1
Capital stock of banks	1,800,000,000	1,879,000,000	4.4
Circulation, national banks	703,940,000	724,874,308	2.9
Net earnings, national banks	131,185,750	154,167,000	17.6
Dividend disbursements	611,000,000	695,000,000	13.7
Value bonds sold, New York	1,317,291,000	630,000,000	*52.2
Value of imports	1,475,000,00	1,550,000,000	5.1
Value of exports	1,730,000,000	1,843,000,000	9.0
Building expenditures	857,550,669	809,000,000	*5.7
Fire losses	203,649,150	229,942,650	12.9
Business failures	151,752,098	†199,607,292	31.5
Cereal crops, bushels	4,719,441,000	5,160,426,000	9.3
Hay crop, tons	64,938,000	60,978,000	*6.1
Cotton crop, bales	10,363,240	12,000,000	15.8
Wool clip, pounds	307,348,000	295,672,000	*3.8
Coal mined, tons	437,176,241	500,000,000	14.4
†Iron ore shipments, tons	42,586,869	43,629,201	2.4
Pig iron production, tons	25,337,002	26,665,341	5.2
Sault Ste. Marie commerce, tons	57,895,149	62,363,218	7.7
Portland cement production, barrels	62,508,461	70,000,000	12.0
Sugar production, tons	1,556,000	1,565,000	0.6
Total mileage railroads	234,950	239,070	1.7
New railroads built, miles	3,748	4,120	9.1
Immigration	1,334,166	1,078,000	*19.2

*Decrease. †Dun's report.

CIVIL SERVICE AND ITS LAWS

Properly speaking, civil service means the service of all persons in the employ of government, national, state or municipal, except those in the army and navy. Civil service, therefore, existed from the time of the foundation of the government. But civil service reform, growing out of the abuses that were saddled upon public office, is of comparatively recent growth in this country. The general practice in the national government was that with every change of presidents from one party to another, there should be a clean sweep of all employes under the government, irrespecttive of merit, age or period of service, with the broad rule applied, "to the victors belong the spoils."

Finally it began to be recognized that there should be no "spoils," that "public office is a public trust," that faithful and competent service should assure permanence, and that the whole system in effect was unnatural and unwise, as well as highly improper. Earnest men, true patriots, began to plan for improvement, and now the country sees less and less of the unseemly scrambles for official place and plunder that used to be the chief evil of changing administrations.

The act of January 16, 1883, popularly known as the civil service act, is entitled "An act to regulate and improve the civil service of the United States." Its purpose, as its title indicates, was to correct certain conspicuous abuses which were then prevalent in connection with the appointment and promotion of civilian employees in the executive branch of the government, and at the same time to improve that part of the public service by increasing the efficiency of the employes, and thus securing a more satisfactory and economical administration of public affairs. In the departments at Washington the classification embraced all persons receiving salaries of not less than $900 nor more than $1,800 a year—altogether 5,652—of whom 135 were excepted from examination. The classification of the Customs Service embraced places having an annual compensation of $900 or over, at ports where 50 or more persons were employed, excluding only those whose nominations had to be confirmed by the Senate. The number of places thus classified, including eleven ports, was 2,573. The number of postoffices classified—being those at which there were 50 or more employes—was 23, and the classified service at these offices included all persons above the grade of workman or laborer except the postmasters, or 5,699 in all. In the three branches of the classified service, therefore, the total number of places made subject to the provisions of the civil-service rules was 13,924. By March 3, 1885, President Arthur, under whom this act became a law, had extended its operations to include 15,573 places. By March 3, 1889, President Cleveland caused it to include 27,330 classified places. By March 3, 1893, President Harrison had extended it to 42,928 places. At this time Secretary Tracy, with the approval of the President, put the Navy Yard Service under the merit system, thus classifying about 5,000 employes. By March 3, 1897, President Cleveland caused the act to cover 81,889 classified places. By June 30, 1901, President McKinley had added 2,233 places to the civil-service list, and under his administration, under various rulings, there were 19,423 places dropped from the merit system and restored to the list of purely appointive offices.

President Roosevelt caused nearly all of the more important places to be restored, and extended as rapidly as possible the merit system over the newly acquired dependencies and colonies.

EXTENT OF THE SERVICE.

It is estimated that the number of positions in the Executive Civil Service is now about 210,000, of which approximately 90,000 are classified competitive positions, 100,000 unclassified, and somewhat less than 20,000 are classified but not subject to competitive examination. Less than 20,000 of the official force are employed in Washington, D. C. Most of the unclassified positions are held by fourth-class postmasters, of whom there are more than 72,000.

Under the act of April 12, 1900, the United States Civil Service supplanted the military service in Porto Rico. Inasmuch as the executive officers and employes under this act become a part of the Executive Civil Service of the United States, they are properly subject to the provisions of the Civil Service acts and rules. On July 5, 1900, the Secretary of the Treasury, with the President's approval, issued an order classifying and including within the provisions of the Civil Service law and rules the officers and employes in and under the Treasury Department of Porto Rico, excepting persons appointed with the advice and consent of the Senate and persons employed as mere laborers or workmen. On August 29, 1900, the Postmaster-General informed the Commission that the United States Postoffice Department, on May 1, 1900, assumed control of the free-delivery service at Mayaguez and San Juan, Porto Rico. The Commission approved the lists of carriers transmitted therewith and authorized the treatment of the offices as free-delivery offices.

On July 5, 1900, the Secretary of the Treasury issued an order classifying the employes of the Treasury Department in Hawaii. The order is similar in scope and language to that of the same date relating to Porto Rico.

On September 19, 1900, the United States Philippine Commission passed an act entitled "An act for the establishment and maintenance of an efficient and honest civil service in the Philippine Islands." In introducing the measure President Taft said:

"The purpose of the United States Government and the people of the United States in these islands is to secure for the Filipino people as honest and as efficient a government as may be possible. It is deemed by the Commission and by the Government which the Commission represents to have every feature of this bill consistent with the Government. The danger in any government, whether it be republican or monarchial, is that public office be used for private purposes. All countries have suffered from this evil, and those countries in which a thorough system of civil service is selected are the first to minimize that danger."

HOW TO ENTER THE CIVIL SERVICE.

Persons seeking to be examined must file an application blank. The blank for the Departmental Service at Washington, Railway Mail Service, the Indian School Service, and the Government Printing Service should be requested directly of the Civil Service Commission at Washington. The blank for the Customs, Postal, or Internal Revenue Service must be requested in writing of the Civil Service Board of Examiners at the office where service is sought. These papers should be returned to the officers from whom they emanated.

Applicants for examination must be citizens of the United States, and of the proper age. No person using intoxicating liquors to excess may be appointed.

A set of specimen examination questions covering all the departments has been prepared by the Commission, with full information as to examinations. This is published in a pamphlet under the title, "Manual of Examinations," and may be obtained free of charge by writing to the United States Civil Service Commission, Washington, D. C. It can also be obtained from any postoffice where there is a civil service department.

The age limitations for entrance to positions in the different branches of the service are as follows:

	Minimum.	Maximum.
Departmental service:		
Page, messenger boy, apprentice, (other than apprentice in mints and assay offices) or student	14	20
Apprentice in mints and assay offices	18	24
Printer's assistant and messenger	18	No limit.
Positions in the Railway-Mail Service.	18	35
Internes and hospital stewards in the Marine Hospital Service and acting second assistant engineer in the Revenue-Cutter Service	21	30
Keeper, assistant keeper and officers of light-house tenders and light vessels in the Light-House Service	18	50
Cadet in the Revenue-Cutter Service and aid in the Coast and Geodetic Survey	18	25
Surfman in the Life-Saving Service	18	45
Superintendent, physician, supervisor, day-school inspector, disciplinarian, matron, and assistant matron in the Indian Service; inspector and assistant inspector of hulls and inspector and assistant inspector of boilers in the Steamboat-Inspection Service	25	55
Observer in the Weather Bureau Service	18	30
All other positions	20	No limit.
(The age limitation shall not apply in the case of the wife of the superintendent of an Indian school who applies for examination for the position of teacher or matron.)		
Custom-House Service: All positions	20	No limit.
Post-Office Service:		
Rural letter carrier	17	55
All other positions	18	45
(The age limitations shall not apply in the case of an honorably discharged United States soldier or sailor of the civil war or of the Spanish-American war who applies for the position of rural letter carrier.)		
Government Printing Service:		
All positions (male)	21	No limit.
All positions (female)	18	No limit.
Internal-Revenue Service: All positions.	21	No limit.

The inestimable value of the merit system to good government is now so universally admitted, and so unassailable from both moral and economic standpoints, that it is being extended throughout the entire field of public service.

Civil Service on the merit system in the cities is making notable progress, as in Chicago, New York and Boston, while in other cities it is still struggling against the spoils system of the professional politicians.

The merit system of the Civil Service is likewise making notable progress among the States, as in New York and Massachusetts, where a practical economic system is now in effective operation.

Likewise many counties of the various

States have adopted civil service rules in which there shall be "no dismissal except for cause, no promotion except for merit." In this way the office spoilsmen among professional politicians can not cause the dismissal even of a janitor without due trial and conviction of a misdemeanor.

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COMPULSORY EDUCATION

Most of the States of the Union, and the District of Columbia, have compulsory education laws under various conditions, many of them made partly ineffective by exceptions.

In Ohio the law is inoperative where the seating accommodations of the school houses are insufficient.

In Massachusetts, the four Cape Cod counties and the mountain counties of the west are exempt.

In the various States, required attendance varies as to age from 7 years to 16 years. The prevailing limits are 8 to 14 years, and as to time, from eight weeks in Kentucky to the entire term taught in Massachusetts and Connecticut.

Where the penalty is on the parent, it varies in fines from $1 in New Mexico to $200 for repeated neglect in Nevada.

The penalty is in numerous places on the child. In Maine if the child is between 10 and 15 years of age and guilty of repeated truancy, it is sent to the reform school; in New Hampshire to industrial school; in Massachusetts, between 7 and 16, to truant school; in Rhode Island to any designated institution; in New York to truant school; in New Jersey to juvenile reformatory, if over 9 years of age; in Pennsylvania to local truant school; in Ohio to a reformatory; in Indiana to a parental home provided by the school board; in Michigan to an ungraded school provided by the board.

Penalties varying from $10 to $100 for non-enforcement of the law are set upon officers in the states of Maine, Vermont, Pennsylvania, West Virgina, Kentucky, Ohio, Wisconsin, Minnesota, North Dakota, South Dakota, Kansas, Montana and California.

In most of the states where there are state institutions for the deaf, dumb and blind, there is compulsory attendance at the parents' expense if they are able.

Exemptions from compulsory attendance are granted for distance from nearest school as follows: California, one mile; Pennsylvania, Kentucky, West Virginia, Indiana, Michigan, Wisconsin, Minnesota, Kansas, Colorado, Nevada and Oregon, two miles; North Dakota, Montana, Utah, two and one-half miles; Idaho, three miles.

A physician's certificate for bodily or mental ailments will exempt children in Indiana, North Dakota, Montana, Wyoming, New Mexico and Utah. In Washington defective children must be sent to state institutions. Poverty is an exemption in the District of Columbia, Nebraska, Rhode Island, Kentucky, Minnesota, Kansas, Montana and California.

The need of the child's service for support of parents exempts it from attendance in Utah, and, for any relative, in Illinois.

Any urgent reason exempts from the law in Pennsylvania and Wyoming.

In Wisconsin and Illinois it is necessary to obtain a decision from a court of record.

In Ohio, the decision of a probate judge on appeal will exempt.

By enactment of the legislatures, in case of poverty, clothing and books are furnished free in Vermont, by the town; in Indiana by the county; and in Colorado by the district. Elsewhere certain local provisions are made for the same purpose.

The following states have made legal provisions for transporting children to school at public expense: Maine, New Hampshire, Vermont, Massachusetts, Connecticut, New York, New Jersey, Iowa, North Dakota and Nebraska, while partial provisions are made in Rhode Island, Wisconsin, Ohio, Pennsylvania and South Dakota.

CHILD-LABOR LAWS.

In New Hampshire, no child under 10 years of age may be employed in a manufacturing establishment, nor one under 16, who cannot read and write, during time schools are in session, under a penalty on the employer not to exceed $30.

In Vermont no child under 14 years is to be employed in any mill or factory unless he has a certificate of school attendance of 14 weeks in the year.

In Massachusetts no child under 14 years of age can be employed during the school term, nor for any work earlier than 6 A. M. or later than 7 P. M. No one under 16 can be employed during school term without a certificate of attendance for the required time, nor any minor over 14 who cannot read and write, during the time when there is a local evening school, unless he shall be attending the same. The penalties on employers are from $5 to $50.

In Rhode Island no child under 12 years can be employed during the school year without a certificate of having attended school eighty days. Fines not to exceed $20.

In Connecticut no child under 14 can be employed who has not a certificate of sixty days' attendance at school. Penalty not to exceed $60.

In New York no child under 12 can be employed during school term, nor for the next two years without a certificate of eighty days' attendance. Penalty $50.

In New Jersey no child under 15 years can be employed without a school certificate for twelve weeks of consecutive attendance. Penalty $10 to $25 or imprisonment one to three months.

In Ohio no child under 14 years can be employed without a certificate of sixteen weeks' attendance. Penalty $25 to $50.

In Illinois no child shall be employed which is under 13 years, for any period of time greater than one day, without a certificate from the school board that the child's service is necessary to support an infirm relative. Penalty, every day being an offense, $10 to $50.

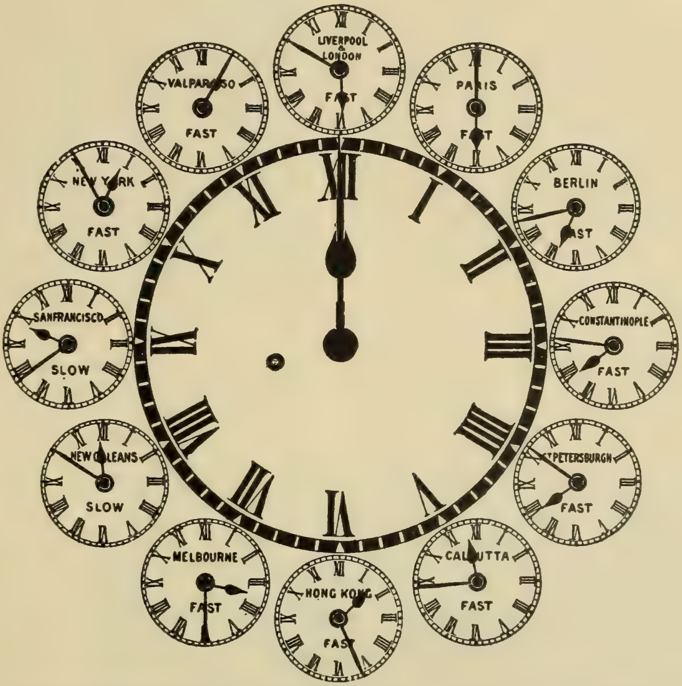
In Michigan every child under 14 years must have attended school four months immediately previous to employment. Penalty $5 to $10 for first offense and not less than $10 for each subsequent offense.

In North Dakota and South Dakota no child under 14 can be employed, except by parents or guardians, while the local public schools are in session, without certificate of twelve weeks' attendance. Penalty $20 to $50 and costs in North Dakota, and $10 to $20 in South Dakota.

STANDARD TIME OVER THE WORLD

When transportation was slow and of small amount, the question of differences in time was of small account, but with the advent of swift movements along parallels of latitude, in the vast volume of traffic of recent years, the problem became one of intolerable perplexity and danger.

Scientific discussion had been going on for years with many suggestions and plans for relief, when in 1884, a conference was held in Washington which divided the world into zones or time belts with the meridian of Greenwich, five miles southeast of London, as a basis. The observatory at Greenwich, which is almost universally the calculating point for the geographical measurements of longitude, was erected by Charles II. for the advancement of navigation and nautical astronomy. It now transmits the time by magnetic currents to all England and is the chief nautical reckoning point for the rest of the world.



CLOCK INDICATING SIMULTANEOUS TIME AROUND THE WORLD.
The center dial represents noon at Chicago and a corresponding variation may be calculated for any hour in the day.

Before the general establishment of what is known as standard time, each town on a given parallel had a different time from that of its neighbor, in accordance with the movement of the sun, but to the confusion of all railroad time. For the public convenience, the United States was divided into four sections or belts of 15 degrees, or one hour each, to be known as Eastern, Central, Mountain and Pacific time. To accommodate the general divisions of the railroads, the dividing lines are drawn irregularly from north to south through railroad terminals or principal towns. On that account, Eastern time includes all the territory between the Atlantic coast and a line drawn from Detroit to Charleston, South Carolina. Central time includes all west to the irregular line drawn from Bismarck, North Dakota, to the mouth of the Rio Grande. Mountain time extends to the western borders of Idaho, Utah and Arizona, while the remainder west is Pacific time. Thus twelve noon in Eastern time is eleven a. m. in Central, ten a. m. in Mountain and nine a. m. in Pacific time. This is easily understood from the fact that it requires an hour for the sun to pass over a little more than a thousand miles, therefore the sun rises upon or is perpendicular over, the eastern end of a thousand miles one hour before it is in the same position at the western end. Standard time for the United States is supplied by the Naval Observatory at Washington. The exact hour of twelve o'clock noon is determined every day by astronomical observation, and the precise time is transmitted to the clocks of the government departments by electricity. The telegraph companies are permitted to telegraph the time thus taken by automatic instruments to all parts of the United States. The instrument at San Francisco registers the time within a fifth of a second after it is taken at Washington, D. C. To do this the telegraph company clears all its wires throughout the United States of all business, three minutes before noon each day, and thus unbroken connection is established over the entire telegraph system of the country.

Not alone is the exact time sent instantly to all parts of the Union, but the extensive system of private and business clocks connected with the telegraph lines are, by an electrical device, regulated together. This is done in each clock by means of an electro-magnet operating a clamp. The magnet is filled with electric force when the circuit is closed to give the noon signal, and the hands of the clock are forced to the exact point of twelve. The telegraph company charges $15 a year for each clock and fully $1,500,000 a year is earned by this service. More than ten thousand clocks are thus regulated in New York City alone.

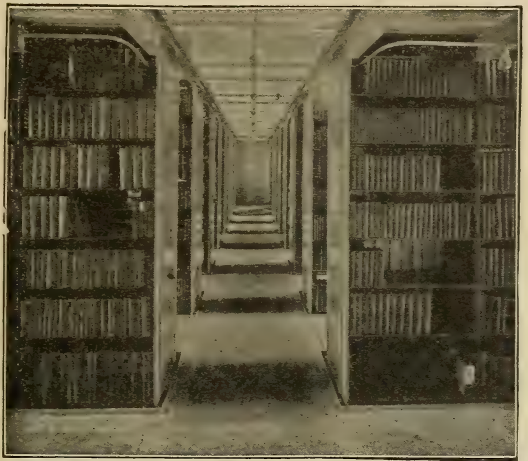
From the staff of the Naval Observatory at Washington a great red ball drops exactly at noon every day, and those seeing it can regulate their watches and clocks accordingly. In seaport towns balls are dropped in the same manner and the seamen can thereby regulate their watches.

PUBLIC LIBRARIES, THEIR GROWTH AND ADMINISTRATION

The administration of a great library, in order to make it most serviceable to those who patronize it, has become one of the learned professions of late years, so rapid has been the growth of the institutions and the uses to which they are put. Architects make special preparation to qualify themselves for the building of libraries. Colleges and universities give special courses for the instruction of librarians in the various departments of their work. Philanthropists have learned that there is no use to which they may put their benefactions for the public good surpassing the gift of funds for the establishment or the extension of libraries, and the reading public, realizing the remarkable advantages to which it has access since libraries so multiplied, gives closer attention to literature and keeps the attendants busy serving the wants of those who love books.

In 1900 there were in the United States 5,383 public, society and school libraries containing 1,000 or more volumes each. The total number in these collections was 44,591,851, or 35 per cent more than in 1896, when the number was 33,051,872. There is one library of more than 1,000 volumes for every 14,118 persons, and there are fifty-nine books for every one hundred of the population. All of these figures entirely exclude all private and small collections, which would increase the total enormously, for there are multitudes of private libraries exceeding 1,000 volumes.

There are fifty-three national and state libraries, of which the Library of Congress, at Washington, is the largest, with more than 1,000,000 volumes. In addition to this library the House of Representatives, the Senate and the various departments of the government have their

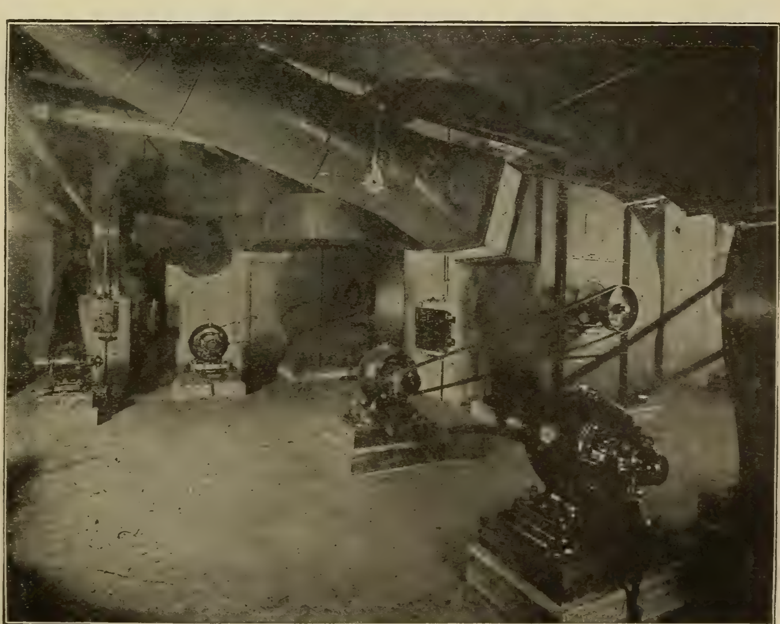


LIBRARY BOOK STACK ROOM.

special collections of books for immediate use, so that the total number of volumes belonging to the government in Washington exceeds 2,000,000. The largest of the state libraries is that of New York, at Albany, with 423,290 volumes.

Of the thirty-six free public libraries of 50,000 or more volumes, that of Boston is the largest, with 772,432 books on its shelves. Thirty-two universities and colleges have libraries of more than 50,000 volumes, and of these Harvard University stands at the head with 560,000 books. There are thirty-seven other libraries in the United States exceeding 50,000 volumes each, belonging to various societies and special collections and extending in several instances to more than 200,000 books.

It is edifying to notice a single city as an example of the wealth of library material in the United States. In Chicago the free public library has a total of 272,276 volumes and 49,805 unbound pamphlets. The aggregate circulation for a single year approaches 2,500,000 volumes, which does not include the use of books kept on open shelves, nor the periodicals and newspapers used in the reading rooms. The splendid public library building which shelters this collection was erected at a cost of several hundred thousand dollars, and is equipped with every modern appliance known to library experts. Of course, it is fireproof throughout, being built entirely of steel,



DYNAMOS AND VENTILATING PIPES, CHICAGO PUBLIC LIBRARY.

cement, glass and tiles. The book stacks or shelves are made of steel. The ventilation of the library is arranged according to a system which makes it unnecessary to open the windows and admit the dust and soot, which are so disastrous to books. All air for ventilation is admitted through the basement, where it is filtered and cleaned before being distributed throughout the building by an intricate system of large pipes and fans.

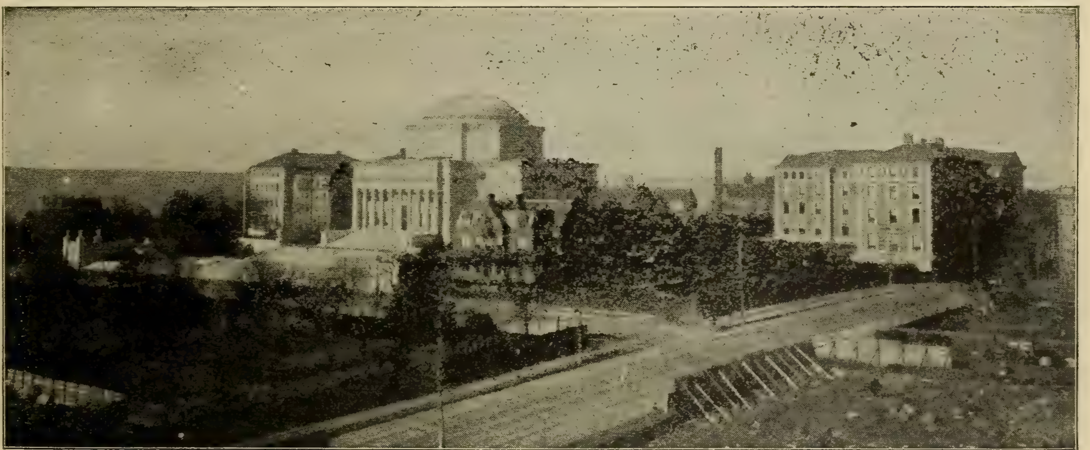
In addition to this library, in Chicago there is the John Crerar library, with more than 75,000 volumes, the Newberry free library with 250,000 volumes, the Chicago Historical Society library with 27,000 volumes and 60,000 pamphlets, the Chicago Law Institute library with 40,000 volumes, the University of Chicago library with 335,000 volumes and 165,000 pamphlets, the Field Columbian Museum library and the library of the Armour Institute, each containing some 15,000 volumes. It is evident that no one need be denied reading matter in such a city for want of opportunity, and the other great cities of the United States make a showing equally creditable.

Andrew Carnegie, the great iron master, has paid special attention to public libraries in his immense contributions to charitable and educational purposes. It is calculated that he has given nearly $15,000,000 for libraries in the United States and Scotland within the last two or three years. To New York city alone he gave $5,200,000 to establish branch libraries. To St. Louis he gave $1,000,000 for a public library, and to a total of nearly two hundred cities he has given public libraries ranging in cost from $15,000 to $750,000. In nearly every instance his gifts have been coupled with the condition that a building site should be provided free of cost, and an appropriation for the annual maintenance of the library be made from public funds. By this means he has stimulated the gift and the expenditure of large sums of money in addition to those which he gave himself, and consequently the totals of his own contributions do not by any means measure the full amount given for such purposes in this country. Indeed, there have been several other gifts of public libraries, ranging in value from $25,000 to $150,000, by men who avowed themselves to be moved by Mr. Carnegie's generosity elsewhere, so that to him must be given a large share in the credit for the remarkable stimulus that has been given to library building within recent years.

AMERICAN COLLEGES AND THEIR GROWTH

It is a characteristic of this age of progress that attention is being paid to the intellectual side of life just as energetically as to industrial and commercial undertakings. Indeed, in many communities the development of the refinements of life is advancing with even greater rapidity. In the comparatively new cities of the Mississippi Valley and the Far West the men of energy and ability, until recently, have been forced to devote all their time and attention to the upbuilding of their own prosperity and that of the communities in which they live. They have had little leisure to think of anything except business. Of late years, however, with their fortunes established and business conditions fixed in more regular channels, they have had more liberty of action for intellectual pursuits and recreation. The result is that our great merchants, miners, railway men, manufacturers and other captains of industry have turned into these finer pursuits the same energy and executive ability that have built great cities in a generation. The libraries, universities, museums, art galleries and other kindred institutions have grown like magic, with enormous rapidity, as a result of the immense gifts made for such purposes. While it is true that money cannot provide the venerable history and the scholastic atmosphere that belong to the older institutions as qualities that come only with age, or the traditions that stimulate those who inherit the halls from which a century of distinguished men have issued, yet material equipment goes far to assist scholarship, and age will be provided by the passing years.

Some of the younger colleges, for instance, with a history dating back hardly ten years, already excel in their endowments and the facilities they offer to students, those institutions with an honorable record of 100 years behind them, and it is not strange that with such conditions they likewise excel in the number of students attracted to them. With unlimited money at their command they are able to employ faculties of the most distinguished scholarship. They offer likewise college libraries, gymnasiums, museums, laboratories and buildings themselves of the greatest, and many a young man passes by the school with the traditions in order to patronize one which has the newest dormitories.



BUILDINGS OF COLUMBIA UNIVERSITY, NEW YORK CITY.

The statistics of American colleges are impressive as indicating the attention that young men and young women are giving to higher learning, and the assistance granted to such institutions either by the public in the state universities or by men of large wealth out of their private fortunes. In the United States there are enumerated 621 colleges, universities and seminaries for higher education which are authorized to grant degrees. In these 12,557 professors and instructors are employed in teaching 153,287 scholars. The income of these institutions annually reaches the immense total of $24,185,367. At least eight of these institutions have more than 3,000 students attending. Harvard University stands at the head of the list, with 5,150 students; Columbia University second, with 4,036, and the University of Michigan at Ann Arbor third, with 3,800, the latter being the largest of all the state universities supported by public funds. The University of Chicago, which, under its present organization, is hardly ten years old, has more than 3,500 students.

BUILDINGS OF THE UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA.

Colleges and universities, generally speaking, have been broadening their work and their policies of late years, confining themselves less to instruction in the classics and mathematics and giving more attention to modern languages, literature and the sciences. They have come closer to the life of the people, and have taken a larger activity in the affairs of every-day life. With the great increase in their financial resources they have entered the field of scientific exploration all over the world, as well as the field of publication with the literary results of their explorations and discoveries. College sports have become of interest, not alone to the young men who share in them, and to their institutions, but to the public at large, so that their football, baseball and boat races are considered among the most important sporting events every season. Even the most conservative and scholastic of the universities and colleges yield to these changing conditions, and even though they may sometimes consider that these sports hold too prominent a place in the life of an educational institution they realize the advertising value of publicity, and that their new classes each year are in large degree attracted by the athletic successes of the respective institutions.

It is impressive to note the immense gifts that have been made within the last few years to certain colleges and universities by some of our wealthy Americans. Andrew Carnegie has given $10,000,000 to establish the University of the United States at Washington, and $10,000,000 to the Scotch universities, all within a single year. John D. Rockefeller, in the same year, 1901, gave $2,000,000 to American colleges, and within ten years has given to the University of Chicago approximately $8,000,000. Mrs. Stanford, in 1901, gave to Leland Stanford Junior University in California, property valued at $30,000,000, and the bequests of her husband and her own gifts prior to that time had already amounted to many millions. Mrs. Hearst gave to the University of California property amounting to more than $10,000,000. Cecil Rhodes in his will left sums amounting to $20,000,000 to assist the cause of education in the English universities, this amount to be available as scholarship funds for students from England, the British colonies and the United States. D. K. Pearsons of Chicago has given more than $3,000,000 to colleges throughout the United States within the last few years. Mrs. Joseph L. Newcombe in 1901 gave $3,000,000 to Tulane University at New Orleans.

The foregoing are but the greatest gifts out of a long list. Several others could be named, amounting to $1,000,000 each, and scores of sums from $10,000 upward. In most cases the amounts were given on condition that the institutions to which the money was granted would raise similar sums through subscriptions from alumni and other friends, so that the amounts given in large sums have been virtually doubled by the raising of smaller amounts.

No one can fail to appreciate the great significance of such an educational movement. It is a recognized fact that education does more to advance the true welfare of a nation than any other influence that can be enlisted, and American colleges and universities have always been a factor of great importance in influencing the national life and policies on important questions at issue. With education multiplying as it is sure to do rapidly under the impetus given it during the closing years of the last century, we may expect to see even greater results in the future than there have been in the past.

AMERICAN COLLEGE SPORTS

Probably no other influence has been as effective in making athletic sports generally popular as has been the great interest taken in them by the young men of American colleges. Leading a studious life through a large part of their time as they do, it is necessary for them to take every opportunity for outdoor exercise, for the sake of their health and the quality of their work. Stimulated to rivalry, first among themselves in their own colleges as they are, and then by loyalty to their institutions to rivalry with other neighboring schools, the spirit of emulation has grown, until now the annual competitions and events in athletic sports have become almost a supreme factor in the college year to hosts of young men.

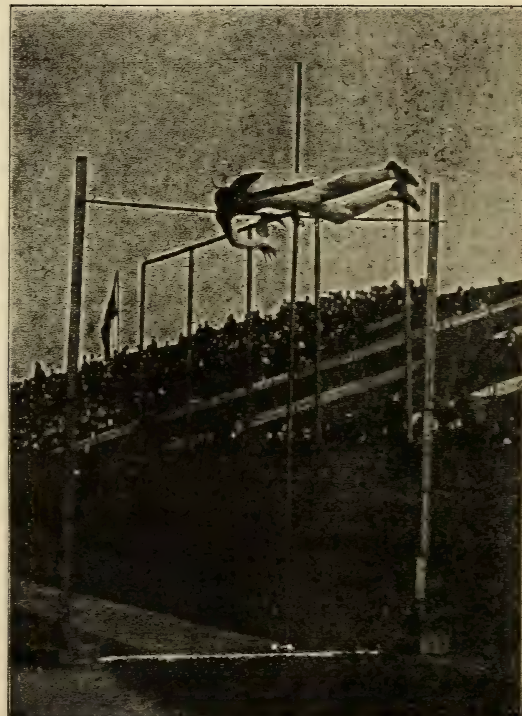
In the fall, each year, football holds the place of highest importance, and in the spring baseball takes a corresponding rank.

As incidental factors throughout the year come contests in tennis, track athletics, gymnasium athletics, rowing, and other sports.

BRINGING OUT THE SHELL.

There are many colleges which do not have access to water, and consequently cannot enter the rowing competition. Those which are located more favorably, however, either at the seashore or beside some lake or river, find in these contests one of the most important events of the year and one which attracts to it thousands of visitors from far away. The "big race" every year, as it is considered in the college world, is that of the eight-oar crews of Yale and Harvard Universities, usually rowed at New London, Connecticut, on the Thames river. On the same day there is also a race between four-oar crews and freshmen crews from the same universities, and the three events serve to make the day an important one in college athletics. These, however, are not the only college crews that race every year, with great importance placed upon the victories. In this country Princeton, Columbia, Cornell, Pennsylvania and other eastern universities, and several of the large western colleges and universities arrange similar events, while in England the annual race between Oxford and Cambridge attracts world-wide interest.

The apparently frail craft in which these races are rowed cut through the water at an astonishing speed, the rowing records

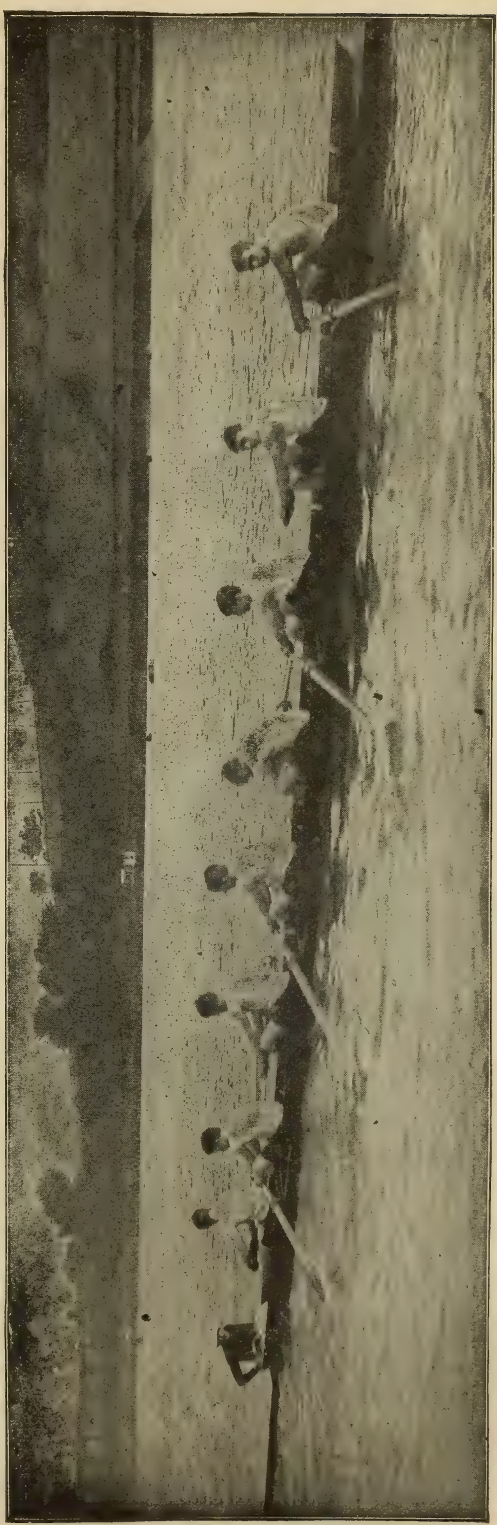


THE POLE VAULT.

for college teams being as low as four miles in a few seconds more than twenty minutes.

Almost every American college and school, from Harvard and Yale down to the smallest village grammar school, has its series of games for the football championship every fall. When Harvard and Yale, Princeton and Columbia, or Pennsylvania and Cornell play their annual game, whether it be in New York, Boston or elsewhere, on Thanksgiving day, thousands of enthusiasts make riotous applause for the victors on whose strength and agility so much depends. In New York, for instance, 60,000 people have been known to be present at such a game. Thanksgiving day, indeed, has become known as the great day for football events the country over. This is one game into which professionalism has entered hardly at all, fortunately for athletic sports.

Another noteworthy game of football is that played between the cadet teams of West Point and Annapolis. It is the army against the navy in this instance, and the young cadets from the two national schools of warfare fight bravely to win the honor for their respective arms of the service. The same energy that they display at this time in a manly spirit of athletic rivalry is the quality which serves them well in later years when they enter more important undertakings in the service of their country. An accompanying illustration represents one of these games, played at Philadelphia on the field of the University of Pennsylvania. More than 30,000 spectators witnessed the spirited contest. Among them were President Roosevelt and the members of his cabinet, the members of the Senate and the House of Representatives, and a number of distinguished officers of the army and the navy. Many special trains ran from Washington, New York and the other neighboring cities to accommodate the immense crowds that desired to view the contest between the young men who are to be our future generals and admirals.

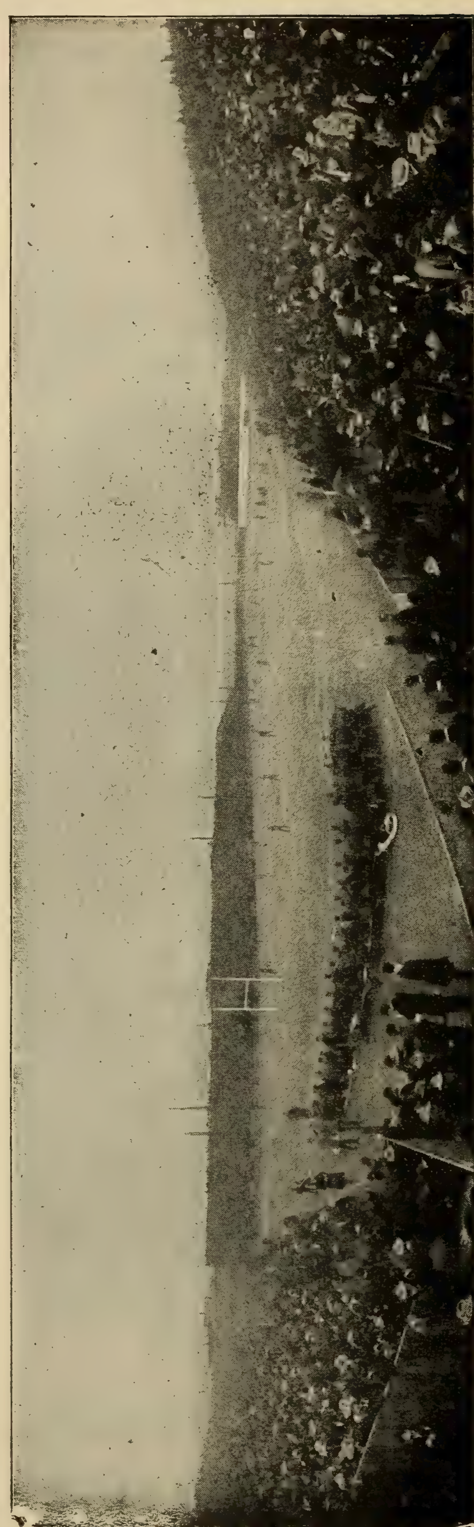


COLLEGE CREW IN AN EIGHT-OARED RACING SHELL.

OCEAN, LAKE AND MOUNTAIN RESORTS

In spite of the energy and fidelity with which Americans stick to their business at all hazards, there are few countries where great summer and winter resorts are more highly developed than they are in the United States. On the Atlantic coast, from Maine to New Jersey, a succession of beautiful summer resorts have grown up, where splendid hotels, attractive bathing beaches and the other conditions which make such places pleasurable, attract hundreds of thousands of visitors every year. At Atlantic City, New Jersey, is the dividing line between the winter and summer coast resorts, for here in both seasons visitors crowd the hotels. Further south it is chiefly winter travelers who patronize the seaside, all the way down to the tip of the Florida peninsula and thence around the coast of the Gulf of Mexico to the Texas cities themselves.

The coasts of the New England states, and Long Island, Delaware and New Jersey, are marked with charming resorts every few miles. Florida, with its splendid hotels facing the gulf, forms a distinct resort region of its own for the winter. From Mobile, Alabama, to New Orleans, facing the Gulf of Mexico, is a shore which the southerners term the American Riviera. On the Pacific another distinct group of resorts has developed, from San Diego in the south to Alaska in the north. San Francisco becomes the dividing line between the summer and winter resorts on this coast. Southward from the metropolis of California are such beautiful winter resorts as Monterey, Santa Barbara, Santa Catalina, Los Angeles and San Diego, while northward in the summer multitudes of tourists



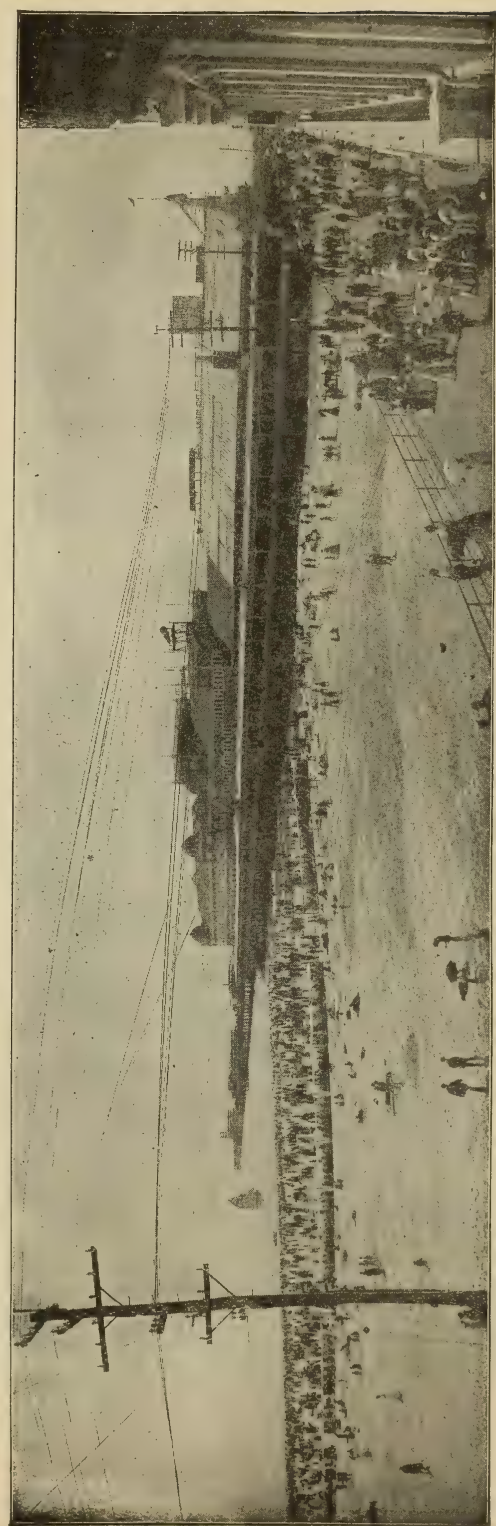
FOOTBALL GAME BETWEEN ANNAPOLIS AND WEST POINT CADETS AT UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA.
President Roosevelt, his cabinet, both houses of Congress and hosts of distinguished citizens were among the 30,000 spectators present. Special trains from New York, Washington and elsewhere helped to swell the crowd.

take advantage of the mountain and coast beauties of Puget Sound, British Columbia, and the Alaskan shores even further north. Monterey and Santa Catalina, likewise, are almost as popular in the summer as in the winter.

Between these two oceans a limitless variety of pleasure grounds await the vacation wanderer at any season. The mountains of New England, the Adirondacks, the Georgia pines, the lakes of Michigan, Wisconsin and Minnesota, the mountains of California and the far west offer choice inexhaustible. Nature has given to this country as lavishly of opportunities for pleasure in wholesome climates and among beautiful surroundings as it has given of the wealth of the forests, the mines and the farm. He would be exacting indeed who should fail to be satisfied in whatever direction he desired to use his activities of mind and body.

WINTER SPORTS IN NORTHERN CITIES

Every country has sports peculiarly its own in the beginning, and those that are best for general use are invariably passed over the boundaries into neighboring countries for appreciative adoption there. It is to Canada, thanks to its cold but favorable winters, that the world owes the development of some of the most wholesome, enjoyable and picturesque of athletic sports. In Quebec, Montreal, Ottawa, Toronto, Winnipeg and a host of smaller cities of the Dominion of Canada, the winter is the season of greatest merriment, the time of most active outdoor life. The low temperature and the deep snow are themselves the factors of which the people take advantage to have their jolliest times.



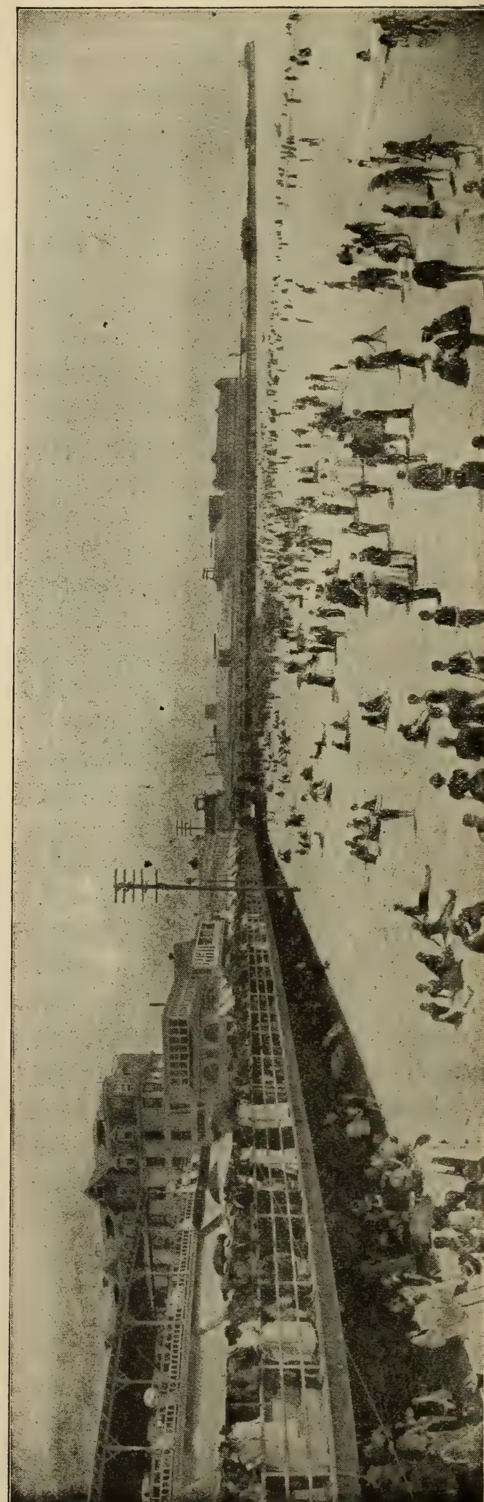
BATHING BEACH, PIER, PAVILION AND THE FAMOUS BOARDWALK, ATLANTIC CITY, N. J.

Sleigh riding and coasting, which in the cities a little farther south are uncertain treats, here become the standard form of amusements through the long winters. The Canadian hills are gay with the bright costumes of multitudes of merry coasting parties. It is here that that most picturesque of snow craft, the toboggan, has been developed to the fleet vehicle used so generally, as a substitute for the ordinary sled with runners, on Canadian hills. The toboggan, indeed, of late years, has been introduced to a considerable extent into the United States, where it has gained much popularity. Instead of runners it has a smooth, polished surface for its whole width, and in an icy trough worn upon the steep hillside the coasters attain a breathless speed before they reach the bottom of the decline. Here, too, in all their picturesque beauty, are seen the gay costumes of many-colored blanket cloth worn as suits and dresses by the young men and women.

The snowshoe is another Canadian improvement of a primitive Indian invention. Over the deep snows which gather in the northern winters the snowshoes bear the sportsman without trouble, so that he may race or hunt at will, uninterrupted by the drifts.

Of course skating is as popular during the Canadian winter as it is in other countries where cold weather comes in earnest. The rivers and lakes, however, are usually covered with snow to such an extent that skating is virtually confined to large rinks which exist in every city, where brilliant illumination helps to make the scene within more gay than it might otherwise be.

Ice-boating, too, has its devotees in Canada. This inspiring sport, however, has its chief favor on the Hudson river and on some lakes of New York and Wisconsin.



CROWD ON THE FAMOUS BOARDWALK WATCHING BATHERS ON THE BEACH AT ATLANTIC CITY, N. J.

ON THE TOBOGGAN SLIDE—CANADA'S FAVORITE WINTER SPORT.

"THE BOUNCE."

Ice-boats are built in triangular form, resting on three skates, the one in the rear serving as a rudder. They have no cabins, and are but skeleton craft, sliding over the ice at railroad speeed and carrying a spread of canvas like that of a small yacht. Experts in handling ice-boats are able to maneuver them in any direction as readily as their cousins at sea are handled, and there is no more beautiful sight than a race between a fleet of these picturesque craft.

As a center of winter sport, and an attraction for multitudes of visitors, Quebec, Montreal, Winnipeg, St. Paul and one or two other cities at various times have built great palaces and castles of ice. Some of these have been noteworthy for their architectural beauty and grace no less than for their novelty. Balls and festivals, illuminations, fireworks, sham battles, and other sports more truly a part of winter festivities, have centered around them to make carnivals of winter which have attracted thousands of travelers from long distances to witness the novel and beautiful scenes.

If one has the instinct for outdoor pleasure, and is resourceful, he will discover that there is no season when nature does not offer some means of sport, both whole-

OVER THE HURDLE IN A SNOWSHOE RACE.

some and entertaining, and winter nowadays does not stand at the bottom of the list.

HORSE RACING THE WORLD OVER

Horse racing for many generations has been called the "sport of kings," and never has there been a time when the sport was more popular or more widely enjoyed than it is today. "It is differences of opinion that make horse races," said a clever writer, and there are few countries where the people do not differ as to the merits of their respective steeds, and back their judgment for a race to test the facts. It is hard to travel to a land so remote that horse races are not popular events in the year's sporting annals. In Melbourne, the temporary capital of Australia and the metropolis of that island continent, is a race course in States as well. In this city of less than 500,000 inhabitants, 100,000 persons will gather at Flemington race course on the day of the Melbourne Cup race, and the prize to the winner of the race sometimes amounts to as much as $75,000.

Far on the other side of the world from

"DERBY DAY" AT WASHINGTON PARK RACE COURSE, CHICAGO.

which the people take pride, claiming it to be the finest in the world. And there at Flemington, once a year, is run a race for a prize known as the Melbourne Cup, which attracts visitors not merely from all the neighboring colonies of Australia but actually from England and the United

Melbourne, in May every year, the people of London, and, indeed, strangers from all the world, gather at Epsom Downs to see the Derby. Unlike most race courses there is no charge made for entering the course at Epsom Downs and viewing the race, and thus, with free admission as a temptation, literally thousands of people spend the night before the race walking the twenty miles from London in order to be among the multitude present. Crowds approaching half a million have been known to be at Epsom on Derby day.

Across the channel from England the French in turn have taken up horse racing, and at Longchamps, near Paris, is a beautiful course where every year, a few days after the London Derby, is run another noteworthy race called the Grand Prix, or the race for the grand prize. Here gathers the fashion of Europe for the most famous day in the annual sporting calendar of Paris.

These three races, the Melbourne Cup, the Derby and the Grand Prix, contend for the honor of being the greatest race in the world. Here in America we have several which rival each other in importance in the sporting world, among them the Futurity and Suburban at Sheepshead Bay, New York, and the American Derby at Chicago, with two or three other races that might be named as of the highest interest to the lovers of the horse. These events attract more attention year after year. The American Derby, run every spring at the Washington Park race course in Chicago, has earned for its winner as much as $49,500 in stake money. Sixty thousand persons have been present to witness the race, and the display of splendid equipages and brilliant fashion makes it noteworthy even beyond the importance of the sporting event itself.

ARMIES AND WARS OF THE WORLD TODAY

In spite of the advance of education and enlightenment, the increased facility of

BENGAL LANCERS FROM INDIA ROUTING CHINESE CAVALRY NEAR PEKIN.

communication and better acquaintance between the nations of the earth, and the progress of material affairs in this industrial age, there is little cessation in the military activities of the world. Of late years the actual hostilities between the great civilized powers have not been numerous, and yet there has been hardly a year without its war. Spain and the United States, Greece and Turkey, Great Britain and the Boers, have had their interchange of warfare. Japan and China fought over the Korean question. Various South American republics have engaged in wars, important enough to themselves and yet hardly noticed by the rest of the world.

A BICYCLE BRIGADE IN THE BRITISH ARMY.

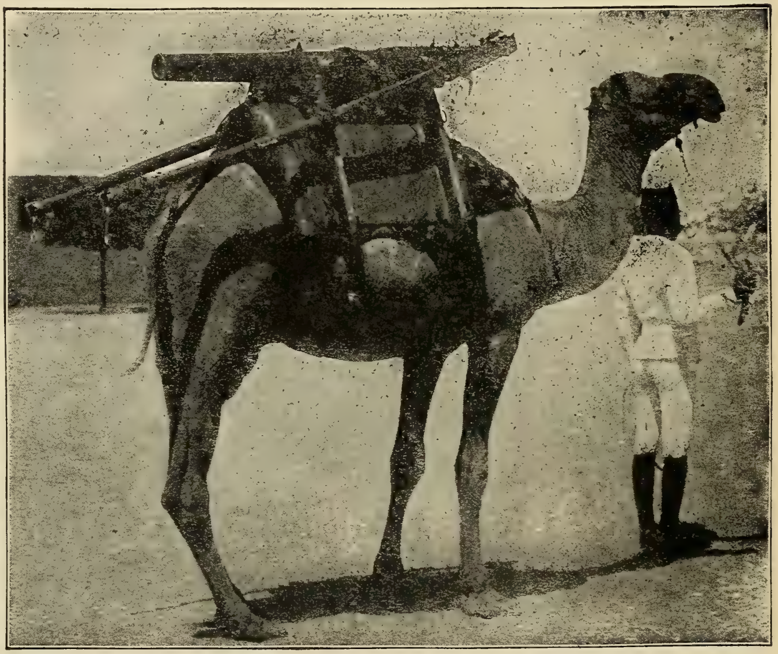
In conflicts between the powers and the various savage or rebellious foes they have raised up to plague them there has been hardly any interruption. Great Britain, indeed, is never at peace, and at least one London paper has a standing head line, year in and year out, "our little wars," under which general title are recorded every year, fatalities that in their total would amount to the losses of a great battle. Egypt and the Sudan, Central Africa, South Africa, the Afghan hills, and indeed almost every place where England's colonial efforts come in contact with native races in possession resenting innovation, are scenes of frequent outbreaks against British rule.

France, likewise, in Senegal, Dahomey, Algeria, the Sudan, Madagascar and Indo-China, has had to fight its way for colonial power. Italy first succeeded and then failed disastrously in Abyssinia, and is now left with a fringe of barren coast on the Red Sea to show for the enormous losses of blood and treasure in the African campaigns.

Spain has seen her whole colonial possessions vanish, except a few worthless tracts at the edge of the desert in Western Africa, and from these she draws no profit. Belgium, with the Congo Free State, seems to be planning commercial development for that great tropical territory, but the end will be reached only with great labor and cost of men and money. Germany and Portugal, likewise, have Central African colonies, in every instance costing far more than they return, and even with the promise of ultimate profit there will be a long intervening period of bitter warfare with natives. Russia is constantly extending her boundaries southward, but has not yet any colonies or possessions except those of contiguous territory with the great empire itself.

We of the United States, fighting Spain to release Cuba from the yoke of oppression, found ourselves inheriting a war with the Filipinos, who were already demanding freedom from their Spanish oppressors. Within its first three years this war of ours with the Filipinos cost us immensely more in money and in men than the parent conflict with Spain itself.

So it is that all Europe, and indeed all the world, is rapidly becoming an armed camp. Nations have adopted the theory that safety can be assured only by eternal vigilance and military strength. The peace rescript of the Emperor of Russia, from which sentimentalists counted so much, was hardly circulated before there was such an outbreak of warfare as the world had not seen for many years. Great scientists and inventors are concentrating their attention upon improvements in the mechanism and art of war. Improved rifles, projectiles and explosives of many varieties have altered the character of warfare on land almost as much as it has changed at sea. No longer are there spirited charges across open fields, or steady advances of regiment against regiment. With rifles effective at a range of one mile, and smokeless powder for the explosive, a force would be annihi-



CAMEL-GUN WITH BRITISH ARMY IN THE SUDAN.

lated long before hand to hand fighting could begin. Artillery and long-distance firing, therefore, have supplemented close work with muskets. Balloons, war-kites, searchlights, machine guns, armored railway cars and other innovations have come into modern warfare. Field hospitals and ambulance systems likewise have been improved, but the happy time is not yet when the Red Cross will have no work to do, and the military organizations of the powers can release their millions of soldiers to some more profitable and productive vocation.

Some detailed information concerning the newest explosives, projectiles, guns and armies will serve to indicate the activities in this direction. Picric acid is obtained by the action of nitric acid on carbolic acid, and from it are made such remarkable destructive materials as dynamite, maximite, cordite and lyddite. The latter was the explosive most favored by the British in their campaigns against the Boers in South Africa. These high explosives, like smokeless powder, are not generally dangerous to handle. They must be prepared with detonating caps for the purpose of exploding them. The dum-dum bullet, a fatal projectile for small arms, is made of nickel, with a point of soft lead. When such a bullet strikes any object it spreads in the shape of a mushroom, making a peculiarly painful and deadly wound. They are not countenanced by the powers openly.

The various machine guns and rapid-fire guns discharge twelve to 1,500 shots a minute, according to their size and mechanism. Some of these are wholly automatic. The Maxim gun, for instance, is so arranged that after each recoil of a previous discharge the shock opens the breech, extracts the empty shell, takes a fresh cartridge, cocks the gun, pushes the shell into its chamber and fires the gun. The cartridges are loaded into the gun in a belt, and all the operator has to do is to pull the trigger the first time and the belt is ground through the machinery at the rate of 600 shots a minute. With such explosives, projectiles and weapons in use it is apparent that warfare is becoming a more dangerous pursuit all the time. The following table shows the armed strength of the great powers:

	Armies		Navies	
Country	Peace	War	Ships	Men
Austria-Hungary	382,808	2,000,000	103	12.899
France	629,500	1,300,000	532	25.500
Germany	621,162	3,260,000	223	33,500
Great Britain	431,302	805,173	537	128,000
Italy	288,409	2,000,000	161	30,398
Japan	225,000	800,000	229	36,080
Russia	1,800,000	4,000,000	220	60,000
United States	91,950	....	309	46,000

THE GERMAN EMPEROR'S AMERICAN YACHT

The schooner yacht Meteor, which was christened by Miss Alice Roosevelt, daughter of the President, when it was launched in New York on February 25th, 1902, in the presence of Prince Henry of Germany, is the first pleasure boat that was ever built for a European monarch in an American shipyard. The vessel from stem to stern was the product of American builders, American designers and American workmen. His Imperial Majesty, the Emperor of Germany, desired that to be the case, in order that he might feel that he possessed a genuine American product. It was not, however, the first American pleasure boat owned by Wilhelm II., who already possessed an American-built schooner, the Yampa, which he had bought some years before from its owner, who was cruising in German waters. When he ordered the Meteor he commissioned the designers of the

Yampa to build a larger schooner, with such additional improvements as have been made in the last fifteen years. Only a few months ago the materials out of which this famous little international pleasure craft was built were scattered all over the United States, from the Atlantic to the Pacific. Polished masts of white pine were growing wild in their native Oregon forests. The iron and steel in the beams and plates were unmined ore in the Pennsylvania hills. The hardwoods for the finishing of the interior were hewn by American hands in American forests; the interior appointments, the plumbing and the fittings were made by American workmen, the sails were made by American sail-makers from American canvas, and the rigging was all the work of our own countrymen. It was natural and appropriate that it should be christened by a genuine American girl, to gracefully emphasize the national character of the whole performance.

The Meteor is a large yacht, having a length over all of 160 feet, a water-line length of 120 feet, a beam of twenty-seven feet and a draught of seventeen feet. There is thus deck-room enough for a court reception. Accommodation is furnished for a crew of at least thirty men. There are two saloons, the main and the ladies' cabin, and three large staterooms, in addition to the Emperor's spacious suite. In size, indeed. the Meteor is the largest schooner-yacht ever put forth from an American shipyard. The quarters are ample, though without ostentation. The comfort of the voyagers was the point chiefly aimed at. Altogether it is a handsome craft, quite good enough for an Emperor or an American. Its cost was about $150,000.

THE SECOND AND GREATER BROOKLYN BRIDGE

The Brooklyn Bridge is a name that has been known the world over for many a year as that of one of the most noteworthy achievements of modern times. A suspension bridge spanning the great East River and bearing the traffic of two great cities, it was indeed worthy of its high fame. But a time is coming now when the original Brooklyn Bridge will have to take a second place and be distinguished by a more specific name, for another Brooklyn Bridge is under construction that surpasses it in every way. The new bridge likewise spans the East River, connecting New York City on Manhattan Island with Brooklyn on Long Island. It is about a mile above the old bridge, and consequently will draw the great traffic from the shopping district of New York that until this time has been compelled to patronize the ferries.

The two steel towers from which the great roadway of the bridge is suspended are 1,600 feet apart, or nearly one-third of a mile. They rise to a height of 335 feet above the water, and the bridge itself is so high above the river that the masts of the largest boat may pass under it. From the tops of these great towers four steel cables, each as large as a man's body, carry a two-story platform twice as wide as a city street, with six railroad tracks, two carriage ways, two promenades and two bicycle paths. In order to attain the height over the river required for navigation, the tracks have to be carried over more than half a mile of streets and houses at each end of the bridge. The weight of the 1,600-foot span between the towers is 16,000,000 pounds, and it will carry with safety a moving load of 9,000,-

000 pounds. The steel in each tower weighs 6,000,000 pounds. The total cost of the bridge and its approaches is about $9,000,000, and of the land about $10,000,000 more. These figures are sufficiently eloquent to speak for themselves, and this greatest of American bridges is indeed a triumph of the builders.

HOW MAPS AND GLOBES ARE MADE

Now that the relations of the different countries of the world have become so intimate and news is transmitted so rapidly and regularly by means of the electric telegraph and distributed by the morning paper, it has become essential to have at hand for ready reference maps of all the world, in order to understand intelligently the things that are happening.

Chicago is the map making center of the country. It is said that more maps are sent out of that city annually than from all the other cities of the United States combined. Most of the railroads obtain their maps from Chicago. Hundreds of thousands of school maps are thrown off Chicago presses, and the majority of bicyclists who are ranging the country carry in their pockets Chicago-published maps made specially for them. Maps from the cheapest to the most expensive are made here, and whether cheap or expensive they follow the same path from the first drawing to the last time of going through the press. The difference comes in the size and the accuracy and care in the making which distinguishes them.

When the map publisher makes up his mind to publish a new map, one of Illinois, for instance, he orders the draughtsmen to make an original drawing. While any mechanical or architectural draughtsman can draw a map, the number who are regarded as expert map draughtsmen is small. The draughtsman takes the map of Illinois published last, and begins his work by copying it on the scale required. That is, he copies it larger or smaller according to the number of miles that each inch on the new map will represent. A map of Illinois six feet long by four feet wide would be made on a scale of six to one; that is to say, each inch on the map would represent six miles of distance.

But the new map must be "up to date," for Americans insist that their maps must show the very latest changes in boundaries, railroads, rivers, size and importance of towns and cities, and modifications of lake shores and seacoasts. Before the draughtsman begins his work the publisher has collected from government surveys, railroad time tables, railroad maps, and county and township surveyors all the information he can find regarding changes. With this information before him the map-maker begins his work. If any dispute or uncertainty arises over any particular section, a tracing is made of the territory under dispute, and this is sent to the official surveyor of that district for correction or approval. The drawing made in india ink is of the size that the map is to be made. All the lettering is put in with the pen, but merely to indicate the place where the type must print the names of the counties, towns, etc. When the drawing is completed it is taken to the engraving-room and turned over to the map engraver.

The engraver first takes a smooth-faced copper plate of the required size, and blackens the face by holding it over a smoking lamp, or by painting it with lamp-black, and then covers it with a composition made of wax and gum, laying on the composition to the thickness of light blotting paper. To get the composition even, the copper plate is slightly heated, for the composition melts easily. When the plate is thus coated it is ready to receive a transfer of the drawing. The back of the paper on which the map is drawn is covered lightly with black, brown or blue chalk, and this chalked surface is laid upon the wax composition which covers the copper plate. Then the engraver, with a fine steel pencil or stylus, goes over every line and mark in the drawing. As the steel point moves over the paper the drawing is copied on the composition, just as a copy of a drawing is made with black carbon paper. The composition is white and the chalk lines stand out conspicuously.

The plate is now ready for the graver, or V-shaped tool used by the engraver. With it he goes over the chalk lines, cutting out the wax composition to the copper plate. As he first coated the plate with lamp black, he can readily see his work, because the graver leaves a black line wherever it touches the copper. The engraver does not cut out the letters. He has an easier and better way; for, setting the names up in type, he places the type in a holder somewhat like a bookbinder's stamp, and then heating the type slightly, presses them into the wax to the copper. The holder is so arranged that the type can be set up either in a curved or straight line. Perhaps there is nothing on a map which excites more curiosity and draws out more guesses than the names of the towns and cities which straddle railroad lines, curve around rivers, and appear in a badly mixed-up condition. Every one knows that the names are printed by type, but how the type came there is a deep mystery to most persons.

When an exact copy of the drawing, with the names marked in type, is made on the plate, the engraver proceeds to "build up" the engraving. He takes a piece of the wax composition about the size and form of a lead pencil, and with a heated iron tool which looks like a piece of darning needle stuck into a handle, he builds up little mounds of wax on each side of the lines and letters. He does this to obtain the "relief," for all the time he has really been making molds in which to cast a copper electrotype. To pour melted copper into this mold would melt the wax instantly, so the map-maker turns to electricity as the agent which will deposit the copper in his wax mold. He suspends the engraved plate or mold in a bath, after first coating the mold with graphite. Not far from it hangs a pure copper plate. To each plate he connects a wire leading from a small dynamo. The current passing from the pure copper plate to the mold, through the liquid, carries with it the copper, which is deposited in the mold, thus really making a copper cast of it. When enough copper has been deposited, the mold is taken off, the copper cast removed, and the reverse of the drawing standing out in bold relief is taken off. This thin shell is backed up with metal to make it solid and strong, and it is then ready to be placed in the press to print thousands of maps of Illinois. To engrave a map about 11 inches wide by 14 inches long requires six weeks' work of the engraver.

The electrotype thus made is used to print the black map. For every color used in the maps, a separate plate must be made.

This explains why the price of a map increases in proportion to the number of colors used. The largest map made in one piece in Chicago is 66 inches long and 46 inches wide. Anything larger than that is made in sections, and the sections are neatly pieced together to make the whole.

Most of the maps made by or for the government are not made by the relief process, but are engraved on steel, copper, or stone. In engraving a map on steel, the steel plate is first coated with a peculiar varnish, which is acid proof. A transfer of the drawing is made on the varnish, but unlike the transfer made on the wax composition in the relief process, the copy is reversed. The engraver cuts through the varnish with his graver, and then the steel plate is placed in a bath of acid, which attacks the steel where it is not protected by the varnish. When the engraving is finished the maps are printed by the usual method of printing steel engravings.

For maps where extreme accuracy is required, as in coast surveys, soundings, and navigators' charts, a sheet of thin, transparent gelatine is placed over the drawing. With a sharp steel pencil the engraver copies the drawing into the gelatine. He then dusts blue powder over the gelatine, and the powder remains in the scratches or etching made by the steel pencil. By pressing this into the varnish the copy, in reverse, is transferred in clean, sharp lines. Engraving on copper or stone is done in much the same manner, and maps made from the stone are simply lithographed. The engraving is first made in the stone, after a copy of the drawing has been transferred to it, and then a transfer is made from the engraving to a flat stone by the lithographic process. The largest map printed from stone is 36 inches by 62 inches. For large wall maps the sections, which pasted together on cloth make the whole, are 48 inches by 42 inches.

What was said to be the largest map ever printed was exhibited at the World's Fair. It was the map of the United States, 14½ by 19½ feet in size. Each inch on the map represented eighteen miles. Near it stood the electrotype from which the map was printed. Its area covered nearly 300 square feet. It was made up of pieces so cleverly joined that the joints could not be detected.

The making of globes requires time, skill and patience. In high-class globes the sphere appears to be covered with a single piece of paper. As a matter of fact the globe is covered with twenty-four pieces, except in small globes, where half as many pieces are pasted on. The lines representing latitude on a globe appear to be straight lines. But with the exception of the equator, all the lines are curved, the curves being of such radius that when the pieces are pasted on the sphere the lines are straight.

In one map publisher's engraving-room in Chicago an engraver worked two and a half years engraving the plates for an eighteen-inch globe. He first secured a perfect sphere eighteen inches in diameter. This sphere was tested in various ways until the engraver was certain it was a true sphere. Then he divided it into twelve sections on the line of the equator, and laid it out on flat paper. Each section was cigar-shaped, curving evenly from point to point. When he cut it and pasted it on his model it wrinkled, and did not lie snugly to the bulge of the globe. He had to experiment for a time until he secured the proper shape, width and curve for his sections, and then he laid out his map accordingly. As eight colors were to be used in printing the globe map, it required fifty-six plates before the globe could be covered.

The globes themselves are made of papier-mache. On this a coat of plaster of paris is laid, and this is turned true in a lathe. This process is used in Chicago in making all high-class globes. The greatest care must be exercised in making the globe maps, for the paper shrinks, and this shrinkage, if too pronounced, would ruin the globe. The paper is always run through the press one way. That is, the sheets are fed in exactly as they lay in the roll of paper when it came from the paper-mill. In this way the fiber of the paper always runs in the same direction in going through the press.

The largest globe made for sale is 30 inches in diameter. Until recently but few globes were made in the United States. To-day thousands of them are made and sold in Chicago alone. An 18-inch globe is now sold for about $35; ten years ago the price of an 8-inch globe was the same as that of an 18-inch globe to-day. The cause of this great reduction in price is found in the constantly increasing demand for globes, for 100 high-grade globes are now sold to one sold ten years ago.

WATCHES AND CLOCKS

The sixteenth century inventor of the watch or spring clock would have deemed it a dream if to his Swiss soul had come a vision of the great watch factories of to-day, their thousands of employes, the division of labor, and the enormous output. Indeed, those Swiss manufacturers who until recent years enjoyed a monopoly of the making of fine watches, can hardly realize now the extent of the industry in this country.

Those watchmaker shops of bygone days, where one or two men constructed an entire time piece, have given way to great factories where hundreds and even thousands of employes earn their daily bread. The dingy work shop has been supplanted by great factory buildings with a thousand distinct departments, well lighted and well ventilated rooms, and a complicated system centering about the superintendent's supply room, to which all parts are taken when completed, and about the factory office, which sells watches not only at home but also to the natives of Africa, to the Australian sheepmen, in short, to the inhabitants of the uttermost parts of the earth. The simple hand tools have given place to hundreds of machines, propelled by one central engine under one guiding hand.

American watches now form a great bulk of the world's entire watch production. Illinois is the seat of two of the greatest factories in the country, one at Springfield and the other at Elgin. Massachusetts has the great Waltham factory, and the work of watch making has been taken up in Ohio.

The modern watch is marvelously complex, yet marvelously simple. Its construction is merely the perfect union of a multitude of simple details. First it is necessary to separate the watch into case and works, for in spite of a popular idea to the contrary, they have no dependence upon each other. Watch works or "movements" in most American factories are manufactured in sizes ranging from number four, which is about the size of a half dollar, to number eighteen, which is fully twice as large. Cases are made corresponding to each of these sizes, and the sizes and the cases are adapted to any make of watch. They are the product of factories established for that purpose and, of course, are of endless variety.

The movements are constructed after various plans, but in most makes they have for their foundation two plates, the lower and heavier one called the pillar plate, and the upper plate, which is often in several sections. Between these two the mechanism of the watch is arranged. The lower plate generally is of brass, the upper of nickle. They are punched from strips of sheet metal to exactly the right size and shape, after which they are smoothed and polished.

To allow room for the little wheels, indentations absolutely exact are made in the foundation plates. This work is done by a wonderful machine which follows the outlines of a steel model, made for a pattern, with absolute mechanical accuracy. The thickness of the plate and the depth of the indentations are measured so as to be perfect, according to a gauge two degrees of which equal a thousandth part of an inch. Into the plate then are drilled the necessary screw holes and apertures for the jewel settings. For every step in the process of preparing the plates there is a new smoothing and polishing given them, so that all rough edges are continually removed.

Watches containing from four to twenty-two jewels are made in most factories. The jewels used are garnets, rubies, sapphires and diamonds. Garnets are the ordinary jewels and a fifteen-jewel watch is considered the standard. The garnets are imported from Coventry, England, and come in packages containing from 500 to 5,000 pairs.

The various wheels of a watch are stamped out of sheets of brass, with the exception of one or two pieces. The springs are made from sheet steel, and the screws of cold steel drawn from wire. The tempering of these various steel pieces is one of the classes of work in factories demanding highest order of skill. In tempering some varieties of screws, and some of them are so small that a glass is necessary to distinguish them from specks, the workman uses a thermometer of a peculiar sort in order that he may watch the temperature to which they are heated and then cooled at the exact point. Other varieties are tempered by watching their colors. They are heated over small furnaces until they give off light of the proper kind, and then are cooled. Screws in a watch of ordinary grade number about forty varieties, all of which are turned, sawed and gauged by girls in the factory.

The pinions, wheels, axles and similar pieces are turned out by girls. One machine cuts the pinion's length from a wire, turns it with three successive cuttings by tools which succeed one another automatically, and deposits the pinion. One girl seated on a stool which moves on rollers on a track can attend to five of these machines at once. The balance wheel, which flits back and forth with such never-varying regularity, requires forty different steps in its manufacture, simple as it appears. Steel and brass disks are brazed together, and are ground down to the required thickness. The united disk is then punched into a rim which is calculated to contain two parts of brass and one of steel.

In the edge of the rim, twenty-six holes are made, and the same number of small screws are inserted to preserve the balance of the wheel.

After the foundation plate receives its jewels and is polished, engraved and stamped with whatever ornamental design it requires, and has passed inspection together with the parts which have been adjusted to it, the whole is brought to the assembling room, where all the work of the factory comes to a successful termination. Each part has been rendered perfect. The works are adjusted, piece by piece, by fine divisions of labor, passing from hand to hand down a long row of workmen's tables in the process. Each man has his particular work and is responsible for it. When once assembled, the mechanism is tested as a whole. Thence it is taken to a refrigerator and subjected to cold. A stay in a hot-air compartment follows this, the temperature of the two tests ranging from forty degrees below zero to 103 degrees above. Not until it passes these tests without being affected is the watch considered to be perfect and ready for the market.

The dial of the watch is made by a complicated process in which a metal plate is coated with enamel, fired and glazed like china, and painted mechanically with the figures and designs before a second firing.

From the intricate details of watch manufacture it is necessary that the factory system be perfect and this necessity is met in most American factories. As a general thing the employes are comparatively well paid. The work is so specialized, however, that none of the employes become watch makers in the real sense of the word, but only skilled in their particular department. Each piece in the mechanism and each step in the process of manufacture is governed by fixed designs and made largely by automatic machinery, so that often an unskilled, inexperienced girl guides the machine which turns out work the most essentially exact.

The United States contains the largest clock factories of the world as well, and clocks made in this country are sold everywhere, their reputation being so high that the German and Japanese imitations, made in large numbers of late years, have actually adopted the designs and the labels of the American manufacturers, in order to obtain a share of the trade by deceiving the customer. The common spring-clocks might be called larger and rougher watches, and the processes of stamping out foundation-plates, wheels, springs and screws are not unlike those of the watch factory, modified to meet the conditions of the larger mechanism. The amazing cheapness with which watches and clocks are made, while their qualities of accuracy are preserved, is, of course, due entirely to the employment of automatic machinery which produces them in great numbers at the least cost. There is another advantage also in the fact that in machine-made pieces all the parts made by a given pattern are interchangeable, so that in the event of an accident, repairs can be made with the greatest ease and at the least expense.

Watch cases are hardly as complicated as are the works, but the factories making them are great institutions with most ingenious machinery in use. Thin sheets of metal are passed through machines which stamp out the disks of the right size, much as coins are stamped out in the mint. The disks are then passed through processes which form them to the right shape. The polishing and engraving are done by machinery, except when some special design is made to order. The filled cases which have become such a popular substitute for the more expensive cases of solid gold, are made by welding two thin sheets of gold on opposite sides of a sheet of steel, and then stamping the disks for the case out of this combination metallic plate. A case of great strength is thus obtained at moderate cost, with a surface of gold which will wear many years without deterioration.

MIRRORS AND THEIR MANUFACTURE

In the days when society and clothing were little appreciated, some heated man, in stooping to drink from a shady forest pool, saw a face in the water. After the first superstitious fear had been overcome he doubtless came again and again, each time with greater curiosity. Perhaps he also called the attention of his wife and daughters to the phenomenon, and as soon as they discovered that their own faces looked up at them from the water, doubtless they began to think of rings for their noses. Thus vanity was born when the mirror was discovered.

Since that time mechanical skill has been engaged in making portable substitutes for the shady pool, according to the model which nature provided. First the mirror was a polished piece of metal, usually bronze, and then it was silver or brass. Everywhere the early society belle went, she carried her mirror along with her in a little box which hung from her girdle. In some cases a slave was specially employed to keep it so highly polished that the reflection would be perfect. This use of metals continued until a comparatively recent time, and then some man who could not afford a piece of silver to look into devised a glass mirror. He found that the amount of metal required to make a thin coating on the glass was exceedingly small, and that its bright surface, being hermetically sealed by the presence of the covering glass, did not require any polishing. From that time to the present the glass mirror has prevailed, and the process of manufacturing has varied only in small details.

In the first place a mirror requires the finest kind of glass, without spot or speck or "blow-holes." The best work is done with the plate glass manufactured in St. Gobain, France, and in numerous cities of Belgium. All the largest manufacturers of mirrors use the foreign varieties in preference to those of American manufacture. The glass comes in huge plates, a quarter of an inch thick, ten or fifteen feet long, and half as broad. As many as a dozen plates are packed in a single box, displaying numerous warnings to "handle with care." When the glass is taken out it is covered with dust and bits of excelsior, and the first thing that is done is to wash it clean with water. Then a dozen of men who know just how to handle a great piece of glass without subjecting any portion of it to a breaking strain carry it into the cutting room. Here a workman in a long leather apron—usually a Frenchman who has had great experience in foreign mirror manufactories—blocks out an order on the plate, say two or three beveled mirrors for some lady's boudoir. A diamond-pointed instrument, with a strong and steady hand behind it, traces the lines of drawings on the glass and cuts a groove so deep that the pieces easily crack out.

Each of these oval pieces is then borne into another room, filled with the humming noises of rapidly-moving machinery. A thin-faced foreign workman, with his sleeves rolled up to the elbows, and a ragged apron draping him from chin to toes, picks it up and places its edge upon the side of a swiftly revolving iron wheel. From a large wooden tank, which strongly resembles a New England ash-leach, a steady stream of sand and water flows upon the iron wheel, and in passing between it and the edge of the glass wears the bevel. The muddy water from the wheel is frequently thrown off in the swift revolutions, and works polka-dot designs all over the operator. But he is a skilled workman, and in his pride in getting the bevel on the glass exactly even—and he must depend wholly on his eye—he doesn't pay any attention to the flying mud.

When the bevel is complete it resembles "mist" or ground glass, and is full of scratches and rough places. The next workman in order smooths the bevel on a rapidly revolving emery wheel, which casts off a perfect shower of sparks. When it is as smooth as it can be made by this process it is passed to a third workman, who applies it to a fine grindstone from Newcastle, and in two minutes almost all traces of roughness have been removed. A small boy sits above the next wheel, which is made of wood, and daubs it with a wisp broom which he dips continually into a tub of water standing near at hand. He and the operator are both covered with the thin gray fluid which the wheel throws off.

By the time the wooden wheel has been used, the bevel, to the ordinary eye, looks as smooth as the other parts of the glass. But to the trained eye of the master-workman, who has watched for flaws in the glass since he was a child, it is far from perfect, and he takes it in his hand and passes the bevel swiftly over a wheel, which is smeared with ordinary rouge, such as the actress uses to make blushes on her cheeks. It may be imagined that this part of the shop has been well treated with red—the men are all red, the floor is red, the tools are red and in passing through the department the visitor frequently acquires involuntary blushes. When the embryo mirror has passed the rouge wheel its bevel is perfect, and it is sent to an expert for inspection. If there are any remaining scratches on the glass they are marked with chalk, and a workman with an old rag smeared with rouge rubs away until it is smooth and fine.

The glass is now ready for the silvering room—a tight, hot, well-lighted apartment in which the workmen wear as little clothing as possible. An inclined plane of boards, which resembles a huge washboard turned on its side, fills one corner of the room, and on this the plates of glass are laid face downward. Over them the workman spouts a stream of water, which cleans off the dirt. Then with another hose he plays on the glass with a sensitizing solution of tin, the exact composition of which is a trade secret. The pieces of glass are next gathered up by a workman and are borne to the "bed."

While it is not provided with pillows, the "bed" is complete in almost every other particular. It has a blanket which is strung across a frame about the size of an ordinary bed, and over this a cotton sheet is stretched. Underneath, so that its surface just touches the blanket, there is a large vat of water kept hot by steam pipes. The embryo mirrors are laid on the bed face down, and while they are yet wet with the sensitizing solution, a workman pours a diluted compound of nitrate of silver, ammonia and tartaric acid over each glass. The exact composition of this solution is also a trade secret, each firm having its own methods for mixing and each is certain that it cannot be beaten in results.

Assisted by the heat from below and by the tin solution, the silver is quickly precipitated on the glass. When the workman in charge thinks the coating is thick enough he pours off the surplus of the silver solution, and the mirror—for it is no longer in an embryo state—is put into a warm "bed" to dry off. Here another workman takes the mirror and paints the back of it with a protective solution. Each firm has a different color of paint and each paint is usually a composition differing from all the others, so that when a mirror is received for resilvering the manufacturer can usually tell just what firm originally sent it out. Frequently in special orders the backs of mirrors are covered with felt.

The whole process in the silvering-room is wasteful of silver, and many devices have been used to preserve all the metal possible. The blankets of the beds and the coverings of the tables where the nitrate of silver crystals are ground up, all go to the refineries for burning, and about 20 per cent of the silver is recovered.

The whole process of making a beveled mirror does not take to exceed an hour by the present methods, and no stage is dangerous to the workmen. When mercury and tin-foil were used a number of years ago, the fumes killed many of the operatives and a mirror could not be completed under ten days.

A large mirror is much more difficult to make than a small one, owing to the difficulty of handling the somewhat fragile glass. The largest mirror ever made in Chicago—so say the manufacturers—was 18½ feet long and 8 feet broad, and it was used in a liquor saloon. Two or three of the five large manufacturers of mirrors in Chicago use French glass almost entirely, for the reason, they say, that it is much finer in quality, and lacks the greenish tint which spoils American glass for the best trade. Chicago not only supplies the home market with mirrors but ships them all over the West and to Mexico, Canada and South America.

Making plain mirrors adds about 20 per cent to the value of the plate glass, or in beveled work 30 per cent. For instance, a piece of plain French plate glass, 5x10 feet, would cost about $75. A plain mirror of the same size would sell for $90.

ART WORK IN BRASS

Ornamental brass work has become an important industry since banks and other business offices have taken to plate glass, mosaic floors, statuary, stained glass over desks, and other decorative luxuries. This style of brass work is but the refinement of a commoner art, and the same men who make car-fittings, valves and brass work for steam engines and other machinery, can step into an "art brass" foundry and turn out high-grade work. The brass is cast in the foundry, cleaned, pickled, buffed, spun, turned, brazed, lacquered and polished in one shop as well as in another; the difference is that finer material, daintier designs and forms and a higher finish are used in ornamental work.

The foundry is the beginning. There the brass is roughly cast to form, and from thence it starts on its way to the finishing bench. Here the alloy of copper and tin, or copper and other metals which make brass, is cast in molding sand. The operation is similar to that used in an iron foundry, particularly in an iron foundry which makes a specialty of light castings—or, as the molders call it, "snap flash" work. The brass molders work at benches—or, rather, troughs—in which is kept the molding-sand, which looks like rich black dirt and is so cohesive that when pinched between the thumb and finger the sand holds together and shows the mark of the pinch. The flask in which the sand is packed around the pattern is made of two frames, one fitting over the other. One frame has legs of wood, called dowels, and the other has holes in which these dowels fit, so that when the frames are brought together, one will remain over the other. The frames are made of four pieces of wood, fitted up with hinge-like corner-pieces, so that the frame can be unlocked and taken away from the sand without disturbing it.

The molder lays one of the frames on a smooth board which goes from one side of his bench to the other, and fills it with sand. In the center and on top of the sand he lays the pattern, and presses it into the sand, and then fits the other frame over it. He shakes over the pattern some fine "parting" sand, and then fills the upper frame with molding sand, ramming it down hard with a couple of hard wood rammers, shaped something like dumb-bells, except that the ball on one end has a flat surface, and on the other tapers to a blunt, chisel-shaped point. After the sand is well pounded around the pattern, the molder scrapes the surplus sand from the top frame with a stick, and runs a pointed wire into the sand toward the pattern, thus providing escapes for the gases which form when the molten metal is poured in. Then he turns over both frames, or the flask, and carefully lifts the bottom frame—now the top one—from the other, exposing the pattern imbedded in the sand. The pattern is withdrawn by driving a steel pin into the wood, or, if it is a white-metal pattern, by means of a screw pin made for the purpose, and the operation is aided by gently tapping the pattern as it leaves the sand.

For hollow castings the cores are now put in place. A core is made of sand, paste and sometimes sour beer, rammed into molds and afterward baked in a large sheet-iron oven over a coke fire. Coremaking is generally done by boys, with perhaps two or three men for making the intricate cores. When the cores are laid in place in the hollow space left by the pattern, the molder scoops out his "gates," or channels, through which the melted brass will find the mold, and then, placing the frames together, he takes off the woodwork and lays on the floor the short board with the block of sand on it. This is the way straight and core work is done. But for some purposes false core work is required, and this is, in miniature, what is done in making the mold for casting large bronze statues.

Some patterns have undercuts which cannot be molded in sand as plain patterns are. They are made with false cores, and this work requires the greatest skill in the foundry department. An ordinary core gives form to the hollows of a casting, or makes the holes through a casting. A false core is a part of the mold built up separate from the mold proper, and as it is in small pieces it can be taken out without removing the pattern. Thus a bust can be buried in the sand, but its irregular form, its deep cuts and incurving depressions make it impossible to withdraw it from the sand without bringing part of the mold with it. The brass-molder gets around this by building up the mold out of sand packed so tight and hammered so close into the different parts of the pattern that each part can be taken away, and when the pattern is removed can be properly assembled again to form the mold. Sometimes a dozen or more pieces are required to build up a false core.

The brass is melted in crucibles, and the furnaces, usually below the floor level, are in a line, so that all the melting is done in one part of the foundry. With a pair of large tongs the crucible is lifted out of the bed and carried to the molds, and the metal is poured into the gate and thus fills the hollow in the sand. The castings which are to be polished are cleaned in water and "pickle"—acid and water—and are then buffed or burnished. Sometimes they are finished by being dipped in strong or weak solutions of nitric acid and water. For "bright dipping" the acid is strong and the brass casting is instantly withdrawn from the bath, but when a dead finish is desired the acid solution is weaker and the casting is left in until a creaming color appears on the surface. In burnishing, the brass is brought to a high finish by being rubbed with polished steel tools, or it is held against buffing wheels, which are thick, soft wheels made of cotton. Rouge, a red polishing mixture, is put on the wheel and the high speed of the wheel polishes the brass. The buffing wheel cannot be used, however, on rough castings or irregular surfaces. The brilliancy and polish of brass which has been burnished or buffed is heightened and preserved by lacquer. This is put on the polished brass by girls, and the lacquer is dried in an oven.

Brass is spun, stamped, pressed and drawn in the same manner as copper, gold and silver, and many of the trade secrets of goldsmiths and silversmiths are shared by brassworkers.

BELLS AND HOW THEY ARE MADE

Ever since the beginning of civilization men have been called to worship by the ringing of bells. As the strand of scarlet runs through all the ropes and hawsers belonging to England's navy, so bells have marked the history of religion. Whenever the Jesuits of old established a mission, a bell was thought almost as important as a priest, and it was often brought from the foundries of Europe at great labor and expense. To many a heathen mind the clangor from the chapel belfry must have been almost synonymous with the white man's God. Even to-day, as soon as a little pine church sprouts up on a village hillside, and before the gloom of the mortgage which hangs over it has been dispelled, the "ladies' aid society" and the "young folks' helping hand" begin to raise money for a bell.

But Christians are not the only bell-devotees. The Chinese and Japanese are among the greatest bellmakers of the world, and they have worked to the glory of Buddha or Confucius. In some ways bells have grown to be more or less a symbol of religious ceremonials.

Whether from these associations or from the fact that early castings were attended with much church ceremonial, the making of bells has something impressive about it. The manufactories are usually great, gloomy, smoky buildings, with no floor but the earth. One end is filled with the bell molds, and not farther away than the arm of a giant crane will stretch, stands the furnace in which the metal is melted.

The whole process has been reduced to a marvelously exact science. Knowing one dimension and the tone of a bell, an expert can figure out all the other measurements and the weight. In fact, the main part of bell-making is done in a clean little room where a man sits busily at work soiling clean paper with figures and drawings.

For instance, the thickness of a bell's edge is one-fifteenth of its diameter, and its height is twelve times its thickness. It must also be constructed of just the right thickness in its various parts, so that when tapped on the curve of the top it will yield a note one octave above its real key note; when tapped one-quarter of the distance from the top it will yield a note which is one-fifth of an octave, and when tapped five-eighths of the distance from the top it will yield one-third of an octave. Where the clapper strikes, all of these three will sound simultaneously, thus yielding the consonant or key note of the bell.

These are exact rules, and they have to be carefully reduced to dimensions. Besides this, the proportions of the metal to the size of the bell must be calculated. Copper and tin are used for large bells, but the mixture varies widely, and almost every manufacturer has a rule of his own. About four parts of copper are ordinarily used with each part of tin.

When the designs have been made for a bell they go to the pattern-maker, whose haunt in his little workshop at one side of the foundry is a veritable museum of tools and patterns. The workman, after carefully making the measurements on a spruce plank, cuts out two long strips of wood, one of them just the contour of the inside of the projected bell, and the other the contour of the outside. This work must be very careful and exact. By the time it is completed the leather-aproned men at the other end of the foundry have made the basin for the mold. It is constructed in the earth, and consists mainly of firebrick and clay. At its center a stout post is planted, perfectly plumb, and just the height of the proposed bell. The two contour pieces from the pattern room are now pivoted to the post in such a way that they will swing around like the free leg of a compass.

In the center of the basin and around the post the workmen build a little furnace of brick, so large that it almost reaches the sweep of the inside contour leg of the compass. It is then pieced out on top with fire-clay, until it exactly conforms to the sweep of the contour leg. After having been made very smooth the little furnace, which is just the size of the inside of the bell, is allowed to harden for a time. This is the core. Then grease is applied and workmen again plaster on the clay until it reaches and is swept smooth by the upper contour leg. This covering of clay is exactly the size and shape of the projected bell. Any designs or inscriptions are now worked in reverse order on the "sham-bell" and plugged in with wax. When it is dry it, in turn, is smeared with grease, and another layer of clay, called the mantle or "cope," is packed on roughly, a hole being left in the top through which the molten metal can be poured.

After having been hardened by drying for a few days the whole mass is caked by building a hot fire in the interior furnace. The wax in the inscriptions and the grease vaporize and pass off. The mantle or the mold for the outer part of the bell can now be readily grappled and lifted off. When the next layer or "sham-bell" is removed and the mantle replaced the space left between it and the core furnishes the bell-mold. Little holes are left in the bottom of the mold for the escape of gas during the pouring. Everything is now ready for the greatest event of the whole process.

In the furnace the great mass of bell-metal is already bubbling away, as liquid as water, and the furnace-stokers below are perspiring with their exertions. Outside and at a safe distance stand the spectators, with the glare of light from the furnace reddening their faces.

Then the master-workman, calm and slow-voiced in spite of his anxiety and responsibility, steps forward and waves his hand. Instantly the throat of the furnace opens and a molten stream of metal, hissing and spitting, gurgles out into a great earthen crucible. As it reaches the bottom, which has been previously littered with charcoal, a great burst of green flame spurts a score of feet into the air. The whole effect is indescribably gorgeous. The faces and the bare, brawny shoulders of the workmen gleam pale against the smoky sides of the furnace. The grimy rafters overhead send back the shower of sparks, and even the glowing mouth of the furnace pales before the brilliancy of the flame. The men rush forward and throw small pieces of broken bells into the crucible to cool the metal a little, and they are melted like icicles in a cauldron of boiling water.

It takes great skill to tell just when the molten metal is of the right temperature to pour. When this moment has arrived the huge arm of the crane reaches forward and lifts the crucible in the air and swings it out until it is just over the mold. Then there is a pause. The visitors are silent, holding their breaths, and the workmen, like the hunter who pauses with game in view and his finger on the trigger, stand motionless, their eyes intently fixed on the glowing crucible suspended high above them.

The work of weeks may be completed beautifully or ruined in an instant. It is like the supreme moment in a tragedy.

Then the heavy silence is broken by the master's voice, and the crucible is slowly tipped and its molten contents stream downward into the mold. A man stands near igniting the gas, which belches out as the metal goes in. If it is not destroyed it may leave blowholes in the bell, thus rendering it useless. At last the metal overflows the mouth of the mold and then the crucible is tipped back. The pouring is complete.

Then the mold is left for several weeks to grow cold and shrink, because if broken open at once the bell would cool more rapidly on the outside than on the inside, and would burst. The moment of breaking off the clay mantle is also one of anxiety. It discloses whether or not the work has been successful.

When entirely extricated and still in its "maiden state," as it is called, the bell is tested, and if it gives out a single pure tone it is regarded as a perfect cast. The manufactory which can turn out the largest proportion of "maiden" bells is the most successful. If the tone is not pure the bell can sometimes be tuned by filing away the parts of the inside surface, but it can never be made equal to a "maiden."

The largest bell ever cast was the celebrated "king of bells," as it is called by the Russians, in Moscow. It was made under the orders of the Empress Anne in 1733, and at the time of its casting a great religious ceremony was held, during which hundreds of nobles threw their silver and gold jewelry into the furnace. The bell measures 22 feet 8 inches across the mouth, 19 feet 3 inches in height and its thickness at the base, where the clapper would strike, is 23 inches. Its estimated weight is from 400,000 to 440,000 pounds. A nearly triangular piece of metal about 6 feet high and 7 feet across the base, weighing 11 tons, is broken out from the rim. There has been much discussion as to whether it was ever rung or not. Be that as it may, the bell now stands within the Kremlin, where it was originally placed, to serve as a chapel for religious exercises. Its value on account of the gold and silver which it contains is said to be very great.

The largest bell in America is in the cathedral of Montreal. Its weight is 28,000 pounds. The old "liberty bell," which rang when the Declaration of Independence was signed, weighs only 1,500 pounds. Early Chinese bells were nearly square, and were welded out of different pieces.

The Mexicans make bells out of clay, baked like pottery, in the form of women, arms, head and skirts.

HOW ARTESIAN WELLS ARE BORED

Artesian wells are changing some of the dry, arid tracts of the west into the best farming lands of the country. The water brought sometimes a thousand feet from under the surface, is conveyed, by irrigating ditches, to the parched earth, rich in all that goes with good producing soil except water, and when that great need has been supplied abundant crops will result. In large cities, equipped with extensive and modern waterworks systems, thousands of artesian wells supply industrial plants with water, and in the long run save thousands of dollars of water taxes to the manufacturers.

In some wells the pressure of water is sufficient to send it to the surface, but from the majority of wells the water is pumped by steam pumps or windmills. The man who bores an artesian well works under a great disadvantage, for he is in the dark as soon as his boring and driving tool is well under the surface of the ground. His drill points, casing, rods, sand pump, reamer or any one of the dozen tools and appliances he uses, may be broken hundreds of feet under ground, but he goes to work to extract the broken tool or dislodge the piece that is stuck as calmly as though it were just at hand.

The ingenious devices used by the well borer for repairing damage and overcoming obstacles, are the result of the hard, exasperating, practical, expensive experience of hundreds of well borers for many years. The business of boring artesian wells, drive wells, oil, gas and other wells made by sinking a line of pipe, has developed into a distinct branch of hydraulic engineering, for water is one of the most important tools used by the up-to-date well borer. In fact, some holes are literally pumped out, and the pipe casing sinks into the ground without a blow or a shove.

In driving a tube well on a farm either a horse-power machine or a portable steam engine is used as power. A hole is bored for some distance and this hole is cased with an iron pipe which is driven into it. The well-driving apparatus consists of a drill screwed to the bottom of the drill rod, which is in sections, so that the rod can be lengthened by screwing sections together.

The drill rods are made of iron pipe, and every thirty feet or so in the hollow drill rod is a valve which opens from beneath. In the drill is a hole, and as the drill is lifted and dropped alternately by the mechanism on the ground, water is poured into the well. This makes a "slush" of the pounded, crushed earth, clay, gravel or stone, and it enters the drill rod through the hole in the drill.

When the drill is lifted, of course the rods, with the water and slush in them, are raised. The drill is dropped suddenly, and as the heavy iron and steel falls more rapidly than the slush and water, the slush passes into the next section above through a valve, which closes when the drill is again raised. In this manner the drillings are lifted to the surface and are there discharged.

The drill is lifted and dropped, crushing its way deeper and deeper into the earth, and as it sinks the iron casing is driven down after it. A pump is always attached to the head of the apparatus, and when water is reached the pump is started, and the sand in the gravel bed is pumped out, forming a reservoir in the clean gravel. This method of sinking a well is rapid and inexpensive.

An improvement on this is the "rolling" and "jetting" process. This is a combination of the principles of hydraulic mining, as practiced in California, and of the diamond drill without the diamonds. In hydraulic mining a stream of water, forced from the nozzle at a great pressure, is directed against the bank, and the earth is washed away just as furrows are cut into the sod on a lawn by the jet of water from a garden hose.

A diamond drill cuts its way into the earth, clay and rock, by revolving a drill-point studded with black diamonds. In the rolling and jetting system used in sinking artesian wells, the cutter is a section of pipe on the lower end of which teeth are cut. As this is revolved in the ground by the machine which grips the pipe and turns it, jets of water are forced down inside of the pipe. The water rushes out from under the cutter's teeth and returns to the surface of the ground on the outside of the pipe. This returning water cushion between the pipe and the earth lessens the friction and gives the casing an easy rotation.

Naturally the hollow cutter carries a core of the material through which it forces its way, and the well-borer utilizes this core, if it be of clay, to build up a clay wall for the bore when it passes through quicksand. If there be not enough clay in the core for this purpose, he puts some in the pipe, and the water carries it down and up, packing it in the quicksand. If a material is met which the cutter finds difficulty in boring, broken emery rock, iron ore, flint sand and other abrasives are sent down through the pipe. For material too hard to be cut by the steel cutter, a cutter set with black diamonds is used. A modification of this hydraulic-cutting combination is a steel "paddy" drill, which is carried down with the casing and cutter. This apparatus permits the use of all the appliances without taking out or letting down other tools. A drill is attached to the end of a hollow drill rod which goes down inside of the casing. The rod and casing have independent movements, so that the drill can work ahead of the casing, or the casing can cut its way without the drill, both of them aided by the water sent down from above.

Enormous augers which bore holes from eight to thirty inches in diameter are used to sink shallow wells. It is conceded that wells more than 60 feet deep should be bored with the well-driving machinery and not with earth augers. The huge auger is fixed to the lower end of a vertical shaft, which is connected with the proper mechanism to twist it around. In the use of horse power the auger shaft is attached to the sweep to which the horse is hitched. Some of the augers are real augers, others are bucket-shaped, with cutting edges, and still others are claw-shaped, but they all cut out the hole, and when full of earth are lifted to the surface, emptied and sent down to corkscrew their way deeper.

Such wells are cased with vitrified, glazed or terracotta tiling, galvanized pipe, etc. If the auger, which is not made for stone work, meets a rock or a boulder, a drill is sent down the hole and the rock is broken or bored through. If it is a loose stone it is lifted from the hole, provided it is not too large for the bore, by "screw tongs," "ram's-horn" rock extractors and other devices of like nature.

A sand pump is a hollow cylinder of iron, fitted with a hinged bottom which opens inside of the cylinder. When it is dropped into the sand the door is forced up and the sand, when inside, holds it closed so that the material can be lifted out.

DISCOVERIES IN MEDICINE AND THE PROLONGATION OF LIFE

Dr. John Pot came to Virginia in 1610, and Dr. Samuel Fuller came over in the Mayflower in 1620. They have the distinction of being the first white "medicine men" within the present limits of the United States. An attentive schoolboy twelve years of age doubtless now knows as much of the genuine principles of health as they did, and he is a dull student if he does not know a great deal more of the structure of the body.

At the close of the Revolutionary War there were about 3,500 medical practitioners in the United States, and only about 400 of these had graduated from any school of medicine. There were then only two medical colleges in this country, and they had conferred only 51 degrees. So few people patronized the doctor that usually he made his living at some other work and practiced medicine as a pastime.

The theory and practice of medicine have since then advanced to a high position among the sciences by the aid of important discoveries made in kindred sciences. The sufferings of the human race have been decreased more than can be estimated, and the happiness of mankind has been advanced in proportion through medical investigation and prophylactic discoveries with their allied sciences. A few of the more important general discoveries may be thus mentioned:

Lady Mary Montagu brought the knowledge of inoculation against smallpox from Constantinople, and Dr. Jenner, in 1798, taking it up as a scientific matter, brought vaccination into general use. In Europe, previous to the introduction of this preventive, at frequent intervals, from one-fourth to one-half of the population of the great cities were attacked by smallpox and 95 per cent of the children under ten years of age died, while more than half of the others were left badly disfigured. In contrast, the greatest epidemic of smallpox in the nineteenth century, that of 1872 and 1873, attacked less than five per cent in any city. In Germany, where vaccination is rigidly required, the deaths from smallpox are less than one-tenth of those of the surrounding countries, where vaccination is not thoroughly done.

LABORATORY WORK IN A MEDICAL COLLEGE.

Auscultation, or listening to the sounds produced in the chest by the heart and lungs, as invented by Laennec in 1819, revolutionized the treatment of diseases of the internal organs of the body.

Dr. J. Y. Simpson of Connecticut made the greatest discovery of the nineteenth century in its application to surgery, by making practical the use of drugs to deaden pain. Anesthetics thus did away with the horrors of surgical operations on suffering human beings.

Chemical cleanliness from all destructive germs in surgical work is the result of the discoveries of Joseph Lister of England. It is estimated that through his discoveries in the use of antiseptics the death rate from infections of wounds has been decreased at least one-half.

The minor discoveries that alone would mark an epoch in almost any science, such as antitoxin, which has reduced the mortality from diphtheria fully 95 per cent, with the discoveries of Pasteur and Koch to avert hydrophobia and tuberculosis, are too numerous to mention except in an ex tended treatise on the subject.

APPLICATION OF THE LIGHT CURE IN A LONDON HOSPITAL.

SPECIAL CULTS AND CURES

Innumerable specifics have meanwhile become popular, to contribute to general practice whatever they contained of value, and then fall into disuse.

The food cure is an exclusive diet of milk, grapes, and farinaceous vegetables during any period of disturbance in health.

The earth cure consists in immersing the body in mud or dry earth during periods of soreness or pain.

The water cure is the use of water at different temperatures either in immersion, douches in solid streams, or by the body being packed in wet sheets. The steam or hot air baths are used in the same connection, with vigorous rubbing with coarse towels.

The air cure, for rheumatism, paralysis, and similar diseases, is also known as the vacuum treatment. It is given by manipulating the limbs or parts of the body under or with vacuum pumps or disks.

The oxygen or ozone cure requires the patient suffering debilitation or lung troubles to live in an atmosphere specially prepared for him in an air-tight room or by the use of special inhalers.

The cure from sun-air baths is applied by exposure of the skin to the direct rays of the sun in dry, still air.

Breathing methods require certain periods each day of deep chest expansion where the air, if possible, is dry and pure.

Cures by electricity are effected by keeping the diseased parts directly in a current of electricity as powerful as may not be painful, for a given time.

The movement cure is a mechanical assistance given to the vital forces known as voluntary and involuntary. It is claimed that a violent agitation of parts that are in a state of torpor arouses and stimulates the circulation through them, both of blood and nervous force. Machinery is used to give vibration, which is said to produce heat and consequent development of energy in the parts.

The lift cure is accomplished by the action of standing erect, knees bent three or four inches, upon a platform resting on spiral springs. The lifter grasps a cross bar connected with the springs, adjusted by weights. The operation is in straightening the bent knees, while otherwise remaining erect, thus lifting the weight, and breathing deeply and rhythmically with each movement.

Mind cures, faith cures, and the like, consist in mentally separating one's self from the disease and giving it no place in the system.

The rest cure is self-explanatory as to treatment. It consists of a complete cessation of mental and physical action for given periods under the most comfortable conditions, or as isolated as possible from all disturbance. The latter has been called the wilderness cure.

SYSTEMS OF MEDICAL TREATMENT

Hahnemann, when he invented Homeopathy, on the principle that like cures like, gave the name Allopathy to the earlier school that cured on the theory of revulsion, that is of substituting one disease for another, as practiced by Paracelsus; and he also gave the name Enantiopathy to the doctrine that a thing is destroyed by its contraries, as practiced by Galen.

Hydropathy was the name given later to the school which effected its cures by the various uses of water, as practiced by the Rosicrucians.

The Eclectic school, as the name suggests, claims to take the best from all systems, but it relied mainly in the beginning on decoctions and extracts of herbs.

Osteopathy has firmly established itself in many places, and depends for its cures on the manipulation of the bony structures of the body. There are numerous minor systems, but the great discoveries of the last few years have almost completely obliterated the former dividing lines of the older medical schools. Physicians, like other thinking men, are becoming more tolerant of varying opinions and methods. The best of them frankly admit that good is found in all schools of practice, and are glad to make use of whatever discoveries aid in the healing of bodily ills and infirmities. So the entire body of medical men, in the highest sense of the phrase are becoming eclectic. No longer do they refuse to consult with their rivals, and the public thus is permitted the benefits of all progress.

OPERATING ROOM IN A GREAT DENTAL COLLEGE.

ELEMENTS OF PHYSICAL HEALTH

The assertion made for so many generations that cleanliness is next to godliness may not be as persuasive as if we were to say that cleanliness is the first law of health and long life. That many persons have attained extreme old age without regard to cleanliness is not very weighty proof that cleanliness is not one of the most goodly assistants to longevity.

Since there are 2,800 outlets to the square inch all over the body, making a personal sewage system of twenty-eight miles of pipes, this effort of nature to get rid of its waste matter should be fully sustained by baths and clean clothing. Fifteen minutes is long enough for any bath, and the water should be warm, tepid or cold, according as the person may find it most enjoyable and beneficial. No absolute rule can apply to all persons and all conditions.

During fatigue and while the stomach is digesting food, there should be no disturbance of the temperature of the skin, nor should a bath be taken within an hour or two after a meal.

Nothing quickens the functions of the body in a more harmonious manner than suitable exercise. It should always stop short of fatigue, and never extend to violence. Exercise of a general nature equalizes the circulation and aids the assimilation of nutriment. It prevents congestions and torpor of all kinds. It is thus of animating service to the mind, and may be regarded as the most important element in the promotion of long life.

Sleep is rest, and rest is the necessary alternate in all energy. Comfort is the first condition of sleep, after the suspension of action and thought. Sleep is the most restorative when it is the most complete suspension of all energy within body and brain. By systematic practice one can thus compose the mind at will and the healthy person should be able to fall asleep within five minutes of the first attempt. Cessation of thought without sleep may even become complete enough to be complete cessation of image-making, and therefore a fully unobstructed rest.

One who has a natural appetite and a normal organism, should never swallow anything that is in any way distasteful, nor should he ever impose any labor upon digestion that should be performed by mastication.

Usually in any derangement of the system, and most derangements come from some torpidity in the digestive organs, the first effect is a disinclination toward food. This is nature's warning that the digestive apparatus is in no condition to do its work and the warning should be heeded.

The organs that take up the nutriment from the food can only use so much, and an excessive quantity of food only dulls their vitality. In times of famine those die of starvation first who have been the heaviest eaters. Those whose habit it has been to eat little can extract more nourishment from the food eaten than the others are able to do, and so suffer less.

THE PULSE IN HEALTH

The frequency of the pulse varies slightly according to temperaments, but the following is regarded as the average:

New born infants from	140	to	130
During first year, from	130	"	115
During second year, from	115	"	100
From seventh to fourteenth year, from	90	"	85
From fourteenth to twenty-first year, from	85	"	75
From twenty-first to sixtieth year, from	75	"	70
In old age, from	70	"	60

CONTAGIOUS AND ERUPTIVE DISEASES

It will often relieve a mother's anxiety to know how long after a child has been exposed to a contagious disease there is danger that the disease has been contracted. The following table gives the *period of incubation* — or anxious period—and other information concerning the more important diseases:

Disease.	Symptoms usually appear within.	Patient is Infectious.
Chicken-pox..	14 days	Until all scabs have fallen off.
Diphtheria....	2 "	14 days after disappearance of membrane.
Measles......	14 "	*Until scaling and cough have ceased.
Mumps.......	10-22 "	14 days from commencement.
Rötheln......	14 "	10-14 days from commencement.
Scarlet fever.	4 "	Until all scaling has ceased.
Small-pox....	12-17 "	Until all scabs have fallen off.
Typhoid fever	11 "	Until diarrhœa ceases
Whooping cough......	14 "	†Six weeks from beginning to whoop.

*In measles the patient is infectious three days before the eruption appears.

†In whooping-cough the patient is infectious during the primary cough which may be three weeks before the whooping begins.

FIRST AID TO THE INJURED—WHAT TO DO IN EMERGENCIES

Drowning. 1. Loosen clothing, if any. 2. Empty lungs of water by laying body on its stomach and lifting it by the middle so that the head hangs down. Jerk the body a few times. 3. Pull tongue forward, using handkerchief, or pin with string, if necessary. 4. Imitate motion of respiration by alternately compressing and expanding the lower ribs about twenty times a minute. Alternately raising and lowering the arms from the sides up above the head will stimulate the action of the lungs. Let it be done gently but persistently. 5. Apply warmth and friction to extremities. 6. By holding tongue forward, closing the nostrils and pressing the "Adam's apple" back (so as to close entrance to stomach), direct inflation can be tried. Take a deep breath and breathe it forcibly into the mouth of patient, compress the chest to expell the air and repeat the operation. 7. *Don't give up!* People have been saved after *hours* of patient, vigorous effort. 8. When breathing begins take patient into a warm bed, give warm drinks, or spirits in teaspoonfuls, fresh air and quiet.

Burns and Scalds. Cover with cooking soda and lay wet cloths over it. Whites of eggs and olive oil. Olive or linseed oil, plain, or mixed with chalk or whiting.

Lightning. Dash cold water over a person struck.

Sunstroke. Loosen clothing. Get patient into shade, and apply ice-cold water to head.

Mad Dog or Snake Bite. Tie cord tight above wound. Suck the wound and cauterize with caustic or white-hot iron at once, or cut out adjoining parts with a sharp knife.

Venomous Insects' Stings, etc. Apply weak ammonia, oil, salt water or iodine.

Fainting. Place flat on back; allow fresh air and sprinkle with water.

Tests of Death. Hold mirror to mouth. If living, moisture will gather. Push pin into flesh. If dead the hole will remain, if alive it will close up.

Cinders in the Eye. Roll soft paper up like a lamp lighter and wet the tip to remove, or use a medicine dropper to draw it out. Rub the other eye.

ANTIDOTES FOR POISONS

First. Send for a physician.

Second. Induce vomiting, by tickling throat with feather or finger. Drink hot water or strong mustard and water. Swallow sweet oil or whites of eggs.

Acids are antidote for alkalies, and vice versa.

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SPECIAL POISONS AND ANTIDOTES

Acids, muriatic, oxalic, acetic, sulphuric (oil of vitriol), *nitric* (aqua-fortis). Soap-suds, magnesia, lime-water.

Prussic acid. Ammonia in water. Dash water in face.

Carbolic acid. Flour and water, mucilaginous drinks.

Alkalies. Such as potash, lye, hartshorn, ammonia. Vinegar or lemon juice in water.

Arsenic, rat poison, paris green. Milk, raw eggs, sweet oil, lime-water, flour and water.

Bug poison, lead, saltpetre, corrosive sublimate, sugar of lead, blue vitriol. Whites of eggs or milk in large doses.

Chloroform, chloral, ether. Dash cold water on head and chest. Artificial respiration. Piece of ice in rectum. No chemical antidote.

Carbonate of soda, copperas, cobalt. Soap-suds and mucilaginous drinks.

Iodine, antimony, tartar emetic. Starch and water. Astringent infusions. Strong tea, tannin.

Mercury and its salts. Whites of eggs, milk, mucilages.

Nitrate of silver, lunar caustic. Salt and water.

Opium, morphine, laudanum, paregoric, soothing powders, or syrups. Strong coffee, hot bath. Keep awake and moving at any cost.

Strychnine, tincture of nux vomica. Mustard and water, sulphate of zinc. Absolute quiet. Plug the ears.

RULES IN CASE OF FIRE

Crawl on the floor. The clearest air is the lowest in the room. Cover head with woolen wrap, wet if possible. Cut holes for the eyes. Don't get excited.

Ex-Chief Hugh Bonner, of the New York Fire Department, gives the following rules applying to houses, flats, hotels, etc.:

Familiarize yourself with the location of hall windows and natural escapes. Learn the location of exits to roofs of adjoining buildings. Learn the position of all stairways, particularly the top landing and scuttle to the roof. Should you hear a cry of "fire," and columns of smoke fill the rooms, above all *keep cool.* Keep the doors of rooms shut. Open windows from the top. Wet a towel, stuff it in the mouth, breathe through it instead of nose, so as not to inhale smoke. Stand at window and get benefit of outside air. If room fills with smoke keep close to floor and crawl along by the wall to the window.

Do not jump unless the blaze behind is scorching you. Do not even then if the firemen with scaling ladders are coming up the building or are near. Never go to the roof, unless as a last resort and you know there is escape from it to adjoining buildings. In big buildings fire always goes to the top. Do not jump through flame within a building without first covering the head with a blanket or heavy clothing and gauging the distance. Don't get excited; try to recall the means of exit, and if any firemen are in sight *don't jump.*

If the doors of each apartment, especially in the lower part of the house, were closed every night before the occupants retired there would not be such a rapid spread of flames.

ACCIDENTS IN THE UNITED STATES

In 1900 there were 2,550 railway employes killed and 39,643 injured; there were 249 passengers killed and 4,128 injured; in other accidents 5,066 persons were killed and 6,549 injured, so that the total casualties for the year were 7,865 and 50,320 respectively.

LIFE AND DEATH RATES

This table shows how many out of 10,000 persons die annually at each year up to 104. It is used by all life insurance companies in their computations of risk, premiums, etc.

Year.	No. Alive.	No. Deaths.	Year.	No. Alive.	No. Deaths.
At birth		1,539	35......	5,362	55
1......	8,461	682	36......	5,307	56
2......	7,779	505	37......	5,251	57
3......	7,274	276	38......	5,194	58
4......	6,998	201	39......	5,136	61
5......	6,797	121	40......	5,075	66
6......	6,676	82	41......	5,009	69
7......	6,594	58	42......	4,940	71
8......	6,536	43	43......	4,869	71
9......	6,493	33	44......	4,798	71
10......	6,460	29	45......	4,727	70
11......	6,431	31	46......	4,657	69
12......	6,400	32	47......	4,588	67
13......	6,368	33	48......	4,521	63
14......	6,335	35	49......	4,458	61
15......	6,300	39	50......	4,397	59
16......	6,261	42	51......	4,338	62
17......	6,219	43	52......	4,276	65
18......	6,176	43	53......	4,211	68
19......	6,133	43	54......	4,143	70
20......	6,090	43	55......	4,073	73
21......	6,047	42	56......	4,000	76
22......	6,005	42	57......	3,924	82
23......	5,963	42	58......	3,842	93
24......	5,921	42	59......	3,749	106
25......	5,879	43	60......	3,633	122
26......	5,836	43	61......	3,521	126
27......	5,793	45	62......	3,395	127
28......	5,748	50	63......	3,268	125
29......	5,698	56	64......	3,143	125
30......	5,642	57	65......	3,018	124
31......	5,585	57	66......	2,894	123
32......	5,528	56	67......	2,771	123
33......	5,472	55	68......	2,648	123
34......	5,417	55	69......	2,525	124

Year.	No. Alive.	No. Deaths.	Year.	No. Alive.	No. Deaths.
70......	2,401	124	88......	232	51
71......	2,277	134	89......	181	39
72......	2,143	146	90......	142	37
73......	1,997	156	91......	105	30
74......	1,841	166	92......	75	21
75......	1,675	160	93......	54	14
76......	1,515	156	94......	40	10
77......	1,359	146	95......	30	7
78......	1,213	132	96......	23	5
79......	1,081	128	97......	18	4
80......	953	116	98......	14	3
81......	837	112	99......	11	2
82......	725	102	100......	9	2
83......	623	94	101......	7	2
84......	529	84	102......	5	2
85......	445	78	103......	3	2
86......	367	71	104......	1	1
87......	296	64			

CREMATION

The burning to ashes of the bodies of the dead is one of the most ancient of customs, in all countries which have had an ancient civilization. The prejudice against cremation is but one Jewish influence among the many influences that through the scriptures have had such a powerful effect upon the feelings and habits of the civilized world.

The poems of Homer show that the custom of burning the dead was common during the Trojan war, more than a thousand years before Christ. Almost every country having a long history has, one time or another in its career, very generally practiced cremation. Evidences show that it has usually partaken of a religious character.

The use of the tomb was forever hallowed among Christians by the method of Christ's burial. The belief in the resurrection of the material body from the grave caused cremation to be looked upon with abhorrence among all those who held to that doctrine.

The cremation of the body of the poet Shelley and that of his friend Williams, in 1822, drew forth a general discussion of the subject, especially among the learned men of Germany and Italy.

In 1874 the closed receptacle was first used, and the second person to be cremated therein was the wife of Sir Charles Dilke, in Dresden.

In 1878, through the efforts of Sir Henry Thompson, the first crematory in England was built at Woking, in Surrey. However, it was four years before there was a cremation and that was done privately. In 1884 England declared it was a legal process of disposal of the dead.

The first crematory in the United States was built by Dr. Le Moyne, at Washington, Pa., in which the first cremation was that of Baron de Palm. Cremation societies for the erection and maintenance of crematories now exist in nearly every large city in the world, and many distinguished persons have recently selected that process for the disposal of their remains.

In 1900, at the Fresh Pond Crematory of New York City, there were 602 bodies cremated. Nearly 4,000 have been cremated at that place. Other places of cremation show a like increase of patronage, and the custom has virtually ceased to arouse comment.

The method of the process is simple, and without any specially harrowing conditions. The furnace is raised to a high degree of heat before the body in the closed receiver is introduced, when the door is closed and the heated air and gas turned in. It requires about half an hour to complete the process, when the wholly oxidized vapors of the body have passed into the air through a high chimney, and the remaining ashes for an adult weigh from five to seven pounds. The cost is about $25, and would be one-tenth of that sum if the custom was general.

The main reasons urged in favor of this method of disposal of the dead are its cleanliness, speed and sanitary results. Opposed to it are the religious ideas of a material resurrection and that it destroys all evidences of crime upon the body. To the first, the answer is given that this method is nowhere forbidden in scripture, and that all things are possible with God; to the other, that more crimes would thereby be detected because of the scientific examination of every body offered for cremation.

LEGAL FACTS AND FORMS

POWER OF ATTORNEY.

Sometimes it is desirable for one who is to be absent from home to empower some one else to act for him and sign his name. The legal document conferring that authority is called a power of attorney. Such an instrument should be drawn with the utmost exactitude, for it is a very important grant, especially if it be general in character. Here is a form, with a variation for general or special power indicated:

Know all men by these presents, That I, John Jones, of the City of Chicago, County of Cook, State of Illinois, have made, constituted and appointed, and by these presents do make, constitute and appoint, Henry Harris true and lawful attorney for me and in my name, place and stead, to lease, sell or make any other disposition whatever of any of my property in said city, [or certain specified property] and to sign, seal and deliver any agreement, assignment, assurance, conveyance or lease to any person who shall purchase, or agree to purchase, such property, or any part thereof, and in due form of law to acknowledge any such instrument necessary to the proper conveying or leasing said premises, or any part thereof, giving and granting unto my said attorney full power and authority to do and perform all and every act and thing whatsoever, requisite and necessary to be done in and about the premises, as fully to all intents and purposes as I might or could do if personally present, with all power of substitution and revocation, hereby ratifying and confirming all that my said attorney or his substitute shall lawfully do or cause to be done by virtue hereof.

In Witness Whereof, I have hereunto set my hand and seal the 2d day of June, nineteen hundred and two.

John Jones [seal]

Signed, sealed and delivered in the presence of John Martin, Notary Public.

AFFIDAVITS AND DEPOSITIONS.

An affidavit is a written statement sworn to or affirmed by the person making the statement, before a qualified officer.

A deposition is the testimony of a witness under oath, reduced to writing, and subscribed to before a qualified officer.

BILLS OF SALE.

Bills of sale are written evidences of agreements by which parties transfer to others, for a consideration, all their right, title and interest in personal property.

The ownership of personal property, in law, is considered changed by the delivery of such property to the purchaser; though in some states, without delivery, a bill of sale is good evidence of ownership, even against creditors, provided the sale was not fraudulently made for the purpose of avoiding the payment of debts.

Juries have power to determine the fairness or unfairness of a sale, and upon evidence of fraud such bill of sale will be ignored and declared void.

Any form of words, importing that the seller transfers to the buyer the title to personal property, is a bill of sale.

FORMS OF DEEDS.

The forms of deeds conveying lands are prescribed by several states, and such forms should be generally used. The requisites of a valid deed are: Competent parties; consideration; the deed must be reduced to writing; it must be duly executed and delivered. The mode and effect of an acknowledgment or of a deed is governed by the law of the state where the land lies, and not by that of the place where the acknowledgment is taken. Where the deed is executed by an attorney in fact, it is customary to have the power of attorney acknowledged by the principal and the deed acknowledged by the attorney. A deed executed by several grantors should be acknowledged by each of them.

WILLS.

All persons are competent to make a will except idiots, persons of unsound mind, and infants. In many states a will of an unmarried woman is deemed revoked by her subsequent marriage. A nuncupative or unwritten will is one made by a soldier in active service, or by a mariner while at sea.

In most of the states a will must be in writing, signed by the testator, or by some person in his presence, and by his direction, and attested by witnesses, who must subscribe their names thereto in the presence of the testator. The form of wording a will is immaterial as long as its intent is clear.

Age at which persons may make wills is

in most of the states 21 years. Males and females are competent to make wills at 18 years in the following states: California, Connecticut, Hawaiian Islands, Idaho, Montana, Nevada, North Dakota, Oklahoma Territory, South Dakota, Utah; and in the following states only females at 18 years: Colorado, District of Columbia, Illinois, Maryland, Missouri, Wisconsin.

DUE BILLS.

A due bill is not negotiable paper, so can not be legally assigned. It is, however, a memorandum of indebtedness, and may be made the subject of an order. Sometimes a due bill is made to take the form of a note, by being made payable one day after date, or on order. To be a true due bill, in due form, it should merely state that there is a given amount in money or goods due this day to the holder.

ORDERS FOR GOODS OR MONEY.

Ordinary orders are a matter of mutual convenience, running much as follows:

$60 CHICAGO, May 10, 1902.

Messrs. Marshall Field & Co.: Please allow the bearer to purchase goods to the value of $60, and charge the same to my account.

HORACE WARNER.

An order is not mandatory. The holder is not obliged to present it, or to trade the full amount, nor is the merchant obliged to fill the requisition. In sending a stranger for any kind of movable property the sender should make out a written order and not rely on a verbal request. One should be very careful in honoring a verbal order, for it may be the person presenting it is a swindler.

When the order is for the delivery of a specified article or articles, a receipt should be given by the person bringing the order, thus:

CHICAGO, May 10, 1902.

James P. Smith: Please deliver to bearer, Henry Walker, my roadcart, left for repair. GEORGE W. JONES.

CHICAGO, May 11, 1902.

Received of James P. Smith on the order of George W. Jones, one roadcart.

HENRY WALKER.

ASSIGNMENTS.

Assignments are any simple form of statement properly witnessed, which transfers the right of property to a designated person.

SPECIAL POINTS ABOUT NOTES.

To be on the safe side, it is well to see to it that any note offered for negotiation is dated correctly; specifies the amount of money to be paid; names the person to whom it is to be paid; includes the words "or order" after the name of the payee, if it is desired to make the note negotiable; appoints a place where the payment is to be made; states that the note is made "for value received;" and is signed by the maker or his duly authorized representative. In some states phrases are required in the body of the note, such as, "without defalcation or discount;" but, as a general thing, that fact is understood without the statement.

The following rules have been compiled from the best authorities and cover the whole ground of the law of notes with accuracy and clearness:

There are two parties to a note, the maker and the payee.

If a note is lost or stolen, it does not release the maker; he must pay it, if the consideration for which it was given and the amount can be proven.

Notes bear interest only when so stated.

A note made on Sunday is void.

A note obtained by fraud, or from a person in a state of intoxication, cannot be collected.

"Value received" is usually written in a note, and should be, but is not necessary. If not written, it is presumed by law or may be supplied by proof.

The maker of an "accommodation" bill or note (one for which he has received no consideration, having lent his name or credit for the accommodation of the holder) is not bound to the person accommodated, but is bound to all other parties, precisely as if there was a good consideration.

No consideration is sufficient in law if it be illegal in its nature.

A note indorsed in blank (the name of the indorser only written) is transferable by delivery, the same as if made payable to bearer.

If time of payment of a note is not named, it is payable on demand.

The time of payment of a note must not depend upon a contingency. The promise must be absolute.

The holder of a note may give notice of protest either to all the previous indorsers or only to one of them; in case of the latter he must select the last indorser, and the last must give notice to the last before him, and so on. Each indorser must send notice the same day or the day following.

Neither Sunday nor any legal holiday is counted in reckoning time in which notice is to be given.

The loss of a note is not sufficient excuse for not giving notice of protest.

If two or more persons, as partners, are jointly liable on a note or bill, due notice to one of them is sufficient.

If a note is transferred as security, or even as payment of a pre-existing debt, the debt revives if the note or bill be dishonored.

An indorsement may be written on the face or back.

An indorser may prevent his own liability to be sued by writing, "without recourse," or similar words.

Written instruments are to be construed and interpreted by the law according to the simple, customary and natural meaning of the words used.

The finder of negotiable paper, as of all other property, must make reasonable efforts to find the owner, before he is entitled to appropriate it for his own purposes. If the finder conceal it he is liable to the charge of larceny or theft.

One may make a note payable to his own order and indorse it in blank. He must write his name across the back or face, the same as any other indorser.

An executor or administrator may indorse and transfer the note of a deceased person.

FORMS OF NOTES.

A Note Negotiable Only by Indorsement.

$200 CHICAGO, NOV. 26, 1901.

Three months after date I promise to pay to John H. Munger, or order, two hundred dollars, value received.

J. T. NORTHROP.

A Note Not Negotiable.

$200. ST. LOUIS, NOV. 17, 1901.

Ninety days after date I promise to pay Charles C. Sears two hundred dollars, value received.

SAMUEL ATKINSON.

Note Bearing Interest.

$100.

Baton Rouge, La., May 26, 1902.

Six months after date I promise to pay R. V. Jennings, or order, one hundred dollars, with interest, for value received.

John Q. Watson.

A Note Payable on Demand.

$150.

Philadelphia, Nov. 30, 1901.

On demand I promise to pay Edgar Whittlesey, or bearer, one hundred and fifty dollars, value received.

John R. Chaffing.

A Note Payable at Bank.

$100. Cincinnati, Dec. 24, 1901.

Thirty days after date I promise to pay Mark I. Rankin, or order, at the Second National Bank, one hundred dollars, value received.

Frank T. Morris.

Guaranty of a Note.

For value received, I guarantee the due payment of a promissory note, dated October 8, 1901, whereby John Paxson promises to pay George Ruthledge eighty dollars in three months.

St. Louis, October 10, 1901.

Thomas Todd.

SINGLE TAX: ITS MEANING AND ITS THEORIES

Henry George, a profound student of financial and fiscal systems, was the first popular advocate of the theory now known as the "single tax." Simply stated, it means only to charge any one occupying land, the exact rental value of the bare land, without improvements, taking the rent thus collected, in place of all other taxes of any sort, as public funds for public uses. It does not suggest displacing any one from land occupied and used. The supporters of this theory are very active, and rapidly increasing in number. They issue the following statement of their position:

The single tax would:

1st. Take the weight of taxation off the agricultural districts where land has little or no value irrespective of improvements and put it on towns and cities where bare land rises to a value of millions of dollars per acre.

2d. Dispense with a multiplicity of taxes and a horde of tax-gatherers, simplify government and greatly reduce its cost.

3d. Do away with the fraud, corruption and gross inequality inseparable from our present methods of taxation, which allow the rich to escape while they grind the poor.

4th. Give us with all the world as perfect freedom of trade as now exists between the States of our Union, thus enabling our people to share through free exchanges in all the advantages which nature has given to other countries, or which the peculiar skill of other people has enabled them to attain. It would destroy the trusts, monopolies and corruptions which are the outgrowth of the tariff.

5th. It would, on the other hand, by taking for public use that value which attaches to land by reason of the growth and improvement of the community, make the holding of land unprofitable to the mere owner and profitable only to the user. It would thus make it impossible for speculators and monopolists to hold natural opportunities unused or only half used, and would throw open to labor the illimitable field of employment which the earth offers to man. It would thus solve the labor problem, do away with involuntary poverty, raise wages in all occupations to the full earnings of labor, make overproduction impossible until all human wants are satisfied, render labor saving inventions a blessing to all, and cause such an enormous production and such an equitable distribution of wealth as would give to all comfort, leisure and participation in the advantages of an advancing civilization.

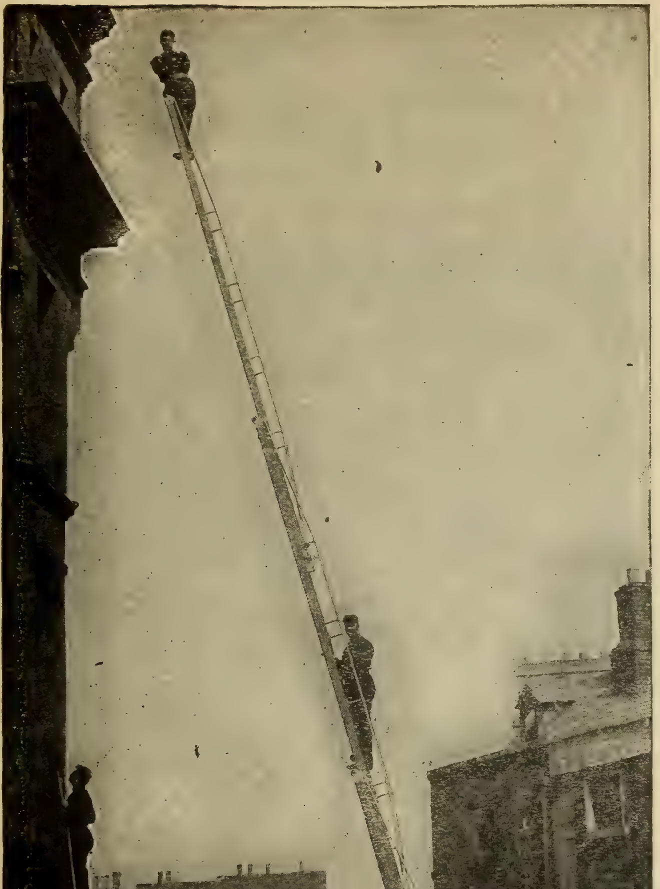
With respect to monopolies other than monopolies of land, we hold that when free competition becomes impossible, as in telegraphs, railroads, water and gas supplies, etc., such business becomes a proper social function which should be controlled and managed by and for the whole people concerned through their proper government, local, state or national, as may be.

HOW FIRES ARE EXTINGUISHED

While cities have been growing so rapidly, and sky-scraper buildings have become such a common feature of the cities, it has been necessary to study constantly for the improving of methods for fighting fire which might destroy property of such great value. So it is that city fire departments have been organized to a high degree of perfection, both for the extinguishing of the flames, and for the saving of life of those who may be in danger. Some of the most ingenious and active of American inventors have busied themselves in this direction, and we do not need to be told that the fire departments include men of tried bravery, whose deeds of courage almost daily rival or excel the most daring deeds of soldiers in battle.

The organization of the fire department in such a city as Chicago, for instance, is a matter of the greatest importance to the entire community. It must be efficient, kept up to the highest standard of excellence, and supplied with the bravest of men and the best of material at all times, if it is to do this work properly. However much political influence may have affected the appointment and administration of the police force, the community has rarely tolerated any invasion of the fire department with political influence. The annual expenditure for the fire department is nearly $1,600,000 for the one city of Chicago. The department includes a total of nearly 1,200 men, organized in almost military fashion, with a marshal and his assistants, chiefs of battalions, captains and lieutenants, in addition to hundreds of engineers, pipemen, truckmen, drivers, stokers and watchmen. These brave men save every year many times as much as the department costs, and the citizens consider it a splendid investment to maintain it. At the slightest sign of deterioration in the fire department, or any reduction in the number of men employed in it which might reduce its efficiency, the fire insurance companies promptly raise their rates for insurance, so that the increase in premiums paid in the city far more than exhausts the slight saving made in the expense of the department.

These facts are typical of the conditions in every other city throughout the country. Even in small towns where no paid fire department is maintained, the custom is to be liberal in the support of volunteer compa-



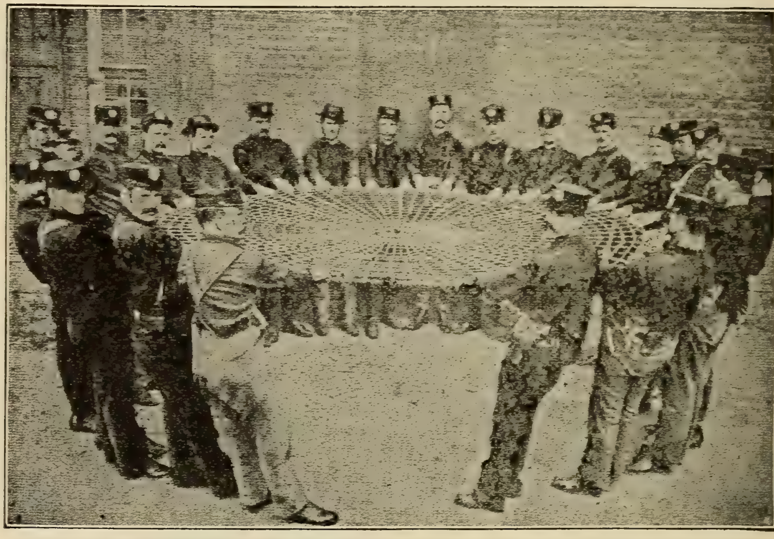
FIREMEN'S EXTENSION LADDER IN SERVICE.

nies, which are usually equipped with the best appliances that the community can afford. In spite of this, the fire losses for the year 1901, the last for which figures are obtainable, amounted to more than $150,000,000, while the loss in life exceeded 200. With such a showing of costly disaster, it is not strange that every effort possible is made to improve the methods of averting such calamities.

Some of the appliances recently put into service in fire fighting are ingenious in the extreme, although they are not always complicated, the simplest being sometimes the best. Portable fire extinguishers are made, by which, if a fire be reached early in its progress, the flames may be extinguished without the aid of water or engines. This apparatus is chemical in its character, releasing gases or liquids which are unfavorable to fire, smothering it as soon as they come in contact with it. One of the simplest of these consists of a small bottle of acid sealed with mica and containing a rubber-covered lead ball. This bottle is within a larger one, holding in addition some gallons of water in which soda is held in solution. The whole apparatus is enclosed in a metal case, and fitted with a hose. When the alarm is given it is inverted, the ball breaks through the mica, and the released acid coming into contact with the soda and water generates gas, which discharges a stream of the liquid about fifty feet.

All firemen agree that the first five minutes of a fire are worth more in fighting it than the next half hour, so that all efforts are made to be as prompt as possible in reaching the scene of danger. Horses ready harnessed and trained to start instantly when the alarm is given, men on the alert every moment when they are on duty, and buildings properly constructed and equipped with safety in view, are prime essentials in addition to the apparatus itself. Nowadays mills, factories and large buildings of all sorts are equipped with hose, ladders, hydrants, fire extinguishers and fire escapes. The employes are organized into companies and drilled to fight fire so as to be ready for any emergency.

There is a firemen's training school in New York, which prepares men for active service in the department before they are permitted to begin the actual responsibilities of the work, and in Chicago and other cities the same results are obtained by drill of all new recruits in the department. They are taught to handle lifelines, safety nets into which people may jump from burning buildings, and the hose, hooks and ladders themselves. They are given drill with the remarkable extension ladders and extension nozzles which enable fires in tall buildings to be fought and rescues to be made, where such work would have been impossible a few years ago. Then they are finally put to work as a part of the crew of an engine or a hose cart, and begin to take their lives in their hands at every call to duty. The public has an immense admiration for the firemen and they can always count on applause for their bravery and support when they need assistance in any worthy movement. There is a halo of glory about a fireman's head which is universally recognized, and until all buildings are proof against destruction by flame, which may be true, thanks to improved building methods, after many years, he will always stand in the place of distinction.



NET FOR CATCHING THOSE WHO JUMP FROM BURNING BUILDINGS.

ASBESTOS CLOTH THAT WILL NOT BURN

A long, lank, slow-voiced Englishman left his native land a score of years ago and settled in Quebec, where he hired out as a laborer in a lumber yard. His great bodily strength, supplemented by his energy and activity, soon won him an excellent position. After he had been at work a number of months he returned one cold winter evening to the capacious, shed-like building in which they all lived. Seating himself comfortably before the pot-bellied cast-iron stove, the open mouth of which glowed red with heat, he deliberately drew off his long, wet boots. Then a pair of socks, much the worse for Quebec mud, came off one after the other, and his companions saw him coolly fling them into the fire.

They made no comment on his action, but when, almost immediately afterward, they saw him reach into the stove with a poker, pull out the apparently blazing socks, and, after giving them a shake, proceed with the greatest unconcern to draw them on his feet again, they stood aghast. It was plainly an exhibition of witchcraft. Then they scrambled over one another in their haste to reach the door, through which they burst into the dark.

The next day they called on the manager in a body and demanded the instant dismissal of the Englishman, loudly declaring that they would not longer eat or drink or work with such a monster. Inquiry being made at once, it was found that the big Englishman had worked in an asbestos factory before crossing the water, and being of an ingenious turn of mind he had managed to secure some of the material, out of which to knit himself a pair of socks. When they became soiled he cleaned them in the fire. But such explanations were of no avail with his ignorant companions, and he was compelled to leave his work.

Asbestos is a wonderful substance. Its name comes from a Greek word meaning inconsumable. Fire will not burn it, acids will not gnaw it, weather will not corrode it. It is the paradox of minerals—for a mineral it is, quarried just like marble. The fibers of which it is composed are as soft as silk, and fine and feathery enough to float on water. Yet in the mines they are so compressed that they are hard and crystalline like stone.

Although the substance has been known for ages in the form of mountain cork and mountain leather, comparatively little has been learned as to its geological history and formation. A legend tells how Emperor Charlemagne, being possessed of a tablecloth woven of asbestos, was accustomed to astonish his guests by gathering it up after the meal, casting it into the fire and withdrawing it later cleansed but unconsumed.

Yet, although the marvelous attributes of asbestos have been known for so long, they were turned to little practical use until about twenty years ago. Since that time the manufacture of the material has grown until it can take its place shoulder to shoulder with any of the giant industries of this country. Indeed, so rapid has been its progress and development that there is almost no literature of any kind on the subject, and to the popular mind it is still one of those dim, inexplicable things. A dealer in asbestos goods says that the majority of persons who use the substance are firmly convinced that it is all manufactured by some secret process from wool or cotton.

Up to the late '70s nearly all the asbestos used came from the Italian Alps and from Syria, but one day a party of explorers discovered a rich deposit in what is known as the eastern townships of Quebec in Canada. Companies were at once formed, and in 1879 the mines were opened. Remarkable as it may seem, however, although the Canadians started factories, in the operation of which they were substantially backed by English capital, it was an American concern, with headquarters in New York, that developed the manufacturing industry most rapidly. The company has now grown so large that it has branches in nearly all the large cities of the country, and the machinery used is specially made and peculiarly adapted to the manufacture of asbestos articles. There are also a number of large factories in England.

The Canadian mines are located in a wild, rough country, almost outside of the pale of civilization. The hills have worn themselves bare of earth, and the bleak rocks glare out in great, bald patches. At one time a scraggy growth of pines clung to the remaining ridges of soil, but forest fires, the hand of man, and the ravages of wind and weather, have left only the dreary waste of burned and blackened stumps. The sides of the hills gape with great holes in which the men—mostly French-Canadians—are at work. The veins of chrysotile, as the Canadian asbestos is called, are from two to four inches in thickness and are separated by thin layers of hornblende crystals. The nearer to the surface the veins run the coarser are the fibers and the less valuable.

The mining is done by means of the most improved quarrying machinery. Holes are drilled in long rows into the sides of the cliffs by means of steam drills. They are then loaded with dynamite and exploded simultaneously by wires connecting with an electric battery in such a way that a whole ledge of the rock falls to the bottom of the pit at once. Then the workmen break out as much of the pure asbestos as possible and load it into great tubs or trucks, which are hoisted out by means of derricks and run along to the "cob house." Here scores of boys are kept busily employed crumbling or "cobbing" the pieces of rock away from the asbestos, and throwing the lumps of good fiber to one side, where it is placed in rough bales or sacks ready for shipment to the factory.

The greatest work in connection with the mining of asbestos is in disposing of the waste rock and the refuse of the quarry. Only about one twenty-fifth of the material quarried is real asbestos, and the rocky parts have to be lifted out and carried away to the dumps at great expense. As if in keeping with the forlorn and blasted appearance of the country the miners are a hard, uncanny class of men, migratory in disposition and exceedingly superstitious. Their wages range from $1 to $1.50 a day.

As the asbestos comes from the mines it is in small lumps of a greenish or yellowish hue and the edges are furred with loose fibers. The more nearly white the asbestos is the better its grade. The length of fiber is also of great importance, the longest being the most valuable.

From the mines the asbestos is taken by rail to the manufacturers in the United States. Here the lumps of the substance are emptied from the sacks and fed into the hopper of a powerfully built machine, not unlike an old-fashioned stone-process flour mill. They are crushed through a series of rolls, until the fibers are all separated into fluffy masses, when they pass out along a trough and into a separator. Here the small pieces of stone and other refuse rattle out through a sieve, and the longer fibers are separated by a series of comb-like sieves into various lengths. The very short ones are taken out to the pulp-mill, where they are ground up fine for the manufacture of solid packing for steam pistons, millboard and other commodities. The longer fibers are gathered together, carded, and spun into yarn, just like cotton or wool. After that the substance may be woven into cloth in various ways. The cloth is of a dirty white color and has a soapy feeling.

The uses of asbestos are almost innumerable. Ground fine, and combined with colors and oils by a secret process, it makes a beautiful paint, which is said to go far toward fire-proofing the surface to which it is applied. Various kinds of roofing are also made by treating strong canvas with a combination of asbestos and felt and backing it with manilla paper. It is extensively used for roofs of factories, railroad shops, bridges, steamboat decks and other places where there is danger of fire.

Nearly every one has seen the thick, asbestos-felt coverings for steam-pipes and furnaces. Asbestos-cement is sometimes used for hot-blast pipes and fire-heated surfaces. As a packing for locomotive pistons, valve stems and oil pumps it is almost indispensable. It is also made into ropes and mill-boards which can be used almost everywhere. Asbestos cloth is being used more every year. Some states require theaters to use an asbestos drop-curtain to protect the audience if the scenery catches fire. Some very beautiful drop-curtains have been made, and the ordinary spectator cannot distinguish them from real cloth.

The yarn is knit into mittens for workers in iron and glass. Goldsmiths use a block of asbestos to solder upon. Combined with rubber—vulcanized—asbestos has almost innumerable uses as an electrical insulator. In this form the substance resembles ebony, and is about as hard. The cloth is also of the greatest importance for acid-fitters in all kinds of chemical processes, for the reason that no acid will eat it.

Asbestos is found in a good many hundreds of places in the world beside Italy and Canada, but the fibers are nearly all splintery and brittle. Rich deposits have recently been found in Wyoming, California and Montana, and the United States may soon come to the front as a producer of the substance. With asbestos worth about $50 a ton, as it is, a good mine of asbestos is more valuable than a gold mine, and as the substance becomes better known and more used it will be still more precious. The time may not be far distant when firemen will be clothed in suits made from asbestos.

MINERAL WOOL AND ITS USES

Since the discovery, some years ago, that asbestos could be felted together into a sort of paper and used wherever a nonconducting, noncombustible packing was needed, the demand for it has steadily increased. New forms and new uses are continually appearing, while the supply is constantly diminishing. This has led to the search for a substitute.

By melting together the various minerals of which asbestos is composed, a material of the same composition is easily obtained, but the stringy, fibrous quality which makes the asbestos so valuable is wanting. An accidental blast or stream of melted slag from an iron furnace gave the first and most important step in the solution of the problem, and from this it has been worked out almost to perfection. At first "glass," or "mineral" wool was made largely from slag, which contains many of the minerals needed—sand, lime and iron. But this product was too glassy, was not tough enough, and melted too easily.

A careful analysis of asbestos was made, and the minerals—limestone, sand, fire-clay or kaolin and iron slag—containing the proper elements, were mixed.

As made now, by the improved methods, waste products from other factories are used principally. Broken glass from windows and from bottle houses furnishes the sand and a part of the lime; pieces of fire-clay bricks, broken glass-pots and dish-ware that has warped and cracked in the kilns furnish the clay; and iron slag from the pudding ovens supplies the iron and part of the sand and lime. A little extra limestone is added. These waste products, besides being cheaper, are better than simple sand, lime and clay would be, as they are in a hard, chunky form, and "stand up" in the furnace, allowing a better circulation of air and gas while heating. Loose sand and clay would pack.

The materials are crushed and mixed according to a rough formula, which is worked out by experiment. It is very necessary that the amount of each should be just right. If too much glass is used the wool is brittle and harsh; if too much clay, the fibers are coarse and heavy, and if too much iron, the product is dark and does not sell wel

The mixed material is placed in tall fire-brick furnaces, with alternate layers of coke, each layer being about one foot deep. Natural gas, where obtainable, is led into the bottom of the furnace, the fire is lighted and a blast of air from a blower is turned on, getting up an intense heat. The glass melts, acting as a flux, and melting the other materials. The part nearest the bottom of the furnace melts first and the whole mass settles down. When the bottom is sufficiently liquid a small hole is opened at the side of the furnace, and the liquid mass is allowed to flow out in a stream about one inch in diameter. As this falls a jet of steam from two flat, fan-shaped nozzles is directed against it, blowing it into a fine spray which, on cooling, is a white, fibrous mass resembling fine, well-washed wool, hence its name.

The spray is blown through a small window into a large collecting room. While the blast is on this room is filled with a white cloud, looking like cotton down. Two furnaces and two rooms are used, alternating with each other. When the blast is finished in one furnace, the downy wool is allowed to settle, and is then scraped from the sides, the floor and the ceiling; it is weighed, packed in bales and then is ready for the market.

The heaviest part which settles nearest the window contains little, beadlike bodies, called in the trade "shot," and due to imperfect blowing. This is remelted or sold for rough packing. The uses of the mineral wool are very numerous and are multiplying all the time. The chief ones are the adulteration of asbestos; packings to retain heat, as on steam pipes, steam cylinders and boilers; and packings to keep out heat, as in ice machines, refrigerators, cold-rooms and cold-storage warehouses. Of late large amounts are used for the deadening of walls and floors in fireproof buildings. The mineral wool is used either loose or in the form of paper, felting or thick wadding.

HOW ARTIFICIAL SILK IS MADE

Dr. Frederick Lehner of Zurich, Switzerland, has opened an active competition with the silk worm by the invention of a cheap and simple process of making an excellent quality of artificial silk. It has been known for a good many years in the scientific world that a substance of practically the same chemical composition as silk could be made, but the secret of rendering the process industrially practical remained undiscovered until Dr. Lehner took up the work. The basis of the discovery rests on the well-known truth in chemistry that many vegetable fabrics, such as waste cotton, cloth, flax, jute and wood, when digested by treatment with acids and alkalis are transformed into cellulose, a substance forming the walls of cells. By combining this material with nitric acid, certain nitrates of cellulose are formed, the higher compounds of which are such well-known explosives as cordite and tonite. The lower or pyroxylin nitrates are less explosive, being a gelatinous substance. If this be drawn out it will divide into numerous short threads or strings of a fine, shiny texture, somewhat like gun-cotton, and most inflammable when dried. To this point a great number of chemists succeeded in getting, but they could not give the product of their test-tubes a sufficient viscosity to admit of being drawn out into long threads. Dr. Lehner tried various solutions, but even when the amount of the pyroxylin was reduced to 7 per cent the compound was still too gelatinous to be worked.

At last he discovered that by adding dilute sulphuric acid to the alcohol ether solution, a part of the water was taken up and "split off" and the nitrates broken down, leaving a 12 per cent solution which was perfectly fluid and of the required viscosity. The process having once been discovered, the manufacture of the fluid is an inexpensive and perfectly simple operation for any chemist.

The method by which the common-looking yellow liquid is converted into beautiful silk threads is most interesting. The machine used is nothing more than a modification of the ordinary spinning frame. The great glass jar containing the silk fluid is set up on a high bench or shelf and the fluid is conveyed downward through pipes to a number of bent glass tubes resting in a trough of cold water. The orifices in the ends of the tubes are exceedingly minute, and rest just beneath the surface of the water. As the fluid flows through the tubes it is quicky cooled and begins to coagulate. On leaving the water about 60 per cent of its soluble portion has been washed away and the remaining thread is of a fine, rich lustre. Six or seven of the strands are gathered up and twisted together, exactly as silk or woolen threads are spun. After it has been wound upon the frame the artificial silk dries and hardens, losing in this process the remains of its soluble matter. In a week's time the thread cannot be distinguished from the real article even by a silk expert except by microscope or chemical examination.

But the thread in this condition retains its characteristics as a nitrate, and is almost as inflammable as gun-cotton. Of course it would never do for use while there was danger at any moment of its blowing up. The consequences of wearing a dress made of such material may be easily imagined. Consequently the thread is submitted to a last process—that of denitration, in which by the use of ammonium sulphide the nitric acid is all neutralized.

After the thread has been again dried, it is really less inflammable than natural silk. It can now be spun to any required thickness, and it is said that the resulting yarn is much smoother and more even than the genuine article. It has another advantage. When the machines are once started the threads can be spun to any required length—endless, if necessary—thus obviating any necessity of stopping the cloth-looms to splice a thread. In addition to this the process can be carried on through winter and summer in any part of the world. There will be no need of mulberry forests or worm hatcheries, for by taking a quantity of cast-off clothing, and perhaps some wood pulp, and mixing them with the acids, the work is done.

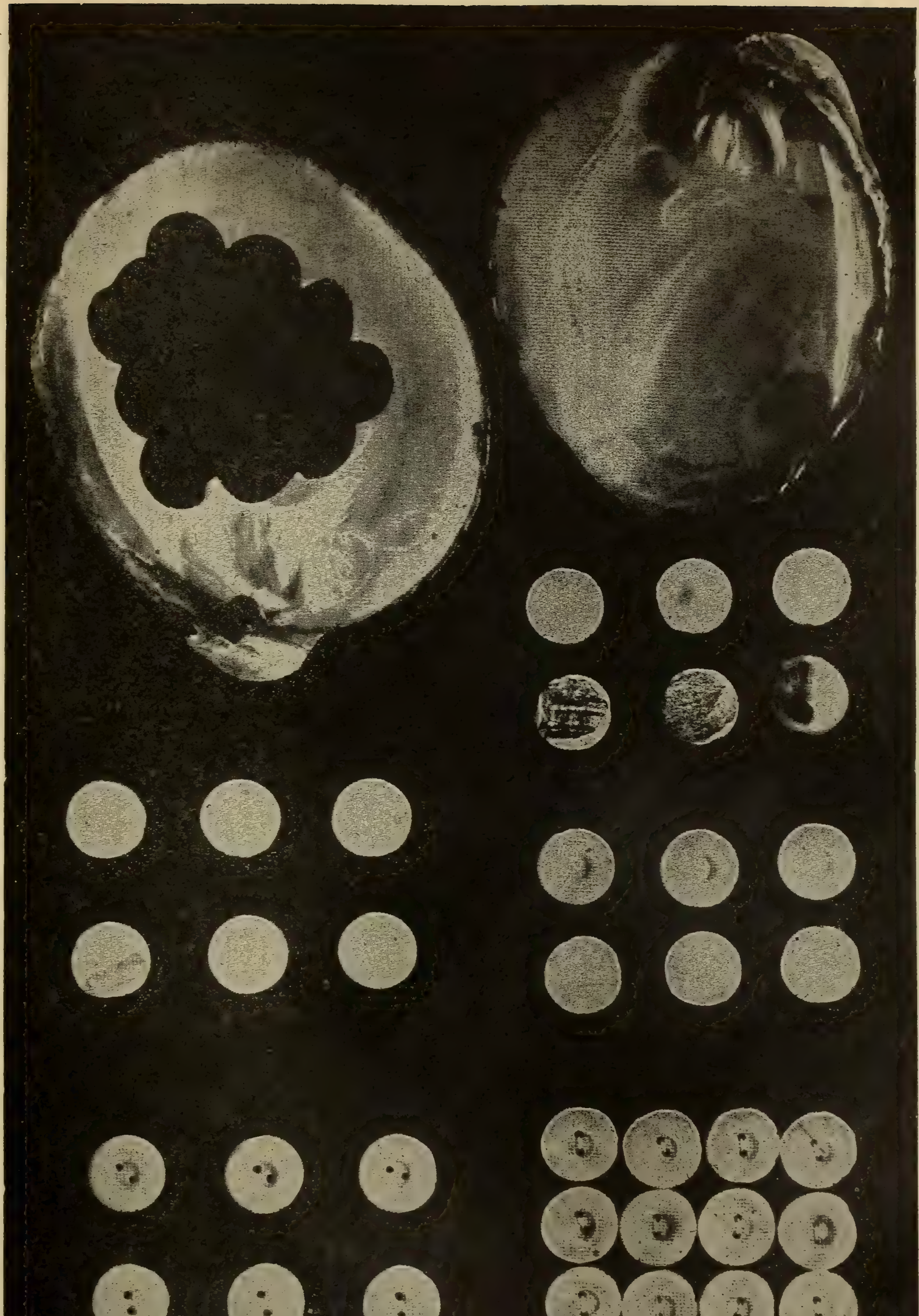
Yet the artificial silk lacks in several particulars of being as good as the natural product, and it is proposed to make it an economic factor in the manufacture of real silk goods. The warp of a fabric may be made of genuine silk and the woof of the artificial silk. In this way the artificial silk would take the place of wool or cotton in a mixed fabric, which would be just as cheap and much finer.

The relative strength of the artificial silk, compared with Italian pure silk, is as 68 to 100. Pure silk has but little elasticity, and when stretched does not go back to its original length; neither does the artificial silk, but its stretching quality (before breaking) is as 73 to 100 relatively. Measure for measure, the relative weight of the same average diameters of pure and artificial silk is 7.25 per cent more in the latter.

BUTTONS, THEIR INVENTION AND MANUFACTURE

Adam did not wear buttons. Even when his wardrobe reached the dignity of containing "other clothes," he was compelled to fasten his apparel with a sash or borrow a spike from Tubal Cain. In fact, until the beginning of the fourteenth century, the world managed to struggle along without these modern conveniences. Buttons were first used as ornaments. They were sewed on according to the taste or caprice of the maker or wearer of clothing, and they were seldom placed where they might have been of practical service, even had there been buttonholes to match them. Some time in the latter part of Queen Elizabeth's reign it was discovered that a small slit cut in the cloth and shoved over the button made these ornaments useful. From that time on the making of buttons grew until it has become one of the most important industries. With the practical use of buttons came a revolution in dress. The last relic of the flowing robes handed down from patriarchal days was consigned to the shelves of museums, and the simpler modern dress was introduced.

It was the fashion in the early days of buttonmaking to sew as many buttons on the clothing as the texture would bear. Even the laboring classes managed to deck themselves to a degree which to-day appears ridiculous. This at once created a demand, and the close of the seventeenth century saw the button industry well established in Europe, the center being then, as now, Birmingham, England. The first buttons were very expensive. They were made chiefly of gold and pearl, rich in design, and inlaid with precious metals and



BUTTONS FROM MISSISSIPPI RIVER PEARL SHELLS.

Showing various stages in the process of manufacture, from the shells to the finished buttons on cards ready for sale.

jewels. Following these came the cloth-covered and silk-covered buttons, which were made entirely with the needle. These brought a high price, and the workmen received the largest wages in those days for needlework. As the demand for buttons increased and man's inventive genius was taxed, machines were produced for the making of steel, brass, inlaid, plated and lacquered buttons, and later for the rapid manufacture of covered buttons.

These last are made by covering with silk, lasting, brocade, twist, velvet, mohair and various cloths, metal disks which have been previously cut out of sheet iron and molded with dies. The frame of this button consists of two pieces of sheet iron, the under piece being slightly convex and having a small round hole in the center through which a tuft of canvas is pressed. This is for sewing the button to the cloth. The upper disk is also slightly convex and made a little larger than the lower piece. The edge of the upper disk is turned down about a sixteenth part of an inch in the medium-sized buttons. These disks are cut from the sheet, formed and made ready for covering by one motion of the "fly press" or punching machine.

For covering, another machine is used, simple in construction, but capable of turning out a great many buttons in a day when operated by an expert. It consists of a central upright shaft, to the lower end of which is attached a die so constructed as to press a piece of cloth around and under the upper disk of the button. The shaft is allowed to move up and down through two heads fastened to a stout frame of iron. Below the upper die is a contrivance having two dies which may be moved at will in line with the upper die. In these the parts of the button are placed. One holds the upper disk and the piece of cloth, the other the under disk. A pressure of the operator's foot on the treadle brings the upper die on the first lower die. This shapes the cloth. The second lower die is shoved under, the treadle is pressed and the button is complete. The dies have not only folded the cloth around and under the upper disk, but they have clinched the two disks of the button close together. An expert worker may make from seventy-five to eighty-five gross of buttons a day with this machine.

Buttons made of vegetable ivory are widely used in this country and in England. The material is obtained from a palm tree that grows in South America. It has the name of "tagua plant," and in Peru it is called "negro's head." When young the seed of this palm contains a milky substance which with age becomes very hard and white, resembling ivory. The seeds as used in commerce are from an inch to three inches in size and almost round. Before they go to the buttonmaking machines they are steamed to render their cutting easier. Then they are sawed into slices of proper thickness. The button is cut out with a tubular saw and each button is turned separately in a small lathe. Other machines are used for drilling holes, polishing and finishing the buttons. Vegetable ivory is capable of receiving almost any color, and the dyeing of buttons made from it is one of the most important and most carefully guarded secrets of the craft.

Livery, emblem and society buttons are made by stamping, the machines used be-
ting the disks for metal buttons. The de-
ing the same in principle as those for cut-

sired figure which the face of the finished button is to assume is cut in the upper die, the reverse being made in relief on the under die. They are stamped and pressed together without soldering.

Materials employed in button making are as varied as the styles of buttons. In addition to metal-covered buttons and those made from other metals, glass, porcelain, horn, bone, India rubber, mother-of-pearl and other products of shellfish and various woods are used. The shells for mother-of-pearl come from the Persian Gulf, the Red Sea, the Pacific coast and Panama. Paper buttons have been made, but not extensively. An English invention uses slate or slit-stone in making buttons and button bodies.

The first buttons made in the United States were of wood, covered by hand with different materials, principally silk. The operation was laborious, but it resulted in the invention of machinery which has built up large factories in the east, Waterbury, Conn., and Easthampton, Mass., being centers of manufacture in this country. New York has several large factories.

The details of preparing the sheet iron for metal and metal-covered buttons are simple. The iron is first scaled by immersing it in acid, after which it is punched out with the dies. The neck, or "collet," is japanned, after being cut, and before the canvas tuft for sewing on is pressed into place. The hollow between the neck and shell is then filled with brown paper, called "button board." The making of these basic parts of the cloth-covered button is confined almost entirely to the eastern states. Western manufacturers buy the material ready to cover. Button shanks, or eyelets, are made of wire on a machine which cuts the wire into desired lengths, bends it into loops and leaves it ready for insertion into the lower blank.

The name "shell" is given to metal buttons made of two disks pressed together and fastened without soldering. A cloth-faced button is made by gluing a piece of cloth, cut the exact size, into the top of a rubber or vegetable ivory body. This leaves a rim of hard material to protect the edges of the button from wearing. In these the thread holes are drilled through a knob turned or molded on the back of the body.

The great decrease in the price of buttons from that which made the first manufactured a luxury, has been due to the introduction of machinery, which now does almost the entire work. Skilled labor does not occupy a large place in the making of buttons, which may also account for their comparative cheapness. Girls and boys may operate nearly all the machinery, which is a combination of automatic features, leaving little to the operator but dexterity in handling the different pieces for the dies.

One of the curious freaks of buttondom, invented some years ago, was a "bachelor's" button. This consisted of an ordinary trousers button with a safety pin attachment. It was to answer in cases of emergency, but it has not succeeded in entirely banishing the more homely but reliable horse-shoe nail.

IN A TYPE FOUNDRY

Every type in a font, like every link in a chain, must be perfect in itself, or else the work of the maker counts for nothing. Perhaps in no other industry, unless it be watch-making, is such scientific accuracy required in every detail. Each measurement must be made to the thousandth part of an inch, and if a mold or a die is not exact to a hair's breadth a whole casting may be lost. For in this age of newspapers every printed page is judged to a certain extent from an artistic point of view, and if the impressions of some type are heavier than those of others, or if the alignment is imperfect or the spacing uneven, it is subjected to condemnation. In this way type-founding becomes a real art.

One of the largest manufactories of type in the world is located in Chicago and the amount of type in tons which it turns out yearly runs well up into the thousands. It is a big, busy building humming with life and movement, more than 350 men and girls working at its benches every day.

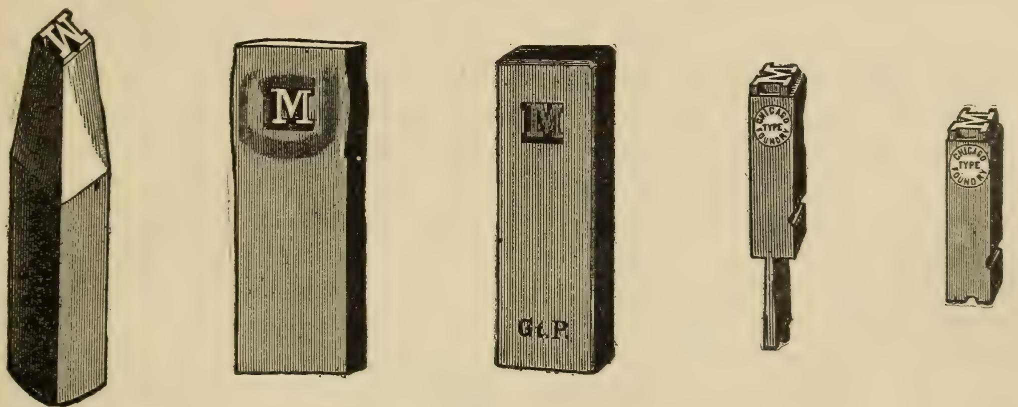
Follow the superintendent down the basement stairs, around the huge boilers and engines, and into the little corner room where the type metal is melted. Here the raw materials are brought, weighed and corded up ready to go to the big iron crucible. There are "pigs" of lead, heavier than an ordinary man can lift, "pigs" of tin and "pigs" of copper. The antimony comes from Japan in square, solid blocks weighing thirty pounds each, and before melting it is crushed to powder between the iron jaws of a crushing machine. Formerly the workmen broke it up with hammers, but the antimony being poisonous, that method was abandoned.

The four metals are mixed according to a secret formula—the lead being the largest ingredient—and placed in a crucible. Antimony, which is a most expensive metal, is used because it gives hardness to the type-composition and because it has the unusual quality of expanding in cooling, thus preventing the type when cast from "falling away" from the mold, and produces sharpness of the face and body of the type. After being melted and thoroughly mixed by stirring the metal is run into pans, and when cool it is ready for the casting machines.

The first step in type-making is the cutting of the letters desired on the ends of pieces of hard, fine steel. This is very difficult work, and the men who do it receive high wages. Each letter in a font must be exactly the same height and the width must be cut according to rule. A separate one of these dies or "punches" is required for each character in every font of type, and the making of them is the most expensive part of the business. Some of them cost as high as $7.

When a set of "punches" is complete it goes to the matrix department. Here little rectangular pieces of pure copper known as "strikes" have been prepared. For minion or long primer type they are about two inches long by half an inch broad. At exactly the proper point near the top of each the steel die is driven in and then the "strike" or embryo matrix goes to the fitter, who rubs and polishes it down on big pieces of sandstone until it is everywhere square and perfect and the depth of the letter is exactly the same as in the rest of the font matrices. An electrotype matrix is also made, usually for use in casting display type, without going to the expense of cutting steel punches. This is done by immersing in a copper solution a piece of brass the size of a "strike" and having a hole at the upper end and allowing copper to be deposited by the action of electricity on a metal die of the desired letter, which is suspended with its face just inside the hole in the brass. Great pains is taken to keep all these molds and dies perfect. More than $200,000 worth of them are stored in a big vault in the basement.

Next the mold is made. This work requires the most skilled mechanics in steel. The pieces are all cut out by lathes, planers and shapers and ground down to just the right size and then polished on emery laps. There are two main parts to the mold, and they may be so adjusted as to make room for casting the bodies of letters of any width from a 3-m size to an i size. A great deal depends on the absolute accuracy of these molds. The matrix is now fastened in the mold so that it will form one end of the hole between the two parts. Then one of the parts is fastened to the casting machine and the other to a movable arm. The metal is kept fluid in a little furnace heated by natural gas, and is projected with great force into the mold by means of a pump. At every revolution of the crank the mold approaches the pump spout, takes a charge of metal, and flies back with a fully formed type, which is cooled with air-blasts and water from above. When the movable arm is as far back as possible, a half of the mold lifts and the type jumps out. At the lower end of each one there is a little "jet" of metal which clings and has to be broken off by an automatic device. In some of the larger styles of type the "jet" is removed by hand. When all of the a's in the font are made, the b matrix is put in, and so on to the end of the alphabet. A casting machine will turn out from 100 to 175 type a minute.



TYPE IN THE VARIOUS STAGES OF MANUFACTURE.
Showing in succession, from left to right, the "punch," the "drive" or "strike," the "matrix," the unfinished type with "jet" and the finished type.

In casting small fonts where frequent changes are made in the molds, the machines are driven by hand-power; but where fonts are large, such as those made for newspapers, steam is the propelling power and the indefatigable little machines go thumping along with little or no attention and do their work with a precision that almost equals human intelligence.

The type is not finished when it leaves the machine. A fringe or burr, somewhat like that which clings to a bullet cast in a mold, still adheres to its corners and sides. This is taken off by a number of girls who rub rows of the type on sandstone laps. The deftness and ease with which they handle the type, which would so easily "pi" in the hands of an inexperienced person, are simply wonderful. All italic and script type are sent to be "kerned." This is a process of cutting away and smoothing the body around the projecting parts of the letter, and it adds materially to the cost of these two classes of type.

The "setters," nimble-fingered girls, sit around low tables, the tops of which are cushioned in velvet. Here the type is dumped and the girls set them in long lines with the nicks uppermost. They now go to the "dresser," who slips the row into a stick or dressing-rod about three feet long, turns them on their faces, fastens them into a slit in an iron bench specially constructed for that purpose, and with a plane cuts a groove in the bottom, which removes the burr left in breaking off the "jet," and gives he type two legs to stand on. He then deftly turns the long row upside down and dresses off the uneven places along the upper and under sides. One firm in Chicago has in use a wonderful new machine which performs most of these operations automatically. It casts the type, breaks off the jets, rubs down the two sides, dresses off the body and grooves the jet end of the type. The type are cast singly, and follow one another through channels, which contain the dressing and grooving devices, onto a long wooden stick.

The work of the inspector, who now receives the type, is the most trying and painstaking of any in the shop. He sits before a big window and with a magnifying glass tightly clamped into his eye examines each type in the row, and if he sees a single defect in any of them he picks the type out with a needle-like awl and it is returned to the melting kettle. Long years of experience and keenness of vision enable the inspector to detect imperfections that would never suggest themselves even to his associates in other divisions of the industry unless their attention was especially directed to them. In the smaller sizes about one type in every twenty is thrown out, and sometimes even a greater proportion.

The lines are now broken up into shorter lines and put up in "galleys" or "pages," about four and one-half by six inches in size. The full font weighs 100 pounds, and if smaller fonts are ordered these are divided into smaller pages, each having its due proportion of "sorts" of letters and characters. After being wrapped in paper and marked they are ready for shipment.

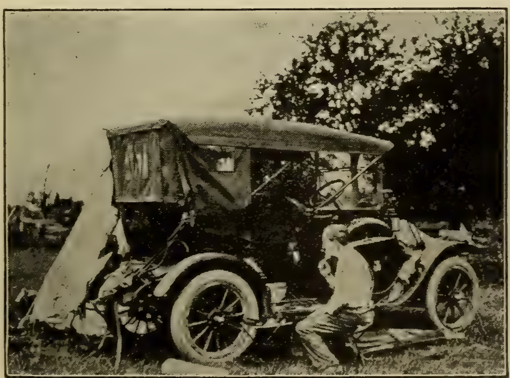
A type font is sometimes measured by weight in pounds, and sometimes by the number of m's which it contains. Job fonts are always turned out by count. The proportion of letters in a font is interesting as showing how much more some letters are used than others. In a 3,000 lower-case m font of "minion 3," for instance, a type smaller than that from which this book is printed, weighing 280 pounds, there are 9,000 a's, 2,000 b's, 4,000 c's, 5,000 d's, 14,000 e's, 800 k's, and 500 j's. E is used more than any other letter in the alphabet. It is followed by t, with 10,000; then by i and a, with 9,000 each; then by s, with 8,000. The least used letters are z, with 300, and j and x, with 500 each. Of the numerals 0 and 1 are most used, having 700 each. Some of the fractions have fifty types to the font and the braces have only twenty-five each.

HOUSE OF LIQUID STONE.

Thomas Edison, the wizard of electricity, has succeeded in making it possible to erect a solid concrete house in a single day at a cost of about $1,000 each.

The one-day house owes its existence to the invention of iron molds, made of three-quarter-inch cast iron, nickel plated and polished inside. Early in the morning these steel castings are taken to the vacant lot where it is desired to erect a house, clamped together with bolts, thus forming a house of iron with hollow walls.

The workmen now mix the concrete, one part cement, three parts sand, and three parts of quarter-inch crushed stone. A derrick raises the mixture to the top of the frame work, which is complete from cellar to rooftree, the various parts being held together by trusses and dowel pins. The concrete is pumped into the top of the molds continuously by compressed air, using two cylinders, and there must be no halt during this operation or a disfiguring line will appear.



Courtesy Outdoor Life.
AUTOMOBILE AS A BARBER SHOP.

These queerest of builders keep pouring in the house until it overflows at the top. In twelve hours the house has been poured inside the iron frame—rooms, floors, stairs, window casings, fire-places, mantel and even the bath tub. In six days the iron frame is unbolted and removed; in another eight days the concrete is completely hardened and the house is ready for occupation.

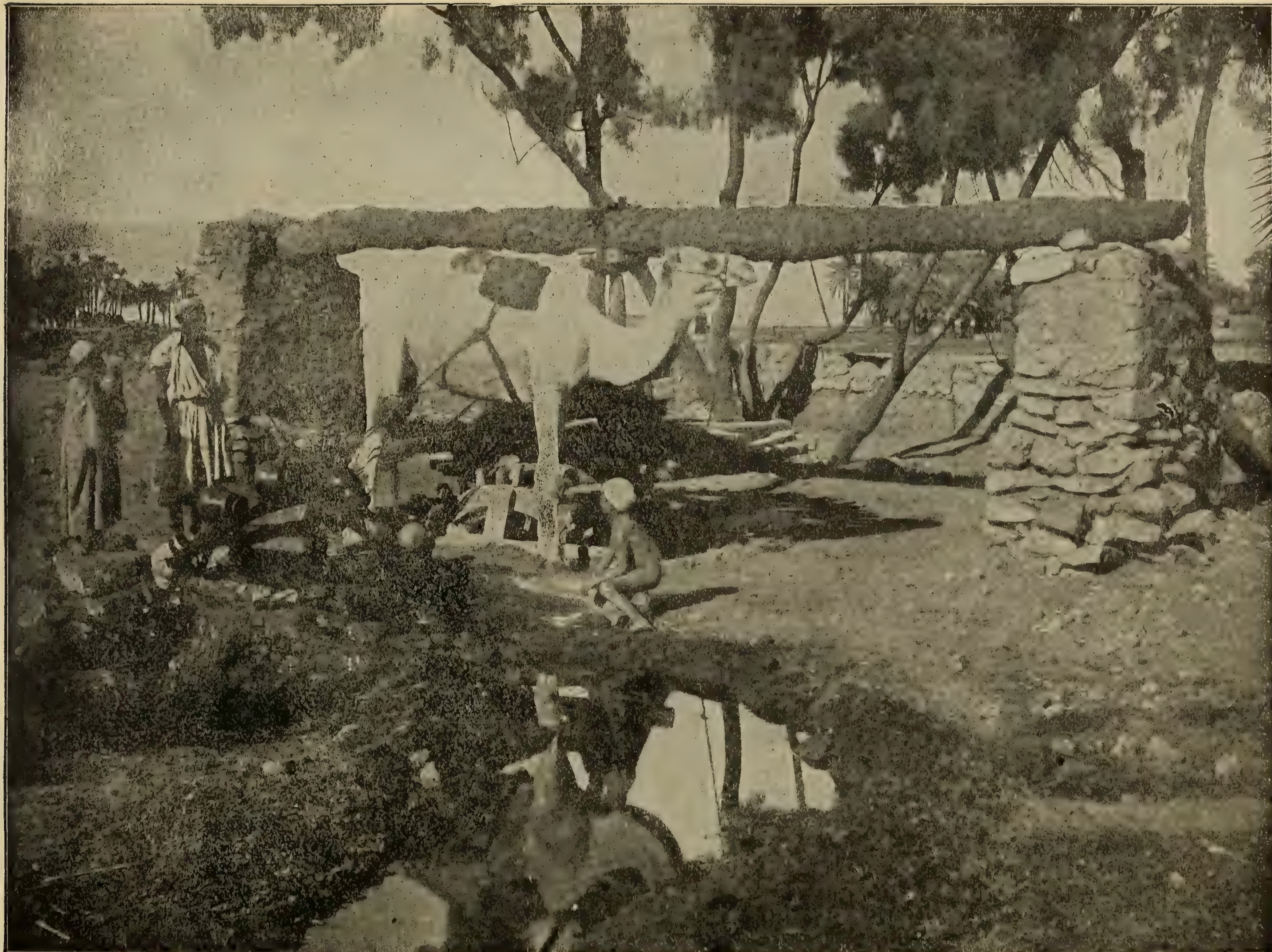
Courtesy of Outdoor Life.
AUTOMOBILE AS KITCHEN AND SIDEBOARD.

Strips of wood around the edges of the floors on which to tack down carpets, and some more around the walls for picture moldings, are put in place in the iron work before the house is poured in.

The tiling around the fire-place and in the chimneys, the gas and water pipes are also stuck in the same way in the concrete walls; furnaces and heating pipes are also cast with the walls, so there is no plumbing bill.

Any type of architecture may be followed in making the original molds, which are estimated to cost from $20,000 to $30,000 per set. These are, however, practically indestructible and any number of houses can be made from the same molds at about $1,000 each.

This concrete house has a cellar, is two stories high and contains seven rooms. There is no fire insurance necessary. To clean the house all that is necessary is to take up the carpets, remove the furniture and turn on the hose. The pipes for the steam heat of this concrete house are so well insulated that only one-quarter of the usual amount of coal is necessary to heat the house thoroughly.



IRRIGATION METHODS IN AN OASIS IN THE SAHARA DESERT.

Water is life in the desert to a degree that we do not realize in our more favored land. This crude machine, turned by camel power, raises water from the little stream to the irrigation ditches, which distribute it among the fields which produce the most luscious of fruits and the other crops on which the desert tribes live.

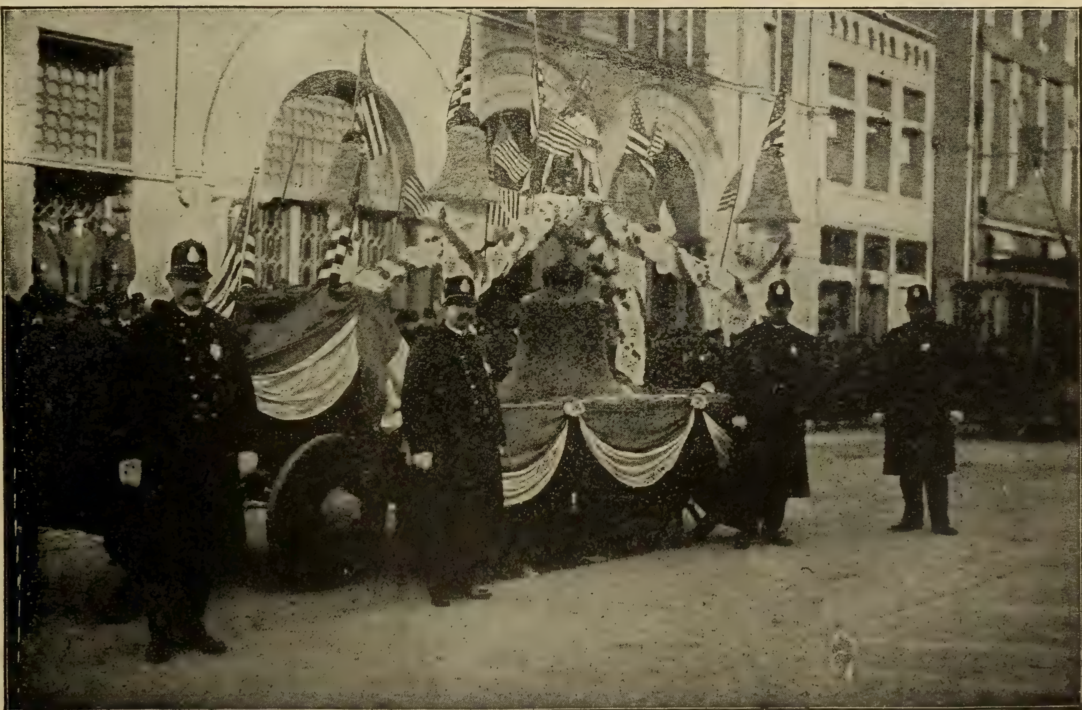
NOTEWORTHY FACTS OF GREAT INTEREST

PART III

SETTLEMENTS AND MIGRATIONS OF NATIONALITIES IN THE UNITED STATES

"From whence came we?" may not be so interesting to us as, "whither do we go?" but it offers some curious facts as to "who are we?"

At the close of the Revolutionary War, there were probably but little more than three million persons composing the new nation. It is estimated that from the Declaration of Independence until the census in 1820, there were not more than 250,000 immigrants, although there were enrolled at that time a total population of



LIBERTY BELL, LEAVING PHILADELPHIA FOR A GREAT EXPOSITION.

9,638,453. From that census up to 1902, there came into the United States a little more than 21,000,000 immigrants, from nearly a hundred different nations, thus, with the natural increase, bringing the population up to nearly eighty millions in 1902.

The colored race in the United States, being free from addition by immigration, except in the time previous to 1800, shows a remarkable ratio in the increase by birth, notwithstanding the fact that their death rate is estimated to be much greater than that of the white people.

In 1790 there were 757,208 colored persons in the United States; in 1840, 2,873,648; in 1890, 7,470,040, and in 1902, an estimated number of about 9,000,000. They were first brought as slaves, 20 in number, to Jamestown, Virginia, in 1619. In 1624 there were but 24 in the colonies; in 1648 there were 300. Then their service as tobacco raisers caused them to be imported in great numbers.

Although the Spaniards made permanent settlements at St. Augustine in 1565, at Santa Fe in 1581, and at New Orleans in 1763, they never increased in numbers and so have made little impression on the general civilization of the country.

The English began their settlement at Jamestown, Virginia, in 1607, but during the rule of Cromwell, the cavaliers or adherents of the Stuarts, came over in such numbers that their character was given to the social and political nature of the whole population. The descendants of these people moved west and their spirit dominated the western belt, covering Kentucky and Tennessee.

Under the persecutions of the Stuarts, the Puritans to the number of about 21,000 came to America, spreading from the first settlement made by them at Plymouth, in 1620, among numerous branches. The descendants of these likewise moved west, and it is estimated that at least 13,000,000 residents of the north trace their ancestry to those sources.

The French came from Canada to the Mississippi Valley and finally made a permanent settlement at Saint Louis in 1764. They had come already, in 1718, in considerable numbers from the French West Indies to New Orleans. They have had no perceptible migrations, but their influence along the track of their first settlements has been widely felt.

The English Catholics came to St. Mary's in Maryland, in 1634, and their line of migration can be distinctly traced along the Ohio Valley, but they chiefly populated the surrounding region.

The English Quakers came to Philadelphia in 1683 and their influence was for nearly two centuries dominant throughout Pennsylvania.

The English debtors and paupers who were taken to Savannah in 1733 went westward and settled the interior portions of Georgia and Alabama, the line extending on through into Arkansas and Missouri.

The Dutch settled the present site of New York City in 1613. Not having a migrating character, they remained to become the chief social and commercial factors of the metropolis. Three presidents of the United States are of that ancestry. Some of the poorer classes moved westward into Pennsylvania where they still retain many of their old customs.

The Germans made their first settlement at Germantown, near Philadelphia, in 1683. The ground was bought from William Penn by Jacob Telner of Crefeld, a town on the lower Rhine near the boundary line of Holland. They were members of the sect known as Mennonites. Since then the immigration from Germany has exceeded that of any other nation.

The Hebrews came first to New York in 1654, from Brazil, twenty-seven in number. Their baggage was seized on landing to pay their passage, and this not being sufficient, two of their number were seized and imprisoned till the remainder was paid. On July 7, 1733, while Governor Oglethorpe and his colonists were assembled at a public dinner on the present site of Savannah, forty Hebrews from London sailed up the river, landed there and proceeded to make themselves at home. It created a sensation, both among the colonists and the London owners of the land, but Oglethorpe was their friend and they remained to become the most influential citizens of the South Atlantic seaboard.

In 1638 the Swedes formed a settlement on the Delaware River, but were compelled to give up their charter to the land, between the encroachments of the Dutch and the claims of the Quakers.

Italians, Chinese and other immigrants who did not come to make this country their home, nowhere have become fixtures as citizens or influential factors in civilization, except in isolated instances.

The Norwegians were among the latest of the permanent additions to the population of the country.

The Albany Patriot of October 24, 1825, contained the following news item: "On Saturday, as we are informed, the Norwegian emigrants that lately arrived in a small vessel at New York, passed through this city, on their way to their place of destination. They appear to be quite pleased with what they see in this country, if we may judge from their good humored countenances. Success attend their efforts in this asylum of the oppressed."

These fifty persons were the first Norwegians to settle in the United States, and their destination was Murray, now Kendall, in Orleans County, New York. Their line of migration was southwest, reaching as far as Central Illinois, with a few families in Kansas and Missouri. In later years they have settled in the states of the upper Mississippi valley.

The Irish immigration began with the revolution and was without record, previous to the census of 1820. It was confined almost wholly to the cities, of which New York was the center. No other nationality has had such a large share of influence on the politics of the Nation.

According to the census of 1900, the principal foreign-born population of the United States was as follows: Germans, 2,600,000; Irish, 1,780,000; British, 1,245,000; Scandinavians, 1,040,000; Russians and Poles, 700,000, and other miscellaneous nationalities to the total of 10,160,000.

GREATEST FACTS IN THE HISTORY OF THE UNITED STATES

Types of civilization in first settlements:

The French at St. Louis, Feb. 15, 1764, at New Orleans in 1718.

The Spaniards at St. Augustine, in 1565, and at New Orleans in 1763.

The English cavaliers at Jamestown in the settlement made in 1607.

The English Puritans at Plymouth in 1620.

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CASTLE GARDEN AND BATTERY PARK, NEW YORK CITY.

This is the extreme southern end of Manhattan Island on which New York stands. The oval building is Castle Garden, which for many years was the receiving station for Immigrants until superseded by Ellis Island, in the bay. The buildings to the right are steamship piers,

The English Catholics at St. Mary's in 1634.

The English Quakers at Philadelphia in 1683.

English debtors and paupers, Savannah, in 1733.

The Swedes at Wilmington in 1638.

The Dutch at New York in 1613.

The Germans at Germantown in 1683.

Declaration of Independencc, July 4, 1776.

Articles of Confederation adopted 1777.

Treaty of Peace between Great Britain and United States confirmed by Congress January, 1784.

Adoption of Constitution of United States in 1787.

Organization of Northwest Territory in 1787.

Louisiana Purchase in 1803.

War with Great Britain declared June, 1812.

Purchase of Florida in 1819.

Missouri Compromise in 1820.

Annexation of Texas in 1845.

War with Mexico, 1846.

Settlement of Boundary Question in Northwest, 1846.

Acquisition of New Mexico and California in 1848.

Discovery of gold in California in 1849.

Missouri Compromise of 1850.

Civil War, 1861 to 1865.

Emancipation Proclamation, Jan. 1, 1863.

Reconstruction Act, March 2, 1867.

Purchase of Alaska in 1867.

Annexation of Hawaii, July, 1898.

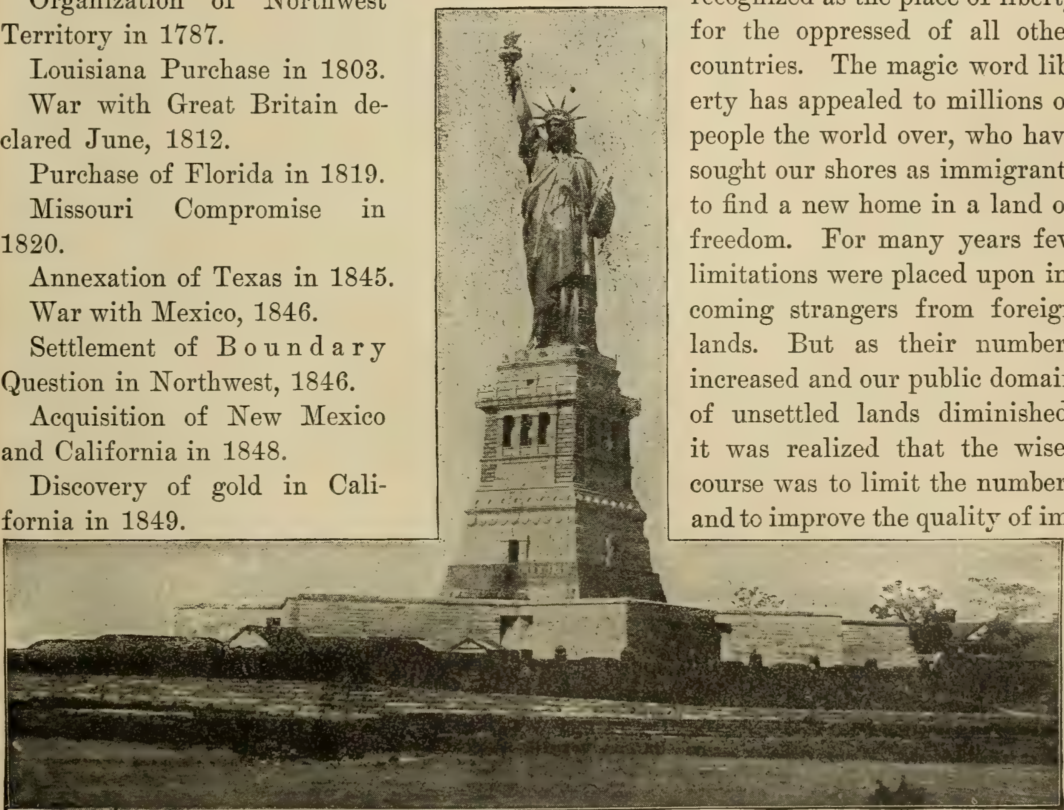
Spanish-American War in 1898.

Cession of Philippines and Porto Rico in 1898.

Philippine War begun Jan., 1899.

HOW IMMIGRANTS COME TO AMERICA

America, almost from the first days of the discovery of the continent, has been recognized as the place of liberty for the oppressed of all other countries. The magic word liberty has appealed to millions of people the world over, who have sought our shores as immigrants to find a new home in a land of freedom. For many years few limitations were placed upon incoming strangers from foreign lands. But as their numbers increased and our public domain of unsettled lands diminished, it was realized that the wiser course was to limit the numbers and to improve the quality of im-



"LIBERTY ENLIGHTENING THE WORLD."

The Bartholdi Statue in New York Harbor, which greets Immigrants arriving in the United States from Europe.

migration where possible. Chinese immigration was altogether forbidden, and certain restrictions were adopted to safeguard the nation from improper European immigrants.

It must be admitted, however, that in spite of legislation forbidding the importation of laborers under contract and the exaction of certain standards of health, intelligence, and money from the immigrants seeking admission, the conditions have not greatly improved. The influx of immigrants from Hungary, Italy and Russia of late years, has been enormous, while there has been a gradual reduction in the numbers from Germany, Scandinavia and the British Isles, or the more desirable elements of population. Of course, it is to be expected that Hungarians, Italians and Russian Jews will develop into good American citizens at least in the second generation here, if not in the first. But they come to this country with but faint realization of the ideals and aspirations of Americans and little prepared for the liberty which rules here. They do not assimilate with the American and the Northern European elements of our population, nor do they scatter into the country, but, forming their own communities in our great cities, they help to add to the puzzling problems which face our students of municipal life.

The greatest number of immigrants reaching the shores of America enters by way of the port of New York. The first conspicuous object which greets them and for which they have been looking all the way across the Atlantic, for it is famed throughout Europe, is the great Bartholdi statue of "Liberty Enlightening the World," that splendid emblematic figure which rises from a little island in New York harbor to welcome the stranger. Most of the immigrants know something of the significance of the statue and it rarely fails to impress them.

This famous statue was designed by Bartholdi, a great French sculptor, and was given to the people of the United States by the people of France. The site on Bedlo's Island was set aside for it by the United States government, and the pedestal was erected by funds given by contributors from all over the United States. The statue is made of thin sheets of copper beaten into shape and fastened about an iron skeleton. The figure of the statue itself is 110½ feet high and weighs 100,000 pounds. The uplifted torch extends this height twenty-six feet more, and adding to this the pedestal, the tip of the torch is elevated 220 feet from the ground. The pedestal is of stone, eighty-two feet high. Some idea of the enormous proportions of the statue may be given from the fact that the forefinger is eight feet long and four feet in circumference at the second joint. The head is fourteen feet high, and forty persons can stand in it. The observation balcony around the torch, just below the flame, is a favorite viewpoint for travelers who wish to see the whole of New York City, with large portions of Long Island, the New Jersey coast, and New York harbor spread out before them in one splendid panorama.

Closely associated with the idea of liberty itself, is that splendid relic now considered our chief emblem of independence, the old Liberty Bell of Pennsylvania. The order for the bell was given in 1751. The State House of Pennsylvania, in Philadelphia, work on which had been suspended for a number of years, was then approach-

RUSSIAN IMMIGRANTS, "THE DOUKHOBARS."

ing completion. A committee was appointed to have a new bell cast for the building, and the contract was awarded to a London manufacturer, the specification being that the bell should weigh 2,000 pounds and cost £100.

In August, 1752, the bell arrived, but though in apparent good order, it was cracked by a stroke of the clapper while being tested. The bell was recast, and the new bell was found to be defective also. Once again there was a recasting of the metal, with the alloy of copper in a new proportion, and this third effort was a success.

It was on Monday, the 8th of July, 1776 (not the 4th), that the bell rang out the memorable message of liberty and signaled the promulgation of the Declaration of Independence. It seemed strikingly prophetic that the bell should have been cast with the motto, "Proclaim liberty throughout all the land, unto all the inhabitants thereof." For fifty years the bell continued to be rung on every festival and anniversary, until it eventually cracked in July, 1835, when it was tolling for the death of Chief Justice John Marshall.

Since that time the bell has been one of the chief attractions to Americans visiting Philadelphia, and its place in the State House has been a shrine for patriots. Of late years the bell has been a conspicuous attraction at the various great expositions held in the United States. Wherever it has been taken, to Chicago, Omaha, Nashville, Buffalo, Charleston or elsewhere, its journey has been a triumphal progress, and thousands of interested citizens have turned out along the way to watch its train in passing. Significant as it is, as a memorial of those colonial days when our forefathers were struggling for independence, this Liberty Bell and the Statue of Liberty seem linked together through the century by a common significance.

IMMIGRATION STATISTICS

The latest statistics of immigrants into the United States from all the world since 1878 are given herewith. It is interesting to note the periods of fluctuation that mark the successive years. The increase from the end of the Civil War to the panic of 1873 was large and almost uninterrupted. Then came a rapid decrease, and until the return of striking prosperity in 1880, the numbers were comparatively small. The next few years showed enormous immigration, with 1882 as the highest water-mark. Again, however, there was a steady decrease for a few years, although the tide turned in 1887. When our last panic came, in 1893, it cut down immigration very rapidly, and since that time, coincident with a more exacting administration of the immigration laws, the numbers have never again approached their highest point, although since 1898 there has been an annual increase. The figures for the years indicated follow herewith. It should be understood that the calculations are made at the close of each fiscal year, which ends with June 30.

1878	138,469
1879	177,826
1880	457,257
1881	669,431
1882	788,992
1883	603,322
1884	518,592
1885	395,346
1886	334,203
1887	490,109
1888	546,889
1889	444,427
1890	455,302
1891	360,319
1892	623,084
1893	502,917
1894	285,631
1895	258,536
1896	343,267
1897	230,832
1898	229,299
1899	311,715
1900	448,572
1901	487,918
1902	648,743
1903	857,046
1904	815,361
1905	1,026,499
1906	1,100,735
1907	1,285,349
1908	782,870
1909	751,786
1910	1,041,570

OUR AMERICAN ARCHIVES AND NATIONAL INSTITUTIONS

That which might be known as the archive of American relics is the Smithsonian Institution or National Museum at Washington. It attained its present form when, in 1881, the building now occupied was completed for the national relics that had been transferred from the Centennial Exposition and the old buildings of the Smithsonian Institution. Although the relics of the Museum and the Institution are housed together, and are under the same management, they are separate organizations. So, with the ten million dollars given to the government by Andrew Carnegie for the establishment of a university of post-graduate scientific investigation, the three will be made to work together in harmony, which, with the nearness of the great

Congressional Library, and the many bureaus of the government, such as the Fish Commission, Geological, Coast, and Geodetic surveys, the Naval Observatory, and the Weather, Botanical, Biological and Entomological Bureaus, will together make the greatest post-graduate university in the world.

POPULATION AREAS OF THE UNITED STATES

America's "seat of empire" is found in the prairie region of the Central West, of which Chicago is the commercial metropolis. The flat or undulating prairie, in its natural state almost bare of trees, but covered with luxuriant grasses, now constitutes the topographic division of the United States which contains the greatest population. The prairie as the home of American citizens has outstripped all competitors. Neither the populous New England hills nor the great Atlantic coast plain, with its large cities and many thriving towns, nor yet the vast interior timbered region with all its wealth and opportunity, has kept pace with the beautiful prairie of the West.

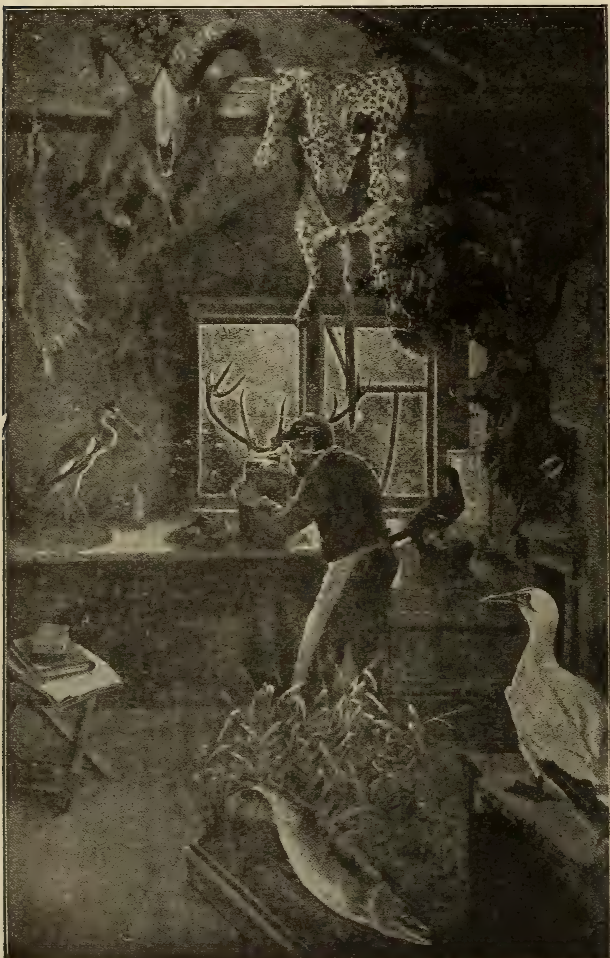
According to the geographers of the census bureau, continental United States is divided into nineteen regions, each having somewhat uniform physiographic features. The population of these regions and their percentage of the whole population of the United States is as follows:

	Population.	Pct.
Prairie region.........	13,300,970	17.5
New England hills (includes New York City and a strip of eastern New York State, also the Adirondacks).....	10,260,153	13.5
Lake region...........	9,571,215	12.6
Interior timbered region.	8,129,760	10.7
Piedmont region........	6,809,103	9.0
Coastal plain (east of Mississippi river)....	6,427,635	8.4
Allegheny plateau......	6,070,246	8.0
Appalachian valley.....	4,499,072	5.9
Coastal plain (west of Mississippi river)....	1,974,677	2.6
Coast lowlands.........	1,865,952	2.4
Mississippi alluvial region	1,227,094	1.6
Ozark hills............	1,203,880	1.6
Coast ranges...........	1,079,992	1.4
Great plains...........	1,052,719	1.4
Pacific valley.........	995,363	1.3
Rocky mountain........	592,972	0.8
Great basin...........	375,345	0.5
Columbian mesas.......	356,758	0.5
Plateau region.........	201,669	0.3

POPULATION AREAS OF THE UNITED STATES.

It is the theory of scientific statisticians that geographic differences exert a profound influence upon the people subject to them. They contend, therefore, that a division of the country into well-marked natural regions affords a better basis for classification of the population of the United States than the political lines often arbitrarily run. Nature, not man, fits a country for population, and the population will be great or small according to the advantages or disadvantages which nature herself has prescribed. Geology, topography, altitude, rainfall, temperature and soil—these are the determining factors. Thus dividing the United States into natural rather than into political regions, it certainly is a noteworthy fact that at the beginning of the new century the prairie region stands first in the list.

More than one-sixth of the whole population of the continental United States lives upon the prairie. The people of the prairie equal one-third of the population of France. They are as many as the people of Germany, leaving out Prussia and Bavaria. They equal one-half of the population of England and Wales. They almost exactly duplicate, in number, the entire population of Mexico, and are but a little short of the total number in Spain. They outnumber the combined populations of Belgium and Holland.



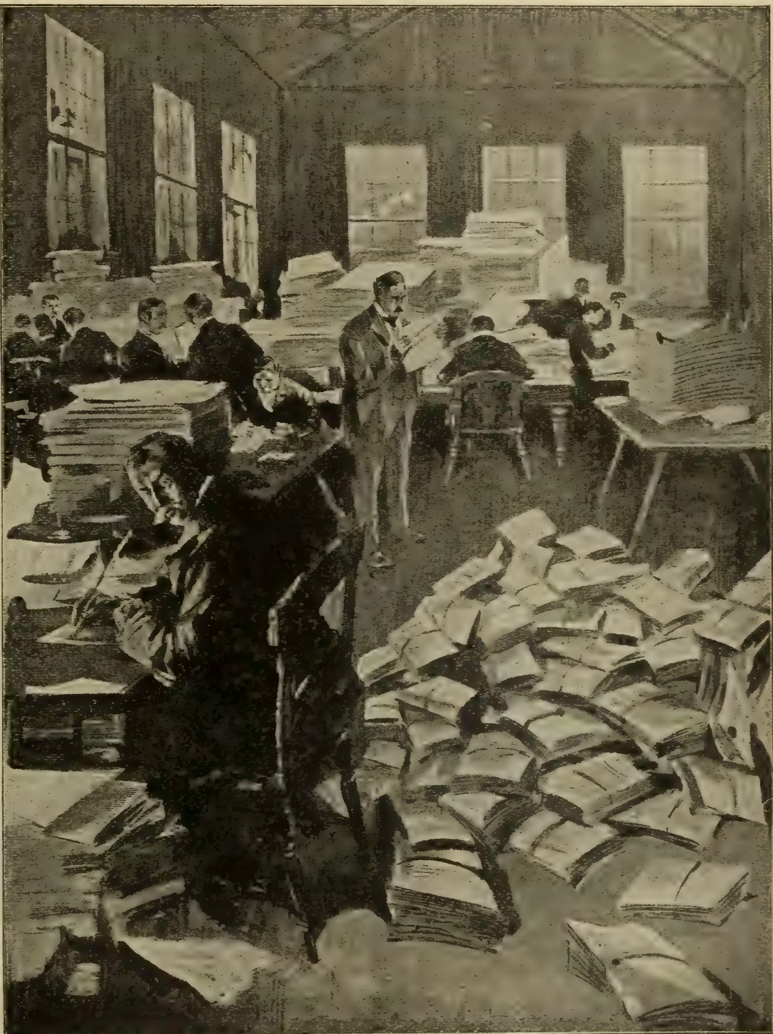
TAXIDERMIST AT WORK.

Strictly speaking, Chicago is not itself in the prairie region. According to the geographers of the census, the great western metropolis stands within the lake region, a few miles from the line where the mighty prairies begin their stretch toward the west and south. This lake region is third in the list of great topographical divisions of the United States, and the two areas which lie on either side of Chicago contain together a population of nearly 23,000,000, or 30 per cent of the entire population of the United States. If to these two be added the interior timbered region lying near to Chicago on the southeast, and embracing most of Indiana, Ohio and Kentucky, and small parts of Illinois, Tennessee and Missouri, it will be found that the three regions adjacent and tributary to Chicago comprise more than two-fifths of the people of the United States.

It is worthy of note that the second most populous topographical region, the New England hills, is the section which gave blood and bone and sinew and spirit to the prairie and the other areas of the farther West. The "star of empire" has taken its way from these hills to the timbered country beyond the mountains, to the borders of the great lakes, to the mighty prairie. There is a homogeneousness between the people of all four of these natural divisions of the continent which cannot be found between any other populous areas; and these four together furnish homes for 54 per cent of the people of the United States.

FACTS ABOUT OUR POSTAL SERVICE

Uncle Sam has many functions to perform in his capacity of governing a great country. With his army, he is a policeman; with his treasury department, he is a banker; with his agricultural department, he is a farmer; and with his mail service, he is a postman, to say nothing of a great many other functions of governing which might be named. In his capacity as a postman, Uncle Sam's mail routes now include the delivery of letters to the Philippines, to the West Indies, and to Alaska, as well as all over the United States. Perhaps most difficult of all these mail routes,



AT WORK IN THE CENSUS BUREAU.

although not the longest, is that by which the miners and whalers in northernmost Alaska have their mail brought to them in winter. The Hudson's Bay Company for more than 100 years has been maintaining communication through the trackless wastes of western and northern British America, from trading post to trading post, all the way from Hudson's Bay to the Mackenzie River, and far up into the Arctic Circle. But not until the discovery of gold in the hidden treasure houses of Alaska and the Canadian northwest, at Dawson City and Nome and points even more remote, did Uncle Sam's postmen have to assume such labor.

It was early in the spring of 1901 that the first carriers were sent to the farthest northern part of Alaska with the United States mail. Two men assumed the dangers of the journey a thousand miles over the ice fields, Francis H. Gambell and W. S. Flanagan. Their course was from St. Michaels to Kotzebue, returning by Cape Prince of Wales, Port Clarence, Teller, Nome, Golovin Bay and Norton Bay. They took with them but one sled, built of light birch and drawn by six Alaskan dogs. Their load included the mail, deer-skin sleeping-sacks, a shot-gun, snow-shoes, cooking utensils, a stove and other supplies, and their food itself, a total load of more than 350 pounds, which would, of course, be lessened day by day.

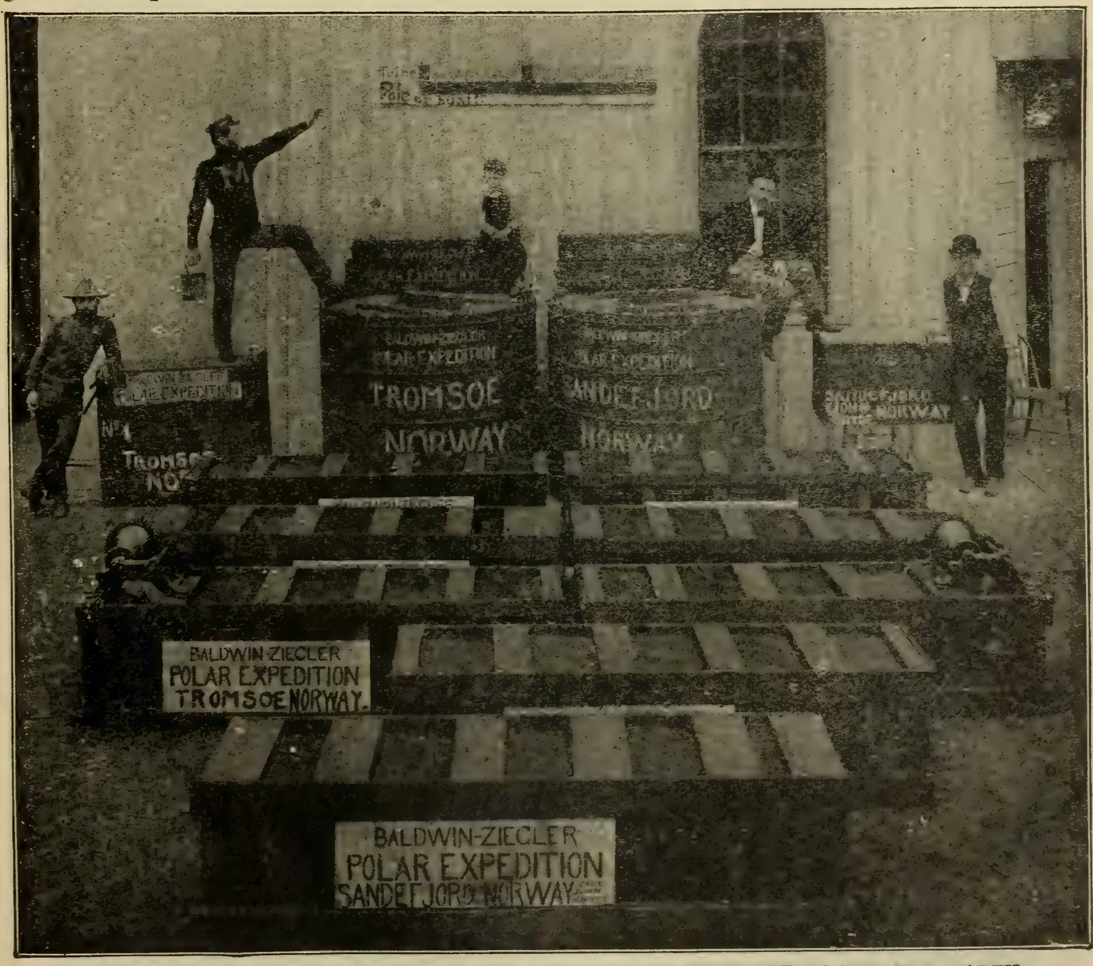
They started on a bright day with the thermometer four degrees below zero, but were not lucky enough to find it so warm all the way. Sometimes it was sixty degrees below zero, with a blizzard blowing, in which event they had to seek such shelter as they could get under the snow or otherwise. Sometimes they had to flounder through soft snow and pack down a trail with their snow-shoes, so that the dogs and sled would not sink down into it. At other times they had a glazed surface of ice or snow-crust and under these conditions traveling was easier.

Although Alaska is by no means a settled country, still it is not as lonesome as it was a few years ago, before the rush to the gold fields began. So sometimes the weary, half-frozen postmen would come to a little hut half buried in the snow, inhabited by Eskimos in some cases and at other times entirely deserted. Whatever the shelter, it was welcome. Frozen ptarmigan could be bought from the Eskimos for dog food, and the warmth of the hut was always grateful. Sometimes it was absolutely impossible to have a warm meal, even in one of the deserted huts. Mr. Gambell tells of one evening when he fed the dogs on frozen salmon and frozen bacon and crawled into his sleeping sack, dressed as he had been on the trail, to eat his supper with his hood and mittens on. His tea got cold before he could drink it, the beans seemed never to have been warmed up, the fork froze to his lips, and the biscuits and doughnuts were so hard that he first cut them up with his ax, so that he might be able to eat them. But in the end his appetite was satisfied and he drew the fur hood of the warm sleeping-sack over him and retired to rest.

At one of the native villages where they were hospitably received and given shelter by the Eskimos, they found the air in the hut so empty of oxygen that a coal-oil stove would not burn. The room was heated with seal-oil lamps, and the heat from the bodies of the human beings and dogs. Before going to bed, the master of the house closed up the only opening. There were fourteen people and two young dogs in that one small room, while the odor from the seal-oil added to the stifling closeness of the air. A few days later the postmen reached

Nome, which was the last station on their great circuit, and there they found what seemed genuine civilization again, with town life going on after the American fashion, in spite of the remoteness of the place. The mails were coming in by way of Dawson City once a week, being carried 2,000 miles by dog-team, and only two months old from home. These are the most remote and the most difficult mail routes which Uncle Sam's postmen have to travel, and they offer another indication of the remarkable ramifications of the services which a great government performs for its citizens.

The United States postal service is the greatest of its kind in the world. It spends more money, employs more men, and interests more people than any other institution ever established. In round numbers there are 75,000 postoffices and 250,000 employes. It handles annually ten billion pieces of mail matter, of which three billion are letters. We spend on the service as much every five hours now as in an entire year of Washington's administration.



CASES OF HIGHLY CONDENSED PROVISIONS, READY FOR SHIPMENT TO THE FAR NORTH.

A GUSHING OIL-WELL IN THE BAKU FIELDS, RUSSIAN CAUCASUS.

THE REGION OF THE YUKON

"Never buy a pig in a poke," is the wise advice of our forefathers, and yet that is what the United States did when it gave, in 1867, seven and a half millions in gold and useless war-vessels to Russia for the territory known as Alaska. Neither party to the transaction had the least idea what the territory was worth. Yet the advice of the old saying was this time at fault, for Alaska has already returned more than the amount of its purchase price in the fur trade alone, with its other vast resources almost untouched.

The Yukon River is two-thirds the length of the Mississippi, and drains a region a little more than one-third the size of the Mississippi Valley. In winter the water freezes to an average depth of five feet, but on the south side of the Yukon Basin, vegetation grows luxuriantly in the summer and cereals of the hardier kind may be made to yield bountiful harvests.

The discovery of gold has caused the heretofore unknown regions to be widely explored and there is every reason to believe that Alaska may support as prosperous a population as any of the Rocky Mountain States. Territorial laws have been

GOLD PROSPECTING IN THE YUKON COUNTRY.

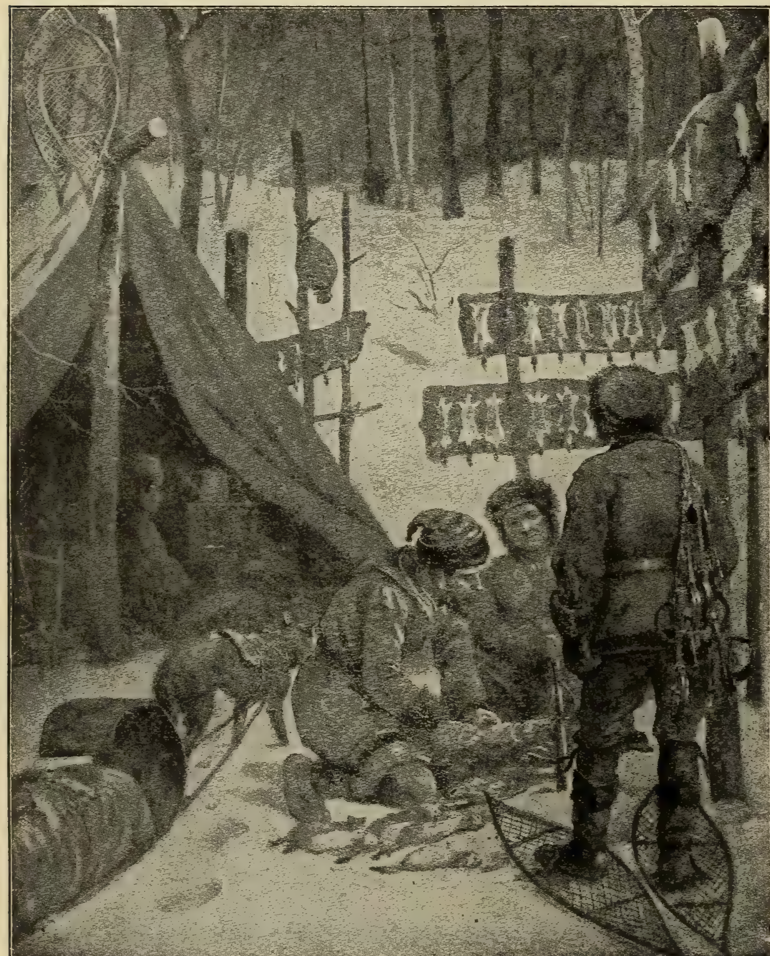
extended over every settlement, schools and churches have followed, until frontier and Arctic hardships have almost wholly given way to the comforts of civilization.

GREAT FUR-TRADING COMPANIES OF CANADA

Far away from the strife of contending political parties, and little visited by outside affairs in the winter, sleeps under its coat of snow the vast kingdom of the fur-traders. Overhead is the dazzling brightness of a northern sky, which at night is covered to the very zenith with dancing auroras. In summer, for two, three, or more months, the streams are unbound, a luxuriant vegetation bursts forth, and the summer green is as intense as the wintry whiteness has been.

Here the fur-trader must remain king. Mink and beaver, marten and otter, wolves, foxes and bears are his subjects, and, as in the case of all autocrats, the subjects exist for the profit of the ruler.

Perhaps one-quarter of North America will always remain the fur-traders' preserve. If a line be drawn from Moose Factory, at the foot of Hudson's Bay, to Norway House, at the northern end of Lake Winnipeg, thence to Fort Resolution on the Great Slave Lake, and westward to the Stikeen River on the Pacific Ocean, the boundary of a region will be marked, to the north of which is the fur-traders' kingdom, which likewise includes the whole Labrador peninsula east of Hudson's Bay. It is true this fur-traders' line has for two centuries been moving northward. Time was when the region of the Great Lakes, from Ontario to Superior and Michigan, was the home of the trader. It was



TRAPPERS AT WORK IN THE FAR NORTH.

for the fur of this large area that the early governors of New France and New York plotted and fought. So, later on, Rupert's Land, as the Arctic region of the north was called, was kept by the Hudson's Bay Company closed under fur-trading conditions.

Through the opening up of this region by the Dominion of Canada, the fur-line was moved north four or five hundred miles. Perhaps from the physical condition of the country, as unsuited to agriculture and possessed of a severe climate, the region north of the line traced above may always remain undisturbed to the fur-trader. Of this, however, no one can speak certainly, for the same declaration was made of New York, then of Canada, and later still of Rupert's Land.

There is a strange fascination about the life of the fur-trader. Placed in charge of an inland fort, surrounded and ministered to by an inferior race, and the leader of a small band of employes, his decisions must be final, and his word taken as law. As a monarch of his solitude he has great responsibility. His supply of goods must be obtained. There are places in the Yukon region where, hardly more than a decade ago, nine years were required from the time goods left London, until news of their receipt reached the shippers in London. It required wisdom and foresight to manage a post so remote.

In the busy season scores of Indians, squaws, and children may be seen in groups seated on the ground in the midst of the fort, their encampment being a group of tents, bark or skin, outside the stockade.

Washington Irving, in 1818, described, in "Astoria," the picturesque and somewhat hilarious life of the fur-trader in the Nor'wester capital of Montreal. Factors, traders, and voyageurs reveled in their liberty till the advance of the season compelled the voyage to be again undertaken. They sang at Ste. Anne, as they entered the Ottawa River, "their parting hymn," prayers were said to the patron saint of the voyageurs, the priest's blessing was received, and they hied away to face the rapid, décharge, or portage of their difficult route. When Fort William, on Thunder Bay, Lake Superior, was reached, they turned over their merchandise to new relays of men.

Scattered throughout the whole fur-trader's territory will be found the half-breed of French-Canadian or Orkney origin. Some beautiful lake or sheltered bend in the river, or the vicinity of a trader's post, has been selected by him as his home, and partly as an agriculturist or gardener, but far more a hunter or trapper, he rears his dusky race. Sometimes, when the engagé had served his score or two of years for the company, he retired with his Indian spouse and swarthy children to float down the streams to the older settlements, to what has been called "the paradise of Red River," and there, building his cabin on land allotted by the fur company, spent his remaining days.

Whatever may be said of its influence on the white man, the fur-trade has been a chief means in cementing the alliance between the white and red man. The half-breeds are a connecting link between the superior and the inferior race.

For many years it was the inflexible regulation of the Hudson's Bay Company to allow no half-breed to become an officer, but the rule could not be maintained, and on account of the Hudson's Bay Company having always assisted in the education and

Christianization of the native people, many of them have risen to high places in the fur-trade, as well as in other spheres of life.

THE WALLED CITY OF THE NORTH

"Quel bec!" (what a promontory) cried a Norman captain as he stood on the deck of his vessel and looked at the great wall of rock which lined the bank of the St. Lawrence.

The Latin nations of Europe have always been very fond of giving nick-names to places newly discovered, especially if derived from some first impression of the scene, so "Quel bec," became Quebec, and has so remained ever since. Quebec, because of its isolated position, has kept its ways with but little regard to the changes of modern civilization. It is the American Gibraltar, and, perhaps, could never have been taken by Wolfe if Montcalm had not heroically scorned to fight behind stone

ICE JAM ON THE ST. LAWRENCE RIVER AT MONTREAL.

CANADIAN BOATMEN IN THE RAPIDS OF THE ST. LAWRENCE RIVER.

walls. Montcalm is buried in the Ursuline Church founded in 1639.

It is noted for the ancient beauty and venerable architecture of its chapels and churches. Here French and English in peculiar harmony, considering racial prejudices and differences in customs, labor and live side by side. Modern conveniences and scientific improvements make slow progress here and it is of all American cities the most like those of Mediæval Europe. The religious customs of the people are everywhere most in evidence and are the first to impress the visitor who is accustomed to the free and easy cosmopolitan ways of life in the United States.

PILGRIMS AND SHRINES IN CANADA

The shrine at Varennes is distinguished by the possession of a miracle-working picture of Ste. Anne, that attracts great crowds of pilgrims. Varennes has been a place of pious resort since 1692, and a beautiful church stands there, from which every year a solemn and stately procession, bearing the precious picture, sets forth, and, passing up and down the village street, makes glad the hearts of thousands assembled to do it honor. One other subsidiary place of pilgrimage is at the lovely little hamlet of l'Ange Gardien, just below the Falls of Montmorenci, where there is a consecrated shrine of Notre Dame de Lourdes, having a statue of Our Lady, before which a perpetually burning light serves to symbolize her unwearying intercession on behalf of those who put their trust in her.

But however deeply these shrines may be venerated, and however successful may be the prayers properly presented at them, they pale in interest before that of Ste. Anne de Beaupre, the oldest and most renowned of them all, known par excellence as la Grande Sainte Anne, because of the surpassing number and brilliance of the miracles that have been wrought thereat, or as la Bonne Sainte Anne, in token of the high place it holds in the affections of the people.

THE GRAND CANYON OF THE COLORADO RIVER IN ARIZONA.

AMAZING WONDERS OF NATURE

GREENLAND AND ITS GLACIERS

When the hymnist wrote of Greenland's icy mountains he embodied in a phrase the extremes which nature exhibits in that inhospitable land. Eric the Red, after being driven from Iceland for the murder of a brother chief, spent three years in exploring the more promising parts of Greenland, and, so grateful was he to this land of refuge, and so much brighter were the prospects here than in lava-stricken Iceland, that in contrast he gave it the name Greenland.

In 1901 there were but 309 persons of foreign parentage in Greenland, and the remainder of the inhabitants were natives fewer in number than ten thousand.

The center and the north and east are so covered with the ice accumulations of ages that no idea can be formed of the nature of the land. From the mountains there run down to the sea vast streams of ice which plow into the sea and become veritable ice-mountains, having indescribable elements of beauty. These great icebergs are cut into such forms by wind and water as to keep the imagination busy with colossal images—caverns that seem limitless, cathedral spires and gothic arches, zigzag clefts as if made by earthquakes, all with changing hues that defy the brilliant changes of the opal and the colors of the rainbow.

Usually a great river of roaring water pours from underneath the sea of ice. Sometimes the icy lake spreads out in a valley several miles across, in which the ice is a thousand feet deep, and then it moves on through a gorge cutting its way with irresistible power.

Denmark has never received much value from its possession of Greenland, and it is doubtful if this great island will ever contribute much more than it does now to the human race.

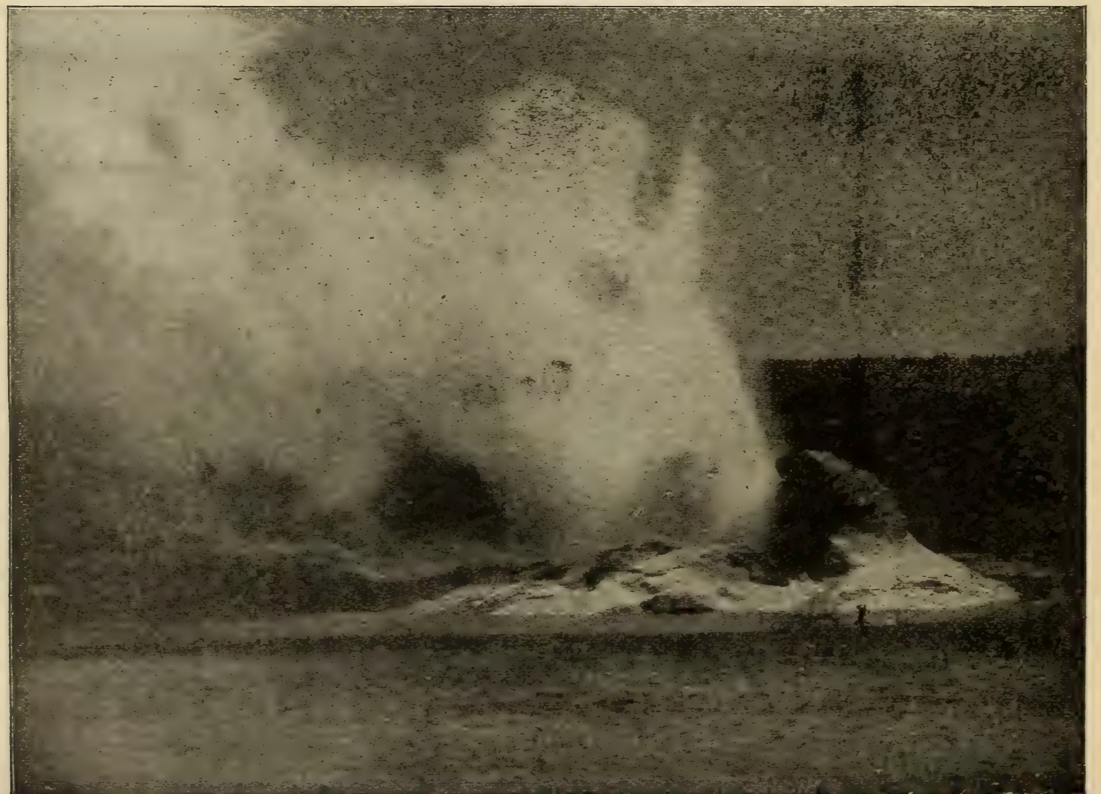
ICELAND AND ITS GEYSERS

Iceland is indubitably one of the most interesting spots on the face of the globe. Though as large as Ireland, it is in the interior a frightful desert; and it is only populated on its southwestern side by about 75,000 souls. Surrounded by stormy seas, which are generally covered with ice, this island,—with its tall, bare mountains, crowned with eternal snows and ice; its numerous precipices; its enormous lava fields, and the ever-present traces of frightful earthquakes and desolating eruptions; without a tree, and, with the exception of the seaboard valleys, without vegetation,—produces a startling effect on the traveler.

The geyser district lies at the foot of a steep but not very lofty hill, in a plain about ten miles in width, doubtless the bed of an old fiord, which runs down to the sea, and resembles an outspread green carpet of marshy pasturage. It is watered by the Tugn flyot and several smaller streams, which fall into the Hvita at the end of the valley. In the northeast the plain is bordered by the Blafell, a lofty extinct volcano, whose summit is partially veiled by clouds, and whose steep sides, denuded of all vegetation, display caverns and ravines filled with masses of snow. Round the plain are also other masses of jagged mountains, which, in the interior of the island, are piled up in gigantic forms; while Hecla, covered with its mantle of snow, proudly looks down upon the whole scene. The elevation of the springs above Reykjavik is, according to Bunsen's calculations, about 360 feet. The principal springs are situated here close together, the two extremes being hardly 600 feet apart.

The most noted of Iceland's geyser springs is that of Strokkur. Preceding each eruption there is the hollow sound of some vast drum struck by a thunderbolt, then a mighty pillar of steam and spray rises with incredible force to the clouds. Following this a solid body of water rises to the height of 800 or a thousand feet. This eruption rarely occupies more than six minutes.

The population of Iceland is quite stationary at 75,000, and their exports are chiefly sheep, wool, dried fish, oil, eider down, moss and seal skins. The only wild animal is the arctic fox.



"OLD FAITHFUL," A GIANT GEYSER OF YELLOWSTONE NATIONAL PARK.

THE GREAT LAVA DESERT OF ICELAND

In the central region of North Iceland is the most extensive solid lava desert in the world. On clear days the inhabitants living at the edge of the rocky tract of barrenness can see in the great distance thin streams of smoke arising as if from the chimney-tops of a city. This has established a firm conviction in the minds of the natives that a strange race of beings inhabit fertile valleys that lie between the volcanic peaks. The country abounds in stories of adventures with those imaginary people.

In 1876 the Danish government sent a scientific exploring party over the wastes and the myths were exploded as far as the more intelligent class of persons was concerned. However, the lava bubbles and volcanic outbursts have left such curious shapes and figures all over the dreary wastes that, if the imagination is allowed the least freedom, almost anything from the most hideous prehistoric creatures to well-arranged modern cities can be conjured up through the naked eye. Though a good field glass may dispel the given illusion, at the end of the range of the glass there will be another fully as startling.

THE GULF STREAM

Among the wonders of physical geography few are more interesting in their relation to this country than what is known as the Gulf Stream. This is an oceanic current of great extent, which takes its rise in the Gulf of Mexico, whence it derives its name. The peculiar formation and position of this gulf render it a receptacle for the waters of the Atlantic, which sweep across the northeastern coast of South America; and, on arriving in the Gulf, they become warmed to a much higher temperature than is anywhere found in the surrounding ocean. The summer temperature of the waters in the Gulf is about eighty-eight degrees, while in the open Atlantic, in the same latitude, it is only seventy-eight degrees.

Thus warmed, the waters pass out of the Gulf northward, in a deep and strong current, between the coast of Florida on the one side and the islands of Cuba and the Bahamas on the other. The stream progresses here with a velocity of five miles an hour. It rolls like a mighty river along the shore of North America, widening as it flows, until it nears the banks of Newfoundland, where it is turned aside, partly by the formation of the coast, which here projects boldly out, and partly by the encounter with strong and adverse currents from the North Atlantic. At the point where it is turned aside it stretches almost across the Atlantic; the current itself, according to some, being about two hundred miles in width, and the warm waters of the stream extending in all more than twice that distance. In the latter part of its course it leaves behind it that remarkable drift of sea-weed known as the Sargasso Sea.

Crossing the Atlantic eastward, towards the islands of the Azores, the main stream gradually becomes lost, and its current spent; but a portion of it continues northward towards the British Islands. Long after the current itself is lost the neighboring seas continue very sensibly affected by the warm waters which it has brought down.

It is important to bear in mind the distinction between the actual current of the

Gulf Stream and the heated waters which are brought down by its agency. The range of the latter extends some hundreds of miles after what is properly termed the Gulf current has ceased.

THE MAELSTROM

The Maelstrom is a whirlpool off the coast of Norway, between the islands of Loffoden and Moskoe; and because of its proximity to the latter is sometimes called the Moskoestrom. Many stories have been written about it which border on the confines of the marvelous rather than of the truth. Poets have been busy with the fact of its existence, and ancient legends have told with wonderful exactness how heroes have dived into the vortex in order to show their zeal for their lady loves, and how virtue and courage have come unharmed out of the great depths, while wickedness and vice have so weighted men that they have been overwhelmed in the whirlpool. Old-world thought led to the belief that at the spot where the Maelstrom was there was a great hole in the earth, through which the water poured, and that those things or men which were engulfed in the pool were either passed through the earth to its other side or were returned broken and drowned to the place whence they came by a return coil in the mysterious water spiral. Water jotuns, or water giants, were of course supposed to preside over the whirlpool, and to arrange according to the dictates of their own fancy who should be saved and who destroyed. One hero whom they permitted to re-visit the upper world was speechless ever after, unable, by sign or word, to give an account of the marvelous things he had seen. Many a ship was sucked down into the watery grave, many a fair cargo lost, and yet the water-demon was not satisfied; no amount of sacrifices seemed to propitiate the hungry ocean gnomes.

Modern science, with its secret-searching light, has scared the water-demon from his lair, and has given an explanation of the causes of the whirlpool, quite incompatible with the existence of such a contrivance as the Maelstrom was represented to be. When the configuration of the land between Droutheim and the North Cape is seen it will not surprise any one that the rush of the tide, cooped up as it is in its passage through the Loffoden Islands, should result in a wash of the whirlpool kind. The strong tide flowing down from the northern sea is caught in a rocky angle, which causes a kink in the stream, twisting it round with violence enough to cause the Maelstrom, the most dangerous whirlpool in the world. The whirlpool is thus described by an American writer: "I had occasion, some years since, to navigate a ship from the North Cape to Droutheim, nearly all the way between the islands, or rocks, and the main. On inquiring of my Norwegian pilot about the practicability of running near the whirlpool, he told me that with a good breeze it could be approached near enough for examination without danger, and I at once determined to satisfy myself. We began to near it about 10 a. m. in the month of September, with a fine leading wind N. W. Two good seamen were placed at the helm, the mate on the quarterdeck, all hands at their stations for working the ship, and the pilot standing on the bowsprit between the night-heads. I went on the main topsail-yard with a good glass. I had been seated but a few minutes when my ship entered the dish of the whirlpool. The velocity of the water altered her course three points towards the center, although she was going eight knots through the water. This alarmed me extremely for a moment. I thought that destruction was inevitable. The vessel, however, answered her helm sweetly, and we ran along the edge, the waves foaming round us in every form while she was dancing gaily over them. The sensations I experienced are difficult to describe. Imagine an immense circle running round, of a diameter of a mile and a half, the velocity increasing as it approximated towards the center, and gradually changing its dark blue color to white,—foaming, tumbling, rushing to its vortex; very much concave, as much so as the water in a funnel when half run out; the noise too, hissing, roaring, dashing,—all pressing on the mind at once, presented the most awful, grand, solemn sight I ever experienced. We were near it about eighteen minutes, and in sight of it two hours."

THE SPECTRE OF THE BROCKEN

The beautiful, deceptive phenomenon known as the mirage is of three distinct kinds. First, there is that form of it where some distant object, below the line of the horizon, and consequently out of the range of vision, seems to be lifted up into mid-air, and to hang suspended there,—sometimes in its natural position, sometimes upside down, and sometimes both ways at once; the image in this latter case being doubled, like a ship and its reflection in the water. Secondly, there is that form of it where some object high up in the air, such as a cloud or a village on a hill, seems to be brought down and to lie floating in a vast lake stretching miles away at the spectator's feet. Thirdly, there is that less frequent form of it, where the setting sun appears to fling huge shadows of terrestrial objects far out into space.

The mirage, in which the object is brought down instead of being elevated, is most frequently seen in the arid deserts of Lower Egypt, where it often proves cruelly deceptive to the thirsty traveler. Dotted about the waste are elevations, on which the natives have built their villages, in order that they may be safe from the flood during the periodical inundations of the Nile. In the heat of the day the mirage brings down an image of the sky upon the level, some few miles in front of the caravan, and produces the effect of a broad expanse of water, in which each village, brought down also, appears as an islet. Lured on by the refreshing prospect, man and beast push hopefully forward, often miles out of their track, to find the waters and islands constantly receding from their view, until the evening comes, and they vanish altogether. So complete is the illusion that not only experienced and scientific travelers, but even the Arabs themselves, are often deceived by it.

The third kind of mirage is seen only from the top of the Brocken, the highest summit of the Harz Mountain range in Hungary. It is there known as the Brockengespenst, or "Spectre of the Brocken;" and very spectre-like it looks in the red evening sun. You no sooner step out upon the plateau on the top of the hill than your shadow, grim and gigantic, is apparently flung right out against the eastern sky, where, with all visible space for a playground, it flits swiftly from place to place, following your every movement. It is only in the evening just before sunset that the phenomenon is visible, so that the shadow is doubly exaggerated, first by the distance and level of the sun and then by the distance of the surface upon which it is projected.

Each of these different kinds of mirage has its own separate cause, though they all depend for their existence upon a special state of the atmosphere. Before the phenomenon is possible the air must be divided into strata of different degrees of density. That done, the mirage follows, sometimes by refraction, sometimes by reflection, sometimes by the projection of shadows.

FAMOUS FOUNTAINS OF PALESTINE

Nearly every pool or spring about Jerusalem is of sacred historical note in some form of legend or story. The best known of these is the Pool of Bethesda. It lay close by the wall of the city at the sheep's gate and the word meant "house of mercy or place of flowing water." Porches and colonnades were in bible times built about it so that the people could protect themselves from the sun.

It was believed by the people that at frequent intervals an angel came down and troubled the waters, after which they had healing qualities. Here is where Christ told the sick man to take up his bed and walk.

This pool is now called Birkeh Israel and the gate near by is called St. Stephen. Little regard is paid to it by the natives and it is in ruins.

Ain Selwau is the name now given to the fountain by which the Lord stood when He said, "If any man thirst, let him come to me and drink." It is mentioned by the prophet as "the waters of Shiloah that go

AMERICAN TOURIST PARTY IN PALESTINE.

softly." It was to this pool that Christ sent the blind man to be healed.

A church was built over it in the middle ages, but it was destroyed by the Mohammedans. On its banks stands a mulberry tree said to mark the spot where the prophet Isaiah was slain by Manasseh.

In a shallow vale by the Jaffa gate beyond the olive groves near Jerusalem is Birkeh el Mamilla, which was known as the fountain of Gihon to which Solomon rode on King David's mule, when Zadok the priest took the horn of oil out of the tabernacle, and annointed Solomon, as the people cried, "God save King Solomon." Near by this ruined fountain is the potter's field bought with the blood money of Judas.

Over toward Jericho is the fountain of Elias, much famed for its healing power in bible times; further on in the fertile valley of Kedron, on the boundary line between Judah and Benjamin, is the most famous pool of modern Palestine. Its Arab name means Fountain of the Mother of Steps. The Jews call it En Rogel; that is, to tread, from the custom of treading linen in the water. This pool is 360 feet in length and 130 feet in width. Here is where Jonathan remained when he sent the little maid to bear a message to David, who had fled from the power of his son Absalom.

It was from the Roman tower Antonio, near by, that St. Paul made his memorable speech to the Jews. This tower is still standing, though half in ruins. Here St. James was slain.

The Christians have named this the Fountain of the Virgin, for here the mother of Jesus came with other Jewish girls to cleanse the linen. To this day the beautiful stream of pure water flowing from this spring is used for the same purpose, and troops of large-eyed oriental girls are seen working about the pool and stream just as has been done here by the girls of Jerusalem for two or three thousand years.

SAGHALIEN, A PARADOX OF CLIMATE

Saghalien belongs to Russia, and is separated from the mainland of Eastern Asia by the Gulf of Tartary.

The island is bathed by two cold ocean currents, and in winter nothing protects it against the icy northwest winds coming from Siberia. At the sea level the snow falls continually, and stays on the ground till the end of May, and the seashore is very cold. Further inland, however, especially as we go higher up, the climate is modified —just the opposite to what is observed elsewhere. It has often been observed in Siberia and in Central Europe that in winter the cold is greater in the plains and the valleys, and that the highlands have a sensibly milder temperature; it is as if the denser cold air accumulated in the lowlands. This fact is very often observed in our climate; there are several very good examples of it; all the trees and shrubs of a valley have been known to be killed by frost, while above a certain level, very clearly marked out, on the hill or the mountain, the vegetation has not suffered at all. The cold air often flows from the summits toward their bases. This is what takes place at Saghalien. The cold air accumulates in the low regions of the island and on the coast; the higher regions have a more elevated temperature. So it happens that the lower parts have an arctic vegetation, while the intermediate altitudes have the vegetation of a temperate zone, sometimes almost sub-tropical. The birch, the ash, the pine, the fir abound in the low regions and form often impenetrable forests, but toward the center of the island appear bamboos, hydrangeas, azalias and other plants that one is greatly surprised to meet, and whose presence can be explained only by the altogether abnormal climatic conditions of the island.

THE ARABIAN DESERT

Arabia meets Palestine on the north, and from these lands have flowed the influence of Moslem and Christian well-nigh covering the world. As Jerusalem is the sacred city of many millions of Christians, so is Mecca the sacred city of many millions of Mohammedans. Not only have two of the great religions come from this small territory of habitable land, but it was once the garden from which came the seed of civilization.

Poets have sung of these lands, romancers have written of them and pious priests have glorified them till in our imagination they are the realms of pearl and amber, redolent with the fragrance of aromatics, spices, frankincense and myrrh.

The poets have been the geographers, and on epic authority we are assured that it is a paradisiac region laden with the inspiration of divine perfumes.

"To them who sail
Beyond the Cape of Hope, and now are past
Mosambic, off at sea northeast winds blow
Sabean odors from the spicy shores
Of Araby the blest; and many a league,
Cheered with the grateful smell, old Ocean smiles."

Here in truth is the dream-land of the world, replete with scenes made awesome through sacred song and story.

Strange remnants of Christian and Moslem occupation still remain almost unchanged.

About nine days of camel travel into the desert from Suez brings the traveler to one of these remnants, a spot of impressive loneliness and desolate grandeur at the foot of Sinai. It is the convent of St. Catherine, made like the stronghold of a castle with battlements on which are mounted ancient guns. The approach of strangers is guarded with all the ceremony of medieval times, when the least relaxation of caution or vigilance might mean destruction. Those approaching come up through the groves of cypress trees to the massive stone walls, where there is nothing but silence and no moving creature is to be seen. Back of the convent the perpendicular sides of the rocky cliffs rise to the height of a thousand feet and add to the solemnity of the scene.

After repeated calls a port hole is opened about 30 feet above the heads of the visitors, the face of a monk appears, and, after surveying the visitors stolidly for a few minutes, he lowers a rope from a windlass.

The letter of introduction from the convent at Cairo, which is indispensable, is fastened to the cord and it is drawn up.

This much of the customs has yielded to the improvement of government and the safety of modern times; they no longer draw the visitors up by the windlass, but after reading the letter a gate is at last opened and the visitor allowed to enter the court. Moses being a holy man alike to Christians and Mohammedans, there are both chapels and mosques about the place where the commandments were given. However, with sectarian perversity the Christian has decided on one mount as the scene of the handing down of the law to Moses and the Mohammedans another. Mount Horeb is the one generally agreed upon by Christendom.

THE GREAT TREES OF CALIFORNIA

All the world has heard of the big trees of California, and those astonishing groves of forest giants which have attracted strangers from far and near to view their wonders. California is a state of great things, with its coast-line as long as that which stretches from Massachusetts to Georgia, its mountains which are surpassed on this continent only by a few Alaskan peaks, its gold mines, its orange groves, and its smiling valleys devoted to farming, all rivals in magnitude as the sources of greatest wealth, and its Yosemite Valley with the great cataract that plunges 1,500 feet sheer in one of its three downward leaps and its colossal domes, spires and arches of pure granite, contrasted with soft tones of green forest and silver lake. Of all these wonders the great trees themselves of the Mariposa and the Calaveras groves are, perhaps, the most conspicuous and the most widely known objects of curiosity. They are the oldest living

TWO GIANTS IN COMPARISON.
Masonic Temple, Chicago, 302 feet in height and Big Tree, 400 feet high.
This ingenious picture, in which the artist shows one of the big trees apparently growing in a city street, depicts how nature's work overtops that of man.

things in the world. The best scientific estimates place the age of the oldest at about 5,000 years, and thus make them survivors of the Miocene period. It taxes the imagination to conceive the age that this means and the natural history of our globe which these grizzly giants have witnessed. With the danger of their complete extinction threatened as it seems to be, they become doubly interesting to us all.

Students of the groves declare that these big trees of California are not akin to any other trees now growing, except some of their own neighbors. Only by comparison with certain fossil remains of cone-bearing trees was the proper relationship found, and the kings of the forest were discovered to be species of the genus Sequoia. In deference, therefore, to the name of our greatest citizen these greatest of trees were named Sequoia Washingtoniana. Popularly speaking, however, the name Sequoia Gigantea has come to be accepted as the characterization of these monsters.

It was just about the time of the rush of the forty-niners to California in the days of gold discoveries that these trees were found. According to the scientists, the Sequoias covered great areas of America and Europe, far back in the mysterious, moist days of the Miocene period when all vegetation took strange, gigantic forms. When the age of ice came and our continents were swept by the glaciers that have left their tracks in every direction some of these ancient forms of vegetable life were exterminated, some were left as fossils and a few have come down to us in visible forms upon the surface of the earth as living things.

These two groves of big trees may be considered as small islands, upon which they were left in safety after the great upheavals of nature that passed around them. Here they have survived through all intervening thousands of years, so that today they have the distinction of being virtually the only survivors of a geologic age that is past. In addition to the two most famous groves, the Mariposa and the Calaveras, there are some other tracts in California which contain groves of Sequoias, although not the largest ones. Altogether there are 200,000 or 300,000 of the species, but of those remarkable for their great size not more than 500.

A common height for the pines, firs and cedars, which grow in the same forests, themselves noteworthy specimens of their own variety, is from 175 to 200 feet, but these are overtopped at least a full hundred feet by the big Sequoias that grow beside them. There are trees in the Mariposa groves which are nearly thirty feet through, and a great many between ten and twenty feet. Inasmuch as the largest trees are still standing, it is impossible to count their rings and measure their age exactly. But one tree that was cut down was found to be 2,200 years old, and another that had fallen to the force of the winds showed an age of 4,000 years. It is a fair estimate, therefore, that the larger ones still are at least 5,000 years old, and this agrees with the calculations as to the period whence they date.

Mr. John Muir, who has studied the trees and mountains and glaciers of the west with affectionate energy, calls attention to the vitality and vigor of these trees, and the fortunate way in which nature has protected them. The bark is thick and fibrous, and all but fireproof, so that forest fires have not been able to destroy the trees. The wood, too, does not decay, and fungus does not, therefore, thrive upon it. Even the trees that have fallen have lain sound for centuries.

The threat of extinction of the great trees comes from two causes. They are not inclined to rear new trees from seedlings, to reproduce their own groves, and the fine old trees themselves in many instances have been attacked by the lumbermen holding the land upon which they grow. The Mariposa grove is now owned and protected by the State of California, and there is an effort under way to purchase the Calaveras grove as a government park. But by far the greater number of the big trees are on land owned by the lumber companies, and many of them are at work on the Sequoia timber. The people of California are becoming aroused to the great value of these forest giants, as sources of interest for the tourists who flock to their state, and it is to be hoped that the vandalism which is threatening the existence of some of the finest specimens will be put an end to by the influence of public opinion and the purchase of the property for permanent preservation. The wood is not particularly valuable as timber, and it seems a manifest truth that the big trees, considered entirely as an investment for the state, would yield more as living curiosities than as lumber piles.

HOW GLACIERS AND ICEBERGS ARE MADE

Great mountains of snow and ice, which float down into the North Atlantic Ocean from the Arctic regions to threaten the safety of vessels crossing from America to Europe, are among the most peculiar and interesting of the works of nature. The land of their birthplace in the far north is not reached by many travelers, except the Arctic explorers themselves, but instead of the traveler coming to the iceberg the iceberg comes to the traveler, thus reversing the famous experience of Mahomet and the mountain.

The coasts of Greenland are the birthplace of the greatest icebergs that come into the Atlantic Ocean. They are produced from the glaciers which fill the valleys of this frozen land.

The story of the glaciers, from which icebergs are but offshoots, is an interesting one. A great weight of snow pressing downwards through crooked mountain valleys is squeezed between the rocky walls and gradually converted into ice. The great body of the glacier, which is neither snow nor ice, but both, creeps along and molds itself to its bed. But in changing its shape and slope its surface is broken by deep crevasses, which begin as simple cracks. These crevasses are caused by the tension or pull of the lower mass of ice upon the upper, and consequently they generally occur transversely or obliquely up-stream. Dirt accumulates in the crack until the whole mass closes by being pushed into a new position. Elevations in the bed of the glacier thus leave a permanent record in the ice which breaks above them. This record is carried on the center of the stream, which moves faster than the margin, and consequently these dirt-lines, which mark the former crevasses, gradually become bow-shaped, until they almost touch each other at the margin. Viewed from above, the effect is very striking, and these dirt-bands, as one may call them, appear sometimes like the graining on a slab of oak. When the crevasse fills with snow instead of dirt the bands are white instead of grey. The newly-fallen snow on the mountain tops is gradually made firm by pressure. Slowly, almost imperceptibly, it begins to glide down the slopes; air, before imprisoned, escapes, and the snow hardens. After a time the mass reaches a steep slope, confined in a valley, and then pressed down from behind and from the sides, it changes into clear, blue ice, streaked with little veins where the air has not been expelled. And so a little tongue of ice begins creeping down the valley until it swells into a great river, terminating in a vertical wall hundreds of feet in height. As the long, sinuous band of ice continually creeps down from the mountains the topmost portion moves faster than the ice below, and finally a piece breaks off, either on the mountain side or in the sea, if the flow has traveled so far. In this way the smaller icebergs are formed.

"Calving" of icebergs, as the breaking off of blocks from the parent glacier is called, is produced by the action of the tide. Upward and downward pressure, exerted by water at the rise and fall of the tide, on submerged portions of the glacier front, forces off a strip of ice, which floats away as a berg.

The Humboldt Glacier, sixty miles in length, is the most celebrated in Greenland, and has a perpendicular face of 300 feet. The glacier was discovered by Dr. E. K. Kane, U. S. N., in 1853. We take the liberty here to quote from Dr. Kane's book, "Arctic Explorations," his striking description of it. "My recollections of this glacier are very distinct. The day was beautifully clear on which I first saw it, and I have a number of sketches made as we drove along the view of its magnificent face. They disappoint me, giving too much white surface and badly fading distances, the grandeur of the few bold and simple lines of nature being almost entirely lost. I will not attempt to do better by florid description; men only rhapsodize about Niagara, and the Ocean. My notes speak simply of the 'long, ever-shining line of cliff diminished to a well-pointed wedge in the perspective,' and again of 'the face of glistening ice, sweeping in a long curve from the low interior'; the facets in front of the cliff rose in solid glassy wall three hundred feet above water-level, with an unknown, unfathomable depth below it, and its curved face, sixty miles in length, from Cape Agassiz to Cape Forbes, vanished into unknown space at not more than a single day's railroad travel from the Pole. The interior with which it communicated, and from which it issued, was an unsurveyed mer de glace, an ice-ocean to the eye, of boundless dimensions. It was in full sight—the mighty crystal bridge which connects the two continents of America and Greenland. I say continents, for Greenland, however insulated it may ultimately prove to be, is in mass strictly continental. Its least possible axis, measured from Cape Farewell to the line of this glacier, in the neighborhood of the 80th parallel, gives a length of more than twelve hundred miles, not materially less than that of Australia from its northern to its southern cape. Imagine, now, the center of such a continent, occupied through nearly its whole extent by a deep, unbroken sea of ice, that gathers perennial increase from the water-shed of vast snow-covered mountains and all the precipitations of that atmosphere upon its own surface. Imagine this, moving onward, like a great glacial river, seeking outlets at every fiord and valley, rolling icy cataracts into the Atlantic and Greenland seas; and having at last reached the northern limit of the land that has borne it up, pouring out a mighty frozen torrent into unknown Arctic space. It is thus, and only thus, that we must form a just conception of a phenomenon like this great glacier. I had looked, in my own mind, for such an appearance, should I ever be fortunate enough to reach the northern coast of Greenland. But now that it was before me, I could hardly realize it. I had recognized, in my quiet library at home, the beautiful analogies which Forbes and Studor have developed between the glacier and the river. But I could not comprehend at first this complete substitution of ice for water. It was slowly that the conviction dawned on me that I was looking upon the counterpart of the great river systems of Arctic Asia and America. Yet here were no water feeders from the south. Every particle of moisture had its origin within the Polar circle, and had been converted into ice. Here was a plastic moving, semi-solid mass, obliterating life, swallowing rocks and islands, and plowing its way with irresistible march through the crust of an investing sea."

The glaciers from which the bergs break off crop out all along the Greenland coast. On the other side of America, on the Alaskan coast, are other great glaciers, one of them, the Muir Glacier, being frequently visited by summer tourists in excursion parties up the Alaskan coast. But these Alaskan glaciers do not send their iceberg children far down into the track of vessels in the Pacific Ocean, as do those of Greenland into the Atlantic.

Up to the middle of August travelers crossing the North Atlantic are very likely to see the fragments of these great mountains of ice which have floated down from Baffin Bay and have not yet entirely melted under the influence of the warm weather. During some seasons these icebergs form a source of considerable danger to ships, and more than one collision between a great Atlantic liner and these navigators from the Arctic have been reported in the list of marine disasters in recent years. Frequently the icebergs bring with them a local fog which screens them for miles around like a low hanging cloud. This results from the contact between the warm, moist air rising from the ocean, and the cold rays radiated from the great body of ice. When a ship enters a fog in the North Atlantic, at such a season, the navigator watches for icebergs quite as carefully as for other vessels. He has two sources of warning when danger threatens. From the iceberg itself, the sound of the steamer's whistle is echoed back to him so that he may judge the direction of the berg and may estimate its distance by the time required for the return of the echo. As he draws nearer, steaming slowly through the fog, a delicate thermometer prepared for the purpose on the bridge of the vessel, responds to the cold given off from the frozen mass, and the mercury falls rapidly. It is at such times that the skill and caution of an able navigator are displayed.

Let us trace the history of one of these great icebergs from the time it has broken loose from the parent glacier to float away into the waters of Baffin Bay, Davis Strait and Smith Sound. Seven-eighths of the weight of the iceberg is under water and one-eighth of it above. When we see an iceberg which extends a hundred feet, or, perhaps, much more above the water, we know that it is practically seven times as great below the surface. This suggests the enormous mass of ice and indicates the danger which it threatens to a colliding vessel. The current acting upon this mass under water causes irregular pieces to be detached. Thus the balance of the berg is changed, and it turns over sufficiently to restore its equilibrium, with the heaviest part once more hanging downward in water. It thus floats, moving with the current generally southward, the sun's rays, wind and frost changing the exposed surface and the outline of the berg itself. When the warmer currents of water are reached in lower latitudes melting takes place, till the bergs finally disappear altogether in the Gulf Stream.

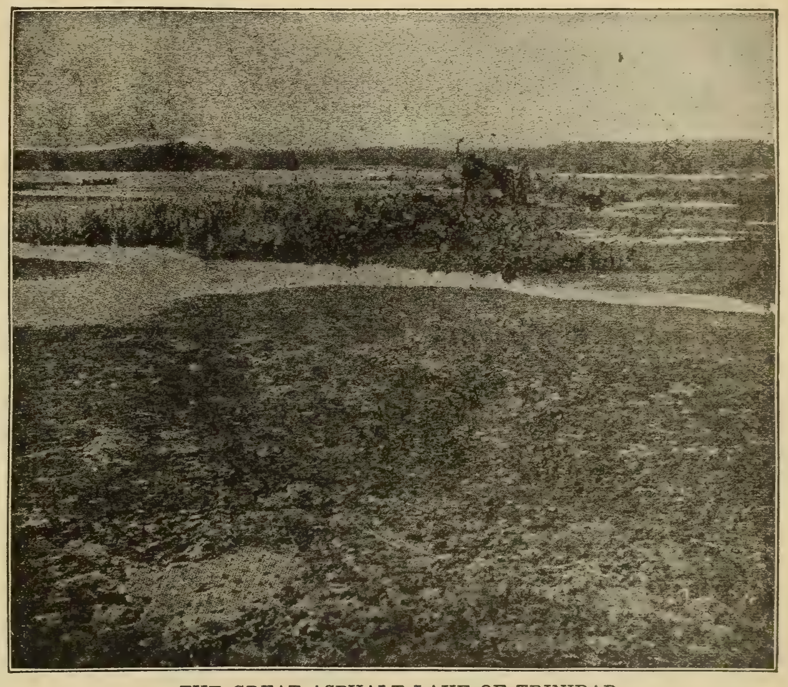
It is this melting of icebergs as they move southward into the warm water that has built up from the floor of the ocean that remarkable tract known as the Grand Banks of Newfoundland. The glaciers of Greenland carry with them as they move toward the sea great quantities of stone and sand, gathered as debris from the mountain valleys where they were formed. The icebergs breaking away from the glaciers and floating southward into the Atlantic carry with them these same fragments, and as they melt ultimately deposit the debris upon the floor of the ocean. This process continuing through centuries upon centuries, they have built in the Atlantic a great plateau, surrounded by deep water, rising within a few hundred feet of the level of the sea. This peculiarly submerged plateau lying to the southeast of Newfoundland covers an area of some 200 by 400 miles. On these Grand Banks are the favorite fishing grounds of the fleets that sail from Massachusetts and Newfoundland every year for cod and mackerel. The greater Atlantic liners usually pass to the south of the Grand Banks in order to avoid the fogs, the icebergs and the fishing vessels which obstruct the more northern route. But in early summer the tourist on a vessel sailing from a Canadian port and crossing the Grand Banks can hardly fail to have the pleasure of seeing one or more of these great travelers from the Arctic, as well as numbers of the fishing schooners themselves, working in these shallower waters.

We observe that the ice of the bergs looks like great masses of chalk or loaf sugar, varnished, if you please, or glistening like powdered glass. At times it is pure white, at others it looks greenish, and we note that this greenish tone is caused by the reflection of light upon masses of ice under water, thrown back upon the exposed surface. The shadow side, away from the sunlight, is a beautiful blue, traceable to the reflection from the sky. We also see icebergs of a beautiful blue color, and these are built up of ice formed from fresh water, the water melting upon the surface of the glaciers, due to evaporation, rain and melting snow, being different from ice or frozen water, containing salt, in that being much thinner or porous, it absorbs light. Charming cobalt blue bands are sometimes seen running through bergs, and these are the streams of fresh water frozen before the berg was formed, invaluable as the fresh water supply of the Arctic ships.

Let us look at that great glacier with irregular front, as high as a six-story house, with a length of a mile and a half. We are steaming about four miles away, and the day is beautifully clear, with bright sunshine. The air is crisp, like one of our winter days, the water calm as a mill pond, and a great silence reigns. Floating pieces of ice called floebergs and icepans, with a seal lying asleep upon them, float by. Arctic birds, the puffin, eider duck, mollomokes and kittiwakes, fly past; a charming tranquillity rests over all and we feel at peace with all the world. A great boom is heard, like the report of a big gun, echoed and re-re-echoed till it dies away. We look toward the glacier. A mass of the ice, as large as eight city houses, is slowly detaching and sliding away, sinking, sinking very slowly, pushing in front of it a high green wave of water, which approaches like a wall. As we look the mass turns over, and as a portion rises the water is thrown off in a great cataract. The mass sinks out of sight, now it rises again. It rocks from side to side, sinks again, nearly out of sight; rises again, turns a little, and thus for twenty minutes it keeps moving. The waves have reached our ship, and we rock, heave and dip under their influence. At last the berg has settled quietly, and is floating with the tide. A beautiful blue cave is visible, a great turret at one end, a sloping mass rising toward the opposite. A great concave channel slanting along its base shows the former action of the water line. This berg will float southward, gradually melting, changing its form, becoming smaller, and finally mingling with the waters of the Atlantic. Thus an iceberg is born and dies.

TRINIDAD AND ITS BITUMINOUS LAKE

Columbus discovered Trinidad in 1498,



THE GREAT ASPHALT LAKE OF TRINIDAD.

and gave it that name because of the three mast-like mountains on it which appeared to rise directly out of the sea. With the island of Tobago it forms the British crown colony of Trinidad. Trinidad has 1,754 square miles and its chief town has the singular name Port of Spain. At the nearest point it is only 9 miles across the Gulf of Paria to the mainland of Venezuela.

Near the village of La Brea is a strange fresh-water lake of about 300 acres, the surface of which is covered with pitch. The asphalt bubbles up in the center and hardens upon the surface, from which it is taken for export. The deepest soundings have never been able to reach any bottom, although the surface of the lake is only 80 feet above sea level.

On the shore nearest the lake a great deal of bitumen is thrown up by the sea. The pitch on the side of the lake next to the sea is never hard, but on the other side it hardens to a great depth and is rent in fissures twenty or thirty feet across. This part of the lake, from which about 100,000 tons are annually exported, consists of 110 acres.

It is estimated that this lake alone would pave all the streets of the world, and that the supply is inexhaustible for all human purposes.

DEATH VALLEY

Away out in California, near the southern extremity of Nevada, far from any railway and lying in the heart of a barren, desert country, is that fatal depression marked on all maps by the name which it has long justified, "Death Valley." The gloomy history of the place for many a year has deterred even the most curious of visitors to the neighborhood from attempting to traverse its barren expanse. And yet Death Valley is being explored in all its parts. Tell that to a Californian and he will laugh at you. "It is impossible," he will jeer. "The fools who try to ask that mouth of hell for its mysteries will die. Death Valley cannot be explored."

But Death Valley is being explored. And the explorers are not plainsmen inured to hardship, but college professors from the East. They come from Boston and Chicago, and are botanists, biologists, and mineralogists. Tell that to a Californian, and he will say that you are insane or they are.

Death Valley comes by its name honestly. It is the most hideous and most fatal spot known to man. No spot in Asia or Africa is so destructive to life. No depression on earth is so far beneath sea level. No other place on earth is so hot. No other desert is dryer.

At one point in the Valley, where the depression is 200 feet beneath the level of the sea, and the width across seven miles, a mountain rises on one side to the height of two miles, and on the other side is another mountain 8,000 feet high. The sides of the two mountains are almost sheer. Into this pit, with its bottom of borax dirt, waterless, the sun beats directly down in summer, and not a breath of wind is ever felt on its floor.

That seven-mile stretch between Funeral Peak and Telescope Peak is the cruelest and most horrible spot on the face of the whole earth. No man could be alive in it in summer for half an hour. The temperature has never been taken. In other parts of Death Valley 137 degrees has been observed and recorded, but no record has ever been made of the summer heat of that terrible seven-mile stretch.

Death Valley is a land of paradoxes. In the summer it kills off the healthy who so much as approach it. In the fall it heals and restores the sick who invade it.

John R. Spears wrote of it: "It is a place where rain-storms are well nigh unknown, and yet one where the effects of cloudbursts are almost unparalleled. It is the hottest place on earth, and yet ice often forms there. It is a place where the air becomes so arid that men have died through lack of moisture when abundant water was at hand, and yet the stopping place of hundreds of duck, geese, and other fowl. It is a region where the beds of lakes are found on the pointed peaks of the mountains. It is a region where a mountain system of the most gorgeous colored rocks is known as the Funeral Range. It is a rent in the earth, the bottom of which, in spite of the washings, probably is deeper below the level of the sea than that of any other valley in the world."

Death Valley has mines and marshes and borax beds. For this reason the exploring party is invading a part of the valley hitherto let alone, for the Los Angeles, San Pedro and Salt Lake Railway is running a new line across the desert country, north of the valley. The road will make somebody rich who owns part of Death Valley and keeps away from it. And it will kill lots of men who own nothing of it and go into it.

The bottom of the valley is made of great acres of saline deposits, beds of borax and salt, which, under a strong sunshine, present a ghastly appearance with their glistening whiteness. The bedrocks are shale and schist left from the Jura-Triassic period, but a most extensive volcanic eruption has so scattered and demoralized the various formations, that widely different deposits are often found within a few feet of one another. There are dozens of craters of extinct volcanoes in the valley, and with their blackened ruins and coating of dark cinders, acres of area, the general whiteness of the valley bottoms stands out all the more lonely and ghastly.

Death Valley lies in Inyo County, many miles from the nearest railroad, 350 miles from the Pacific Ocean, and close beside the Nevada-California state line. It is a part of the Mojave and Colorado deserts, and is the quintessence of all that is melancholy, grim, and withered in desert characteristics. The valley proper is about one hundred miles long and fifty miles wide.

The mirages of Death Valley are the most remarkable in the world. Every day in any season one sees among the parched hills and scaled mountain sides, phantasmic pictures, miles in area, of foaming mountain streams, sylvan shades, alfalfa fields, and browsing cattle-scenes, reflected from the sides and tops of the Sierras. Occasionally scenes from the Pacific Ocean may be reflected in the mirages, and sailing ships and tossing waves may be seen amid the shimmering, desolate sand hills and alkali cañons of Death Valley. The Indians call the mirages the Big Spirit's pictures. Sometimes in the hottest weather the mirage will remain floating wonderfully distinct in the valley for a day at a time, but generally it lasts only a few minutes. Then the phantasma vanishes in a twinkling, to be soon succeeded by another, until as many as seven different mirages have been seen there in one day.

Sand storms are a serious thing on the Colorado and Mojave deserts, but nowhere do they approach the deadliness of the sand storm in Death Valley. The simoons of the Arabian Deserts are well known in literature, but the explorers of Death Valley say the simoons are mere babes by the side of a howling gale of hot sand in this place. The hot air rising from the cañons and the bottom of the valley encounters the cold atmospheric currents from the Sierras and Rockies, and the rushing of the cooler air into the valley instantly creates a storm undreamed of in any other part of the world. For hours at a time the sand storm rages, occasionally for a day and a night.

Nothing alive can brave the hurricane. The man who will keep close within a tent, with his head wrapped in a blanket, will survive, but he will suffer with the heat almost as severely as if in an oven, and for days thereafter with pain from smarting nostrils and inflamed ears and eyes. Old-time plainsmen who know about all the hardships a man's anatomy can experience, are a unit in saying that the desert sand storm, more particularly a Death Valley sand storm, is the most trying physical ordeal. The mountains which bulwark Death Valley show the terrific erosion of their flinty faces by successions of these tempests. Here and there are starved grease-root plants, like stunted, starved trees that have been half-buried in the sand during these storms. Many a man who has been a desert teamster or a mining prospector has suffered chronic inflammation of the eyes by reason of having experienced one of these whirlwinds of alkali sand.

The nearest water course to Death Valley is the Amargosa River, a little stream that trickles down in an enormous bed from away up among the mountains in Nevada. Centuries ago the Amargosa was a mighty, roaring torrent that eroded granite rocks and ate a river bed half a mile wide for over eighty miles. The Amargosa touches the extreme southwestern end of Death Valley, and in this locality lizards and venomous crawling things may be occasionally seen darting from under the rocks. In the same locality tiny rivulets of heavily charged borax water issue from the base of ancient volcanoes and form in pools. Hundreds of acres of the purest borax are created here by the intense evaporation, and large fortunes have been made by Californians, who haul the product across the desert to the railroad station in Mojave.

Death Valley gets its name from its ghastly aspect, its desolation, and its deadly effect upon many a venturesome or ignorant mining prospector who has attempted to cross it in the summer, and who has died of thirst there. Among all the tales of grim hardships and dreadful suffering by emigrants to California before there were railroads west of the Missouri River, none is so pitiful as that of the party who got lost in Death Valley in 1849. There were five hundred emigrants in a caravan at Salt Lake City in August of that year. All were going to the gold fields of California. A division of opinion arose as to the safest and easiest trail across the trackless plains and the Sierras to the new El Dorado. Some two hundred of the party struck out for the southeast and found the old Santa Fe trail, which finally led them to southern California. The rest went plodding in a caravan across the wastes of southern Utah. There was nothing to show them the way through the lifeless, roasting valley, past the bald mountains, and then westward over the towering Sierras.

The caravan was in the land of thirst. For four months the starving, half-crazed men and women wandered hither and yon through the region of horror, seeking some pass between the mountains to the Pacific Ocean. Mirages led them vainly away from the trail. Their wagons fell apart from dryness, and horses daily fell under the withering heat. The oxen fell, and the stalwart men sickened and died in the camps. One day nine young men became separated from the main party, and years later their whitened bones were found in an extinct volcano crater, where they had crawled in their delirium and weakness.

For days the gaunt, weak men in the party went without food. The days were too hot to be out in the sun, and they confined their efforts to the nights for finding paths that might lead out of the roasting tomb.

At last eighty-two of the original party —now mere skeletons and so weak they could scarcely walk—found a passageway through the Funeral Mountains, and summoning all their little remaining strength, managed to get up and out of Death Valley into the cool and well-watered region of southern California, beyond the Sierras. One of the party, the Rev. J. W. Grier, weighed 188 pounds when he left Salt Lake City, and when he reached Los Angeles eighteen weeks later his weight was down to 92 pounds. Two of his brothers and one of his sisters-in-law died during the awful journey.

The story of the destroyer is not told without an account of Lieutenant Wheeler. Wheeler was a young officer fresh from West Point, who, immediately upon his graduation, in 1870, was assigned to a one-company post in western Nevada. After going through the loneliness of a Nevada winter in his little post, under direct command of his captain, a former West Point instructor, with whom he had quarreled at the academy, Wheeler came to an open personal breach with his captain in the spring and vowed henceforth he would speak no words to his superior other than those enjoined upon him by the military regulations. The captain, resenting his subordinate's silence, piled upon him every disagreeable, onerous and unnecessary duty conceivable.

In July, 1871, his captain ordered young Wheeler to take two men and search for the most direct path across Death Valley. Wheeler marched off in the direction of the mantrap, and when he arrived at the edge of the valley of destruction he sought a guide. A halfbreed Mexican and Indian volunteered for $20 to steer the party across. "Here is your money," shouted Wheeler, "and now I'll hold you to what you said. Start across."

The halfbreed, frightened at the earnestness of the man whom he had expected to hoodwink, began to back and fill on his offer. "Fix bayonets," ordered Wheeler to his two men. They did so. "Now march that man across that pit in front of you."

Toward nightfall the three started, the two soldiers with fixed bayonets, the guide in front of them. The next morning the two soldiers came back separately. One was utterly raving and permanently insane. The other, suffering from sun-stroke, drank a few drops from Wheeler's canteen, then lay down to rest in a boulder's shade. In the afternoon he was dead. Wheeler was never sane after his all-night vigil waiting by the side of Death Valley for his two men to come back. The guide wandered off from the two soldiers and was never seen alive again, although his wife identified his bones the following winter by means of a string of beads which he wore around his neck.

BORAX AND ITS PRODUCTION

Every man who went to California in the early '50s hoped to have a gold mine of his own, where he could settle down and become as wealthy as a national bank with little or no exertion. But unfortunately nature has not provided enough gold mines

TEAM OF TWENTY MULES HAULING BORAX FROM DEATH VALLEY.

Wagon wheels 7 feet and 5 feet in diameter; hubs 18 inches and 22 inches long; tires 8 inches wide, 1 inch thick; steel axles 3½ inches in diameter; bed 16 by 4 feet, 6 feet deep; weight 8,000 pounds; capacity 20,000 pounds; water tank wagon in rear.

to go all around. Consequently it was not long before the country was flooded with a tatterdemalion swarm of men, half miners, half tenderfeet, who, instead of being their own millionaires, were seeking an opportunity to relieve the ache under their belts. They were also bent on discovering something—that is what they had come for—and if it couldn't be a gold mine it might be a silver mine, a diamond drift or anything—they cared very little what. And that is how the vast borax deposits of the region came to be unearthed.

Previous to that time borax came mostly from Asia, and it was an expensive and little known commodity, sold from some small glass bottle on the apothecary's shelf. But within ten years after the time the disappointed gold miners found the deposits of borax it had become almost as common as table salt. Today the work of digging, transporting and refining it has grown to be a vast industry.

Borax was discovered out west by a man with an idea. Dr. John A. Veatch was a good deal of a geologist, and when he went west to look for gold and saw the vast stretches of parched and bitter alkaline plains he concluded from his knowledge of rock formations that borax could be found somewhere in the region. So he began to look for it deliberately, and one day early in 1856 his prospecting spade struck a small deposit in a dried lake bottom. It was not worth much, but it set a great crowd of miners peering about in the hope of finding better deposits. A few years after, some prospectors discovered that the bottoms of several California lakes were full of borax crystals, and from mining in the earth they began pumping water out of huge caissons set in the mud and then digging the earth up inside them and washing out the crystals. Although the borax thus found was not pure it could be used for manufacturing fluxes of various sorts, and the substance was greatly cheapened.

But the greatest discovery was made in that great, hot region, "Death Valley," in California. It was made in a most romantic way. In 1880 Aaron Winters lived with his wife, Rosie, in a gulch known as Ash Meadows, not far from the deadly mouth of Death Valley. He was so fond of his wife that he would not allow her to be long absent from him, although their little hut on the side of the mountain was 100 miles from the nearest neighbor in a wild, rugged, forsaken country. One day a desert tramp came along and stopped over night at the Winters home and told the hunter about the borax deposits of Nevada. When he went away Winters thought that he had seen deposits of the kind described on his explorations down into Death Valley. Accordingly the strange couple went together to make the search, having previously provided themselves with certain test chemicals, which, when combined with borax and ignited, would produce a green flame.

Having procured a piece of the substance which he believed to be borax, Winters and his wife waited for nightfall to make the test. How would it burn? For years they had lived like Piutes on the desert, entirely without luxuries and often wanting for the very necessities of life. Would the match change all that? Winters held the blaze to the substance with a trembling hand, then shouted at the top of his voice: "She burns green, Rosie! We're rich! We're rich!"

They had found borax. The mine was sold for $20,000, and Winters took Rosie to a ranch in Nevada, but she could not stand prosperity, and a few years later she died.

Borax crystals are no longer dug even in California and Nevada, because the substance has been found in much more convenient form for refining in combination with lime. In this state it occurs in mountain strata, and it has to be mined exactly like silver or copper, but the cost is far greater. In the first place the region is totally destitute of water and fuel of any kind, both of which have to be transported long distances. Indeed, so dry is the country that workmen frequently go insane, and both men and horses perish miserably from thirst if water is not kept constantly at hand.

Besides all of the difficulties, accentuated by the necessity of having the finest machinery and skilled labor, all of the ore has to be transported for scores of miles over the desert before it reaches the railroads.

This work is mostly done by the aid of huge wagons with broad-tire wheels, weighing about 8,000 pounds each and having a carrying capacity of 20,000 pounds. To each wagon several teams of horses and mules are hitched, and the long trip across the desert and through perilous mountain passes begins. One of the wagons in the train is provided with a tank of water, for it would be impossible to travel without it. The drivers are rugged, fearless men, partaking of the characteristics of the country. They can swear as artistically at their mules as any teamsters in the world, and can drink as much whisky, but they are withal a hearty, hospitable set.

On reaching the railroad the ore from the great wagons is loaded on box-cars and transported several hundred miles to the refineries, one of the largest of which is located on San Francisco bay. Here the rough, broken masses of brown rock are unloaded at the door of a long, shed-like building, and the process which is to transform it into beautiful crystals of borax is soon under way. The crude material first passes between the jaws of a rock-breaker, from which it comes out in small, pebble-like pieces. Then it goes into the hopper of a machine not unlike an old-fashioned buhrstone flour-mill, where it is thoroughly pulverized. It now has about the appearance of buckwheat flour, and is ready for the final process of separating the borax.

To accomplish this it is thrown into a great steam chest or pressure boiler, called a digester, and carbonate soda in a fixed proportion is added. When heat is applied in the furnace below and the mass within the boiler is churned with plungers, the digestion in the big stomach begins. The carbonic acid in the carbonate of soda suddenly deserts the soda, and unites after many spurts and fizzings with the lime in the borax ore, which is nothing more than borate of lime. Then the boracic acid in the ore finds more attractive company with the deserted soda, and in the united state becomes bichlorate of sodium, which is only the aristocratic name for borax. It is still in solution, however, and as soon as it cools off it is run into great vats filled with a myriad of steel rods. On these rods the borax crystallizes just as rock candy clings to a string. When the borax is all out of solution the rods are withdrawn from the water, and the crystals of borax scraped off. By dissolving them again and recrystallizing, a purer form of borax is secured. When powdered it is ready for the market.

Borax is used in hundreds of different ways, and, as people become more familiar with it, the demand grows greater. The great packers consume large quantities in the dry packing of meat for export, and iron and glass workers and enameling factories use it constantly as a flux.

But the greatest portion of the whole amount is consumed in the household. Not being a patented commodity it sells at its real market value, which is about 7 cents a pound. Its alkaline properties make it valuable for softening hard water, and for cleaning woodwork. Almost every housewife is familiar with it. It is also used in various ways as a medicine and in the toilet. It is also said to be death on insects of all kinds.

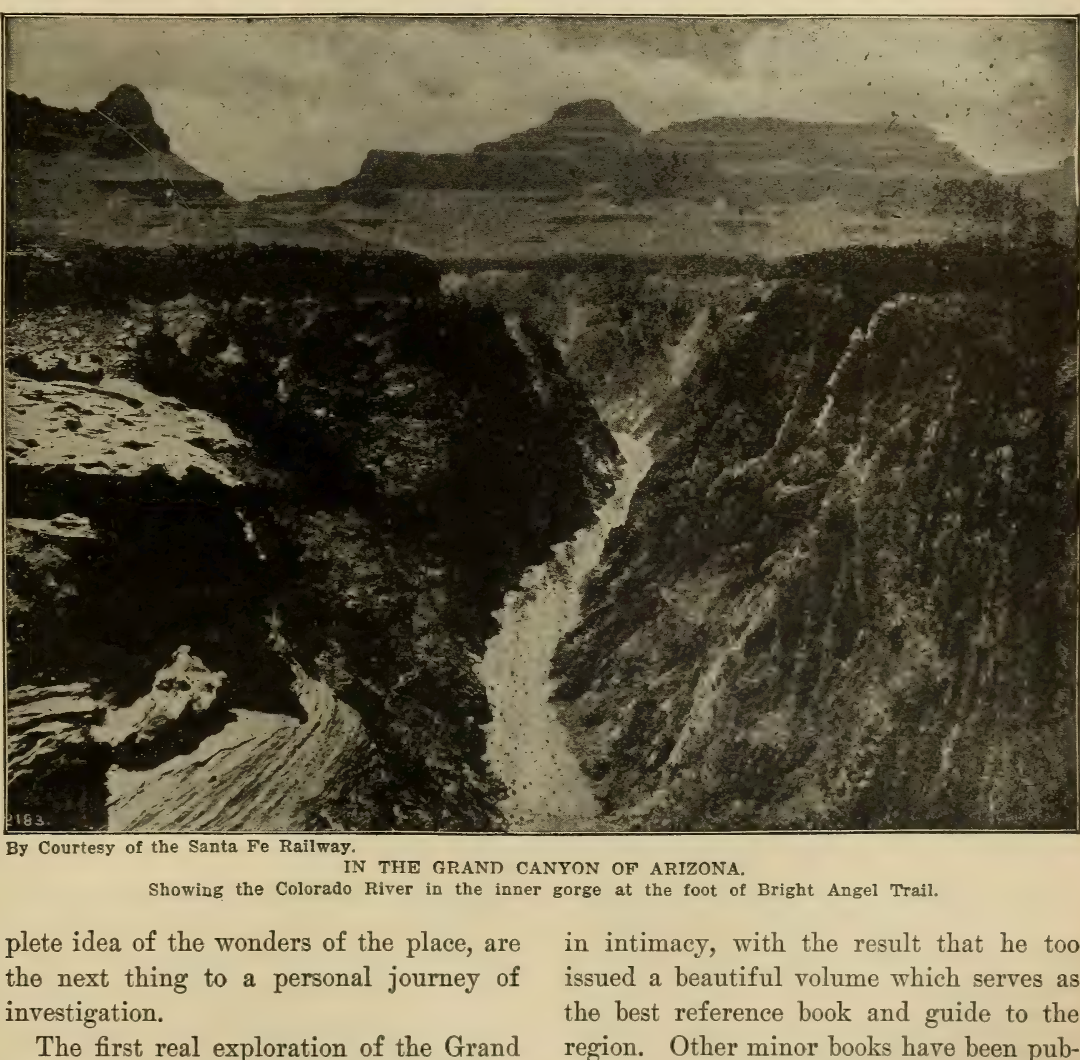
An artificial ivory, called lactitis, is now made of skimmed milk coagulated, mixed with borax, and submitted to tremendous pressure. This substance is used for combs, billiard balls and other articles.

THE GRAND CANYON OF ARIZONA

Travelers agree that the Grand Canyon of Arizona, formed where the Colorado river has carved a great channel for itself across the northwestern part of that territory, is the most wonderful of all scenic displays in the world. For many years this amazing chasm was unknown to white men or unvisited by them, but in more recent times trails were cut and then roads, and now a railway has been built until it may be viewed with entire comfort and ease by any one who takes the transcontinental journey by way of the railway which reaches the brink of the canyon. As access became easier and travelers began to increase in number, the beauties and grandeur of the place became better known.

To-day it is the favored destination of geologists, artists and explorers who find no other scene so worthy of their attention in all the world. Some of the most eminent literary men and graphic lecturers have journeyed thither, and their accounts, although falling far short of giving a complete idea of the wonders of the place, are the next thing to a personal journey of investigation.

The first real exploration of the Grand Canyon was made by Major J. W. Powell in 1869, and since that time no other exploration has equaled his journey in daring or surpassed it in achievements. He has published a book of great value, descriptive of that exploration and others which he made in succeeding years. The artist George Wharton James, some years later, lived for a considerable period on the brink of the Canyon and in its depths, studying its varied moods and painting it in intimacy, with the result that he too issued a beautiful volume which serves as the best reference book and guide to the region. Other minor books have been published, including artistic and valuable guides issued by the railway company. Magazine articles have been contributed by such authors as C. F. Lummis, Harriet


By Courtesy of the Santa Fe Railway.
IN THE GRAND CANYON OF ARIZONA.
Showing the Colorado River in the inner gorge at the foot of Bright Angel Trail.

Monroe, Joaquin Miller, Hamlin Garland, Charles Dudley Warner and others. Poets, too, as well as painters and photographers, have lent their art in the effort to interpret and picture the glories of the Canyon. It is a subject of never failing interest and one to which no one has yet done justice.

Few men have known the Grand Canyon of Arizona better than did C. A. Higgins, who camped in it, traveled all its trails, and studied it in every one of its changing conditions. An artist by temperament, he saw the spendid scene in all its significance, and with a graphic pen told what he saw in modest fashion. The account which follows is condensed from an article by Mr. Higgins.

"The Colorado is one of the great rivers of North America. Formed in southern Utah by the confluence of the Green and Grand, it intersects the northwestern corner of Arizona, and, becoming the eastern boundary of Nevada and California, flows southward until it reaches tidewater in the Gulf of California, Mexico. It drains a territory of 300,000 square miles, and, traced back to the rise of its principal source, is 2,000 miles long. At two points, Needles and Yuma on the California boundary, it is crossed by a railroad. Elsewhere its course lies far from Caucasian settlements and far from the routes of common travel, in the heart of a vast region fenced on the one hand by arid plains or deep forests and on the other by formidable mountains.

"The early Spanish explorers first reported it to the civilized world in 1540, two separate expeditions becoming acquainted with the river for a comparatively short distance above its mouth, and another, journeying from the Moki Pueblos northwestward across the desert, obtaining the first view of the Big Canyon, failing in every effort to descend the canyon wall, and spying the river only from afar. Again, in 1776, a Spanish priest traveling southward through Utah struck off from the Virgin River to the southeast and found a practicable crossing at a point that still bears the name 'Vade de los Padres.'

"For more than eighty years thereafter the Big Canyon remained unvisited except by the Indian, the Mormon herdsman and the trapper, although the Sitgreaves expedition of 1851, journeying westward, struck the river about 150 miles above Yuma, and Lieutenant Whipple in 1854 made a survey for a practicable railroad route along the thirty-fifth parallel, where the Santa Fe railway has since been constructed.

"The establishment of military posts in New Mexico and Utah having made desirable the use of a waterway for the cheap transportation of supplies, in 1857 the War Department dispatched an expedition in charge of Lieutenant Ives to explore the Colorado as far from its mouth as navigation should be found practicable. Ives ascended the river in a specially constructed steamboat to the head of Black Canyon, a few miles below the confluence of the Virgin River in Nevada, where further navigation became impossible; then, returning to the Needles, he set off across the country toward the northeast. He reached the Big Canyon at Diamond Creek and at Cataract Creek in the spring of 1858, and from the latter point made a wide southward detour around the San Francisco Peaks, thence northeastward to the Moki Pueblos, thence eastward to Fort Defiance, and so back to civilization.

"That is the history of the explorations of the Colorado up to forty years ago. Its exact course was unknown for many hundred miles, even its origin being a matter of conjecture. It was difficult to approach within a distance of two or three miles from the channel, while descent to the river's edge could be hazarded only at wide intervals, inasmuch as it lay in an appalling fissure at the foot of seemingly impassable cliff terraces that led down from the bordering plateau; and to attempt its navigation was to court death. It was known in a general way that the entire channel between Nevada and Utah was of the same titanic character, reaching its culmination nearly midway in its course through Arizona.

"In 1869 Major J. W. Powell undertook the exploration of the river with nine men and four boats, starting from Green River City, on the Green River, in Utah. The project met with the most urgent remonstrance from those who were best acquainted with the region, including the Indians, who maintained that boats could not possibly live in any one of a score of rapids and falls known to them, to say nothing of the vast unknown stretches in which at any moment a Niagara might be disclosed. It was also currently believed that for hundreds of miles the river disappeared wholly beneath the surface of the earth.

"Powell launched his flotilla on May 24, and on August 30 landed at the mouth of the Virgin River, more than one thousand miles by the river channel from the place of starting, minus two boats and four men. One of the men had left the expedition by way of an Indian reservation agency before reaching Arizona, and three, after holding out against unprecedented terrors for many weeks, had finally become daunted, choosing to encounter the perils of an unknown desert rather than to brave any longer the frightful menaces of that Stygian torrent. These three, unfortunately making their appearance on the plateau at a time when a recent depredation was colorably chargeable upon them, they were killed by Indians, their story of having come thus far down the river in boats being wholly discredited by their captors.

"Powell's journal of the trip is a fascinating tale, written in a compact and modest style, which, in spite of its reticence, tells an epic story of purest heroism. It definitely established the scene of his exploration as the most wonderful geological and spectacular phenomenon known to mankind, and justified the name which had been bestowed upon it—the Grand Canyon, sublimest of gorges, Titan of chasms. Many scientists have since visited it, and, in the aggregate, a large number of unprofessional lovers of nature; but until a few years ago no adequate facilities were provided for the general sight-seer, and the world's most stupendous panorama was known principally through report, by reason of the discomforts and difficulties of the trip, which deterred all except the most indefatigable enthusiasts. Even its geographical location is the subject of widespread misapprehension.

"Its title has been pirated for application to relatively insignificant canyons in distant parts of the country, and thousands of tourists have been led to believe that they saw the Grand Canyon, when, in fact, they looked upon a totally different scene, between which and the real Grand Canyon there is no more comparison 'than there is between the Alleghenies or Trosachs and the Himalayas.' There is but one Grand

Canyon. Nowhere in the world has its like been found.

"Stolid, indeed, is he who can front the awful scene and view its unearthly splendor of color and form without quaking knee or tremulous breath. An inferno, swathed in soft celestial fires; a whole chaotic underworld, just emptied of primeval floods and waiting for a new creative word; eluding all sense of perspective or dimension, outstretching the faculty of measurement, overlapping the confines of definite apprehension; a boding, terrible thing, unflinchingly real, yet spectral as a dream. The beholder is at first unimpressed by any detail; he is overwhelmed by the ensemble of a stupendous panorama, a thousand square miles in extent, that lies wholly beneath the eye, as if he stood upon a mountain peak instead of the level brink of a fearful chasm in the plateau, whose opposite shore is thirteen miles away. A labyrinth of huge architectural forms, endlessly varied in design, fretted with ornamental devices, festooned with lacelike webs formed of talus from the upper cliffs, and painted with every color known to the palette in pure transparent tones of marvelous delicacy. Never was picture more harmonious, never flower more exquisitely beautiful. It flashes instant communication of all that architecture and painting and music for a thousand years have gropingly striven to express.. It is the soul of Michael Angelo and of Beethoven.

"A canyon, truly, but not after the accepted type. An intricate system of canyons, rather, each subordinate to the river system in the midst, which in its turn is subordinate to the whole effect. That river channel, the profoundest depth, and actually more than 6,000 feet below the point of view, is in seeming a rather insignificant trench, attracting the eye more by reason of its somber tone and mysterious suggestion than by any appreciable characteristic of a chasm. It is perhaps five miles distant in a straight line, and its uppermost rims are nearly 4,000 feet beneath the observer, whose measuring capacity is entirely inadequate to the demand made by such magnitudes. One can not believe the distance to be more than a mile as the crow flies, before descending the wall or attempting some other form of actual measurement.

"Mere brain knowledge counts for little against the illusion under which the organ of vision is here doomed to labor. Yonder cliff, darkening from white to gray, yellow and brown as your glance descends, is taller than the Washington monument. The Auditorium in Chicago would not cover one-half its perpendicular span. Yet it does not greatly impress you. You idly toss a pebble toward it, and are surprised to note how far the missile falls short. By and by you will learn that it is a good half mile distant, and when you go down the trail you will gain an abiding sense of its real proportions. Yet, relatively, it is an unimportant detail of the scene. Were Vulcan to cast it bodily into the chasm directly beneath your feet, it would pass for a boulder, if, indeed, it were discoverable to the unaided eye.

"Yet the immediate chasm itself is only the first step of a long terrace that leads down to the innermost gorge and the river. Roll a heavy stone to the rim and let it go. It falls sheer the height of a church or an Eiffel Tower, according to the point selected for such pastime, and explodes like a bomb on a projecting ledge. If, happily, any considerable fragments remain, they bound onward like elastic balls, leaping in wild parabola from point to point, snapping trees like straws; bursting, crashing, thundering down the declivities, until they make a last plunge over the brink of a void; and then there comes languidly up the cliff sides a faint roar, and your boulder that had withstood the buffets of centuries lies scattered as wide as Wycliffe's ashes, although the final fragment has lodged only a little way, so to speak, below the rim. Such performances are frequently given in these amphitheaters without human aid, by the mere undermining of the rain, or perhaps it is here that Sisyphus rehearses his unending task. Often in the silence of the night some tremendous fragment has been heard crashing from terrace to terrace with shocks like thunder peal.

"The spectacle is so symmetrical, and so completely excludes the outside world and its accustomed standards, it is with difficulty one can acquire any notion of its immensity. Were it half as deep, half as broad, it would be no less bewildering, so utterly does it baffle human grasp."

Within the last few years a hotel has been built on the very verge of the canyon, and a railway has been built which connects directly with the transcontinental trains at the station of Williams, Arizona. This makes the journey available for any traveler, and since the train service to the rim of the canyon was established, visitors have multiplied rapidly. This is one of nature's marvels which can not be spoiled by the arrival of numbers or the building of hotels, so enormous is it, and with the Colorado river still roaring in its channel, continuing the mighty work of erosion, we may presume that the Grand Canyon of Arizona will remain as long as the world lasts, carving a deeper gorge, century by century, inspiring profound emotions in the beholders after generations have passed.

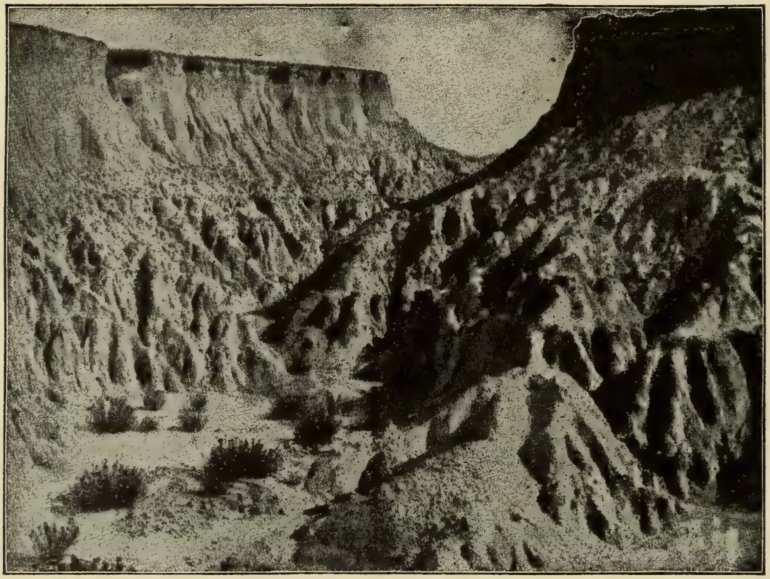
THE DAKOTA "BAD LANDS"

Hardly more than half a century ago, some of our greatest statesmen earnestly opposed any legislation or expenditure for the development or the exploration of the great region of the United States west of the Mississippi river. Even Daniel Webster, when the first transcontinental railway was under discussion in Congress, declared that he would never vote to appropriate one cent to connect the east with the Pacific coast, across thousands of miles of utterly worthless, uninhabitable desert country. A few government exploring parties had traversed the great west and reported on it, and accounts of various regions had come from daring pioneers and explorers who had forced their way beyond the frontier, out of sheer joy of life in the wilderness. This was virtually the extent of knowledge of what is now the prosperous and populous land of the west.

Such areas as what we know as the "Bad Lands" of Dakota, the "Terres Mauvaises" of the French voyageurs, went far to justify the bad name which was ascribed to the entire country before it was realized that these peculiar formations were but a small portion of the whole. We can well spare a little of the vast domain which our country holds between the Mississippi and the Pacific to display the varied works of nature in different humors. The mountain ranges, the canyons, the waterfalls, the glow of color on the rock walls of cliff and gorge

—these all have their value as truly as do the wide and fertile prairies or the mighty forests. The Yosemite Valley, the Yellowstone National Park, the Grand Canyon of Arizona, the Garden of the Gods and the Bad Lands of Dakota are wonderful and beautiful instances of the variety of nature's impulses and works when forces are unrestrained.

The Bad Lands occupy a large part of southwestern South Dakota, between the Missouri river and the Black Hills. They are tracts of barrenness, reminders of a prehistoric age, and of special interest to the geologist, as the place of deposit for petrifactions, which they have hidden away for ages under as forbidding ground as can well be imagined. They are a picture of desolation, seamed and gashed by the elements, ribbed and trussed by strata of fossils great and small, which seem to hold the sterile soil together, while cactus and sage-brush are the only visible forms of vegetation. The richness of the fossil beds has attracted the attention of many scientific expeditions since access to this strange region became easy. The great universities of the east and west send parties of their geological students here every year, under the leadership of their professors, to delve into the mysteries of the past as they are indelibly recorded in the eternal rock.



IN THE DAKOTA "BAD LANDS."

But the scientific visitor is not the only one well repaid by a journey to the Bad Lands. Nature's freakish humor here has made a multitude of interesting things even in the worst of the barrenness and desolation. Grotesque carvings in the rocks; the tangle of canyons, cliffs and buttes; the glow of varied color that meets the eye; the pure air and the beautiful sunsets, all unite to make the region one of great interest even to the layman.

Historically the Bad Lands are closely associated with the Black Hills, which are their neighbors. During the period of frontier warfare, when the gold discoveries around Deadwood had stimulated the invasion of white men to violate their treaties with the Indians, these regions were citadels for the savages. Among the labyrinths of the hills and gulches they could evade pursuit or plan their raids to best advantage. Custer, Harney, Miles and the other great campaigners of the west found their task a difficult one to conquer the red enemy in such a country and establish him in peace on the reservations to the east of the Black Hills. Here was where Sitting Bull fought some of his greatest fights. Now the Bad Lands and the Black Hills alike are regions of peace, the latter busy with mining and commerce, the former left in virtual solitude except for the visits of interested geologists and tourists.

CRATER LAKE, AN OREGON WONDER

The great west has furnished the world with some of the most marvelous of the works of nature. Stupendous canyons and gorges, big trees thousands of years old, cataracts hundreds of feet in height, mountain ranges, plains, deserts, salt lakes, geysers and other natural objects in endless variety, attract the traveler from afar. Little known, and difficult of access because of its distance from a railway and its rugged surroundings, is Crater Lake, in the state of Oregon, one of the most wonderful of all the sights beheld by the energetic traveler.

Crater Lake is situated in the heart of the mountains of southwestern Oregon, about seventy miles from the California line, and twice as far from the Pacific ocean. It is necessary to drive eighty miles from the nearest railway station to reach it, and though the highway is a good military road running to Fort Klamath on the Klamath Indian reservation, not many travelers make the journey. It was discovered on June 12, 1853, by a party of prospectors. The Indians of southern Oregon have known of it for ages, but until recent years none have seen it, for the reason that a tradition, handed down from generation to generation, described it as the home of myriads of sea-devils, and it was considered certain death for any brave even to look upon it. The lake was first explored in 1886 by officers of the United States geological survey. W. G. Steel of Portland, Oregon, long an officer of the Oregon Alpine Club, accompanied the expedition to the lake, which he had visited the previous year, and after a period of exploration wrote an account of the wonders of the place, from which the following facts have been drawn.

The lake is almost egg-shaped, ranging northeast and southwest, and is seven miles long by six in width. The surface of the water is 6,251 feet above sea level, and it is completely surrounded by a wall of cliffs from 500 to more than 2,000 feet high, which are scantily covered with coniferous trees. At times, when gazing from the surrounding wall, the skies and cliffs are seen perfectly mirrored in the smooth and glassy surface over which the mountain breeze creates scarce a ripple, and it is with great difficulty the eye can distinguish the line dividing the cliffs from their reflected counterfeits.

To the southwest is Wizard Island, 845 feet high, circular in shape, and slightly covered with timber. In the top of the island is a depression or crater—the Witches' Cauldron—100 feet deep and 475 feet in diameter. This was evidently the last smoking chimney of a once mighty volcano. The base of the island is covered with very heavy and hard rocks, with sharp and unworn edges, over which but few visitors have clambered. Farther up are deep beds of ashes, and light, spongy rocks and cinders, giving evidence of intense heat. Within the crater, as without, the surface is entirely covered with volcanic rocks.

Directly north of the island is Llao Rock, a grand old sentinel, reaching to a perpendicular height above the surface of the lake of more than 2,000 feet. From the top of it you can drop a stone and it will grow smaller and smaller, until your head begins to swim and you see the stone become a mere speck and fade entirely from view; and at last, nearly half a mile below, it strikes the unruffled surface of the water and sinks forever from sight in the depths of an almost bottomless lake.

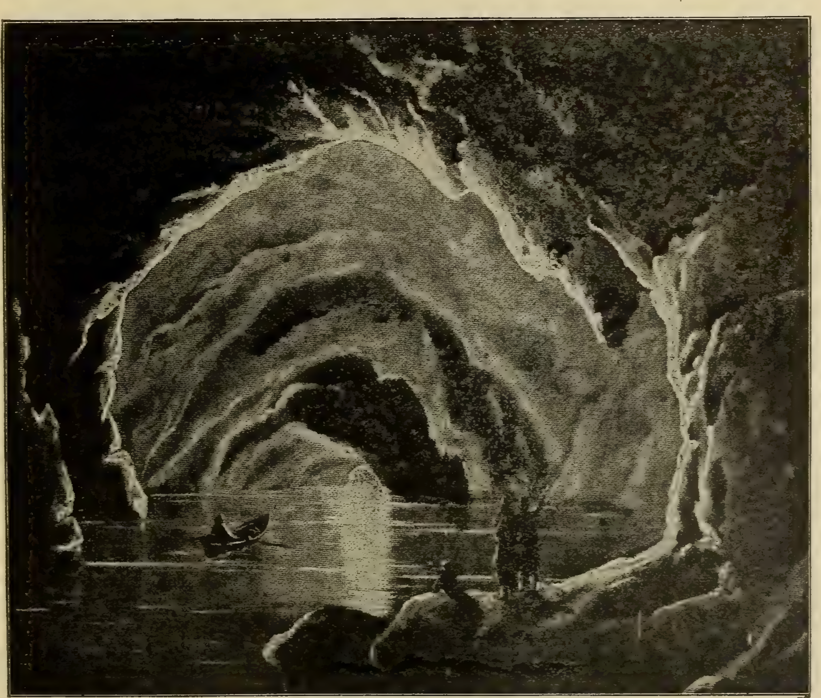
There is probably no other point of interest in America that so completely overcomes the ordinary Indian with fear as Crater Lake. From time immemorial, no power has been strong enough to induce him to approach within sight of it. For a paltry sum he will engage to guide you thither, but before you reach the mountain top will leave you to proceed alone. To the savage mind it is clothed with a deep veil of mystery, and is the abode of all manner of demons and unshapely monsters.

When the exploration of the lake was made, boats had to be built in Portland, Oregon, transported 340 miles by rail, and then carried to the lake on wagons, 100 miles into the mountains, where they were launched over sheer cliffs 1,000 feet high. Soundings were made all over the lake, and the greatest depth found was 2,008 feet, while 600 feet was the depth of the shallowest water. The shore is entirely encircled with precipitous cliffs, coming down at but one place as low as 500 feet above the water. On one side, however, it was possible to make trails to the water's edge. Grottoes, bays, islands, cliffs and many strange formations help to magnify the beauty of the scene.

In closing his account of this phenomenon, Mr. Steel says in part: "Crater Lake is but a striking memento of a dead past. Imagine a vast mountain, six by seven miles through at an elevation of 8,000 feet, with the top removed and the inside hollowed out and filled with the clearest water in the world to within 2,000 feet of the top; then place a round island in one end, 845 feet high, in which dig a circular hole tapering to the center like a funnel, 100 feet deep and 475 feet in diameter, and you have a perfect representation of Crater Lake. The surface of the water is twenty-three feet higher than the summit of Mount Washington. What an immense affair it must have been, ages upon ages ago, when, long before the hot breath of a volcano soiled its hoary head, standing as a proud monarch, with its feet upon earth and its head in the heavens, it towered far, far above the mountain ranges, aye, looked far down upon the snowy peaks of Hood and Shasta, and snuffed the air beyond the reach of Everest. Then streams of fire began to shoot forth, great seas of lava were hurled upon the earth beneath. The elements seemed bent upon establishing hell upon earth, and fixing its throne upon this great mountain. At last the foundations gave way and it sank forever from sight, down, down, down, deep into the bowels of the earth, leaving a great black, smoking chasm, which succeeding ages filled with pure, fresh water, giving to our day and generation one of the most beautiful lakes within the vision of man."

GREAT CAVES OF THE WORLD

It will be long before the wonders of nature are all revealed to man, for in addition to those which tempt travelers to remote and almost inaccessible parts of the world, there are others continually being discovered beneath the surface of the earth. Caverns have always had a mysterious interest wherever discovered. Their darkness, the unknown depths to which they may lead, the dangers of exploration in them, all appeal strongly to the seeker after the marvelous. They are almost always the result of the action of water. Those upon the seashore are hollowed out by the action of the waves, either by means of the constant battering of the surf, or the dissolving of some of the elements in the rock. Those which are found inland, among the mountain ranges or elsewhere, come in like fashion from the percolation of water from the rocks above, and the gradual chemical processes that take place.



BLUE GROTTO OF CAPRI, ITALY.

The most famous cavern of the former class is the Blue Grotto of Capri. This is found in the island of Capri in the Mediterranean Sea, not far from Naples. It can be reached only when the water is comparatively calm, by small boats which follow around the rocky coast and pass directly into the grotto under an arch which spans the channel. Once within, a succession of vaulted arches forms the roof of the grotto, which extends for a considerable distance into the island. Of course the sea within is calm, except when storms outside send their waves through the arched entrance and make the passage impossible. The rocks which form the roof are of a peculiarly beautiful blue in color and covered with glittering crystals. The light which passes through the entrance and reflects from the surface of the water seems to be multiplied many times, and gives the grotto a striking beauty. When artificial lights are used at night or to heighten the effect by day, the color effects are magnificent and the fame of the grotto is well justified.

The largest cavern commonly visited and conveniently open to tourists, if not the largest in the world, is Mammoth Cave in Kentucky. Two hundred miles of avenues, passages and vaulted chambers are opened to visitors and it is well known that the cave is by no means fully explored. From a descriptive sketch by Dr. R. Ellsworth Call, a careful student of the Mammoth Cave and its conditions, the following facts of interest have been selected:

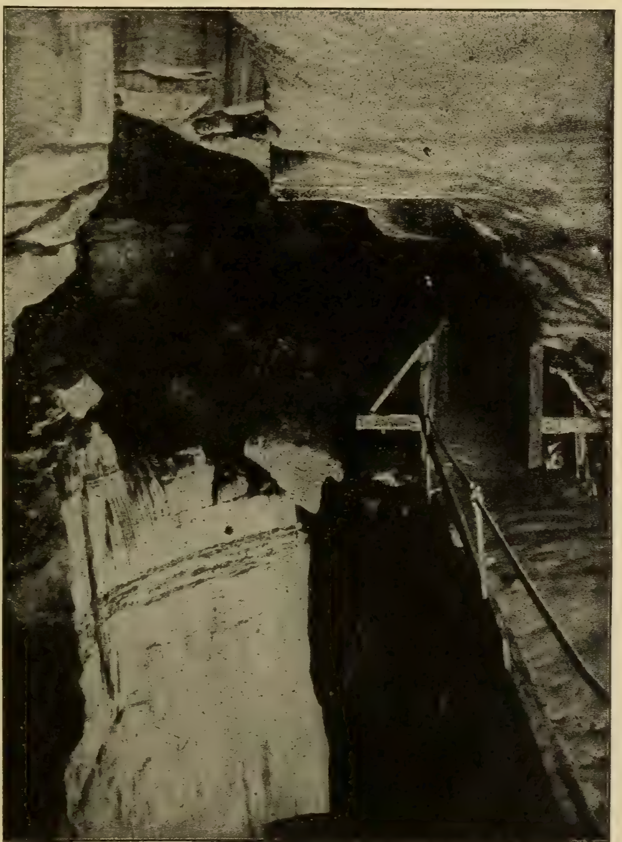
Mammoth Cave owes its discovery to an accident, so the story goes, which happened in the year 1809. It is the old story of a hunter and a bear, the pursuer and the pursued. The bear was wounded and sought its lair in a vain endeavor to escape. Hutchins, for such was the hunter's name, lost no time in acquainting others with this important discovery, and Mammoth Cave became both a fact of history and science. It is strange to relate that its first exploitation was connected with simply mercenary motives and that saltpeter intended for use in gunpowder, and connected with the War of 1812, was the incentive that led to more complete examination. The men who mined the salt soil, rich in niter, are the men who first gave to the outside world any reliable information of the great extent of this now famous world's wonder.

Within the cavern the changes which have occurred since the days of saltpeter are few. There is only that change which comes from wider acquaintance with the windings of the chambers into those that are new and formerly unknown, a change which makes the visitor despair of ever fully unraveling all the passages and crevices along which he journeys or through which he crawls. Bridges over rivers and stairs leading up impassable cliffs, the iron guards along places of danger, alone tell the visitor of the work of man.

It is impossible to mention all the objects of interest to visitors in this most gigantic cavern. The Fairy Grotto, the Gothic Avenue, Martha's Vineyard, Crystal Avenue, Echo River, Gorin's Dome, the Giant's Coffin, the Corkscrew, the Standing Rocks, the Rotunda, Audubon's Avenue, Spark's Bower, Lover's Leap, the Ruins of Karnak, Shelby's Dome, and a multitude of other special sights are shown to every visitor.

The Echo River is one of the most remarkable features in this most remarkable group of wonders. Only a small portion of its whole course is accessible to visitors, but this part is truly wonderful. At times the river flows with almost imperceptible current, while at other times it fills quite to the top the great River Hall, blotting out the Dead Sea and the River Styx, both of which are really parts of the underground stream. It is traversed by boats for a distance of half a mile, and the ride over its clear waters is one of the unique experiences of the world. Nowhere else can it be duplicated. The voyager passes under a low arch for a short space, and then the roof rises rapidly away from the water and he enters upon his subterranean water journey in real fact. Nearly all the river is one vast resonator. Its branching avenues and side crevices, its lofty roof of limestone rock, its ancient battlemented shores, all serve as reflectors of every sound, no matter how slight, and send it back intensified a thousand times, with its roughness blended into one sweet volume of glorious harmony.

Perhaps visitors to Mammoth Cave are most impressed with the lofty domes and deep pits which are found in some portions of this underground domain. Of those that are accessible to the visitor without great danger and fatigue, the best known are Gorin's Dome, the Bottomless Pit, Mammoth Dome, Napoleon's Dome, the Maelstrom and Scylla and Charybdis, all but two of which are situated in that intricate and wonderful portion called the Labyrinth. The first named is viewed through a natural circular opening in the wall, quite three-fourths of the way from the bottom. Illuminated by the guide from a point still above that at which the visitor is situated, the effect through the brilliant lights on the walls beyond, white as alabaster, folded in a thousand curious and fantastic forms, is indescribably grand and impressive. Coupled with the great size of the space, everywhere shading off into infinite gloom, is the roar of falling water or the splash of Lilliputian cascades if seen in the dry season. Below, but beyond observation, is a portion of Echo River into which from a station high above it is possible to throw stones, the fall of which awakens ten thousand sounds and echoes. Stalactite matter of purest white, lends a variety to the vertical walls. Not far away is the Bottomless Pit, and above it, rising sheer to the topmost level of the cavern, is Shelby's Dome. Its bottom, for notwithstanding its name it has one, is nearly two hundred feet below the level at which the observer stands.



THE BOTTOMLESS PIT, MAMMOTH CAVE.

Of all the pits which the visitor sees, that called Mammoth Dome is the largest and most impressive. From the top to the bottom the distance is nearly 280 feet, while at the end the Ruins of Karnak stand out in bold relief. These giant columns closely resemble the works of art of some long lost underground race.

Far from the Mammoth Cave of Kentucky, in the Black Hills of South Dakota, is another great cavern called the Wind Cave, which was discovered in 1877. Three thousand rooms have been discovered in it, varying in size from an ordinary bedroom to more than three acres, and over a hundred miles of passages have been explored without finding the end. Out of fourteen different routes, three have been opened to the public. Its geological formation is a puzzle to the student, as the formations have no parallel in other well-known caves, and seem to upset many well-established theories. Another mystery is the fact that at times the wind blows into the cave at the mouth and at other times blows out, but when blowing a gale it is felt only at the entrance.

Other caverns, large and small, have been discovered in the United States, including some of great interest in Colorado, and others in New Mexico. This country is not unique in such works of nature, but we seem to have by far the largest and most beautiful of all, and Mammoth Cave is by all means the most famous and the most commonly visited.

THE LAND OF THE MIDNIGHT SUN

The entire Arctic and Antarctic regions may be properly called the "Land of the Midnight Sun," for at the poles darkness rules for six months in the year, and just within the Arctic and Antarctic circles the sun may actually be seen at midnight. In practice, however, the north coast of Norway has become known by this phrase, for it is the most accessible place where the striking and picturesque phenomenon of sunshine at midnight can be seen. To reach the polar region elsewhere means a genuine Arctic voyage, attractive enough for the explorer, but quite out of the question for the casual tourist. To see the midnight sun off the coast of Norway, however, it is necessary only to buy a ticket and board one of the fine vessels, built like great yachts, which make a voyage to the North Cape and beyond every summer, from various European ports. The entire coast of Norway, skirted during these voyages, is characterized by bold and beautiful scenery, with great cliffs, deep inlets or fjords, and mammoth glaciers. Waterfalls tumble from the heights above, and the life of the people in the little Norwegian villages is no less picturesque than the natural beauties of the region.

Hammerfest, the most northern town of Europe, is the metropolis of the Arctic regions, and the port from which many polar exploring expeditions have taken their departure from civilization. During the two summer months, the sun remains continually above the horizon and the climate becomes very warm. Even in the winter, when darkness rules for two months, the weather is mild enough to permit the fisheries to be carried on as usual.

Then comes the North Cape, the extremest point in Europe, looking out over the Arctic Ocean. It is a dark, gray, slate rock, furrowed with deep clefts, rising nearly 1,000 feet abruptly from the sea. The traveler lands on the east side of the Cape, where a path has been constructed over the green, mossy slope to the top. Here the hour of midnight is awaited, when the northern sun, creeping along the horizon, and the immeasurable ocean in apparent contact with the skies, form the grand outlines in the sublime picture presented. With the North Cape ends the island belt, and the coast is washed directly by the sweeping waves of the Arctic Ocean. Beyond is the region of mystery, which is gradually being penetrated year after year, a few miles at a time, by those persevering explorers who are seeking the pole.

Says an appreciative writer, speaking of conditions in this far-northern region: "The polar night in the highest latitudes begins in October and lasts until nearly February. Then the sun appears each day, at first for a moment only, and then longer and longer, till by May it does not set at all. For three months there is perpetual day. For three months more the days rapidly shorten. By the time October is past, darkness is on again and the Pole is wrapped in long night and inclement winter. Nature then takes on its fantastic ice forms. Freezing is sudden and persistent. Storms are violent and of long duration. The seas are ice-bound, the rivulets locked in silence, the land covered with an immense depth of snow. Everything living has been making preparation for this. The sea animals, except the few hardy enough to brave the ice-covered depths, have departed. The birds and many land animals have moved southward, where food and shelter are surer. The people, all Eskimos, have given up their seal hunts in the extreme north, and have built their winter huts out of ice blocks in some favored nook, or contiguous to some well-known resort of the seal or walrus. In these they doze away their tedious winter existence, warmed and lighted by lamps burning fat, and fed by blubber, which is mostly eaten raw. If they open for a moment a window or doorway, the confined air of their huts is immediately precipitated in the form of a shower of snow.

THE MIDNIGHT SUN, OFF THE NORTH COAST OF NORWAY.

"When the sun reappears, to shine perpetually for the summer months, the change is great. Weak as its rays are, they constantly serve to break up the strongest ice fields and loosen the stoutest packs. There is a commotion in the frozen seas more dangerous than a tempest. The ice groans and labors. It cracks with thunderous reports. Huge mountains topple and fall. And then, when fields and floes are sufficiently broken to obey the currents, whole areas, large as a state, float away, bearing unlucky ships or whatever they may have imprisoned. By the end of June the ice of the Arctic sea is commonly divided and scattered. Then there is excessive moisture everywhere, and thick fogs hang over land and water, almost incessantly. But in July the water no longer chills the atmosphere and precipitates moisture. It is a bright month and in sheltered spots the heat may become excessive. This heat, together with the absence of man and the loneliness of nature, is taken advantage of by myriads of animals from the air, land and sea. They congregate in the cliffs to lay eggs and hatch broods, gather in quiet nooks to bring forth their young, or swarm in shoal waters to spawn.

"Do not expect to find much verdure in the Arctic region. Even before you enter the Arctic circle you will notice that trees have been getting smaller in size, and that only the hardier ones, as the birches and pines, exist at all. Passing on, the trees disappear entirely except in sheltered spots. About the Pole is an immense zone destitute of all trees. The only vegetation consists of lichens, mosses and a few varieties of stunted grasses, with here and there, in protected places, a trailing plant or two. Though nature generally wears a more stern and forbidding aspect on advancing toward the Pole, yet these high latitudes have many beauties of their own. Nothing can exceed the beauties of an Arctic sunset, clothing the snow-clad mountains, fantastic ice shapes and clear skies with all the glories of color, nor can anything be more serenely beautiful than the clear, starlit night, illuminated by the moon, which is seen like a shield of burnished silver through the highly rarefied air, and circles for days around the horizon, never setting until she has run her long course of brightness.

"But of all the magnificent spectacles that relieve the gloom of the Arctic winter, there is none so gorgeously resplendent as the Aurora Borealis. It bursts with the suddenness of a storm, as indeed it is an electrical storm, upon the northern horizon, and speeds to the zenith in a great arch of flame, heaving and waving to and fro, sending out flashing beams, playing the tricks of meteors in color and velocity. Then there is a gathering of splendors in the center of the magnificent arch. The brilliancy of the meteoric streams grows more intense. The red color of their base, the green of their middle, the yellow of their tips become deeper and more vivid. They dart with greater vivacity through the skies; the earth itself is clothed with a magical light; the sea, where unfrozen, and the ice fields, gleam with a strange and weird beauty. Heaven and earth tremble in their outlines as if all were unreal, and night hides the charm of the spectacle by her imposing silence. Gradually the crown fades, the brilliant bow dissolves, the streams shorten, the meteoric play is less vivid and frequent, the storm subsides, and the gloom of winter succeeds the midnight magnificence."

NIAGARA FALLS

The tremendous cataract of Niagara Falls, with the wonderful rapids above and below, has been recognized for centuries as one of the greatest natural wonders of the world. From the time of the first discovery by Europeans until to-day, Niagara has been sought by travelers who thought themselves well repaid for a journey of any length when they stood for their first view of the Falls, upon the verge of the precipices that look upon it.

The earliest account which we have of the Falls was written by the missionary priest, Father Louis Hennepin, and printed in his "New Discovery" in 1697. It would be difficult to find a more picturesque traveler's tale than the good priest told as it is quoted herewith, and he may be pardoned his extravagances when we remember that he had never seen anything of the sort before.

"Betwixt the lakes of Ontario and Erie, there is a vast and prodigious cadence of water, which falls down after a surprising and astounding manner; insomuch that the universe does not afford its parallel. 'Tis true, Italy and Suedland boast of some such things, but we may well say they are but sorry patterns when compared with this of which we now speak. At the foot of this horrible precipice we meet with the river Niagara, which is not above a quarter of a league broad, but is wonderfully deep in some places. It is so rapid above this descent that it violently hurries down the wild beasts while endeavoring to pass it to feed on the other side, they not being able to withstand the force of its current, which inevitably casts them headlong, above six hundred feet high. This wonderful downfall is compounded of two great cross streams of water and two falls, with an isle sloping along the middle of it. The waters which fall from this horrible precipice do foam and boil after the most hideous manner imaginable, making an outrageous noise, more terrible than that of thunder, for when the wind blows out of the south, their dismal roaring may be heard more than fifteen leagues off."

Since Father Hennepin's time, multitudes of poets, artists and prose writers have painted with word or brush the glories of Niagara, and millions have visited it. In the space here at command, it would be a fruitless effort to attempt a description which would be satisfactory either to writer or reader. This American wonder, so stupendous, so beautiful and so accessible, should be visited by all. The curve of the gigantic Horseshoe, the green wooded islands, the ponderous curtain of the American Fall, the gorges, the rapids, the whirlpool and the surroundings offer inexhaustible scenes of marvelous beauty and of great variety.

The wide-traveled, judicial-minded and discriminating Anthony Trollope penned the deliberate opinion: "Of all the sights on this earth of ours which tourists travel to see, I am inclined to give the palm to the Falls of Niagara. In the catalogue of such sights, I intend to include all beauties of nature prepared by the Creator for the delight of His creatures. I know of no other one thing so beautiful, so glorious, and so powerful. At Niagara there is that fall of waters alone. But that fall is more graceful than Giotto's Tower, more noble than the Apollo. The peaks of the Alps are not so astounding in their solitude. The valleys of the Blue Mountains in Jamaica are

(By courtesy of the Michigan Central Railroad.)

NIAGARA FALLS, THE WORLD-FAMED CATARACT.

Showing the American Fall, Goat Island and the Horseshoe Fall from Prospect Point.

less green. The finished glaze of life in Paris is less invariable, and the full tide of trade round the Bank of England is not so inexorably powerful."

WONDERS OF THE DEEP SEA

The time may come when there will be no portion of the earth's surface that has not been surveyed and explored by man. The work of enterprising travelers has now been carried on within a measurable distance of the North Pole; the highest mountain ranges are gradually succumbing to the geological surveyor; the heart of Africa is giving up to us its secrets and its treasures, and all the desert places of the earth are being visited. The bottom of the deep sea was until quite recently one of these unknown lands. It was regarded by most persons as one of those regions about which we do not know anything, and never shall know anything, and do not want to know anything.

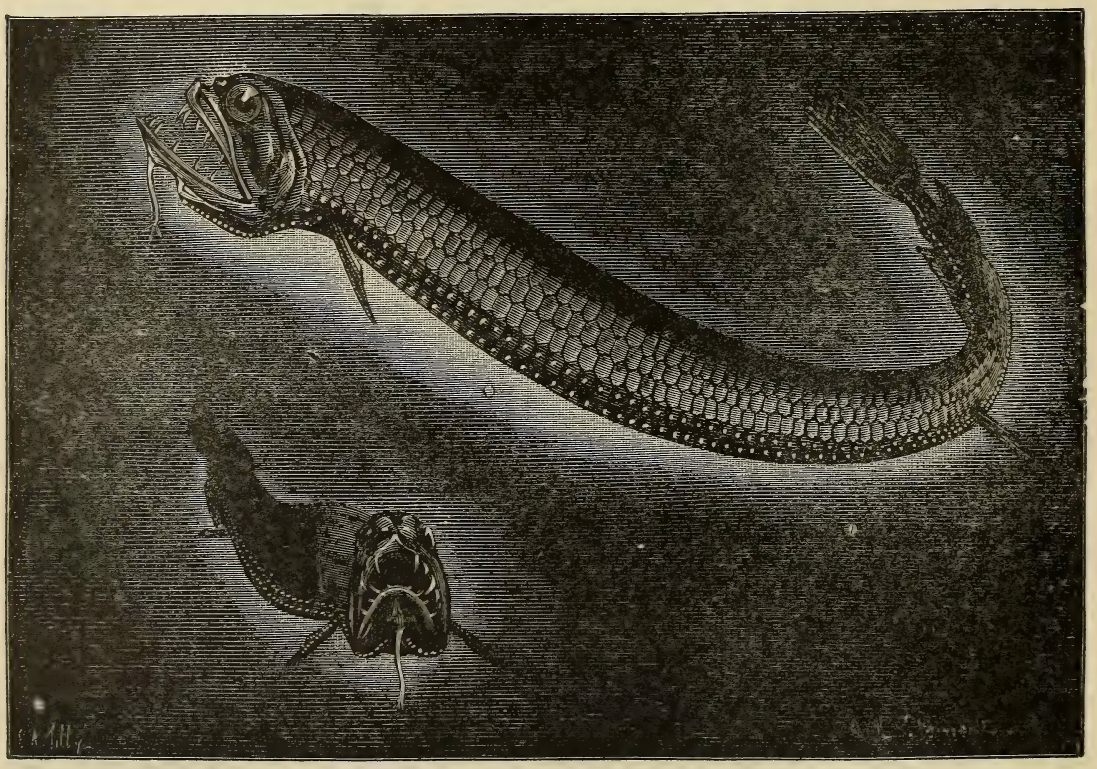
But the men of science fifty years ago were not disposed to take this view of the matter. Pushing their inquiries as to the character of the sea fauna into deeper and deeper water, they at length demanded information as to the existence of forms of life in the greatest depths. Since that time, by the aid of various government appropriations and scientific expeditions, a large amount of information has been placed at our command about this most interesting region.

Hardly more than fifty years ago, the methods of deep sea investigation were so imperfect that naturalists believed life to be practically non-existent in the abysses of the great ocean. Various navigators and scientists, prior to that time, had recorded isolated discoveries of strange creatures, brought up from the depths of the sea on their sounding lines, but the facts were not scientifically classified, nor do they contribute much to the knowledge of ocean depths. Americans were pioneers in these investigations, and in 1853 two officers of the American Coast Survey made one of the most important discoveries of an inhabited region at the bottom of the sea. In 1860 the doctor on board a British man-of-war collected thirteen star-fish from a depth of 1,260 fathoms. The Norwegians and the Swedes, likewise, became active about the same time.

The physical conditions of the abyss of the great oceans are such that it is not surprising that the naturalists of the early part of the last century could not believe in the existence of life at the bottom of the deep sea. The extraordinary conditions of such a region, the enormous pressure, the absolute darkness, the probable absence of any vegetable life from want of direct sunlight, might very well have been considered sufficient to form an impassable barrier to animals migrating from the shallow waters, and to prevent the development of a fauna, peculiarly its own. The peculiar physical conditions of the deep sea may be briefly stated to be these: It is absolutely dark, so far as actual sunlight is concerned; the temperature is only a few degrees above the freezing point; the pressure is enormous; there is little or no movement of the water; the bottom is composed of a uniform fine, soft mud, and there is no plant life.

At a depth of 2,500 fathoms, the pressure is, roughly speaking, two and one-half tons per square inch, that is to say, several times greater than the pressure exerted by the steam upon the piston of our most powerful engine, or, to put the matter in other words, the pressure per square inch upon the body of every animal that lives at the bottom of the Atlantic ocean is about twenty-five times greater than the pressure that will drive a railway train.

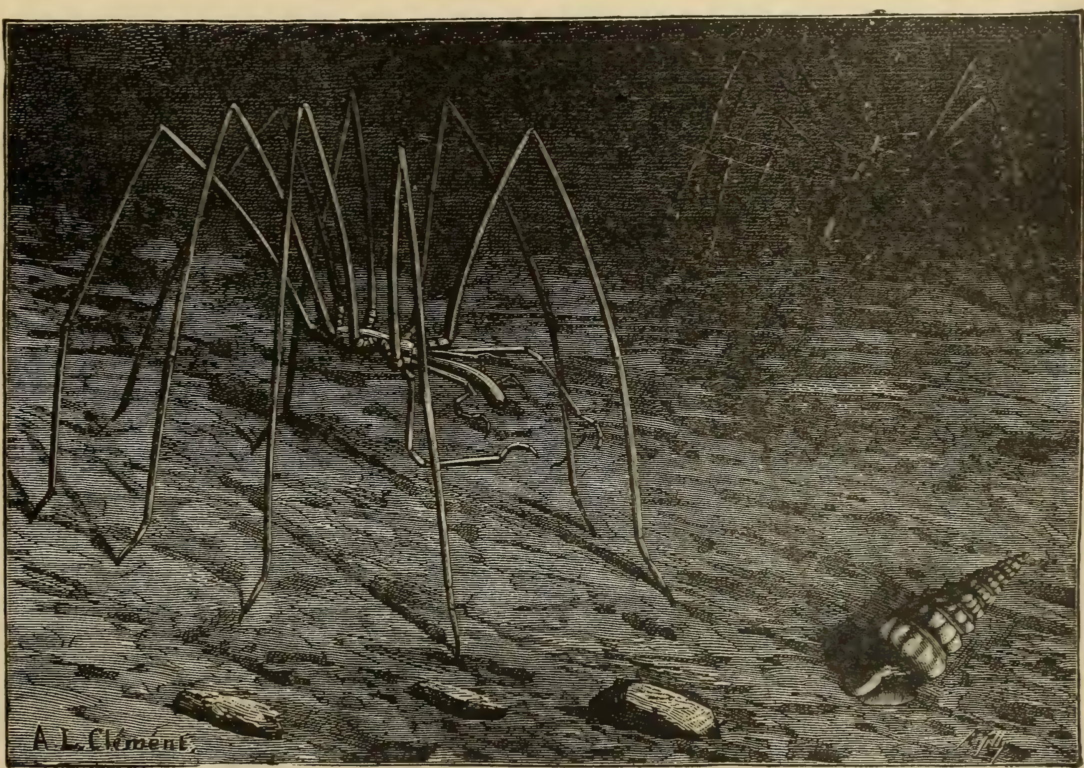
It is but reasonable to suppose that the ability to sustain this enormous pressure can be acquired by animals only after generations of gradual migrations from the silent shallow water. Those forms that are brought up by the dredges are usually killed and distorted by the enormous and rapid diminution of pressure in their journey to the surface and it is probable that shallow water forms would be similarly killed and crushed out of shape were they suddenly plunged into very deep water. The fish that live at these enormous depths are in consequence of the enormous pressure liable to a curious form of accident. If in chasing their prey or for any other reason they rise to a considerable distance above the floor of the ocean, the gases of their swimming bladder become considerably expanded and their specific gravity very greatly reduced. Up to a certain limit the muscles of their bodies can counteract the tendency to float upwards, and enable the fish to regain its proper sphere of life at the bottom. But beyond that limit the muscles are not strong enough to drive the body downward and the fish becoming more and more buoyant as it goes, is gradually killed on its long and involuntary



STOMIAS BOA. HALF NATURAL SIZE. FROM A DEPTH OF A MILE AND A QUARTER.

journey to the surface of the sea. The deep sea fish then are exposed to a danger to which no other animals in this world are subject, namely, that of tumbling upwards.

The most recent experiments that have been made tend to show that no sunlight whatever penetrates to a greater depth than half a mile. But although it is highly probable that not a glimmer of sunlight ever penetrates to the depths of the ocean, there



COLLOSENDEIS ARCUATUS, FROM A DEPTH OF ONE MILE.

is in some places a very considerable illumination, due to the phosphorescence of the inhabitants of the deep water.

The floor of the ocean, if it were laid bare, would probably present a vast, undulating plain of fine mud. Not a rock, not even a stone, would be visible for miles. The mud varies in different parts of the globe according to the depth and the proximity of land and the presence of the neighboring volcanoes or the mouths of great rivers.

It has not been determined yet with any degree of accuracy where we are to place the limit of vegetable life, but it seems probable that below a hundred fathoms no organisms excepting a few parasites are to be found that can be included in the vegetable kingdom. All plants except a few are dependent upon the influence of direct sunlight and since sunlight cannot penetrate more than a few hundred fathoms of sea water, it is impossible for the plants to live below that depth. The absence of vegetable life is an important point, for it is in consequence necessary to bear in mind that the food of deep sea animals must be derived from the surface. It is possible that the creatures of the deep sea in some cases feed upon one another, but the fauna would soon become exhausted if it had no other sources of food supply. This other source of supply is derived from the bodies of organisms that fall from the upper waters of the ocean.

Now let us note briefly a few points of interest about the creatures themselves that have been found. The different oceans and different depths, roughly speaking, show distinct characteristics in the life found therein, as truly as do the different continents of the world. So the scientists have marked out the different zones and localities on it. Strangely enough the creatures of the deep sea vary in color to a very remarkable extent. Shades of red occur rather more frequently than they do in the fauna of any other zone or region and there are no blue animals known to live in deep water, while green, also, is extremely rare in the greatest depths. The eyes of the animals that live in deep sea water undergo curious modifications. In the majority of cases, we find that the eyes are either very large or very small. In depths of 300 to 600 fathoms the majority are large eyed forms. This is as we should expect, for it is more than probable that many of these forms occasionally wander into the shallower waters where there is a certain amount of sunlight. In depths of over one mile, the small eyed and blind forms are in the majority, although many large eyed forms are to be found.

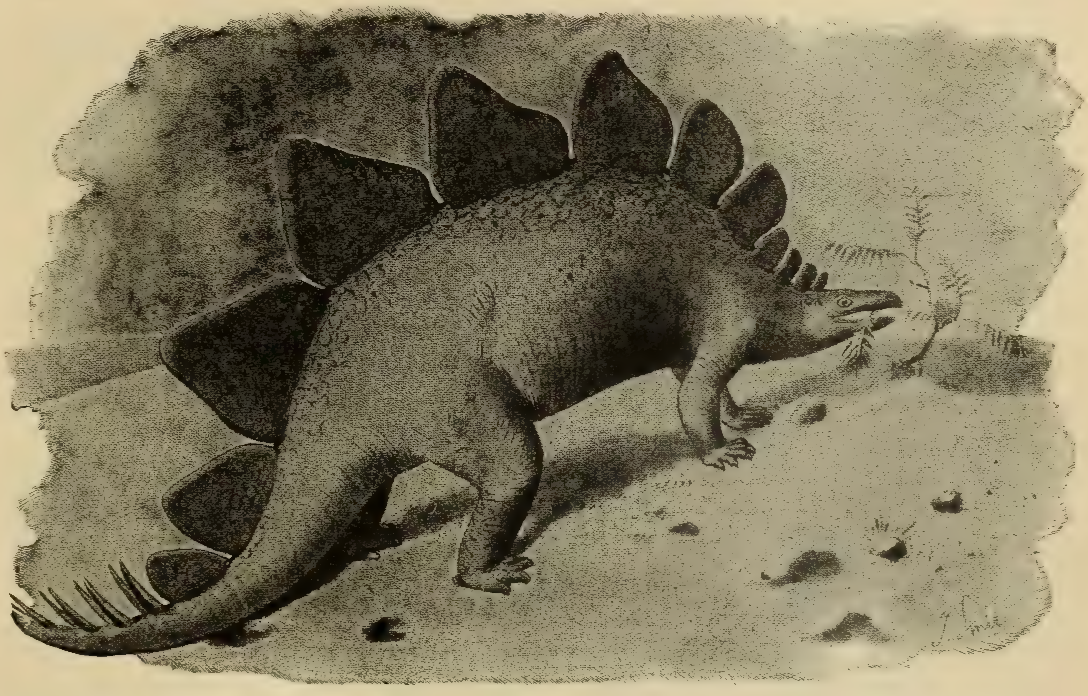
In these abysmal depths are found representatives of all the great classes of marine life which are recognized, from the true fish, which are of the highest order, through crustaceans, mollusks and seaworms to the lowest forms of protozoa, coelentera and echinoderma. The species are not large in comparison with those known to us in shallower depths, but range in size from minute forms to some which measure eight or ten inches in length. It may be a little puzzling to understand exactly what profit can come from costly investigations of these abysmal depths, and the answer must be found in the broad generalization that all knowledge is valuable, and the more we know about this world of ours the better No land has yet been found where life does not exist, and the most profound depths of the sea, miles below the surface, are likewise found to be teeming with life. Nature's wonders are everywhere, and the true scientist desires to learn of the most obscure and the most remote things as truly as of those which are near and obvious.

EXTINCT MONSTERS

Menageries and zoölogical gardens have given to every one a pretty fair idea of the characteristics of animal life to-day. These are supplemented by a wealth of fine pictures which make the rarest creatures familiar enough in appearance. But there were wonderful creatures here in this earth before man was created, and but few of them are known by name or appearance. to the average reader of to-day. And yet the actual appearance and habits of life of these extinct monsters which lived thousands of years ago can be conceived with some accuracy, thanks to the studies of learned men who have searched deep in the science of comparative anatomy. Various technical works exist upon this subject, and at least one popular account of the forms of ancient animal life. From the latter, by the Rev. H. N. Hutchinson, the following interesting facts are summarized.

Let us remember that it is not mere imagination that guides the man of science in such matters, for all his conclusions are intended to be based on reason. For millions of years countless multitudes of living animals have played their little parts on the earth and passed away, to be buried in the oozy beds of the seas of old times or entombed with the leaves that sank in the waters of primeval lakes. The majority of these perished beyond all recovery, leaving not a trace behind. Yet a vast number of fossilized remains have been in various ways preserved, sometimes almost as completely as if Dame Nature had thoughtfully embalmed them for our instruction and delight.

Down in those old seas and lakes she kept her great museum in order to preserve for us a selection of her treasures. In the course of time she slowly raised up sea beds and lake bottoms to make them into dried land. This museum is everywhere around us. We have but to enter stone quarries and railway cuttings, or to search in coal mines or under cliffs at the seaside, and we can consult her records.



A GIGANTIC ARMORED DINOSAUR. LENGTH, ABOUT THIRTY FEET.

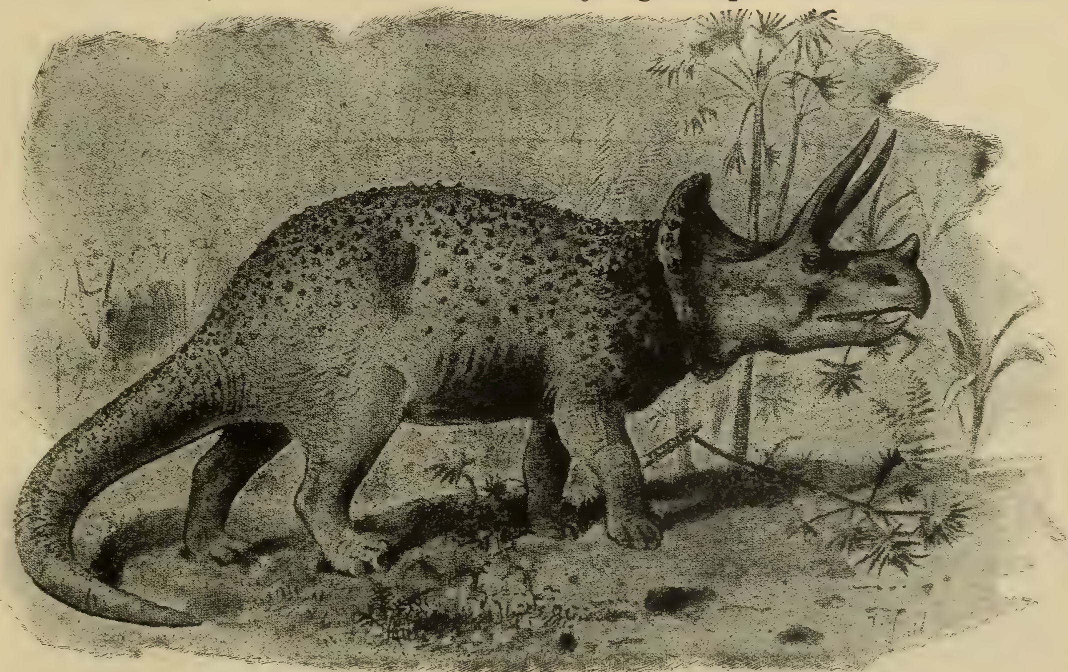
It is to Cuvier that the world owes the first systematic application of the science of comparative anatomy and palæontology, as the science is called which treats of the living beings, animal, or vegetable, which have inhabited this globe at past periods in its history. He paid great attention to the relative shapes of animals, and the different developments of the same kind of bones in the various animals and especially to the nature of their teeth. So great did his experience and knowledge become that he rarely failed in the naming of an animal from a part of its skeleton. He appreciated more clearly than others before him the mutual dependence of the different parts of an animal's organization. "The organism," he said, "forms a connected unity in which the single parts cannot change without modifications in the other parts."

As he progressed in these studies, Cuvier was able with considerable success to restore extinct animals from their fossilized remains, to discover their habits and manner of life, and to point out their nearest living allies. To him we owe the first complete demonstration of the possibility of restoring an extinct animal. His "law of correlations," however, has been found to be not infallible, but like other laws having its exceptions. To take one out of many examples of this law: carnivorous animals, such as cats, lions and tigers, have claws in their feet, very different from the hoofs of an ox, which is herbivorous, while the teeth of the former group are very different from those of the latter. Thus the teeth and limbs have a certain definite relation to each other, or in other words are correlated. Again, horned quadrupeds are all graminivorous (grain-eating) and have hoofs to their feet. The following anecdote serves to illustrate Cuvier's law. One of his students thought he would try to frighten the master, and having dressed up as a wild beast, entered Cuvier's bedroom by night and presenting himself by his bedside, said, in hollow tones: "Cuvier, Cuvier, I have come to eat you." The great naturalist, who, on waking up was able to discern something with horns and hoofs, simply remarked: "What! Horns —Hoofs! Graminivorous. You can't."

It is impossible to describe in detail all of the greater extinct monsters which inhabited the earth, the ocean or the air, and thousands of smaller creatures are well-known and identified in museums which cannot even be suggested here. All we can do is to speak briefly of a few of the most interesting or peculiar. For instance, on the coast of Great Britain there lived sea scorpions, possessing a coat of armor, jointed bodies and limbs for crawling, swimming or seizing their prey. They were distant cousins of the crustaceans of the present day, lobsters, crabs and shrimps, but they measured at least six feet in length.

In the same waters, and about the same time, dwelt the old fish lizard or ichthyosaurus. Cuvier, describing it, said of this creature that it possessed the snout of a dolphin, the teeth of a crocodile, the head and breast bone of a lizard, the paddles of a whale or dolphin, and the vertebræ of a fish. It was a powerful monster, swimming rapidly enough to catch the fish upon which it lived. The long and pointed jaws were a striking feature of these animals, and their eyes were very powerful and large. The largest entire skeleton preserved in a museum measures twenty-two feet long, and eight feet across the expanded paddles, but from detached heads and parts of skeletons it is probable that some of them were between thirty and forty feet long. Then there were long necked sea-lizards known as the plesiosaurus, which, to the head of a lizard united the teeth of a crocodile, a neck of enormous length, resembling the body of a serpent, a tail and body having the proportions of an ordinary quadruped, and the paddles of a whale. These also grew to a length of more than twenty-two feet. More than twenty species of these long necked sea-lizards are known to geologists.

Was there ever an age of dragons? Tradition says there was, but there is every reason to believe that the fierce and bloodthirsty creatures, of which such a variety present themselves, are but creatures of the imagination based, no doubt, on the huge uncouth reptiles of the present human era, such as crocodiles and other creatures. Nevertheless in spite of all manifest absurdities of the dragons of various nations and times, geology reveals to us that there once lived upon this earth reptiles so great and uncouth that we can think of no other but the time honored word "dragon" to convey the slightest idea of their monstrous forms and characters. The dinosaurus was an order comprising the largest reptiles that ever lived; and while some of them in a general way resemble crocodiles, others show in the bony structures they have left behind a very remarkable and interesting resemblance to birds of the ostrich tribe.



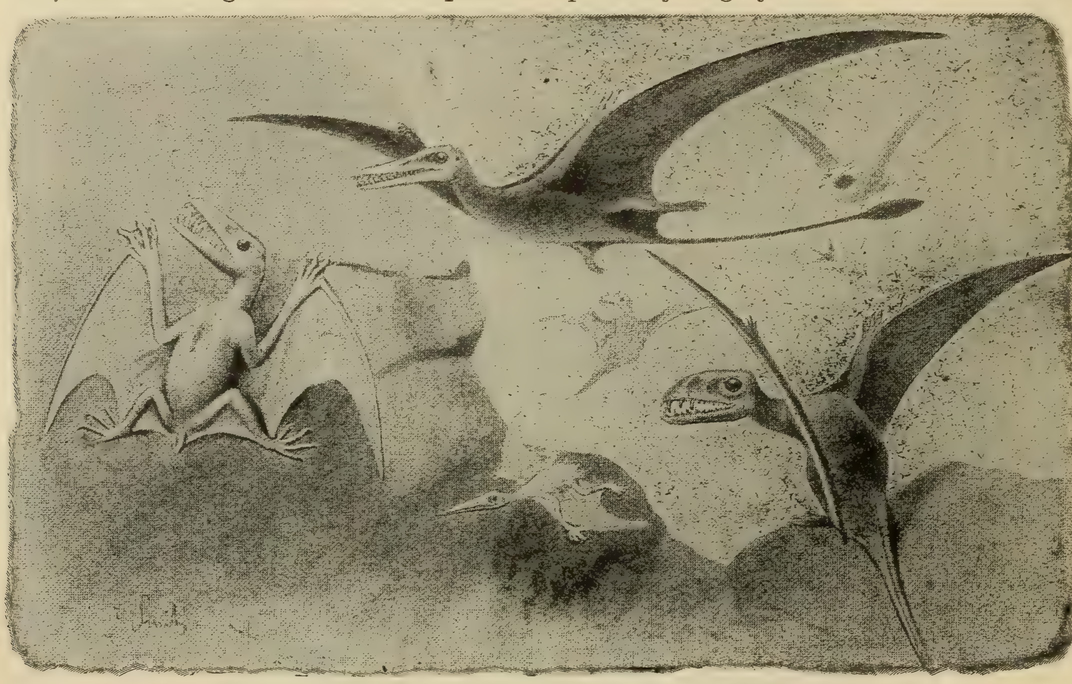
A GIGANTIC HORNED DINOSAUR. LENGTH, ABOUT TWENTY-FIVE FEET.

Their remains are found not only in Europe, but in Africa, India, America and even in Australia. The geologist finds that they reigned supreme on the earth throughout the whole of the great mesozoic era. Their bodies were in some cases defended by a formidable coat of armor, consisting of bony plates and spines, thus giving them a decidedly dragon-like appearance. They all had four limbs and in many cases the hind pair were very large compared to the fore limbs. The largest of the family were truly colossal in size, far excelling the rhinoceros and elephant of to-day.

One division of this family was the

brontosaurus, a vegetable feeding lizard. It was nearly sixty feet long and probably, when alive, weighed more than twenty tons. Each track made by the creature in walking occupied one square yard in extent. Its remains are found in the jurassic rocks in Colorado. Another member of the dinosaur family, the atlantasaurus, must have obtained a length of over eighty feet, and assuming that it walked upon its hind feet, a height of thirty feet. A thigh bone of one of these has been found entire, and it measures six feet and two inches in length. Colorado has yielded large numbers of most interesting fossils of this variety. Some of them were carnivorous, and some were diminutive creatures only two feet in length.

In addition to the dinosaurs or land dragons, there was another great order of reptiles that acquired the power of flying about like bats and flying foxes do now. The scientists called them pterodactyls, but they may very properly be termed "flying dragons." Some were no larger than small birds, but the largest had a spread of wing, or rather of the flying membranes, of twenty-five feet. Imagine a flock of these hovering over an antediluvian landscape, in which the animal life below them was supplied by eighty-foot dinosaurs and sea scorpions six feet long. Skeletons of sea serpents to a length of eighty feet have been found in the fossil deposits of Kansas.

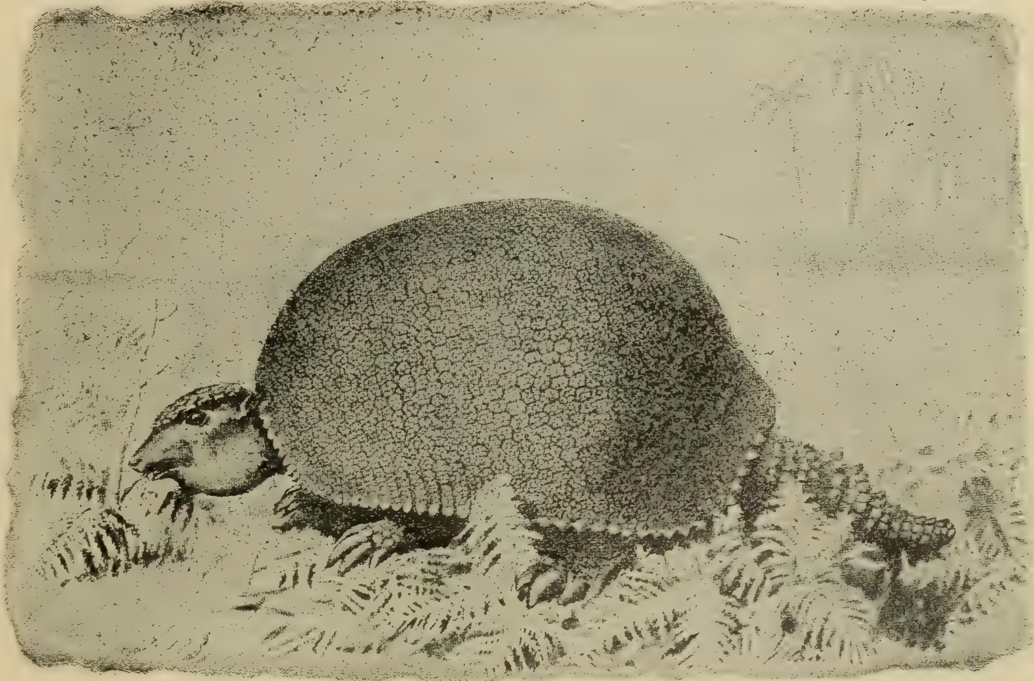


GROUP OF SMALL FLYING DRAGONS OR PTERODACTYLS.

Now we come to the great mammals of the past, animals not entirely unlike some that we know now, although immensely larger. America has been one of the most fruitful sources of information concerning these great creatures. In Wyoming have been found skeletons of a great animal called the tinoceras, which was akin to the rhinoceros, the elephant, the hippopotamus, and which measured about twelve feet in length without the tail. Its weight, when alive, is calculated to have been three tons. Great numbers of bones of these creatures have been found. Another equally picturesque creature found east of the Rocky Mountains was the brontops, still larger, with toes instead of elephant-like feet.

India, too, has yielded some strange monsters, including huge ones not unlike the moose of to-day, and a gigantic tortoise found complete as a fossil. From South America we obtain remains of gigantic mammals allied to sloths, ant-eaters and armadillos. The length of the best preserved specimen of these sloths is eighteen feet. The gigantic representative of the armadillo from South America is a huge armored creature more than eight feet long.

The mammoth and the mastodon are the creatures of the past whose names are most familiar to us, because they have come into the language and because they are not so long extinct as some of the strange creatures heretofore described. Approximately whole specimens of these primeval elephants have been found in the frozen regions of Siberia, preserved in the ice. The mammoth, indeed, has been actually seen in the flesh, and not only seen but eaten both by men and animals, although the meat had been frozen perhaps for several centuries. Fossils, remains of these elephants, have been found in Europe, Africa, Asia and North America. There is to-day a large trade in the ivory of the mammoth from Siberia, both eastward to China and westward to Europe. Various islands along the Siberian coast yield the huge tusks in great number. The most perfect specimen exists in the museum of



A GIGANTIC ARMADILLO, FROM BUENOS AYRES. LENGTH, NINE FEET.

the St. Petersburg Academy, the skeleton complete all except one leg, the skin still attached to the head and feet, and a large quantity of the hair remaining. This mammoth was discovered frozen in 1801 on the north coast of Siberia, and after several years was brought to St. Petersburg and mounted there. It had come to light by the thawing of a great block of ice which had covered it, and the people of the neighborhood had cut off the flesh and fed their dogs with it for two years before it was finally protected in the interest of science, and brought to Europe. There are at least nine cases on record of the discovery of frozen mammoths in northern Siberia, and it is not likely that the huge animal is long extinct.

The mastodon was similar to the mammoth, but probably preceded it in time. There is reason to think that in America it was contemporary with man in the prehistoric age. Numbers of partial specimens have been found in Kentucky, Ohio, Missouri, and other parts of the United States.

Of all the monsters that ever lived on the face of the earth, the giant birds were perhaps the most grotesque. New Zealand contributes the giant moa, a bird which stood twelve feet in height. The natives who were living at the time of the first white settlement of New Zealand, about 1840, declared the bird to be still in existence, but it cannot be learned that any white man actually saw the living creatures, although a search was made for them. However, fragments of shell and feathers were found with the bones of the birds, so that it is quite certain they had not been long extinct. In 1882 the head, neck, two legs and feet of a moa were found in a cave, having the skin still preserved in a dried state covering the bones, and some few feathers of a reddish hue still attached to the leg. In the island of Madagascar, also, the remains of a giant bird and its eggs have been found. One of the eggs had a diameter of fourteen inches, and would contain more than two gallons, or as much as three ostrich eggs or 148 hen's eggs.

The remains of a deer have been found in Ireland measuring in height to the summit of the antlers, ten feet, with a spread of the antlers from tip to tip of eleven feet.

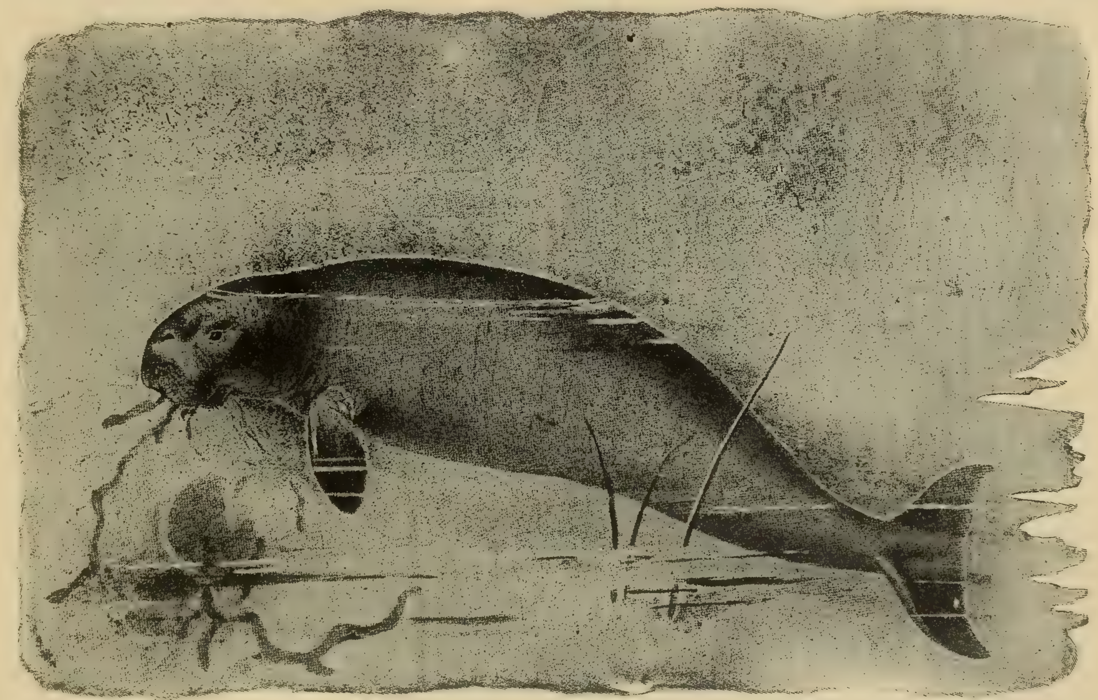
It has been possible at this time to give only the briefest mention of some of the strangest and most gigantic of the extinct monsters which once inhabited this earth. They are all recognized as absolutely authentic by scientists, testified by the incontrovertible proof of their remains, fossil or otherwise. In the era that preceded the birth of man, when animal life took these strange forms and vegetation was hardly less grotesque and gigantic in comparison with the world of to-day, is a field for study of unending interest and variety. What would we not give for actual landscape photographs of those wonderful scenes!

MAN AND NATURE BEFORE THE DELUGE

It is an accepted fact that the science of the earth and the wonders of nature have their culmination and terminus in man, the final link in the chain of life. A famous Canadian geologist, Sir J. W. Dawson, in one of his works makes an interesting study to answer the question, if possible, how and when this chief cornerstone was placed upon the edifice of nature. He puts this in the form of a narrative, based on geological facts only, and from his chapter on the subject of early man, the following paragraphs are condensed.

The glacial age had passed away. The lower land, in great part a bare expanse of mud, sand and gravel, had risen from the icy ocean in which it had been submerged, and most of the mountain tops had lost their covering of perpetual snow and ice. The climate was ameliorated and the sun again shone warmly on the desolated earth. Gradually the new land became overspread with a rich vegetation, and was occupied by many large animals. There were species of elephant, rhinoceros, horse, bison, ox and deer, multiplying until the plains and river valleys were filled with their herds, in spite of the fact that they were followed by formidable carnivorous beasts, fitted to prey on them.

At this time, somewhere in the warm temperate zone, in an oasis or island of fertility, appeared a new thing on the earth. A man and woman, walking erect in the forest glades, bathing in the waters, gathering and tasting every edible fruit, watching with curious and inquiring eyes the various animals around them, and giving them names which might eventually serve not merely to designate their kinds, but to express actions and emotions as well.



STELLER'S SEA COW. LENGTH, THIRTY-FIVE FEET.
Found alive by Steller at Behring's Island in 1741, but extinct since that time.

How this event happened, science is still unable to answer, and though we may frame many hypotheses, they all remain destitute of certain proof in so far as natural science is concerned. We can here only fall back on the old traditional and historical monument of our race, and believe that man, the child of God and with God-like intellect, will and consciousness, was placed by his maker in an Edenic region and commissioned to multiply and replenish the earth. The when and where of his introduction, and his early history, when introduced, are more open to scientific investigation.

That man was originally frugivorous, or fruit- and grain-eating, his whole structure testifies. That he originated in some favorable climate and fertile land is equally certain, and that his surroundings must have been of such a nature as to give him immunity from the attacks of formidable beasts of prey also goes without saying. These are all necessary conditions of the successful introduction of such a creature as man, and theories which suppose him to have originated in a cold climate, to struggle at once with the difficulties and dangers of such a position are, from the scientific point of view, incredible.

But man was introduced into the wide and varied world, more wide and varied than that possessed by his modern descendants. The earliest men that we certainly know inhabited our continents when, as we know, from ample geological evidence, the land of the northern hemisphere was much more extensive than at present, with a mild climate and a rich flora and fauna. If he was ambitious to leave the oasis of his region, the way was open to him, but at the expense of becoming a toiler, an inventor and a feeder on animal food, more especially when he should penetrate into the colder climates. The details of all this as they actually occurred are not within the range of scientific investigation, for these earlier men must have left few if any monuments, but we can imagine some of them.

Man's hands were capable of other uses than the mere gathering of food; his mind was not an instinctive machine like that of the lower animals, but an imaginative and inventive intellect, capable of adapting objects to new uses, peculiar to himself. A fallen branch would enable him to obtain the fruits that hung higher than his hands could reach. A pebble would enable him to break a nut too hard for his teeth. He could easily weave a few twigs into a rough basket to carry the fruit he had gathered, to the cave or shelter or spreading tree or rough hut that served him for a home; and when he had found courage to snatch a branch from some tree ignited by lighting, and to kindle a fire for himself, he had fairly entered on that path of invention and discovery which has enabled him to achieve so many conquests over nature.

Our imagination may carry us yet a little farther with reference to his fortunes. If he needed any weapon to repel aggressive enemies, a stick or club would serve his purpose, or, perhaps, a stone thrown from his hands. Soon, however, he might learn from the pain caused by the sharp flints that lay in his path the cutting power of an edge, and armed with a flint chip held in the hand or fitted into a piece of wood he would become an artificer of many things, useful and pleasing. As he wandered into more severe climates where vegetable foods could not be obtained throughout the year, as he observed the habits of beasts and birds of prey, he would learn to be a hunter and a fisherman and to cook animal food, and with this would come new habits, wants and materials as well as a more active and energetic mode of life.

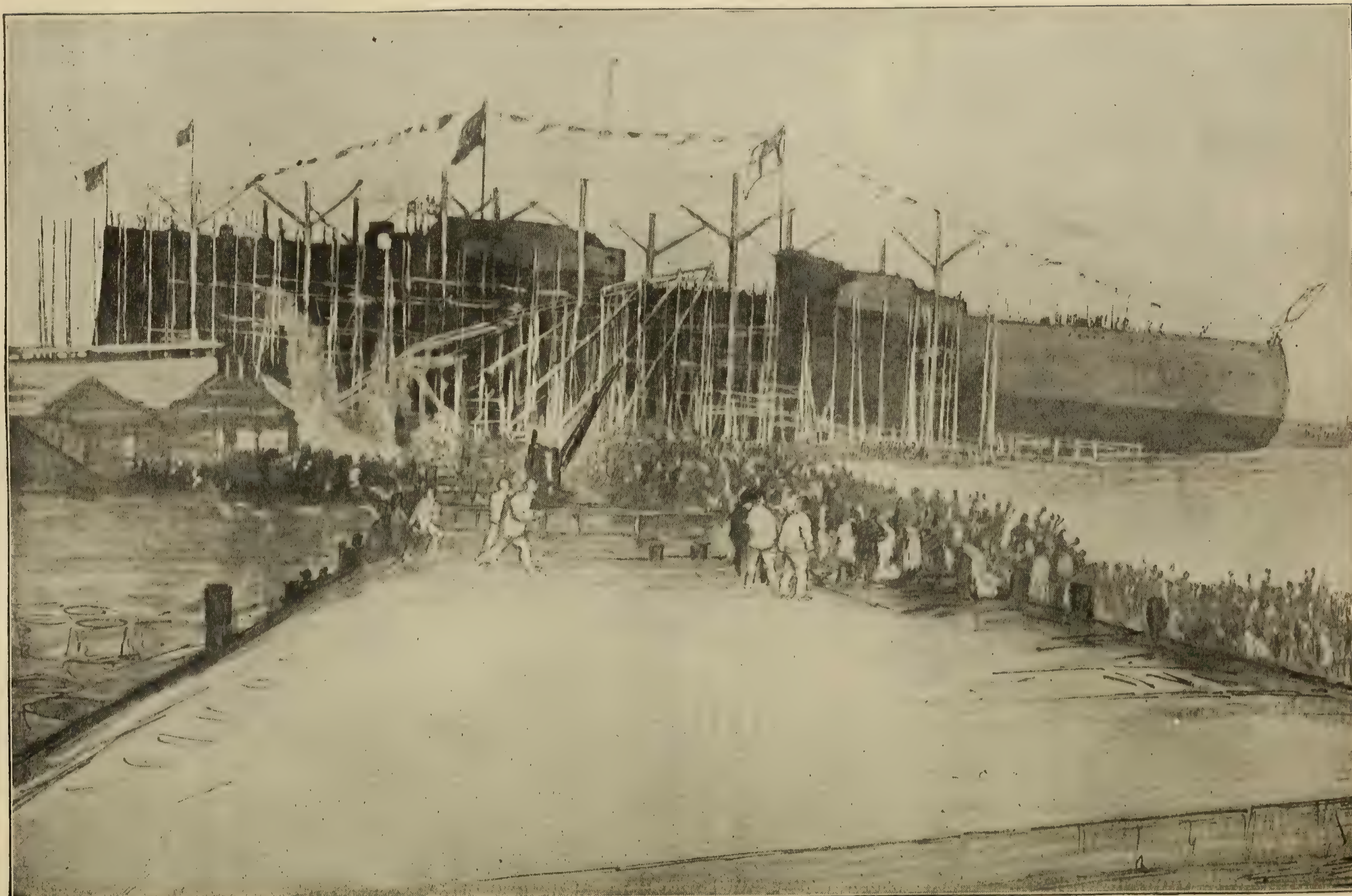
He would also have to make new weapons and implements, axes, darts, harpoons, scrapers for skins, and bodkins or needles to make skin garments. He would use chipped flint where this could be procured, and, failing this, splintered and rubbed slate, and for some uses bone and antler. Much ingenuity would be used in shaping these materials, and in the working of bone, antler and wood, ornaments would begin to be studied. In the meantime, the hunter, though his weapons improved, would become a ruder and more migratory man, and in anger or in desire to gain some coveted object, might begin to use his weapons against his brother man. In some more favored locations, however, he might attain to a more settled life, and he, or more likely the woman, his helpmate, might contrive to tame some species of animals and to begin some culture of the soil.

It was probably at this early time that metals first attracted the attention of man. The ages of stone, bronze and iron believed in by some archæologists are more or less mythical to the geologist, who knows that these things depend more on locality and on natural products than on stages of culture.

Probably all these ends had been to some extent and in some localities attained in the earliest human period, when man was contemporary with many large animals now extinct. But a serious change was to occur in human prospects. Hilltops, long denuded of the snow and ice of the glacial period, were again covered, and cold winter sealed up the lakes and rivers and covered the ground with wintry snows of long continuance. With this came a change in animal life and in human habits. Now began a fierce struggle for existence in the more northern districts inhabited by man, a struggle in which only the hardier and ruder races could survive, except, perhaps, in some of the more genial portions of the warm temperate zone. Men had become almost wholly carnivorous, and had to contend with powerful and fierce animals. Tribe contended with tribe for the possession of the most productive and sheltered habitats. Thus the struggle with nature became aggravated by that between man and man. Violence disturbed the progress of civilization, and favored the increase of power of the rudest tribes, while the more delicately organized and finer types of humanity, if they continued to exist in some favored spots, were in constant danger of being exterminated by their fiercer and stronger contemporaries.

In mercy to humanity this state of things was terminated by a great physical revolution, the last great subsidence of the continents, that post-glacial flood which must have swept away the greater part of men and many species of great beasts, and left only a few survivors to repeople the world, just as the mammoth and other gigantic animals had to give place to smaller and feebler creatures. In these vicissitudes it seemed determined, with reference to man, that the more gigantic and formidable races should perish, and that one of the finer types should survive to repeople the world.

Thus we have followed, as closely as science can interpret the chronicles, the progress of mankind from the creation to the deluge, and his development of the natural conditions in which he found himself. It is a fascinating study and an inexhaustible one. As the poet has aptly said, "The proper study of mankind is man," and these pioneers of our race are entitled to full attention in connection with the other wonders of the natural world, which we have inherited from them.



LAUNCHING A GREAT FIGHTING "DREADNAUGHT."

The United States Government has under construction four more of these mighty war ships—over 550 feet long, 93-foot beam, speed 28 miles per hour, displacement 26,000 tons; carrying 12 12-inch and 14 5-inch guns and many smaller ones.

SOLID FOOD FOR SOUND MINDS

READING THAT MAKES ONE WISER AND HAPPIER

A COUNTRY BOY'S CHANCES IN A LARGE CITY

AT a certain average age, begins the yearning for city life of the boy reared amid rural scenes. Then comes the "winter of discontent," which too often ends in his utter undoing.

The abandonment of agricultural pursuits by the country youth, and his entrance upon a city career, are likely to furnish a cause of trouble both in city and country.

GROWING NEED OF "HELP" ON THE FARM.

Agriculture now, more than ever, needs the service of all those bred to the farm and thoroughly familiar with its daily routine. The summer of 1903 brought clamorous demands from numberless farms in the grain-growing states for help in caring for the waiting crops, and multitudes of farmers were only too willing to accept inferior workers at from $2 to $3 per day to meet the requirements of harvesting.

CROWD INTO THE CITY.

On the other hand, hosts of farm lads, dissatisfied with the simple and unvarying course of farm life which, from distorted views, had become monotonous and irksome to them, plunged into the uncertainties of the already thronged cities, only to discover that their expectations were illusive and vain. So crowded have become the avenues of business endeavor by seekers after clerical employment that commercial enterprises in the important centers of trade can arbitrarily fix the wages paid to applicants for work. The conditions are such that great commercial houses while ever competing for patronage, never compete for help, as necessity compelled in case of the farmers before mentioned.

CAUSES OF OVER-SUPPLY OF CITY "HELP."

The natural increase in the city population from births, the constant accretions from country sources, the large extent to which women and girls have been substituted for men and boys in stores, offices, factories and shops, and the endless output of graduates from the business colleges, have barred the way to "positions" against thousands of disappointed people.

ONLY THE FITTEST SURVIVE THE STRAIN.

Unless the boy from the country is the possessor of rare qualities, city life is likely to prove to him a delusion and a snare. Only the fittest, in such a change, can survive the strain. As a rule, the youth bred to city life is much more likely to succeed than his country competitor for a job, because he is imbued with the push of the bustling mart, and is thoroughly familiar with the surroundings. He is, moreover, less liable to succumb to the temptations that hedge about him because he is safeguarded by the attractions and restraints of home.

Let the country boy, except in rare instances, stay at home, at least until he has saved enough of his sure earnings to begin mature life in an independent way. Let the country boy remember that the country is better far than the great metropolis, for mental and moral development, and for the establishment of strong individual character. The country, and the small town (not the city) give to the nation its towering celebrities. What great scholars, orators, theologians, scientists, lawyers, or statesmen have sprung from the environments of a great municipality? Let the wise country boy be mindful of these things, and stay where he is until he has laid the foundation of a successful career.

VALUE AND CHARM OF A GOOD LETTER

Letter writing will soon be numbered among the lost arts. It has come about through the increase in postal facilities that we have to write so many letters that we do not care to spend overmuch time on any one, or any series. The modern methods of travel which seem to have annihilated distance, have given to correspondence less importance in our eyes than it formerly had.

SCRIBBLING LETTERS COMMON.

People no longer write letters; they scribble them. But what others do in this connection is, or should be, nothing to you. It is your creed that all things should be done well. In letter-writing, particularly, you will take great pride and pleasure. Your letters stand for you. You do not enter a friend's house, utter half a dozen poorly expressed commonplaces, and then depart. Nor should your letters show as little care. Representing you, they should show you at your best. The envoys of your love, your friendship and your interests, you should see to it that nothing about them is disappointing.

THE LETTER A MESSENGER OF ITS WRITER.

Every one of them has need to be a worthy messenger, now to console, now to amuse, now merely to pass the time of day. There is no present so sweet to receive as a beautiful letter. In your letters trivialities may have ample room. To those you love, they are very pleasing, running over with such little details as correspond with chattering,—little details,—the unimportant things that separation makes important.

THE HEART SPEAKS.

Nothing more is required than that your heart should be in the matter. "The scholar sits down to write," says Emerson, "and all his years of meditation do not furnish him with one good thought or happy expression; but it is necessary to write a letter to a friend—and forthwith, troops of gentle thoughts invest themselves on every hand with chosen words."

GLOW OF AFFECTIONATE LETTER.

An affectionate letter! What a glow it leaves in the heart! It is a disappointment when the postman passes the door. But to take pleasure in receiving letters is not consistent with a neglect in writing them. To be sure, they take up much time. But it seems very certain to you that the time is not wasted. It is so much pleasure that you can give away at the cost of a little red stamp. You make your letters members of your life. What you do, what you are, what you think,—that you set down, and all else that comes into your head. Your letters are very intimate.

A GOOD LETTER MIRRORS THE MIND.

A good letter is the mirror of the mind. It is something that flashes. It is an epigram. Herein lies not the least benefit of letter-writing—that many things must be set forth in so small a space.

SPONTANEITY IN LETTER WRITING.

Letters are never so charming as when they are written spontaneously—when they arrive unexpectedly. Letter writing is hard work, and the mood for hard work is illusive. Practice writing; make your letters characteristic of yourself always.

COURTESIES OF LIFE

In the present scramble for wealth, position, rank and recognition, we are fast losing sight of the more important courtesies of life. The future of our families and, incidentally, the well-being of our old age depend more on our home existence than upon any advancement we may make in the different enterprises which occupy the minds of men.

AMENITIES OF HOME LIFE.

If some are indifferent enough to popular opinion to devote more time to the civilities of their homes than is the general custom, let us recognize the fact that their judgment is nearer right than that of others who are more prominent. While we must acknowledge the great social good accomplished by those who strive in the interest of the public, we must admit that the most useful sphere for American mothers and, in most cases, daughters, too, is the home.

FAMILY TRAINING.

Primitively, woman was a helpmeet, a complement, not another self—the two parties to marriage filling their respective spheres, forming a perfect unit, and yet with each one's work impossible to the other. In spite of all contrary opinion, woman's highest mission is to guard the sacred precincts of the home, for, before any other training whatever, comes the family training,—that preliminary training in which correct personal habits, respectful treatment of elders and superiors, obedience to authority, courtesy and morality are inculcated. Freedom from home control in the young is painfully evident, showing the need of a closer watch and guard over the domestic circle, and the imbuing of offspring with a greater regard for parental authority and parental judgment. Children speak to their parents and act toward them in a manner that would have been shocking a few generations ago.

Many parents fail to exact the courtesy due them from their children, fearing that the child may consider it a vain assumption of dignity. This negligence is followed by a less respectful demeanor toward father and mother and those in authority. Courtesy, or true politeness, is not a garb to be put off and on at will. On the other hand, it improves with use.

If we daily maintain the courtesies in home life which we extend to associates and acquaintances, our politeness in social circles would not savor so much of affectation. Chesterfield advised his son to use good grammar even when talking to his dog, in order to acquire the habit of correct expression. It is well to observe this rule with all the minor attainments which go to make us agreeable. Unless we respect ourselves enough to practice the common civilities, we cannot be anything but brusque and impolite. Our manners are often self-conscious, crude and vulgar. "If they don't like my way," says one, "they can take the less of it." Until such misdirected individuals enter into a circle the manners of which are more reserved and refined than their own, they have no realization of the fact that their ways are unacceptable, or that they are different from those of more agreeable people.

Brusqueness is not always manifest in what one says, so much as in the manner of speaking of an ordinary matter, or in an abrupt entrance, a disrespectful or lounging attitude, or a noisy salutation. "Every heart knoweth its own bitterness," says the Holy Writ. And it is an unpardonable familiarity, and also a display of egotism, to inflict upon others a minute description of the details of one's own small affairs.

SINCERITY AND KINDLINESS.

Anybody can recapitulate the troubles of the shop, of the kitchen, the nursery and the petty grievances of the neighborhood. We must learn to take human nature as we find it, and, at the same time, search for the brightest and best qualities among those with whom our lot is cast. Good will to our fellows and sincere motives should be the underlying principles which govern our intercourse with mankind. It is no hard task to cultivate a kindly feeling for others. There is no veneer that will stand the test of time. Our shallow courtesies may please for awhile, even if but occasionally assumed; but, in an unguarded moment our rougher self is revealed. The only solid basis of true politeness is the possession of right principles and virtuous character, the leading of a true life. Natural kindliness of heart and sincerity of intention must be back of all our actions. Unfeigned courtesy is best acquired and maintained in the daily intercourse of our homes.

THE HIGH SCHOOL AND ITS PART IN EDUCATION

The American High School is an important factor in the educational work of today. In a state of the size of Illinois there are said to be 310 high schools. The same estimate holds good in other states with the same number of inhabitants.

NUMBER OF STUDIES TAUGHT IN ILLINOIS HIGH SCHOOLS.

The number of study subjects offered in individual schools varies from 10 to 30. The total number of studies taught in the Illinois high schools is 49. Of these, eleven are termed constants—that is, they are taught in more than 75 per cent of the schools—and eight of them are taught in more than 85 per cent of the schools. These eleven branches in the order of their prominence, are algebra, geometry, physics, botany, Latin, English literature, zoology, physiology, general history, civic history and physiography.

Mathematics, literature, language and science, each has its place in almost every high school of the state. The belief that another constant is essential to the completeness of this list is rapidly growing. The demand for manual training is generally conceded, but there are as yet very few instances of its introduction.

ATTENDANCE AT THE SCHOOLS.

The data in regard to attendance shows the total enrollment of the schools reporting to be 34,824. Of this number there are 11,773 boys and 23,051 girls. The total attendance of seniors is 4,390, with 1,655 boys and 2,735 girls. It is noted with enthusiasm that, while the total percentage of boys attending high schools is but 33.8, the percentage increases to 37.5 for the senior class. Among teachers the number who are normal school graduates gives a percentage of 15.6, while the college graduates show a percentage of 54.4. The number of teachers who hold master's and doctor's degrees is large.

These statistics constitute a fair average for other states, with the exception, possibly, of New York and Pennsylvania.

The following table shows the hours devoted to each branch of study:

Algebra	47,560
Geometry—Plane	33,840
Geometry—Solid	10,960
Trigonometry	1,010
Arithmetic	3,540
Bookkeeping	7,610
Descriptive geometry	63
English grammar	480
English composition	31,620
Rhetoric	20,860
English literature	52,170
Latin	100,350
German	27,540
French	9,400
Greek	9,120
Spanish	170
Swedish	440
General history	30,410
English and American history	21,600
Ancient history	95
Greek and Roman history	10,500
Mediæval and modern history	670
French history	140
Civics	15,200
Political economy	2,210
Physics	38,660

Chemistry	20,840	Drawing—Mechanical	320
Botany	19,650	Elocution	350
Zoology	19,070	Formal spelling	220
Biology	690	History of commerce	260
Physiology	14,530	Manual training	1,120
Astronomy	4,740	Music	760
Physiography	14,880	Mythology	30
Geology	2,390	Pedagogy	140
Psychology	380	Physical culture	420
Commercial geography	300	Reviews	360
Commercial law	2,320	Stenography and typewriting	480
Constitutional history	45		
Drawing—Free-hand	9,630		

These figures comprehend all the high schools in the State of Illinois

THOUGHTS ABOUT HOME

The average theory of home life is that the happiness of home depends almost solely upon the wife and mother; that woman's first and highest mission is her home; that there are no clouds that ever overhang the home that sunbeams, bright and joyous, cannot penetrate. Love and reason, hope and aspiration, blend in a glorious, gorgeous rainbow of promise that arches the holy circle of home.

WHAT HOME MEANS.

Home means much in this twentieth century; it means all that makes life really worth the living. It is the object to which all unselfish endeavor is directed. It is the one solitary spot in the desert of the world where all those principles taught us in childhood preserve their living green, and reach out of the twilight of the past into the sun-gold of the future, preserving unbrokenly for generations to come the lessons therein taught.

THE WORD HOME.

Home is a word that we love to linger on. It brings around our hearts a confiding trust and repose. It has been said that there is no sweeter word in all the dialects of earth than the word home, unless it be the word "Mother," and home always suggests her and clusters about it more happy and hallowed associations than any other place. Its impressions are the strongest, deepest and most ineffaceable. It means life after death, the hereafter, to all who are blessed with offspring, in whom their own characteristics and energies are perpetuated.

It is the golden chrysalis, wherefrom the hope of the future takes wings at last. The home life is the nucleus around which all life has its growth, and that its tone and coloring are transmitted not to one generation alone, but to many generations, is an indisputable fact.

MOTHER.

Some writer has said that each member of the family contributes his or her share towards the making of the home, but the principal, presiding spirit is the wife and mother. She is, or should be, its life, heart and center.

The mother holds the key of the soul, and she it is who stamps the coin of character for her sons and daughters. Then crown her queen of the home. We should make our homes as tasteful as possible and beautify them with all the adornments which nature and our purse can provide. We should adorn our grounds with those natural attractions which the Creator has so profusely spread around us, and especially should we adorn the family circle with noble traits and kindly inclinations, fill the atmosphere with affection and thus induce others to love rather than fear us.

WHAT MAKES AN IDEAL HOME?

The ideal home is not made up simply of furniture and fixtures and decorations. The furnishing may be elaborate and luxurious, the decorations of the most artistic character, the arrangements for comfort perfect in every respect. Still, if it lacks the sunshine and warmth of love and affection it is not an ideal home; it is cold and dull and without life. It is marvelous, too, if the home lacks this element, how soon it will be manifest. The absence of it permeates the very atmosphere. There are homes, however, whose memory is a perpetual joy, and to which we always turn with emotions of gladness and pleasure. Neither statuary nor paintings may grace niche or wall. They are plain and unpretentious, lacking everything but the necessaries of life. Yet they are filled with beauty because of the spirit of love and affection abiding therein.

DUTY OF FATHER AND MOTHER.

It is the duty of every father and mother to make the home attractive. Make the living rooms pleasant, give them the sunniest side of the house. The plant that lives in the shade is sickly and unsightly.

30

ORDER.

One of the indisputable conditions of a pleasant home is the preservation of order. Have a place for everything and put everything in its place. "Order is heaven's first law." We should cultivate a habit of reading, if we have it not. We need it as well as we need air and sunshine, sleep and food. How refreshing it is to be able to lose one's self, even for a short time, in places where nature reigns.

BOOKS.

The humblest country boy or girl, kept at home by poverty and having to perform menial labor, may, if he will, with the aid of books, use the eyes and ears and brains of all men, everywhere and in all ages.

To-day the whole world of thought is before us and at our disposal, in every city and village, for a mere pittance. Every home should have a library. What bread and other articles of food are to the body books are to the mind, and, as the mind craves knowledge, its wants should be supplied or provided for with great care. A library always affords the choicest companionship. Some books are inspiring. Every page and sentence stirs us to higher motives and a higher life. Others inspire us with awe and veneration as we read them. Others are fragrant; they breathe the air of the mountain, the hillside, the valley, the home. Those who have a well-selected library may dine with kings and reason with philosophers, associate with poets and painters, and number the master thinkers of all ages among their personal friends. A home without books is a dreary, inhospitable place. A good book is always a genial companion. We should select our libraries with the greatest care, beginning them with the Bible, and making the poets our especial friends, adding, each year, such books as may come within our reach. This is a sure means of refinement and education.

MUSIC.

The home is almost as incomplete at the present day without some musical instrument, as it would be without books. We should cultivate a taste for music, both instrumental and vocal. Music is classed among the fine arts, and is taught as a science which all may learn. Music has a refining, inspiring and patriotic influence. From the mother's lullaby to Mozart's requiem masses, in the masterpieces of Haydn and Beethoven, we can mark the influence of music. Who has not felt the quickening spirit while singing, or listening to, the sweet melody of the gospel hymns? Have we not the testimony of thousands that martial music thrills the soldier with a spirit of bravery on the field of battle?

It has been said that no great musician has ever been convicted of a great crime. Shakespeare, as also well known, makes melodious utterance a test of civilization. Besides bespeaking a soft voice for a woman, he says: "The man that hath no music in himself, nor is moved with a concord of sweet sounds is fit for treason, stratagems and spoils."

NATURE'S MELODIOUS SOUNDS.

We are certainly a music loving people. Let us have it, then, in the home. Nature has done her part generously. She sings to us through warbling birds, and whispering pines, rearing waves and whistling winds. The least we can do is to join in the melody of nature, and by so doing, we add one more to the many bulwarks which should ever protect and surround the home.

MODERN METHODS OF COMMERCIAL EDUCATION

Commercial education is considered in these days to be a very important feature of the equipment of young men for business, and the development of the commercial training school has been very extensive. Not only have business colleges grown to a stage of high efficiency themselves, but as an outgrowth of them commercial courses have been introduced into the public and high schools, and some universities have established departments of commerce.

THE PUBLIC BUSINESS-SCHOOL.

The public business-school has become a very close competitor of the private institution of the same character, and as a consequence, the privately conducted institution has been forced to avail itself of the most improved and scientific methods in every particular.

THE TERM OF STUDY.

The modern business college of the most advanced type instructs its pupils in bookkeeping, shorthand, typewriting, business methods, commercial law, correspondence, and kindred subjects. The time required to complete the course is from four to eight months, varying with the adaptability of the student. One college announces that some of its particularly ambitious students have finished the complete course in from eight to ten weeks.

It will thus be observed that the student may advance as he chooses. There are no classes in which all do the same work. The system of instruction adjusts itself to the individual, and every attention is paid to the fact that the student is seeking at the earliest possible moment to devote himself to active business affairs. Each department of these schools is highly developed. In bookkeeping, for example, the fact is recognized that under the high-pressure methods of modern business, there is no time to train employes in business. The young man or woman who wishes to take a position must be ready to perform his or her duties at once. Consequently in the bookkeeping course, each rule and the reason for it are carefully explained to the student. He is given school currency, notes, drafts, invoices, etc., and works on living business transactions, instead of spending weeks in the dry study of mere text-books.

Every detail of a modern office is illustrated, and students are given actual practice in letter filing, letter-press copying, indexing and drawing up all kinds of business papers. The students are well grounded in arithmetic, and taught to be rapid and accurate in figure. They are also taught to write, not only speedily, but well. They take a course in common law, are drilled in letter-writing and spelling, obtain a complete understanding of the latest labor-saving methods of accounting, and are trained to perform all the details and routine of office work.

SHORTHAND.

In teaching shorthand the students are usually divided into three grades. When the principles of shorthand have been mastered, speed in writing is attained through systematic practice under the supervision of a skilled and experienced teacher. This point, in the best schools, is reached in from three to five weeks. The grades are then as follows: 1. Where dictation is at the rate of from 30 to 90 words a minute. 2. Where the rate is from 90 to 110 words a minute. 3. Where the rate is from 110 to 125 words a minute.

A MODEL OFFICE.

Some of the colleges have introduced what is called a "model office," where shorthand holds full sway. This office has every appliance and convenience of a modern commercial office. Here are duplicated the exact conditions that obtain in the offices of the largest and most progressive business houses.

AIDS TO PROGRESS IN STUDY.

Among the facilities for study are the newest style of desks, new typewriters, with the very latest improvements, the leading card-index systems, folio indices, letter presses, the mimeograph, the newest style—everything the student may be required to use later in actual business. All pupils regularly devote a considerable period of their time to this work, familiarizing themselves with the details of office routine, and obtaining a practical instead of a theoretical knowledge of business systems and methods.

THE SCHOOL CORRESPONDENCE.

The school correspondence, as well as that of the employment department, is conducted in this office. The instructor, who is here the employer, in effect, gives each student, in turn, actual dictation. This is then transcribed, passed to the instructor for examination, and, if necessary, is corrected. The student then attends to the copying, indexing, cross-indexing and mailing of the correspondence. It is a part of the plan of the more progressive schools to assist all their students to obtain positions. To do this effectively; a thoroughly systematized employment department is maintained, which keeps in close touch with a large number of business firms, from which requests for employes are continually received. Banks and trust companies have regularly on file with these institutions applications for the services of the particularly bright and capable. The tuition fees are moderate, and board may be obtained at a reasonably low rate.

SPARKS OF SCIENCE

ABOUT COLOR.

Solar light is a compound substance, consisting of what is termed the seven prismatic colors, namely: red, orange, yellow, green, blue, indigo and violet. These when properly separated comprise the colors of the rainbow, and when combined in a beam, are called white light.

A BEAM OF SUN WAVES.

A beam of waves from the sun is composed of a bundle of ethereal waves, and these waves are of different lengths. The length of a light-wave is the distance from its crest to a similar point on the next wave. The different lengths of waves produce the different colors to our vision. Those productive of red require 39,000, placed end to end, to make the length of an inch, and those productive of violet require about 57,500.

THE COLOR, RED.

When we contemplate the beauty of the color we call red, as we see it in the rainbow, the solar spectrum, in the red leaves of a blooming rose or elsewhere in nature or in art, let us remember that to produce this color, 477,000,000,000,000 of little ethereal waves enter the eye and impinge on the retina in every second of time; and in the same interval 700,000,000,000,000 of these waves enter our eyes, and produce in us the sensation we call violet. When 577,000,000,000,000 impinge on the retina they produce the sensation of green, and the other colors between the red and the violet are all produced in the same manner.

COMPOUNDS OF COLORS.

A compound of red and green will produce white light. Yellow and blue will do the same, and for the same reason, because they are complementary colors.

NO SUBSTANCE HAS NATURAL COLOR.

No substance which we see in nature or art has any natural color. What we popularly term the color of an object is produced, and its color determined, solely by its power of absorption and reflection, and by these qualities alone.

LEAVES OF A TREE OR BLADES OF GRASS.

For this we will instance the leaves on a tree, the green grass, the beautiful flowers. A full sunbeam, with all its elements of color, is showered promiscuously on everything in nature, and the molecular construction of this green leaf, for instance, or of the grass, is such that it absorbs all of the ethereal waves except those of a given length, and these it repels or reflects; the reflected waves, twining back and impinging on the retina of the eye, produce in us the sensation of color, and that color is green. All the other waves are absorbed by the leaf, and produce heat instead of light.

THE PANSY.

The beautiful pansy absorbs all the rays of the solar beam except the shortest ones, that are capable of making themselves sensible to our visual organs, and these short waves are turned back by reflection, and, impinging on the retina of the eye, produce in us the sensation of violet; and so it is through all the range of colors. To repeat, every object in the natural world or the world of art receives the full beam of ethereal waves, or its full beam of colors, which are all the colors of the spectrum or rainbow. It then selects such of these waves, as owing to their length and the position of their planes of vibration, it is unable to absorb, reflects them back to the eye, and the length of these reflected waves determines the color of the object.

The coloring matter that makes the pigment which to us is black, absorbs *all* of the solar beam that falls upon it, and hence no color is reflected back to the eye; on the other hand the white paper on which we write absorbs none of these waves, but reflecting the entire beam back to the eye, we have a compound of all of the colors, and this compound is white; hence we call the paper white. As before said, color is not inherent in anything.

OCEAN CABLES IN WAR TIME

TWELVE CABLES UNDER THE ATLANTIC.

Stretching across the Atlantic bed to-day are twelve cables, ten of them being American and British, two being French, while one German cable has just been completed from the Azores. These cables are as follows: Anglo-American, four cables, from the west of Ireland to Newfoundland; Commercial, three cables, from the west of Ireland to Nova Scotia, but passing Newfoundland in shoal water; direct United States, one cable, from the west of Ireland to Nova Scotia, but passing Newfoundland in shoal water; one French cable, Pougier Quartier, from Brest to St. Pierre, also passing Newfoundland in shoal water; another French cable, Generale, from Brest to Cape Cod; and a German cable, from Emden, via the Azores, to Cape Cod, both passing Newfoundland in shoal water.

THE GERMAN CABLE.

As the German cable runs partly through Portuguese territory, it is regarded as unreliable and practically valueless to England in time of war. There are two cables from Lisbon to Brazil via the Cape Verde Islands, but their connections are complicated, and they are deemed unreliable because of the countries in which their terminals lie. No country at war with England would hesitate to strike at her cables, and would cut them, as well as those of the American companies. If the work were to be done by the American Navy, it would not hesitate to cut the cables owned in this country, so as to completely sever England's communications with the western hemisphere.

THE FRENCH CABLE FROM BREST.

In the case of France, it is pointed out that a warship at sea might pick up the Brest cable (the location of which is known only to the French officials) and could thereby communicate with the home office, learn if war had been declared, and receive precise instructions, repairing the French cable before departing to sever the enemy's wires.

BRITISH CABLES LANDING AT CORNWALL AND CONNAUGHT.

The British Navy is supposed to be competent to protect the cables landing at the Cornwall and Connaught coasts, while cable cutting in deep water is only possible to experts on regular slow-going cable ships, whose movements would undoubtedly be watched by Great Britain.

CUTTING CABLES IN THE SPANISH-AMERICAN WAR.

Cable experts say that the difficulties met with by the American Navy in cutting cables during the Spanish-American war were the result of inexperience, and that a man who knew his business would, on board a sea-going tug, have all of the Atlantic cables off Cape Canso completely at his mercy, and could finish the job in 48 hours.

POINTS OF LAW

Law is a rule for action established by a government or other competent authority to regulate justice and direct duty. Law may be between God and man either in natural or revealed form; or it may be between man and man. The latter form is divided into several kinds: national or municipal, which may embrace constitutional, cannon or ecclesiastical laws; equity or common law, which embraces what might be called public or criminal laws; and private or civil laws, besides which there is still international law.

CIVIL LAW.

Civil law is the system which the people of a State enact for their welfare. This branch deals particularly with all things not criminal. In that it is private, it has to do with actions between individuals, such as indebtedness, actions on notes, mortgages, etc., the adjustment or acquiring of titles, collections, marriage and divorce, and the like. Branches of the civil law are many, such as commercial law, which has to do principally with business affairs of commercial houses; insurance law, for regulating insurance companies; maritime law, for questions pertaining to affairs of the sea; military law, for armies; municipal law, for cities; sumptuary laws for people dealing in intoxicating liquors, etc.

CRIMINAL LAW.

Criminal law is generally punitive, where civil law exacts only a settlement. The state steps in to inflict a penalty on a malefactor who acts against the good of the public. Criminal carelessness is a crime, though accident is not. If a faulty boiler explodes, or a badly constructed building burns and causes loss of life, some one is liable to punishment for it. Yet a man may accidentally discharge a firearm and kill some one, and not be held for it.

Ignorance of the law is no excuse.

You may not lawfully condone an offense by receiving back stolen property.

POLICE ARRESTS.

Police are not authorized to make arrests without warrants duly sworn out before a magistrate, unless they personally know that an act has been committed that calls for the arrest.

FORCIBLE ENTRANCE ON WARRANT.

When a warrant has been sworn out for a man accused of crime, his house may be entered forcibly.

EMBEZZLEMENT.

Embezzling is theft by an officer, agent or servant of a corporation.

FELONY.

Felony is a high crime, the highest of the principal classes in which crimes are divided by statute. A grave crime exceeds in grade a misdemeanor.

GRAND AND PETIT LARCENY.

Grand larceny involves over $25; petit larceny anything below that amount.

ARSON.

Arson is the crime of feloniously setting fire to a building.

DRUNKENNESS NO EXCUSE FOR CRIME.

Drunkenness is no legal excuse for committing a crime, but when carried to the extent of delirium tremens, it may be adjudged insanity.

ASSISTANCE COMPULSORY ON POLICEMAN'S APPEAL.

Officers of the law are empowered to appeal for assistance, and anyone to whom they may appeal is in law bound to assist.

FORGERY.

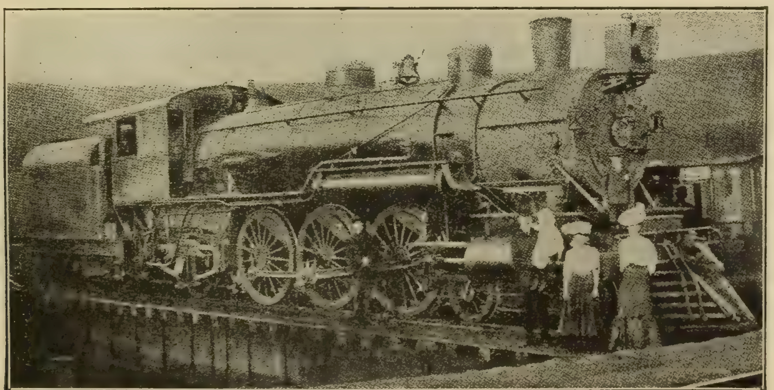
Forgery is the copying or signing the name of another with deceitful or fraudulent intention.

MURDER.

Murder in the first degree must have been premeditated, malicious and willful. Killing in duels is murder.

PERJURY.

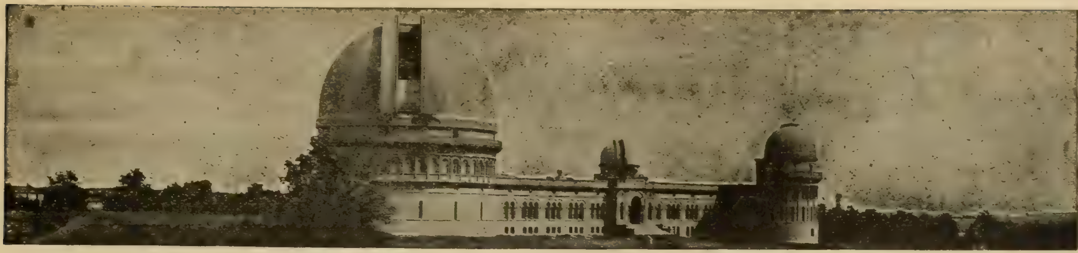
Willful false swearing is perjury. A false statement under oath, which is qualified as the belief of the affiant, does not constitute perjury. Subornation of perjury is a felony.



MONSTER PASSENGER ENGINE OF MODERN TYPE.

DEPARTURE OF THE SACRED CARPET FROM CAIRO, FOR MECCA.

Once a year the Khedive sends a beautiful carpet to the tomb of Mohammed, in charge of the Mecca pilgrims. It is hung in the tomb until brought back by the next year's pilgrims, when it is given to some mosque which it is desired to honor.



THE YERKES OBSERVATORY, WILLIAMS BAY. WISCONSIN.

SAVING THE FORESTS

A problem of vital importance presents itself to the American people in the preservation of its forests. For centuries, with the onward march of civilization, has been heard the sound of the ax, hewing away indiscriminately at the mighty trees of the country. While the damage from this onslaught has not been irremediable, nevertheless, some sections of formerly beautiful and valuable country present a sorry sight. The lesson has been learned in many places that the forest lands must be protected.

Several advantages of forest saving are apparent at once. If lumbermen chop away at our noble trees without plan or scientific knowledge, but a few years will pass until serious results will follow. In the first place a constant supply of lumber cannot be insured unless means are taken to prevent the felling of small trees, which are the beginnings of new forests. Without this young growth, future generations will be without lumber.

DISTRIBUTION OF MOISTURE DEPENDENT ON FORESTS.

Inhabitants of sections which were formerly well-wooded and now stand stripped of their timber, have discovered to their sorrow that the irrigation of the soil, even in a fertile country, depends greatly upon the forests. However much the forests may affect the rainfall itself, they have a powerful influence in the distribution of its moisture. The regulation of the flow of streams is mainly insured by forests. The heavy masses of tangled roots and matted leaves of the forest lands collect the moisture, and hold it pent up for a long time.

FORESTS PREVENT FLOODS AND DROUTH.

This prevents great floods during spring thaws, and, conversely, prevents seasons of drouth by allowing this stored up water gradually to find its way to the brooks and rivers. Thus, streams valuable for water power are preserved in their natural volume, and economic purposes are subserved. Compare the wildly-rushing, muddy-stream, rolling in the spring through timber-stripped country, and the same stream dry, in the season when moisture is most needed in its valley for crop maturing, with that stream whose current is still regulated by kindly forests. This comparison has gradually become so effective that much good is resulting from it.

LESSEN THE NECESSITY FOR IRRIGATION.

As the tide of improvements moves further westward, the problem of developing arid and waste lands is being studied more closely. In the great deserts, scientific irrigation is already turning desolation into a paradise. Agriculture in the West depends more and more upon the forests. In many sections moisture depends upon storage reservoirs. These often give way through the breaking of dams. This can be obviated, but many others are stopped up with silt. This latter evil has only one remedy, the forest. Even the irrigation ditches receive their water from streams whose sources are in great forest reserves. When it is considered that there are in this country nearly one hundred million acres of land, not yet under cultivation, which may be reclaimed by irrigation, and that this land will support twenty million souls, the possible benefit from the preservation of forests may be imagined.

NATIONAL FOREST RESERVES.

The United States Government has taken a hand in this great work, congress having passed an act March 3, 1891, establishing national forest reserves. From President Harrison down, each successive executive has designated many acres of forest land to be set aside. In some instances in the West, these reserves constitute the greater part of the whole territory of the State. In the whole United States there still remain nearly 1,000,000 square miles of timber land. Under the careful direction of the General Land Office, the United States Geological Survey and the Division of Forestry of the United States Department of Agriculture, much may be done with this timber.

There has been something of a hue and cry, due largely to selfish interests, against the establishing of the reservations. On some of the great public lands, sheep-grazing is an important and valuable industry. These sheep often stray through the forests in huge droves, trampling down the young tree growth and hardening the soil. Ruin to the woodland often follows, and that in itself would prevent further grazing. But the sheep herders overlooked this feature and fought against the reserves, fearing the exclusion of their sheep. When the true value of preserving the timber land was understood, and it became known that sheep could be grazed in small herds, the movement progressed rapidly.

DESTRUCTION OF FORESTS BY FIRE.

Fire alone, it is estimated, causes a loss of $50,000,000 a year to forests. In thickly timbered country this is little thought of, for what is plentiful is regarded cheaply. But the tremendous economical importance of this great national resource is being brought home to the many. In such States as are made up of treeless plains, timber must be had for building, else the onward march of civilization will cease.

THE RAINFALL AND DISTRIBUTION OF FORESTS.

The distribution of forests in general corresponds with that of rainfalls. The Pacific coast has perhaps the finest and heaviest timber in the world. It is not the oldest States that have the smallest forests. Those that border on the Atlantic coast, with the exception of one, have a wooded area of more than 36 per cent of their entire territory. Louisiana has 62 per cent; Alabama, 74 per cent, and Texas, 24 per cent; about two-thirds of the surface of the Gulf States (except Texas) is covered with timber.

THE WEATHER BUREAU AND ITS WORK

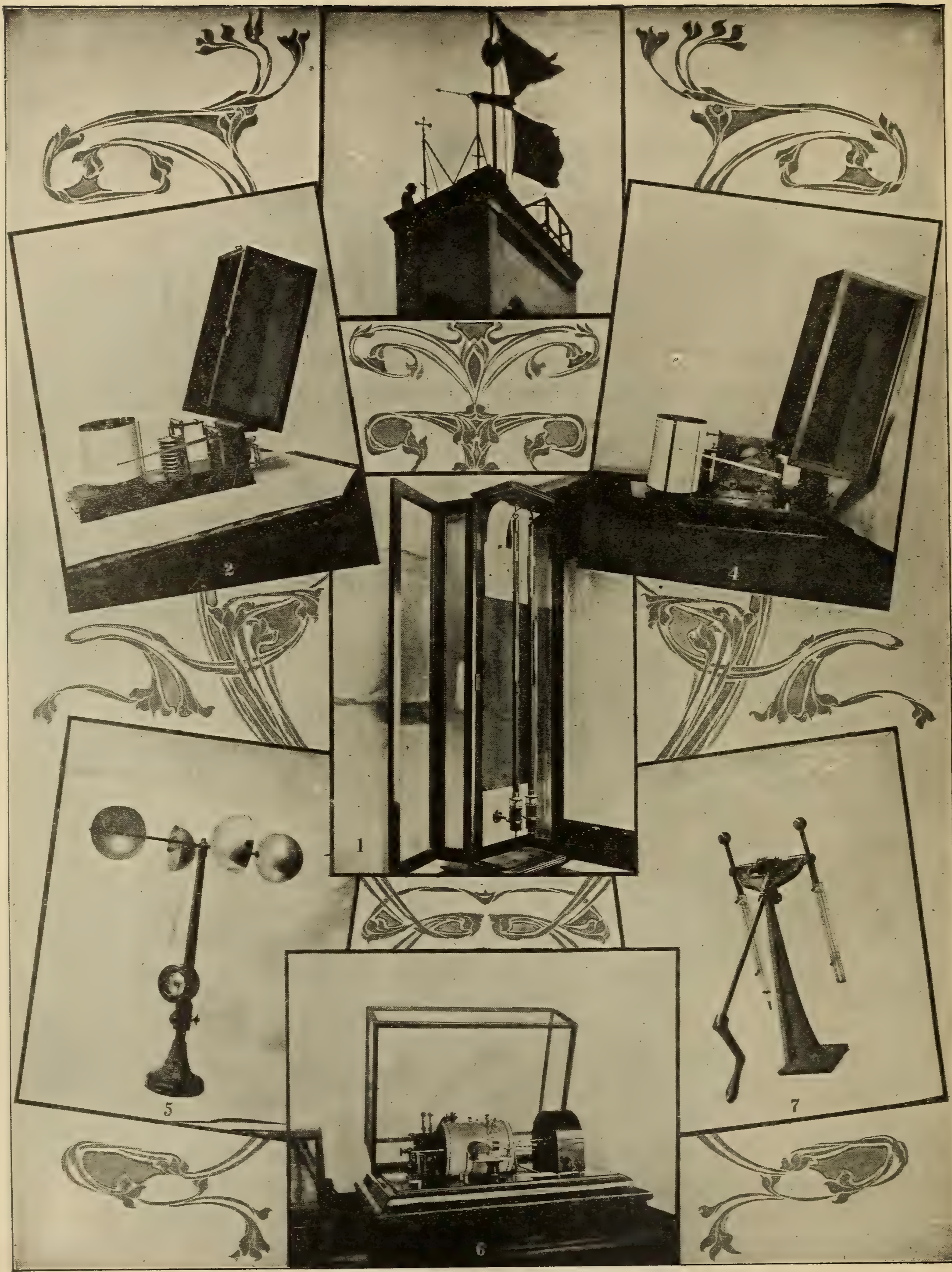
Before the invention of the electric telegraph for the prompt communication necessary between various parts of the world, and the numerous special instruments devised by scientists for recording atmospheric conditions, people depended upon the opinions of keen local observers, whose experience had taught them the significance of various visible signs. All sorts of traditions and predictions that had come down from the past were heeded. The origin of scientific weather study is of comparatively recent date. Even now the value of it is not fully understood. The well-founded doubts and jests based upon the superseded method of predictions still remain. People do not realize the completeness of the organization of the Weather Bureau and the real scientific accuracy of its work. A single error in a forecast becomes more conspicuous than a score of accurate predictions, and the result is that the weather man is still not fully appreciated.

MEDICINE HAT, ON THE SASKATCHEWAN RIVER.
From the great plains of the Canadian northwest come the blizzards of mid-winter.

The Weather Bureau of the United States Department of Agriculture publishes daily more than 100,000 weather bulletins, not counting the forecasts in the newspapers. Most of these bulletins are in the form of postal-cards, printed by postmasters from telegraphic reports, and sent by them to outlying towns for display at suitable points. There is also an elaborate system of redistribution, by means of telephones and railroads from established centers, so that there are comparatively few accessible places which do not now receive daily weather forecasts, even a very short time after the observers have completed their work. The old system of conveying information about the weather, by means of flag displays, is also in general use.

It is a wonderful picture of atmospheric conditions that is presented twice daily to the trained eye of the weather forecaster. It embraces an area extending from the Atlantic to the Pacific, from the north coast of South America northward to the uttermost confines of Canadian habitation. America's cold waves, hot waves and storms are shown wherever present in this broad area. Their development since last reported is noted, and from the knowledge thus gained their future course and intensity is quite successfully forecast. Every twelve hours the kaleidoscope changes, and a new graphic picture of weather conditions is shown. Nowhere else in the world can meteorologists find such an opportunity to study storms and atmospheric changes.

In our Atlantic and Gulf ports there are floating over $30,000,000 worth of craft on



INSTRUMENTS AND EQUIPMENT OF A WEATHER BUREAU STATION.

1. Barometer; 2. Barograph; 3. Signal tower showing flags, anemometer, anemoscope and time ball; 4. Telethermograph; 5. Anemometer; 6. Triple register; 7. Hygrometer.

any day of the year. And at every port, whether on the Atlantic, on the Pacific or on the Lakes, there is either a full meteorological observatory or a storm-warning display man, who attends to the lighting of the danger lights at night, to the display of the danger flags by day, and to the distribution of storm-warning messages among vessel masters. While the daily predictions of rain or snow by which the public measures the value of the weather service are subject to a considerable element of error, namely, about one failure in five predictions, the marine warnings of the service have been so well made that in over six years no protracted storm has reached any point of the United States without warning being displayed well in advance. As a result of these warnings the loss of life and property has been reduced to a minimum.

FORECASTING ROOM, CHICAGO STATION OF THE WEATHER BUREAU.

The shipping of the Atlantic seaboard is protected with greater certainty through these warnings than that of any other part of the American coast for the reason that practically all of the storms, except those from the Gulf, which reach the Atlantic coast, originate in the Mississippi Valley. The meteorological data of the Mississippi Valley storms, covering the entire period of the service of the Weather Bureau, shows that these storms reach the Atlantic coast in about twenty-four hours from the beginning of the eastward movement. It is only necessary, therefore, for the weather observers to note the origin of the Mississippi Valley storm and the beginning of its eastward movement, in order to predict accurately the time of its arrival on the Atlantic coast and give warning to shipping.

It is a notable example of the utility of the American weather service, extended into the West Indies, that the great Galveston hurricane of 1900 was detected on September 1 at the time of its inception in the ocean south of Porto Rico, and that the reports were so complete that at no time did the observers lose track of the storm. Such full information was given as it progressed northward, that notwithstanding the extensive commerce of the Gulf of Mexico, little or no loss of life or property occurred upon the open waters of the Gulf. The destruction of life at Galveston was much less than it would have been without the warning that had been given.

When a marked cold wave develops, warnings are given so far in advance that farmers and shippers are able to save property of enormous value by protecting it from frosts. There is one instance recorded in the Weather Bureau showing from definite information that more than $3,400,000 worth of property was saved by the advance warning in reference to a single cold wave. The fruit interests of California derive great benefit from rain warnings. On account of the peculiar topography of that region, these warnings are made with a high degree of accuracy, but a few hours before the coming of the rain, yet far enough in advance to enable the owners of vineyards, most of which are connected by telephone, to gather and stack their trays and thus save the drying raisins from destruction. In the cranberry marshes of Wisconsin the flood gates are regulated by the frost warnings of the Bureau, and where formerly a profitable crop was secured only once in several years, it is now the rare exception that damage occurs. Growers of sugar-cane in Louisiana, the truck gardeners from Virginia to the Gulf, and the orange growers of Florida, time their operations by the frost warnings of the Bureau. From the estimates of these industries it is believed that the amount annually saved to them is far greater than that expended for the support of the entire department.

The flood warning service in operation along large rivers is another valuable feature. It is now possible to foretell three to five days in advance the height of the river at a given point within a few inches. The danger line at every city has been accurately determined, so that when a flood is likely to exceed this limit, residents of low districts and merchants having goods stored in cellars are notified to move their property out of reach of the rising waters. An illustration of the efficiency of this system was shown during the great floods of 1897. Throughout nearly the whole area that was submerged, the warning bulletins preceded the flow by several days, and the statisticians of the government estimate that $15,000,000 worth of live stock and movable property was removed to high ground as the result of the forewarnings. Measurements of snowfall in high mountain ranges of the west have given the Bureau information by which very accurate estimates may be made as to the supplies of water from this source, to be expected during the growing season. In this way the weather service has been brought into close contact with those interested in irrigation, and has become a valuable aid to them.

The instruments used in a fully-equipped signal station of the Weather Bureau are most ingenious and perfect in their applications. The ordinary thermometer and barometer, with which most people are familiar, are but rudimentary in the processes of forecasting the weather. Nevertheless they are prime requisites. The barometer registers the changing pressure of the atmosphere. The barograph is an improved barometer, which keeps perpetual record, automatically, of the atmospheric pressure. The telethermometer combines the functions of the thermometer and the telegraph. It registers automatically, inside the signal office, what the temperature is outside, communicating from the thermometer without by an electric current over a wire. The anemometer registers the velocity of the wind. It is a perfectly balanced windmill on a small scale, connected with a dial. The anemoscope is better known in familiar language as a weather vane, for it merely points the exact direction of the wind. The hygrometer measures the humidity of the atmosphere, and thus helps to forecast rains. Then there is a triple register of great value, which records the conditions as to wind, rain and sunshine. All such instruments are gradually being brought to a higher degree of perfection, as increased attention is being given to meteorology.

It was about one hundred years after the invention of the barometer, namely in 1747, that Benjamin Franklin divined that certain storms had a rotary motion, and that they progressed in a northeasterly direction. A hundred years later other scientists gathered data and completely established the truth of that which Franklin had dimly outlined. So it was that Americans were the pioneers in discovering the rotary and progressive character of storms, and in demonstrating the practicability of weather service. This country has always kept in the lead among practical meteorologists, largely because of its area, which renders it possible to construct such a broad picture of air conditions as is necessary in the making of the most useful forecasts. It would require an international service in Europe to equal ours in the extent of area covered, and in practical value. Australia, with an area equal to that of the United States, and well-defined conditions, has followed our example with a highly organized, effective service.

In 1870 Congress established the Weather Bureau under the War Department, and it was administered under the direction of the military branch of the government for some eighteen years, until it was transferred to the Department of Agriculture. Under the new regime its value has multiplied many times and the expenditure of the $1,000,000 annually which the service requires has become of slight consequence in comparison with the immense benefits it produces.

MAN MAKING ASCENSION BY KITES.

HOW THE MODERN THEATER IS CONDUCTED

Something of the glamour of romance and mystery veils the world behind the footlights to those who have never lived within that mystic circle, but the life is anything but romantic and mysterious to the players and the workers.

THE THEATER WORKHOUSE.

On the contrary, while to the public a theater is a playhouse, it is, to those connected with it, something of a workhouse. Either a mental or physical effort is required almost every minute of one's working hours. The ceaseless routine of duties necessary to the completion of each production commences at the desk of the manager, who reads the manuscripts of countless plays, and selects the one he thinks will most please the public.

THE MANAGER'S SELECTION OF A PLAY.

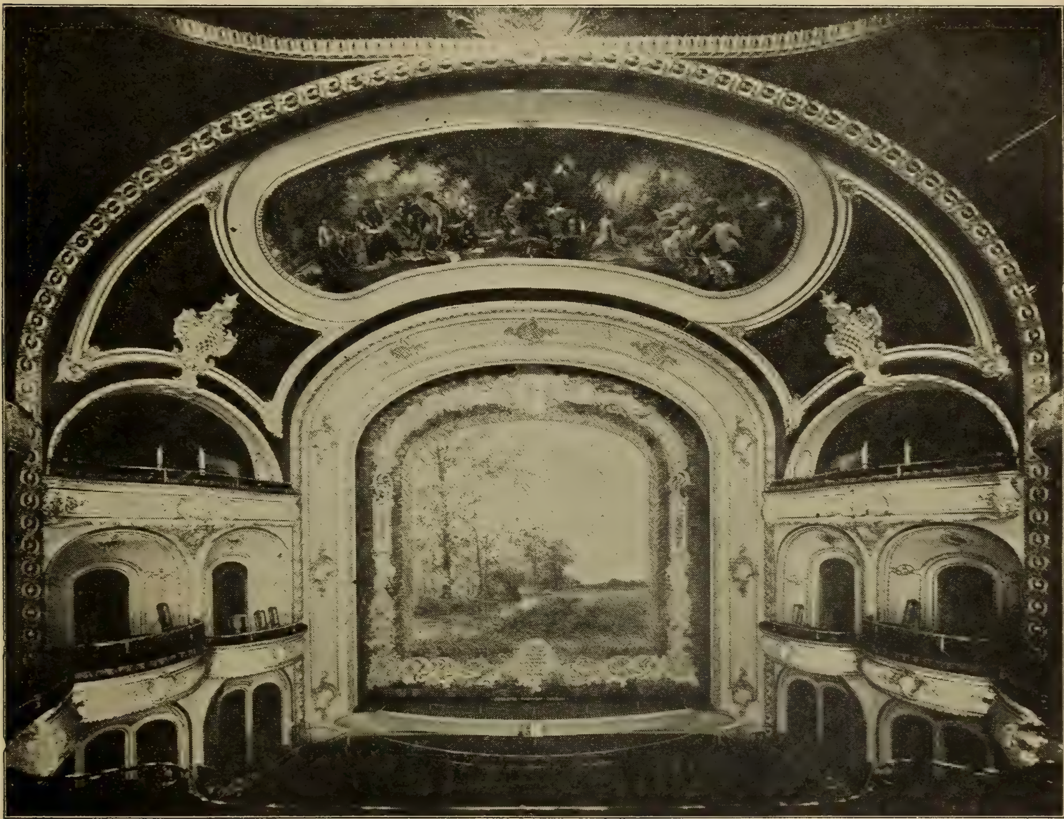
These manuscripts are obtained either from the playwright direct, or from the playwright's agent. Accompanying each manuscript is a statement of the royalty to be paid for the plays used. This right of royalty sometimes costs the manager as much as $1,000 a week. There are plays that cost even more than that; but the average cost is about $500 per week.

WHERE COSTUMES ARE MADE.

THE STAGE DIRECTOR'S PREPARATIONS.

After the manager has selected a play to follow any given production, the manuscripts go immediately to the stage director, who is the power behind the throne (footlights), and the autocrat of the world on and beneath the stage. It is his province to direct, and his duty to apportion, the various tasks involved in the mechanical construction and the mental preparation of a play.

After having read the manuscript the



By courtesy of Geo. R. Lawrence, Chicago.
VIEW SHOWING PROSCENIUM AND BOX ARRANGEMENT OF A MODERN THEATER.
Illinois Theater, Chicago.

stage director begins "to plot," not like the villain in the play, but with pencil and paper. Using those business materials, he draws the scene plot, and several other minor plots, varying in number and importance according to the extent of the production.

THE SCENIC ARTIST, PROPERTY MAN, ELECTRICIAN AND STAGE CARPENTER.

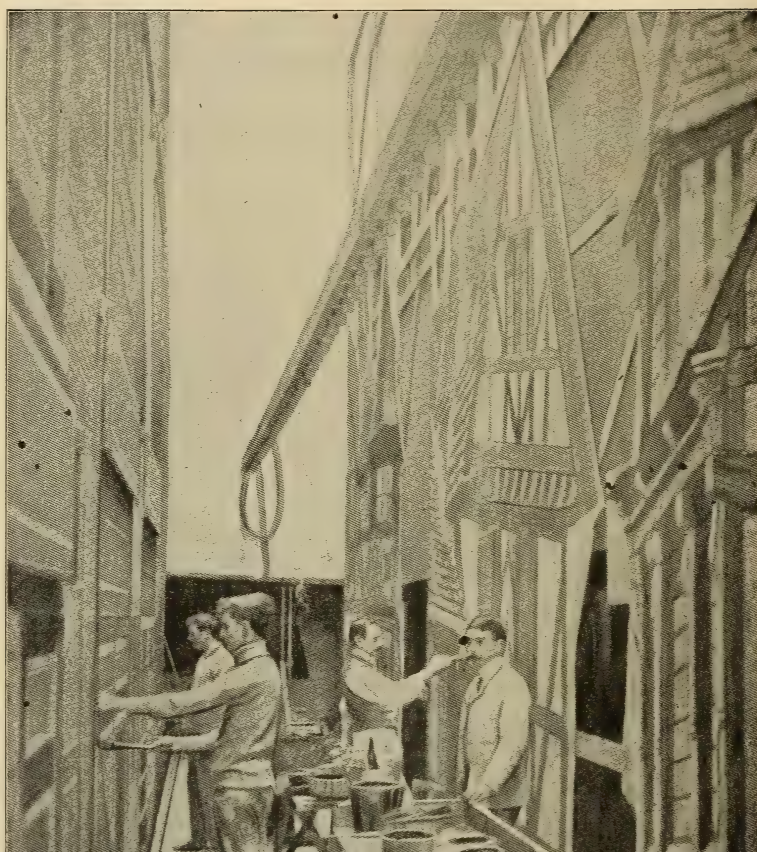
This finished, he turns over the scene plot to the scenic artist, who immediately wrinkles his brows for an imaginative conception of an original interior or a fresh landscape. The stage director assigns the property plot to the property man, who begins to get the hundred and one articles that are to be a part of the coming production. The light plot goes to the electrician, who at once begins planning the light effects for this particular play. Still another plot goes to the stage carpenter, who at once sets about with saw, hammer and nails to make such frames as are necessary.

THE ORCHESTRA LEADER.

The "plotting" does not end here, for, the leader of the orchestra, whose duty it is to select the proper character of music for each situation — something tremulous, for the tears, something lively, for laughter, and something heroic for the melodramatic, is given a "plot."

ASSIGNMENT OF PARTS.

These plots having been formed and distributed, the stage manager then proceeds to cast the play—that is, he mentally canvasses the individual talents of the members of the company and assigns to each one the part most suited to that person. Sometimes a player possesses sufficient versatility to fill any role, but such versatility is rare. Good judgment in assigning the parts is therefore an indispensable attribute of a good stage manager. Not every player, to be sure, is invariably assigned to the part he would most like to play, but the part he would most like to play is not always the part he could play best. As to that, the stage director is the judge, and upon the correctness of his judgment frequently depends the success of the production.

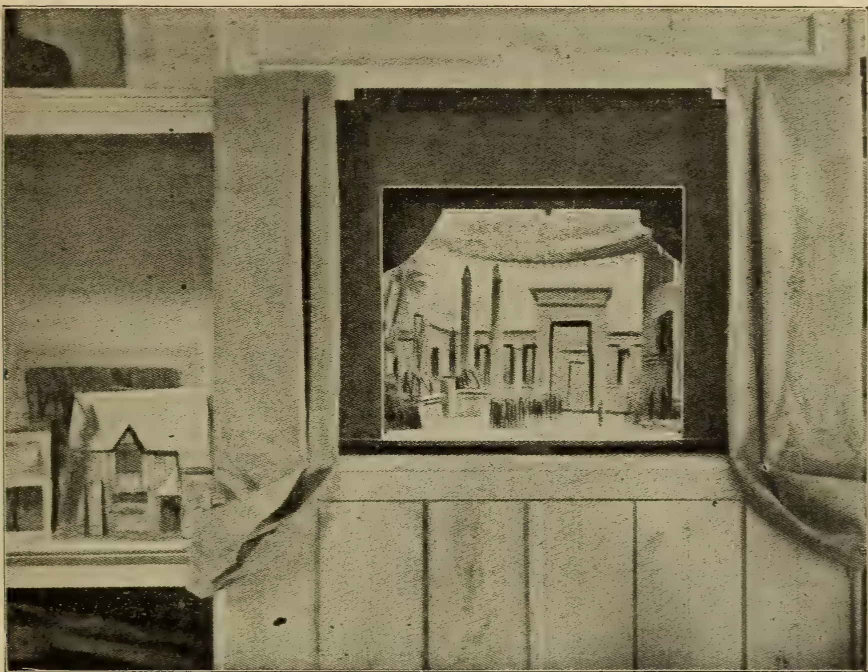


By courtesy of the Columbia Theater, Chicago.

WHERE SCENERY IS PAINTED.

UP IN THE "FLIES."

While the property man goes about the getting together of the "props" the scenic artists high up in the flies are busily working upon the scenery for the coming production. The paints are "cooked" and the colors blended upon such canvases as are to be used. For each production there is an entirely new outfit, giving a freshness of scenic investiture to each play that is practically impossible with traveling organizations.



By courtesy of the Columbia Theater, Chicago.
MODEL FOR STAGE SCENE.

MODERN FEATURES IN STAGE PRODUCTION.

In producing plays at the present time nothing is impossible. Lightning is made to go zig-zag across the stage at the will of the electrician, miniature lakes and fountains are the work of the stage carpenter and manager, and, in fact, so far advanced are the methods of the modern stage that a locomotive may be made to appear as if going through flames at a terrific rate of speed, while in fact it is absolutely stationary. Flame is often made with cloth and colored lights. Steam is made to take the place of smoke. The ear, too, is deceived as well as the eye, and thus the most realistic effects are achieved.

All this varied and elaborate procedure involves a large expenditure, which finds its return, with a very handsome margin of profit, in the patronage received from the theater loving public. The popular tendency to crowd before the footlights never seems to diminish, and if the plays are of the proper character, the amusement and edification obtained from witnessing histrionic productions constitute a wholesome diversion.

GATHERING CORK

The cork tree belongs to the class of oaks, and grows in the impenetrable forests of Spain, in the southwestern portion of France, in Algiers and in Senegambia. There are two trees, quercus suber and quercus occidentalis, that, from time to time, shed their bark or outer coating. This coating covers the cork of trade; but the bark shed by nature is not marketable, because it does not contain any sap, which is necessary to retain the elasticity.

PEELING FOR INDUSTRIAL PURPOSES.

Cork for industrial purposes is gained by peeling. After a tree is three years old, the peeling may commence; but cork of that age is of inferior quality, and the peeling would kill the tree. Trees of twenty years' growth give cork of a fair quality, improving until the tree has gained the respectable age of 100 or 150 years, when the bark becomes hard and unwieldy. Circular incisions are made around the trunk of the tree, which are connected by perpendicular cuts, allowing the two half circles to be removed. Care must be taken not to disturb the fiber, or inner bark, which keeps the tree alive.

PRESSING INTO PLATES.

The peeling process can be repeated on the same tree at intervals of from eight to ten years, yielding cork plates from one to four inches in thickness. The half round cork pieces are pressed into plates while still moist from the tree. Then the rough coatings are removed, and the plates are immersed in boiling water for several minutes and pressed again. After that they are piled in bundles, fastened by iron hoops, and are ready for the market. The raw material will sell from four to 70 cents per pound, according to the quality and thickness. The full-grown cork tree reaches a height of 70 feet, and a diameter of five feet. The quality of the cork depends very much upon the lay of the land,—that exposed to the greatest heat being the finest. Each tree yields cork of two dimensions,—the bark on the northern side of the tree being the thinnest.

The imported tree is said to thrive in some portions of the United States, but the region of the Pyrenees supplies most of the world's demand for the cork of commerce.

The tree blossoms in April or May; the fruit ripens from September to January, falling on the ground as soon as ripe. The acorns are edible, and resemble chestnuts in taste.

Cork intended for the market is generally stripped off a year or two before it would naturally come away. The cork of the first barking, which is removed usually when the tree is about twenty-five years old, is known as the virgin bark. The taking of this bark rather promotes the health of the tree. The average yield of commercial cork is about 45 pounds to one tree.

USES OF CORK.

Aside from stopping bottles and casks, cork is used for floats of nets, swimming belts, etc., and for inner soles of shoes. The waste bits are made into linoleum. The Spanish black used by painters is made by burning cork in close vessels.

THE PHOTOPHONE—THE LATEST SCIENTIFIC MIRACLE.
Telephoning on a Ray of Light Without Wires

POPULATION OF AMERICAN CITIES OF MORE THAN 100.000.

(1910 Census.)

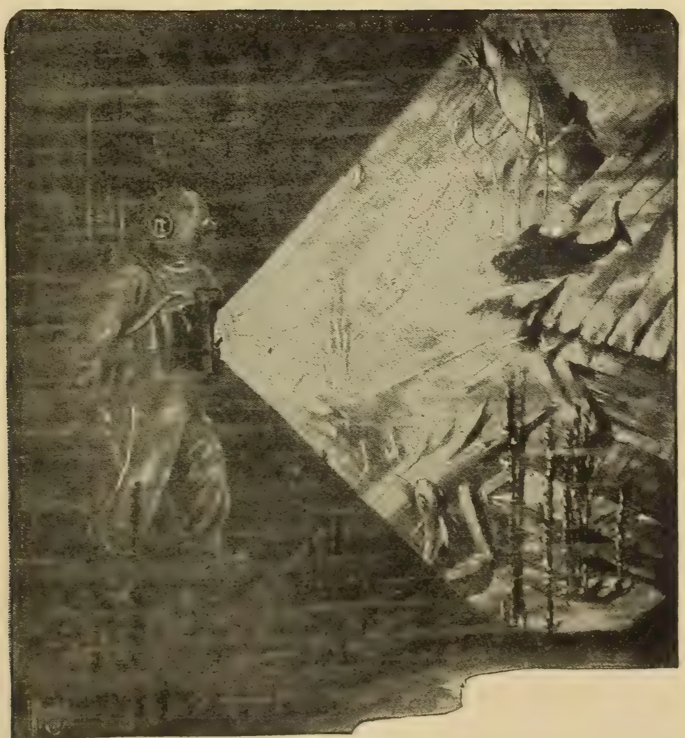
City.	1910.	City.	1910.	City.	1910.
New York, N. Y.	4,766,883	Minneapolis, Minn.	301,408	New Haven, Conn.	133,605
Chicago, Ill.	2,185,283	Jersey City, N. J.	267,779	Birmingham, Ala.	132,683
Philadelphia, Pa.	1,549,008	Kansas City, Mo.	248,331	Memphis, Tenn.	131,105
St. Louis, Mo.	687,029	Seattle, Wash.	237,194	Scranton, Pa.	129,867
Boston, Mass.	670,585	Indianapolis, Ind.	233,650	Richmond, Va.	127,628
Cleveland, Ohio	560,663	Providence, R. I.	224,326	Paterson, N. J.	125,600
Baltimore, Md.	558,485	Louisville, Ky.	223,928	Omaha, Neb.	124,096
Pittsburg, Pa.	533,905	Rochester, N. Y.	218,149	Fall River, Mass.	119,295
Detroit, Mich.	465,766	St. Paul, Minn.	214,744	Dayton, Ohio	116,577
Buffalo, N. Y.	423,715	Denver, Colo.	213,581	Grand Rapids, Mich.	112,571
San Francisco, Cal.	416,912	Portland, Ore.	207,214	Nashville, Tenn.	110,364
Milwaukee, Wis.	373,857	Columbus, Ohio	181,548	Lowell, Mass.	106,294
Cincinnati, Ohio	364,463	Toledo, Ohio	168,497	Cambridge, Mass.	104,839
Newark, N. J.	347,469	Atlanta, Ga.	154,839	Spokane, Wash.	104,402
New Orleans, La.	339,075	Oakland, Cal.	150,174	Bridgeport, Conn.	102,054
Washington, D. C.	331,069	Worcester, Mass.	145,986	Albany, N. Y.	100,253
Los Angeles, Cal.	319,198	Syracuse, N. Y.	137,249		

POPULATION OF AMERICAN CITIES OF LESS THAN 100,000.

(1910 Census.)

City.	1910.	City.	1910.	City.	1910.
Akron, Ohio	69,067	Cranston, R. I.	21,171	Jacksonville, Fla.	57,699
Alameda, Cal.	23,383	Cumberland, Md.	21,839	Jamestown, N. Y.	31,297
Alexandria, Va.	15,329	Cumberland, R. I.	10,107	Janesville, Wis.	13,894
Allentown, Pa.	51,913	Dallas, Texas	92,104	Johnstown, N. Y.	10,447
Alton, Ill.	17,528	Danbury, Conn.	20,234	Johnstown, Pa.	55,482
Altoona, Pa.	52,127	Danville, Ga.	19,020	Joliet, Ill.	34,670
Amsterdam, N. Y.	31,267	Danville, Ill.	27,871	Joplin, Mo.	32,073
Ann Arbor, Mich.	14,817	Davenport, Iowa	43,028	Kalamazoo, Mich.	39,437
Ansonia, Conn.	15,152	Decatur, Ill.	31,140	Kansas City, Kas.	82,331
Ardmore, Okla.	8,618	Des Moines, Iowa	86,368	Kingston, N. Y.	25,908
Argenta, Ark.	11,138	Dubuque, Iowa	38,494	Knoxville, Tenn.	36,346
Arlington, Mass.	11,187	Duluth, Minn.	78,466	Lackawanna, N. Y.	14,549
Atlantic City, N. J.	46,150	Dunkirk, N. Y.	17,221	LaCrosse, Wis.	30,417
Auburn, N. Y.	34,668	Duquesne, Pa.	15,727	Lancaster, Pa.	47,227
Augusta, Ga.	41,040	East Chicago, Ind.	19,098	Lansing, Mich.	31,229
Aurora, Ill.	29,807	Easton, Pa.	28,523	Laredo, Texas	14,855
Austin, Texas	29,860	East Orange, N. J.	34,371	Lawrence, Mass.	85,892
Barre, Vt.	10,734	East St. Louis, Ill.	58,547	Lewiston, Maine	26,247
Battle Creek, Mich.	25,267	Elgin, Ill.	25,976	Lexington, Ky.	35,099
Bay City, Mich.	45,267	Elizabeth, N. J.	73,409	Lima, Ohio	30,508
Bayonne, N. J.	55,545	Elmira, N. Y.	37,176	Lincoln, Neb.	43,973
Belleville, Ill.	21,122	El Paso, Texas	39,279	Little Falls, N. Y.	12,273
Beloit, Wis.	15,125	Enid, Okla.	15,799	Little Rock, Ark.	45,941
Berkeley, Cal.	40,434	Erie, Pa.	66,525	Lockport, N. Y.	17,970
Binghamton, N. Y.	48,443	Evansville, Ind.	69,647	Lorain, Ohio	28,883
Bloomfield, N. J.	15,070	Everett, Mass.	33,484	Lynchburg, Va.	29,494
Bloomington, Ill.	25,768	Fitchburg, Mass	37,826	Lynn, Mass.	89,336
Boise, Idaho	17,358	Flint, Mich.	38,550	Macon, Ga.	40,665
Boone, Iowa	10,347	Fort Dodge, Iowa	15,543	Madison, Wis.	25,531
Braddock, Pa.	19,357	Fort Wayne, Ind.	63,933	Malden, Mass.	44,404
Brockton, Mass.	56,878	Fort Worth, Texas	73,312	Manchester, N. H.	70,063
Brookline, Mass.	27,792	Freeport, Ill.	17,567	Medford, Mass.	23,150
Brownsville, Texas	10,517	Fulton, N. Y.	10,480	Melrose, Mass.	15,715
Burlington, Vt.	20,468	Gadsden, Ala.	10,557	Meriden, Conn.	27,265
Butte, Mont.	39,165	Galveston, Texas	36,981	Middletown, Conn.	11,851
Cambridge, Ohio	11,327	Geneva, N. Y.	12,446	Middletown, N. Y.	15,313
Camden, N. J.	94,538	Glens Falls, N. Y.	15,243	Middletown, Ohio	13,152
Canton, Ill.	10,453	Gloversville, N. Y.	20,642	Moline, Ill.	24,199
Canton, Ohio	50,217	Great Falls, Mont.	13,948	Mobile, Ala.	51,521
Carnegie, Pa.	10,009	Green Bay, Wis.	25,236	Montgomery, Ala.	38,136
Carson City, Nev.	2,466	Hamilton, Ohio	35,279	Mount Vernon, N. Y.	30,919
Cedar Rapids, Iowa	32,811	Harrisburg, Pa.	64,186	Muskogee, Okla.	25,278
Central Falls, R. I.	22,754	Hartford, Conn.	98,915	McAlester, Okla.	12,954
Charlotte, N. C.	34,014	Haverhill, Mass.	44,115	McKeesport, Pa.	42,694
Chattanooga, Tenn.	44,604	Hazelton, Pa.	25,452	McKees Rocks, Pa.	14,702
Chelsea, Mass.	32,452	Hoboken, N. J.	70,324	Nashua, N. H.	26,005
Chester, Pa.	38,537	Holyoke, Mass.	57,730	Newark, Ohio	25,404
Chickasha, Okla.	10,320	Homestead, Pa.	18,713	New Bedford, Mass.	96,652
Chicopee, Mass.	25,401	Honolulu, H. I.	52,183	New Britain, Conn.	43,916
Clinton, Iowa	25,577	Hornell, N. Y.	13,617	New Brunswick, N. J.	23,388
Cohoes, N. Y.	24,709	Houston, Texas	78,800	Newburgh, N. Y.	27,805
Colorado Springs, Colo.	29,078	Hudson, N. Y.	11,417	Newcastle, Pa.	36,280
Corning, N. Y.	13,730	Huntington, W. Va.	31,161	New London, Conn.	19,659
Cortland, N. Y.	11,504	Hyde Park, Mass.	15,507	Newport, Ky.	30,309
Council Bluffs, Iowa	29,292	Ithaca, N. Y.	14,802	Newport News, Va.	20,205
Covington, Ky.	53,270	Jackson, Mich.	31,433	Newport, R. I.	27,149

City.	1910.
New Rochelle, N. Y.	28,867
Newton, Mass.	39,806
Niagara Falls, N. Y.	30,445
Norfolk, Va.	67,452
Norristown, Pa.	27,875
North Braddock, Pa.	11,824
N. Tonawanda, N. Y.	11,955
North Yakima, Wash.	14,032
Norwich, Conn.	20,367
Oak Park, Ill.	19,444
Ogdensburg, N. Y.	15,933
Ogden, Utah	25,580
Oklahoma City, Okla.	64,205
Olean, N. Y.	14,743
Orange, N. J.	29,630
Oshkosh, Wis.	33,062
Oswego, N. Y.	23,368
Oyster Bay, N. Y.	21,802
Pasadena, Cal.	30,291
Passaic, N. J.	54,773
Pawtucket, R. I.	51,622
Pensacola, Fla.	22,982
Peoria, Ill.	66,950
Perth Amboy, N. J.	32,121
Petersburg, Va.	24,127
Pittsfield, Mass.	32,121
Plattsburg, N. Y.	11,138
Portland, Maine	58,571
Portsmouth, Va.	33,190
Poughkeepsie, N. Y.	27,936
Pueblo, Colo.	44,395
Quincy, Ill.	36,587
Quincy, Mass.	32,642
Racine, Wis.	38,002
Reading, Pa.	96,071
Rensselaer, N. Y.	10,711
Revere, Mass.	18,219
Roanoke, Va.	34,874
Rockford, Ill.	45,401
Rock Island, Ill.	24,334
Rome, Ga.	12,099
Rome, N. Y.	20,497
Rutland, Vt.	13,546
Sacramento, Cal.	44,696
Saginaw, Mich.	50,510
St. Joseph, Mo.	77,403
Salem, Mass.	43,697
Salt Lake City, Utah	92,777
San Angelo, Texas	10,321
San Antonio, Texas	96,614
San Diego, Cal.	39,578
San Jose, Cal.	28,946
Sault Ste. Marie, Mich.	12,615
Savannah, Ga.	65,064
Schenectady, N. Y.	72,826
Shawnee, Okla.	12,474
Sheboygan, Wis.	26,398
Shenandoah, Pa.	25,774
Shreveport, La.	28,015
Sioux City, Iowa	47,828
Somerville, Mass.	77,236
South Bend, Ind.	53,684
South Omaha, Neb.	26,259
Springfield, Ill.	51,678
Springfield, Mass.	88,926
Springfield, Mo.	35,201
Springfield, Ohio	46,921
Stamford, Conn.	25,138
Staunton, Va.	10,604
Superior, Wis.	40,384
Tacoma, Wash.	82,972
Tampa, Fla.	38,524
Taunton, Mass.	34,259
Temple, Texas	10,993
Terre Haute, Ind.	58,157
Topeka, Kas.	43,684
Trenton, N. J.	96,815
Troy, N. Y.	76,813
Tulsa, Okla.	18,182
Utica, N. Y.	74,419
Waco, Texas	26,425
Wakefield, Mass.	11,401
Waltham, Mass.	27,834
Warwick, R. I.	26,629
Waterbury, Conn.	73,141
Waterloo, Iowa	26,693
Watertown, Mass.	12,875
Watertown, N. Y.	26,730
Watervliet, N. Y.	15,074
West Hoboken, N. J.	35,403
Weymouth, Mass.	12,895
Wheeling, W. Va.	41,641
Wichita, Kas.	52,450
Wilkes-Barre, Pa.	67,105
Wilkinsburg, Pa.	18,924
Williamsport, Pa.	31,860
Willimantic, Conn.	11,230
Wilmington, Del.	87,411
Wilmington, N. C.	25,748
Winthrop, Mass.	10,132
Woburn, Mass.	15,308
Woonsocket, R. I.	38,125
Yonkers, N. Y.	79,803
York, Pa.	44,708
Youngstown, Ohio	79,066
Zanesville, Ohio	28,026



From Popular Electricity.

ELECTRIC LIGHT FOR USE OF DIVERS.

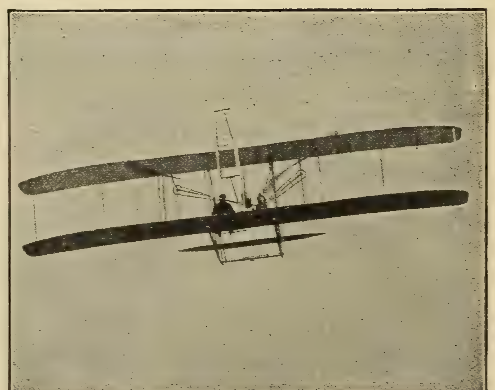
BIG AMERICAN CROPS IN 1910.

Though the aggregate yield of all grains in 1910 was 5,160,426,000 bushels, the largest ever known, the aggregate value of all crops in the table is only $3,735,464,000, or 6.3 per cent less than the aggregate value in 1909, which was $3,971,426,000, owing to an average of 8.5 per cent lower prices. The 1910 yield in bushels was greater than the 1909 yield by 440,985,000 bushels, or 9.2 per cent, and 320,000,000 bushels, or 6.6 per cent, in excess of the previous record-breaking yield of 1906. The corn and oat crops were the largest ever raised, and the wheat crop has been exceeded only twice.

Final estimates of the crop reporting board of the bureau of statistics, United States Department of Agriculture, indicate the harvested acreage, production and value of important farm crops of the United States in 1910 to have been as follows:

Crop—	Year.	Acreage.	Bushels, production.	—Farm value Dec. 1— per bu.	Total.
Corn	1910	114,002,000	3,125,713,000	48.8	$1,523,968,000
Winter wheat	1910	29,427,000	464,044,000	89.1	413,575,000
Spring wheat	1910	19,778,000	231,399,000	89.8	207,868,000
All wheat	1910	49,205,000	695,443,000	89.4	621,443,000
Oats	1910	35,288,000	1,126,765,000	34.1	384,716,000
Barley	1910	7,257,000	162,227,000	57.8	93,785,000
Rye	1910	2,028,000	33,039,000	72.2	23,840,000
Buckwheat	1910	826,000	17,239,000	65.7	11,321,000
Flaxseed	1910	2,916,000	14,116,000	230.6	32,554,000
Rice	1910	722,800	24,510,000	67.8	16,624,000
Potatoes	1910	3,591,000	338,811,000	55.5	187,985,000
Hay	1910	45,691,000	a60,978,000	b$12.26	747,769,000
Tobacco	1910	1,233,800	c984,349,000	d9.3	91,459,000

a-Tons. b-Per ton. c-Pounds. d-Per Pound.



REAR VIEW OF WRIGHT AEROPLANE.

QUESTIONS AND ANSWERS

The following is an easy method of "posting up" on the subjects treated in this volume. They are intended to impress upon the mind the information given. The list covers the World of Work and includes all things which are wont to attract the attention and store the minds of readers and thinkers.

In daily intercourse, both business and social all persons are at times confronted by problems requiring quick solution. To aid in readily solving them these questions are formulated and the answers indicated. They will be found to meet the constantly recurring needs of men and women in every vocation, serving as a medium of ready reference to the Mechanic, Farmer, Artist, Railroader, Clerk, housekeeper, professional and business man, as well as the Sportsman, Speculator, Inventor, Teacher and Student, and all seekers after useful knowledge.

The asking and answering of these questions will prove a welcome benefit and unique entertainment around the fireside, or at social gatherings or any place where pleasure and advancement are appreciated

Questions and Answers

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