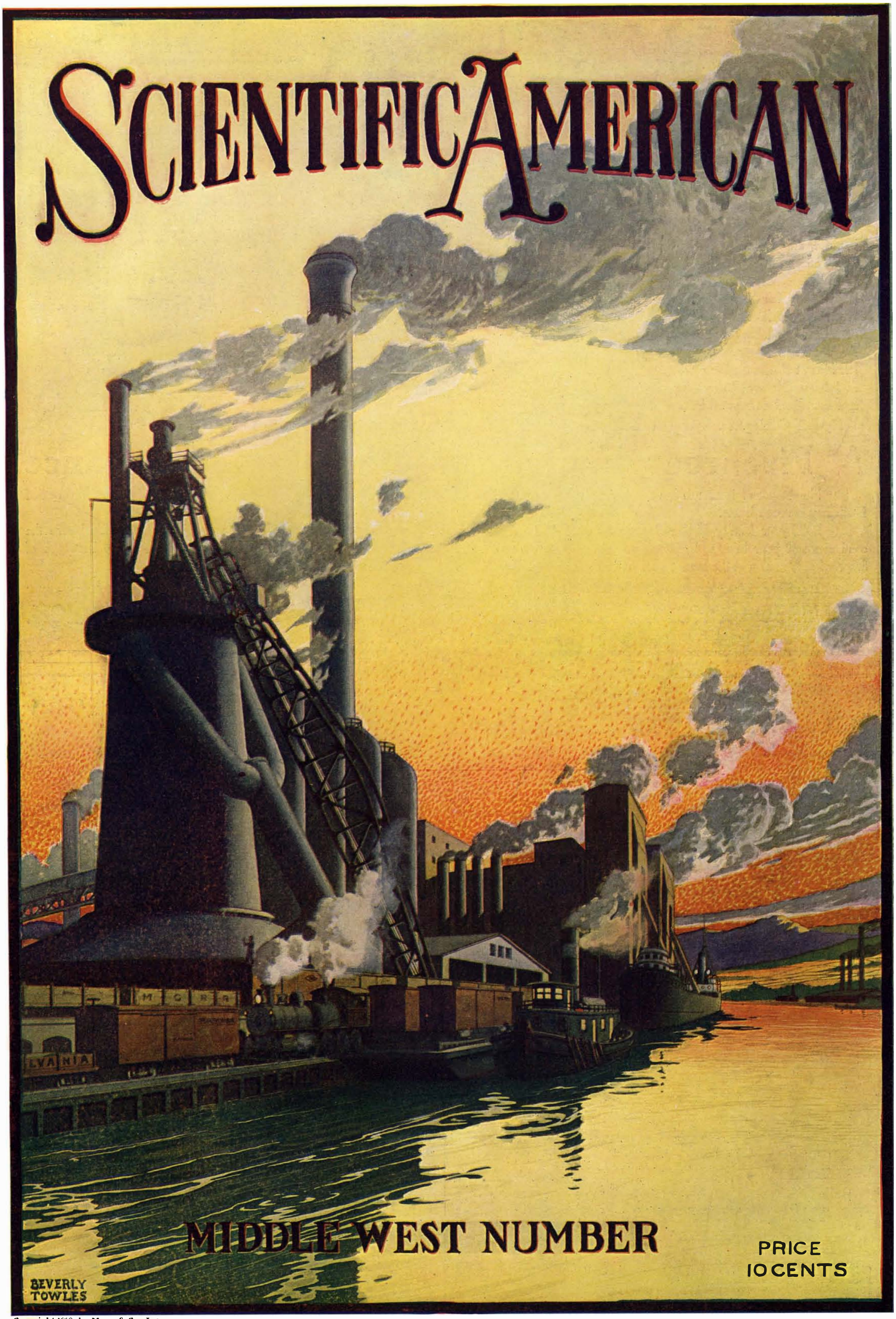

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New York, N. Y.

December 11, 1909

No. 24. Vol. CI.

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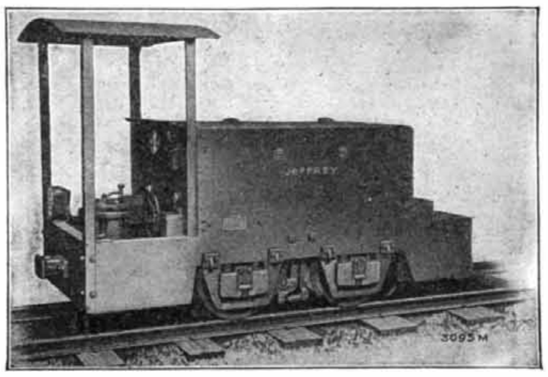

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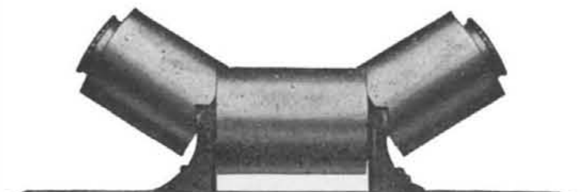

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A POPULAR ILLUSTRATED WEEKLY OF THE WORLD'S PROGRESS

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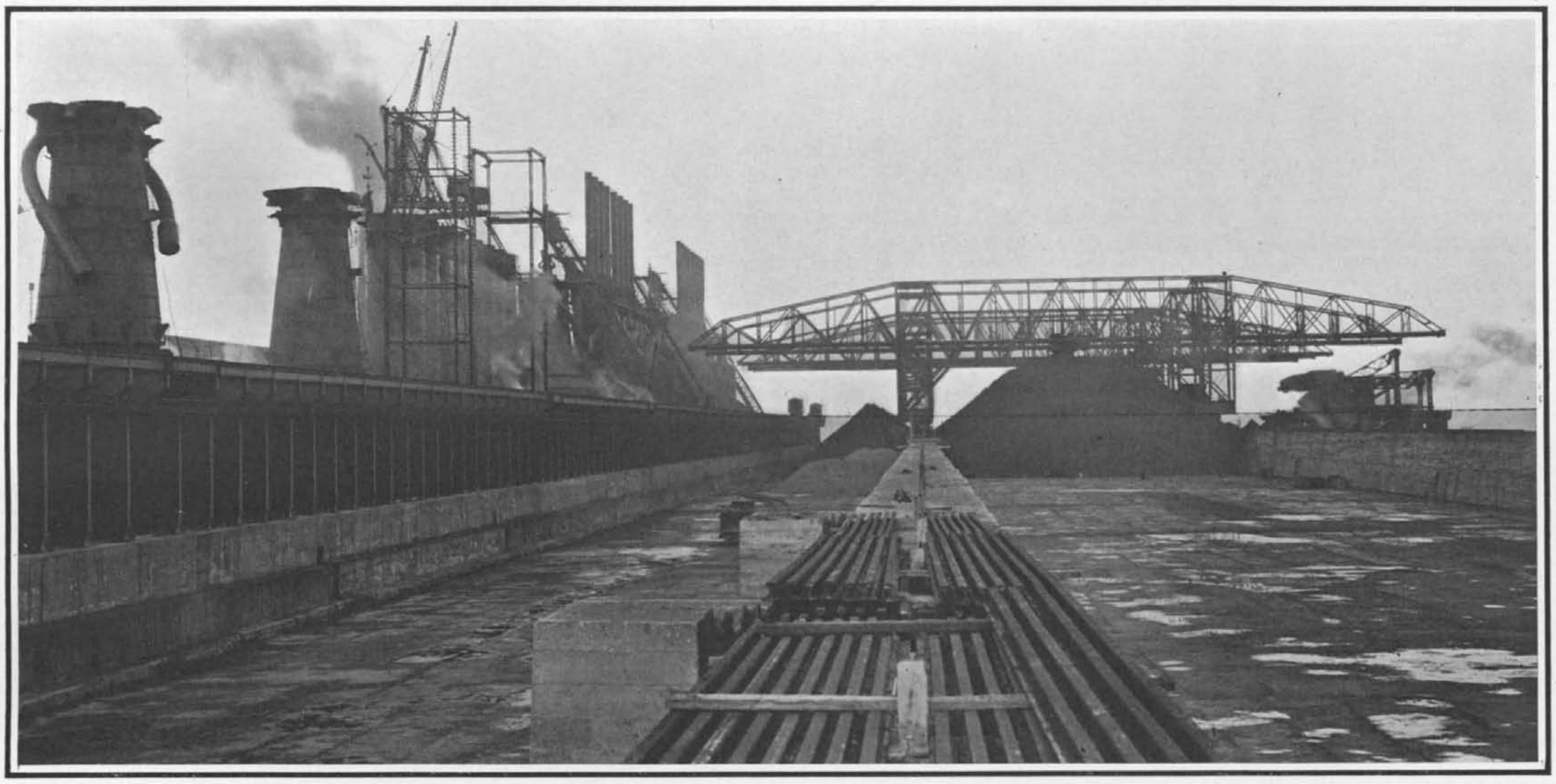

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GARY: THE LARGEST AND MOST MODERN STEEL PLANT IN EXISTENCE.—[See page 441.]

SCIENTIFIC AMERICAN

ESTABLISHED 1845

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NEW YORK, SATURDAY, DECEMBER 11th, 1909.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

AGRICULTURE THE BASIS OF PROSPERITY.

If any doubt existed that agriculture is the true basis of the prosperity of the United States, it must surely give way before the astounding array of figures presented by the Secretary of Agriculture in his Thirteenth Annual Report, which has reached this office as we go to press with the Middle West Number. Figures of statistics that reach into the billions become, at least to the average mind, merely symbolical; but when the Secretary tells us that for the present year the value of farm products in the United States is $8,760,000,000, and that it represents a gain of $869,000,000 over the year preceding, we can understand why it is that not even our vast manufacturing activity, expressed in great steel mills, machine shops, and factories innumerable, can compare in the value of its output with the products of the farm.

Elsewhere in the present issue we have shown how greatly our industrial prosperity has been due to the invention of labor-saving machinery. Particularly potent has been this influence during the past decade, during which there has been an increasing appreciation of and demand for the latest and most improved appliances. Formerly, the scarcity of hired labor discouraged the farmer in the endeavor to get out of his land the full measure of its productive capacity. Thanks to mechanical appliances, the output for a given amount of hired help has been trebled, and in certain classes of work has been multiplied tenfold.

To our excellent State agricultural colleges, furthermore, and the various educational institutions devoted to agriculture, to say nothing of the work of the Bureau of Agriculture, is due much of the credit for the present prosperity. The farmer of to-day is getting a larger return from the land because of his more intimate knowledge of the character of the soil; the nature of the crops for which that soil is adapted; and the proper times, seasons, and methods of plowing, seed time, and harvest.

These influences, coupled with the rapid increase in the acreage of cultivated land, and the breaking up of the old ranges and huge wheat farms into smaller holdings on which intensive cultivation is carried on, have served during the past eleven years to just about double the annual value of farm products, the increase being from $4,417,000,000 to $8,760,000,000. The total value for these eleven years reaches the enormous sum of seventy billion dollars. Little wonder is it that in some of the great corn and wheat-producing States of the Middle West the farmers are enjoying a period of unparalleled prosperity. This princely sum has served to sweep away the farm mortgage—that nightmare of the struggling husbandman of fifteen or twenty years ago; it has established banks; has replaced the tumbledown homestead with modern homes filled with the latest conveniences of civilization; by telegraph, telephone, and railroad, it has brought the farmer into intimate touch with the outside world, making him, in no mean sense, cosmopolitan; and it has served to render doubly secure the traditional right of the farmer to be considered as the backbone of the nation in its larger financial and political interests.

In looking through the details of this report, we find that the corn crop takes the lead in value, with a total of $1,720,000,000; and this, the Secretary tells us, nearly equals the value of the clothing and personal adornments of the 76,000,000 people enumerated by the census of 1900. Equal in value to the gold and silver coin and bullion of the United States, "it has grown up from the soil and out of the air in 120 days —$15,000,000 a day for one crop!" Second in value is the cotton crop, the lint and seed of which are worth about $850,000,000 to the farmer. Then follows wheat, whose crop this year is worth about $725,000,000 at the farm. The hay crop represents 665 million dollars; oats, 400 million dollars; potatoes, 212 million dollars; and tobacco, nearly 100 million dollars.

In conclusion, it should be noted that the increase of $869,000,000 in the value of farm products this year over 1908 is sufficient to buy a new equipment of farm machinery for over six million farms, and that the value of the cereal crops of the farmer would pay for all the machinery, tools, and implements of the entire manufacturing industry. Finally, the Secretary tells us that the value of all crops of $5,700,000,000 would make a half payment on the value of all steam railroads according to the valuations of 1904.

The pertinence of these statistics to an issue devoted to the Middle West will be appreciated when it is borne in mind that the Middle or Central West contains more than one-half of the wealth invested in improved farms in the United States; that it has more than one-half of the live stock and neat cattle; that it produces nearly 80 per cent of the food products, and more than one-half of the cereals that are grown in the entire country.

SEA STRENGTH OF PRINCIPAL NAVAL POWERS.

Toward the close of each year our Navy Department, through its Office of Naval Intelligence, issues a comparative table showing the warship tonnage of the principal naval powers. It is based on the number and displacement of warships built and building of 1,000 or more tons, and of torpedo craft of more than 50 tons. The statement for the present year, which shows the relative standing of the navies on November 1st, possesses special interest because it gives an authoritative statement as to the present strength of the navies in ships of the "Dreadnought" type—a subject regarding which the public has been treated during the past few months to overmuch literature of a sensational and misleading character.

Of battleships of the "Dreadnought" type, Great Britain has afloat and completed four, Germany two, and the United States two. France, Japan, Russia, Italy, and Austria have not as yet completed a ship of the "Dreadnought" type. Of "Dreadnoughts" under construction, Great Britain possesses seven, Germany six, the United States four, Japan two, Russia four, and Italy one. France and Austria have no "Dreadnoughts" under construction. In this connection it should be mentioned that our Navy Department does not consider that a battleship is entitled to be reckoned as of the "Dreadnought" type unless her main battery consists entirely of guns 11 inches or more in caliber. This eliminates the six French battleships of the "Danton" type, carrying four 12's and twelve 9.4's, and the three Austrian battleships of the "Ferdinand" type, carrying four 12's and eight 9.4's.

Of armored cruisers of the "Invincible" type, Great Britain possesses three, and has two under construction; Germany has none completed, and three under construction; and Japan has one completed and one building. Adding together the totals for ships armed entirely with big guns, both "Dreadnoughts" and "Invincibles," we find that Great Britain has seven completed of 125,450 tons displacement, and nine under construction of 191,000 tons; Germany has two completed of 36,000 tons, and nine under construction of 183,000 tons; the United States has two completed of 32,000 tons, and four under construction of 83,460 tons; Japan has built one of 14,600 tons and is building three of 56,200 tons total displacement; Russia has none completed and is building four of 92,000 tons total displacement; Italy has none completed, and one of 18,600 tons under construction; France and Austria have nothing either afloat or on the stocks of the all-big-gun type.

Of battleships of the first class, other than "Dreadnoughts" (in which enumeration the Navy Department includes all battleships of about 10,000 tons displacement or over that are less than twenty years old, unless they have been reconstructed and re-armed since 1900) Great Britain possesses forty-nine of 714,750 tons displacement; Germany, twenty-four of 282,424 tons; the United States, twenty-five of 334,146 tons; France, seventeen of 215,270 tons; Japan, twelve of 171,898 tons; Russia, five of 166,000 tons; Italy, ten of 122,600 tons; and Austria, three of 31,800 tons. Great Britain, Germany, the United States and Italy are building no battleships of this class, but France has six, Japan one, Russia four, and Austria three under construction.

Of armored cruisers other than the "Invincible" type, Great Britain possesses thirty-five of 416,600 tons displacement; Germany, nine of 86,693 tons; the United States, twelve of 157,445 tons; France, twenty-one of 192,982 tons; Japan, eleven of 180,900 tons; Russia, seven of 70,200 tons; Italy, eight of 59,000 tons; and Austria, three of 18,800 tons.

In the class of torpedo-boat destroyers, Great Britain leads with 148, followed by Russia with 97, Germany with 79, Japan with 56, France with 56, the United States with 17, Italy with 17, and Austria with 6. Great Britain has 20 torpedo boat destroyers under construction, the United States 19, Germany 18, France 16, Japan 3, and Austria 6.

The following table gives the relative order of warship tonnage both at present and when all the ships now under construction are completed. It will be noted that the only change in relative standing in the second list is that Germany will take the second position at present held by the United States.

RELATIVE ORDER OF WARSHIP TONNAGE.

Nation.	At Present, Tonnage.	With All Vessels Completed, Tonnage.
Great Britain	1,758,350	2,005,873
United States	682,785	785,687
Germany	609,700	820,692
France	602,920	766,906
Japan	396,368	489,704
Russia	259,263	412,250
Italy	216,038	257,818
Austria	114,897	167,297

Referring to the statistics of total displacement, particularly of battleships of the pre-"Dreadnought" type, we wish to draw attention to the fact that although Germany possesses only one battleship less than the United States, the average displacement of the German ships is very much smaller, being about 11,770 tons as against 13,370 for the United States battleships. Furthermore, our strength in this class of vessel is incomparably stronger, since every one of these twenty-five ships carries a main battery of four guns of 12 or 13-inch caliber, whereas ten of the German battleships carry nothing heavier than a 9.4-inch gun, a weapon which at the great ranges of 7,000 to 9,000 yards at which modern battles will be fought would be altogether ineffective against battleship armor. Hence, as late as a year ago, when Germany had no "Dreadnoughts" afloat, she actually possessed only fourteen battleships capable of fighting effectively at modern ranges, as against twenty-five flying the United States flag, and forty-nine under that of Great Britain.

It is here that the careful observer of naval development must look for an explanation of the feverish haste with which Germany is building a fleet of "Dreadnoughts." The short-sighted policy which led to the mounting of the 9.4-inch gun as the principal arm in her first two squadrons of battleships, left her navy in a very serious condition when the absolute superiority of the 12-inch gun was demonstrated in the battle of the Sea of Japan. Her present lavish expenditure on battleships must be regarded rather in the light of an effort to retrieve a disastrous error than as a distinct challenge to the supremacy of the British or any other navy.

Nor is it any answer to this view of the case to state, as has so often been done of late, that the construction of the first "Dreadnought" robbed all existing battleships of their right to be named as such. We confidently predict that the battleships of the older class will play an unexpectedly important *rôle* in the next great war; and when two theoretically unsinkable fleets of "Dreadnoughts" have hammered each other into a state of comparative exhaustion, it will be the nation that can send in the most numerous second line of older ships, armed with a mixed battery of 12's and smaller rapid-fire pieces, that will win the day.

THE SECOND REFRIGERATION CONGRESS.

The Second International Congress of Refrigeration will convene in Vienna, Austria, from September 29th to October 3d, 1910. If anything like the interest displayed at the first congress is experienced, the meeting will be a tremendous success.

At the first international congress, which was held in Paris, France, October, 1908, out of a total membership of more than 6,000, about 2,000 were in actual attendance from all parts of the world. About thirty delegates went from America (out of a membership of 401), representing the principal cold-storage houses, manufacturers of ice-making machines, and other allied industries. The first congress was a complete success, and has been the means of arousing the highest interest in the work of refrigeration. Since it was held, national associations of refrigeration have been formed in many different countries, including the United States, Great Britain, Germany, Austria, France, etc., where the preservation of perishable products is being investigated and studied with great care. There is every reason to expect substantial results of a practical character. The second congress, to be held in Vienna in 1910, is being organized very systematically, having the advantage of the experience of the first congress, and it is safe to say that the second congress will make still more valuable additions to our knowledge on the subject involved.

These matters are of the greatest importance to a large and growing industry, particularly in the United States, involving as they do the encouragement of growers and producers of perishable products.

According to the Geological Survey, the United States leads all other countries in the conversion of raw asbestos into manufactured products, although much less than 1 per cent of the material used is mined in this country.

ENGINEERING.

Plans for another subway in Brooklyn are being considered by the Public Service Commission. If adopted, this will be an extension of the Brooklyn part of the bridge loop through the Eastern Parkway and Brownsville sections.

The efforts of the Chilian engineer, Señor Unduraga, for a canal project which had as its object the construction of a rival system to the Panama Canal, have been abandoned. The canal was to extend from the Gulf of Darien along the Altrato River and its branches across Colombia to the Pacific. German and British capitalists have expressed their willingness to build a canal which cannot be closed in case of war; the Colombian government, however, would not agree to give a concession, owing to the fear of possible reprisals on the part of the United States.

The new steamers "Olympic" and "Titanic" will be equipped with glass screens on the promenade decks, so that an unobstructed view seaward can be obtained by the passengers in all weathers. Passengers suffer much discomfort by the heavy canvas screens which are strung into place when rain or spray drives on board. The new glass screens will not interfere with the view of the boisterous sea, and will also do away with the stuffy feeling engendered by the canvas. The "Rotterdam" is thus equipped, and the novelty has met with much favor. The windows are of heavy plate glass, carefully balanced, and slide up or down in the steel fittings which complete the seaward side.

The War Department of the United States has been strongly fortifying the islands at the mouth of Manila Bay. On El Fraile Island a fixed battleship of concrete having two steel turrets has been erected, in each of which turrets are mounted two 14-inch guns, which can be trained in any direction by the gun crew inside. The guns are operated by the general fire-control station on Corregidor Island, where the principal fortifications of the mouth of the bay are located. These fortifications are practically complete, and include six 12-inch, one 10-inch, four 6-inch, and four 3-inch guns. There are also twelve 12-inch mortars and sufficient equipment for mining the two channels to Manila Bay. The artificial ship referred to will be about 100 feet wide and 1,200 feet long.

One hundred and fifty locomotives of the Lehigh Valley Railroad are being equipped with a new fuel-saving device. On all locomotives the air-brake pumps are operated by steam, and it has been the practice to conduct the exhaust steam from the pumps to the smokebox, to which the stack is attached, and then to release it, causing a draft. Considerable work is done by the brake pumps when the locomotive is at a standstill, thus causing a needless loss of fuel. By the new arrangement, the exhaust steam is carried outside instead of inside the smokestack. Tests made by the above-named railroad show that the company is saving about 1,000 pounds of coal per locomotive on the descent of the grade from Glen Summit to Penn Haven Junction, Penn., a distance of twenty-six miles.

Heavy explosions in the sewers of a portion of New York city containing many garages, states a contemporary, again draw attention to the danger of allowing petrol to enter sewers. Some of these explosions were so violent as to resemble the explosion of a small boiler. Manhole covers were blown into the air, windows in the neighborhood were shattered, and a number of persons injured. The sewers of the city discharge into tide water, and at high tide the sewage in them backs up in some cases. It is probable that petrol floated on the surface of the sewage when the latter was backed up by high tide, and its vapor was ignited by a spark that might have been due to several causes. While such explosions will not follow every discharge of petrol into sewers, their occasional occurrence and the possibility of much serious injury from them, states our contemporary, are a justification for rigid rules efficiently enforced to prevent the practice.

A new device for the prevention of train collisions was recently tested on the Erie tracks between Newark and Nutley, N. J. The device is an electric one, and is intended to obviate head-on collisions. When the fast-approaching trains equipped with the new device get within half a mile of each other, the air brakes are set automatically, not with the usual suddenness in an emergency, but with a gradually increasing force, the same as a skillful engineer would employ in bringing his train to a halt at a station. The trains stopped far enough away from each other to avoid mishap, and all this happened without either engineer moving a hand toward the throttle lever or air brake, the device working automatically. The invention is operated by a third rail, the shoe from the locomotive touching the rail, and receiving power through it both for the operation of the emergency brake and also for a telephone. The principle is similar to that of the block-signal system, the track being divided into zones. The brakes can be applied sharply or their operation may be graduated, so that trains may be slowly brought to a standstill.

ELECTRICAL.

Electrical exhibitions seem to be growing in favor with manufacturers, and also receive hearty support from the general public. Only the other day Boston had its first electrical show, and now we learn that San Francisco is to have one from January 29th to February 5th, and Philadelphia during the week beginning February 14th, 1910.

A firm in Germany that is building a storage battery locomotive has adopted the Edison storage battery because of its efficiency and lightness. A small locomotive about 25 feet in length has been built. It is equipped with two series motors of 35 horse-power each, which are geared to the axles. The locomotive weighs 19½ tons, including the battery, which weighs 5.9 tons. At a recent test the locomotive traveled 130 miles on a single charge, drawing a car weighing 33 tons.

The city of Ashtabula, Ohio, is being fitted with a new telephone equipment, which is called "automanual," for the reason that it is largely automatic, though it requires some manual control. The telephone operator is provided with three sets of keys, one of which is operated to connect her receiver with the calling line, and as soon as she receives the number she presses keys corresponding to this number, and then operates a starting key, which automatically connects the calling line with the desired subscriber. This done, the two circuits are disconnected from all other lines and from the operator, so that the conversation cannot be overheard or interrupted by anyone.

The German Agricultural Department has been developing the peat lands between Aurich and Wilhelmshaven. A canal has been dredged through them, with small branch canals to drain out the bog. It was found necessary to operate the machinery used for this purpose with electricity, because the vibration of steam engines caused earth slips. Accordingly, an electric power station was established. The quantity of peat obtained from these lands was so large that it was difficult to find a market for it all without doing injury to the smaller peat-bog owners. Consequently, the peat was used in the power station for fuel, and the power output was increased so as to supply distant centers as well as the immediate neighborhood with current.

Steam turbines are not the best prime movers for driving propeller shafts, because they are not sufficiently flexible and their greatest efficiency is obtained only when they are operating at speeds that are too high for the propellers. For this reason efforts have been made to introduce an efficient transmission gear between the turbine and the propeller shaft. At a recent meeting of the Society of Naval Architects and Marine Engineers, held in this city, a paper was read by Mr. W. L. R. Emmet on this subject, proposing the use of a combination electric drive. While the general idea is not new, Mr. Emmet presents some novel details. Twin screws would be used, each driven by an electric motor and a low-pressure turbine, the motor being energized by a generator connected to a high-pressure turbine. The low-pressure turbine would deliver three-fifths of the power when traveling at full speed, and at low speed would carry no load whatever. A proposition has been made to the government to equip one of the new battleships with this system.

A number of questions on electrolysis were submitted by the chairman of the Electrolysis Committee in Chicago to the United States Bureau of Manufactures for investigation by American consuls in ten of the largest European cities. The questions were as follows: 1. The use of the track rails for the electric return circuit of street railway lines. 2. The permissible drop in potential over the return circuits of street railway lines. 3. The maximum difference in potential between track rails used as return circuits and gas pipes, water pipes, or other metallic structures contiguous to the track. 4. Regulations or practices with reference to electrically connecting track rails to gas mains, water pipes, or other metallic sub-structures. A summary of the answers of the consuls in the cities referred to has just been published in the Daily Consular and Trade Reports. In all of the cities rails are used for the return circuit. The permissible drop in potential over street railway return circuits in London is 7 volts maximum; in Paris, 1 volt per kilometer, 5 volts maximum; in Vienna, 5 to 7 volts; St. Petersburg and Moscow, 1.5 volts in the city and 3 volts in the suburbs; Glasgow and Liverpool, 7 volts, and Christiania, 10 volts. The potential difference between track rails and contiguous pipes for London was pipes +1.4 volts and pipes —4.2 volts; Paris, average of 1 volt; Vienna maximum observed, 1 volt; Glasgow observed less than 1 volt; Liverpool maximum, 4.5 volts; Christiania maximum, about 5 volts. In London and Glasgow electrical connections between negative returns and contiguous pipes are permitted. The cities of Berlin and Brussels make no specific regulations regarding any of the last three questions.

SCIENCE.

Prof. Hergesell of the Strasburg University is bound for St. Thomas, West Indies, to make atmospheric observations on the Atlantic as part of an international study undertaken by the great meteorological observatories of the world.

A German chemist has found 135 grains of free organic bases, estimated as nicotine, and 10 grains of combined organic bases, estimated as nicotine, in the smoke from 300 cigars. Hence, of the entire quantity of organic bases which is contained in tobacco smoke, 93 per cent are present in the free state.

French colonial authorities have inaugurated a serious attempt to introduce in the French market the zebu of Madagascar as a substitute for beef. The first batch of a dozen carcasses sold in the Paris stalls brought the prices of the highest grades of cattle. Herds of zebus, otherwise known as Indian oxen, which have been threatened with extermination, are now being rapidly restored, and probably 4,500,000 head roam the plateaus of Madagascar. The meat of the zebu is said to be savory and nutritious, and is equal to beef.

Some fabrics can easily be made waterproof by soaking them in a solution of celluloid in acetone, ether, amyl acetate, or other volatile solvent. The evaporation of the solvent leaves the fabric coated with a thin film of celluloid which is firmly united with the fiber. The thickness of the film can be increased by repeating the operation or by using a stronger solution. Fabrics thus treated are absolutely waterproof and can be washed without absorbing water. Linen which is first starched and then treated by this process can be washed with soap and water without removing the starch.

Plans for a national Audubon university on the University Settlement plan, to be endowed with $1,000,000, have been announced in this city. Based on the known annual crop loss of $1,000,000,000, due to the spreading pests that the insect-eating birds destroy, the calculations of the National Association of Audubon Societies, which is back of this project, show that the teaching of bird value from such an institution must result in wiping out at least one per cent of the huge national penalty for popular lack of knowledge on this subject. For every hundred thousand dollars put into this work of economic education a million is sure to be saved to the agricultural interests of the whole people. Successful agriculture means general prosperity, and thus every merchant, manufacturer, and business man of any sort is vitally interested and should bear his part in the plan to educate the public in the great economic principles of bird conservation.

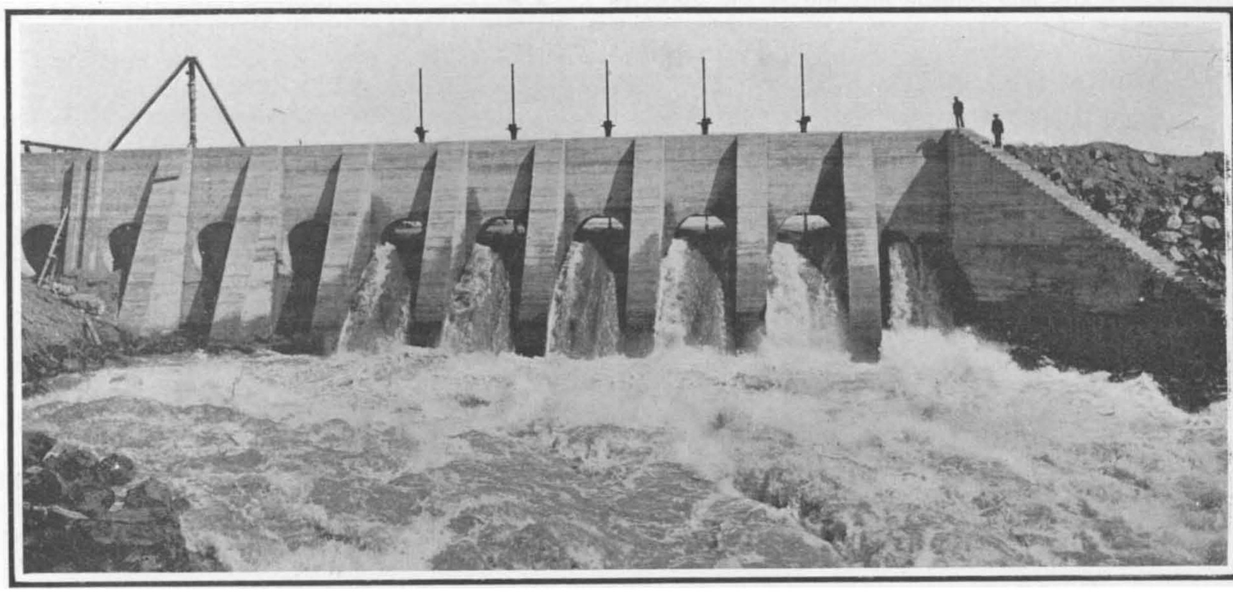
The manioc root contains from two to three hundredths of one per cent of hydrocyanic or prussic acid, which is so poisonous that even this small proportion may produce serious results if it is not thoroughly removed by washing, in the preparation of tapioca, semolina, and other food products which are obtained from the manioc. The presence of prussic acid in these products has been detected by analysis. The same statement is true of the coarser products employed in brewing, distilling, and cattle feeding, some of which have been found to contain a quantity of hydrocyanic acid equivalent to a dose of more than half a grain Troy in the daily ration of an animal. Thorough cooking volatilizes the hydrocyanic acid already present and destroys the diastases which convert certain saccharine ingredients into cyanogen compounds, as has been proved in the case of Javanese and Burmese beans, which also contain hydrocyanic acid, but manioc products are often fed raw. They should always be thoroughly cooked, and should be analyzed if the slightest ill effect follows their use.

Mr. C. P. Butler, astronomer at the Observatory of Solar Physics, has just presented to the Royal Photographic Society of London some very curious photographs of the spectra of Jupiter, Saturn, Uranus, and Neptune, taken by the American astronomer Percival Lowell at the Flagstaff Observatory. There are, in fact, in these spectra, absorption bands which coincide with the rays of chlorophyl, which is, as everyone knows, the green coloring matter of vegetable cells. Thus, one would be led to believe, from these results, that these planets might be covered with some sort of vegetation colored with chlorophyl. Remark worthy of attention: The lines corresponding with the absorption bands of chlorophyl are more intense as the planet is farther from the sun, so that it is on Neptune that plants would be met with in greatest numbers and would be most vividly colored with green. But again, it would have to be admitted that these planets were all covered with luxuriant vegetation at the moment when the photographs were taken, which seems all the more improbable, because everything leads us to believe that Jupiter and Saturn are worlds far from being completed. However, these results are very interesting, although contradicting the opinions generally received, and they deserve to be noted while awaiting another explanation.

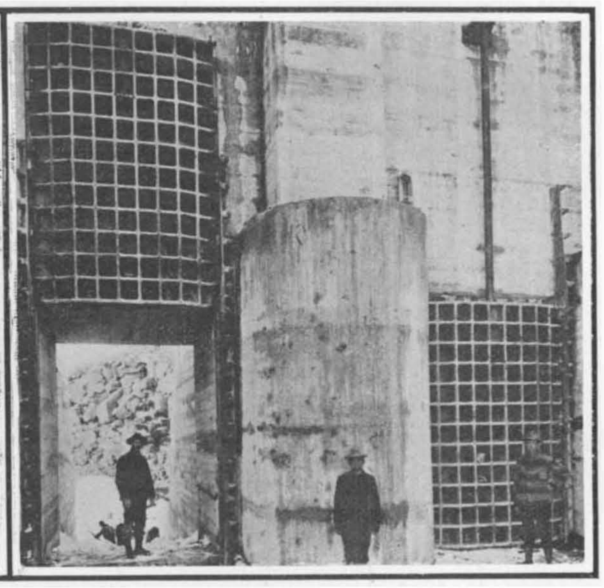
The Reclamation of the Arid Lands of the West.

Of all the public works undertaken by the United States government, there is probably none that is more popular than the noble scheme for the reclamation of the arid and semi-arid lands of the West. The story of the construction of huge artificial reservoirs, far-reaching canals, and costly tunnels, for the storage of the flood waters and their conveyance to barren lands which await only the magic touch of the irrigation ditch to develop their wonderful fertility, is one of fascinating interest; and the progress of the work has been made thoroughly familiar to the people of the United States by the brush and camera of the artist and the ever-ready pen of the descriptive writer.

We must not make the mistake, however, of supposing that the history of irrigation in the United States dates from the year 1902, when the government decided to apply its vast resources to the problem. For its beginning we must go back to the remote and unwritten past, even to the romantic age of the cliff dwellers; for there is clear evidence that in the valleys of New Mexico there once existed a complete system of irrigation canals, that served to render these now desolate districts both fertile and populous. For reasons which we do not know, and probably never shall, these ancient and highly developed races degenerated; their homes fell into decay; and their great engineering works became obliterated. Centuries later, with the advent of the Spanish settlers, irrigation was reintroduced in southern California and in the lower valley of the Rio Grande. The mission fathers, also, by the aid of small dams and canals, rendered

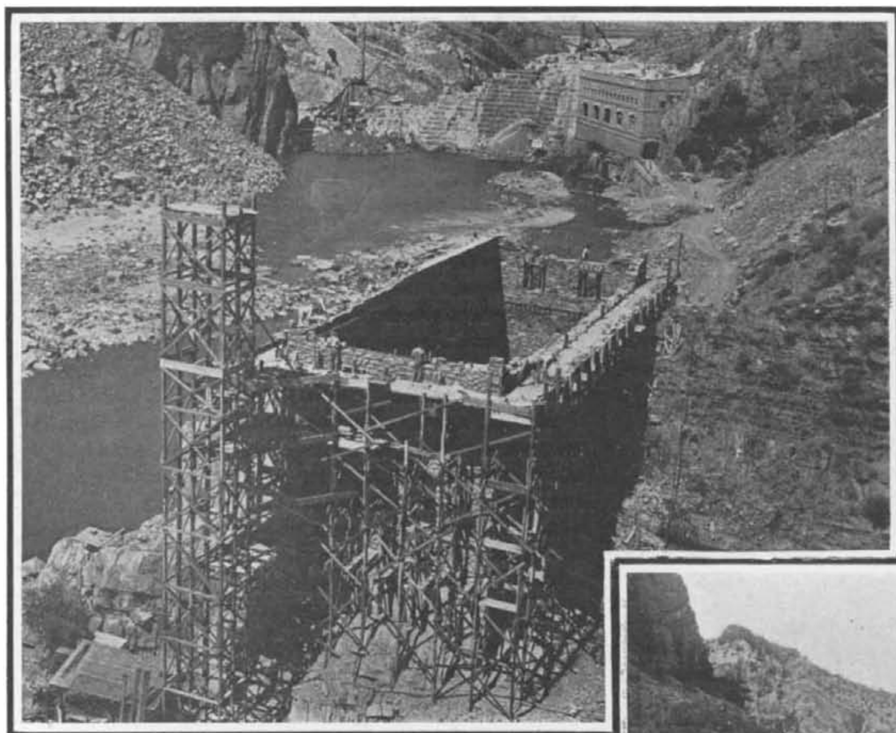


This view shows 22,000 second-feet passing through five 8 x 12 foot gates and five large and two small penstock openings in diversion channel.



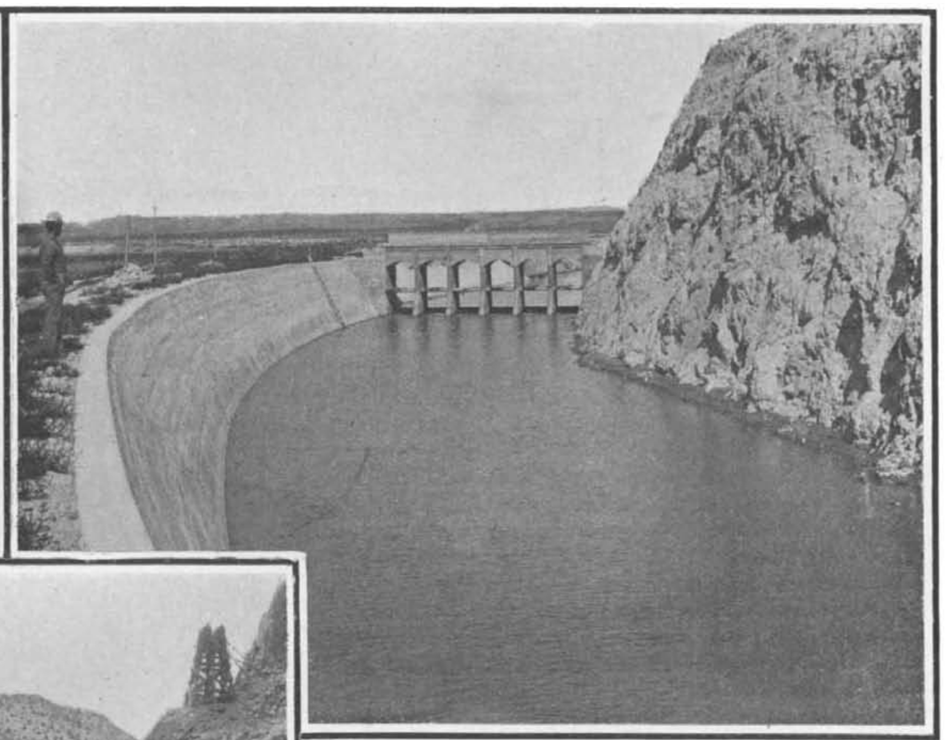
Two of the 8 x 12-foot coffin gates in diversion channel dam.

MINIDOKA PROJECT, IDAHO.



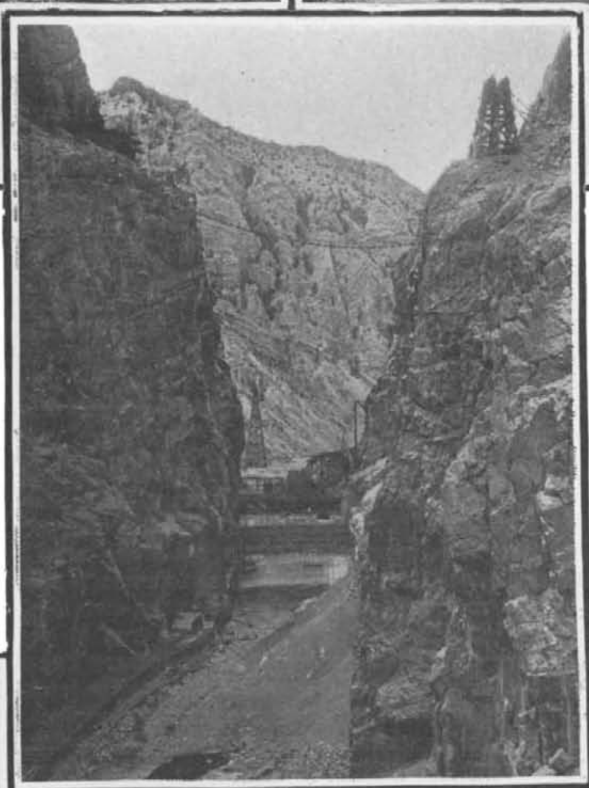
Height of dam, 284 feet. Impounds 1,284,000 acre-feet of water. Will irrigate 210,000 acres. The power house is shown in the foreground.

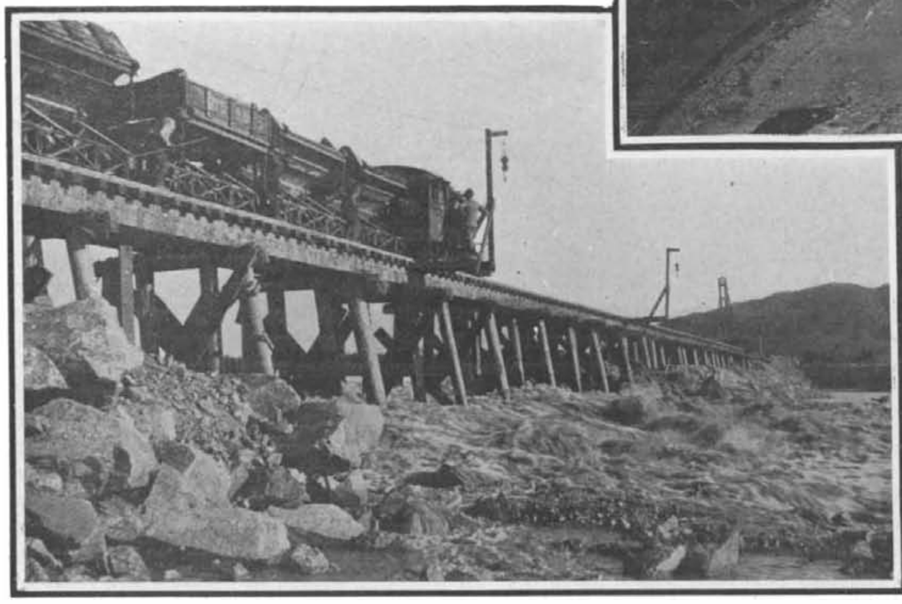
ROOSEVELT DAM. SALT RIVER PROJECT, WYOMING.



Interstate waterway at Mollies Fork.

NORTH PLATTE PROJECT, NEBRASKA-WYOMING.





Trainloads of rock were dumped into the stream.

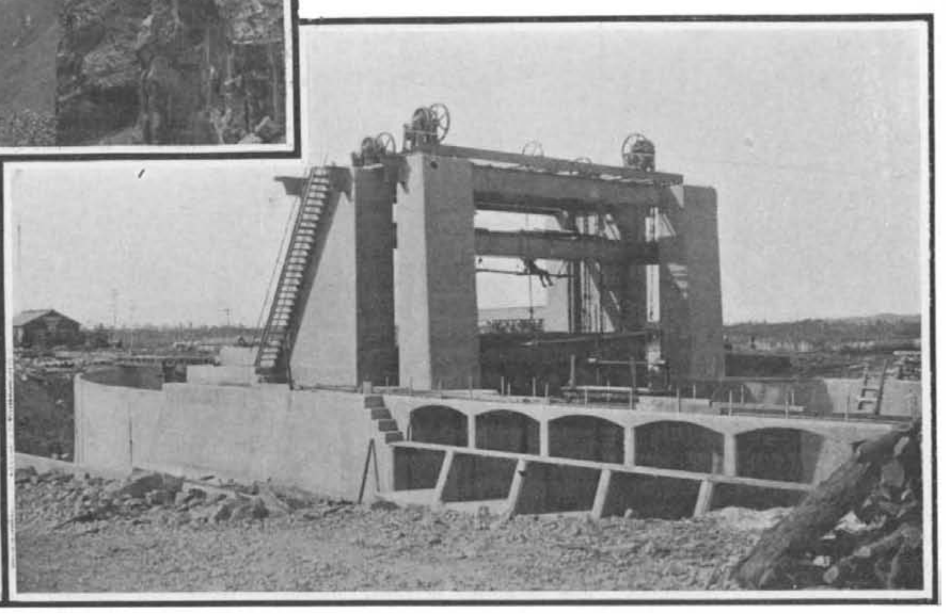
View of work on the upper trestle, Dec. 19th, 1908.

CLOSING THE COLORADO RIVER.

Dam, 310 feet high. Irrigates 100,000 acres

Shoshone dam looking up canyon.

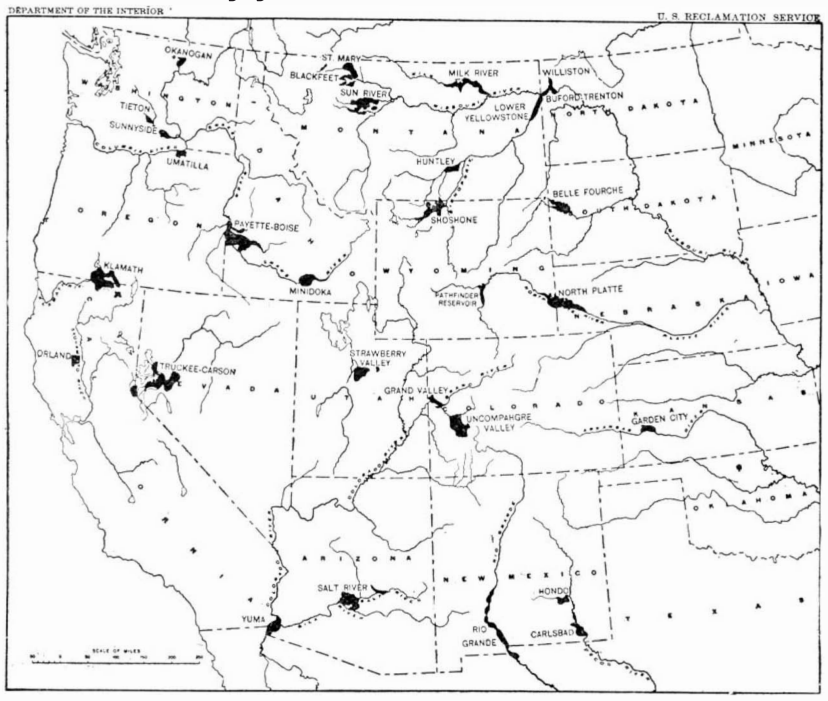
SHOSHONE PROJECT, WYOMING.



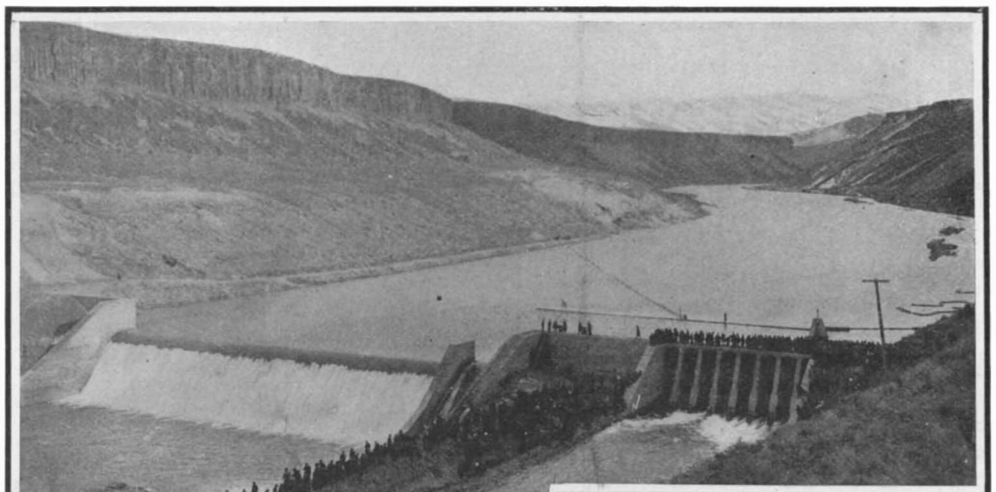
This project will irrigate at first 100,000 acres.

Laguna dam, Yuma project, California.

GATES AND REGULATOR OF ARIZONA SLUICEWAY.

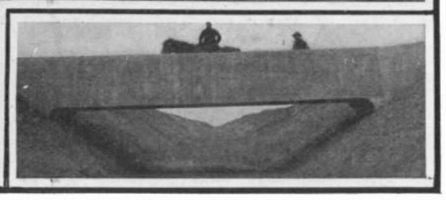


MAP SHOWING IN BLACK PRINCIPAL IRRIGATION PROJECTS IN THE WESTERN STATES.



Dam and headworks seven miles from Boise.

PAYETTE-BOISE PROJECT.



Concrete flume over main canal.

HUNTLEY PROJECT, MONTANA.

fruitful certain local areas in California.

The first successful attempt to apply irrigation to the arid regions is to be credited to the Mormons, who in 1847 made their notable settlement on the barren lands of the great interior basin, on the site where now stands Salt Lake City. With the growth of the colony, the work of leading in water from the various outlying streams was extended, and work has been carried on with such good effect that the present extensive system has been pronounced by the Department of Commerce and Labor to be "the most efficient in the country." Many of the pioneers of California turned from mining to irrigated farming, and the work has subsequently been extended to other States, until at the present time over eight million acres of land, which at one time was looked upon as worthless desert, is under cultivation and is producing crops each year, whose worth is estimated at over $100,000,000.

There are four regions of the United States in which irrigation is practised: The arid region, comprising those States and Territories in which agriculture depends almost entirely upon irrigation; the semi-arid region, lying midway between the Rocky Mountains and the Mississippi River, where the rainfall is uncertain; the rice-producing States, comprising parts of Texas, Louisiana, the Carolinas, and Georgia; and the humid States, represented by several of the New England, Middle Atlantic, and Gulf States, where there is a limited amount of irrigation. A Government Report of irrigation in the United States in 1902 showed that in the arid States and Territories 8,471,641 acres were under irrigation; in the semi-arid States and Territories, 403,449 acres; in the rice States of the South, 606,199 acres; and 5,788 acres in the humid States, making a total for the whole country of 9,487,077 acres. The number of farms included in these systems were 134,036, and the total cost of the work $93,320,453. Practically, the whole of this work has been done by private enterprise. It includes irrigation of every kind, from the ambitious scheme of the large corporation down to the individual irrigation ditch of the small farmer. The whole of this work is due to private enterprise, unaided by the government.

Naturally, private enterprise has attacked the problem in those districts where the physical obstructions were the least and in which the water could be impounded, or large rivers tapped, and the supply brought to the land to be irrigated with the least possible expenditure of time and money. There still remained vast areas of arid and semi-arid land, estimated at some thirty millon acres in all, which, if the necessary engineering skill and large amount of capital could be found for executing the necessary works, might be rendered fruitful and opened up for settlement.

In 1902 the government decided to undertake this great work of reclamation, and Congress passed a law providing that the money received from the sale of public lands in the States lying within the arid region be set aside as a reclamation fund, to be used in surveys and in the construction and maintenance of irrigation work. A law was passed providing that the reclaimed lands were to be sold in tracts of not less than 40 or more than 160 acres. Under its terms, the settlers are to buy their lands direct from

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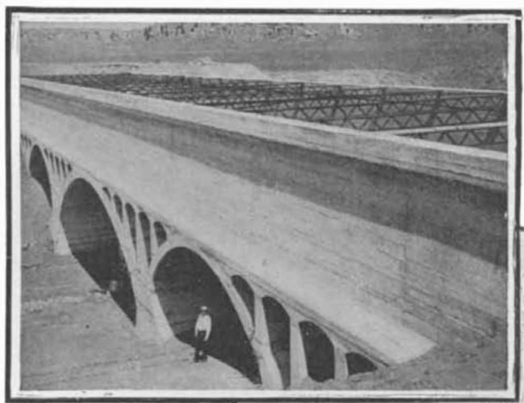
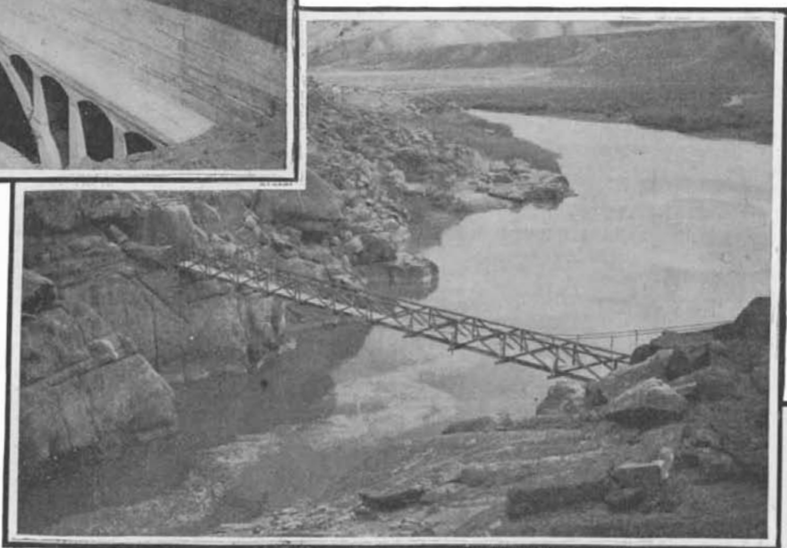
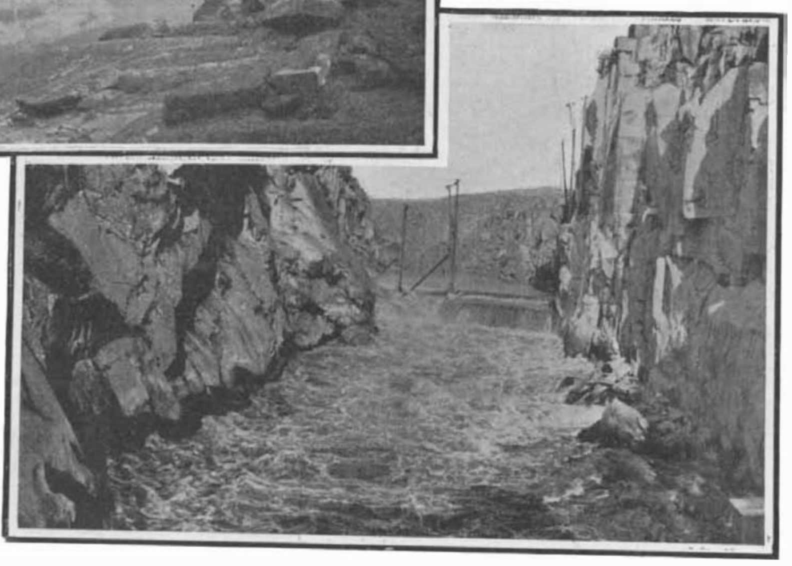


Concrete flume which carries interstate canal across Spring Canyon.



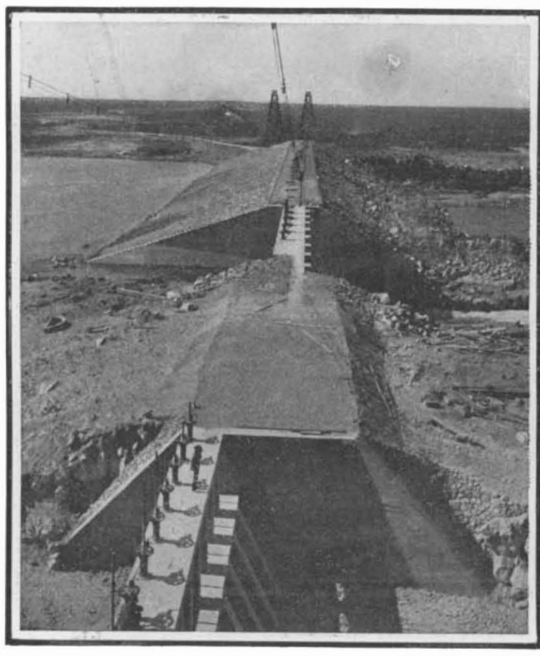
Footbridge across North Platte River, Pathfinder dam.

This project irrigates 110,000 acres.



Pathfinder dam, 215 feet high, during construction.

THREE VIEWS OF NORTH PLATTE PROJECT, NEBRASKA-WYOMING.



The dam and regulating gates.

The spillway at south end of dam.

THE MINIDOKA PROJECT, IDAHO, IRRIGATING 160,000 ACRES BY 1911.

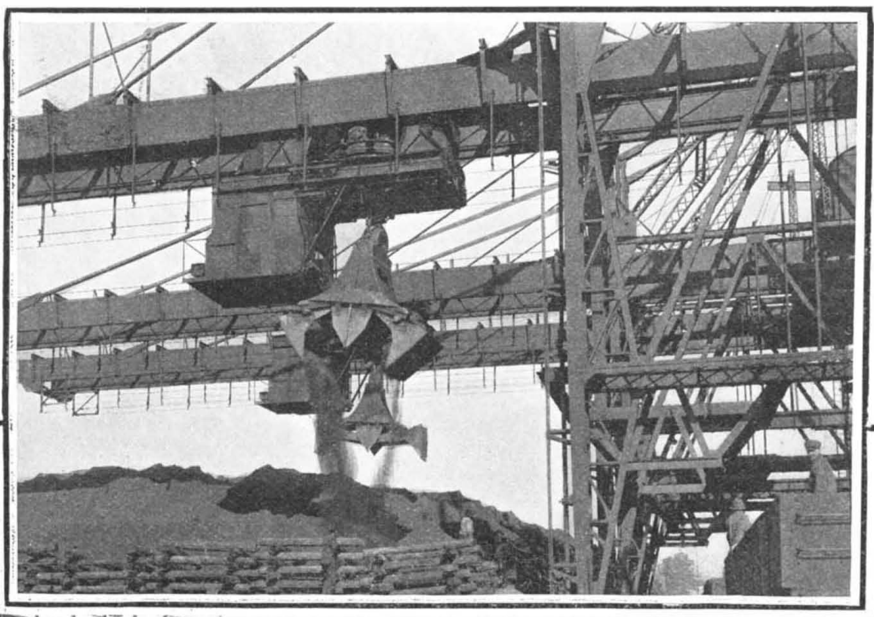
The Wonderful Iron Mines of Lake Superior—How the Ore is Mined and Carried in Bulk.

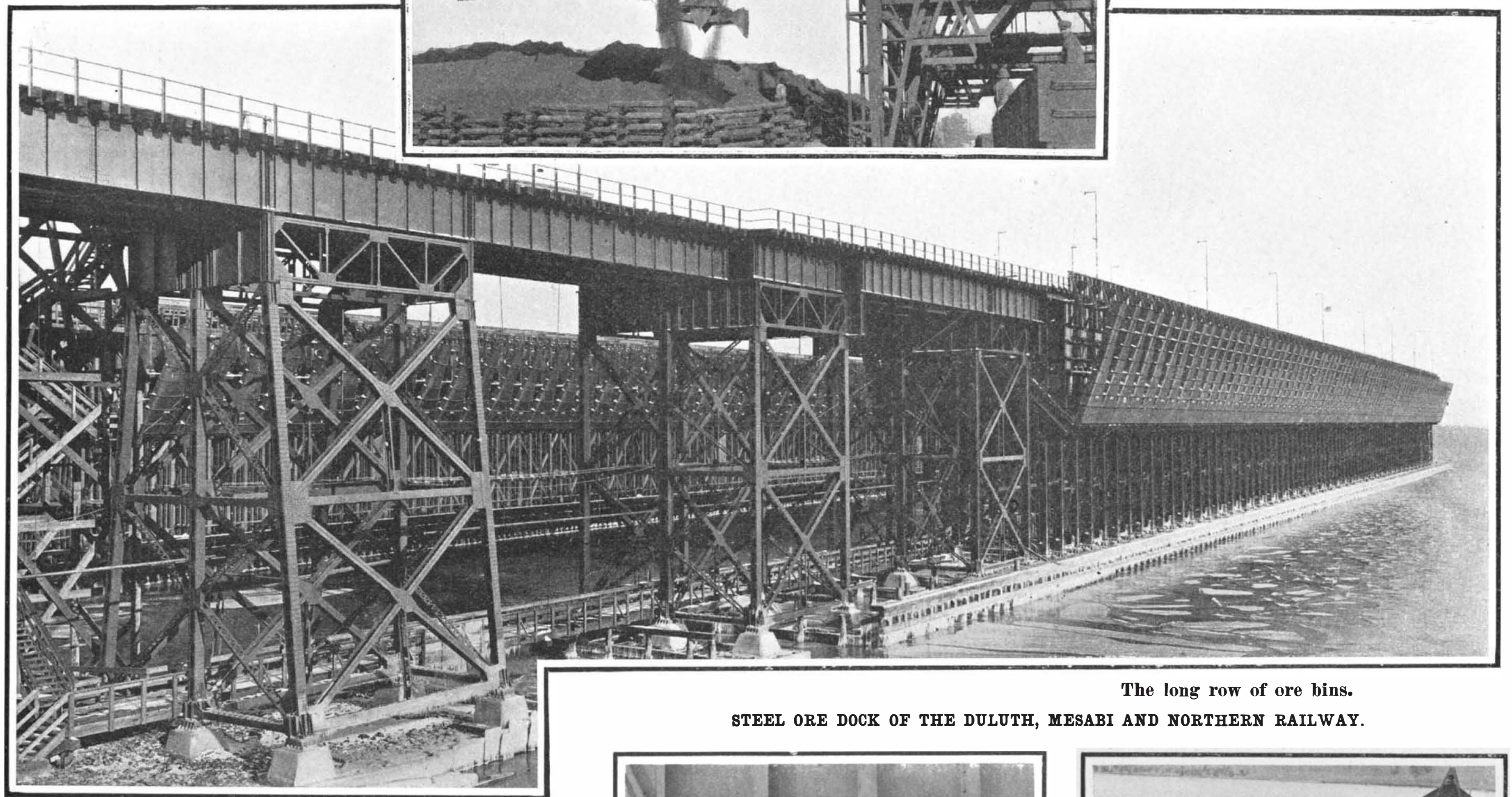
It usually happens that the attainment by a particular people of great distinction in some special branch of the industrial arts is due to the natural characteristics of the country in which they live. This is certainly true of our own country, whose wide extent and rich natural resources have impelled us to the construction of ingenious appliances for the handling and transportation of material in great bulk, which have made the name of the American mechanical engineer known throughout the civilized world. Particularly is this true with regard to the mining and transportation of minerals, the most bulky and less costly of which (coal and iron ore) are produced and shipped on a scale of magnitude not equaled in any other country of the world.

In a Special Number, devoted to the Great Middle West, a conspicuous position must necessarily be taken by the steel industry. Elsewhere we have dealt with Gary, where the largest and most up-to-date steel works in the world has lately been put in operation. The present chapter describes the vast deposits of rich iron ore which lie near the shores of Lake Superior, and those methods of mining, transportation, loading and unloading, by which the enormous bulk of ore, which is necessary to keep the blast furnaces of our steel works in continuous operation, is brought from mine to furnace at a cost so low as to enable this country to manufacture steel far more cheaply than any other country in the world.

The Lake Superior Iron Mines.—If Nature had set out with the determination to assure for the United States the premier position in the steel industry of the world, she could scarcely have done so more effectively than by spreading out around the western and southern shores of Lake Superior those huge deposits of iron ore above referred to. Not only do the ore formations cover vast areas, but in the wonderful Mesabi mines the ore lies practically at the surface of the ground, and frequently, after a few feet of overlying material have been stripped off, the cars can be run right into the mine and loaded directly by steam shovels. Furthermore, the Lake Superior ore is of unusual richness, much of it running over sixty per cent iron. The principal mines are located in ranges, of which the most famous are the Menominee, Marquette, and Gogebic ranges in Michigan, and the Vermillion and Mesabi ranges in Minnesota. The mines are located from twenty-five to seventy-five miles from the shores of Lake Superior. Eight separate railroads carry the ore to as many shipping ports on the lake, where it is unloaded into twenty-six docks having a total storage capacity of 1,326,616 tons. The total hauling capacity in a single day

Five-ton buckets unloading material at the stock pile.

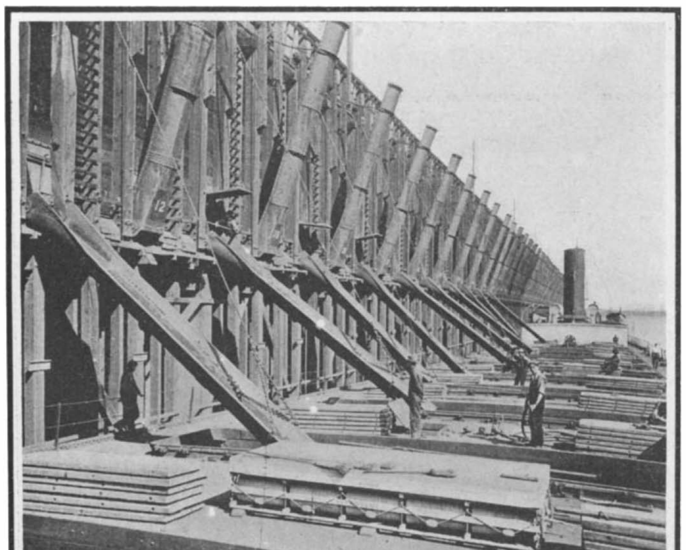




The long row of ore bins.

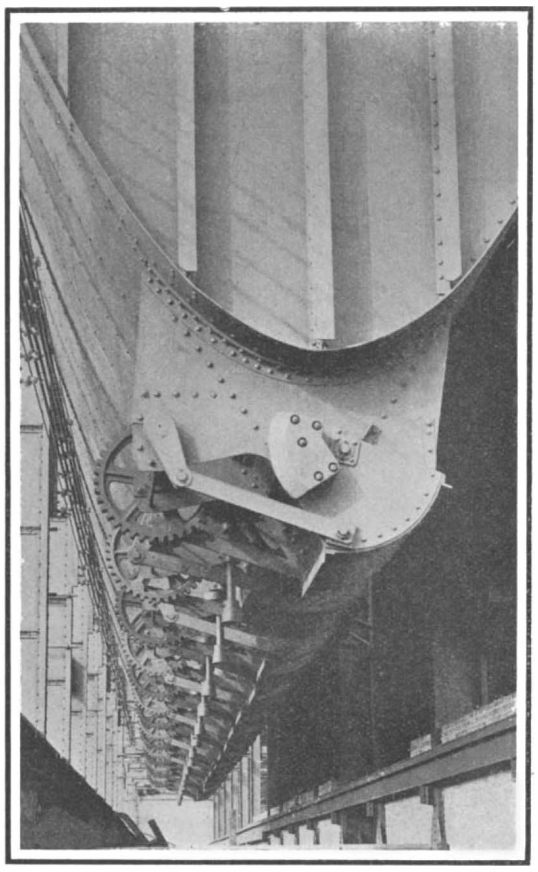
Steel viaduct approach over which trains run to the ore bins.

STEEL ORE DOCK OF THE DULUTH, MESABI AND NORTHERN RAILWAY.



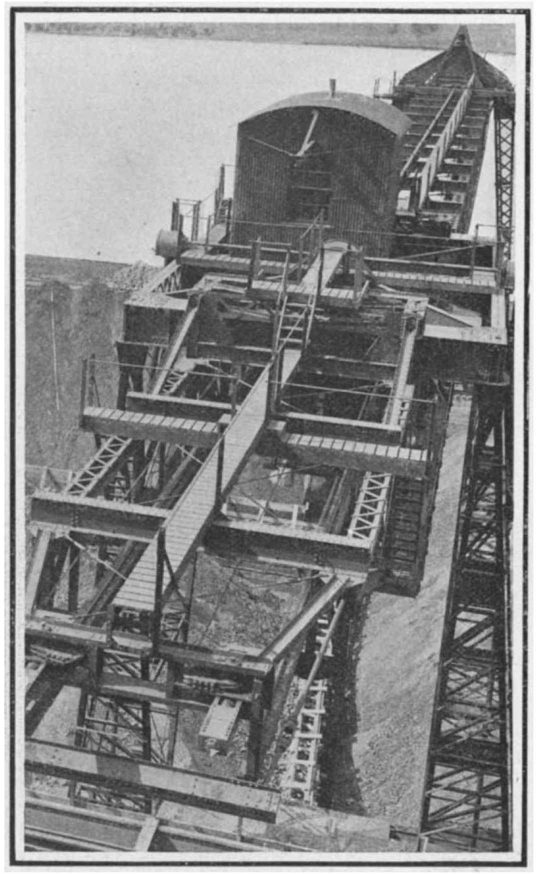
The ore discharges through spouts by gravity into the holds of the steamers.

VIEW OF STEEL ORE DOCK AT DULUTH, MINN., TAKEN FROM DECK OF STEAMER.



The ore is delivered to these bins from the steamer or stock pile.

ORE, LIME, AND COKE BINS AT FEDERAL FURNACE STEEL PLANT.



Shows details of Brown hoisting machinery. Length, 354 ft. 8 in.; bucket lifts $7\frac{1}{2}$ tons.

TOP VIEW OF ELEVATED BRIDGE TRAMWAY AT BUFFALO, NEW YORK.

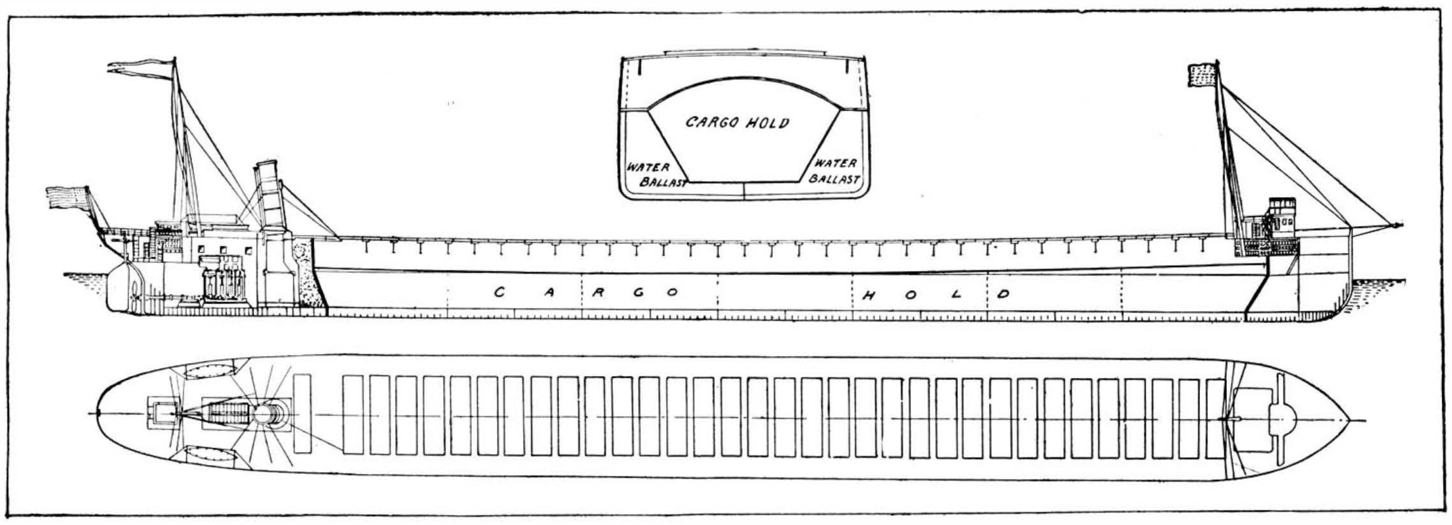
of these eight railroads combined is 250,000 tons. The greatest record for unloading is that of the Duluth, Mesabi & Northern, which in a single day has loaded 165,000 tons into sixteen steamships.

In the course of an interesting and illuminating address dealing with the history of the Lake Superior mines, given last summer by William J. Olcott, president of the Oliver Mining Company, Duluth, the speaker drew attention to the fact that in 1844, while William A. Burt was surveying township lines and making geological observations in Marquette County, Michigan, he noticed a deflection of eighty-seven degrees from the normal of the solar compass, and thereupon sought for and found at several points outcrops containing iron ore. In 1847 a forge was started about three miles from these outcrops, and on February 10th, 1848, the first iron to be made in the Lake Superior region was produced by Ariel N. Barney, the daily output of the forge being about six tons. The early development of these mines was little more than crude exploration. In the winter of 1850, the first ore was hauled to Marquette on the shores of Lake Michigan. In 1852, Congress granted to the State of Michigan 750,000 acres of land for the construction of a small canal around the Rapids of St. Mary's River, connecting Lake Superior and Lake Huron. The canal was completed in 1855, and the first shipment of iron ore consisted of 132 tons, which passed through the canal on August 17th of that year. In those early days mining was done by open-pit-work methods, the ore being hauled out in carts and dumped into railroad cars. The Marquette range furnished all the iron ore from Lake Superior until 1876, when shipments began to be made from Menominee range, from which the total output to date has been 63,641,213 tons. In 1885, shipments began to be made from the Gogebic in Michigan and Wisconsin, and from the Vermillion mines in Minnesota. Up to date from Vermillion alone over 28,000,000 tons of high-grade ore have been shipped.

The most famous of the Lake Superior mines, however, are those of the great Mesabi range in Minnesota, which extends for an unbroken distance of eighty miles and includes no less than eighty-six mines. The geological formation is peculiarly favorable for mining. The greater part of the ore bodies lie horizontally, and are covered by a shallow bed of glacial drift. To get at the ore, it is merely necessary to remove the surface covering, and then excavate the ore with the steam shovel, loading it directly into the cars, trains of which are run into the mines for this purpose. Furthermore, the ore beds are as rich as they are extensive, for analysis shows them to consist of from 47.50 per cent to 61.26 per cent of pure iron, with an average for the whole district of probably about 57 per cent of iron. Although the first mine in the Mesabi range was discovered as late as 1890, in the year 1907 over 27,000,000 tons were shipped from this range alone. "It is the low cost and capacity for enormous production of the Mesabi range," says Mr. Olcott, "that is the guarantee of the continued supremacy of the United States in the manufacture of iron and steel."

We are accustomed to look upon the excavation of

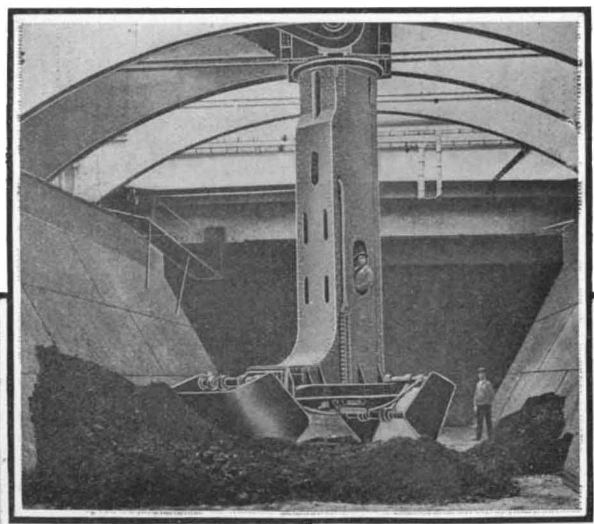
(*Continued on page 449.*)

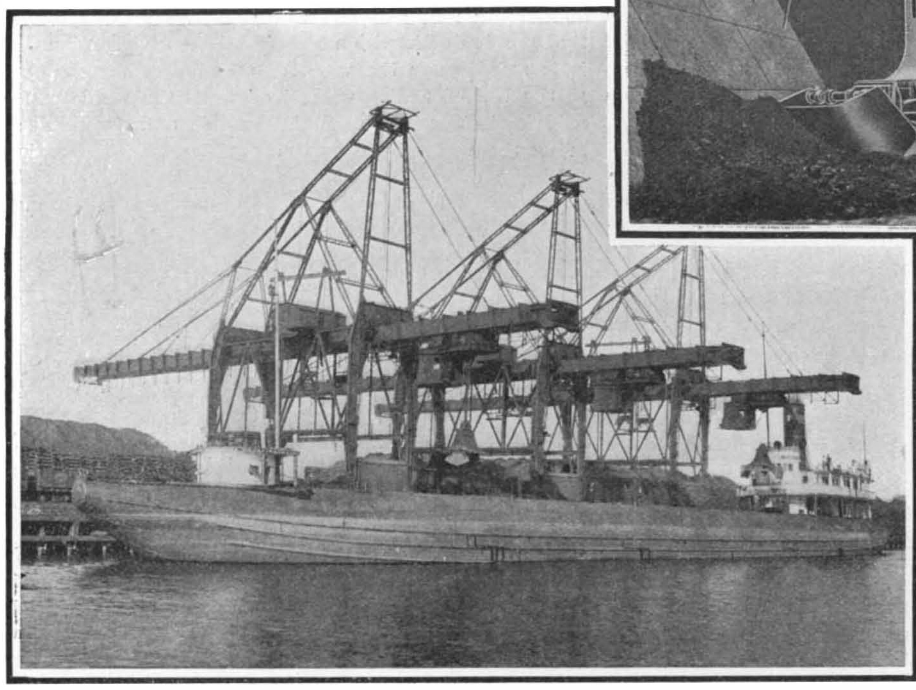


Transverse section, inboard profile, and plan, showing the one great hopper hold 409 feet long with its 33 hatches.

THE "WOLVIN," A TYPICAL LAKE STEAMER FOR THE TRANSPORTATION OF ORE. CAPACITY 11,536 TONS.

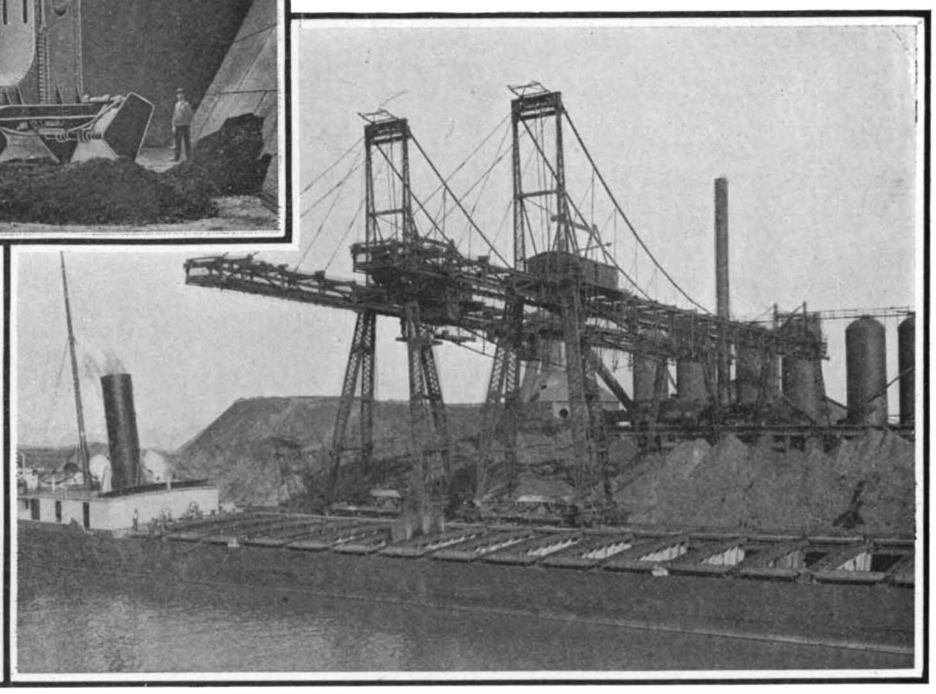
Ten-ton bucket of unloader in hold of the "Wolvin."





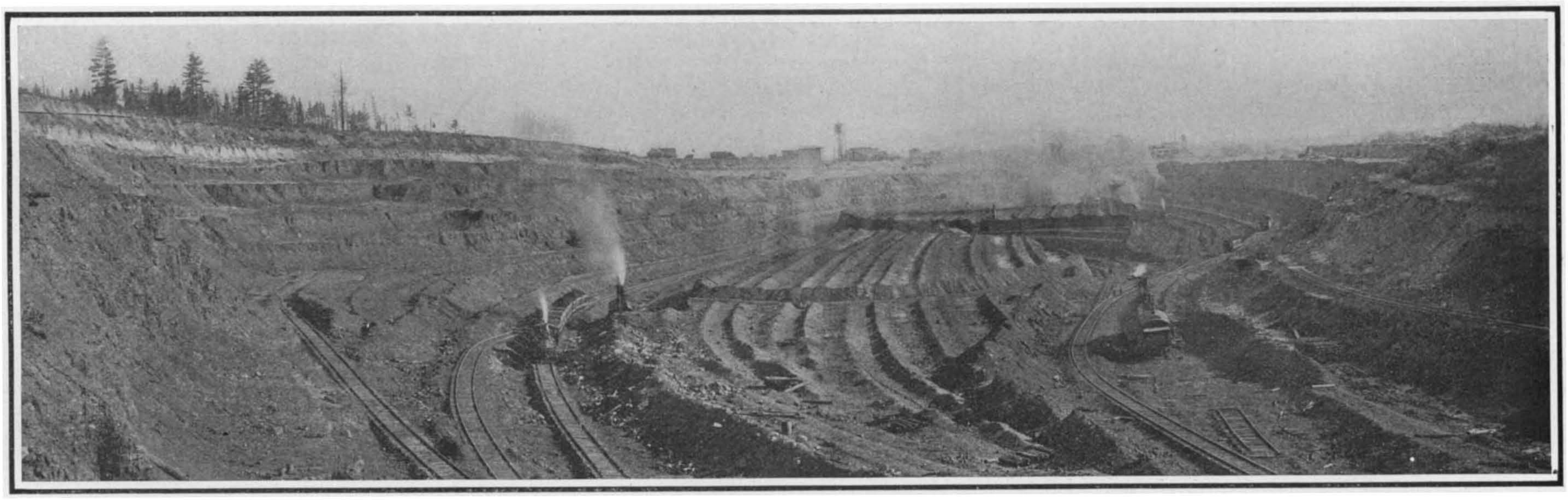
Length of bridge, 222 feet 8 inches. Bucket lifts 5 tons.

THREE FAST PLANTS UNLOADING WHALEBACK STEAMER.



Length of tramway, 360 feet. Bucket capacity, 5 tons.

TWO BROWN TRAMWAYS UNLOADING A TYPICAL LAKE STEAMER.



The iron ore lies so near the surface that after stripping the glacial surface material a vast horizontal bed of rich ore (60 per cent iron) is exposed. The ore is dug by steam shovels and loaded directly into the cars. Over 1,000,000 tons are shipped out every year.

THE FAMOUS IRON MOUNTAIN MINE OF THE MESABI RANGE.

THE RECLAMATION OF THE ARID LANDS OF THE WEST.

(*Concluded from page 429.*)

the government, instead of obtaining them by rent or purchase from land and irrigation companies. The price of the land is determined by the cost of the irrigation works for that particular district, and the funds thus obtained are turned into the general Reclamation Fund, and used for the construction of work in other districts. The settlers pay for the land in installments, and payment must be completed by the end of ten years. In addition to paying for the land, the farmer is subjected to an annual charge for the water, and the money so received is also applied to the maintenance and improvement of the work. It can thus be seen that the fund is made self-perpetuating.

The general surveys for this wonderful work have been made, and the scheme includes some twenty-eight different "projects," as they are called, the location of which is indicated on the accompanying map by shaded areas. We also present a table, which gives the area in acres and estimated cost of such part of each project as will be completed by the year 1911. They vary in size from the Salt River project in Arizona, which will bring 210,000 acres under cultivation by the year 1911, at a cost of $6,300,000, down to the Garden City stream in Kansas, which will irrigate 8,000 acres at a cost of $350,000. By the close of that year, nearly 2,000,000 acres will have been reclaimed, at a cost of $70,000,000. The works are in various stages of progress. Some are under survey; a few have been only recently commenced; while others are practically completed and are already supplying water to certain sections of the areas served. At the present time over 1,000,000 acres are ready for irrigation, and certain areas, which a few years ago formed part of a dry and trackless desert, are now supporting about 21,000 people on farms whose fertility is in many cases truly phenomenal. A large number of towns have sprung up, and the newly-opened districts are being connected by branch lines with the trunk railroads.

The beneficent work of the government does not cease with the turning off the water into the canals. In each district it maintains farmers who are experienced in the local conditions, for the purpose of teaching the newcomers how to till their land suitably to the special conditions and requirements of the districts in which they have settled. Government demonstration farms have been established, upon which the fruits and cereals most adapted to the local conditions are raised.

Now it must not for a moment be supposed that the two million acres of land to be brought under irrigation by 1911 represent the whole of the government scheme. As a matter of fact, it marks merely the beginning of a vast system, which contemplates the recovery of no less than thirty million acres. These are large figures; let us translate them into the terms of population and taxable value. It is estimated that a fair average value per acre of the irrigated farms, including the value of the land and of the improvements thereon, is $150 per acre. If this is a conservative estimate it follows that the total value of the reclaimed land, when it has been brought under full cultivation, will be $4,500,000,000. Not only will this vast property be added to the total taxable value of the farms of the United States, but judging from present conditions, it will provide homes for at least fifteen millions of people, one-half of them living on the farms, and the other half in towns and cities. Several of the latter have already been founded in the areas covered by the completed schemes, and are showing every evidence of healthy life and growth. Furthermore, the government will possess a valuable asset in the water powers which can be developed by utilizing the great available head of water on many of the projects. By January 1st, 1910, about fifty thousand hydraulic horse-power will be available. This belongs to the government, and will be sold to the settlers for power, light, and other purposes at the cost of production. So valuable is this asset alone, that it will make up the entire cost on some of the projects.

TABLE SHOWING THE TWENTY-EIGHT PROJECTS OF THE RECLAMATION SERVICE.

The areas and costs are for such portions of the various projects as will be completed by 1911.

Location.	Project.	Area in Acres.	Estimated Cost.
Arizona	Salt River	210,000	$6,300,000
California	Orland	30,000	1,200,000
California-Arizona	Yuma	100,000	4,500,000
Colorado	Uncompahgre	140,000	5,600,000
Colorado	Grand Valley	50,000	2,250,000
Idaho	Minidoka	160,000	4,000,000
Idaho	Payette-Boise	100,000	3,000,000
Kansas	Garden City	8,000	350,000
Montana	Huntley	30,000	900,000
Montana	Milk River, including Saint Mary	30,000	1,200,000
Montana	Sun River	16,000	500,000
Nebraska-Wyoming	North Platte	110,000	3,850,000
Nevada	Truckee-Carson	160,000	4,800,000
New Mexico	Carlsbad	20,000	640,000
New Mexico	Hondo	10,000	370,000
New Mexico	Leasburg	10,000	200,000
New Mexico-Texas	Rio Grande	160,000	8,000,000
North Dakota	Pumping, Buford-Trenton, Williston	40,000	1,240,000
Montana-North Dakota	Lower Yellowstone	66,000	2,700,000
Oregon	Umatilla	18,000	1,100,000
Oregon-California	Klamath	120,000	3,600,000
South Dakota	Belle Fourche	100,000	3,500,000
Utah	Strawberry Valley	30,000	1,500,000
Washington	Okanogan	8,000	500,000
Washington	Sunnyside	40,000	1,600,000
Washington	Tieton	24,000	1,500,000
Washington	Wapato	20,000	600,000
Wyoming	Shoshone	100,000	4,500,000
		1,910,000	$70,000,000

It is impossible within the limits of the present paper to do more than to give a brief outline of some of the more important of these great works.

Yuma Project, California.—This project consists in the diversion of the waters of the Colorado River by means of the Laguna Dam into two canals, one on each side of the river. The dam is located about ten miles northeast of Yuma, Arizona. These canals will irrigate all the bottom lands of the Colorado and Gila rivers in Arizona between Laguna Dam and the Mexican boundary, about 84,000 acres in all; and in California they will serve 17,000 acres of bottom lands in the Yuma Indian Reservation. This region resembles the fruitful valley of the Nile in its soil, climate, and droughts. The dam, which stretches entirely across the river, is remarkable more for its length than for its height. Unlike the huge Roosevelt, Shoshone, and Pathfinder dams, to be described later, it is an overflow weir, its purpose being to back up the waters of the Colorado sufficiently to provide a full supply for the two irrigating canals. By the year 1911 it will supply water to 100,000 acres at a cost of $4,500,000.

Salt River Project, Arizona.—Of an entirely different character are the engineering works of the great Salt River project, by which, within two years from now, 210,000 acres will be irrigated at a cost of $6,300,000. This project involves the construction of a storage dam, 284 feet in height, at Roosevelt, Arizona, which will impound 1,284,000 acre feet of water—that is to say, sufficient water to cover that number of acres one foot deep. The dam is most advantageously located in a deep and narrow canyon, whose bottom and sides are of rock. The storage basin of the dam, which will have a superficial area of 25.5 square miles, will be large enough to catch and store the waters of the great floods to which the Salt River, in common with most of the rivers of the arid regions, is liable. Because of the remoteness of the work, the construction of the dam has involved heavy incidental engineering expenses. It was necessary to cut a costly road over which to carry in the machinery and supplies; and because of the high price demanded in the bids for the supply of cement, the engineers were driven to the expedient of erecting a cement mill and manufacturing the cement on the spot. The water is released from the dam by massive gates. It flows down the canyon to a point forty miles below the dam, where it is diverted into two main canals, one on each side of the river. A power canal, 18.5 miles long, serves to develop electric power by which water will be pumped from underground sources, and increase the irrigable area by 50,000 acres, making 210,000 acres in all that will be brought under irrigation by 1911 at a cost of $6,300,000.

Shoshone Project, Wyoming.—Near the northern boundary of Wyoming, the government is building another remarkable dam, which has the distinction of being the loftiest structure of the kind in the world. It will rise 310 feet above its foundation; and so narrow is the canyon that the masonry will measure only 175 feet along its crest. Here, as at the Roosevelt Dam, it was necessary to cut a road many miles in length out of the solid rock in order to gain access to the site. The dam will create a reservoir with a storage capacity of 456,000 acre-feet, and by 1911 the water will be available on some 100,000 acres of choice land. The dam will regulate the flow of the water, and thirty miles below the dam the stream will be turned into a tunnel three and a quarter miles in length which will conduct it by a large canal into the district to be irrigated.

North Platte Project, Nebraska-Wyoming.—The third of the lofty dams is the structure known as the Pathfinder Dam, so named after the well-known explorer, Gen. John C. Fremont, who nearly lost his life at the site of the dam in trying to row through the canyon. Although the structure is about 100 feet less in height than the Pathfinder Dam, the storage basin above it is of such favorable formation that it will impound over 1,000,000 acre-feet, and will be capable of holding in check the greatest of the floods to which the restless North Platte is subject. Below the dam the government has built a great canal, 95 miles in length, which will carry the water to the irrigable lands of Wyoming and Nebraska. The broken character of the ground necessitated the construction of several important concrete viaducts, one of which is shown among our illustrations. Because of the porous nature of the soil the canal for many miles of its length is lined with concrete. By 1911 this system will have brought 110,000 acres under irrigation. When the whole scheme has been developed it will serve some 200,000 acres in Wyoming and an equal amount in Nebraska.

Minidoka and Payette-Boise Projects, Idaho.—One of the most important works of the Reclamation Service is that which is being carried out on the Snake River in Idaho. At Minidoka a dam and regulating gate have been built across the river, and 130 miles of canal and 190 miles of ditches will serve to convey the water to 160,000 acres of land. Farther down the river, near the border line between Idaho and Oregon are the Payette-Boise works, which by the end of 1911 will bring 100,000 acres under cultivation. Ultimately, this project will reclaim 372,000 acres of land in the Payette, Boise and Snake rivers in southwestern Idaho.

Uncompahgre Valley Project, Colorado.—To the public mind the most spectacular of the irrigation works is that known as the Uncompahgre Valley, and this because of the great tunnel through the mountain recently opened by President Taft, which forms the most notable feature of the work. In southwestern Colorado the Uncompahgre and Gunnison rivers flow in approximately parallel courses, 10 miles apart, on either side of a mountain range some two thousand feet in height. The Uncompahgre, which is a comparatively insignificant stream, flows through a valley containing 700,000 acres of rich land, whereas the Gunnison, a much larger river, flows in a deep canyon, where there is practically no land available for cultivation. The United States engineers decided to cut a tunnel, 10½ feet by 12 feet in cross-section, for six miles through the mountain. The location of the tunnel was fixed at a point where the canyon is over half a mile deep. A road sixteen miles long was cut down this gorge, the machinery brought in, power plant established, and a few months ago the tunnel was completed. When President Taft opened the works the waters of the Gunnison River began to flow through the mountain, and emerged in a valley, where they will render fertile some 140,000 acres of rich soil.

In conclusion, we should again impress it upon the mind of the reader that the 2,000,000 acres, which will be brought under cultivation by the year 1911, represent only about one-fifteenth part of the fertile land which will ultimately be opened for settlement when the various schemes shown on the accompanying map have been worked out to their full development. So judiciously has the matter been handled by the United States Reclamation Service that the work will be self-supporting and self-perpetuating. So successful has that portion of it which is completed proved to be, that it is safe to say the work of reclaiming barren lands in the United States will go on until the whole of the arid lands upon which it is possible and profitable to bring the water have been brought under cultivation.

Limits of space prevent any extended reference to the nature and quantity of the crops that will be produced on these irrigated lands. In many sections the greater part of the acreage will be devoted to the raising of hay and forage, and particularly of alfalfa, for which there is a great demand as winter feed for cattle. The stock, which during the summer is fed upon the high pasture land, in the winter is driven down to the irrigated valley farms, where it feeds directly from the stack. Irrigated land yields about five tons of alfalfa to the acre and its average value is about $5 per ton. As many as 300,000 head of sheep have been fed in this way in one winter on irrigated land near Billings, Montana. The fertility of the farms is something that must be seen to be appreciated. Average land in the East will yield 15 bushels to the acre. On irrigated land in Colorado the yield is 40 bushels. The Eastern farmer may gather in a year one hundred dollars' worth of apples from an acre, whereas on the irrigated land of the West the value of the crop will reach $450 to the acre; and according to Mr. J. C. Blanchard, statistician of the United States Reclamation Service, apple orchards on irrigated land in the Yakima Valley have yielded from $300 to $1,200 per acre annually, while good orchard land sells at from $300 to $2,000 per acre, when containing full-bearing trees. In this same valley the value of farm products in 1907 reached the magnificent sum of $3,625,000, and 65,000 cattle and 20,000 sheep, of a value of $2,000,000, were ranged and fed.

With the purpose of studying enormously high voltages a short experimental transmission line has been built in Sweden which is adapted to operate at 500,000 volts. A special form of transformer is used to furnish this high electro-motive force. Circulating oil is used for insulation between the high and low-tension windings. The line is supported on the suspended type of insulators which are hung at a distance of 11 feet apart. Tests of the surface discharge showed that a wire of 10 square millimeters (0.0155 square inch) cross section would discharge at 35,000 volts; of 20 square millimeters at 50,000 volts, of 100 square millimeters at 200,000 volts, and of 250 square millimeters at 390,000 volts. As the tension was raised to 480,000 volts, the noise grew very loud and sparks leaped from the insulators. At night the glow of the discharge could be seen 2½ miles away.

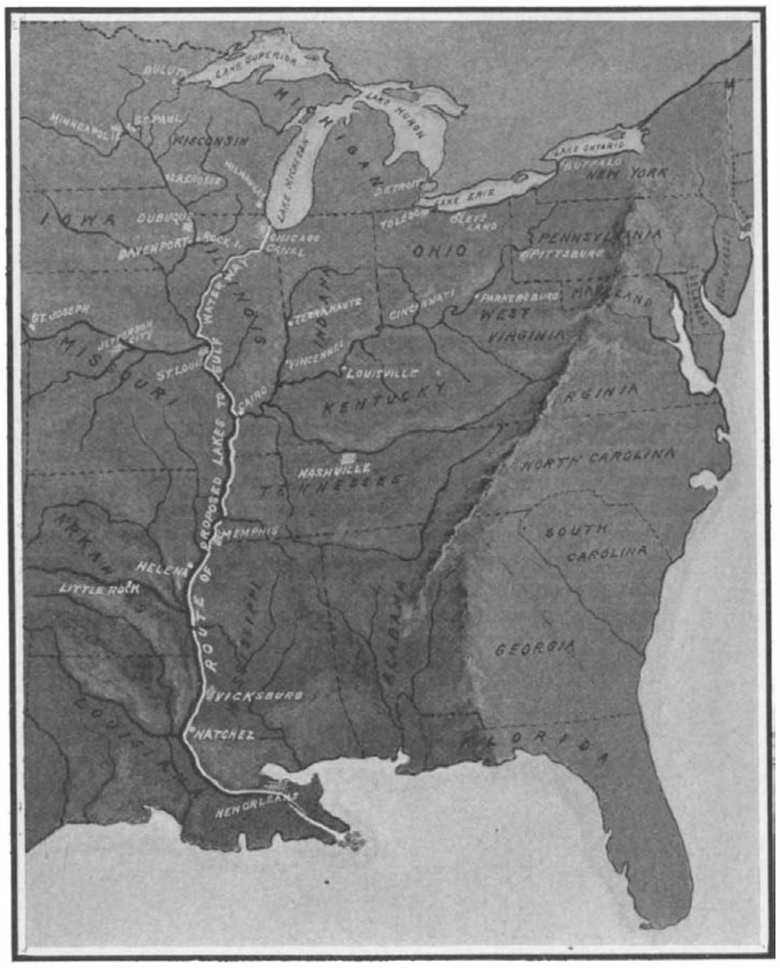
The Proposed Lakes-to-the-Gulf Deep Waterway.

That portion of the United States which is popularly known as the Middle West, and in the government reports as the North Central Region of the United States, comprises twelve States, whose combined area is 753,550 square miles, and its population approximately thirty millions. Within its boundaries are included one-fourth of the area and one-third of the population of the United States.

Originally regarded as part of the so-called "Great American Desert," the Middle West represents to-day more than one-half of the value of the improved farms of the country; contains more than one-half of the live stock; produces nearly eighty per cent of the food products, and over one-half of the butter, corn, wheat, oats, barley, rye, flaxseed, potatoes, and poultry that are raised in the entire United States. Furthermore, as a manufacturing center it contains thirty-five per cent of the total number of manufacturing establishments, and turns out annually thirty-three per cent of the manufactured products of the country. Also from the Middle West comes thirty-three per cent of the bituminous coal mined in the United States, and seven-tenths of the iron ore.

The wealth of a country is very closely related to its facilities for transportation; moreover, students of the economics of transportation have come to realize that ideal conditions can be reached only when a country is served by a combined system of railroads and canals or other waterways. Of the former, the Middle West possesses a veritable network, being served by over 86,000 miles of track, which represents some forty-three per cent of the total mileage of the United States. This railroad system has been developed along lines that are admirably adapted to meet the conditions, which are, that a huge and bulky tonnage shall be hauled long distances at a low cost. Nowhere in the world is freight moved so cheaply as here. But when we speak of the railroad system of the Middle West as being admirable, and while every credit is due for the Herculean efforts which have been made to keep pace with the growth of the country, it must be admitted that this vast network of lines, great as it is, has failed to keep pace with the rapid and enormous increase in the products of the farm and the factory. Evidence of this is seen in the steadily recurring periods of congestion, when the railroads are quite unable to move the tonnage that is offered with anything like reasonable expedition.

Nature, however, has provided the Middle West with a system of natural waterways which awaits only the adjusting hand of the engineer to make it capable of transporting at low cost and with reasonable celerity the more bulky freights of the Middle West, leaving the railroads to deal with the higher class freights, for whose more rapid transportation a greater charge is levied and willingly paid. We refer, of course, to the Mississippi River.

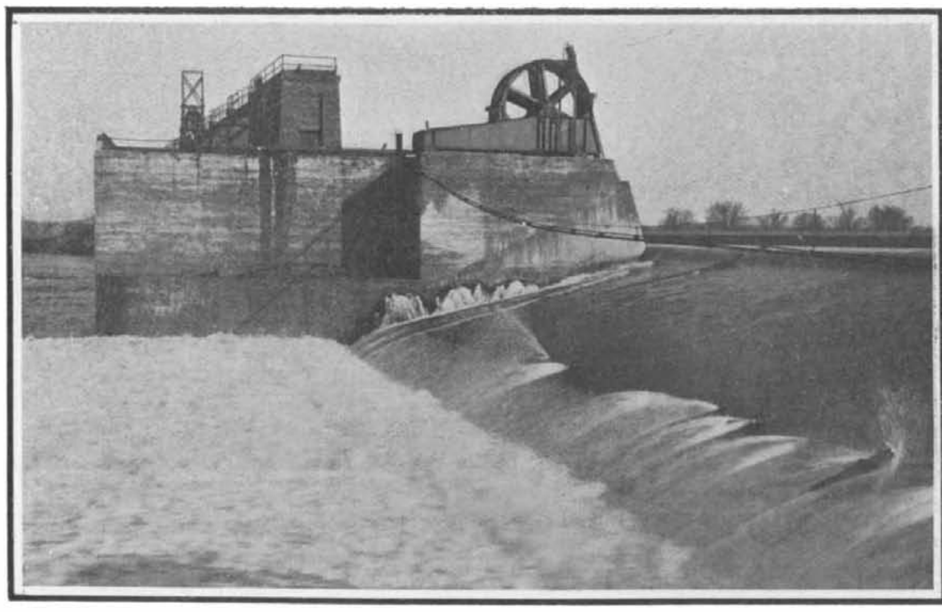


BIRD'S EYE VIEW, SHOWING THE VAST AREA OF COUNTRY TO BE SERVED BY THE GULF TO THE LAKES WATERWAY.

This noble river, which penetrates the Middle West throughout its entire length from north to south, has six hundred tributaries, forty-five of which are navigable, and its drainage area is 1,367,454 square miles. Its tributaries reach away east and west from the parent stream for a distance of 4,300 miles. If one were to set out in a motor boat with the intention of following every one of these affluents, from its point of discharge into the Mississippi up to the head of navigation, his upstream journeys would aggregate sixteen thousand miles, and cause him to traverse twenty-three States and Territories.

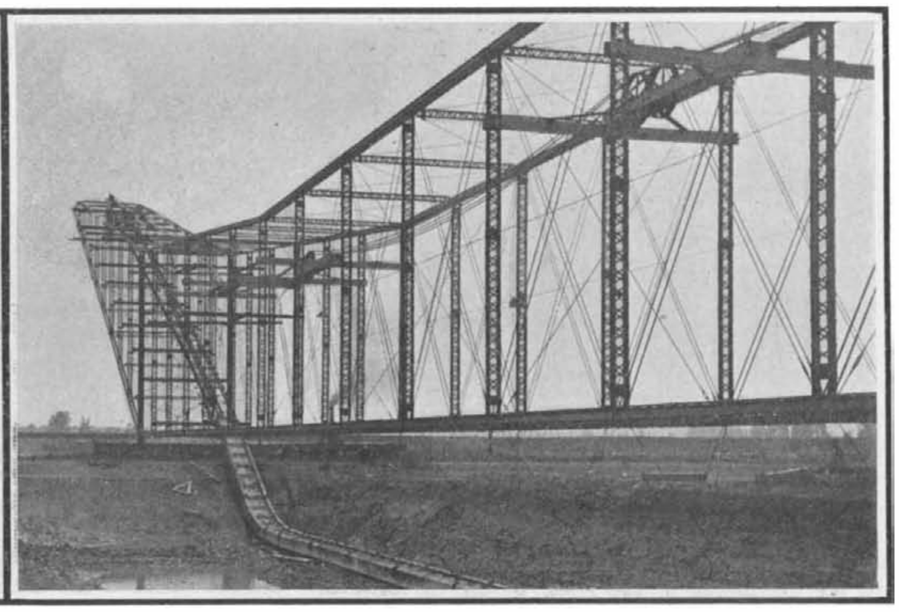
In the early days of the settlement and development of the Mississippi Valley, the transportation both of passengers and freight was dependent almost entirely on the river and its tributaries. With the advent of the steam railroad and the opening up of what had been known as the Great American Desert lying to the west of the Mississippi, and with the construction of a railroad system paralleling the river, there was a gradual decline of water-borne traffic, the passenger travel almost in its entirety, and the freight traffic in an ever-increasing degree, being absorbed by the new and swifter means of transportation.

The utility of this great river for the conveyance of freight is greatly curtailed by the fact that it is subject to heavy floods which wash away its banks and deposit the ma-

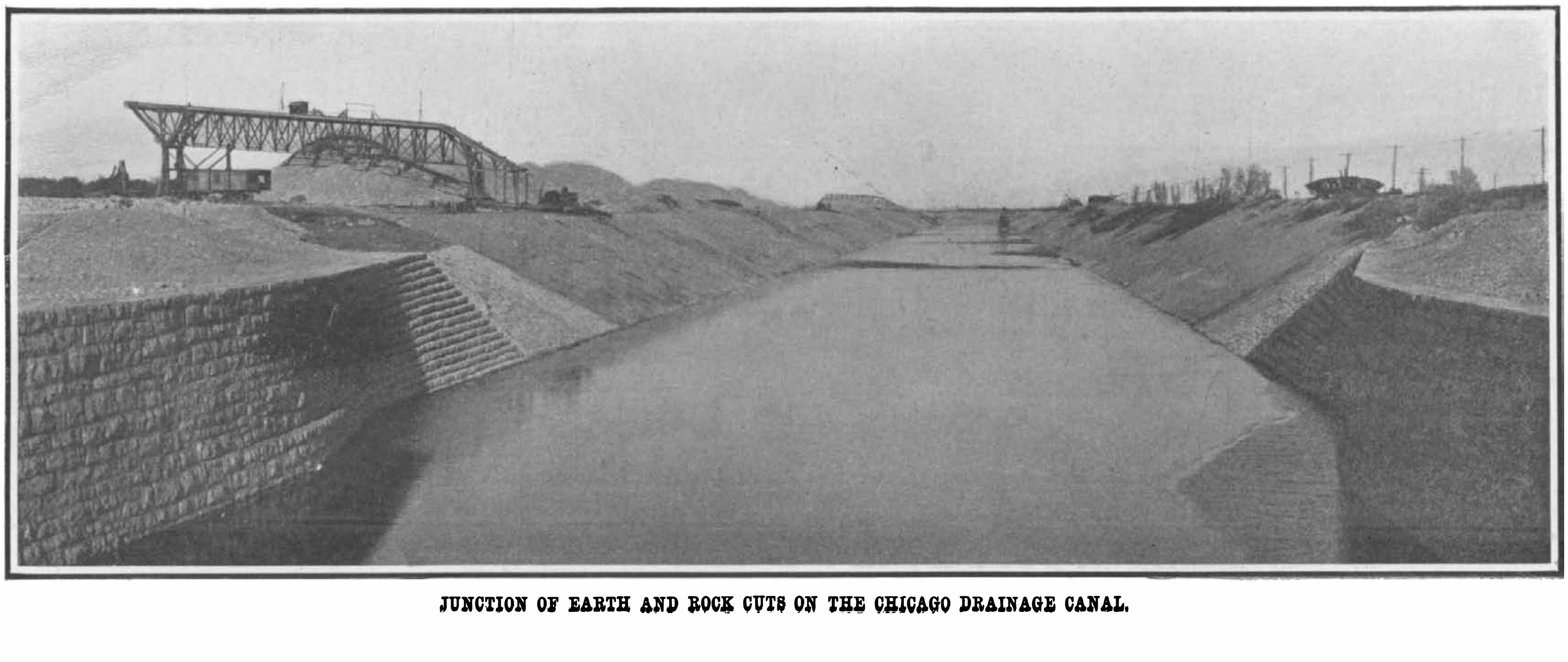


Bear-trap dam; downstream view.

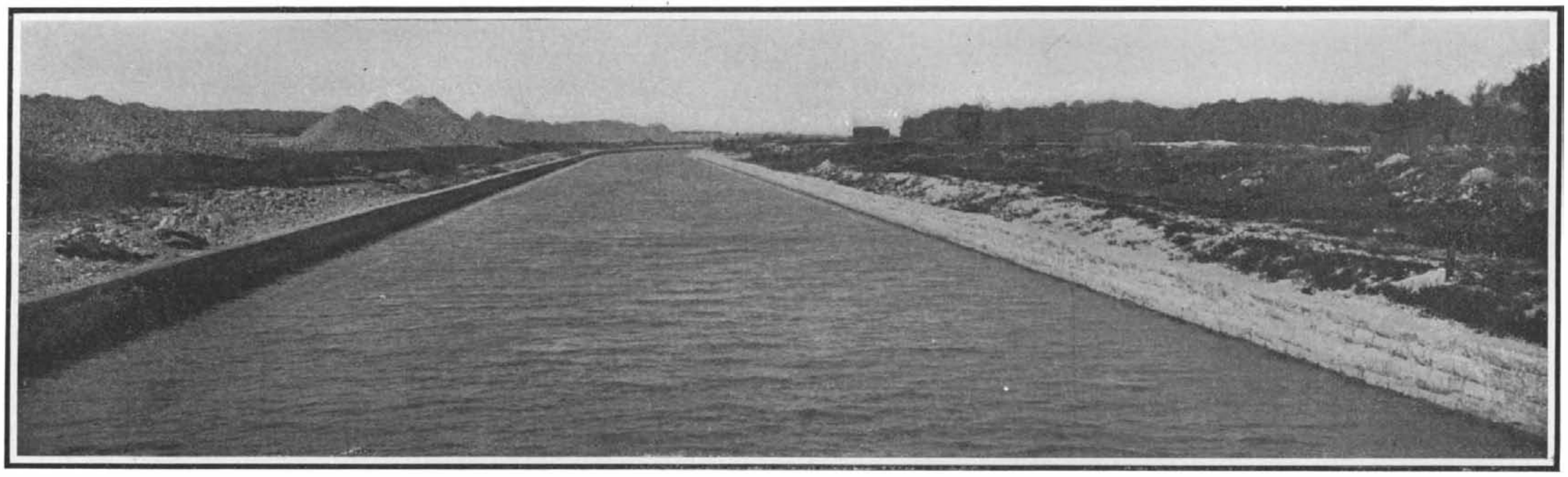
CONTROLLING WORKS OF DRAINAGE CANAL.



TYPICAL EXCAVATOR AT WORK ON DRAINAGE CANAL.



JUNCTION OF EARTH AND ROCK CUTS ON THE CHICAGO DRAINAGE CANAL.



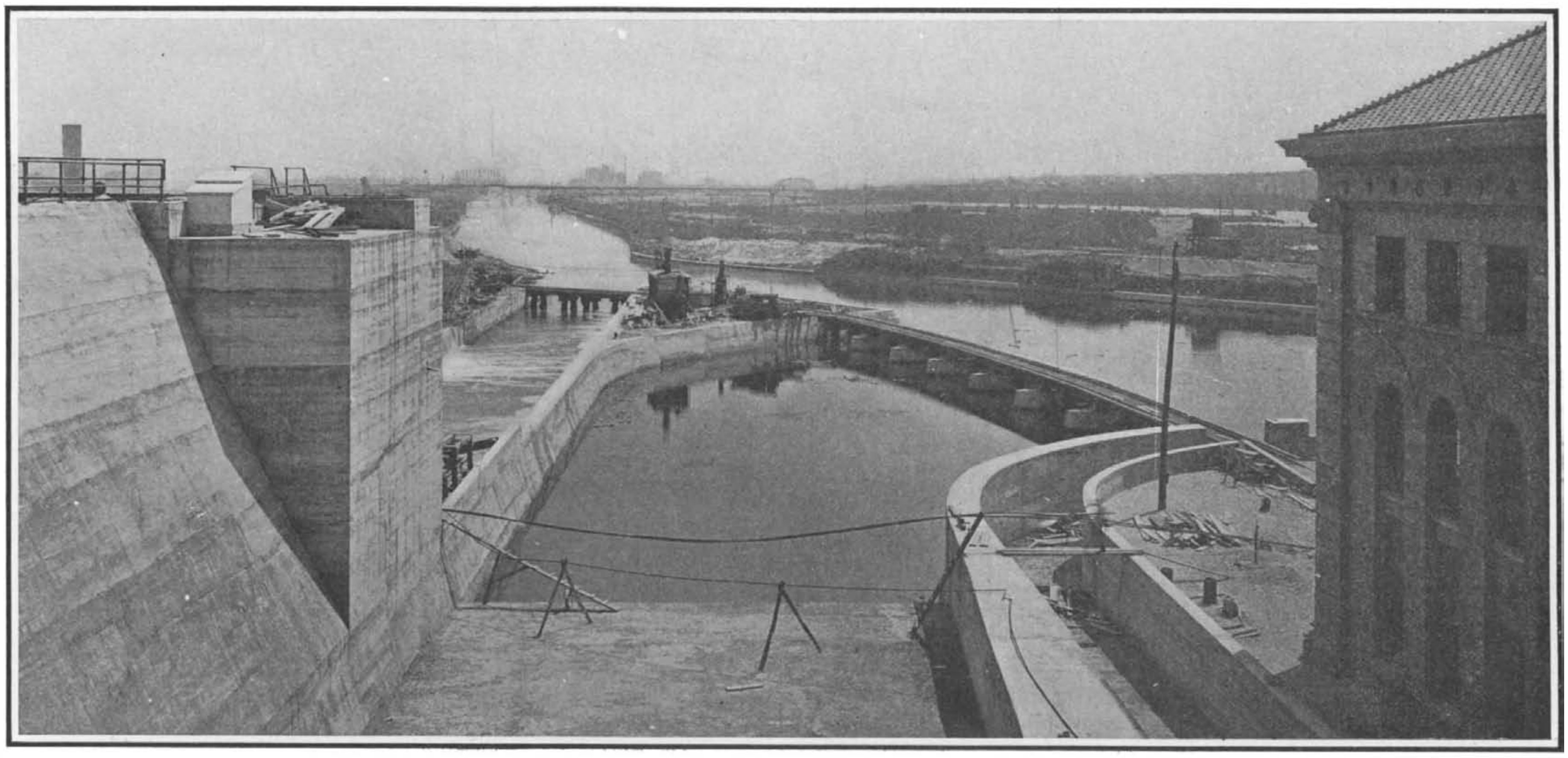
This great artificial channel, 22 feet deep, 110 to 202 feet wide, and 28 miles long, will form the first section of the Lakes-to-the Gulf waterway.

MAIN CHANNEL OF DRAINAGE CANAL, ROMEO CURVE IN DISTANCE.

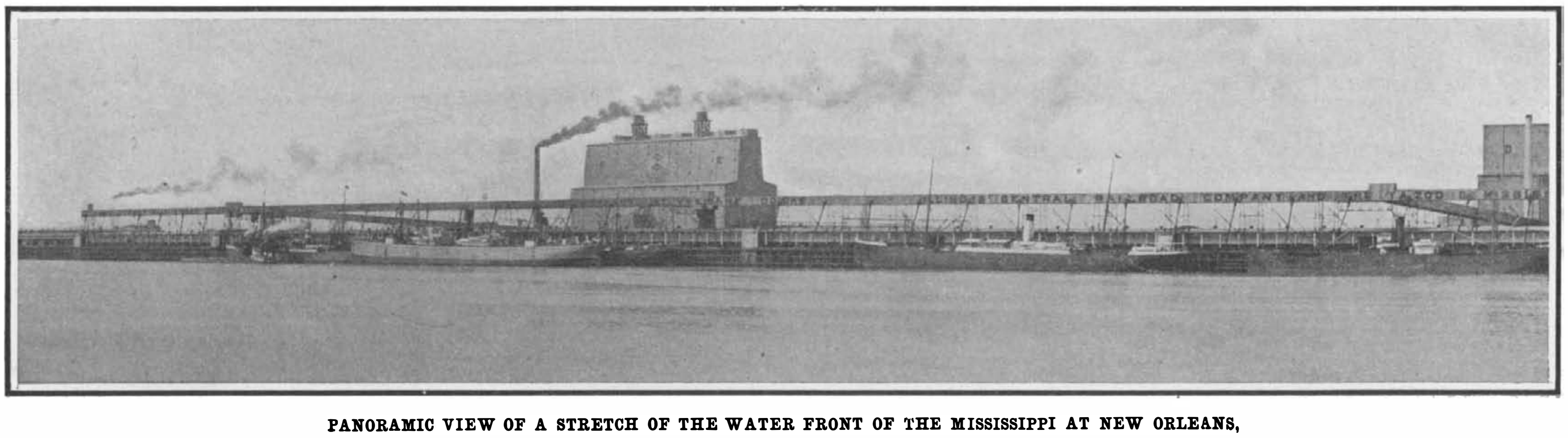
terial in shoals, that not only render navigation difficult and hazardous, but put a serious limit upon the size and character of the fleet of vessels employed. For many decades past, the United States government has maintained a low-water depth of between eight and nine feet from St. Louis to the Gulf. This has been done by a system of bank protection, dikes and dams, assisted by dredging. The depth secured, however, is so limited as to absolutely prevent the development of the traffic to a point commensurate either with the magnitude of the river, or the agricultural and industrial wealth of the vast empire which Nature destined that it should serve.

The recent encouraging revival of interest in the development of our waterways has been nowhere more marked than in the Mississippi Valley. Among the various schemes for the improvement of the river, the one which overshadows all is the proposal for a deep waterway, with a minimum depth of fourteen feet, from Lake Michigan at Chicago by way of the Illinois and Mississippi rivers to New Orleans on the Gulf of Mexico. The proposal for a waterway from the Lakes to the Gulf dates from the first settlement of the country, and from that time to this several surveys have been made. As far back as 1848, the State of Illinois built the Illinois and Michigan Canal, which leaves the Chicago River six miles from the lake, and extends to the head of navigation on the Illinois River at Lasalle, a distance of nearly one hundred miles. The project included the improvement of the river down to the Mississippi by a system of locks and dams calculated to give a minimum depth from Chicago to St. Louis of seven feet.

The Lakes-to-the-Gulf Waterway.—The present active agitation for the construction of a fourteen-foot waterway from the Lakes to the Gulf originated at the time when the State of Illinois authorized the construction of the Chicago Drainage Canal. This great artificial waterway, which, with its connections, is nearly forty miles in length, was constructed for the purpose of preventing contamination of Lake Michigan by the sewage of the city, the whole of which was at that time being discharged into the lake. The distance from the mouth of the Chicago River to its junction with the main drainage canal is six miles, and this portion of the channel is to be widened to two hundred feet with a mid-channel depth of twenty-six feet. The main channel is cut from the river through the divide which separates Lake Michigan from the watershed of the Des Plaines and Illinois rivers. It has a uniform depth throughout of twenty-two feet, and it varies in bottom width from 110 feet to 202 feet according to the character of the material, earth or rock, through which it is cut. Its length from the Chicago River to the controlling works at Lockport is 28.05 miles. Subsequently to the completion of the canal, a water-power extension was constructed, which added another 4.30

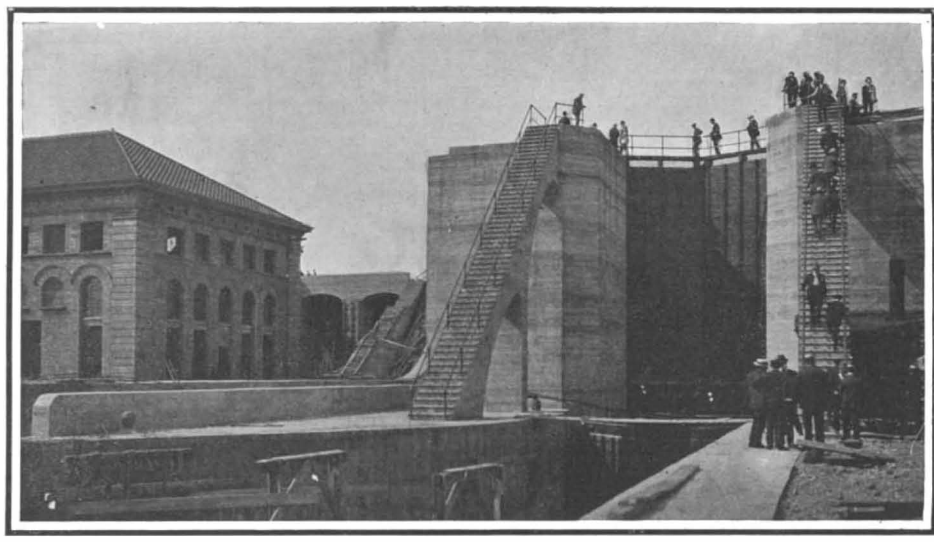


LOCK WALL; OVERFLOW FOR 48 AND 12-FOOT DAMS; TAIL RACE AND POWER HOUSE.

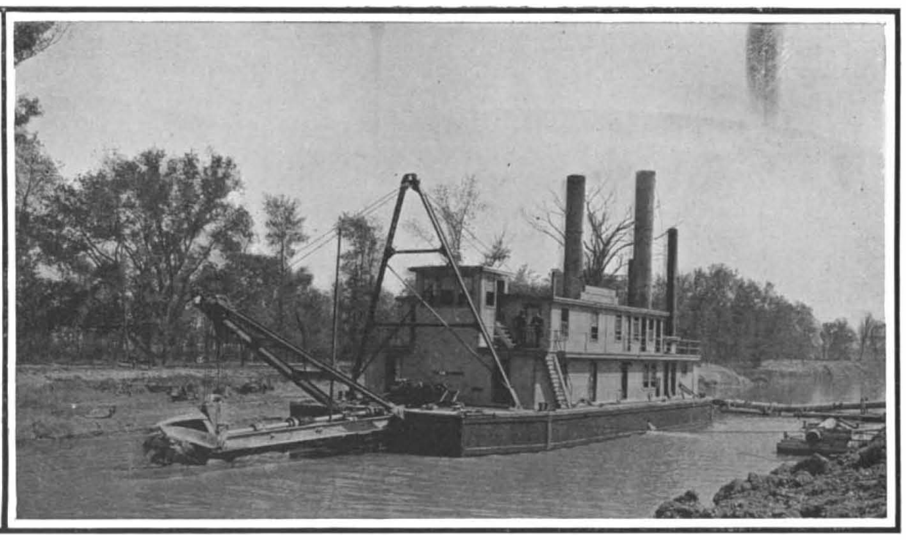


PANORAMIC VIEW OF A STRETCH OF THE WATER FRONT OF THE MISSISSIPPI AT NEW ORLEANS.

THE PROPOSED LAKES-TO-THE-GULF WATERWAY.



THE LOCK AND ONE END OF THE POWER HOUSE.



HYDRAULIC DREDGE EXCAVATING CHANNEL.

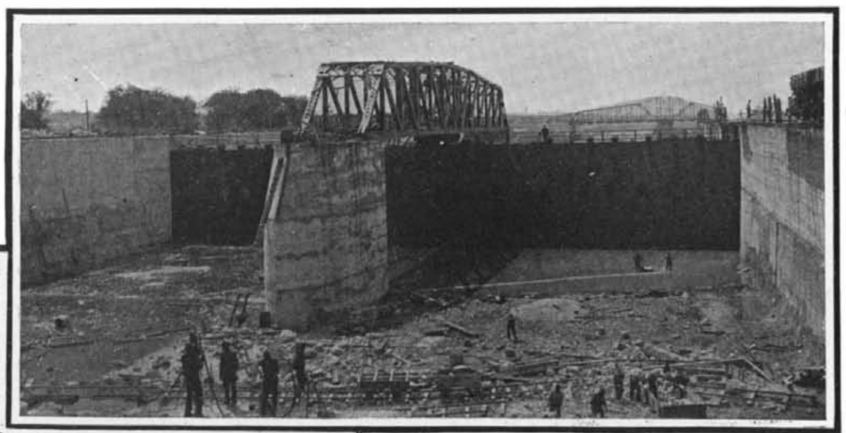
miles of waterway, making a total from Lake Michigan of about 38½ miles. Into the drainage canal is admitted from Lake Michigan a volume of water whose flow is equal to 10,000 cubic feet per second.

At the end of the canal proper are controlling works consisting of gates and a movable bear-trap dam, by which the flow of water from the main channel is controlled, and the height of the water regulated. There are seven metal sluice-gates of the Stoney type with a vertical travel of 20 feet and an opening 30 feet wide, and the bear-trap dam has a vertical oscillation of 12 feet on an opening of 160 feet. South of the controlling works the Des Plaines River (tributary to the Illinois River) has been widened and deepened to accommodate a flow of 1,500,000 cubic feet of water per minute. The main channel, the extension to Joliet, etc., involve a total excavation of over 42,000,000 cubic yards of material, and the estimated cost of the completed work is $50,000,000.

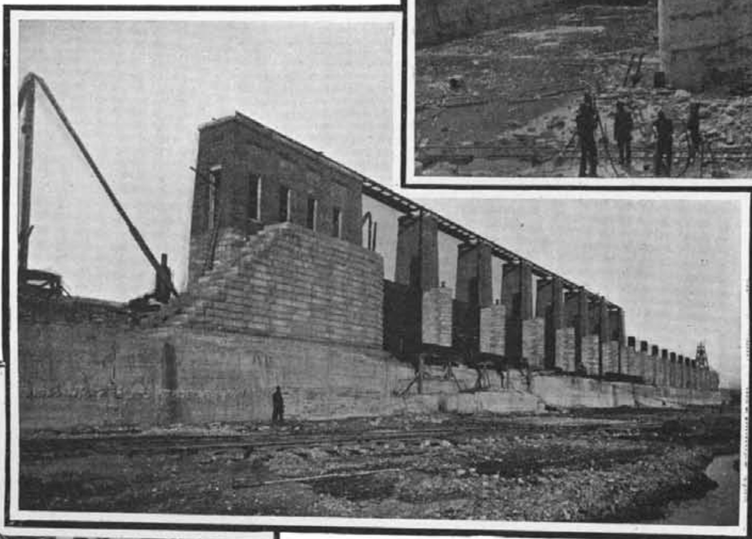
The legislation authorizing the development of the water power passing through the Chicago canal was secured in 1903, the scheme contemplating the extension of the main channel as a waterway and canal for four miles south from the controlling works. The power house, of which we present an illustration, was located on this extension, two miles below the controlling works, at a point where a drop of 34 feet is available for development. The power-house building, which was constructed wholly of concrete, is 70 feet wide, 47 feet high, and 385 feet long.

In 1902 Congress provided for a survey by its engineers to determine the feasibility of building a 14-foot waterway from Lockport to Grafton on the Mississippi, near the mouth of the Illinois River; and in 1905, the Board of Engineers submitted a proposal to canalize the river from Lockport to Utica, a distance of 63.5 miles. The plans provide for locks 80 feet wide, 600 feet long, and with 42 feet of water over the sills.

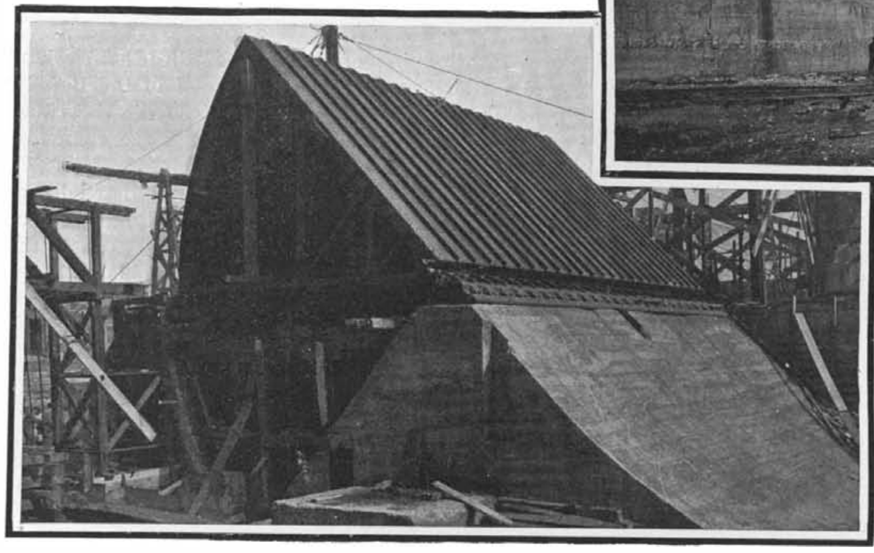
From Utica to Grafton on the Mississippi, 229.5 miles, it was proposed to dredge a channel having a bottom width of 200 feet, and depth at low water of 14 feet. It is considered that the volume of 10,000 cubic feet, which passes through the Drainage Canal, from Lake Michigan, will supply sufficient water during the summer season to give the required depth of 14 feet from Lockport to the Mississippi River. Furthermore, it is estimated that the 10,000 cubic feet of water per second will serve for the development of about 135,000 horse-power in that portion of the canal lying between the Drainage Canal and Utica. The State of Illinois stands ready to undertake the whole of the work from the end of the Drainage Canal to Grafton, stipulating to turn over the completed navigable channel to the United States on condition that the State retain control of the water power, and that the expense of maintaining the channel be borne by the Federal government.



UPSTREAM FACE BUTTERFLY DAM; CHANNEL EMPTY, DAM CLOSED.



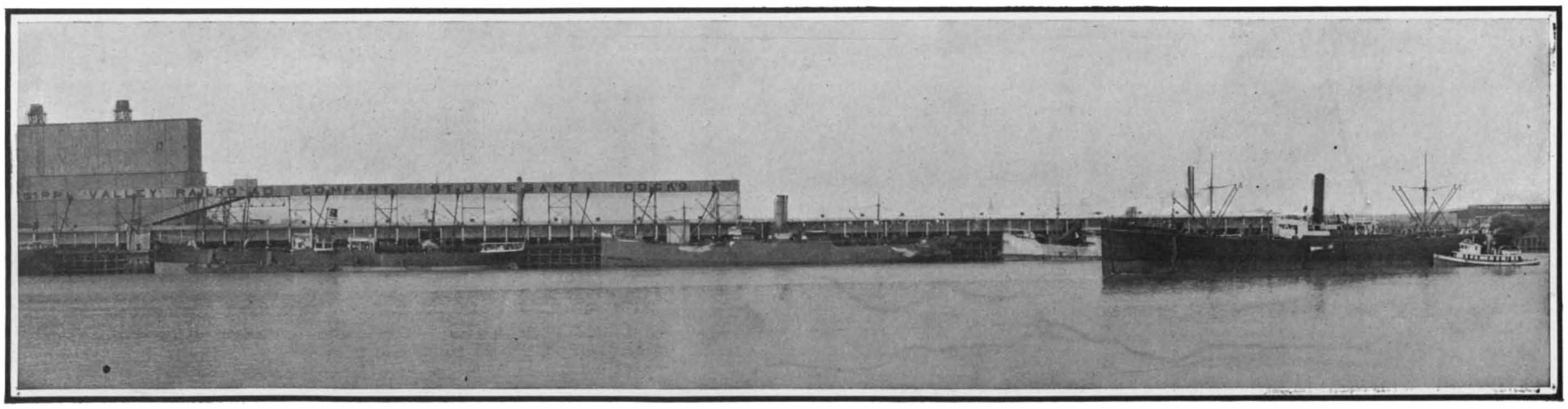
CONSTRUCTION OF STONEY GATES AT CONTROLLING WORKS.



FORTY-EIGHT-FOOT SECTOR DAM AT POWER HOUSE.

The problem presented by the 38 miles of the Mississippi River from Grafton to St. Louis is complicated by the discharge of the Missouri River, which acts as a serious disturbing element; and it was proposed to avoid the difficulty by the construction of an entirely separate waterway along the easterly bank of the river. The plan provides for the construction at Alton of a huge wicket dam 2,500 feet long, which, by raising the water level 14½ feet, would create a pool that would raise the low water level at Alton about 8 feet and, in combination with dredging, would enable the full 14 feet of depth to be maintained. A canal would be cut from the pool, just above the easterly end of the dam, and extend parallel with the river, to the Merchants Bridge at St. Louis, a distance of 38 miles. The canal would be maintained at the level of the Grafton to Alton pool, and at its southerly end a lock 80 feet wide and 600 feet long with a lift of 30 feet would pass the vessels down from the canal to the deep water at St. Louis.

St. Louis to Cairo.—The most difficult portion of the whole waterway from the Lakes to the Gulf is the stretch of 180 miles from St. Louis to Cairo. At low water the river falls on a grade of 0.6 foot per mile, producing a rapid current, and there is the added complication that an enormous amount of sediment is brought down from the Missouri River. Three methods have been proposed for dealing with this difficult section. First, the construction of an independent canal. This would be the simplest solution of the problem and the surest, but its cost would be altogether prohibitive. The second scheme would be to



PANORAMIC VIEW OF A STRETCH OF THE WATER FRONT OF THE MISSISSIPPI AT NEW ORLEANS.

THE PROPOSED LAKES-TO-THE-GULF WATERWAY.

canalize the river by building across it at stated intervals submerged dams, which would change the total slope of 109 feet into a series of pools, with locks for passing the ships from one to the other. This scheme is open to the objection that the enermous amount of silt brought down by the Missouri River, and the material from the constantly eroding banks of the river, would ultimately fill up the pools and necessitate heavy dredging. The third method, and probably the best, would be to maintain the stream at a stated width between banks that were thoroughly protected with revetments.

It is not unlikely that the ultimate solution of the problem will consist in a combination of the three methods suggested above. It must not be forgotten, moreover, that the volume of water available on this stretch during the lowest stages of the river will be increased by the 10,000 cubic feet per second discharged from Lake Michigan through the Drainage Canal. Further presumptive evidence of the feasibility of the maintenance of not less than 14 feet throughout the year is to be found in the fact that the improvement work, which has been carried on by the government engineers under limited appropriations for a number of years, has shown it to be entirely possible to maintain a least depth of 8 feet throughout the period of the lowest stages of water.

CAIRO TO THE GULF OF MEXICO.—South of Cairo, the Mississippi enters the "great alluvial basin," and the question becomes one of keeping the river within its banks and controlling the floods. In this reach of the river the low water flow is 70,000 cubic feet per second, which at high water increases to 1,600,000 cubic feet. For over half the year, except in years of unusually low water, a depth of 14 feet is available. The 300 miles of the river from Red River to the Gulf provides sufficient depth at all seasons of the year even for ocean-going ships; but from Cairo to the mouth of Red River, a distance of 165 miles, there are obstructing bars which would have to be cut through to maintain the 14-foot depth.

For the past six years the engineers have had little difficulty in maintaining a 9-foot channel through these bars by dredging. The Mississippi River Commission during 1907 maintained eight dredges at different bars during the low-water season, in order to determine the possibility of maintaining a depth of 14 feet, and at three different points it was found possible to develop and maintain depths of 16 feet, 17 feet and 16 feet respectively.

THE PRESSING NEED FOR THE NEW WATERWAY.—That the railroads are incapable of handling with facility and dispatch the business of the busy season was recently recognized by James J. Hill, when he advocated increasing the trackage by the expenditure of $500,000,000 for new roads. The necessities of the West, however, are so pressing that they cannot await the duplication of railway mileage; moreover, the business men of the entire country, who are interested in the movement of freight, realize that the only permanent and economical solution of the various transportation problems is the improvement of the streams and rivers of the United States. A complete system of waterways would act as a regulator of rates and, as we have noted above, would serve to relieve the railroads of the more bulky freights which are the cause of the present congestion.

That the Lakes-to-the-Gulf Waterway would be a beneficial and profitable enterprise is shown by a comparison of the freight movement by river and by rail from the port of St. Louis for the years 1865 to 1900, the statistics of which, gathered by J. A. Ockerson, of the Engineers' Club of St. Louis, were published in the Report of the Mississippi River Commission for the year 1901. They show that the maximum rate on wheat by rail from St. Louis to New York was 24.6 cents per bushel in 1877 and 11.6 cents per bushel in 1900, as against 8¼ cents in 1877 and 4¼ cents in 1900 from St. Louis to the seaboard at New Orleans. Again, the total number of bushels of grain exported from St. Louis from 1883 to 1900, inclusive, was 761,004,715. The average rate per bushel from St. Louis to Liverpool by the Mississippi and Gulf route was 6.85 cents less per bushel than by rail *via* Atlantic ports. These figures show that the magnificent sum of over $52,000,000 might have been saved to the producer and shipper had the grain been carried by the river route.

The possibilities of river traffic are shown by the two following illustrations. The steamer "Sprague," a typical stern-wheel towboat of the Mississippi River type, recently took down the river at one hand the cargo of 67,000 tons of coal. It would have required nearly 2,000 cars containing the average carload to haul this single cargo. Again, the "Harry Frank" has carried 9,266 bales of cotton and a quantity of cotton seed at a single load. This single cargo would have made 300 train carloads. There is a wrong impression in the popular mind as to the relative speed of transportation by water and rail. The "Sprague" took down her huge cargo in barges at a speed of from 75 to 100 miles per day, which is much faster than the average speed, as given by a high railway authority, of freight carried by rail.

It is our firm belief that the opening of a waterway 14 feet deep from the Lakes to the Gulf would not only cause an immediate development of the existing traffic, but that a type of steamer suitable for lake and river traffic would be built to meet the special requirements. Furthermore, we believe that the results would be so encouraging as to warrant, before many years had gone by, the expenditure of additional sums of money in increasing the depth of the channel to 20 feet for the accommodation of through shipments in bulk from lake and Mississippi ports to foreign countries.

Halley's Comet.

The total eclipse of the moon on the morning of November 27th was well observed by Prof. Brooks at Smith Observatory, Geneva, N. Y., the sky being unusually clear after a long period of clouds and storms. As a naked-eye spectacle the eclipse was a very beautiful one, the moon when immersed in the earth's shadow having the appearance of burnished copper. All the different phases took place according to the predicted times as follows:

	H.	M.
Moon entered shadow	2	11 A. M.
Total phase began	3	14 A. M.
Middle of eclipse	3	55 A. M.
Total phase ended	4	36 A. M.
Moon left shadow	5	38 A. M.

The moon was in Taurus, and the occultation of a number of stars by the moon was observed.

Several bright meteors from the Biela radiant, and which were due that night, were noted.

Most interesting of all, however, was the observation of Halley's comet with the large telescope during the total phase of the eclipse. During moonlight the comet was quite invisible even in the largest telescopes, it being yet quite a faint object. But during totality the sky was quite black, and on setting the telescope to the computed place Prof. Brooks had this celebrated comet at once in the field of view. Although faint and small, a mere misty spot with a central condensation and diffused edges, it was an easy object in the 10-inch aperture equatorial telescope. But in a few weeks it will be considerably nearer the earth, and should be visible in moderate-sized instruments.

The position of the comet on the morning of November 27th was right ascension 4 hours 44 minutes 10 seconds; declination north 16 degrees 18 minutes—a short distance south and east of the bright red star Aldebaran in the constellation Taurus.

The comet is moving westerly through Taurus at the rate of about one degree daily, but changing very slightly in declination toward the south.

A New System of Wireless Telephony.

Prof. Majorana has made his hydraulic microphone the basis of a new system of wireless telephony. The hydraulic microphone consists essentially of a small glass tube, which is attached to a stretched membrane and serves as the outlet of a jet of slightly acidulated water, which is subjected to a certain constant pressure. The descending stream passes, at a short distance below the outlet, between two platinum electrodes, establishing a connection, the resistance of which is modified by the local variations in the diameter of the stream which are produced by the vibrations of the membrane. The electrodes and the liquid between them complete the circuit of a Poulsen generator, which consists essentially of an electric arc in an atmosphere of hydrogen. When words are spoken into the mouthpiece attached to the membrane, the arc emits aerial electric waves, which are in exact accordance with the sound waves striking the membrane, and from which the spoken words can be reconstructed, by suitable devices, at the distant station. Prof. Majorana has experimented with a thermo-electric and a rarefied gas receiver, and has transmitted speech to a distance of nearly 200 miles.

A Rule for Stairways.

BY A. E. DIXON.

In the building of stairways and ladders there is a simple little rule that is of general application and makes the most comfortable and practicable affair to climb. It is:

$$2 \times \text{the riser} + \text{the tread} = 24 \text{ to } 25 \text{ inches.}$$

For a ladder this gives a vertical distance between rungs of 1 foot, and the rule is based on the common-sense principle that it is more than twice as hard to lift as it is to go on the level but there is less of it to do.

In a power plant the stairs should be straight in order to permit of handling long lengths of pipe, etc. In regard to width, 2 feet 9 inches is about the minimum, but the stairs are sometimes cut a little narrower; where room is available it is better to make the stairs 5 feet wide, which gives plenty of room for two to pass without crowding.—Power.

Correspondence.

A TREADLE BOAT.

To the Editor of the SCIENTIFIC AMERICAN:

Back in 1856, when I was eight years old, my parents and I had to cross the Hudson River from Hudson to Athens, N. Y. We crossed in a ferryboat which was propelled by horses which worked a treadle beneath the upper or main deck. These boats were in common use at that time. From this you will see that what may seem curious to the present generation is in reality something that was very common half a century ago. CHARLES A. HARRIS.

Two Harbors, Minn.

ANOTHER MAGIC SQUARE.

To the Editor of the SCIENTIFIC AMERICAN:

In the October 30th issue of the SCIENTIFIC AMERICAN you publish a certain five square which contains an inscribed diagonal square having all the odd numbers of the square within said inscribed square. Any square based upon a prime number can be arranged so

62	52	42	32	22	1	112	102	92	82	72
74	64	54	44	23	13	3	114	104	94	84
86	76	66	45	35	25	15	5	116	106	96
98	88	67	57	47	37	27	17	7	118	108
110	89	79	69	59	49	39	29	19	9	120
111	101	91	81	71	61	51	41	31	21	11
2	113	103	93	83	73	63	53	43	33	12
14	4	115	105	95	85	75	65	55	34	24
26	16	6	117	107	97	87	77	56	46	36
38	28	18	8	119	109	99	78	68	58	48
50	40	30	20	10	121	100	90	80	70	60

as to conform to the same conditions. Rummaging among a lot of eleven squares made some years ago, I found one having all the odd numbers in same general position, but need a little transposition to render the odd numbers regular. I inclose you the rearranged square, showing many interesting features besides the massing of the odd numbers. A. GALPIN.

Appleton, Wis.

A Metallic Filter.

In all filters of the type of the Chamberland "candle" the fine particles suspended in the liquid are retained rather by adhesion to the filtering diaphragm than by inability to pass through the channels which traverse the latter, as the diameters of these channels are much larger than those of the particles and microbes which are arrested. The capillary forces are able to exert this filtering action because of the great length and irregularity of the channels of these filters of porcelain or infusorial earth. The use of these filters is attended by two inconveniences.

1. After a longer or shorter interval (only 3 or 4 hours in some cases) microbes are found to pass the filter, either because their proper motions are too swift to be stopped by the capillary attraction, or because they multiply in the channels of the filter.

2. The long and sinuous channels offer great resistance to the flow of viscous liquids, and this resistance, in contrast to the filtering power, continually increases.

Gobbi has devised a metallic filter, the efficiency of which depends upon the narrowness of its channels and which removes microbes permanently, while the molecular adhesion is lessened by straightening the channels and diminishing their length.

The Gobbi filter consists of a strip of nickel 1/250 inch thick, about 1/16 inch wide and several hundred feet long, very finely corrugated transversely and rolled into a coil which can be tightened or loosened by a screw. The filtering channels, formed by the opposed corrugations of the successive spires, are straight and only 1/16 inch long (the width of the nickel ribbon) while their diameter can be made less than those of the smallest known microbes by tightening the screw.

This filter not only arrests all microbes during a period of several days but retains colloidal particles much smaller than microbes, so that solutions of dyes are completely decolorized by passing through the filter.

Several American railways are experimenting with mechanical stokers for locomotives. In very few cases have accurate tests been taken, and those that have show results unfavorable to the stoker. Where the firing is well within the capacity of one man without mechanical aid there does not appear to be much reason for installing mechanical stokers, although in America it is hoped that they will help to abate the black smoke nuisance.

American Harvesting Machinery—The Birth and Growth of a Vast Industry.

If the political economist is asked to designate the ultimate source of the wealth of the United States, he will point without hesitation to our vast agricultural interests. In colonial days and during the first three-quarters of a century of our life as an independent republic, we were essentially an agricultural people. With the introduction of the steam railroad and the development of our merchant marine, came the development of our manufactures; but these, compared with our agricultural interests, were at first insignificant. With the introduction of Bessemer steel, however, we began to make rapid strides in all lines of manufacture, and during the past half century we have moved rapidly forward to the premier position among the great manufacturing countries of the world. Nevertheless, it is a fact that to-day, in spite of our leading the world in manufactures, it is customary for Wall Street to base its forecasts of the immediate prosperity of the country upon the predictions of the State Agricultural Department as to the prospect of the next year's harvest.

This fact of the close relation between the products of our farms and the prosperity of the nation as a whole is pretty well known to every American; but probably few people realize how greatly the development of the farm lands of the United States and the development of their full productive capacity has been due to the invention of special agricultural implements, and particularly of that marvel of ingenuity, the American harvesting machine. Originally designed to aid the farmer in developing sparsely populated districts in his own country, in which the amount of available manual labor was sadly disproportionate to the vast area brought under cultivation, American agricultural machinery has been shipped in enormous quantities to every agricultural country in the world, and has been undoubtedly the most potent factor in developing the vast cultivable areas of every continent of the world.

For the beginnings of the agricultural implement industry as we know it to-day, we must go back to the year 1831 and to the State of Virginia, where Cyrus H. McCormick built the first practical grain-harvesting machine. Compared with the modern harvester, it was but a crude affair. Nevertheless, it contained the essential elements that have been found in every grain harvester that has proved a success from that day to this. The parent machine had a main wheel frame, from which projected to one side a platform containing a cutter bar, having fingers through which reciprocated a knife which was driven by a crank. Upon the outer end of the platform was a divider, which separated the grain to be cut from that to be left standing. Above the platform was placed a reel, which served to hold the grain against the reciprocating knife and throw the cut grain back upon the platform. The machine was drawn by a team which walked by the side of the grain. This machine was successfully operated on the farm of John Steel near Steel's tavern in the summer of 1831. The farmers of those days were proverbially conservative, and it is amazing to learn that it was not until 1840 that Mr. McCormick succeeded in making his first sale. It was not until he had gone personally on horse-back among the farmers of Indiana, Illinois, Ohio, and Kentucky, and obtained from them written orders for

FORTY BINDERS AT WORK IN A WESTERN WHEAT FIELD.

A COMBINED REAPER AND THRESHER DRAWN BY THIRTY HORSES AND MULES AT WORK ON A FIELD OF BARLEY IN OREGON.

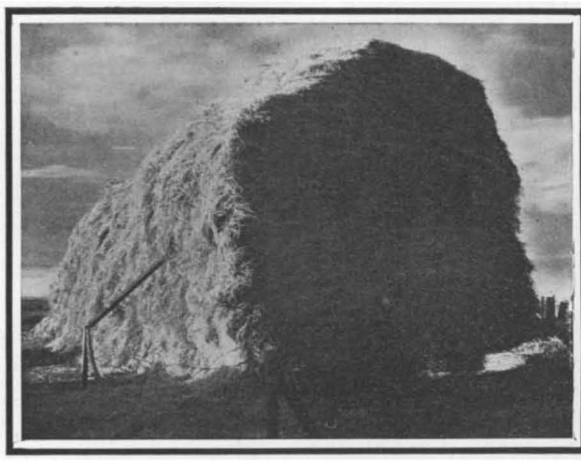
his machines, that he induced a firm in Cincinnati to take up their manufacture.

The next step in the development of the reaper of 1831 was the addition of the raker's seat, a device invented by McCormick in 1845, by which the raker could be carried upon the machine and rake the grain from the platform to the ground. In the spring of 1851 McCormick exhibited his reaper at the World's Fair at London, and was awarded the Grand Council Medal. On this occasion the judges referred to the reaper as being worth to the people of England "the whole cost of the exposition." At a later exposition McCormick received from the French government the decoration of the Legion of Honor for "having done more in the cause of agriculture than any living man."

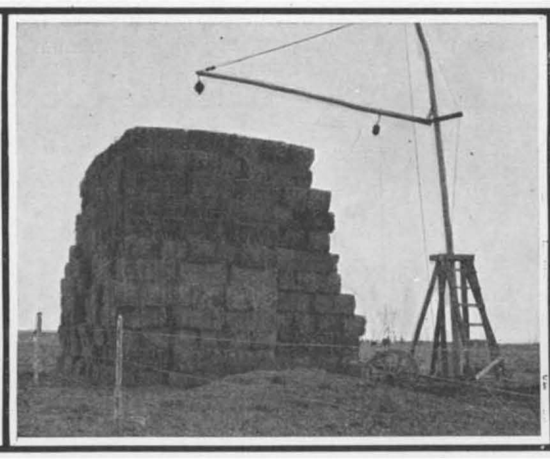
The next step was taken in 1849, when the Mann brothers of Indiana added a series of endless bands for carrying the grain, after it had been cut and reeled upon these bands, to the side of the machine, from which it was dumped upon the ground. In the same year Jonathan Haines brought out the first "header," which was pushed ahead of the horses, clipping the heads of the wheat, which were carried on endless aprons to the side of the machine and deposited in wagons.

In 1850 Adams and Gifford built the first hand-binding harvesting machine, which contained a platform upon which the grain fell from the endless apron, where it was bound by men carried upon the reaper.

The next stage of development toward the modern self-binding harvester was the attachment of a binding device to take the grain that had been cut and raked into gavels, and bind the same automatically into bundles; the patent for this device being taken out by Heath of Ohio in 1850. Then came Jacob Bethel in 1864, who patented the knotting bill which loops and forms the knot, and the turning cord holder for retaining the end of the cord; and later in 1873, after associating himself with A. Wood, he built and sold what was probably the first automatic self-binding harvester that was ever put upon the market. After various attempts had been made to use wire for binding, Gorham in 1874 put in the field the first successful automatic self-sizing binder. This remarkable machine contained the essential elements of the McCormick reaper with the ingenious grain binder added. The grain is delivered upon a platform, where it is seized by packers, carried forward into a secondary chamber, where it is compacted by the packer against a yielding trip so arranged that when sufficient grain is accumulated the trip yields and starts the binding mechanism into operation. The cord is carried on the machine in a ball. The grain is forced against this cord by the packer, and when the binder starts, the needle encircles the gavel, carrying the cord to a knotting-bill of the Bethel type. Here the end is again seized by the

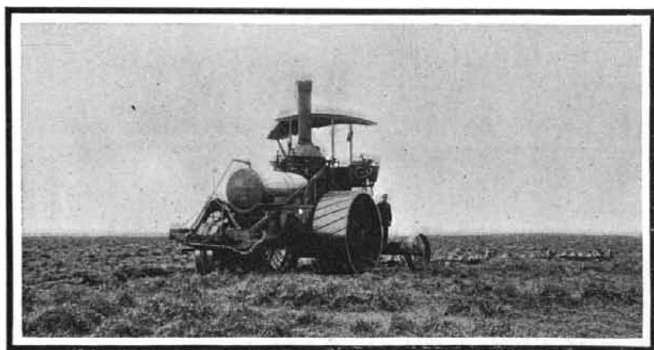


A 100-TON STACK OF ALFALFA RAISED ON IRRIGATED LAND.

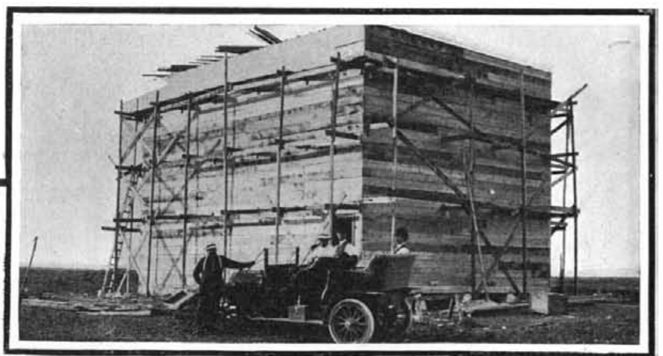


BALED HAY RAISED ON IRRIGATED LAND, TRUCKEE, NEVADA.

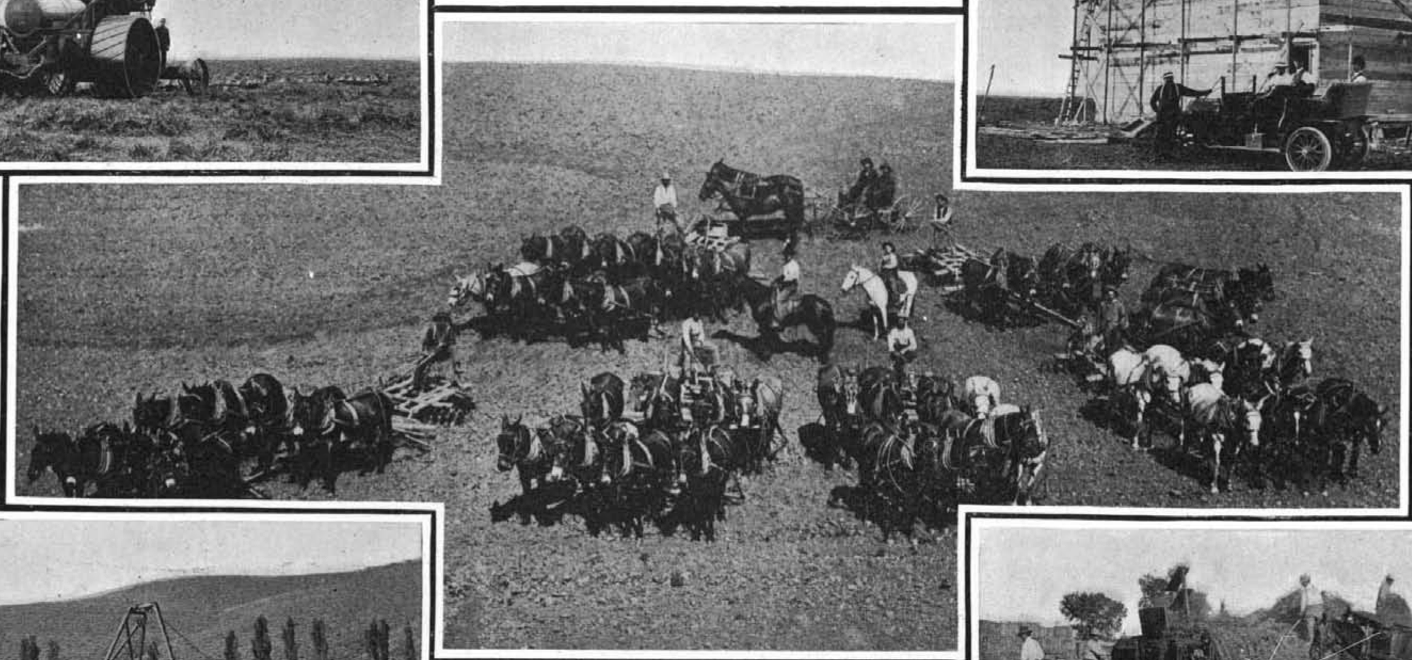
MACHINE LOADING ALFALFA AT LODI, CALIFORNIA.



GANG OF PLOWS DRAWN BY A POWERFUL STEAM TRACTION ENGINE. ON THE LARGER FARMS STEAM IS RAPIDLY REPLACING HORSE POWER.



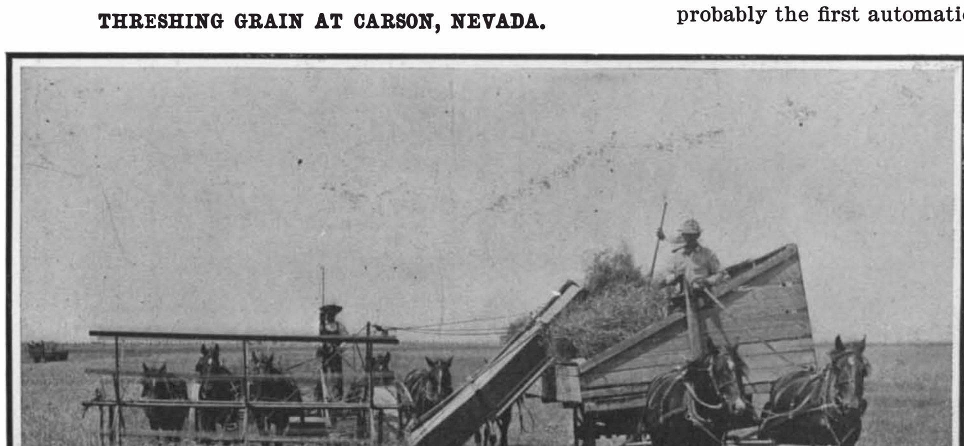
TYPE OF ELEVATOR ERECTED ON IDAHO RANCH FOR INDIVIDUAL USE. FROM THESE ELEVATORS THE GRAIN IS SHIPPED BY RAIL.



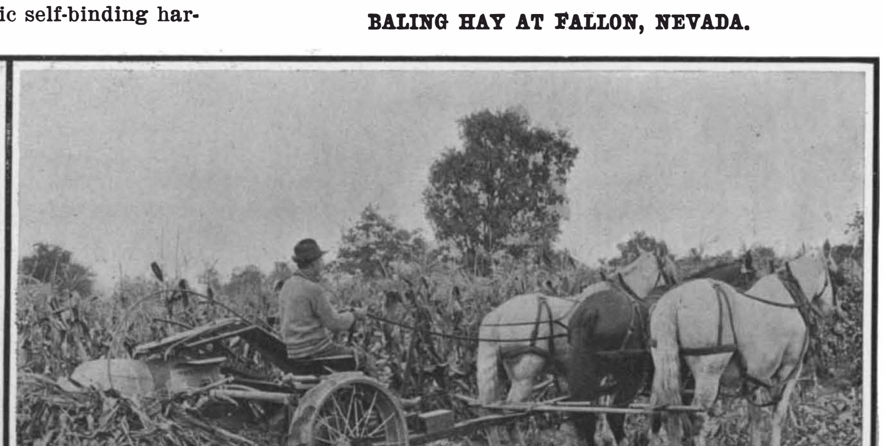
TYPICAL OUTFIT ON A LARGE OREGON FARM.

THRESHING GRAIN AT CARSON, NEVADA.

BALING HAY AT FALLON, NEVADA.



HEADER AT WORK IN A KANSAS WHEAT FIELD.



CORN BINDER AT WORK IN THE FIELD.

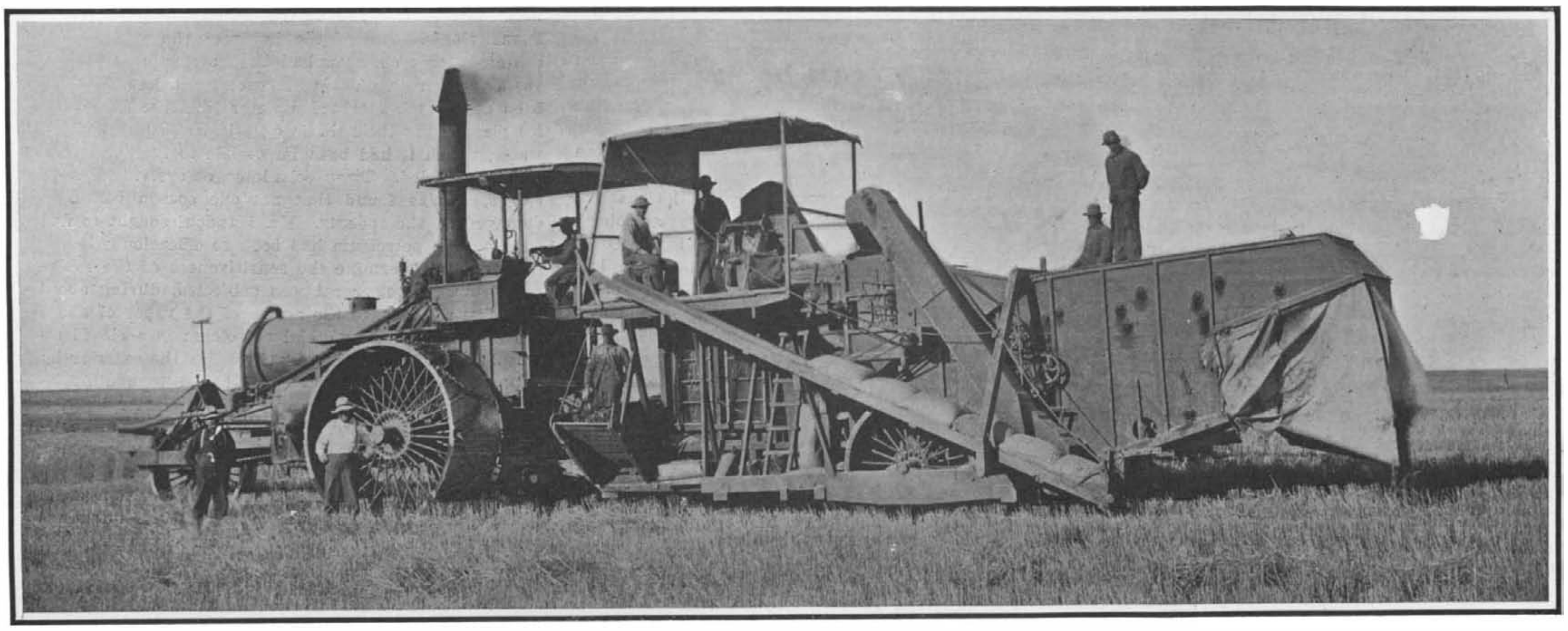
rotating holder, the loop formed, the ends of the bands severed, and the bundle is discharged, bound, from the machine. At the same moment a gate, which, during the binding operation, has shut off the flow of grain, retracts, and the operation is again repeated.

In the thirty-five years since the production of the first successful self-binder, the progress in the development of the harvester has been in the direction of improving its mechanical details and increasing its size and capacity. Originally, the threshing of the grain was done by separate threshing outfits which traveled from farm to farm for this purpose; but with the opening up of the huge wheat ranches of the West, there has been developed and brought to great perfection a combined harvester and threshing machine, several illustrations of which are herewith reproduced. These wonderful machines cut, thresh, and sack the grain at one operation. As they travel through the field, one sees the cutting bar, 15 to 25 feet in length, slicing its way through the standing grain, and on the other side he witnesses the steady delivery of the grain in sacks, ready to be hauled to the railway elevator. The largest of these machines are to be found in operation on the Pacific coast. They are either hauled by teams of from thirty to forty horses, or by large steam traction engines. The biggest of these, a Best machine, is hauled by a traction engine of 110 horse-power. The cutting bar is 25 feet long, the separator or thresher measures 54 inches, and has a capacity for cutting and threshing 65 to 100 acres of wheat per day, the amount depending upon the condition of the grain to be harvested. The cutting bar of the horse-drawn machine is 16 feet long, and the thresher measures 36 inches. This machine can cut from 35 to 40 acres per day. The harvesting expenses, when using the steam harvester, are from 35 cents to 50 cents per acre, and the horse-drawn machine operates at an expense of from 50 to 70 cents per acre.

There are but few statistics obtainable with relation to the early growth of grass-cutting and grain-reaping machinery. In 1840 there were three reapers made, and less than that number of people were employed upon them. In 1845, 50 people were employed in the manufacture of 500 machines. In 1850, the production had increased 3,000; and in 1860, 20,000 machines were produced, in the manufacture of which 2,000 people were employed. About the year 1880, shortly after the automatic cord binder was perfected, there was an immediate and marked increase in the output, so that by 1885 there were more than 100,000 self-binding harvesters built and sold, and 150,000 reapers and mowers, 20,000 people being engaged in their production.

Although the American harvesting machine has exerted the most potent influence in the development of the arable lands throughout the world, there has been a similar advance in the improvement of other agricultural implements, and a similar growth in the magnitude of the industry devoted to their manufacture. For the following statement of the progress made as shown by a comparison of methods, old and new, we are indebted to Mr. M. R. B. Owings, of the International Harvester Company:

Plowing by Old Methods and New.—The old wooden beam walking plow has been superseded by the modern steel-beam riding gang plow. Throughout the great Northwest, and in nearly all the region west of the Mississippi River, the plow drawn by a traction engine has long since passed the experimental stage. Several 16-inch plows are drawn by a 20-horse-power traction engine. On a large farm, where three or four such outfits are in operation at the same time, it is not difficult to understand how thousands of acres of good wheat land can be plowed, harrowed, and seeded within a comparatively short time; for tractors are also used to operate seeding machines, both the pulverizing and seeding being done in one operation. With the old-style plow, two acres per day could be plowed, at the cost of $2.50 per acre. With the gang plow drawn by gasoline tractor, one and one-fourth acres can be plowed in an hour, at the cost of 75 cents an acre. If the plows are drawn by a steam tractor, the cost is $2 per acre.



This machine cuts the wheat, threshes it, and delivers it ready sacked in one continuous operation.

REAR VIEW OF A 50-HORSE-POWER HARVESTER COMBINE.

SUMMARY OF THE AGRICULTURAL MACHINERY INDUSTRY, 1850-1895.

	Census. 1905*	1890	1870	1850
Number of establishments	648	910	2,076	1,333
Capital	$196,740,700	$145,313,997	$34,834,600	$3,564,202
Salaried officials, clerks, etc., number	7,199	3,717	(4)	(4)
Salaries	$7,572,646	$3,704,667	(4)	(4)
Wage earners, average number	47,394	38,827	25,249	7,220
Total wages	$25,002,650	$18,107,094	$12,151,504	$2,167,868
Miscellaneous Expenses	15,178,098	11,129,548	(6)	(6)
Cost of materials used	48,281,406	31,603,265	21,473,925	2,445,765
Value of products	112,007,344	81,271,651	52,066,875	6,842,611

* Exclusive of the statistics of 93 establishments engaged primarily in the manufacture of other products. These establishments made agricultural implements to the value of $1,349,679.

Threshing Machines.—The threshing outfit commonly used thirty years ago consisted of the old-fashioned separator and the now antiquated horse power. There were one or two band cutters; and one or two feeders, according to the width of cylinder, were required to feed the grain into the machine; three or four men measured and sacked the grain, while three

The harvester is shown at work in the wheat field of an Idaho corporation that owns 10,000 acres. The average yield on this ranch is 30 bushels to the acre.

FRONT VIEW OF THE HARVESTER COMBINE SHOWN ABOVE.

to six men were kept busy stacking the straw in a cloud of choking dust.

The modern threshing machine is equipped with an automatic band cutter, self-feeder, automatic weighing and sacking device, and pneumatic swinging straw stacker, the necessary power to operate all of which being either a gasoline or steam traction engine. By the old method of growing wheat, the time required to produce a bushel is three hours. The modern harvesting machines can cut the time down to ten minutes; the old cost being 17¾ cents per bushel, as compared with 3½ cents per bushel now. The old threshing machine had a capacity of 175 to 225 bushels per day; the modern machines can handle 2,000 bushels and over in the same time.

Haying Machines.—A similar advance has been made in machines for handling the hay crop. The old revolving, wooden-tooth hay rake has given place to the self-dump, sulky, steel hay rake. This machine can be operated by a ten-year-old boy, who can do more and better work than could a man using the old method. The hay tedder enables the farmer to cure his hay quickly, and greatly improve the quality of the hay. By means of the hay loader, timothy, clover, or alfalfa can be taken direct from the swath and loaded on the wagon. With the modern sweep rake, the hay can be taken direct from the swath or cock and put into the stack with the hay stacker. Extensive use is also being made of the derrick hay fork, especially when the hay is to be put away in the mow.

Corn Machines.—Thirty years ago, much of the corn crop was planted by hand, cultivated with a one-horse walking plow, cut by hand with the corn knife, and put into the shock by main strength and awkwardness. To-day the check rower automatically plants the corn in hills exactly the same distance apart, so that the corn will be in rows, no matter in what direction you may look at the field; in other words, the young corn can be cultivated with a riding sulky cultivator both ways, east and west, as well as north and south, which of course thoroughly destroys all weeds. When the crop is matured, the modern corn binder cuts and binds the corn into bundles ready to be put in the shock. One man with a corn knife can cut about one acre of corn in a day; the modern corn binder cuts and binds six to ten acres in a day.

The corn husker and shredder has been developed and perfected within the last twenty years. This wonderful machine enables the corn grower to double the value of his corn crop. Heretofore, corn has been husked by hand, and the stalks have been allowed to stand in the field and go to waste; for cattle will not eat standing corn stalks. Cutting corn by hand was a slow and laborious task at best; but with the modern corn binder the farmer can cut his corn crop promptly, at the time when the nutritious juices are still in the stalk. With the husker and shredder he can husk his corn and shred the stalks, leaves, and husks into stover, which can be put away in the mow the same as hay, or can be baled. Cattle, horses, and sheep can be fed on shredded fodder all winter, and they will be kept in good condition without any other feed. In the United States nearly one hundred millions of acres are devoted to growing corn. About two tons of corn stalks are grown on every acre. The modern improvements made in the machines used for handling the corn crop make it possible for the farmer to save two hundred million tons of corn fodder, which, when shredded into stover, is fully equal in feeding value to good timothy hay. At the low estimate of $5 a ton, the husker and shredder alone, if the whole corn crop were shredded, would annually add one billion dollars to the agricultural wealth of the country. The corn sheller enables the farmer to shell his corn quickly, if he does not wish to market his crop in the ear.

Cream Separator.—In the old days, the milk was strained into crocks and put away in the cellar over night. The cream was skimmed from the crocks, and laboriously churned into butter by hand. This old method left the skimmed milk almost valueless—cold, sour, and diluted to such an extent that it had little value for feeding purposes. When the cream separator is used, the skimmed milk is both sweet and warm, and is much relished by calves and pigs. A great deal of work involved in handling the milk is saved by the use of a cream separator. The milk does not have to be carried into the house or to the cellar, or to the spring or cooling tank; there are no unnecessary cans, crocks, pans, and other vessels that must be washed. The cream separator enables the farmer to double his dairy products with less than one-third of the work involved in handling the milk the old way. The yearly income from a good cow should be $89.25. Under the old methods the yearly loss was $22; which is altogether eliminated by the use of the cream separator.

Gasoline Engine.—Among the improvements which have helped to transform drudgery to a pleasurable pastime on the farm, the gasoline engine must be given a prominent place. When we were boys on the farm nearly all the odd jobs were done by hand. The wood pile and the corn crib were always full of terrors for the average farm boy; but the gasoline engine has wrought a magical change. This mechanical handy man will furnish power to operate the cream separator, to churn, and to feed the ensilage cutter, and it will saw the wood and shell the corn, and do innumerable other chores that are familiar to everyone who has been brought up on the farm. The gasoline engine is both an economical and reliable power, and it needs but little attention. A 10-horse-power engine of good design uses about one gallon per hour when doing its full 10-horse-power work. The trolley car and the telephone are doing much to bring the farm into closer touch with the larger cities; but it is the gasoline engine that is doing most to keep the boy on the farm. It is made in various styles and sizes, to suit the needs of the ten-acre farm as well as those of the ten-thousand-acre ranch.

Manure Spreader.—A great deal has been written about the abandoned farms of New England; and were it not for the improvements made on the manure spreader, now so generally used, the same doleful story would be written about many farms in the Ohio, Mississippi, and Missouri valleys. This region has always been known as the garden spot of the world; but even the marvelous fertility that is so common in Illinois, Ohio, Iowa, Missouri, and other States, noted for their bounteous crops, would soon become exhausted if the soil were not replenished with plant food. The manure spreader makes it possible for the farmer to renew the fertility of his soil every year. Instead of growing fifteen bushels of wheat to the acre, he fertilizes his ground properly, and reaps a harvest that will average thirty bushels to the acre; indeed, many fields have been known to yield as much as fifty bushels per acre.

The modern farmer is working with a well-defined purpose. His constant aim is to do less work that requires muscle and brawn, but more brain work. He purposes to purchase machines that will do the drudgery and irksome tasks, while he himself can find time to solve the problems of farm management. A little head work, properly applied to the management of a farm, will often turn loss into profit.

A Zeppelin Polar Expedition.

The object of the Zeppelin Polar Expedition Society, recently organized in Germany, is sufficiently explained by its title. The executive committee has decided to send a preliminary expedition to Spitzbergen, in the summer of 1910, for the purpose of studying the ice of the polar sea and determining the conditions which must be satisfied by a dirigible balloon operating in the polar regions. The committee attaches great importance to new improvements which will enable Zeppelin balloons to make long journeys, and deems it necessary to make preliminary voyages over sea in order to solve numerous problems which are very important to the practice of aeronautics in such conditions. An airship will be at once designed for oversea flights and should be completed by the beginning of the year 1911.

It might be thought that, as Peary and Cook have reached the pole—and found nothing there, as could have been foreseen—it is useless to send out a polar expedition in an airship, but this view would be erroneous. In previous expeditions the explorers have had neither leisure nor facilities for the collection of important scientific data. If the Zeppelin expedition is successful its members will be less hampered by lack of time, and less exhausted by fatigue and privation. Hence they may be expected to make scientific observations of great value.

Aging Wines with Ozone.

The quality of wine is greatly improved by natural aging in wood or glass, but this method keeps a large amount of capital unemployed and involves a loss of 4 or 5 per cent by evaporation. The same improvement in the wine can be accomplished more rapidly by the action of oxygen. Boussingault proved that exposure to oxygen makes new wine less acrid and hastens the deposition of impurities in the form of lees. It is asserted, furthermore, that wine does not improve by age, either in wood or in glass, unless it has already absorbed a certain quantity of oxygen from the air, and Pasteur has proved that wine deprived of oxygen is not altered by keeping.

Artificial aging has often been tried but it has been found impossible to obtain the desired result by the introduction of either pure oxygen or pure ozone. The process patented by Alfred Dorn, a few years ago, appears to be more successful. It consists in the introduction of oxygen, and its transformation into ozone in the interior of the mass of wine. A tubular electrode connected with an oxygen tank and an induction coil is inserted into the cask, and a portion of the oxygen thus introduced is converted into ozone by the electric current. The operation is continued for a period varying from twenty to ninety minutes, according to the quality and quantity of the wine. For distilled spirits it may be necessary to continue the treatment six hours. This rapid treatment must be followed by natural aging for a short time, but new Bordeaux wine acquires by this method, in from forty to sixty days, the quality of wine kept for many years in bottles.

Rats and Petroleum.

The treatment of stagnant water with petroleum, which is effectual against mosquitoes, operates also in an indirect manner on rats. Mr. Mandoul has made investigations on board "L'Imerethie" during September, 1907. These are abstracted in the Archives de Parasitologie. One of the holds of the ship, which contained silk cocoons, had been almost entirely devastated by rats. Their presence there had probably been due to the saccharine water from the fruits and ice placed near the hold in question. To this body of water, which it had been impossible to remove, petroleum was added. Two weeks later, on arriving at Marseilles, it was found that not one cocoon had been damaged by the roden Mr. Mandoul sought to find out how the petroleum had been so efficacious; he endeavored to determine the sensitiveness of the rat to petroleum. A sewer rat was subjected, during about forty-five minutes, to the action of the vapor of about 100 grammes of commercial petroleum in a closed atmosphere (a bell communicating with the exterior by a narrow orifice). The animal began to exhibit labored breathing and, during the last quarter hour, a lassitude in its movements. After these manifestations the animal licked the hairs of its beard; it was depressed and ate little. Three days afterward it was found dead in its cage. The autopsy showed that its viscera were very congested, and that the intestines contained some petroleum. Another rat was subjected to a diet of petroleum. It refused bread treated with petroleum, but accepted meats. It died after about a quarter of an hour. The author made inquiry in petroleum refineries, and upon boats which transport this product. Rats do not exist there or are very rare. Mr. Mandoul concludes that rats have a peculiar aversion for petroleum, which drives them away rather than poisons them, the aversion with which they are inspired resulting from their desire to seek shelter from its toxic action. In addition, the petroleum, thanks to its insecticidal effect, rids the rats of their parasites and of the infectious germs which they are able to transmit.

Chicory Coffee.

At the Congress of the French Association for the Advancement of Science, which was held in Lille, Mr. F. Dorveau gave a communication in which he studied the history of the usage of the roasted root of chicory, as a substitute for coffee—we are inclined to say, as an adulteration of coffee.

The author of this invention is unknown; perhaps he was not willing that future generations should know the name of him who conceived what many consumers cannot fail to call a misdeed; it is true that the growers of chicory, and the manufacturers thereof, have worked hard to erect a statue for him.

Not only is the name of the inventor unknown, but even the date of the invention has been seriously disputed, and is a question which has long been discussed. After examining the documents, Mr. Dorveau believes he has been able to establish that the Dutch used chicory in 1690. There was a delay of almost a century before its usage spread beyond the country of its origin; the Prussians were the first to adopt it in 1763; the French have been making use of it since 1771, and there has been a singular development of the usage of chicory in France since that date.

Valmont d'Bomare, in praising the usage of chicory in his dictionary of natural history, published in 1875, without doubt contributed more than anyone else to its widespread use.

How Long Will the World's Supply of Iron Last?

Less than 2 million tons of iron ore was mined in 1800, less than 11 million tons in 1850, and nearly 85 million tons in 1901. Some day the world's supply of iron will be exhausted, and the question, when this day will come, has already been discussed. According to Prof. Binz, the total quantity of iron ore contained in known and workable deposits amounts to about 8,000 million tons, distributed as follows: Germany, 2,200; Russia, 1,500; France, 1,500; United States, 1,100; Sweden, 1,000; Spain, 500; England, 250 million tons. As an annual production of 50 million tons of iron means an annual consumption of from 100 to 150 million tons of ore, the entire available supply of iron ore, as estimated above, will be exhausted before the close of the twentieth century. Apart from the fact that vast regions of the earth have not yet been explored in search of mineral deposits, this conclusion appears far too pessimistic for the reason that ores very poor in iron, which are not now worked but could be worked in case of necessity, exist in great abundance. Hence an exact answer to the question appears to be neither necessary nor possible, at present.

Gary: The Largest and Most Modern Steel Works in Existence.

The rapid increase in the business of the United States Steel Corporation rendered it necessary, some four years ago, to make a considerable increase in its plant. The more or less congested conditions surrounding the various existing establishments led the company to search for a site where a large area of land could be purchased at a reasonable price, and which would be located within economical hauling distance of the great centers from which the supplies of ore, coke, and limestone could be derived. Such a location was found in the State of Indiana on the south shore of Lake Michigan, some twenty-five miles south of the city of Chicago. Here the company purchased a tract of over 9,000 acres, with a frontage on Lake Michigan of seven miles. One thousand acres of this property, including a water front two miles in extent, was selected as the site of the new steel plant. The property was a dreary waste of drifted sand, entirely uninhabited and covered with a scanty growth of grass and scrub timber. It was an ideal location for the purpose; for on one side it was accessible by the ore-carrying steamers from Duluth, and on the other side it was served by several trunk railroads over whose tracks the coke and limestone could be brought in and the finished products hauled away, without any intermediate handling or trans-shipment.

With such a virgin site to build upon the designers of the plant were able to work with a free hand; and the component parts of this, the greatest steel plant in existence, were therefore laid out with a strict regard to the economical handling of the enormous masses of raw material and finished product. It can be understood that where the total tonnage of material handled in any industrial establishment runs into the millions, it is of the highest importance that this material shall pass from process to process, from building to building, with as little handling and as short a haul as possible; and in laying out the huge open-air structure and inclosed buildings which cover the 1,000 acres that include the present plant, strict attention was paid to this feature. Furthermore, advantage was taken of several recent improvements in the art of steel manufacture, notably that of utilizing the blast furnace gases in gas-driven power plants to operate the blowing engine and provide electrical power for the operation of the various mills. Apart from the vast extent of the plant the feature which has attracted the attention of the engineering world to the Gary steel plant is the great economies which have been effected by the use of gas-driven engines of great size for the generation of practically all of the power required for operating the machinery. The plant is owned by the Indiana Steel Company, to whose vice-president, Mr. G. G. Thorp, we are indebted for assistance in the preparation of the present article.

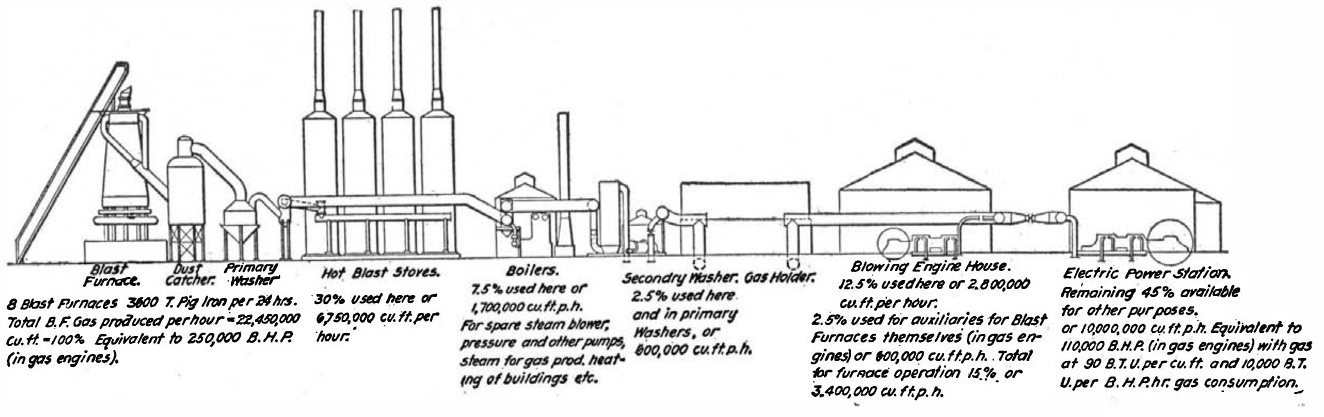


DIAGRAM SHOWING THE DISTRIBUTION OF THE FURNACE GASES AT GARY.

Work was commenced in March, 1906, and at the present time over one-half of the plant has been completed and is in operation. The work of construction is being steadily prosecuted and when the whole work is finished the equipment will be as follows:

A harbor, with complete ore-unloading facilities, and a storage yard capable of accommodating 5,000,000 tons of ore.

Sixteen modern blast furnaces, having an annual capacity of 2,400,000 tons of pig iron.

Six open-hearth furnace buildings, each containing fourteen 60-ton furnaces. The combined annual capacity of this plant is 3,750,000 tons.

A billet mill and a rail mill, the largest in the world, capable of turning out 4,000 tons of rails per day; plate mills, an axle-making plant, and a large group of merchant mills, the above plants having a combined capacity sufficient to roll all of the steel that can be produced in the open-hearth furnace plants.

A blowing plant of a total capacity of 92,000 horsepower for furnishing air to the blast furnaces, operated by gas engines of 64,000, and steam engines of 28,000 horse-power total capacity.

An electric power plant, driven by gas engines of a combined capacity of 120,000 horse-power, for operating the various mills.

A complete equipment of mechanical shops at which all of the repairs can be made and much of the machinery required by the plant.

A water supply system, served by two 10-foot conduits leading from Lake Michigan, whose pumps are capable of supplying 170,000 gallons of water per day under a head of 120 feet.

A railway system extending throughout the plant which includes 125 miles of standard railway track.

TOWN OF GARY.

Adjoining the steel plant the company has built an entirely new town for the accommodation of its employees. Already it houses some 15,000 people, of whom about one-third are employed at the works, and includes about 500 dwellings, three hotels, and a schoolhouse built by the company. Also many dwellings and business blocks have been erected by private persons. The town has been laid out on the most approved modern lines with broad, brick-paved, concrete, or macadam streets and cement sidewalks. It contains its own waterworks and gas plant, and the whole town is lighted from a large generating station in the steel plant. Space has been reserved for two recreation parks, and everything is being done to render this city comparable with the best model industrial cities of the country.

THE ORE DOCK AND UNLOADING APPLIANCES.

When the ore steamers from Duluth arrive at Gary, they enter an artificial canal, 22 feet deep and 250 feet wide, which extends at right angles with the shore line for a distance of 4,650 feet inland, when it widens out into a 750-foot diameter turning basin. The west bank of the canal adjoining the steel works is formed by a massive concrete retaining wall, back of which, extending parallel with the canal, are the ore unloaders, the ore-handling bridges, and a vast open concreted area, with concrete walls on either side, for the storage of the ore for winter use. The completed plant will include ten unloading machines of the Hulett type. Each machine consists of a massive walking-beam, at the outer end of which is a vertical arm ending in a 10-ton grab bucket. The steamer is moored alongside the concrete bulkhead, and as soon as the hatches are off, the unloaders thrust their 10-ton buckets into the holds, bring up the ore, and deliver it to a conveyer car, which runs back and discharges it into a trough on the edge of the stockyard, or into a hopper on the machine from which it can be shot into cars. The machines will have a combined unloading capacity of 2,500 tons of ore per hour. Working in conjunction with the Hulett unloaders will be ten Hoover & Mason traveling conveyer bridges. These huge structures, five of which are shown in our panoramic view of the steel works, are about 500 feet long. They extend from the concrete trough, before mentioned, into which the Hulett unloaders discharge, clear across the whole width of the stockyard. Each bridge is provided with a 15-ton grab bucket, by which the ore is picked up from the trough and deposited in the stock pile, from which it is picked up again as it is needed and loaded into the blast furnace supply cars. The object of the huge storage yard, which is 4,000 feet in length, is to enable the company to provide a sufficient supply of ore to operate the plant during the five months of the year when lake navigation is suspended. Its total capacity is about 5,000,000 tons.

THE BLAST FURNACES.

Back of the stockyard and extending parallel with the same are eight blast furnaces (to which eight more will be added), each with its equipment of four hot-blast stoves. The blast furnaces are 88 feet in height from the tap hole from which the hot metal is drawn to the top of the furnace lining, and the capacity of each is 450 tons per day.

Between the stock pile and the furnace is a long line of elevated storage bins arranged in two parallel rows. One row is for coke and the other for ore and limestone. Above the bins are four tracks on which travel two 60-ton electric transfer cars. The ore is loaded into the transfer cars by the buckets of the overhead ore bridges. The coke and limestone are brought up over the bins by rail and deliver their load directly by gravity. At the bottom of the bins are spouts controlled by electrically operated gates, and below these are tracks which run the full length of the bins. Traveling on these tracks are electrically operated lorries into which the ore, coke, and limestone are delivered from the bin spouts. The lorries carry the materials to what are known as the "furnace skips," of which there is a pair to each furnace. The skips run upon an inclined railway which runs direct from a pit below the transfer cars to the charging platform at the top of the blast furnaces. Each trip of the skip is made in about 60 seconds, and its average load consists of about 7,000 pounds of ore, or 6,000 pounds of limestone, or 3,600 pounds of coke. The operator merely starts the skip on its journey. Its journey up the incline and the halt at the charging platform above are purely automatic.

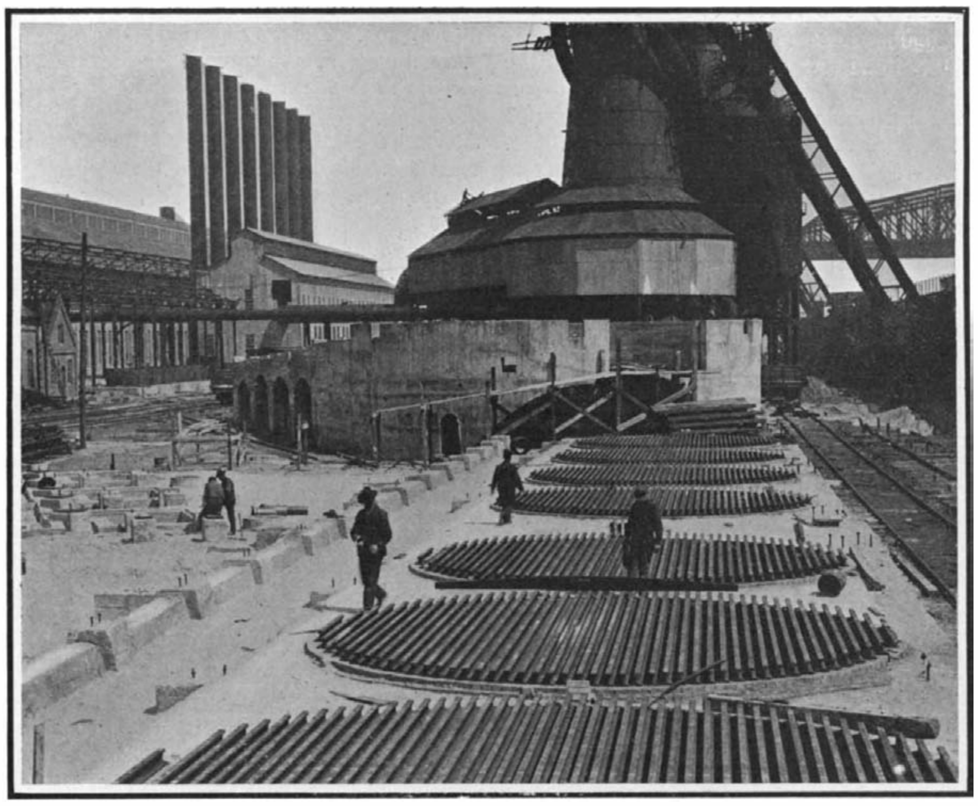
The blast furnace is a huge steel shell lined with a thick wall of firebrick. Its interior diameter is 15 feet at the base or hearth, 21½ feet at a height of 13 to 21 feet above the hearth, 16 feet at the top. It is loaded full with a charge of coke, limestone, and iron ore. The air for combustion is introduced through a series of water-cooled tuyeres, which enter the furnace near the top of the hearth. This air is supplied by huge blowing engines at an average pressure of 18 pounds per square inch. Part of the hot gases from the top of the furnace, after first having been cleaned in the primary washers, are led through the hot stoves, of which there are four, to each furnace, as shown in our panoramic view of the plant. The stoves are huge cylindrical plate-steel structures, filled with a honeycomb of firebrick. The burning of the gases in the stove raises the temperature of the firebrick; and, when this has reached a certain point, the gases are cut off from that stove and turned into another one of the series. At the same time the cold air from the blowing engines is caused to pass through the now heated firebrick of the first stove, where it takes up the heat given up by the combustion of the furnace gases, and returns it to the blast furnace. The operation of the blast furnace is continuous, and the temperature varies from that of the molten iron in the hearth at the bottom to that of the cold charge which has just been introduced at the top. As the charge is reduced, it gradually descends as molten metal and as slag, the slag, because of its lighter weight, floating on the top of the molten metal. At regular intervals the slag and the metal are separately drawn off into ladles, the slag being hauled to the slag pile and the metal being taken to the mixers or cast into pig metal as hereafter described. Each furnace at Gary has a capacity of 450 tons per day.

CLEANING AND DISTRIBUTION OF BLAST FURNACE GASES.

The most striking novelty in the Gary steel plant is the substitution of gas engines for steam engines in producing the enormous quantity of power necessary for operating this huge establishment. The blowing engines, which supply air for the blast furnaces, are operated in part by gas engines of a total of 64,000 horse-power; and all of the mills are driven by electric motors, current for which is produced by electric generators driven by gas engines of the largest size and of a combined capacity of 120,000 horse-power.

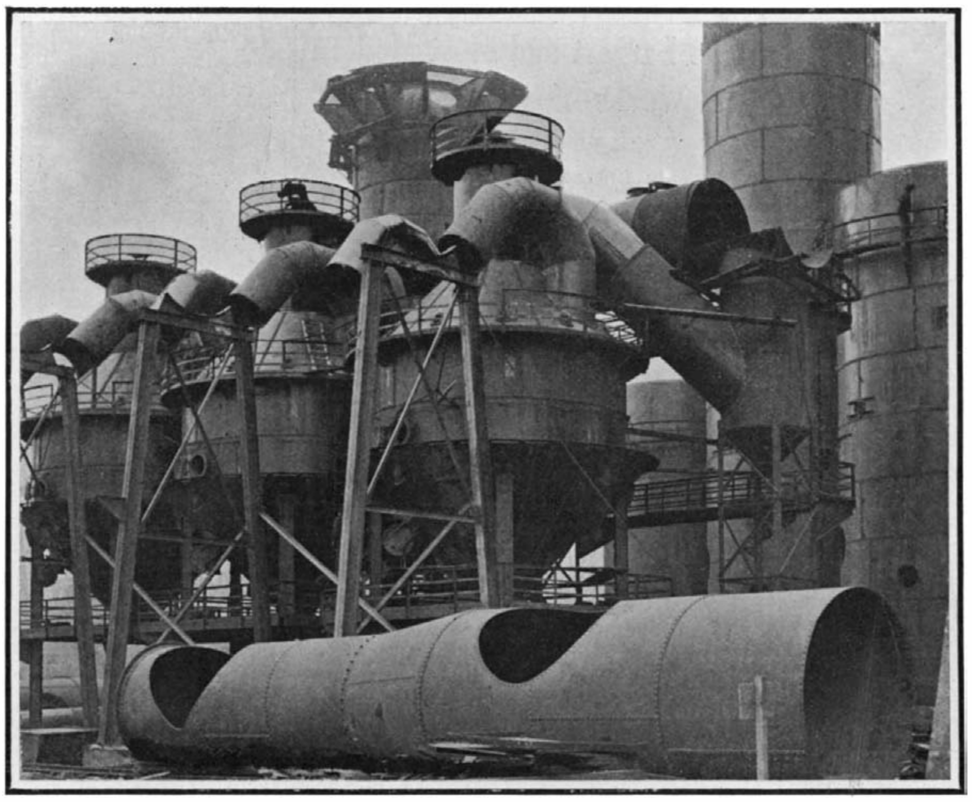
Originally, in the early days of steel making, the gases were allowed to escape from the top of the blast furnace and go to waste. Then the tops of the furnaces were closed and the gases were conducted to large boiler houses, where they were used to raise steam for driving the steam blowing engines throughout the plant. In the latest improvements as installed at Gary the whole of the gases are utilized. The diagram shown herewith gives the distribution of these gases, and it should be remembered that the figures given are for eight furnaces only, which together produce 22,450,000 cubic feet of gas per hour. When the whole sixteen are running the total production will be about 45,000,000 cubic feet per hour. Of this amount 30 per cent is used in heating the hot stoves, in which, as we have seen, the air is heated before entering the blast furnaces. The steam boiler plant uses 7.5 per cent, 2½ per cent disappears in the gas washers, the blowing engines 12½ per cent, and 45 per cent is available for the gas engines in the electric power station. All the gas from the top of the blast furnaces first passes through dust catchers and a primary washer, which remove the larger part of the solid impurities; and that part of the gas which is burned in the hot blast stoves and under the boilers goes direct from the primary washer to its destination. The gas which is destined for the gas engines passes through another washing plant, of which there are four to each pair of blast furnaces. The gas as thus

(Continued on page 450.)



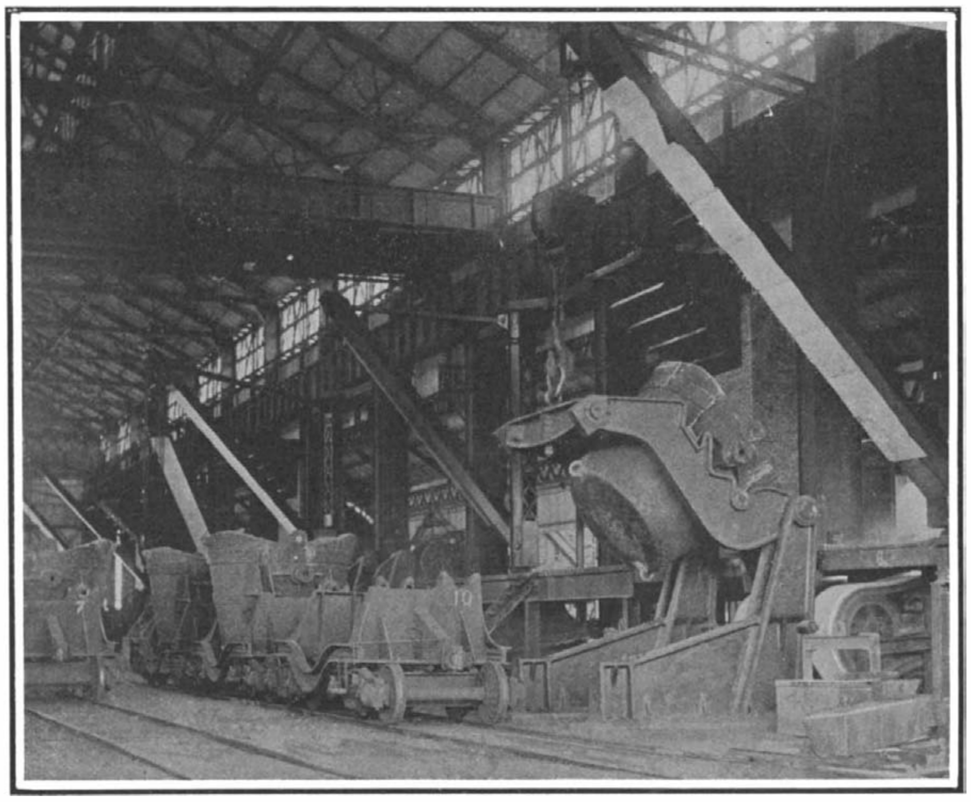
The air blast is heated in the hot stoves before entering the blast furnaces,

Steel rail and concrete foundations for the hot stoves.



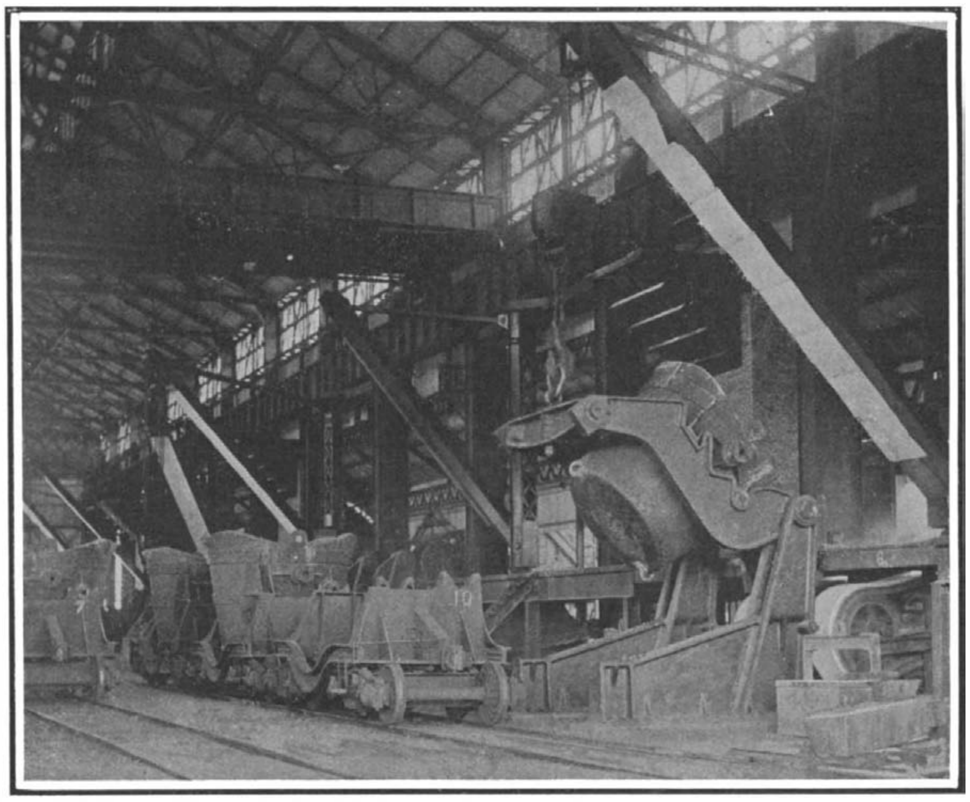
The power for operating the Gary plant consists of huge gas engines driven by the furnace gases.

Dust catchers and washers for purifying the furnace gases.



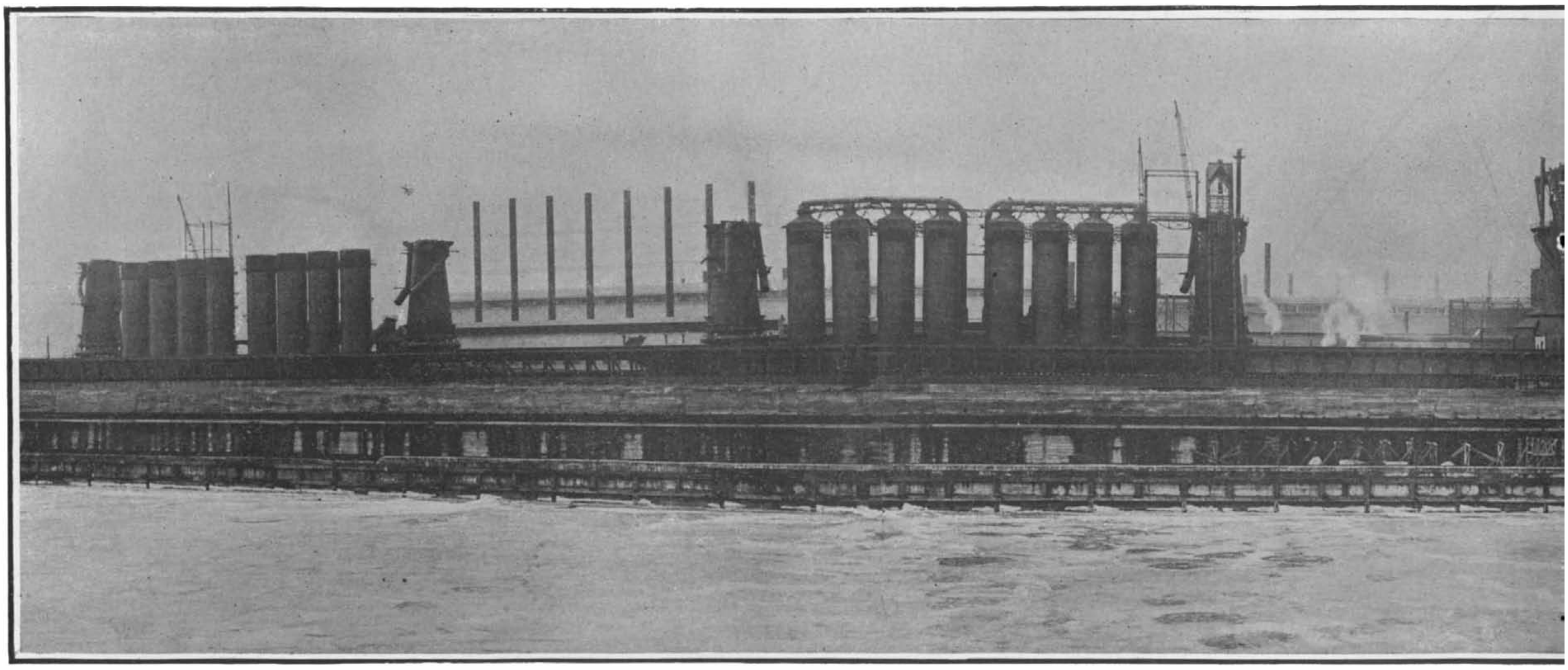
The molten iron from the furnaces is brought to the open hearth furnaces in 60-ton ladles, one of which is here shown.

Charging platform of the open hearth furnaces.



On Sundays and holidays the hot metal from the blast furnaces is cast into pigs.

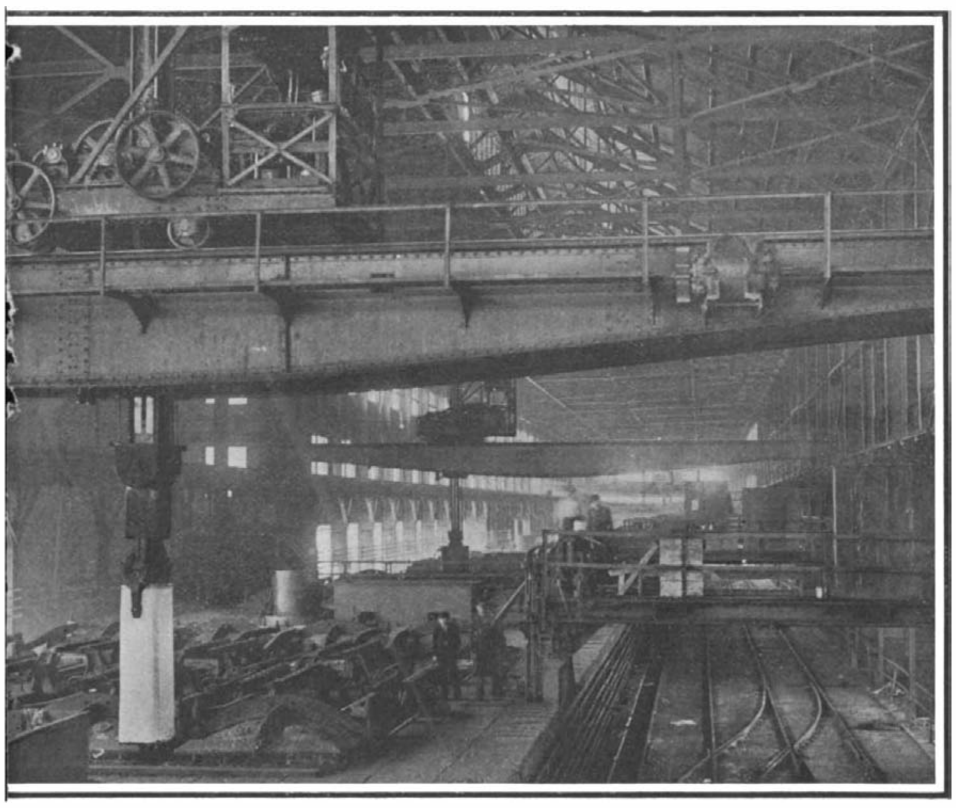
Interior of the pig-casting machine building.



Group of two furnaces and stoves.

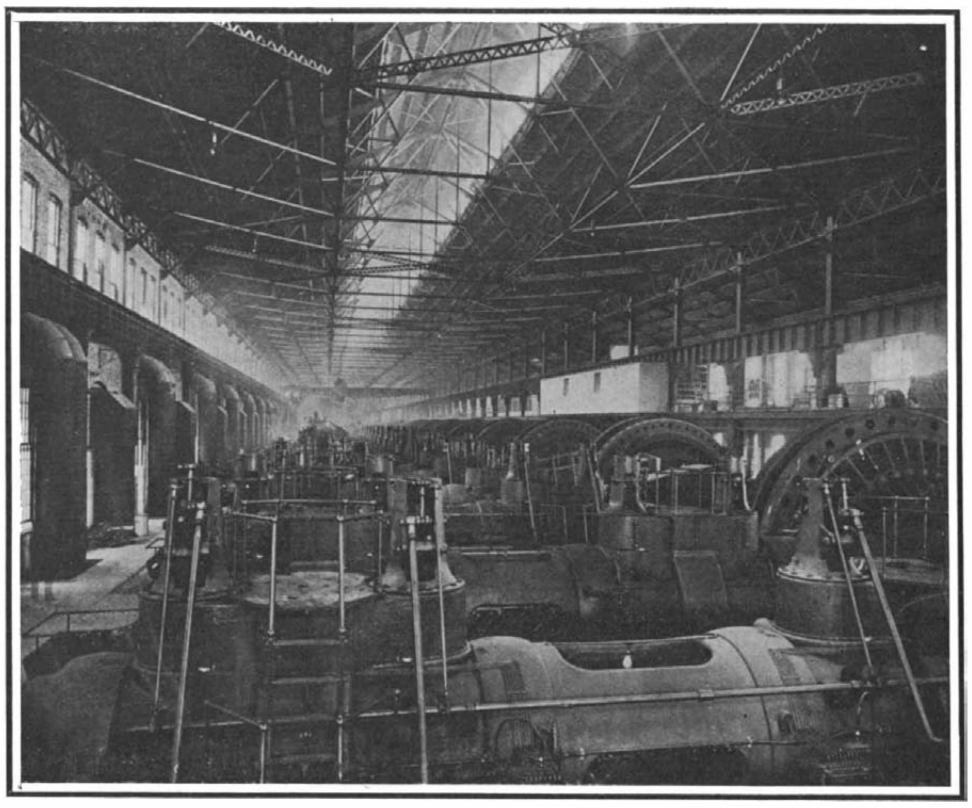
Group of two furnaces with their stoves.

PANORAMIC VIEW OF GARY STEEL PLANT, TAKEN FROM THE ARTIFICIAL HARBOR, 5,400 FEET IN



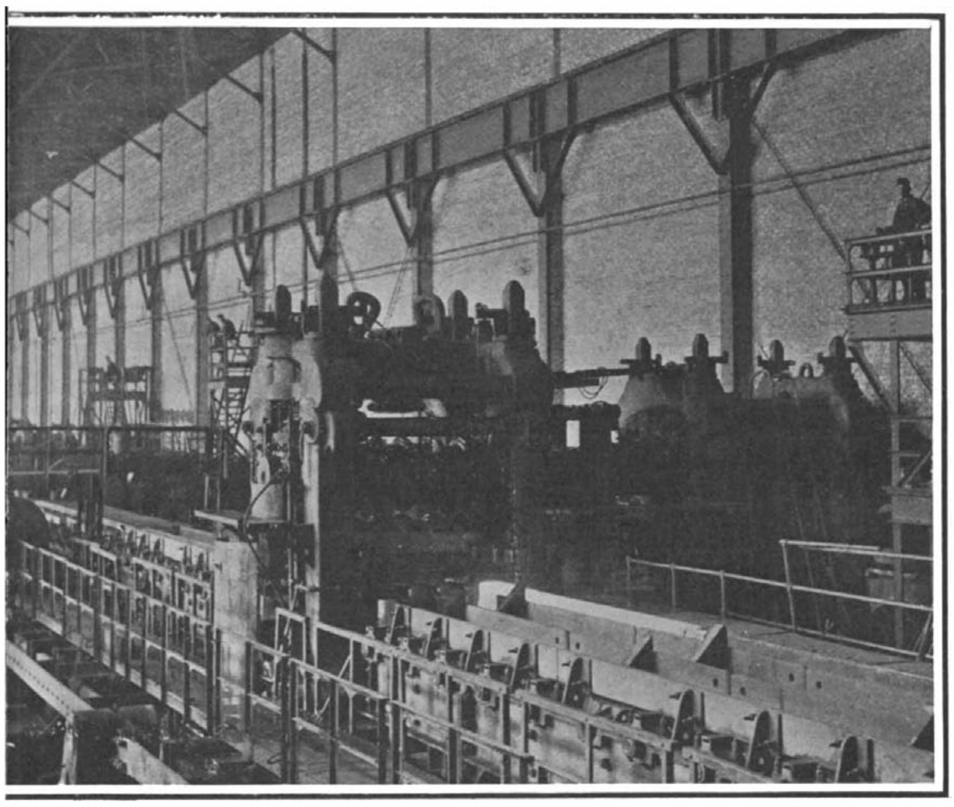
Here the ingots are heated in gas-fired underground furnaces to the proper temperature for rolling.

The soaking pits.



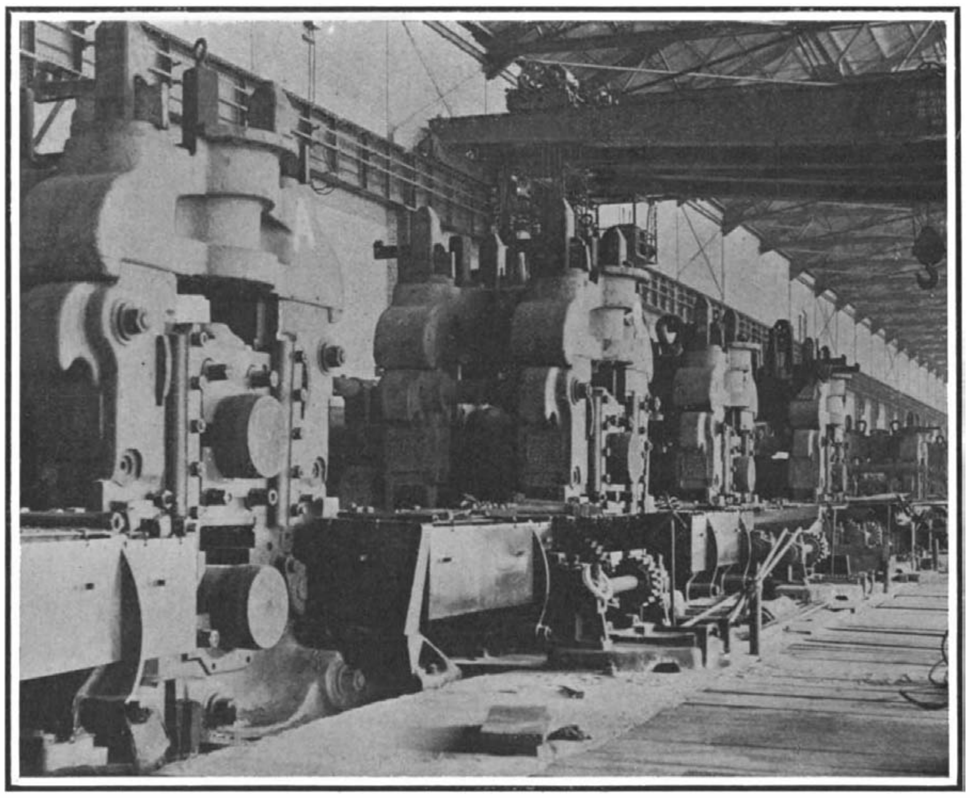
Contains 17 gas engines each of 3,500 horse-power.

Gas-driven 60,000-horse-power electric power plant.



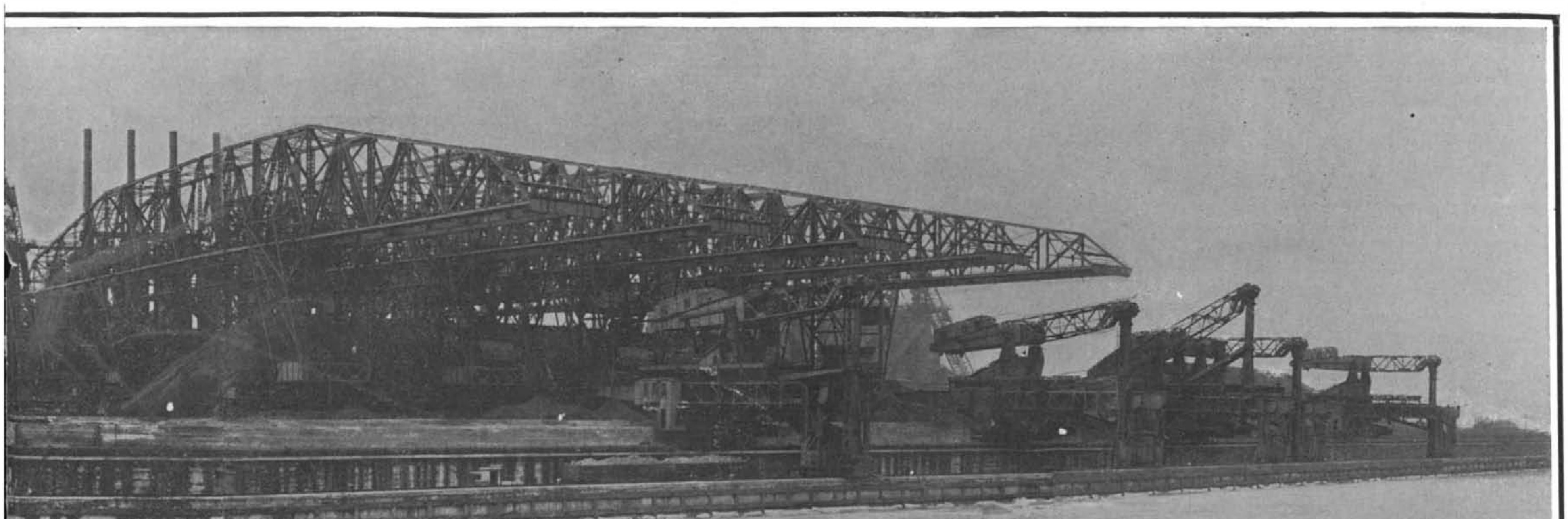
This mill, the largest in the world, can roll 4,000 tons of rails in a single day.

Three-high rolls in the rail mills.



Contains four 40-inch blooming mill stands each driven by a 2,000-horse-power electric motor and a 32-inch mill driven by a 6,000-horse-power motor.

View of the billet mill



Five traveling conveyer bridges for transporting the ore to stock yard and furnaces.

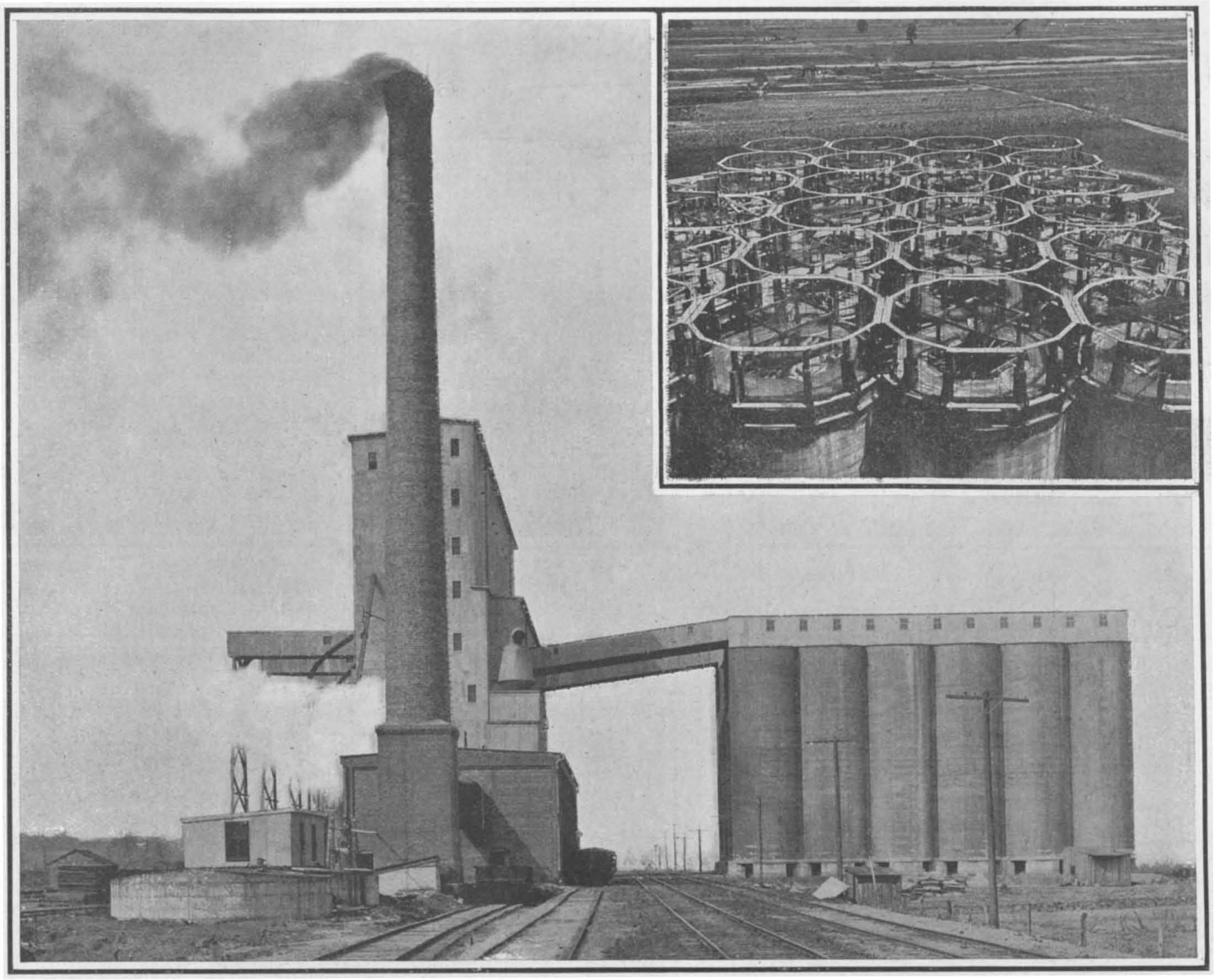
Five unloaders for transferring ore from steamers.

LENGTH, WHICH HAS BEEN EXCAVATED FOR THE ADMISSION OF THE LAKE ORE STEAMERS.

The Handling and Storage of Our Huge Grain Crop.

Few people outside of those who are connected with the garnering, handling, transportation, and distribution of our grain crop, appreciate either its magnitude or the wonderful plant and organization which are required for its transfer from the farm to the consumer's table. The latest available statistics are those for the year 1908; and they give the crop return as follows: corn, 2,642,687,000 bushels; spring and winter wheat, 659,030,000 bushels; oats, 789,161,000 bushels. Adding to these totals, those for barley, rye, and buckwheat, we get as grand total for the year 4,304,689,000 bushels.

In view of these figures, one can readily understand that the acreage in the United States which is devoted to the raising of maize, wheat, etc., has about trebled during the past thirty years. The increment has taken place chiefly in the great Middle West, and more particularly to the west of the Mississippi River; in the Dakotas, in western Kansas, and in California, Oregon, and Washington. The section of the United States which includes these new farm lands is one of magnificent distances. The fields of golden grain are scattered over an area that is measured by square miles in the hundreds of thousands. When the fostering care of the farmer has brought the grain to its full maturity, he is confronted with the tremendous problem of finding not only a market but one in which the price will be amply remunerative for his twelve months of labor. These four billion bushels of grain must be gathered together to certain distributing centers and thence sent out to the millions of consumers who are scattered throughout the habitable globe. It is evident at a glance that in this, as in every problem of a commercial character involving the handling of a vast tonnage made up of widely scattered units, the question of profits will be directly determined by the systematic skill and suitable machinery and plant employed for such a colossal task. The solution of the problem has been found in the American elevator and the distinctively American system of freight transportation by railroad. Both of these have been developed along lines which have enabled the United States to handle wheat with an economy and dispatch which is not to be matched in any part of the world.

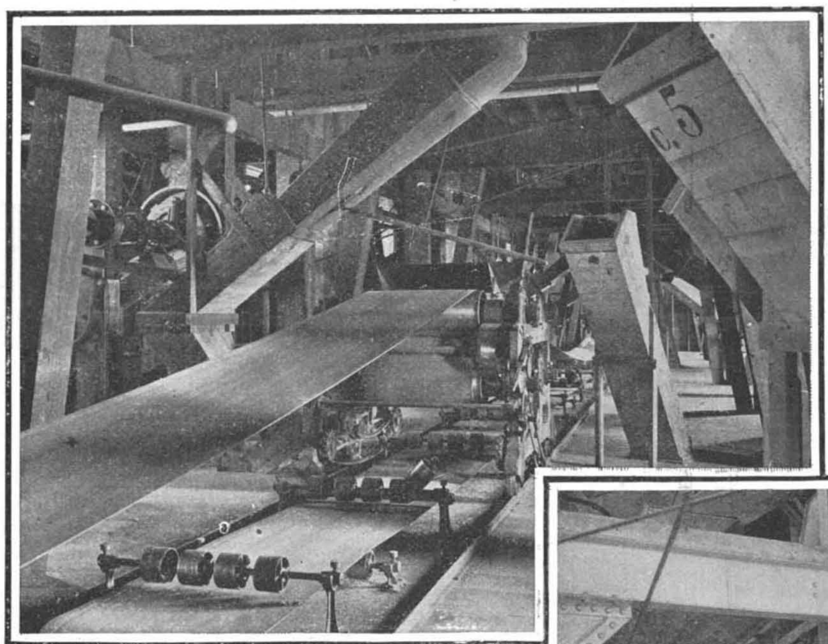


The working house. Upper view shows building of the concrete bins.

SANTA FE ELEVATOR AT ARGENTINE, KANSAS. CAPACITY, 1,000,000 BUSHELS.

By way of illustrating the methods by which our grain crop is handled, we will follow the course of a consignment of grain from a farm on the western prairies, across the broad American continent and out to sea.

In the description which follows we wish to express our indebtedness to the John S. Metcalf Company, engineers, of Chicago, for photographs and descriptive matter of several of the huge elevators which they have built for various companies.

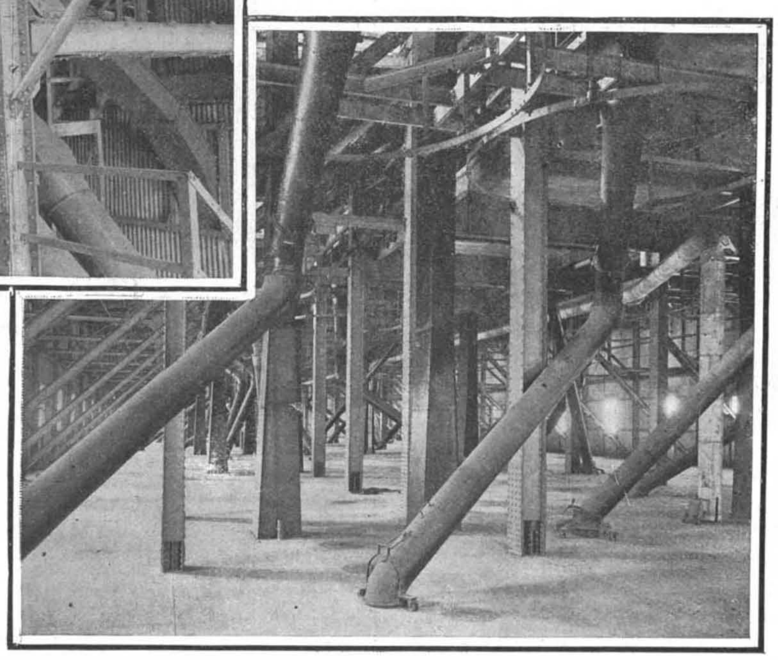


BELT CONVEYER AND TRIPPING MACHINES FOR DISCHARGING WHEAT FROM BELT.

The first step in the journey is seen in the farmer's wagon jolting with its load of wheat along a country road, let us say in Dakota, to the nearest railway siding. Here the wagon is driven up an incline leading into a plain wooden structure measuring twenty by twenty-four feet and extending some forty-five feet into the air. This building is the primitive grain elevator, known as the "receiving house." He has no sooner halted his wagon than the fore wheels are raised and the hinder ones depressed, so that his load falls through a trap door into a cleaner, where the wheat is relieved of foreign matter—leaves, bits of straw, twigs, etc.—and then is emptied into the boot of an elevator leg. The leg, which is essentially the same for all elevators, large or small, consists of an endless rubber belt running over two pulleys, one in the boot at the bottom, and the other in the head. Upon the belt are fastened at regular intervals small metal cups facing in the direction in which the belt travels. As the pulleys revolve, the cups scoop up the grain from the boot, carry it to the head, and as the cups are inverted in passing over the strap pulley, empty it into a spout placed there to receive it. The legs of these small country elevators can lift a thousand bushels an hour; the legs in the huge elevators at Chicago, Buffalo, or other great elevator centers, can lift as much as ten thousand bushels an hour. As the grain is delivered from the head of the elevator, it descends through wooden spouts into four grain bins from ten to twelve feet in depth, which form the main part of the building.

The next step is to load the wheat into the freight cars, which are shunted upon a siding adjoining the elevator. The operation is simple. The grain is drawn from the bottom of the bin into the boot of the elevator, lifted to the top of the house, weighed in hoppers, and then allowed to flow by gravity through a spout into the cars. These are the essential operations of all grain elevators, big or small, whether the building is built to accommodate five thousand bushels or two millions. From the receiving house the cars are hauled to one of our great Middle West cities, such as Kansas City, St. Louis, or, as would probably be the case, Chicago. In conjunction with other trainloads of wheat they will finally be rolled alongside of, or into a covered way beneath, a huge structure 300 to 500 feet in length, 250 to 400 feet in width, and towering 150 feet

THE SPOUTS ARE NUMBERED TO CORRESPOND WITH DIFFERENT BINS.



SPOUTS FOR DISTRIBUTING GRAIN TO THE BINS.

into the air. If it be one of the older buildings of its kind, it will be built of timber; but if it be of the latest construction, such as that shown in our illustration of the 2,000,000-bushel elevator for the Grand Trunk Railway at Tiffen, Ontario, or the Santa Fé elevator at Chicago, Ill., of 1,500,000 bushels capacity, it will be built of brick, or tile, or reinforced concrete, this last being the material employed in the two elevators referred to. An elevator of this character is actually a huge warehouse for grain, which is designated by a registered title, is inspected and licensed by the State, and is under the close supervision of the city Board of Trade. Before admission into its bins, the grain must be carefully weighed and classified; and when it has once been placed there, the warehouse receipt becomes to all intents and purposes in the money market, the grain itself. It is as easy to deal in it in the market as it is to transfer money in a bank from one account to another. Although the length of time that the five thousand bushels which once filled the little receiving elevator will lie in these bins at the great warehouse depends upon circumstances, the period of its sojourn is a very restless one —restless not for the grain itself, but for that negotiable slip of paper which stands for its sign manual in the market. This may journey hither and thither from seller to buyer, until in a short space of time it may happen that our five thousand bushels have been sold and bought, and sold yet again, and that by the mere flick of a man's finger.

Arrived at the great city elevator, the car doors are rolled back and our five thousand bushels of grain are immediately attacked by what is known as the "power shovel." This consists of a large two-handled scoop, to which is attached a rope that is wound upon a rotating drum.

The drum is so fixed upon its shaft that when the man at the shovel walks away with the latter the drum readily unwinds, but as soon as he stops the drum commences winding up the rope and hauls the scoop back to the point at which it started. There are a pair of these shovelers to each car and they carry the scoop back, bury it in the wheat, and guide it as it is pulled forward out of the door of the car and discharges its contents into a hopper that leads to the boot of a huge elevator leg. Two of these shovelers can unload from the cars thirty thousand bushels of grain in a single day.

Now, although we have stated that the little receiving house contains all the essential principles of construction and operation of the big city elevator, the likeness is only a general one. The latter are enormous affairs, the greater part of whose bulk is taken up by the grain bins. These in the older elevators were always square in section and some sixty feet in depth. A typical one of this kind is one belonging to the Armour Elevator Company at Chicago which receives grain from the Milwaukee road. It is 550 feet in length and 156 feet high. It can unload 500 cars of wheat per day, and can deliver 100,000 bush-

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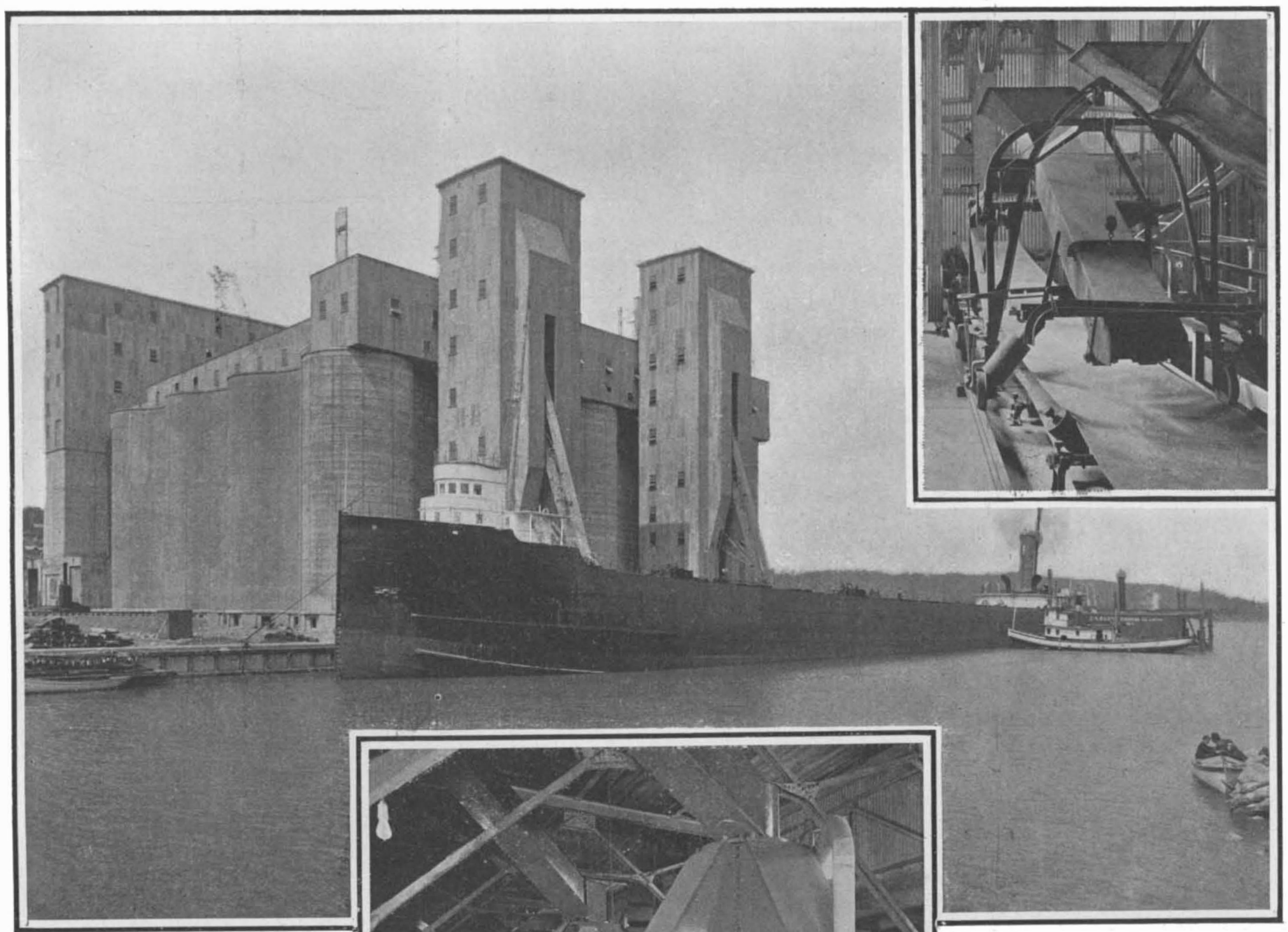
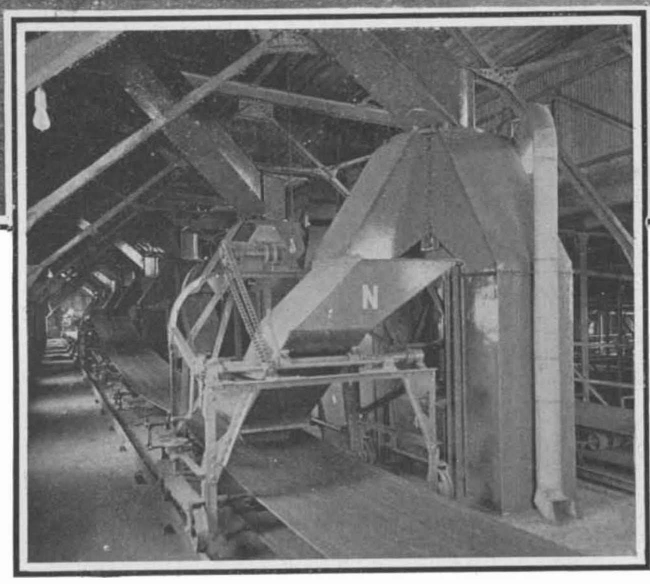
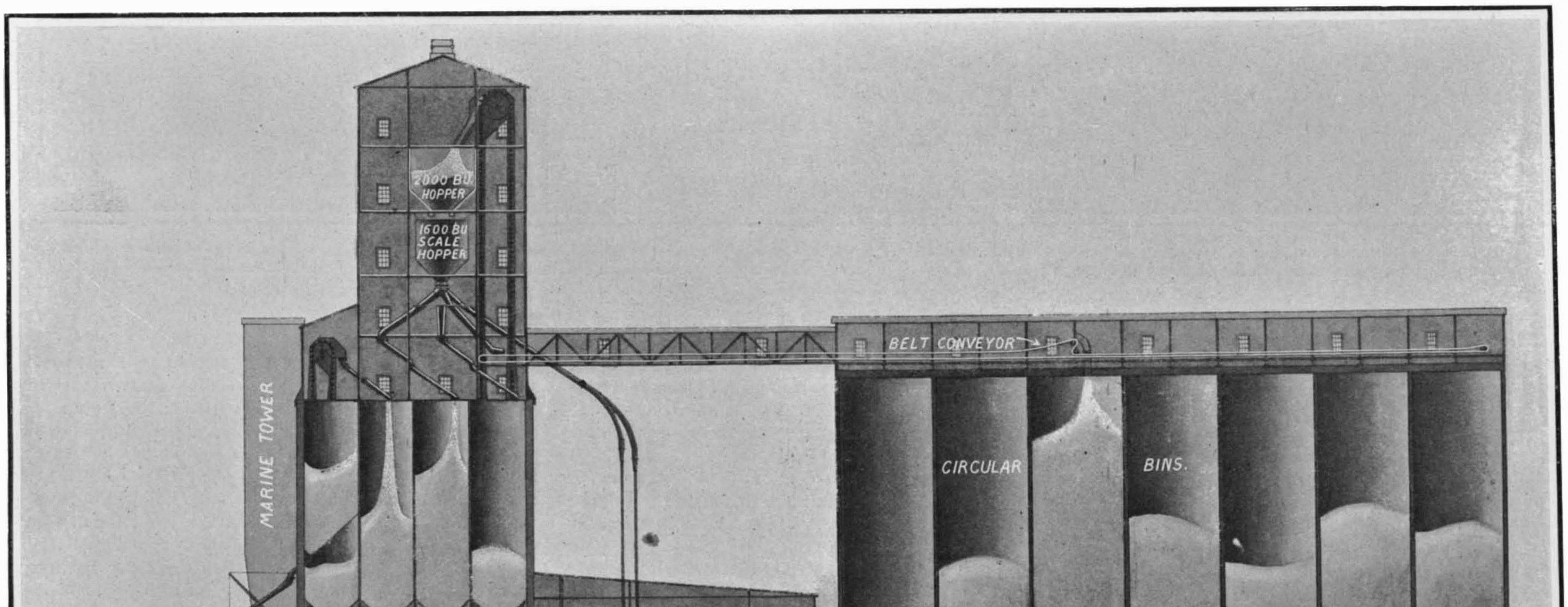


The steamship is being unloaded by tower legs.

TWO MILLION BUSHEL CONCRETE ELEVATOR OF GRAND TRUNK RAIL ROAD.



SPOUTING AND BELT CONVEYER ABOVE STORAGE BINS.



Steamer unloading at wharf. Working house where wheat is distributed. Tracks for loading and unloading cars. Circular bins for storing the wheat, served by belt conveyers above and below bins.

SECTIONAL VIEW OF THE SANTA FÉ ELEVATOR AT CHICAGO.

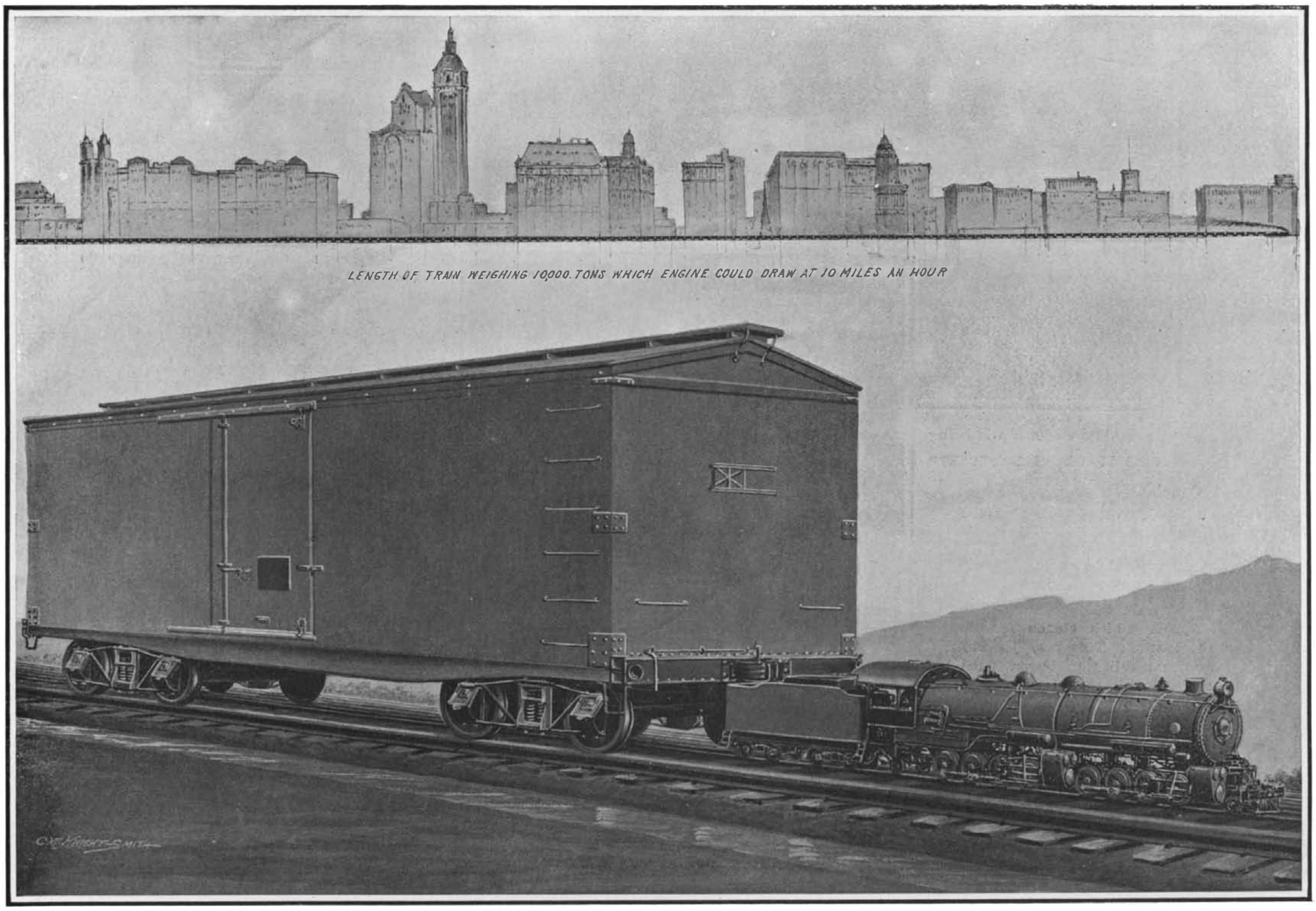
Chicago and the Railroad System of the Middle West.

The Capital of the Middle West.—When the first American settler, John Kinzie, the Indian trader, established himself at the mouth of the Chicago River in the year 1803, he little imagined that he was responsible for the beginnings of one of the greatest cities in the world, nor did he know that he had accidentally hit upon the very spot which, by virtue of its geographical location, was destined to become the greatest railroad center in the world. On the other hand, to do justice to this first settler, it should be mentioned that the spot which he chose for the home of himself and family was a center, even at that early day, well adapted for such trade as came his way; for as far back as the early days of French exploration, the Chicago river formed part of a line of travel by which the Indians reached the Mississippi River. By journeying up the river and its south branch, a portage of some four or five miles brought the Indians across the divide, and enabled them to launch their canoes on the Des Plaines River, down which they could pass to the Illinois River and so to the great Mississippi. It is interesting to note in this connection that the Chicago Drainage Canal, a splendid waterway 22 feet deep and from 110 to 202 feet wide, follows approximately this old Indian trading route.

Whether or no John Kinzie had any conception of the great strategical importance of the place which he had selected to make his home and drive his bargains, subsequent history has shown that this lonely spot in the remote wilderness was destined to become the greatest meeting and distribution point of that wonderful network of railways which has grown up so rapidly over the whole face of the United States. On the opposite bank of the river from the Kinzie home the United States government located Fort Dearborn, a mere stockade containing two blockhouses, the first garrison of which consisted of one company of infantry of the First Regiment. The settlement at Fort Dearborn made but little growth until after the war of 1812, and in 1830 it consisted of a hamlet of log houses tenanted by less than one hundred people. In 1827 Congress authorized the construction of the Illinois and Michigan Canal, and the State was granted alternate sections of land on both sides of the canal route. The commissioners proceeded to lay out towns, one of which was Chicago, which was located at the eastern terminus of the canal. The lands were thrown open for purchase in the year 1830. Buildings were erected, and a movement of settlers at once commenced, chiefly by way of the lakes and largely from New York and the New England States. In 1833 Congress made an appropriation for a harbor at Chicago; a channel was cut through the sandbar at its mouth; and in 1834, for the first time, a schooner sailed up the river. Three years later the town was incorporated as a city with a population of 4,170.

The canal failed to fulfill the high hopes with which it had been constructed, and indeed it was not finally completed until the year 1848; but a new method of transportation was at hand, which was destined to do for Chicago and the surrounding country all and far more than had ever been promised by the canal. In the year 1847 the first mile of railroad (running toward Galena, Ill.) was commenced, and three years later there were forty-two miles of connecting lines. In February of 1852 the city was connected with the East by the Michigan Southern Railway, and in the following May by the Michigan Central. The effect upon the growth of population was instantaneous. Although between 1837, the year of its incorporation, and 1840 the city had increased only from 4,170 to 4,479 in population, the inception of railroad construction proved such a powerful stimulus, that by 1850 Chicago had a population of 28,269; by 1860, of 109,206; and by 1870, of 306,605. Then, in 1871, came the Great Fire. That terrible disaster, by all the logic of human events should have dealt a death blow to the city, or at least have retarded its growth for many a decade to come. Three and a third square miles of the city were swept out of existence, and property valued at $187,000,000 was destroyed; but so far from checking the growth of Chicago, the disaster served merely to demonstrate the latent resources of the city, and the unbounded faith both of its people and the country at large in its future destiny. The wreck of the wooden city was quickly swept away, and within two years the burned area was covered with buildings of the most modern type; furthermore, nine years after the disaster Chicago had passed the half million mark with a population of 503,298. In the next ten years, the population had more than doubled, the census of 1890 showing 1,105,540. In 1900 it had grown to 1,698,575 souls; and the city's area, which in 1837, the year of its incorporation, was 2.55 square miles, had increased to 190.638 square miles. To-day the population of Chicago is estimated to be 2,572,900, and the assessed valuation of all taxable property is $477,921,976.

Chicago the Greatest Railroad Center in the World.—It takes but a look at the railroad map of the United States to understand why Chicago is to-day, and has been for many years, the greatest railroad center in any country. Situated at the southern end of Lake Michigan, which projects far down into the great empire of the Middle West, it not only intercepts all the great trunk railroads, which reach with their connections from the Atlantic to the Pacific, but it forms a natural meeting and transfer point for those products of the West, which seek the advantage of water transportation to and from the East afforded by the chain of Great Lakes. In the opening up of the vast unoccupied regions of the West and Middle West, Chicago, in common with St. Louis, formed a natural starting point for the pioneers and immigrants who were seeking to better their fortunes in a new and undeveloped country. In this work of development, the railroad was always the predominant factor. Starting from Chicago, lines began to radiate out over the wide and fruitful areas of the great Mississippi Valley, across the vast prairies, which awaited only the plowshare and the husbandman to develop their latent fertility; and into the far-distant Rockies, where lay hidden a vast store of mineral wealth. On the other hand, the eastern railroads, as they pushed their way across the range of mountains which separates the older eastern States from the great Middle West, naturally laid their course for Chicago as the natural point of connection with the rapidly extending railroad systems of the West. Meanwhile, the discovery of gold in California, and the increasing enlightenment as to the natural resources in timber and agricultural land of the country lying between the Rocky Mountains and the Pacific coast, had led to an extensive immigration by sea and overland into that country. Railroads were built upon the Pacific coast; and it was not long before the systems of the Middle West began to push boldly through the Rocky Mountain range, with a view to securing transcontinental connections. The completion of the first road of this character, the Union Pacific, was fol-



This huge Baldwin freight engine, weighing 300 tons, was built for the Southern Pacific Railroad. It is capable of hauling at 10 miles an hour a train of 139 cars weighing, with load, 72 tons each. The train, weighing 10,000 tons, would reach for over a mile or, say, from City Hall Square to the Battery, New York. The lower cut represents the size of a single car, 200 feet by 45½ feet by 62 feet, that would be necessary to contain the load of wheat handled.

THE MOST POWERFUL FREIGHT ENGINE AND THE LOAD IT CAN HAUL.

lowed by the building of the Northern Pacific, the Atchison & Santa Fé, the Great Northern, and this year the Chicago, Milwaukee & St. Paul completed its transcontinental connection. Meanwhile, a great north-and-south route was being built in the Mississippi Valley, which ultimately developed into the present Illinois Central Railway, by which direct communication is afforded from Chicago to the Gulf.

It is impossible within the limits of the present article to enter into the history of the development and growth of the complicated network of railroads which is directly tributary to Chicago; but the claim of the city to be the leading railroad center is suggested by the following table, which gives the number of through and suburban trains into and out of Chicago and the name and mileage of the various tributary roads. It will be seen that out of a total mileage of about 225,000 miles of the whole of the United States, nearly one-half, or 100,123 miles, is directly tributary to the city, and that, over these roads, a total of 1,294 trains enter and leave the city daily:

RAILWAYS TRIBUTARY TO CHICAGO.

Number of Trains In and Out of Chicago. Thro.	Sub-urban.	Name of Railway.	Mileage.
19		Atchison, Topeka & Santa Fé.......	9,976
10		Baltimore & Ohio	4,447
29		Chicago & Alton	998
37	76	Chicago, Burlington & Quincy......	8,950
84	206	Chicago & Northwestern Line......	9,665
10		Chicago Great Western	1,457
	12	Chicago Terminal & Trans. Co......	258
12		Chicago, Indianapolis & Louisville..	578
4		Chicago, Cincinnati & Louisville....	284
	21	Chicago & Western Indiana........	50
11		Chicago & Erie	2,383
81	14	Chicago, Milwaukee & St. Paul......	8,659
11	12	Grand Trunk System	6,212
46	253	Illinois Central	6,201
45	91	Chicago, Rock Island & Pacific......	7,525
		New York Central Lines, including:	
25	46	Lake Shore & Michigan Southern.	
31		Michigan Central	12,524
6		Chicago, Indiana & Southern.....	
10		Minneapolis, St. Paul & Sault Ste Marie	3,889
		Pennsylvania Lines, including:	
24	22	Fort Wayne Route	11,235
16		Pan Handle Route	
8		Pere Marquette	2,318
22		Wabash Railroad	2,514
541	753		100,123

Receiving and Distributing the Freight.—Elsewhere in the present issue we have spoken of the productiveness of that great empire of the Middle West of which Chicago is the capital. Spread out over the twelve States, which in government reports are known as the North Central Division of the United States, with their area of 753,550 square miles, and their population of over 30,000,000, are between 85,000 and 90,000 miles of track. Within this area is more than one-half of the wealth invested in improved farms in the United States, and over one-half of the live stock and neat cattle. It produces 78 per cent of the total food products and more than one-half of the butter, cereals, potatoes, and poultry that are raised in the entire country. Although distinctly an agricultural district, it is rapidly moving forward to its ultimate position as the leading manufacturing center. Already it possesses 190,000 manufacturing establishments, representing an invested capital of over $3,000,000,000, which pay out annually between $700,000,000 and $800,000,000 in wages, and the value of whose annual products is about $4,500,000,000, or about 35 per cent of the value of the products of the whole country. As far back as 1905, the total output of bituminous coal was 81,000,000 tons, or over 33 per cent of the total amount of bituminous coal mined in the United States. That Chicago is the center to which the products of the West and Middle West are carried for distribution and reshipment is shown by the statistics of the Chicago Board of Trade for 1908, from which we learn that in that year the railroads brought into the city over 10,000,000 barrels of flour and 239,000,000 bushels of wheat, corn, oats, rye, and barley, of which over 9,000,000 barrels of flour and over 180,000,000 bushels of cereals were reshipped by lake and railway. In the same year over 3,000,000 cattle and 8,652,000 hogs were received at the stockyards by rail. Of potatoes over 12,500,000 bushels, and of hay some 300,000 tons were brought in, mainly by rail. Limits of space prevent any further statement of statistics, but enough has been quoted to give an adequate impression of the enormous quantity of freight which day by day enters the city, either for home consumption or for reshipment to other ports.

Chicago has solved the problem of redistribution and reshipment admirably by the construction of a belt railroad, which extends around the city, and connects with each of the railroad freight terminals. As the trains roll into the various yards, they are broken up, and the various cars sorted out and rearranged according to the particular railroad over which their journey is to be continued, or the particular point within the city at which delivery is to be made. The resorting of the cars is done in some cases by gravity, the cars being started down a gentle incline, at the bottom of which the track communicates by switches with scores of parallel tracks, on which the separate trains are made up. This railroad is a complete organization in itself, possessing its own locomotives, train hands, and office staff; and the system of distribution is probably the most efficient of its kind in the world. In this connection it is interesting to note that within the limits of the city of Chicago are more miles of railroad track than some States contain within their borders. Altogether 2,494.59 miles of track are owned by eighteen of the twenty-six lines which center in Chicago.

Chicago's Sixty Miles of Freight Subway.—The Illinois Tunnel Company owns and operates sixty miles of subway for freight traffic under the business heart of Chicago. Connections are made with all of the principal freight and passenger stations of the city, and with the docks on the three branches of the Chicago River. There are also connections with the basements of many of the leading wholesale, retail, and manufacturing industries of Chicago. A disposal station is situated on the west bank of the Chicago River, from which vast quantities of excavated material, refuse, and other waste are loaded on scows and transported to final dumping grounds away from the city. The direct connection of the freight subway and this disposal station saves hauling through the streets of Chicago thousands of tons of waste material. The tonnage of freight handled to and from the railways through the tunnel has shown a steady increase during the last six years, and has decreased the hauling by teams through the city. Whether the bore of this tunnel will be enlarged to accommodate passenger traffic, as well as freight traffic, is one of the problems now under consideration; but it seems reasonable to expect that a start will be made in the near future on some plan to handle the immense passenger business within the city underground, and thereby relieve the congestion of the streets.

Railway Terminal Facilities.—Until recently the terminal facilities for passenger service in Chicago have not been commensurate either with the importance of the city or with the size of its passenger traffic. This condition, however, is being fully corrected. The president of the Pennsylvania Railroad recently announced that a new station would be built in Chicago, and that the work would be started at an early date, and pushed to completion as rapidly as possible. The cost of the new Union Station is to be about $25,000,000, and it will be occupied by the same railroads that now use the Union Station—the Pennsylvania, the Chicago, Milwaukee & St. Paul, the Chicago & Alton, and the Chicago, Burlington & Quincy.

The Northwestern Railway is completing a $20,000,-

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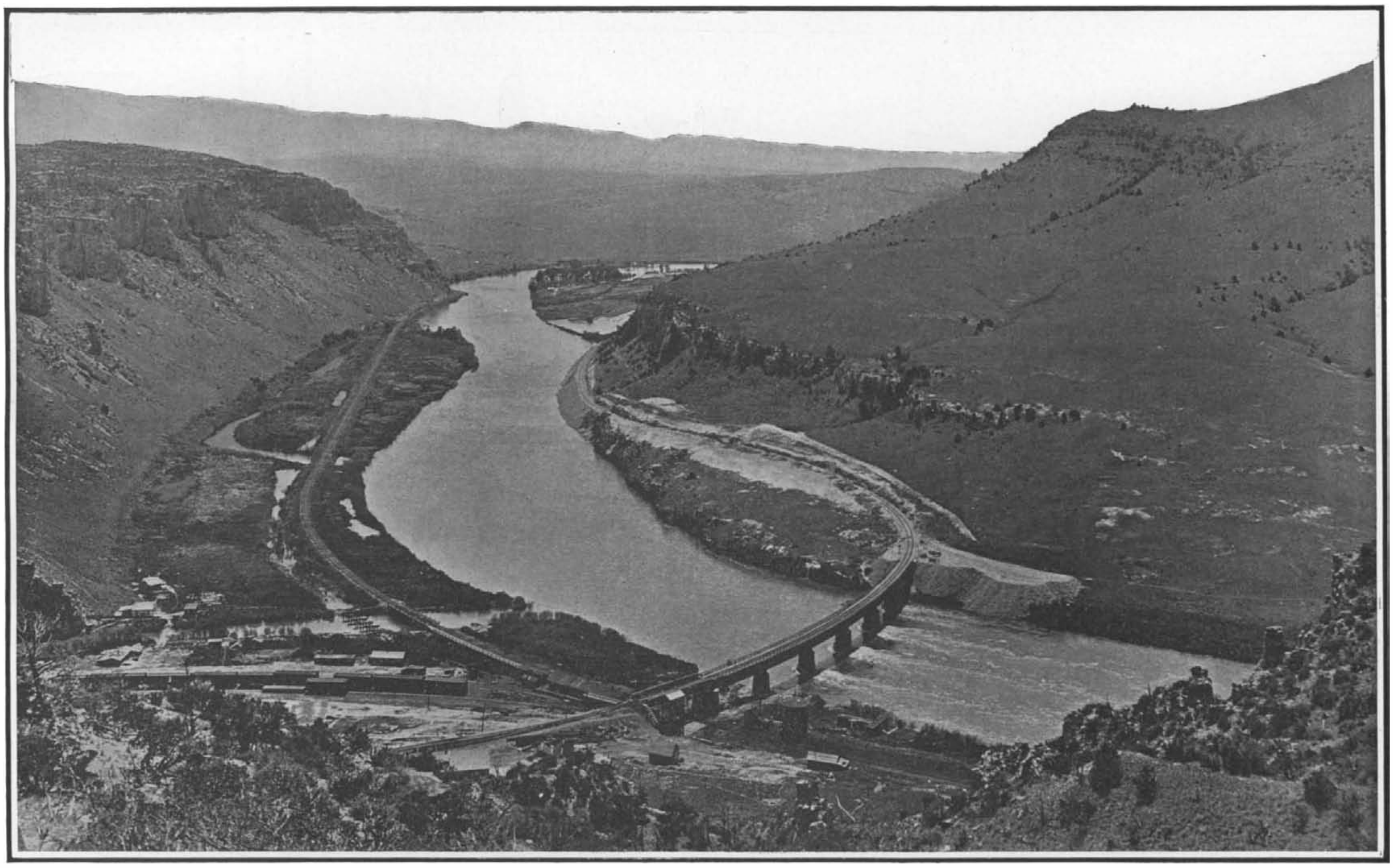


This line, the latest to be constructed to the coast, is 2,175 miles in length, was built within the brief space of 36 months.

Bridge across the Missouri River at Lombard, Montana.

THE EXTENSION OF THE C., M. & ST. P. RAILROAD TO THE PACIFIC COAST.

IRON THAT WILL NOT RUST.

In 1856 Sir Henry Bessemer invented a process of steel making which revolutionized the iron and steel business. By this method it was possible to turn out an immense tonnage at a low cost and with a low percentage of carbon and manganese. To be able to produce in large quantities and at a low cost a metal which had even greater tensile strength and ductility than good iron, at once enabled steel to take the place in commerce hitherto held by iron.

While steel had a greater tensile strength and greater rigidity than iron, it had certain limitations which have grown increasingly apparent. These limitations appear in the use of steel where it is subject to severe corrosive agents; as, for example, in the atmosphere of cities impregnated by the fumes of gas or coal smoke, at the seashore with its salt air, in the ground with its dampness, or in localities where it becomes the intermittent conductor of electrical currents. Steel has come to be considered, under these conditions, and notwithstanding its extreme hardness of texture, a comparatively short-lived metal.

Iron nails, taken from demolished houses that were built in the eighteenth century, are handed about as curios; for to-day, in many a shingled roof, the shingles outlast the steel nails. The Department of Agriculture voiced the sentiments of the farmer when it urged upon wire makers the necessity of improving the character of the wire fence, so that the farmer using it would not have to renew it every five to nine years. The thrifty housewife, pleased with the beauty and strength of her new galvanized water pail, is surprised and indignant at having her maid call her attention, as it seems to her after a very short time, to the holes in the bottom.

It is generally considered a plausible, if not demonstrated theory, that this fugitive nature of steel comes from its chemical structure. The elements introduced into the molten mass of iron in the furnace and in the ladle to convert iron into steel are essentially impurities. Under certain conditions an electrolytic action is set up within the structure of the steel between these impurities, with a resultant disintegration of the metal.

There is a growing conviction that the corrosion of metals is due to this electrolytic action. According to the latest theory, rusting commences on the surface of the metal because of a difference of potential there, a condition which is due to the impurities in the metal, such as carbon, sulphur, phosphorus, and particularly manganese. Dr. A. S. Cushman, in a pamphlet entitled "The Corrosion of Fence Wire," published by the United States Department of Agriculture, arrived at the conclusion that steel corroded more rapidly than iron for several reasons, chief among which were the following:

First. The presence of and the irregular distribution of manganese in steel, there being little if any of that substance present in iron.

Second. The greater destruction of steel by electrolysis as compared with iron, due to the presence of manganese and various metalloids in greater quantities than in iron.

Third. The absence of slag in steel, whereas the slag distributed throughout iron was believed to act as a rust preventive.

The same authority says: "If we accept the electro-chemical explanation of the corrosion of iron, there can be no doubt that conditions which inhibit electrolytic effects also inhibit corrosion, and *vice versa*. The purer the iron in respect to certain metals which differ electro-chemically from iron, and the more carefully the lack of homogeneity and bad segregation are guarded against, the less likely are the electrolytic effects to become serious. These points constitute the essential problems which confront the manufacturer who desires metal that will have a high resistance to corrosion."

A few years ago the American Rolling Mill Company, of Middletown, Ohio, began to investigate the possibility of producing from their open-hearth furnaces, from which they were making high-grade steel by the usual method, a steel very low in carbon and manganese. The success achieved in this direction suggested that it might be possible to reduce the scrap and pig iron to a molten mass in an open-hearth furnace and cast it into ingot iron, without introducing the impurities that are known to be active agents in corrosion.

In making steel by the open-hearth process, the furnace is charged with many tons of selected scrap and pig iron, and the charge is raised to a sufficient temperature to burn out the carbon and the greater part of the other impurities. When these have been reduced to the desired extent, a predetermined amount of carbon and, in particular grades of steel, of other ingredients, is added to the molten metal, until its composition has been brought to the exact point called for by the specifications for the particular grade of steel which is being made. In the experimental work of the company above referred to, the treatment was entirely one of elimination, the effort being to get rid of practically the whole of the impurities, and bring the metal as nearly as possible to the condition of absolutely pure iron. They carried the process of burning out the impurities even further than is done in the manufacture of commercial steel; and there the process stopped, leaving in the bath a remarkably pure iron, which was subsequently cast into ingots, and was available for use in the rolling mills and elsewhere for manufacture into commercial products.

An analysis of this iron in comparison with commercial steel, as made by William M. McPherson, professor of metallurgy, Ohio State University, Columbus, Ohio, showed the following results:

	Steel.	American Ingot Iron.
Sulphur	0.048 per cent	0.021 per cent
Phosphorus	0.094 per cent	0.005 per cent
Carbon	0.11 per cent	0.02 per cent
Manganese	0.47 per cent	Trace
Silicon	Trace	Trace

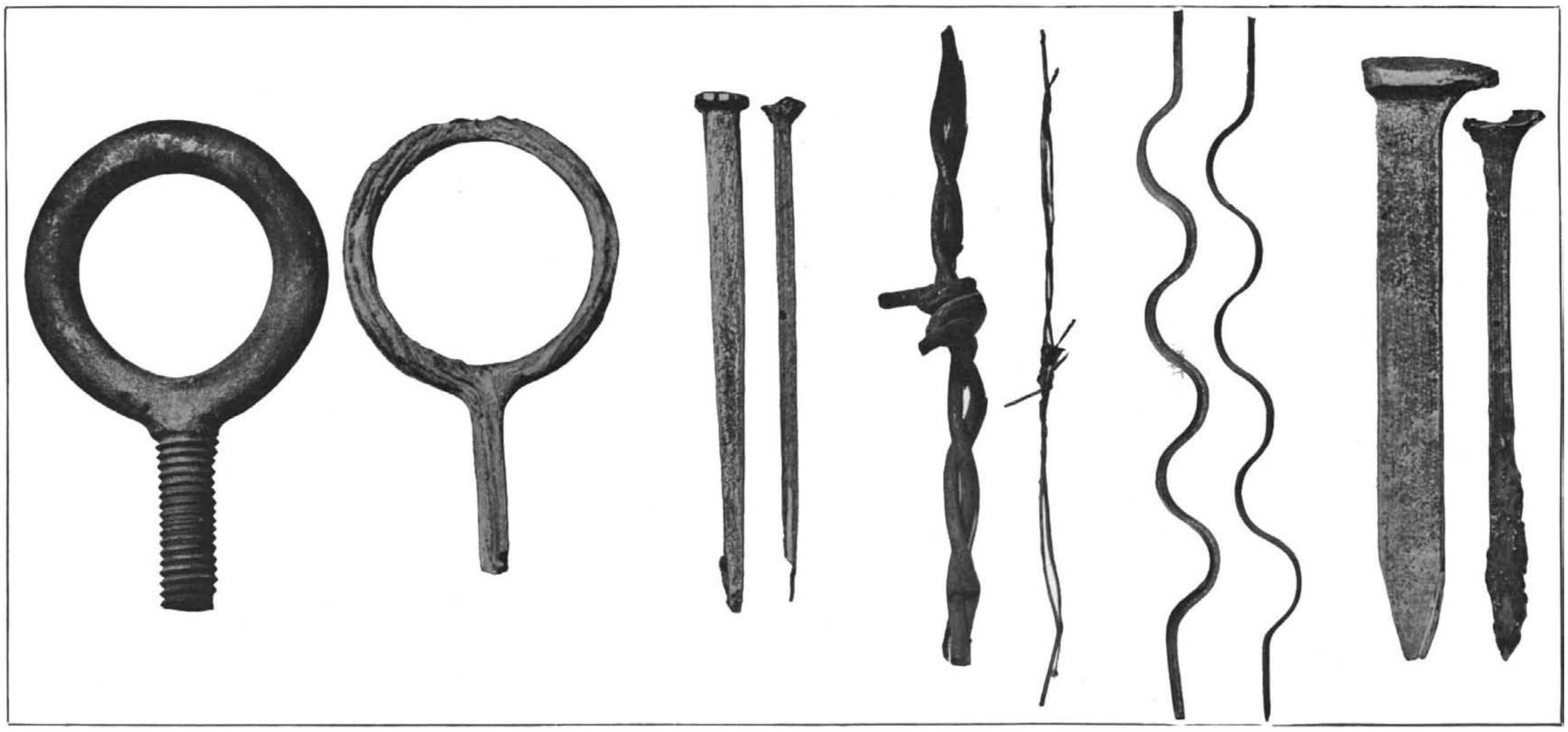
The corrosion test of the above samples, which were immersed in a 5 per cent solution of sulphuric acid for twenty-four days, showed:

Loss, steel	14.41 per cent
Loss, American ingot iron	0.21 per cent

"The above material," says the report, "is very exceptional for its purity, and is the most non-corrosive material that I have examined."

Four specimens of ingot iron subjected to tests to determine its tensile strain showed the following results: Breaking strain per square inch, from 49,857 pounds to 51,905 pounds; limit of elasticity per square inch, from 35,395 pounds to 41,377 pounds; elongation per cent of length, from 40 per cent to 48 per cent.

We present a set of comparative illustrations, showing the results of corrosion tests on various articles of commerce, one of each pair being made of the new ingot iron, and the other of steel or other material. In every case, both specimens were immersed in a bath of 25 per cent sulphuric acid. The ingot iron and charcoal eyebolts were treated in the bath for six hours, at the end of which time the ingot-iron eyebolt showed a loss of 15.5 per cent, and the charcoal-iron eyebolt a loss of 77.3 per cent. In a five-hour test of two railroad spikes, the ingot-iron specimen lost 11.2 per cent, and the steel spike 79.1 per cent. Even more remarkable was the comparison of ingot-iron and barbed-wire fencing material, the steel wire losing 92.3 per cent at the end of one and a half hours, and the ingot-iron wire losing only 6.1 per cent. In a forty-five minutes' test of two nails, the steel nail lost 68.9 per cent, and the ingot-iron nail 4.13 per cent. The two specimens of corrugated roofing material were placed in the bath for fifty minutes, at the end of which time the steel specimen had lost 78.2 per cent, and the ingot iron 2.4 per cent.



Ingot iron. Loss, 15.5%. — Charcoal. Loss, 77.3%. — Ingot iron. Loss, 4.13%. Steel. Loss, 68.9%. — Ingot iron. Loss, 6.1%. Steel. Loss, 92.3%. — Ingot iron. Loss, 2.4%. Steel. Loss, 78.2%. — Ingot iron. Loss, 11.2%. Steel. Loss, 71.9%.

CORROSION TESTS IN BATH OF 25 PER CENT SULPHURIC ACID.

CHICAGO'S SIXTY MILES OF FREIGHT SUBWAY.

In our Engineering Number of December 5th of last year we illustrated a system of freight subway which had been proposed for solving the serious problem of freight congestion on the streets of this city. In the present Middle West Number we present illustrations of a complete system of freight tunnels, aggregating sixty miles in length, which has been completed below the business center of Chicago, and is now regularly engaged in conveying merchandise and the city's mail directly to and from the railways, the Post Office, and the various office and commercial buildings of the city. The Chicago freight tunnels stand as a unique achievement among the great municipal undertakings of the world; and the capital city of the Middle West very justly prides itself upon the magnitude and completeness of this constructive work, which ranks in importance with that other great Chicago enterprise, the Drainage Canal.

The underlying conditions which have led to the construction of the subway are the same as those that have prompted two powerful construction companies to make an offer to build a similar freight subway system beneath New York city, namely, the intolerably congested condition of the street traffic. It is the slow-moving and bulky dray and the various freight and express vehicles that are chiefly responsible for the growing street congestion in the business centers of our great cities. It is claimed that, before the construction of its tunnel system, the conditions in the heart of Chicago were worse than in any other city,

(*Continued on page 456.*)

THE WONDERFUL IRON MINES OF LAKE SUPERIOR.

(*Continued from page 431.*)

the Panama Canal as the greatest task of its kind ever undertaken; yet it is a fact that at the close of the present year the stripping of the surface material and the excavation of the ore from the Mesabi range alone during the seventeen years that mining has been carried on will represent a total of excavation equal to that required for the Panama Canal.

TRANSPORTATION OF THE ORE.—Apart from the easy accessibility of the ores, particularly in the Mesabi range, the low cost at which the iron ore is delivered to the railroad cars or on the stock pile at the Lake Erie ports is due in a large measure to the present system of mechanical handling and transportation which enables a huge tonnage to be moved in a minimum of time and for a minimum of cost. From the time the ore is lifted by the shovel in the "open-pit" mine, or is loaded into the skip of the deep underground mine, it is handled entirely by mechanical means and no human hand comes in contact with it. The trains of ore cars, as they arrive at the Lake Superior ports, are run out directly above long elevated docks, consisting of continuous rows of ore bins. The hinged bottoms of the cars are released and the loads dropped into the ore pockets, where the material remains until the ship steams alongside for loading. Hinged to the bottom of the ore pockets are long rows of metal chutes, and as a chute is lowered into position over the hatch of the steamship, the gate at the bottom of the ore pocket is opened, and the ore slides by gravity into the hold. The ore-shipping piers of the Great Northern Railway at Superior are capable of receiving and loading from five to six million tons of ore in a season, and they have a record of loading a ship of 5,250 gross tons in 30½ minutes. An even greater feat was the loading of the steamer "H. E. Corey," of 10,000 tons capacity, at Duluth and Iron Range steel ore dock at Two Harbors, Minn., this season, in 39 minutes. One of the piers of the Great Northern Railway Company is 73 feet above water level, 62½ feet wide, nearly half a mile in length, and has a storage capacity for 87,500 tons. The construction of a special type of ship of large tonnage for the ore trade, coupled with the invention of unloading machinery of great capacity at the terminal ports, has brought the cost of transportation down to a very low figure. Thus, a ton of ore is now hauled one hundred miles by rail from the most distant mines in the Lake Superior range to a Lake Superior port, is loaded into the ship, is carried one thousand miles by water, and unloaded into cars or onto the stock pile at a Lake Erie port, at a cost of less than $1.80 per ton.

The iron-ore steamer of the Great Lakes has been designed with a strict reference to the economical loading, transportation, and unloading of iron ore in bulk. Its characteristics are great length, moderate draft, and a huge cargo hold which extends continuously for nearly the whole length of the vessel, and is provided with a continuous row of hatches extending the full length of the hold. We present an inboard profile and a cross section of the "Wolvin," one of the largest of the typical ore steamers. This vessel is 560 feet in length, 56 feet beam, and 32 feet deep. The cargo hold is built in the form of a long hopper, whose sides slope from the main deck to the top of the ballast tank. The hopper is 43 feet wide at the top, 24 feet wide at the bottom, and extends continuously for a length of 409 feet. The space between the hopper and the outside of the vessel forms two series of water-ballast tanks, the ballast space being divided into compartments by athwartship bulkheads built in at intervals of 60 feet. The tanks have a maximum capacity of 8,000 tons of water. Transverse stiffness is afforded to the sides of the vessel by a system of arched girders, which also serve to support the upper deck and the hatch covers. Between the girders are 33 hatches, each of which measures 9 feet by 33 feet in the clear. The largest single cargo of ore carried by the "Wolvin" was 11,536 tons, a feat which she performed in 1904. The pilot house, bridge, and captain's quarters are forward at the bow. Aft of the cargo space are the coal bunkers, boiler room, engine room, and the quarters for the crew.

Great as are the dimensions of the "Wolvin," they have been exceeded regularly in each succeeding year. The "E. H. Gary" in 1905 carried a single cargo of 12,368 tons; in 1906 the "J. P. Morgan" carried a single cargo of 13,272 tons of ore, and in 1907 she carried 13,800 tons. Equally remarkable for size are some of the sailing cargo ships, the most notable of which is the "John Smith," which in 1907 carried a single cargo of 9,408 tons.

It is the magnitude of the ore trade which has made the Sault Ste. Marie canal the most important artificial waterway in the world, at least in respect of the bulk of tonnage passed through. According to figures given at the thirteenth annual meeting of the Lake Superior Mining Institute, the maximum freight traffic through the canals for a single day was on August 26th, 1907, when 487,000 tons were passed through in 121 vessels. The total traffic into and out of Lake Superior for that year was 58,217,214 tons, on which $38,458,345 were paid as freight charges. Of this total tonnage, 68 per cent was iron ore.

UNLOADING AND HANDLING MACHINERY.—In order to keep pace with the low cost and speed with which the huge bulk of iron ore is mined, loaded into special steamers, and carried to its destination at the various Lake Erie ports, it was necessary to design special unloading machinery, capable of lifting the ore from vessels and loading it, either into the stock pile or into railroad cars, with proportionate speed and at a relatively small cost per ton. The design and construction of this class of machinery has grown to such importance, that there are several large industrial concerns which are occupied almost entirely with this class of work. In one of our views illustrating the interior of the hold of the "Wolvin," and also in the general panoramic view of the water front of the Gary Steel Works, we show what is known as a Hulett automatic ore unloader. Four of these machines, located at the docks at Conneaut, Ohio, are credited with having taken out of the "Wolvin" 7,257 gross tons of ore in four and one-half hours. At present there are five of the Hulett unloaders at Gary, and when the plant is completed there will be ten. The plant consists of a massive walking beam, to the outer end of which is pivoted a vertical arm. At the bottom of the arm is a bucket capable of lifting ten tons at each operation. As the bucket descends into the hold of the vessel, the two halves open, and are automatically moved apart in a horizontal direction, so as to make a wide "grab" of the ore. The machines at Gary are carried on two tracks 62 feet apart, and span two railroad tracks laid parallel to the edge of the dock. They are operated by electricity, and each weighs about 450 tons and requires only three men for its operation. They are showing a capacity for unloading ore at an average rate of 300 tons per hour for each machine. As each bucket-load is lifted, it delivers the ore to a conveyer car, which travels back to the rear of the machine, and discharges its load into suitable hoppers at the rear.

By the courtesy of the Brown Hoisting Machinery Company, we are enabled to present photographic views of several types of unloading machinery as installed for the unloading of iron ore, coal, and other heavy materials in bulk at various ports on the Great Lakes. During the recent meeting in New York of the Society of Naval Architects and Marine Engineers, a paper was read on Material Handling Equipments for Lake Vessels which traced the development of this type of machinery from the year 1880. At that time dock managers were looking for some mechanical means for lifting the ore from the ship and depositing it at some distance from the face of the dock; and this was first accomplished by a cableway machine, built and erected at Cleveland in 1880 under Mr. Alex. E. Brown's supervision. From that first device have been developed the mammoth machines of the Brown hoist type. They consist essentially of a long overhead bridge extending at right angles with the dock and supported on two towers, one at the dock, the other 200 to 300 feet inshore. Upon the bridge are rails, on which travels a self-propelled trolley. Upon the trolley are motors for hoisting the load and for moving the trolley to and fro upon the bridge. In unloading, the trolley runs out over the hold; the grab bucket descends and grabs its 5 to 7 tons of ore; raises it, and then the trolley travels back to the stock pile, where the load is dropped.

GARY: THE LARGEST AND MOST MODERN STEEL WORKS IN EXISTENCE.

(*Continued from page 441.*)

purified has an average heat value of 95 British thermal units per cubic foot.

It is estimated that 2½ times as much power can be derived from a given quantity of gas with gas engines as with boilers and steam engines.

THE OPEN-HEARTH FURNACES.

The hot metal is tapped from the bottom of the furnaces into 40-ton ladles, mounted on massive eight-wheeled trucks, which are hauled successively beneath the pouring spout. When a train of ladles is made up it is hauled to the mixer building, which contains two huge receptacles, each of 300 tons capacity. Into these the ladles discharge the hot metal, and the mixing of the product of the different furnaces insures a uniform average of composition of the metal. From the mixers, which are arranged so that they can be rocked or tilted, the molten metal is poured into 60-ton charging ladles which are conveyed to the charging side of the open-hearth furnaces on electric transfer cars. From these cars the ladles are picked up by a 75-ton traveling crane and the metal is poured into the open-hearth furnaces through a runner.

The whole of the output of the Gary plant consists of open-hearth steel, and the open-hearth furnace plant is by far the largest of its kind in the world. It is housed in large steel-frame buildings, 193 feet in width and 1,190 feet long. Ultimately there will be six of these buildings, each containing fourteen 60-ton furnaces, or eighty-four furnaces in all. To the molten metal with which each furnace is charged there is added a certain amount of steel scrap; and the charge is then subjected to the fierce heat of burning gases which enter at one end of the furnace, pass over the charge, and leave through flues at the other end. From time to time samples are taken from the furnace and tested. The object of this treatment is the same as that of the air blast in the Bessemer converter, and though the operation consumes more time the product is very much more reliable. The impurities are burned out of the metal until the proper percentage of carbon, etc., for the particular grade of steel which is being made has been reached. The metal is now ready for pouring.

Down each side of the long line of open-hearth furnaces is a set of railroad tracks on which the metal is brought to or removed from the furnaces, and handled thereat. On the tapping side on which the treated metal is withdrawn from the furnaces is a line of massive standards in which are placed the ladles of 80 to 100 tons capacity into which the metal is poured. When they are full, the proper amount of ferro-manganese is added to the metal in each ladle, and they are then picked up by 125-ton traveling cranes and carried to platforms, from which, by opening a plug in the bottom, the molten steel is poured into the ingot-molds, large cast-iron molds 65 inches in height, tapering from 20 by 24 inches at the bottom to 18¾ by 22¾ inches at the top. Here the metal cools to the point of solidification. The mold is then lifted off the ingots which, by the way, are carried on four-wheeled cars, each car carrying four molds, and after having been heated to a uniform heat throughout in the "soaking pits" the product is ready for rolling in the billet mill or the rail mill.

It should be mentioned that in order to take care of the product of the blast furnaces on Sundays and holidays, when the open-hearth furnaces are not at work, the hot metal is brought in ladles to the casting machine, where it is poured into an endless chain of traveling molds which passes continuously below the mouth of the ladle. There will be eleven of these machines for the service of the complete plant.

BILLET MILL.

Standing parallel with the rail mill is an electrically operated billet mill, in which a portion of the ingots are rolled down to suitable size for further manipulation throughout the plant. Here are four 40-inch blooming mill stands, each pair driven by a 2,000-horse-power electric motor, and a five-stand continuous 32-inch mill driven by a 6,000-horse-power motor. Beyond this are two blooming shears, 12 x 12 inches and 10 x 10 inches. Next, the blooms go to a 24-inch 6-stand continuous mill, driven by a 6,000-horse-power motor, or to a pair of cooling beds for shipment. If further reduction is desired the billet is sent to a 6-stand 18-inch continuous mill and rolled down to sizes varying from 3½ inches square to 1¾ inches square.

LARGEST RAIL MILL IN THE WORLD.

The Gary plant contains the largest rail mill in existence. It is also the only electrically driven mill which rolls rails direct from the ingot without reheating. The proportions are immense, the main building being 990 feet long by 76 feet wide, with another building containing the soaking pits, for both rail mill and billet mill, which is 1,350 feet long by 84 feet wide. The soaking pits are square chambers with hydraulically-operated sliding doors in the roof, capable each of holding four 4-ton ingots. They are heated by gas and in them the ingot is brought up to the proper temperature for rolling. The roll trains are driven by six 6,600-volt induction motors, three of 6,000-horse-power and three of 2,000-horse-power. The finished rails are taken to inspection beds in a finishing department and are then loaded on the cars. This rail mill can turn out 4,000 tons of 80-pound rails in twenty-four hours.

GAS-ENGINE-OPERATED BLOWER PLANT.

Air blast for the furnaces is produced in two buildings, 550 and 600 feet long and 104 feet wide, which are among the most interesting features of the Gary plant. The blowers, of which are are twenty in all, are driven by sixteen gas engines and four steam engines. These blowing engines are of great size and power. The gas and blowing cylinders are placed in tandem. The gas cylinders are 42 inches in diameter and the blowing cylinder 72 inches, and they have a common stroke of 54 inches. Each engine is of 2,000 horse-power and runs at a speed of 60 revolutions per minute, and each delivers 32,000 cubic feet of free air per minute at a normal pressure of 18 pounds per square inch. The gas engines were built by the Allis-Chalmers Company and the Westinghouse Machine Company. When the plant of sixteen furnaces is completed there will be no less than thirty-two of these engines with a total horse-power of 64,000.

GAS-DRIVEN ELECTRIC POWER PLANT.

The most interesting feature of the whole establishment at Gary is the huge power house, 105 feet wide and 966 feet long, which provides the electric current for one-half of the complete plant. It is the largest gas-power plant in the world and contains seventeen horizontal twin-tandem double-acting Allis-Chalmers gas engines of 3,500 horse-power, each directly connected to a 2,500-kilowatt generator, fifteen of which are 6,600-volt alternating-current machines and the other two 250-volt direct-current machines. These huge engines are the largest ever constructed for the use of blast-furnace gas. Their cylinders are 44 inches in diameter by 54 inches stroke. Each twin unit carries on a 30-inch shaft a 23-foot 100-ton fly-wheel. The plant also contains two Curtis steam turbine generators for starting and for auxiliary service in case of necessity. Additional gas-electric engines will be provided in two separate buildings, aggregating 60,000 horse-power. Thus the ultimate capacity of the electric power plant will be 120,000 horse-power.

Limitations of space prevent any more detailed description of the many features of interest which are found at Gary. The combined steel plant and city of Gary are the most noticeable instance in America of the rapidity with which a large area of apparently valueless land may, at comparatively short notice, be transformed into a huge center of industrial activity. Not only is about one-half of the plant in operation, but the adjoining city already has a population of 15,000 souls. Four years ago the site was a wind-blown waste of sand on the shores of Lake Michigan.

THE HANDLING AND STORAGE OF OUR HUGE GRAIN CROP.

(*Continued from page 445.*)

els per hour to cars or boats. It has a rated storage capacity of 2,500,000 bushels; and it may be mentioned here that the elevators of the Armour Company alone are capable of storing 13,500,000 bushels a day. This elevator is constructed entirely of wood, and the square bins, which range in size from 500 to 7,000 bushels capacity, are built of spruce planks, 2 x 4 inches at the top of the bin and 2 x 10 inches at the bottom, laid lengthwise upon each other, and each spiked to the layer below. The whole interior of the main body of the building is built up of a perfect honeycomb of these bins. The bottoms are tapered and finished in spouts to insure a free delivery of the grain in unloading.

The more modern elevators, such, for instance, as those designed by the Metcalf Company and shown in our illustrations, are built of reinforced concrete, the bins being circular in form; are of great strength, and of thoroughly fireproof construction. The square tower-like building contains the elevating, cleaning, weighing, and conveying machinery. At about the middle height of this building horizontal covered passageways serve to contain conveyer belts, by which the cleaned and weighed grain is transferred to the top of the bins and loaded into the particular bin desired.

The annual shipment of grain to Europe is about 150,000,000 bushels, and as our five thousand bushels from the Dakota farm are destined to cross the ocean, we will trace its course from the Chicago elevator in which it is reposing to its final stowage in the hold of an ocean cargo steamer. At the end of its railway journey to Chicago, the grain passes through similar experiences to those it

(*Continued on page 452.*)

NEW BOOKS, ETC.

NELSON'S PERPETUAL LOOSE LEAF ENCYCLOPEDIA. Editor in Chief, John H. Finley, LL.D., President of the College of the City of New York. Associate Editors, William Peterson, LL.D., C.M.G., Principal of McGill University, Montreal, Canada, and George Sandeman, M.A., Edinburgh, Scotland. New York: Thomas Nelson & Sons, 1909. Twelve royal octavo loose-leaf volumes, illustrated with colored plates, plans, and engravings.

In these days, when history is making so rapidly as to call for daily and even hourly editions of newspapers, and science is advancing at such a pace that new periodicals are constantly cropping up to announce developments in specialized branches, the mere task of collecting this mass of material, condensing it, classifying it, sifting out the errors, and finally putting it in such a form as to be of value as a record for the well informed man, is in itself stupendous; but it is disheartening to know, as all makers of encyclopedias do know, that the very day after publication, the work is beginning to grow old and out of date. The mass of information which is crammed between the covers of an encyclopedia is living material, matter that is as alive as the age in which we live. Hence, it is inconstant. Part of it is aging and dying, much of it is developing and expanding and is giving birth to new ideas, and the effort to keep all this material in alphabetical order and keep it abreast of the times has always been a serious problem, which the publication of annual volumes has not solved for the reason that the additional matter published contains only the new facts, while leaving the old and worn-out ideas in the original encyclopedia, where they are liable to mislead the reader. A new departure in this line has just been made in the Nelson Loose-Leaf Encyclopedia, which is so arranged that any facts which may become out of date can be taken out of the very heart of the volume and replaced with new material without in the least affecting the alphabetical order or destroying the arrangement as a book of ready reference. The loose-leaf binding is ingeniously contrived to give the volume the appearance of being permanently bound. Nelson's Encyclopedia was first prepared in permanent binding in 1907. When a year later the loose-leaf edition was published, it was found necessary to make 600 changes in order to bring the encyclopedia up to date. A large staff of editors is employed to keep the present encyclopedia up to the hour, and from time to time new leaves are issued and sent to the subscribers, furnishing them with authoritative information on current topics, and informing them where to insert the matter in the encyclopedia. As an illustration of the up-to-dateness of this system, a set of leaves was issued last month on the death of Governor Johnson and on the Cook-Peary controversy. These leaves are temporary, and in March of each year a complete set of leaves of about 500 will be sent to each subscriber to add to his encyclopedia and to replace matter that is out of date. Formerly, a man could obtain better information on the occurrences of the previous decade than those of the current year. With the advent of Nelson's Encyclopedia such is no longer the case. The subjects covered in this work are many, probably a greater variety than is to be found in any other encyclopedia of the same number of volumes. The articles are, therefore, short and concise. The aim of the encyclopedia appears to be to provide general information and to avoid technical language as far as possible, to furnish not merely a record of events, but to give instructions wherever possible that will be of practical value to the reader. Take, for example, the entry "Cycle." Not only is a brief history of the bicycle given, but also instructions to the prospective buyer of a wheel which will enable him to choose the best machine, and hints on the care of a wheel. This strikes us as a rather unique feature, but one that will doubtless be appreciated by many subscribers to this work. The articles are a trifle more brief than one would like to have them, but they are accompanied by carefully selected bibliographies for those who desire to study the subject further. The encyclopedia appears to be an exceptionally good gazetteer, containing many geographical names that do not appear in other works of this kind. A pronouncing dictionary is placed at the end of each volume, so that if a person is in doubt as to the pronunciation of a certain word he can look it up very quickly and without having to wade through the body of the book, where his attention is liable to be diverted by the many interesting subjects which the volume contains.

WILD FLOWERS AND TREES OF COLORADO. By Francis Ramaley, Ph.D. Boulder, Colo.: University Book Store, 1909. 8vo.; 78 pp.

This little volume is intended as an introduction to Colorado plants. It is not a result of book study, but of many summers' work on Alpine heights and on the plains. It will prove of interest to all students of botany, particularly if they live in the State of Colorado.

TABLES AND OTHER DATA FOR ENGINEERS AND OTHER BUSINESS MEN. By Charles B. Ferris, B.S. Knoxville, Tenn.: Published by the University Press. Price, 50 cents.

(*Continued from page 451.*)

had at the receiving house. It is discharged into the boot, carried up the leg, and spouted into the bins. This time, however, instead of one leg, there may be from sixteen to twenty; and the four bins will have increased to over one hundred. Our five thousand bushels of grain, then, are discharged by gravity from the bottom of the bin to the boot of an elevator, are lifted and discharged again into a big spout, through which they flow directly down into the hold of a lake cargo vessel moored alongside the elevator.

This vessel is of a special type which has been developed for the lake trade. Although she may be capable of carrying over ten thousand tons of cargo, she is nothing more nor less than a huge barge with straight, parallel sides; blunt of bow and stern; with accommodations for the seamen at the bow, and with engine, boilers, and captain's accommodations at the stern. The main body of the ship consists of one vast hold, access to which is gained by a long line of hatches. Our 5,000 bushels of grain together with hundreds of thousands of bushels that may have been gathered from half a dozen different centers in the wheat-growing districts of the West, now start on their long journey at ten or twelve knots an hour to Buffalo, being consigned to one of the great waterside elevators in that city. The vessel is moored alongside the elevator, with its hatches opposite a huge tower-like structure built against its side and extending a story higher than the rest of the building. Inside of the tower and swinging from a hinge at its top is a huge steel-and-timber structure, which is nothing more nor less than our old friend the belt elevator grown to Brobdingnagian proportions. Almost before the ship is alongside and the hatch covers are off, this swinging elevator is moved until its boot hangs directly over the opening into the hold. The boot is extended until it enters the hold and is buried deep in the mass of grain. The elevator leg is some 90 feet in length and it can be raised or lowered some 50 feet if necessary. In a single hour it can lift 15,000 bushels out of the hold and into the elevator.

As the grain reaches the head of the tower leg, it is shot directly into a receiving bin. Beneath this bin is a weighing scale with a hopper of 200 bushels capacity. The scales are set for a certain weight, and the weighing hopper is filled by pulling a lever which moves a slide in the bottom of the receiving bin above. The man who does the weighing is so expert that he can fill the scale hopper with the exact amount, no more nor less, once in every fifty seconds; which he must needs do when the huge marine leg is pumping grain out of the hold at the rate of 15,000 bushels per hour. From the weighing hopper the grain is delivered direct to the storage bin; or if, like our 5,000 bushels, it be destined for transportation across the sea, it will be carried across the building and out again as fast as the railway cars can be found to accommodate it. The cars will carry the grain direct to one of the great grain-exporting seaports, Portland, Boston, Newport News, or New York.

The method of operation at the seaport elevators is similar to that of the Chicago warehouse. The main difference is that, whereas at Chicago the barge steamer lay against the side of the elevator and the grain was delivered directly to the hold through the spout below the open door, it will frequently happen that the grain must be carried several hundred feet out over a pier and there discharged into the hold of the ocean-going steamship. This is done by means of a belt conveyer.

Now, this is not by any means the first time that our consignment of grain has made its acquaintance with the belt conveyer, which has been aptly described as the elevator leg belt stripped of its metal cups and lying upon its side. The belt conveyer is extensively used in the vari-

(*Concluded on page 453.*)

RECENTLY PATENTED INVENTIONS.

Pertaining to Apparel.

WAIST AND SKIRT SUPPORTER.—A. M. PRESTON, Broxton, Ga. The objects here are: to provide a supporter which is at once simple in construction, durable and certain in operation: to provide a device which will lie closely and snugly to the form; and to provide a device which is neat and presentable in appearance.

SELF-SUPPORTING STOCKING.—G. GRAHAM, New York, N. Y. The invention relates more particularly to the means employed for supporting a stocking. The upper portion of the stocking is so formed that it in itself constitutes a garter, so that no separate supporting means need be employed. The invention covers any fabric foot covering, as for instance, socks, hose, half-hose, etc.

Electrical Devices.

TROLLEY-POLE CATCHER.—J. H. WALKER, Lexington, Ky. The purpose in this case is to provide a construction in connection with the pole and a lower connection, whereby the pole may be prevented from rising to a perpendicular position when the trolley wheel jumps the wire, and whereby the pole may be held in any intermediate position and may be permitted to freely move in contact with the wire in the operation.

Of Interest to Farmers.

JOURNAL FOR AGRICULTURAL IMPLEMENTS.—A. C. DITMAR, Davenport, Wash. An efficient journal is provided which can be attached to a plow beam or the like for the purpose of revolubly mounting a colter disk or other part, in which the disk can be set at any angle, which will fit any kind of plow, in which the spindle is in a dust-proof boxing, and in which the wearing parts are supplied with lubricant.

ANIMAL COVER.—C. L. HASTINGS, Fond du Lac, Wis. The aim in this invention is to provide a durable cover, which is particularly useful for cattle, by means of which the animal can be well covered, when necessary, which thoroughly envelops the body, leaving the head, neck, and legs free, and in which means are provided to prevent the displacement of the blanket from the rear of the body.

Machines and Mechanical Devices.

FILLING DEVICE.—J. PAPISH, 605 Freeman Street, Valparaiso, Ind. The aim is to provide in this invention, a device by means of which powders, crystals or other granular material can be expeditiously and easily introduced into small-necked bottles and the like, which requires little effort to operate it, and which fills the receptacles without spilling any of the material which is being introduced into the receptacle.

Railways and Their Accessories.

DOOR.—C. B. WHITMAN, Watervliet, N. Y. This improvement in doors is especially designed to be used in connection with street railway cars, and has for its purpose to automatically register the number of passengers entering, and which will permit of the exit without operating the registering mechanism. The movements of the motorman on the platform will not be more restricted than when the usual type of door is employed.

NOTE.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

INDEX OF INVENTIONS

For which Letters Patent of the United States were Issued for the Week Ending November 30, 1909,

AND EACH BEARING THAT DATE

[See note at end of list about copies of these patents.]

(*Continued on page 453.*)

(*Concluded from page 452.*)

ous inland and Great Lake grain warehouses for transporting the grain horizontally from one part of the warehouse to the other. Thus, when the wheat is shoveled out of the railway car into a spout below the open door, it will frequently happen that the transfer takes place at some distance from the particular one of the twenty elevator legs by which the grain is to be lifted to the top of the bin. In this case it will be allowed to fall through onto a broad traveling belt of the kind shown in our illustration, upon which it will move swiftly until it reaches the spot at which it is to be delivered or "tripped." Here the belt will pass over a set of pulleys arranged above one another in such a way that the grain can be shot off the belt for such further handling as may be desired. In this particular case it will be delivered to the boot of the elevator, carried up, and discharged to its own particular bin.

Time saving is a great consideration in these huge warehouses, and one of the most interesting features is the system of swinging distributing spouts, intervening between the receiving and weighing bins at the head of the elevators and the huge honeycomb of storage bins below. One of our views shows these spouts, hinged below the floor of the top story of the building and capable of being swung around and over the top of the particular bin to which the grain is to be delivered. This arrangement is one of many ingenious arrangements by which the enormous mass and weight of grain can be received, weighed, placed in its own particular bin, drawn away therefrom, lifted, transported horizontally, and finally delivered to car or steamship in the least possible time, with unfailing accuracy, and at the minimum of cost.

In the above description we have traced the grain from a farm in the Middle West to the hold of the steamship that would carry it to Europe. As regards the general system of receiving, selling, and distributing the grain, the same methods apply to the wheat which is consigned to the great flour mills, say, of Minneapolis, or to any of the centers in which it is prepared for the consumption of the masses.

CHICAGO AND THE RAILROAD SYSTEM OF THE MIDDLE WEST.

(*Continued from page 447.*)

000 passenger station, that will be ready for occupation early in 1910. With one exception it will be the largest passenger terminal in the United States. Over thirteen acres of ground will be occupied by the station and station tracks. The approaches cover thirty additional acres, fifteen acres being used for the north and the west approaches. The present station, with capacity for handling fifty thousand passengers per day, is now overtaxed; the new terminal will be capable of taking care of a quarter of a million people every twenty-four hours.

The plans call for an elevated terminal, reached by two elevated approaches of four tracks each, and a train shed 800 feet long and 320 feet wide, that will contain sixteen tracks, each with a capacity of fifteen cars. The area of the basement is over two acres; the street floor of the station building covers one and three-quarters acres; the train shed, six acres. Altogether there will be practically ten acres of floor space devoted to public use. One of the most important features is the treatment of the train shed. This structure will not have the usual long black expanse of sooty roof that offends the eye. The sixteen long tracks which will occupy the shed will be covered by what is known as the "Bush roof," in which the curve of the roof over each pair of tracks is broken by a concrete slot or duct, running the length of each track, and so placed that the locomotive funnels will discharge through it into the open air.

The electrification of Chicago steam railways inside of the city limits is at

(*Continued on page 454.*)

Legal Notices

Bearing for trough conveyers, etc., roller, H. Bentley 941,972
Bearing, roller, H. Hess 941,636
Bearings, means for introducing balls into ball, E. Geschke 941,632
Bed, folding, L. B. Jeffcott 941,879
Bed, folding, J. H. Edmonds 941,982
Bed, invalid, J. H. Comer 941,620
Bedstead mount buffing machine, J. F. Gail. 941,706
Belt, drive, A. G. Kolbe 941,786
Bench dog, E. A. Schade 941,816
Bill holder, I. H. P. Colleen 941,559
Binder, G. P. Wigginton 941,481
Binder, Wigginton & Hodges 941,482
Binder attachment, self, E. Pennington 941,945
Binding post, L. Steinberger 941,893
Blind stop, H. L. Beadle 941,552
Boat, C. Hoffman 941,923
Bobbin holder, S. W. Wardwell 941,595
Boilers, engine setting for horizontal, G. W. Morris 941,460
Book, manifolding copying, Whyte & Rau 942,023
Boot and shoe forms, holder for, T. F. McCann 941,723
Bottle caps, device for removing, Forsyth & Wallace 941,865
Bottle closure, Richards & Ahnfeldt 941,651
Bottle neck protector, V. Durand, Jr 941,769
Bottle, non-refillable, E. B. Barner 941,551
Bottle, non-refillable, Jenssen & Weitzel 941,994
Bottle receptacle, milk, A. G. Brodhead 941,853
Bottle stopper, D. Landau 941,788
Bottle, telltale, Midbo & Gulbrandson 941,890
Bowling alley pin setting mechanism, L. A. Brigel 941,611
Box or container, J. F. Byrne 941,356
Brake apparatus, fluid pressure, M. Corrington 941,914
Buckle, L. H. Fishel 941,702
Building block, E. Chapman 941,617
Building block and wall, F. J. Schuster 941,656
Buoy, automatic locating, Marcou & St. Peter 941,377
Bushing and check valve, combined reducing, W. S. Jacobs 941,713
Bushing for pulleys, gears, and the like, H. G. Wolf 941,602
Cab signal circuit, P. J. Simmen 941,541
Cabinet, envelop, H. K. Smith 941,736
Cableway, T. S. Miller 942,038
Calculating machines, index plate for, J. Graber 941,774
Calendar, E. C. Mahon 941,719
Camera, I. O. Perring 941,688
Camera, H. W. Conner 941,696
Can cap dropper, E. M. Cobb 941,357
Can closing device, J. H. Pelletier 941,533
Can heading machine, J. Brenzinger 941,755
Canceling machine, letter, L. Blessing et al. 941,848
Candy pulling machine, H. S. Brewington 941,610
Cane, wax-like product obtained from sugar, A. Wynberg 941.401
Canopy frame having doors, W. S. Davidson 941,765
Canopy, ventilating, J. N. Moody 941,685
Car, E. S. Bucknam 941,855
Car bolster, C. H. Anderson 941,691
Car controlling system, electric, A. B. Stitzer 941,391
Car coupling, C. H. Tomlinson 941,965
Car, dump, S. Otis 941,381
Car fender, J. D. Wright 942,027
Car fender, air actuated street, J. M. Clancy 941,497
Car fender, street, A. L. Mazzanovich 941,527
Car fender, street, G. J. Fleissner 941,984
Car for transporting ore or other material, W. C. Carr 941,405
Car, hand, J. D. Kerr 941,420
Car heater, J. F. McElroy 942,040
Car, passenger railway, L. E. Paden 941,807
Car seats, wear strip and retainer for securing coverings to the frames of, F. H. Henry 941,875
Car wheel, motor, G. B. Winter 942,025
Cars or the like, system of precooling fruit, A. Faget 941,443
Carbureter, A. H. Warmsley 941,393
Carbureter, J. H. Cooper 941,406
Carbureter, C. G. Leonard 941,424
Carriage, folding baby, A. W. Loshbough 941,374
Carrier. See Stereopticon slide carrier.
Cash register, W. H. Muzzy 941,378
Cataloguing system, R. T. Close 941,499
Cement block for wall structure, W. L. Davidson 941,624
Cement, process and apparatus for artificially aging or seasoning Portland, T. A. Edison 941,630
Chair, Berzon & Goldberg 941,555
Chair, C. L. Greilick 941,919
Check controlled mechanism, F. C. Kainer 941,716
Chocolate confections, machine for the manufacture of, A. H. Savy 941.537
Churn, D. Rees 941,948
Cigar, self-lighting, D. G. Vale 941,966
Cigarettes, etc., machine for packeting, E. L. Bracy 941,490
Clamp, D. A. Ducharme 941,504
Clod crusher, C. G. Stelzer 941,740
Clothes line hanger, G. T. Van Riper 941.898
Clothes rack, suspended, B. B. Bosworth 941,909
Clothes wringer, A. Lovett 942,001
Clutch, G. W. Brubaker, Jr 941,973
Coal, briqueting, C. E. Hite 941,454
Coating machines, holder for liquid, R. A. Beausejour 941,607
Coin collector, A. M. Farnsworth 941,509
Coke drag, S. Richter 941,385
Coke oven door, W. O. White 941,398
Collar, H. C. Miller 941,795
Comb, M. E. Purdy 941,586
Composing and casting machine, typographical, Pearce & Billington 941,384
Concentrator slime feeding device, J. B. Green 941,918
Concrete building construction, R. V. Woods 941,837
Concrete construction, metal tie for, E. Chapman 941,616
Concrete mixing machine, R. G. Leverich 941,998
Concrete pavements, laying, F. S. Lamson 941,886
Concrete pile, reinforcer, T. Stedman 942,018
Concrete wall mold, D. A. Marshall 942,004
Containing can, W. H. Hoyt 941,781
Conveyer, F. Eberhart 941,364
Coop, poultry, J. A. Emert 941,507

(*Continued on page 454.*)

(*Continued from page 453.*)

present a big problem to Chicago terminal lines and a popular subject with the people and the newspapers. Although an ordinance was passed by the City Council compelling Chicago railroads to provide other than steam power within two years, it is frankly stated by the authors of the ordinance that they appreciate that the work cannot be done within this time, but that they hope to see a start made toward electrification of Chicago terminals. At present the fight is centered on the Illinois Central Railway, the trains of which run along Chicago's otherwise beautiful lake front. The smoke and noise from the frequent suburban trains on the Illinois Central at the city's front door have accentuated the popular demand for a change in motive power.

It will be pertinent just here to give a few facts illustrating the magnitude of the business done by some Western roads, and the punctuality with which it is carried on. Subsequently to an announcement by one of the leading Eastern roads that one of its crack trains between New York and Chicago had been on time during 123 consecutive days, the Burlington route drew attention to the fact that the Denver Limited ran the distance of 1,026 miles into Denver from Chicago on time for 136 consecutive days, and that it was on time 531 days out of 546 days from January 1st, 1908 to June 30th, 1909. That there has been a gratifying improvement in the safety of railway travel is shown by the fact that this company carried over 19,000,000 passengers during the past year and that not a single one of these was killed. A similar creditable record is reported by the St. Paul, the Northwestern, the Santa Fé, the Rock Island, and the Alton roads. The Burlington system alone employs 42,100 officers and men, owns 1,703 locomotives and 52,403 freight cars, carried during the past year 32,379,520 tons of freight, and its receipts amounted to $78,500,000, an increase of about 100 per cent in ten years. Another instance of the volume of business in and out of Chicago by rail is afforded by the Chicago & Alton Railway, which on a mileage of 998.8 miles moved 9,668,927 tons of freight, carried 3,828,056 passengers, and received and forwarded at Chicago 3,749,920 tons of freight.

Modern Improvements in Track and Rolling Stock.—The present necessarily brief survey of railroad conditions in Chicago and the Middle West would be incomplete without some reference to the really remarkable improvements which have been made during the past twenty-five years, both in the roadbed and in the rolling stock. The pioneer roads, built when capital was scarce, and extended into countries in which they had to literally create the traffic from which returns upon the investment could be made, were necessarily, if we may be excused the expression, "cut according to the cloth." "Cheap first cost" was the controlling motive of their construction; and the locating engineer was told to lay out his line with as little disturbance of the surface of the ground as possible. Hence, he ran his survey around the hills, or over them by steep grades, instead of through them by cut or tunnel. His line ran down into the valleys, or crossed them by cheap timber trestles. Wood was used in place of costly steel for the bridges over streams and rivers. The ties were frequently laid directly upon the surface of the ground, with practically no ballast beneath them; the steel rail was of the lightest weight which could carry the engines and cars. Twenty-five years ago, fifty tons was the average weight of the engine, and twenty tons was the maximum load for a car. The grades over the mountain were frequently two per cent, and sometimes ran up to three per cent or over, thereby greatly limiting the load which any one engine could haul over a given stretch of land.

With the settlement of the country and the development of the passenger and freight traffic, the various railroad com-

(*Continued on page 455.*)

Cord terminal, F. Parsons.................. 941,808
Corn husking implement, S. B. Dykes....... 941,505
Corn sheller, W. J. Moore.................. 941,798
Cornice brake, G. C. Keene................. 941,783
Couch and bed, convertible, L. B. Jeffcott.. 941,878
Couch, electrovibratory, W. A. Church...... 941,673
Cradle, C. H. Johnson...................... 941,927
Cream separator, centrifugal, P. L. Kimball 941,881
Cream separators, drum for centrifugal, J. & A. Persoons.......................... 941,809
Crib, J. B. Stalter......................... 941,429
Crushing machine, flexible, H. E. Gregg.... 941,710
Cue, R. J. Preast.......................... 941,728
Cultivating machine, Koszegi & Szechenyi.. 941,422
Cultivator, G. M. Roper.................... 941,589
Cultivator, J. Hobson, Jr.................. 941,678
Current apparatus, alternating, W. Stanley. 941,467
Current collector, underrunning, S. B. Stewart, Jr. 941,390
Current meter, alternating, W. Stanley..... 941,469
Currents, means for rectifying single-phase, J. L. Woodbridge..................... 941,599
Cutter bar, E. J. Wolfvom.................. 941,400
Cutting tool for applique work, W. Vogel... 941,967
Cycle, motor, J. E. Allen.................. 941,903
Dashboard brace, F. H. Hosay............... 941,711
Dental engine handpiece swivel, A. W. Browne 941,612
Dentistry, M. R. Koons..................... 941,718
Die cutting machine, D. P. Robinson....... 941,953
Display cabinet, L. W. Welch............... 942,022
Display rack, inclosed, W. K. Williams..... 941,483
Display sheets or curtains, frame for, L. C. Davidson 941,622
Distilling wood alcohol and other products, apparatus for, B. R. & M. J. Lyster.... 941,641
Distributing machines, apparatus for the control and the registration of the operations performed by, G. I. F. Soulage.... 941,892
Door check, C. L. Butler................... 941,492
Door check, R. W. Hubbard.................. 941,782
Door closer, W. W. Bjorling................ 941,907
Door fan attachment, J. N. Hatcher........ 941,921
Door fastener, B. B. Fairman............... 941,771
Door fastener, sliding, J. McAllister et al.. 941,379
Door hanger, W. D. Thompson............... 941,664
Door, revolving, Clymer & Deffen........... 941,619
Door, revolving, C. J. Cruyge.............. 941,699
Door stop, W. La Baw....................... 941,885
Doors, automatic control of water-tight, W. L. Merrill 941,428
Dosing device, liquid tight, E. M. Bajon... 941,905
Doubling apparatus, P. E. Donner.......... 941,700
Draft appliance, F. M. Smiley.............. 941,545
Draft device, C. P. Hansen................. 941,920
Drawing instrument, C. C. Page............ 941,687
Dredger, caisson, R. A. Gardner........... 941,869
Drill and stay bolt cutter, combined, F. Fleming 941,568
Drive, four wheel positive, O. A. Goodrich.. 941,514
Drying apparatus, hair and fur, E. Deslot.. 941,980
Drying sheet material, apparatus for, C. E. Moss 941,721
Dyeing wool, H. Winslow.................... 941,399
Egg separator, Heatherington & Long....... 941,415
Elastic connecting strap, J. J. Shea....... 941,659
Electric appliances, attachment for, H. W. Denhard 941,979
Electric cable terminal, C. W. Davis....... 941,859
Electric cell or battery, primary, A. Heil.. 941,416
Electric circuit controller, H. W. Leonard.. 941,425
Electric circuits, means for controlling, G. W. Hart 941,777
Electric furnace, C. A. Keller............. 941,419
Electric furnace for gas reactions, Dieffenbach & Moldenhauer................... 941,768
Electric machine, dynamo, F. B. Howell.... 941,456
Electric machines, cross connection for dynamo, R. Siegfried................. 941,388
Electric meter, F. M. Vogel............... 941,436
Electric meter, P. C. Morganthaler........ 941,459
Electric meter, W. Stanley................ 941,468
Electric switch, F. W. Smith.............. 941,660
Electrical apparatus, wall cabinet for, E. R. Le Manquais 942,002
Electrical cable terminal, C. W. Davis...... 941,860
Electrical distribution system, R. J. Dearborn 941,362
Electrical distribution system, P. M. Lincoln 941,372
Electrical distribution system, J. L. Woodbridge 941,600, 941,601
Electrical distribution system, W. E. Winship 941,690
Electroplating apparatus, L. Potthoff....... 941,535
Elliptic spring, H. Jeffrey................ 941,521
Embossing appliance, L. H. Orr........... 941,632
Emulsion, producing a mineral oil, S. Knopf 941,785
Engine. See Internal combustion engine.
Engine piston head, A. Starke............. 941,737
Engines, muffler cut-out for explosive, L. Raffalovich 942,011
Engines, spark timer for internal combustion gas, O. L. Brainard............... 941,556
Envelop, L. C. Van Riper.................. 941,392
Envelop, R. Landenberger.................. 941,525
Envelop, P. Forschler..................... 941,924
Exhibiting apparatus, S. B. Moscovitz...... 942,008
Fan, L. J. Wing........................... 941,834
Fastener, J. A. Simpson................... 941,542
Fastener, C. A. Conrard................... 941,977
Faucet for cheese apparatus, J. Brensike... 941,694
Fence post staple, J. Darling............. 941,978
Fender or trolley wheel guard, J. A. MacMahon 941,790
Fertilizer distributer, G. E. Alphin........ 941,603
File box, Keck & Doin..................... 941,681
Film frame apparatus, B. Day.............. 941,500
Finger pad, J. G. Marsh................... 942,003
Fire hose coupling, H. J. Hickey.......... 941,990
Fire arm, S. B. Smith..................... 941,662
Fishing rod, W. A. Austin................. 942,030
Flower pot holder, A. Haglund............. 941,448
Fluid motor, A. Mill...................... 941,582
Fluid pressure brake, W. P. A. MacFarlane 941,684
Fluid pressure regulator, B. H. Petley...... 942,042
Flushing device, basin, E. Kuhn........... 941,997
Folding machine, E. D. Wallace........... 941,747
Frame, L. B. Stetson...................... 941,894
Freezer, G. F. Dickson.................... 941,767
Fuel, artificial, R. W. Howell............. 941,577
Fuel feeding apparatus, R. Putnam......... 941,587
Furnace, L. Whittaker..................... 941,480
Furnace, M. W. Sewall.............941,657, 941,658
Furnace bridge walls, protecting cap for, J. R. Fortune 941,569
Furnace grate, F. Girtanner............... 941,572
Furnaces, smoke consuming attachment for, W. P. Choitz.......................... 941,496
Gage, R. Atkinson......................... 941,843
Game apparatus, W. B. Beckley............ 941,488
Game apparatus, A. De Meurisse........... 941,793
Gang edger, U. Anderson.................. 941,751
Garment hanger, W. F. Freeman............ 941,510
Garment support, movable, L. G. Dodge.... 941,501
Garment support, movable, L. G. Dodge, et al 941,502
Garment supports, guard for rotary, S. D. Young 941,669
Garment supporter, S. Kopps.............. 941,787
Gas burner, J. Weintz 941,437
Gas burner, B. A. Geurink 941,708
Gas escape, H. H. Fulton 941,917
Gas kiln, E. Schmatolla 942,013
Glases, apparatus for cleaning, Ahlen & Siebert 941,841
Gearing, change speed, F. D. Pouch........ 941,727
Gearing, friction, G. H. Chisholm.......... 941,856
Glass etching machine, A. B. Knight....... 941,883
Glass, machine for making wire, J. I. Arbogast 941,842
Glass, method of and apparatus for drawing continuous sheets of, E. Fourcault.. 941,866
Glass, method of and means for manufacture of window, R. L. Frink 941,512
Glass molding machine, W. J. Miller...... 941,935
Glass molds, construction of, F. M. McKernan 941,584
Glazing tile, brick, or the like, F. E. Goldsmith 941,635
Governor, fly ball, M. Haeberlein 941,775
Grain treating apparatus, E. Sorenson...... 941,821
Grates, shaker for fire, Zuech & Diemer.... 942,029
Grating, screen, screen door construction, and the like, E. McClure 942,039
Grease or lubricant cup, G. W. Bowen...... 941,849
Gun support, C. O. Lawson 941,640
Guns, range keeper for, Dawson & Horne.... 941,626
Gymnasium horse, A. J. Thornley.......... 941,665
Gyve, F. C. Nagle 941,942

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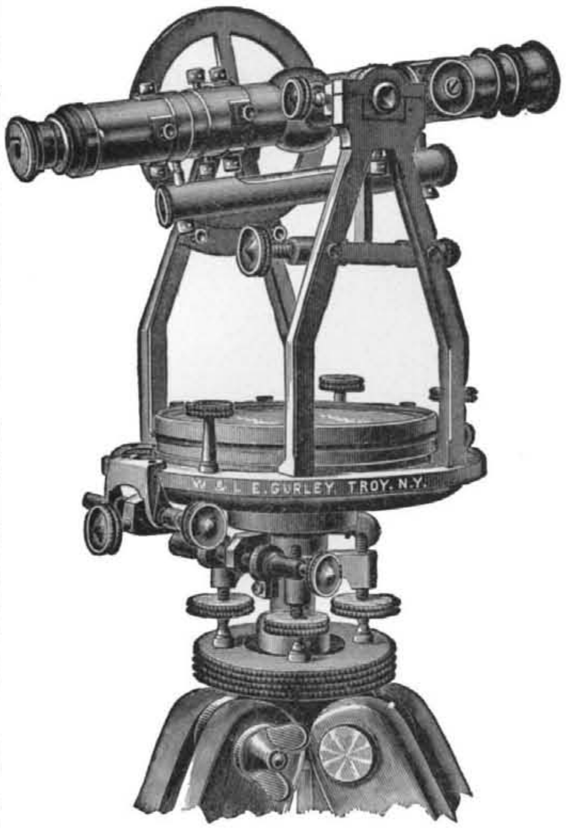

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panies began to find themselves in a position to bring their roadbed and rolling stock up to a higher standard, suitable to the rapidly increasing movement of freight and passengers; and during the past fifteen years hundreds of millions of dollars have been expended in this work. Much of the track has been relocated; curves have been eased or eliminated altogether; grades have been cut down; timber trestles have been replaced by solid earth or rock embankments; wooden bridges have given place to massive structures of steel; heavy grades over the mountain summits have been eliminated by the simple but enormously costly process of tunneling right through the solid mountain itself; millions of tons of rock ballast have been distributed and tamped beneath the ties; and the light rails of 56 to 60 pounds weight to the yard have given place to rails weighing from 75 to 90 pounds.

Furthermore, many of the important western railroads are double-tracking their lines. The Santa Fé is building double track for its main line between Chicago and Kansas City, and beyond as far as Newton, Kansas. Between Chicago and Newton 644 miles of second track are now in operation, having been recently built at a cost of $22,500,000. Between Chicago and St. Paul and Minneapolis, the St. Paul road has been pushing to completion the double-tracking of its main line; and between Chicago and Omaha the Northwestern Railway has already completed its double track, and the Burlington road will complete the same work at an early date.

The transcontinental roads which have been built during the past few years will, of course, be spared these costly expenses for betterments. In a recent issue of the SCIENTIFIC AMERICAN SUPPLEMENT we gave a complete description of the Pacific Coast extension of the Chicago, Milwaukee & St. Paul. On the afternoon of March 29th of this year the last rail of this extension was laid. It is now known as the Chicago, Milwaukee & Puget Sound Railway. The first shovelful of earth on this enterprise was turned in April, 1906, so that the whole of this $100,000,000 enterprise was completed in three years' time.

The improvement in railway track has been fully matched by the development of the rolling stock. Freight cars have increased in capacity from 20 tons to 50 tons; passenger engines have increased in weight from 50 tons to 135 tons; and freight engines from 60 to 70 tons have gone up to a weight of 213 tons—the above being the weights merely of the engines alone. The largest passenger engines are the magnificent six-coupled, ten-wheel engines used on the New York Central and allied roads, and built by the American Locomotive Company. They have cylinders 22 inches in diameter by 28 inches stroke, coupled to three pairs of 79-inch driving wheels. The boiler, 6 feet in diameter, has 4,195 square feet of heating surface. The engine alone weighs 130.7 tons, and the maximum tractive power is 16.7 tons. These engines can haul as many as fourteen Pullman cars, or say about 800 tons of train, on the level, at 55 to 60 miles an hour.

Even more striking has been the growth in weight and power of freight locomotives, especially since the introduction of the articulated type. The largest and most powerful of these is a mammoth affair built by the Baldwin Locomotive Works for the Mountain Division of the Southern Pacific Railway. It is a compound with two high-pressure cylinders 26 inches diameter by 30 inches and two low-pressures 40 inches in diameter by 30 inches stroke. The boiler has 6,393 square feet of heating surface. The engine alone weighs 213 tons, and the engine and tender together weigh just under 300 tons. This engine is capable of taking a 2,000-ton train over the heavy grades of the Mountain Division of the

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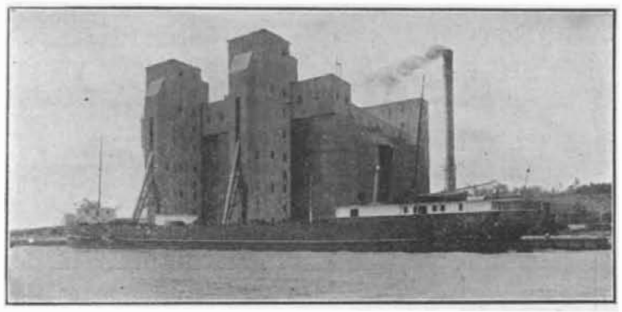

2,000,000 Bushel Concrete and Steel Grain Elevator, Built for the Grand Trunk Pacific Railway, Tiffin, Ontario.

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Southern Pacific, and on the level it would be capable of hauling a train weighing 10,000 tons and carrying about 7,000 tons of freight at a speed of ten miles an hour.

CHICAGO'S SIXTY MILES OF FREIGHT SUBWAY.

(*Continued from page 448.*)

not even excepting New York. The many trunk railroads which center in Chicago have done their best to shorten the haul to and from the freight terminals and the various business houses, for if one looks at a map of Chicago it will be seen that these terminals are located in the very heart of the city, and that they have reached a point beyond which, because of the high value of land, they cannot possibly go.

The credit for the solution of the problem of freight distribution is due to Albert G. Wheeler, who several years ago applied to the City Council for a franchise on behalf of the Illinois Tunnel and Telephone Company for the construction of a system of tunnels which should be used for the transmission of "sounds, signals, and intelligence by means of electricity or otherwise." The franchise was granted and work was commenced in a very unostentatious manner, the necessary capital being found by private parties. The lines as now completed extend from Armour Avenue and Archer Avenue on the south to Chicago Avenue and Kingsbury Street on the north to Green Street on the west. The greater part of the sixty miles of tunnel is six feet in width and seven and a half feet in height, but there are also trunk tunnels which are twelve feet in height and vary in width from ten to fourteen feet. It was stipulated that the floor of the tunnel should be about forty feet below the street level, and as it is generally seven and a half feet high, it follows that the tunnel roof is about thirty-three feet below street level. By constructing the system at this depth all interference with the water and gas pipes and sewers of the city was avoided, and sufficient room was left for the construction of a complete passenger subway system between the street surface and the tunnel whenever the city should be prepared to take up such a work.

It was stipulated in the franchise that the tunnel must be built below the center line of the streets, and this has been done. In prosecuting the work, shafts were sunk, as a rule, in the basements of various buildings, which were rented for the purpose of the tunnel company; and these basements were used for mixing the concrete and for installing the air-compressing plants which supplied the necessary air at ten pounds pressure for the pneumatic system under which the whole work was prosecuted. From the shafts above mentioned the workmen drifted out to the center of the street, where the work of excavation was carried on in opposite directions. In the earlier years of construction the material was hoisted to street level, loaded into contractors' carts, and hauled to the dumping ground on the lake front; this work being done entirely in the night time, to avoid any interference with the already crowded traffic of the day time. In later years the dump cars have been run to the surface by means of an incline and hauled by electric locomotive to the lake front,

(*Continued on page 457.*)

(*Continued on page 457.*)

(Continued from page 456.)

where already an addition has been made to the area of the city's park of about twenty acres. As the average fill is forty feet in depth, it can be understood that, had this enlargement been made by the city itself, it would have cost about $600,000.

The system is operated entirely by electricity, and the equipment consists at present of 175 motors of the Jeffrey and the General Electric types and 3,502 cars. There is a telephone installed on every block, and the movements of the trains are directed entirely by this means.

Although the wording of the franchise would indicate that the tunnels were to be constructed primarily for the installation of telephone and telegraph lines, it will be understood that the greatest revenue-earning power will be derived from the transportation of freight. It is estimated that about one hundred thousand tons of freight are hauled through the streets of Chicago each day; and if the tunnel company should haul only one-third of this, the total for the year would amount to over ten million tons. Hitherto no great effort has been made to push this branch of the business; but now that the system is about completed, it is expected that full connections will be made with the various business houses, and great increase in traffic will follow. Connection between the various warehouses and the tunnels is made by sinking a shaft and equipping it with electric elevators, which run from the track level below to the particular floors of the warehouse upon which the freight is to be delivered. In the case of a big warehouse, such as Marshall Field & Company, the loaded cars are hoisted to the desired floor, unloaded, loaded with the outgoing freight, returned to the tunnel, and drawn to the particular railroad freight station desired. It will not, of course, be possible to have direct connection between warehouse and tunnel in every case, and hence central depots will be provided at various suitable locations throughout the city, so placed that the average haul by team will not amount to more than one or two blocks. One immediate advantage of the system is that the wholesale houses are now able to carry on business throughout the twenty-four hours of the day. Under present conditions, after the teams have gone home for the night, the goods that are ready for shipment have to wait until the following day; and at busy seasons of the year it is not unusual for a delay of several days to occur. By using the tunnel system, the merchant can make immediate shipments of his freight, whether it consists of one truckload or fifty.

The tunnels will serve many useful purposes outside of that of transportation of merchandise. One of these, and a very important one, is that of the hauling away of material from the excavations for buildings within the city. Hitherto, this has been done by teams upon the surface; but the present method is to run a steel chute from the excavation down to the tunnel on an angle of about forty-five degrees. The workmen wheel the material to the mouth of the chute, and dump it; and it is received and drawn away by cars, which are successively moved below the mouth of the chute in the tunnel. When a train has been made up, an electric locomotive hauls it to the dump on the lake front. By this method as much as 2,100 cubic yards of material has been removed from the basement of a single building in one day. The best that has ever been accomplished by teams in the same time is 420 cubic yards. Another important service rendered is that of bringing coal to the boiler plants of the various houses and the hauling away of ashes and other refuse.

In no direction has the tunnel proved more successful than that of the transportation of mail. A twelve by thirteen-foot subway has been constructed below the United States Post Office building, ex-

(Concluded on page 458.)

Peanut shelling machine, R. M. Newland.... 941,686
Pen, composite, J. F. Betzler 941,403
Pen, reservoir, W. W. Sanford............ 941,466
Pencil holder and sharpener, combined, C. H. Haase 941,518
Pencil sharpener, R. F. George 941,631
Perforating machine, L. W. G. Flynt 941,704
Phonograph attachment, H. A. Smith 941,546
Piano player, electropneumatic, A. R. Trist. 941,432
Piano tuning pin, Sack & Tyler 941,730
Pipe hanger support, R. A. Jenckes........ 941,714
Pistol, automatic, R. Wiles 941,749
Pitman box, C. M. Jennings 941,638
Plant pulling implement, W. H. Miller...... 941,644
Planter attachment, W. C. Reynolds........ 941,971
Planter, corn, A. J. Anderson............ 941,485
Planter, corn, G. M. Gorman 941,874
Planter, potato, W. A. Hall, Sr............ 941,449
Planter, seed, W. N. Jay 941,579
Planter shoe truck, Kilby & Kerr 941,421
Plate bar heating furnace, L. C. Steele..... 941,738
Plates and sheets, manufacture of, D. S. Brookman 941,854
Plates and sheets, manufacture of, S. A. Davis 941,861
Plow, E. M. Buckhannan 941,614
Plow, disk, Sholar & Pace 941,817
Plow fender, double shovel, Fairs & Walker. 941,772
Plow points, automatic device for attaching and releasing, Logan & Barnett 941,933
Plow, reversible disk, E. H. Sholar 941,818
Plow, sulky, W. H. Lee 941,887
Plows, spreading attachment for, H. M. Jack 941,369
Pneumatic cleaner, S. Markstein 942,037
Pole, vehicle, C. B. Schleichter............ 941,386
Power operated machine, safety trip device for, C. F. Pfalzgraf 941,726
Primary battery, C. E. Hite............ 941,366
Printing and folding machines and the like, automatic sheet feeder for, H. Hollings 942,036
Printing in colors, J. R. Brown 941,670
Printing machine, combined perfecting or two-clor, H. A. W. Wood............ 941,598
Printing press sheet feeding apparatus, C. Hermann 941,778
Projection apparatus attachment, W. J. Ashley 941,752
Pulp shaping machine, A. Komp 941,884
Pump, A. W. Schramm............ 941,958
Pump, centrifugal, D. V. Burrell.......... 941,557
Pumping or forcing mechanism, air, H. Harsant 941,450
Puzzle for the blind, raised, M. A. Houghton 941,680
Rail fastener, G. M. Cote 941,697
Rail fastening device, J. E. Hanique...... 941,575
Rail joint, M. Thorson 941,473
Rail joints, splice bar for, W. P. & S. G. Thomson 941,472
Rail tie, Churchill & O'Neill............ 941,913
Railway and rail support therefor, W. L. Remer 942,032
Railway joint, G. W. Amos 941,604
Railway rail, S. W. Lyman 941,580
Railway rail brace, E. J. Anthony........ 941,693
Railway rail locking mechanism, E. J. Anthony 941,692
Railway switch device, G. R. Johnson...... 941,522
Railway switches, manufacture of slide plates for, R. J. Davidson............ 941,623
Ratchet drill, G. W. Figg 941,916
Razor blade clamp, A. H. Fleming........ 941,566
Reamer, A. E. Church 941,912
Refrigerating apparatus, W. W. Seay...... 941,733
Refrigeration, process, W. W. Seay........ 941,734
Register or ventilator, E. D. House...... 941,367
Register or ventilator, H. S. Hart........ 941,413
Relay, T. W. Gleeson 941,709
Relay, Corwin & Bals............ 941,761
Rheostat, G. H. Dorgeloh 941,441
Ribbon reversing mechanism, automatic ink, R. E. Benner 941,554
Rifle practice, sand box for, H. P. Maxim.. 941,642
Ring clamp, F. C. Widman 941,832
Road and land leveling machine, W. Kaiser 941,929
Road and street construction, J. H. Amies. 941,548
Rock drill, internal combustion, L. L. Scott. 941,731, 941,732
Roller. See Land roller.
Rolling ribbed bars, T. W. Jenks 941,880
Rotary combustion engine, F. Fleming...... 941,567
Rule, P. F. Burns 941,492
Rule, G. A. Mongelli 941,936
Sad iron, C. W. Wodznski 942,026
Safe, revolving, J. S. McCormick............ 941,940
Sanding, abrading, or polishing machine, F. Schimmel 941,957
Sash, metal window, F. E. Duering........ 941,629
Saw, R. Hoe, Jr. 941,455
Saw, A. P. Fridstrom 941,705
Saw joiner and gage, C. C. Du Bose...... 941,981
Saw resawing machine, band, C. E. Cleveland 941,758
Scale, W. F. Stimpson 941,590
Scale, automatic weighing, M. E. Reisert... 941,588
Scale, weighing, A. H. Neureuther 941,725
Self-sealing can, J. F. Ross............ 941,729
Sewing machine power transmitter, A. B. Cohn 941,857
Shade hanger, window, B. F. Gindlesperger. 941,987
Shaker screen, vibrating, L. C. Dibert..... 941,862
Sharpening device, razor, W. H. Dunn..... 941,564
Sharpening machine, coal puncher, J. B. & W. W. Word 941,484
Sharpening razors and razor blades, device for, F. Myers 941,529
Shears, J. R. Seabright............ 942,043
Sheet metal supporting arm, R. W. Sweet. 941,591
Sheet metal working press, Norton & Krummel 941,866
Shell feeding machine, H. A. Stillwell...... 941,823
Shipping box, M. B. Claff............ 941,438
Ships' helms mechanism for indicating and recording the movements of, Russell & Jung 941,955
Shock absorber, H. C. Turner............ 941,594
Shoe tree, T. G. Redington 941,947
Shoe tree or form, W. H. Bayard 941,353
Shutter operator, A. Weber............ 941,899
Shutter releasing device, H. A. Tierney... 941,592
Siding, I. S. Conover 941,358
Sifter, ash, J. S. Brown 941,613
Sign for advertising purposes, etc., changeable, Chadbourne & Simpson.......... 941,695
Silo doors, interlocking lever for, W. A. Holnagel 941,679
Sinew extractor, G. A. Congdon 941,759
Skinning and cutting tool, Wallder & Ashton 941,829
Sliding gate, F. H. Doering 941,628
Slip indicator, G. A. Johnstone............ 941,418
Smoke preventive apparatus, I. M. Sullivan. 941,547
Sodium salt of lactalbumin, making a neutral, Fischer & Bergell 941,773
Solder, aluminum, J. Wirgovits............ 941,835
Sound records, production of double faced, F. L. Capps 941,975
Speed changing device, D. O. James...... 941,925
Speed indicator governor, A. Brossmann.. 941,516
Speed mechanism, change, C. B. Elmore. 941,506
Spike holder, H. O. Crippen............ 941,621
Spinning apparatus, transverse motion for yarn, A. E. Rhoades........ 941,648, to 941,650
Spinning machine speed changing device, McDevitt & Walton 941,645
Spokes, tenon forming machine for wheel, E. & E. E. Davis 941,625
Spool and twine holding device, H. Reicherter 941,949
Sprayer, portable, A. B. Morgan 941,528
Spring fabric, H. E. Gates 941,447
Spring fastener, F. Bowen............ 941,754
Spring wheel, C. W. Baeder............ 941,550
Sprinkler, J. W. Campbell 941,671
Stacker, pneumatic, P. Miller............ 941,583
Stacker, pneumatic straw, G. H. Bathrick. 941,606
Steam generator, J. C. Parker............ 941,462
Steam trap, J. W. Barton........ 941,846, 941,847
Steps, safety device for treads of, A. I. Davis 942,031
Stereopticon slide carrier, P. R. Hoy....... 941,712
Sterotype trimmer, C. W. Baeder 941,549
Stoker, G. Andersen 941,486
Stoker, locomotive mechanical, D. F. Crawford 941,698
Stop motion, twister, A. E. Rhoades........ 941,463
Stove, E. R. Cahoone 941,974
Stove, gas, S. H. Blodgett 941,908

(Concluded on page 459.)

Classified Advertisements

Advertising in this column is 75 cents a line. No less than four nor more than 10 lines accepted. Count seven words to the line. All orders must be accompanied by a remittance. Further information sent on request.

READ THIS COLUMN CAREFULLY,—You will find inquiries for certain classes of articles numbered in consecutive order. If you manufacture these goods write us at once and we will send you the name and address of the party desiring the information. There is no charge for this service. **In every case it is necessary to give the number of the inquiry.** Where manufacturers do not respond promptly the inquiry may be repeated.

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LOCAL REPRESENTATIVE WANTED.—Splendid income assured right man to act as our representative after learning our business thoroughly by mail. Former experience unnecessary. All we require is honesty, ability, ambition and willingness to learn a lucrative business. No soliciting or traveling. This is an exceptional opportunity for a man in your section to get into a big paying business without capital and become independent for life. Write at once for full particulars. Address E. R. Marden, Pres., The Nat'l Co-op. Real Estate Co., Suite 378, Marden Bldg., Washington, D. C.

Inquiry No. 8918.—For manufacturers of "Wydt's Electro-Catalytic Sparking Plug."

WANTED.—Machine to manufacture a special Safety Pin (all wire). I prefer to get it made by some company in quantity lots, or on royalty. For particulars, address J. H. Reed, Lancaster, Wis.

Inquiry No. 8987.—Wanted, the manufacturers of the Van Winkle Woods & Sons, and the Weber power meters.

WILL PURCHASE COMPANIES now in operation or furnish capital for promoting franchises for gas companies, trolley, water, electric light, or natural gas, patents or other good enterprises. For information, address P. L. Gallagher, Prudential Bldg., Newark, N. J.

Inquiry No. 8996.—Wanted addresses of manufacturers of machinery for working orange wood manicure sticks.

EDUCATIONAL.

CIVIL SERVICE EMPLOYEES are paid well for easy work; examinations of all kinds soon; expert advice, sample questions and Booklet 40 describing positions and telling easiest and quickest way to secure them free. Washington Civil Service School, Washington, D. C.

Inquiry No. 8990.—For information regarding shoes not made of leather but similar to the same and are as durable.

PATENTS FOR SALE.

FOR SALE. Patent No. 900,457. An improved lathe rest for holding cylinders while being bored in an engine lathe. For further particulars address A. E. Whiting, Weston, W. Va.

Inquiry No. 9014.—For manufacturers of machinery, supplies, etc., to equip a small plant for the manufacture of iridium-tipped gold nib making for fountain pens.

FOR OUTRIGHT SALE.—U. S. Patent No. 934,238. Canadian Patent No. 120,706 agricultural implement, that will revolutionize the present methods. Most important since the Binder. Effectively whips the soil from the roots of weeds, etc., and pulverizes the soil: hence better crops, no more weeds, and less labor. Actuated by motor power and applicable from smallest gardens to largest farms. Address Nathan Tripp, Sub Station No. 9, Grand Rapids, Mich.

Inquiry No. 9016.—Wanted, machinery necessary for an installation of a plant for refining salt by a modification of the Bessemer process.

FOR SALE.

FOR SALE.—Engine lathe, swings 9½ in., takes 25 in. between centers. Complete with full set change gears to cut all size threads, 3 to 40 in. Price only $43.50. Address L. F. Grammes & Sons, Allentown, Pa.

Inquiry No. 9023.—Wanted, to buy silk machines from re-reeling, twisting, doubling, to the final process of making it into clothes.

PARTNERS WANTED.

YOUNG, energetic electrician, German, wants a partner with sufficient capital, to cover expenses of patents and models in mechanical lines for my original inventions. Write T. Roman, 493 E. 168th St., New York City.

Inquiry No. 9025.—Wanted, address of rubber manufacturers in Germany.

AN INTEREST in Patent No. 855,032 will be given a responsible firm who will manufacture and place on the market a novelty, and an improvement on a staple article for which there is a large sale. Small amount of capital would probably be needed. Partner Box 773, N.Y.

Inquiry No. 9028.—Wanted, to buy a washing machine that is run by a coil spring motor.

LISTS OF MANUFACTURERS.

COMPLETE LISTS of manufacturers in all lines supplied at short notice at moderate rates. Small and special lists compiled to order at various prices. Estimates should be obtained in advance. Address Munn & Co., Inc., List Department, Box 773, New York.

Inquiry No. 9029.—Wanted, catalogues and all information on machinery for braiding straw in manufacturing straw hats.

A LIST OF 1,500 mining and consulting engineers on cards. A very valuable list for circularizing, etc. Price $15.00. Address Munn & Co., Inc., List Department, Box 773, New York.

Inquiry No. 9034.—For manufacturers of machinery that could reduce stumps to kindling wood.

Inquiry No. 9036.—Wanted, the address of the manufacturers of "Cycle Ball Bearing Suspenders."

Inquiry No. 9038.—Wanted, the address of the Chipman Electric Purifying Co.

Inquiry No. 9042.—Wanted the address of Farney Safety Razor Co.

Inquiry No. 9044.—Wanted to buy outfits necessary for agate polishing.

Inquiry No. 9046.—Wanted, machinery used for the manufacture of all kinds of fruit boxes, baskets and crates.

Inquiry No. 9047.—Wanted, the address of parties who install plants for making oxygen orozone gas.

Inquiry No. 9048.—Wanted, address of manufacturers of metal table slides for extension tables.

Inquiry No. 9049.—Wanted, to buy rotary brushes suitable for a shoe shining machine.

Inquiry No. 9050.—Wanted, to buy equipment for manufacturing starch and denatured alcohol from potatoes, also manufacturers of equipments for vegetable canneries.

Inquiry No. 9051.—Wanted, to buy machinery for extraction of cotton seed oil on a small scale.

Inquiry No. 9052.—Wanted, to buy machinery, etc., for a beer plant, that manufactures beer by means of glucose.

Inquiry No. 9053.—Wanted, address of firms who install plants to manufacture nitrogen.

Inquiry No. 9054.—Wanted, address of manufacturers of articles made from mica.

(Concluded from page 457.)

tending from Jackson Boulevard to Adams Street. The mail is thrown down chutes from the mailing platform to the platform of the subway, where the pouches are placed in the cars of the company and sent on to their destination. In the receiving of the mail at the Post Office, the pouches are unloaded from the cars onto a thirty-inch belt, which carries them up an incline to a point just below the driveway, where a cross-belt receives them and delivers them onto the mailing platform. For this work the tunnel company employs sixty-six electric motors and one hundred and fifteen cars. During the year 1907, the electric mail trains made 337,060 trips and carried 10,059,567 bags, pouches, and packages of mail, with a record of 99.51 per cent perfect as regards the time of delivery at the various tunnel stations. On the day before Christmas of that year, the tunnels handled over 50,000 bags, pouches, and packages, which were transported in 1,391 cars and in 1,229 trips.

It can be readily understood that a complicated transportation system such as this, involving an enormous number of cross-overs and switches, demanded for its safe and uninterrupted operation a very complete system of signaling. The method adopted is what is known as the Stolken train-signaling system, the invention of Mr. J. J. Stolt and Mr. W. J. C. Kenyon, the vice-president of the tunnel company. Limitations of space prevent any detailed description, but in brief the system may be described as one which does not employ track circuits, but which embodies two distinctive adaptations; first, the absolute protection of an intersection of two tracks, and secondly, the maintenance of a signal or alarm for a definite time after a circuit closer has been actuated. The method is automatic. For the protection of an intersection of tracks, on each of which there is traffic in only one direction, red signal lamps are employed, which are lighted by an approaching train. These lights are so placed that warning is given to a train on the other track and to any train which may be approaching from the rear. After the train has set the warning signals, it crosses the intersection, and as it passes on restores all the signals to the "clear" or no signal condition. In addition to the red lamps, a green lamp is provided on each track, which indicates to the motorman of an approaching train that his signals are working properly, and so gives him permission to go ahead.

Stove stand, gas, W. F. Krumsee 941,524
Stovepipe elbow, D. Witt 941,836
Street sweeper, Wurzer & Hartman 941,838
Sweeping apparatus, J. Cable 941,494
Switch handle, electric, J. G. Peterson 941,534
Switch keys, bank of locking, Corwin & Bals 941,763
Switch point lock, J. M. Shaul 941,735
Switch stand, C. Raiter 941,813
Switch stand, Reinoehl & Long 941,814
Switches, control of electrically operated, A. S. Cubitt 941,408
Synchronizing apparatus, P. Pierini 941,891
Syringe, J. W. Short 942,015
Tank, E. E. Straw 941,895
Target practice apparatus, coin controlled, H. H. Cummings 941,360
Telemeter for two successive observations, C. Pulfrich 941,812
Telephone connector, intermediate, Hearn & Fedejohann 941,519
Telephone, desk, Corwin & Bals 941,762
Telephone exchange system, C. L. Zahm 941,839
Telephone line selective switch device, J. H. Swanson 941,743
Telephone system, H. G. Webster 941,666
Telephone users, indicating coin holder for, E. F. Stone 941,824
Telephony and telegraphy, wireless, A. W. Sharman 942,044
Telpherage system, H. Miller 941,938
Tent, portable, A. F. Leach 941,458
Textile conditioning apparatus, I. E. Palmer 941,382
Textile stock, composition for dressing, E. Dath 941,361
Thermo electric generation, J. D. Taylor .. 941,826
Thermometer, oven, L. S. White 941,667
Tie. See Bag tie.
Tie and rail fastener, A. M. Moylan 941,937
Tiling machine, block, W. P. Meeker 941,792
Tire for vehicles, cushion, E. E. Euchenhofer 941,508
Tire, pneumatic, C. M. Gautier 941,871
Tire shoe manufacturing machine, pneumatic, W. C. State 941,962
Tire, spring, W. L. Johns 941,926
Tool handle, E. Zinn 941,901
Tool holder, C. Grunder 942,034
Tool, pneumatic, R. H. Wallace 941,748
Tool support for tools or tool holders, G. C. Barnes 941,845
Tools, protecting arrangement for rotary, P. G. C. Lundberg 941,427
Tooth regulating device, J. Aderer 941,840
Toy and game trap shooter, C. A. Evans 941,864
Toy flying machine, J. Stomberg 942,020
Toy, rolling, O. Prior 941,946
Trace hook, A. P. Hoard 941,520
Track construction, H. Ehman 941,674
Track lifter, R. B. Wakeley 941,476
Track, overhead, A. H. Neller 941,805
Trains, means for transferring passengers to and from moving, J. Ross 941,954
Transmission controller, C. E. Cox 941,407
Transmission mechanism, friction, J. Becker 941,402
Trolley catcher, C. I. Earll 941,363
Trolley retriever, C. Palm 941,944
Truck, car, C. B. Goodspeed 941,515
Truck, power, J. B. Heverling 941,677
Trunk, W. T. Fuller 941,446
Trunk harness, A. D. Williams 941,969
Tube, H. I. Van Nostrand 941,745
Tug or carrier, thill, W. R. Noggle 941,943
Turbine blade, Loud & Panter 941,375
Turbine blade holding means, C. Gilson 941,411
Turbine blading, J. E. Snyder 941,389
Turbine, compound, G. Meyersburg 941,794
Turbine controller, W. A. Loudon 941,426
Turbine, elastic fluid, G. Westinghouse 941,395
Turbine, elastic fluid, R. N. Ehrhart 941,409
Turbine, marine, G. Westinghouse 941,396
Turpentine cup, E. A. McKoy 941,724
Twine cutter, J. H. Keating 941,995
Twyer, injector, G. A. Williams 941,833
Type setting and casting machine, C. Koske, 941,931, 942,932
Typewriter cabinet, M. Foley 941,985
Typewriters, paper feed for, E. S. Mansfield. 941,889
Typograpic machines, keyboard mechanism of, H. Pearce 941,383
Umbrella, folding, J. Casale 941,615
Umbrellas and parasols, securing notches to sticks of, J. B. Riehl 941,952
Vacuum cleaner, I. L. Green 941,675, 941,676
Valve, W. C. Marsh 941,934
Valve, automatic air, J. P. Marsh 941,791
Valve, automatic antiscalding and mixing, F. L. White 941,596
Valve, dry pipe, H. G. Baker 941,971
Valve for steep tanks, J. F. Dornfeld 941,442
Valve gear for engines, T. Jolma 941,523
Valve mechanism for heating apparatus, J. L. Fitts 941,703
Valve replacing apparatus, E. W. Goodwin 941,873
Valve, safety, J. C. Watson 941,478
Valves and wash basins, bath tubs, or other receptacles, mechanism for operating the outlet, J. Miller 941,797
Vault, grave, S. Fry 941,986
Vehicle brake, W. T. Hinshaw 941,876
Vehicle construction, motor, E. Gruenfeldt .. 941,517
Vehicle cushioned wheel, W. J. Higman ... 941,453
Vehicle, foot propelled, N. R. Thibert 941,471
Vehicle propelling means, J. C. Leydorf 942,000
Vehicle seat, F. J. Elsner 941,893
Vehicle wheel, H. O. Clark 941,976
Vehicles, antislipping tread attachment for motor, M. Jensen 941,993
Vehicles, pilot light shifting attachment for, Hampton & Smith 941,574
Vending device, liquid, H. G. Cordley 941,760
Vending machine, food, I. O. Carlson 941,495
Vent cap, J. R. Williams 941,668
Ventilator and smoke consumer, combined, J. Wood 941,900
Vessels, determining positions of, R. A. Fessenden 941,565
Vise, fluid actuated, Sistek & Spinka 941,543
Voting machine, J. H. McElroy .. 941,800, 941,802
Voting machine interlocking mechanism, J. H. McElroy 941,801
Wagon side board attachment, Sanders & Rebman 941,956
Wainscoting, walls, and the like, composition of matter for the finishing coat on, G. Clapham 941,498
Wall covering, W. M. Stevenson 942,019
Washing machine, M. M. Hanson 941,989
Water closet and tank, J. W. Sharp, Jr. .. 941,539
Water heater, H. R. Churchill 941,618
Water heater, B. B. Kinkade 941,882
Water heating system, B. B. Kinkade 941,784
Water meter, H. I. Dilts 941,563
Water tube boiler, J. P. Sneddon 941,820
Water wheel, W. Van Sooter 941,474
Weigher, automatic grain, L. S. Godfrey ... 941,633
Well capping device, oil, F. M. Henning 941,452
Wells, apparatus for firing explosives in, L. H. Broadwater 941,852
Wheel. See Spring wheel.
Wheel, Bertrand & Portsche 941,753
Wheel, J. W. Meyer 942,005
Wheels, apparatus for treating wooden, J. J. Lipe 941,683
Wick burner, incandescent, J. Herzog 942,035
Wigs, parting foundation for, P. E. Tattoon 941,744
Windmill regulator, automatic, C. C. Peterson 941,647
Window pane fastener, D. D. Crouse 941,764
Wire and wire fabric stretcher, R. W. Sibley 942,016
Wire stretcher, J. Morehead 942,006
Wire working implement, C. J. Smith 942,017
Wrench, C. C. Swanson 941,431
Wrench, H. M. Gaines 941,707
Yoke, neck, C. R. Schleicher 941,387

A printed copy of the specification and drawing of any patent in the foregoing list, or any patent in print issued since 1863, will be furnished from this office for 10 cents, provided the name and number of the patent desired and the date be given. Address Munn & Co., Inc., 361 Broadway, New York.

Canadian patents may now be obtained by the inventors for any of the inventions named in the foregoing list. For terms and further particulars address Munn & Co., Inc., 361 Broadway, New York.

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Concrete Reinforcing

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Rio de Janeiro.

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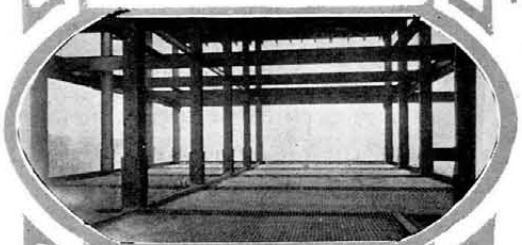

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A few reasons why

CLINTON ELECTRICALLY WELDED WIRE

is a superior concrete reinforcement

¶ It is constructed of high grade drawn steel wire. Such reinforcement is therefore a material of tested strength and quality.

¶ It is a strong, durable steel wire mesh, not formed by looping or twisting the wires but by electrically welding the transverse and longitudinal wires securely together.

¶ The welded connections are just as strong as the wires themselves.

¶ The perfect union between longitudinal and transverse wires provides an absolute barrier against movement of the fabric in the concrete. A perfect and inseparable bond of union with the concrete is thereby obtained; hence the wires cannot possibly slip in the concrete.

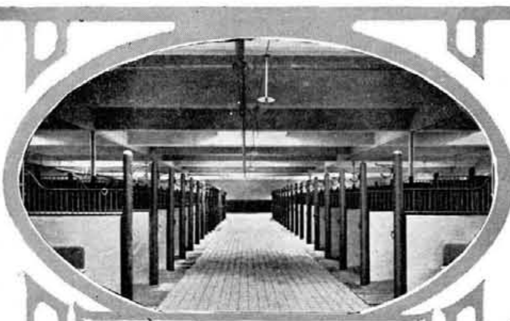
¶ The mesh is rectangular. Therefore all reinforcing is on direct lines of tension and the material naturally performs its duty in the simplest and most efficient manner. It does not have to do its work in a zigzag and complicated way.

¶ Being manufactured in rolls of any desired length, all that remains to be done, when it reaches the work, is to merely roll it over the forms, thereby providing a continuous, unbroken reinforcement extending from one end of the building to the other.

¶ Great quantities of material can be laid in a very short time, by the most unskilled labor, with the absolute assurance that every wire is securely held in its proper place.

¶ The spacing of the wires has been established accurately at the factory and the various reinforcing units cannot be knocked about and scattered all over the work.

¶ The great economy with which it may be laid and the absolute assurance of correct results make the material admirably adapted to all types of concrete construction. (*See illustrations.*)



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FIRST NATIONAL BANK BUILDING
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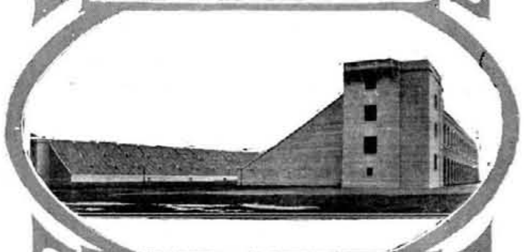

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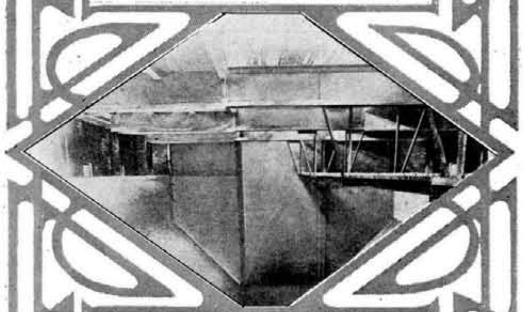
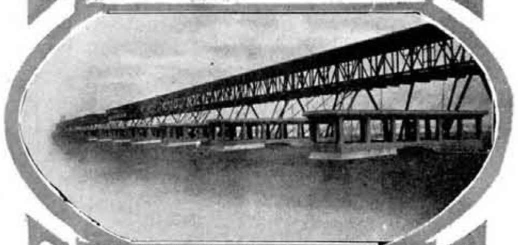


COAL POCKET
York Steamheating Company's Plant



ROOF AND CONVEYER GALLERY
HARBOR SHEDS
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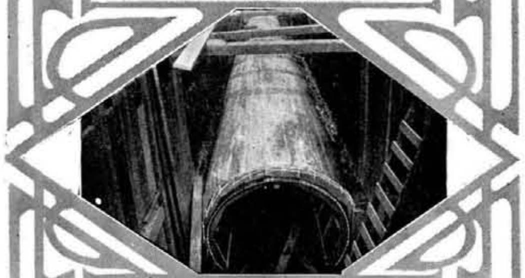

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