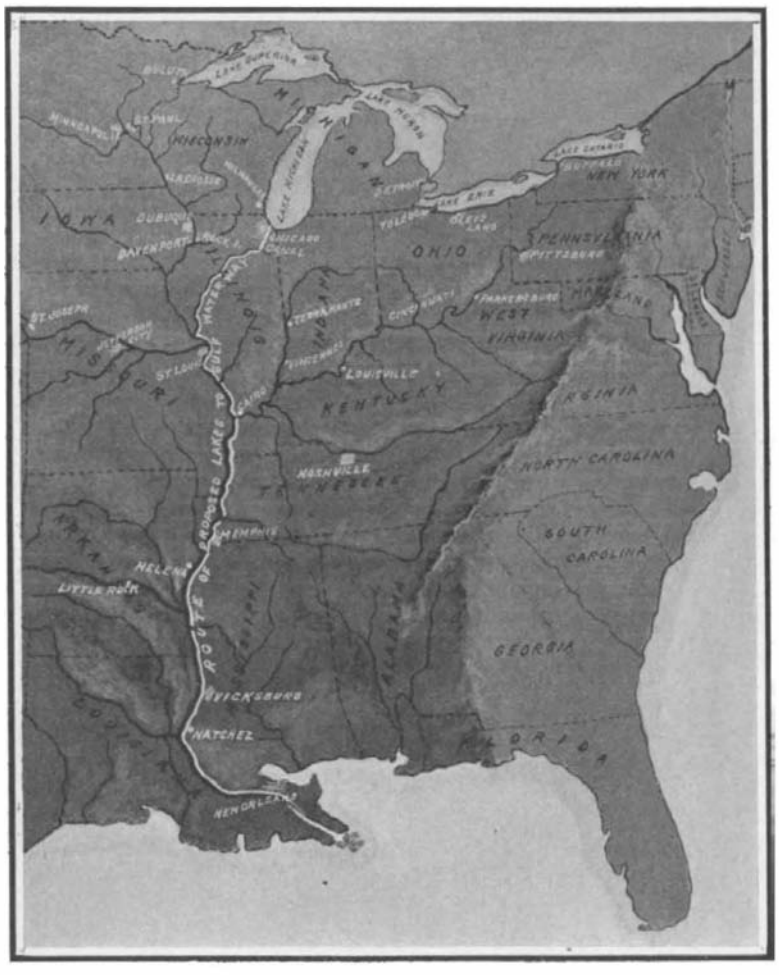
The Proposed Lakes-to-the-Gulf Deep Waterway.

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.

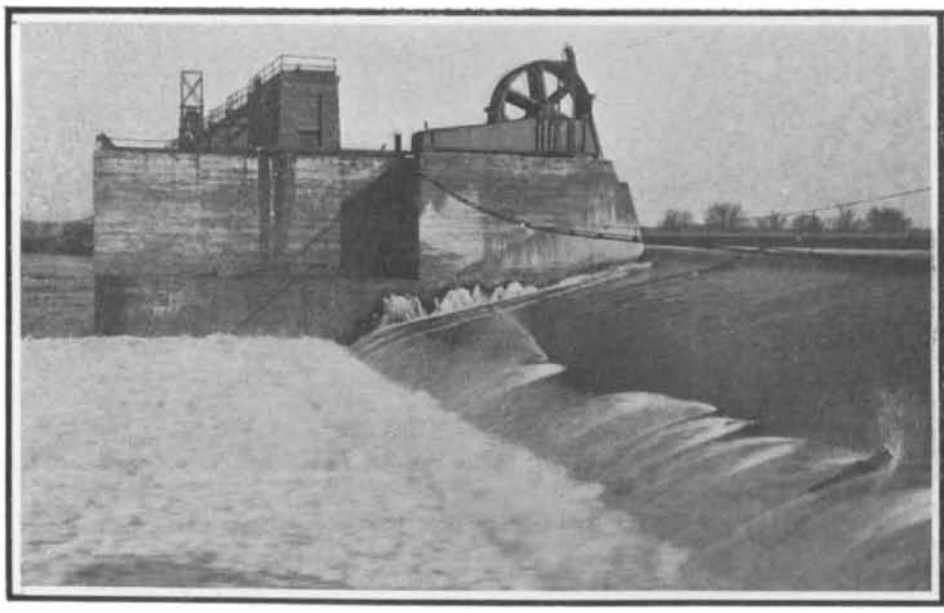


BIRD'S EYE VIEW, SHOWING THE VAST AREA OF COUNTRY TO BE SERVED BY THE GULF TO THE LAKES WATERWAY.

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.

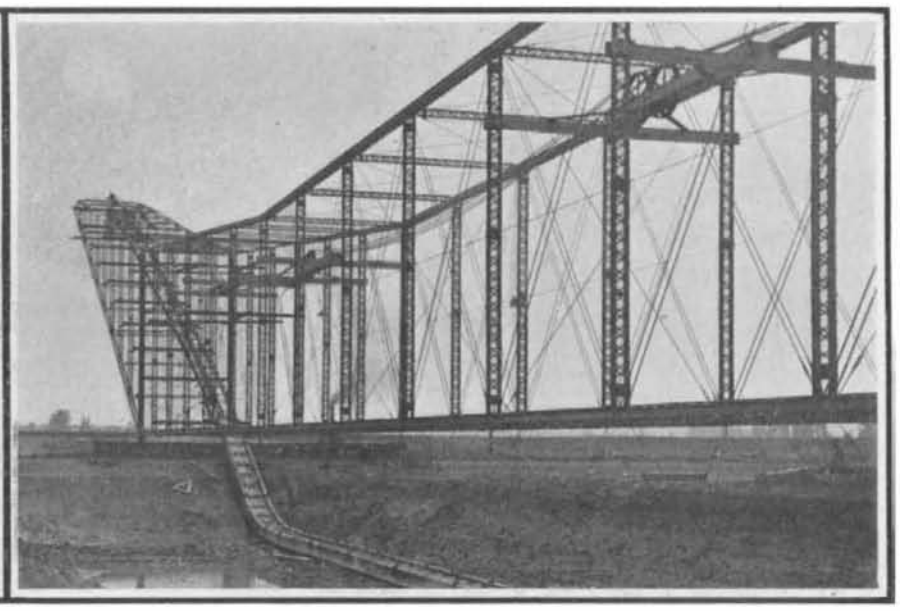
In the early days of the settlement and development of the Mississippi Valley, the transportation both of passengers and freight was dependent almost entirely on the river and its tributaries. With the advent of the steam railroad and the opening up of what had been known as the Great American Desert 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-

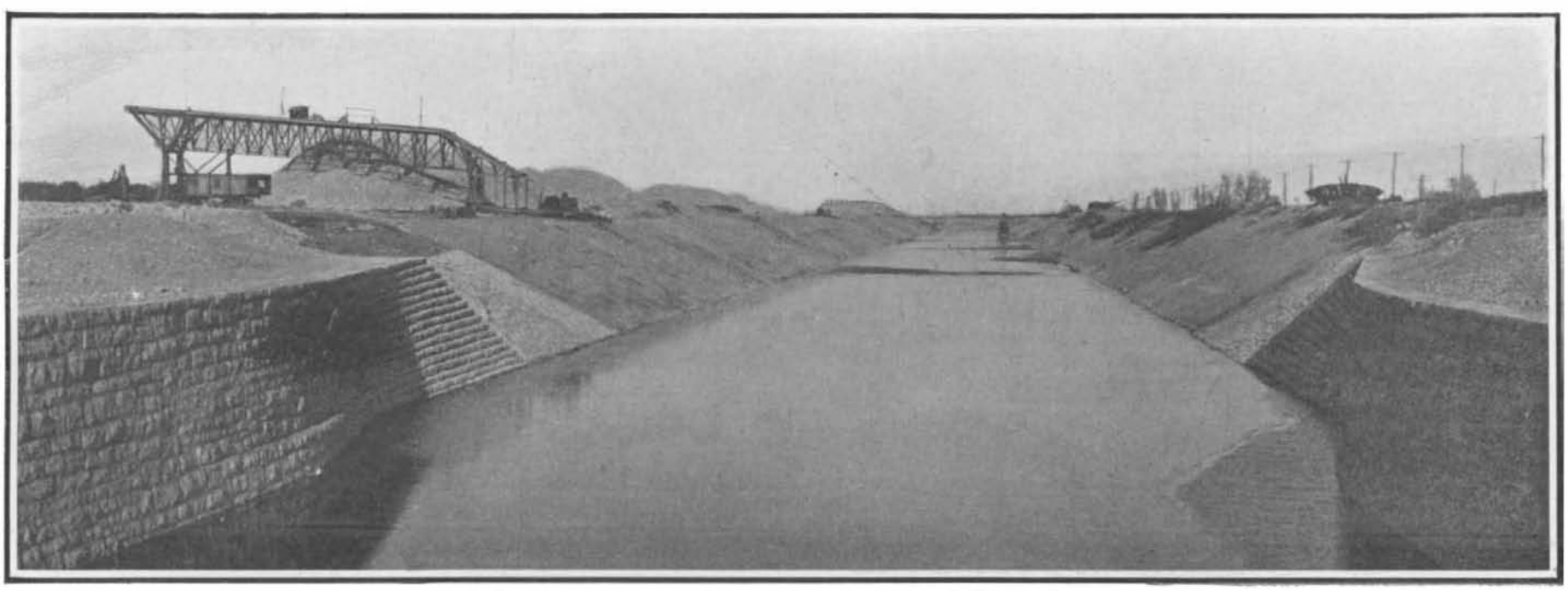


Bear-trap dam; downstream view.

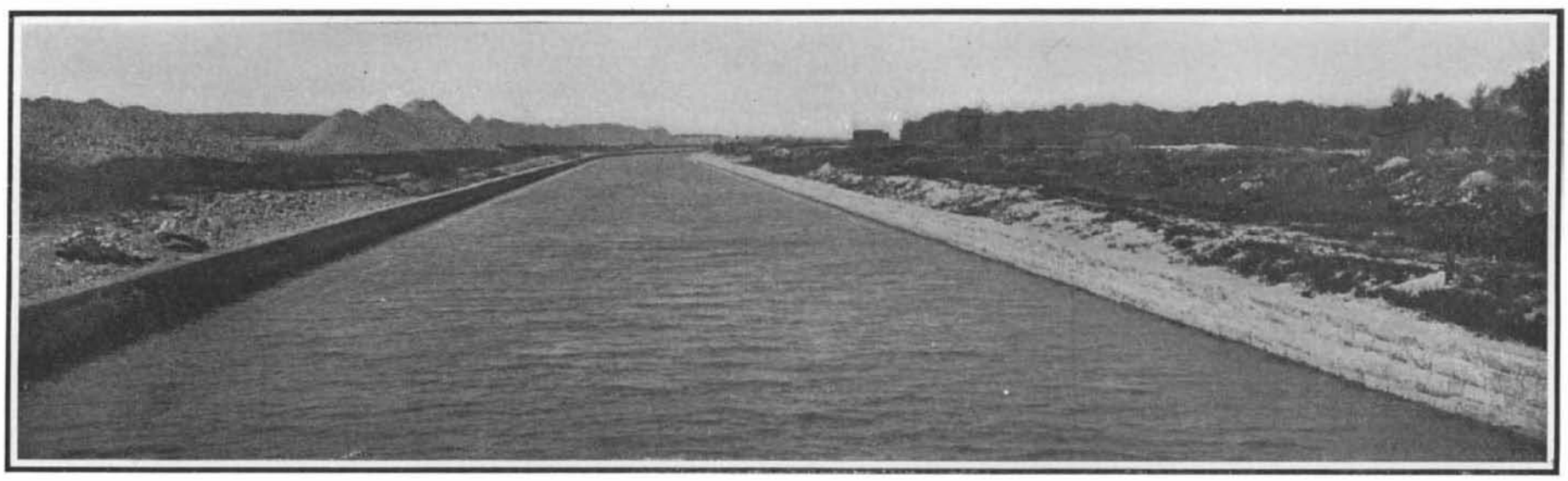
CONTROLLING WORKS OF DRAINAGE CANAL.



TYPICAL EXCAVATOR AT WORK ON DRAINAGE CANAL.



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



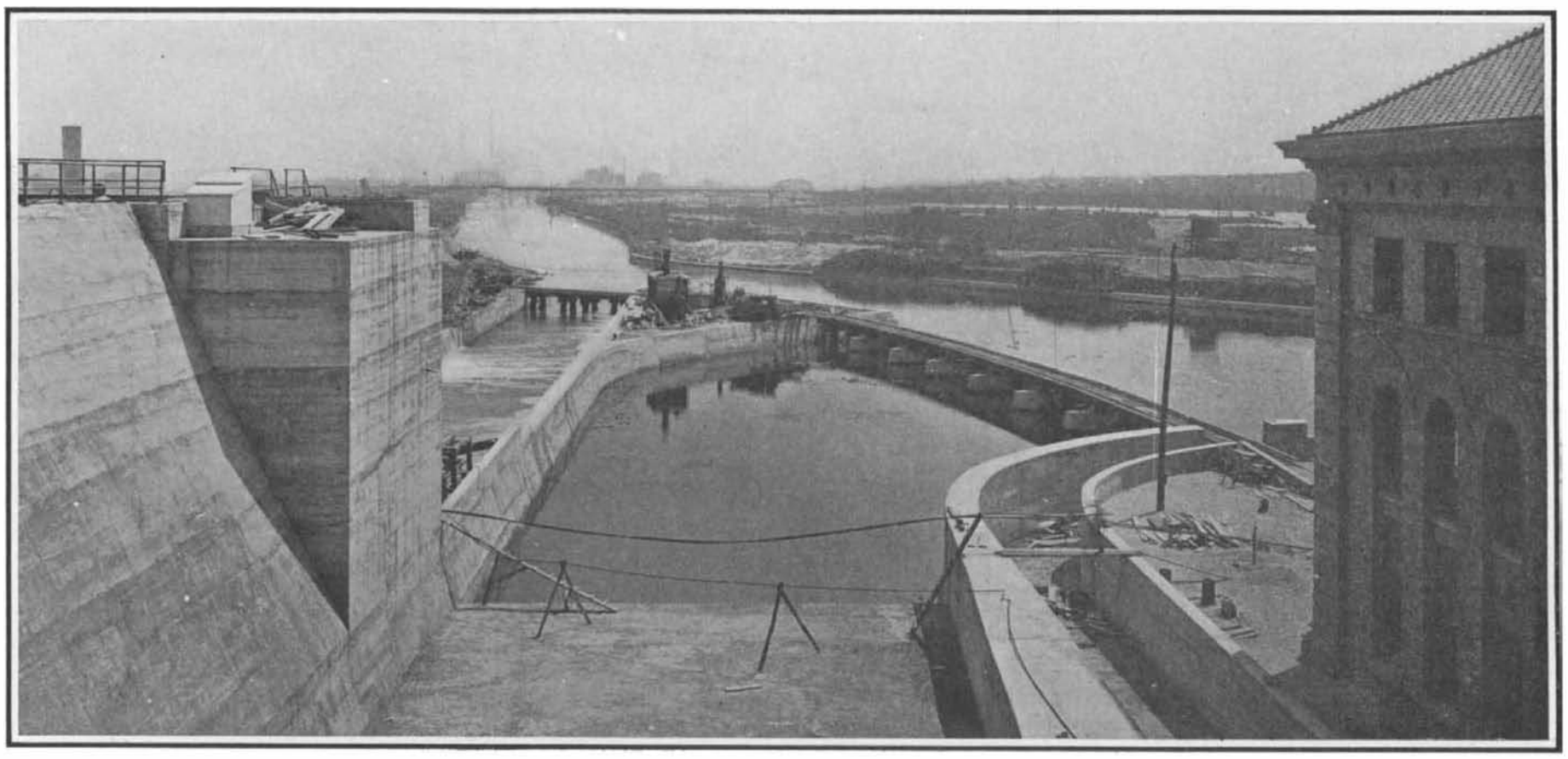
This great artificial channel, 22 feet deep, 110 to 202 feet wide, and 28 miles long, will form the first section of the Lakes-to-the Gulf waterway.

MAIN CHANNEL OF DRAINAGE CANAL, ROMEO CURVE IN DISTANCE.

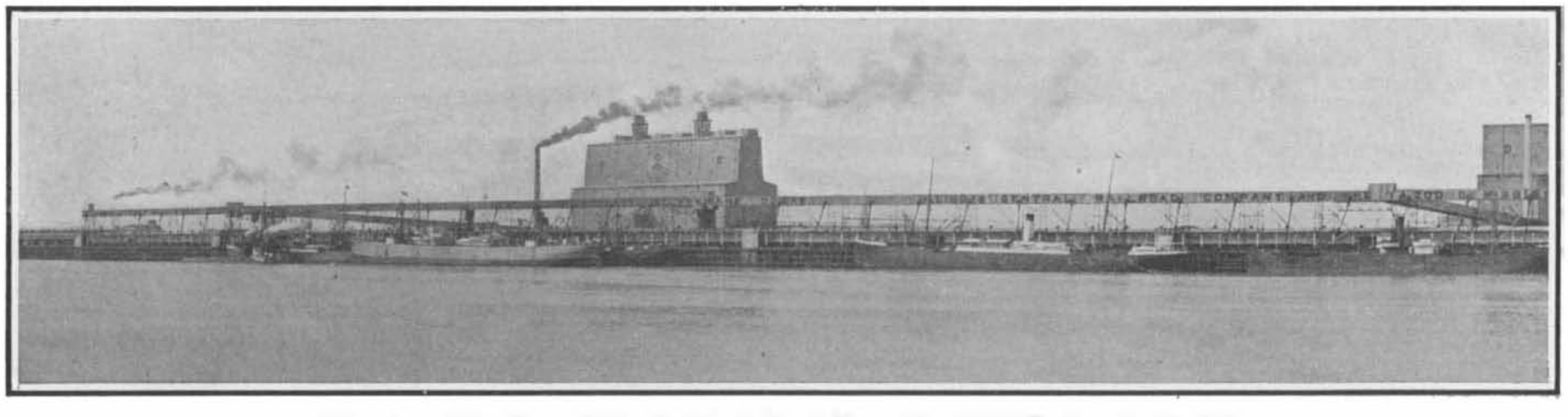
terial in shoals, that not only render navigation difficult and hazardous, but put a serious limit upon the size and character of the fleet of vessels employed. For many decades past, the United States government has maintained a low-water depth of between eight and nine feet from St. Louis to the Gulf. 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

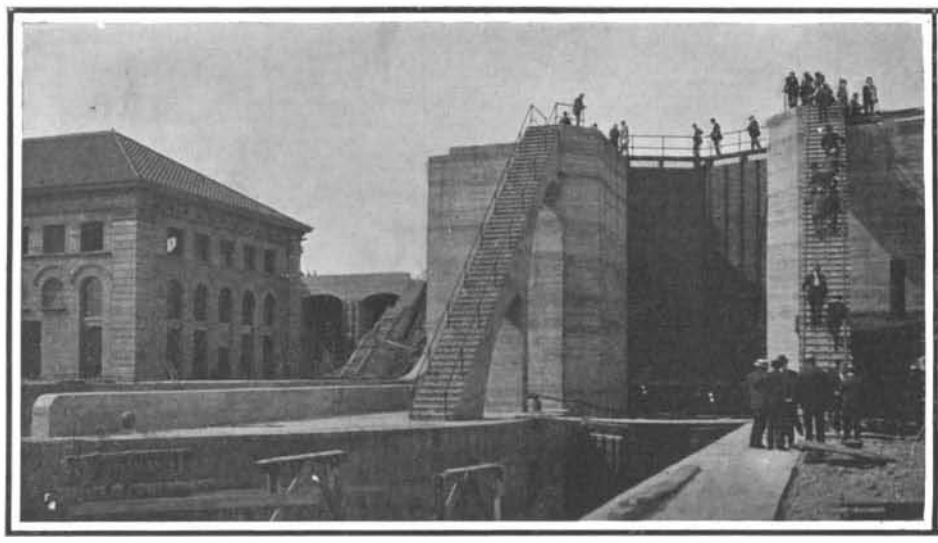


LOCK WALL; OVERFLOW FOR 48 AND 12-FOOT DAMS; TAIL RACE AND POWER HOUSE.

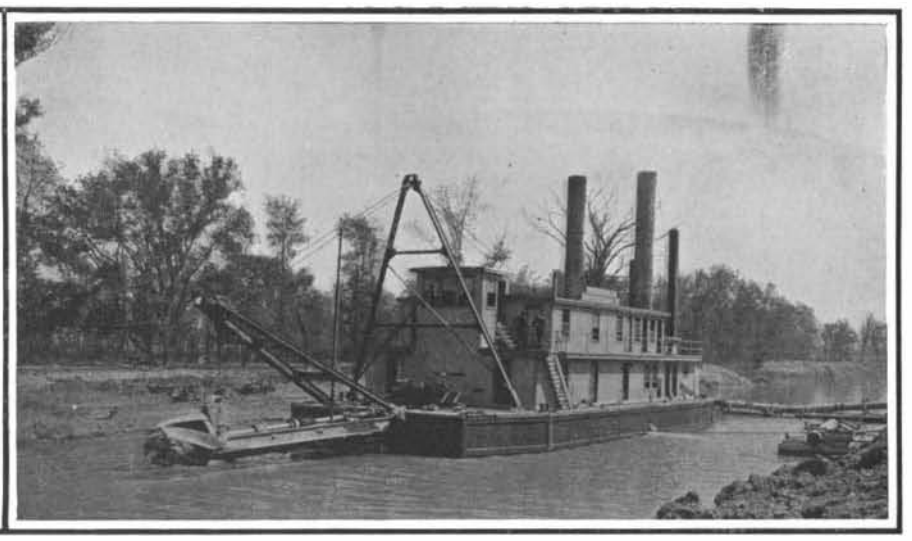


PANORAMIC VIEW OF A STRETCH OF THE WATER FRONT OF THE MISSISSIPPI AT NEW ORLEANS,

THE PROPOSED LAKES-TO-THE-GULF WATERWAY.



THE LOCK AND ONE END OF THE POWER HOUSE.

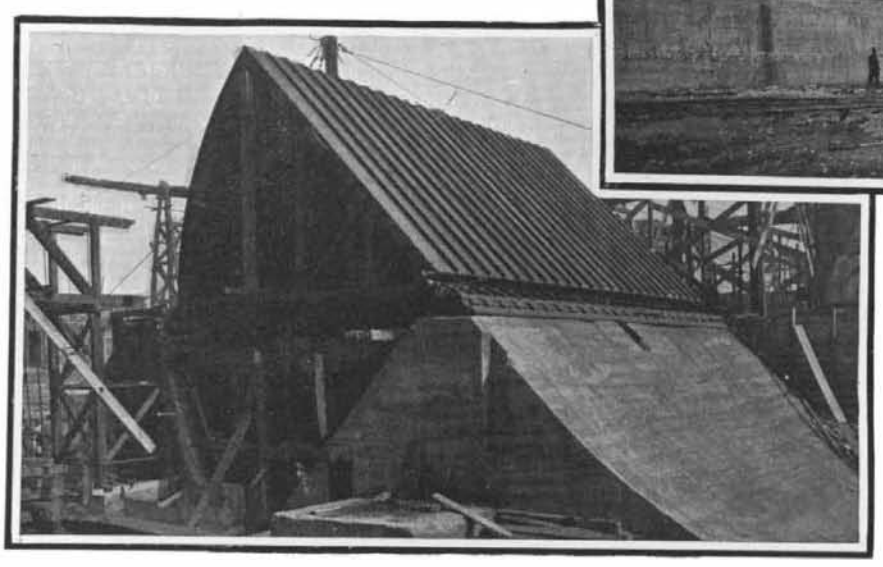


HYDRAULIC DREDGE EXCAVATING CHANNEL.

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.

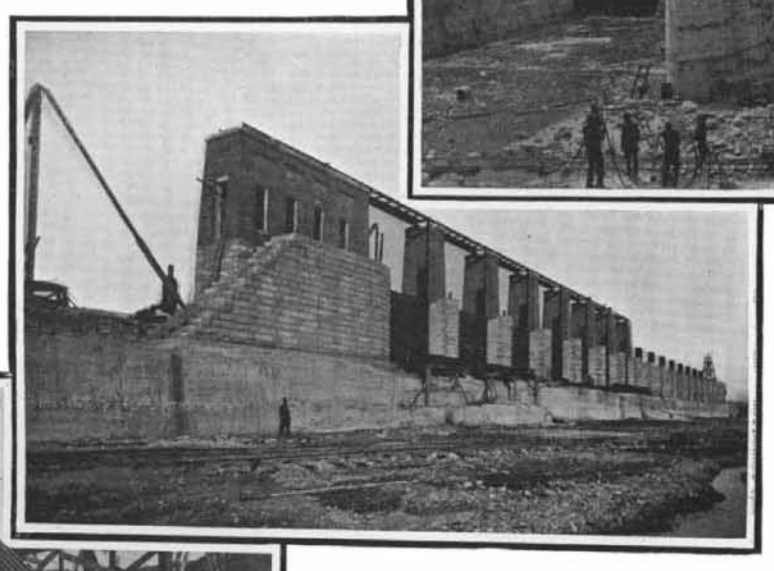
The legislation authorizing the development of the water power passing through the Chicago canal was secured in 1903, the scheme contemplating the extension of the main channel as a waterway and canal for four miles south from the controlling works. The power house, of which we present an illustration, 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.



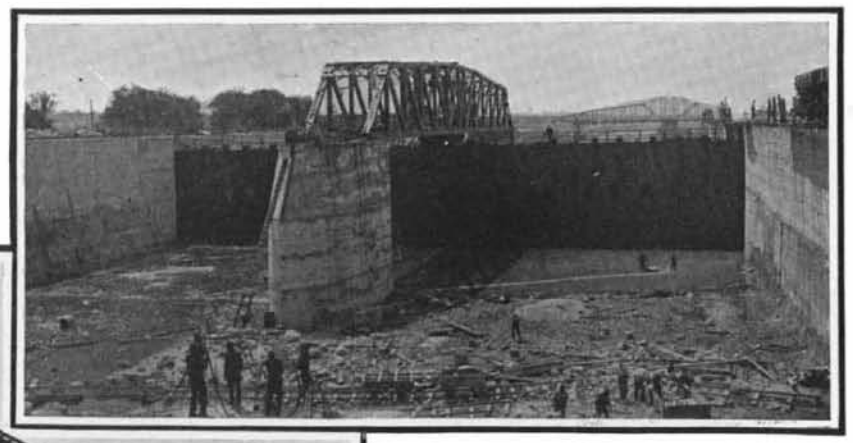
FORTY-EIGHT-FOOT SECTOR DAM AT POWER HOUSE.

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.



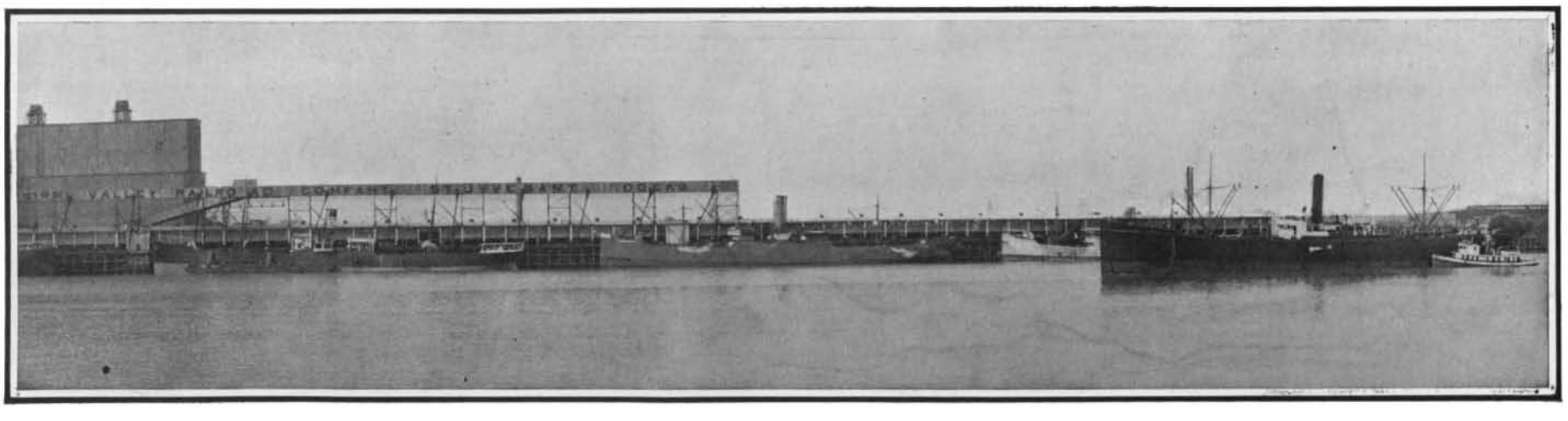
CONSTRUCTION OF STONEY GATES AT CONTROLLING WORKS.



UPSTREAM FACE BUTTERFLY DAM; CHANNEL EMPTY, DAM CLOSED.

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 × the riser + the tread = 24 to 25 inches.

For a ladder this gives a vertical distance between rungs of 1 foot, and the rule is based on the commonsense 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 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.

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	55	46	36
38	28	18	8	119	109	99	78	68	58	48
50	40	30	20	10	121	100	90	80	70	60

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.