THE NEW INLAND WATERWAY.

BY J. A. STEWART.

Few people are fully aware of the magnitude and far-reaching consequences of the colossal enterprise in which the city of Chicago has been engaged for the disposition of its sewage. By the new sanitary canal, now practically completed, and quietly opened on January 20, the inter-ocean metropolis will not only have a more effective sewerage plant but also a better drinking water supply. Furthermore, the far-seeing project involves the institution of a new inland waterway by which vessels of the twentieth century may sail from the Gulf of Mexico through the Mississippi to the Great Lakes.

The accomplishment of this immense undertaking was rendered possible by the peculiar geography of the Great Lakes. Lakes Michigan and Huron are practically on the same level, about 580 feet above the sea, while Lake Erie is only about eight feet lower. Lake Superior is an independent basin twenty feet higher. The basin of the lower three of the lakes is so delicately poised, that only four feet of rocks and two of gravel at Chicago prevents them from spilling over into the Mississippi valley at high water. The rock bottom of the Niagara where it leaves Lake Erie, according to Prof. Wright, is only thirty feet lower than the rock-shelf which forms the barrier west of Chicago. The canal will turn a portion of the water of the Great Lakes along an old glacial outlet into the Mississippi valley. Thus Chicago engineers are at great expenditure doing something for which Nature herself had to all appearance previously arranged.

Under the general direction of the trustees, elected by popular suffrage, the work has been successfully prosecuted. The general plan of the great canal is to connect the south branch of the Chicago River with the Desplaines River at Lockport, Ill., whence it will flow to the Mississippi, a total distance of 34·05 miles. It is not a canal with locks to regulate the flow of water, but an open channel, which has greater cross section dimensions than any of the world's great shipways. Where it cuts through the rock it is 160 feet wide, and in the earth sections it slopes from 110 to 200 feet at the bottom to from 200 to 300 feet at the top—a channel sufficient to float the commerce of the vast empire of the West. The ultimate capacity of this channel is to be not less than 10,000 cubic feet per second when the lake is at Chicago datum (the low water of 1847), which is 4·7 feet below the high water of 1838 as established at Milwaukee. The law permitted the channel to be developed through the earth sections on the basis of a capacity of 5,000 cubic feet per second, provided that the same is enlarged with the growth of population to the ultimate capacity of 10,000 cubic feet per second, which is sufficient in the view of the law to so dilute the sewage of 3,000,000 people as to maintain a sanitary condition throughout the channel and in the streams into which it is to discharge—the Desplaines and Illinois Rivers.

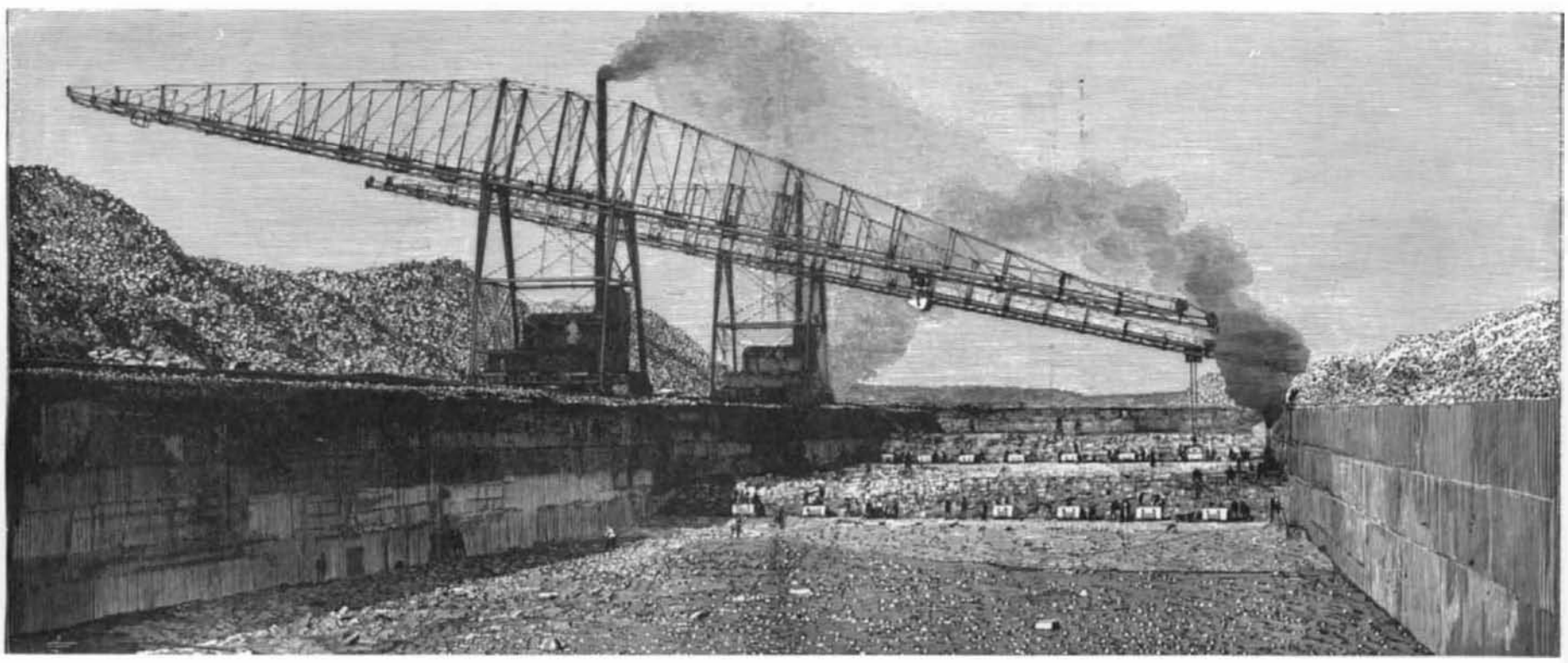
The work in the Chicago River has involved, first, dredging from the lake to Roby Street to a uniform depth (except over tunnels) of twenty feet below the flow line. Second, constructing between Monroe and Van Buren Streets a covered conduit or bypass through the lands of the Pennsylvania and Alton Railroad companies. This bypass has a section for flow of water fifty feet wide and sixteen feet deep. Third, removing two center pier bridges, one at Taylor Street and the other the railroad bridge just south of it, and building in their places bascule bridges of the rolling lift type. At Canal Street a bascule bridge is substituted for the "jack-knife" bridge. The river has been widened and redocked at various places. The result of these improvements is adequate provision for a flow of 300,000 cubic feet per minute.

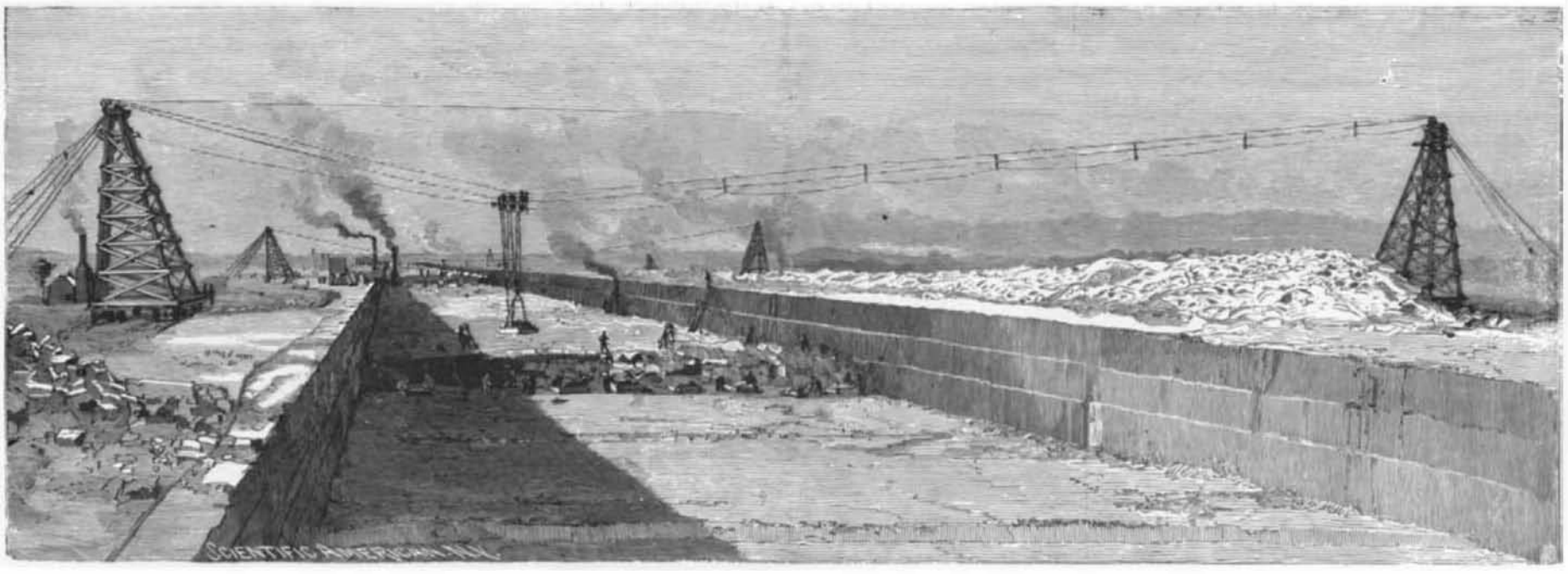
The distance from the mouth of the Chicago River to the junction of the main channel with the west fork of the south branch at Roby Street is 5·8 miles. The main channel begins at this point in the southwest quarter of the city and extends to the controlling works at Lockport, a distance of 28·05 miles. Beyond these works the water is to be discharged into the Desplaines River, down the declivity to and through the city of Joliet, a distance of 7·1 miles.

Earth was first broken on "Shovel Day," September 3, 1892, on the rock cut below Lemont. For 7·8 miles out from Chicago, the channel was constructed with a present capacity of 300,000 cubic feet per minute, the future enlargement being simply a matter of dredging through comparatively easy material. The 21 miles in the Desplaines valley is through glacial drift of the most difficult character and through rock, and this part of the work was carried out on the ultimate basis of capacity. The standard dimensions adopted were for 14·9 miles through the rock cut 160 feet wide at bottom and 162 feet at top with a grade of one foot in 20,000 feet, and in the earth and drift for a distance of 13·15 miles, 202 feet at bottom and 290 feet at the water line when the channel is carrying 22 feet of water, with a declivity of one foot in 40,000 feet, excepting, however, the 7·8 miles at the Chicago end previously mentioned, which were constructed with a width of 92 feet less than the standard earth section.

In order to accomplish the work, the upper Desplaines River, a stream of wide fluctuations and no reliable fountain supply, was given a new course and practically lifted out of its old bed, which was then used for the canal. This bit of engineering involved the construction of about thirteen miles of new river channel (the "river diversion" channel) and about nineteen miles of levee built to control the water of the Desplaines watershed. At the head of this river diversion it was necessary to provide a safety valve in the form of a spillway to allow surplus waters an outlet. This spillway is a concrete dam, 397 feet long, capped without stone, and its wings faced with stone masonry. No water flows over it until the volume passing the water gage above it reaches 300,000 cubic feet per minute. Its crest is 16·25 feet above Chicago datum.

The southern end of the main drainage channel at Lockport is enlarged so as to form a "windage basin" in which large vessels may be turned around. Here also are located the controlling works of gates or movable dams, by which the flow of water from the main channel into the tail race, which is to deliver the outflow into the lower Desplaines River, can be regu-





Cantilever Cranes and Hoisting and Conveying Cables at Work on Rock Cuts.

THE CHICAGO DRAINAGE CANAL IN COURSE OF CONSTRUCTION.

lated. At the controlling works provision had been made to meet the fluctuations in Lake Michigan within a range of five feet above datum and eight feet below, or an extreme oscillation of 13 feet. The fall from datum at the controlling works to the level of the upper basin is about 42 feet, in a distance of about four and one-third miles.

Seven sluice gates of metal, with the necessary masonry bulkheads and one beartrap dam, comprise the controlling works. The gates are the modified Stoney gate type, having a vertical play of 20 feet and openings of 30 feet each. The beartrap dam has an opening of 160 feet and an oscillation of 17 feet vertically. This dam is essentially two great metal leaves hinged together and working between masonry bulkheads. The downstream leaf is securely hinged to a very heavy foundation, and the upstream leaf is so placed as to present the barrier to the water. In operation, water is admitted through conduits controlled by valves beneath the two leaves. To raise the crest of the dam, water is admitted from the upstream side and the discharge shut off until the desired height is obtained, and then the valves are adjusted so that the volume of water beneath the leaves shall be constant. To lower the crest, the water beneath the leaves is drawn off until the desired height is reached, when the valves are again arranged to maintain a constant volume of water.

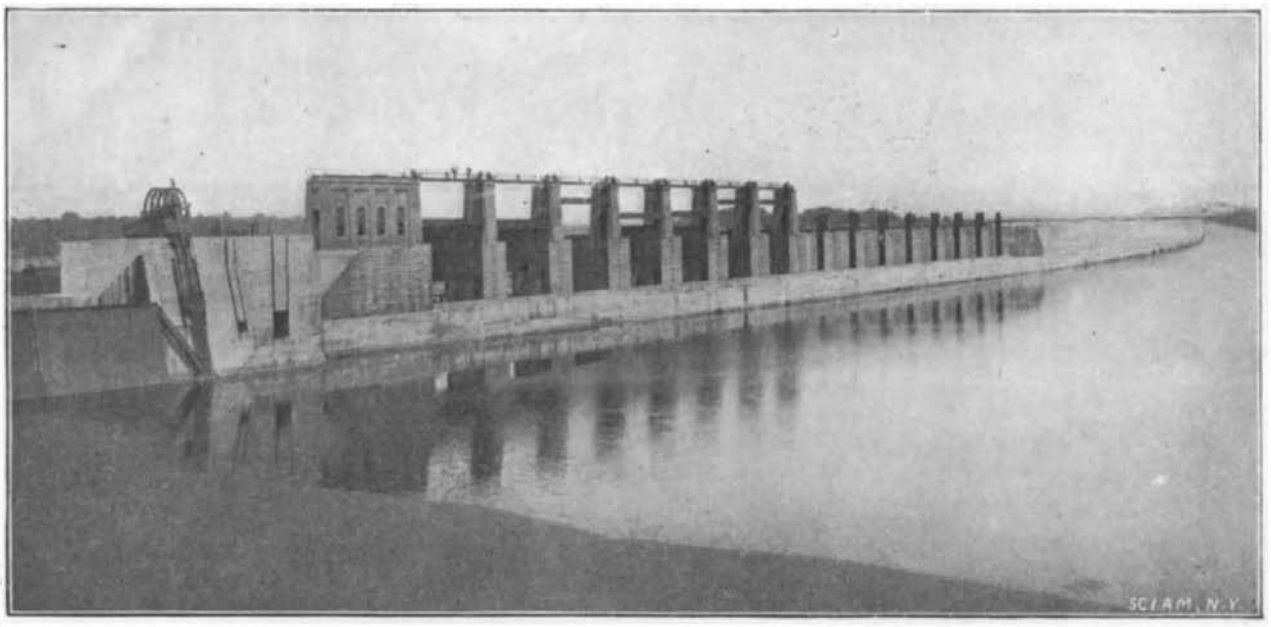
The lower Desplaines River below Lockport follows the trough of the valley down a steep declivity to the Illinois and Michigan Canal basin in Joliet. The work in this position consisted of straightening, widening and deepening the river to give it a flowage capacity of 1,500,000 cubic feet of water per minute. This involved, in the city of Joliet, the rebuilding of certain dams and locks and the removal of others in the canal; the construction of a massive concrete wall to separate the canal from the river; a great deal of costly excavation to admit of an extensive water power development which is the property of the State; and the substitution for smaller bridges of new ones of modern steel and greater span and width.

It is a noteworthy fact that all the bridges on the main drainage channel are movable structures. There are six for public highways and seven railroad bridges. The bridges on the walled and solid rock sections of the work are all "bobtailed," (or have arms of unequal length) counterweighted structures, with first piers on the right bank, and long arms spanning the entire channel, thus avoiding any obstruction to the flow from center and protection piers. These bridges are of the latest design, conforming to the heaviest modern specifications.

The total amount of excavation presents an interesting feature. The grand total reaches 43,478,659 cubic yards for both the drainage channel and the river diversion. The whole volume of the earth and rock excavated, it is claimed, if deposited in Lake Michigan in forty feet of water, would make an island one mile square, with its surface twelve feet above waterline.

For the method of work, various well-known devices were utilized, though no established precedent was followed. Some original methods were introduced by ingenious contractors. On certain earth sections, cars, especially constructed, were loaded by steam shovels and drawn up by steam hoists to a proper height where they ran on to a tipple and were automatically dumped. On other sections the contractors erected bridges spanning the banks, their supporting piers being carried on trucks which traveled on tracks parallel with the channel. An inclined track ran down from the bridge into the cut, up which were drawn the cars by steam hoists, after being loaded by steam shovels, to be automatically dumped and then returned to the pit. Hydraulic dredges were economically and effectively used on the old channel of the upper Desplaines, which was overlaid with muck to a considerable depth. The sides on the rock sections were cut down vertically by channel machines, steam drills being used which were worked by compressed air from a central power station. The top lifts were removed by the use of carts and tram cars, supplied with traction by steam hoisting engines. The lower lifts were removed by cable-ways, high power derricks and cantilever conveyers, the last proving the most perfect device for the purpose of hoisting and disposing of material, although the cableways did excellent service. The cantilever conveyer used was practically a bridge spanning the channel with cantilever arms projecting over the cut on each side. On this were mounted the necessary sprocket wheels and other machinery for carrying a series of steel pans which form the conveyer belt. The structure was 640 feet from end to end, and it was mounted on trucks traveling upon tracks parallel with the channel. Its capacity was 500 cubic yards per hour.

Financially, the realization of their sanitary device has involved a large expenditure for the people of Chicago. There has been expended to date on the construction $23,693,014.20, one million of which was for the river diversion, one-quarter of a million for the controlling works, and two and a half millions for bridges. In addition the right of way has cost over three millions; administration, more than two millions; and maintenance nearly one hundred thousand, making a total outlay, inclusive of three and a half millions for interest charges, of $33,525,691.20 to January 1, 1900.



CONTROLLING WORKS AT LOCKPORT, ILLINOIS.

Silicide and Bisulphide of Molybdenum.

The preparation of silicide of molybdenum has been the subject of a number of experiments made by M. Vigoroux, who has given an account of his results to the Academie des Sciences. M. Moissan had already shown that the molybdenum produced in his electric furnace combined directly with silicon. The experimenter continues the study of this combination. To produce it he takes the product obtained by the calcination of molybdate of ammonium, which is a mass containing variable proportions of the two oxides, Mo O_3 and Mo O_2; this is mixed with crystallized silicon. Thus, to 100 grammes silicon are added 250 grammes of the oxides, and the whole is heated in a carbon crucible introduced into the electric furnace, which works at a current of 1,000 amperes and 50 volts. During the heating the molybdenum liberated combines with the silicon, the larger part of the slag is volatilized, and after cooling there remains a mass which has a metallic appearance, its fracture indicating an abundance of crystals. These are separated by subjecting the mass to electrolytic action, it being used as the anode in a bath of dilute hydrochloric acid, the cathode being a plate of carbon. A weak current detaches the crystals, which fall to the bottom of the vessel. After treating alternately with aqua regia and potassium hydrate, the crystals are subjected to the action of hydrofluoric acid, then washed and dried. These crystals contain the silicides of molybdenum, iron and carbon. By means of tungstate of cadmium the silicide of carbon is removed, but it was not until after many trials that a product was obtained which was free from iron. The silicide of molybdenum thus obtained corresponds to the formula $Si_3 Mo_2$. Its properties are analogous to those of the silicide of tungsten previously obtained by the same experimenter. Thus, in chlorine gas it burns with incandescence near 300° C., forming tetrachloride of silicon and a black perchloride of molybdenum, which is deposited upon the glass.

Another preparation of molybdenum has been studied by M. Marcel Guichard, the bisulphide, which has not been previously obtained in any considerable quantity. After numerous experiments, two forms of the bisulphide were obtained, the crystalline and the amorphous. As to the crystalline form, Dr. Schelten, in 1889, obtained small quantities of microscopic crystals by melting carbonate of potassium with sulphur, and adding by degrees molybdic anhydride. Starting from this synthesis, the following process was employed: A mixture is made of 150 grammes carbonate of potassium, 310 grammes sulphur, and 200 grammes bioxide of molybdenum. This mixture is heated for half an hour to the maximum temperature of a Perrot gas furnace. After cooling, the mass, consisting of polysulphide and sulphomolybdate of potassium and bisulphide of molybdenum, is treated with water, which leaves undissolved the crystals of the bisulphide; the experimenter has thus obtained as much as 80 grammes. If for the bioxide of molybdenum is substituted molybdate of ammonia, the quantity obtained is less, but the sulphide is well crystallized, and specimens of one millimeter length, of hexagonal form, were found; these are of a grayish-blue color, resembling that of natural molybdenite. The amorphous form of the sulphide has been obtained by Scheele by the action of sulphur upon molybdic anhydride at a high temperature.

The experimenter has obtained a considerable quantity by the following process: With 50 grammes of crystallized molybdate of ammonium, finely powdered, are mixed 100 grammes sulphur, and the mixture is well packed into an earthen crucible, which is covered, and placed in a larger crucible, the interval being filled with lampblack. A white heat is maintained for one hour in the gas furnace. The sulphide thus produced contains still a small quantity of oxygen, as analysis shows. It is again mixed with its weight of sulphur, and re-heated as before. The bisulphide is thus obtained in a pure state, and it appears as a gray powder, the whole of the molybdenum having been transformed. As to its chemical properties, it is not acted upon by sulphur in the form of solution in chloride of sulphur in a sealed tube, and phosphorus is equally without action upon it. The experimenter has tried to obtain a sub-sulphide by a gradual reduction of the bisulphide by hydrogen, but finds that the reduction takes place with production of the metal, without passing by the sub-sulphide. It has been shown that natural molybdenite, which is a bisulphide nearly pure, loses its sulphur at the temperature of the electric arc, giving the metal. In studying this action upon the bisulphide, the experimenter finds that a new product, the sesquisulphide, is formed; this he intends to make the subject of a future communication.

Experiments of M. Becquerel.

M. E. Becquerel has presented at the last meeting of the Academie des Sciences an account of a new series of experiments which he has made upon the action of radio-active matter in a magnetic field. In the experiments previously described, the active matter contained a large proportion of the newly discovered element radium; in continuing his experiments with matter containing the other new element, polonium, discovered by M. and Madame Curie, which possesses properties analogous to the former, he finds that the action is entirely different; the radiations from this body, while showing in other respects nearly the same activity as those of radium, are not appreciably affected by the magnetic field. M. Becquerel shows this conclusively in the following experiment. The preparation of polonium is placed between the poles of an electro-magnet whose intensity equals 4,000, then 10,000 c. g. s. units; above this, at distances varying from 2 to 10 millimeters, a photographic plate was disposed horizontally. This plate was not enveloped in black paper, as in the case of radium, as the rays from this body are absorbed to a considerable degree; the operation was therefore carried out in the dark. Under these conditions, after some minutes' exposure an impression is obtained upon the plate which is symmetrical with relation to the radiant source, and this impression is the same, whether the magnet is excited or not. If the preparation of radium is then substituted under the same conditions, an impression is obtained upon the plate which, under the influence of the magnetic field, is thrown over to one side as in the previous experiments. It thus appears that the radiations emitted by polonium are not influenced in the same manner as those of radium. It has been observed also that these rays are very unequally absorbed by different substances. To these observations should be added those made by M. and Mme. Curie upon the compounds of uranium, which are found to be unaffected by the magnetic field.

At a recent congress of Russian railway officials, it was decided, says The Railway Review, that there should be erected at various places hospital stations and baths, and that in some regions bathing cars should be run, as is now done along the Siberian Railway.