ant still is the certainty that these new monsters, if fully loaded, will draw more water than is at present to be found in many spots.

Much thought has been given to this subject of late, and it has resulted in an entire revision of opinion. Heretofore the accepted policy has contemplated a deepening of channels by dredging, and millions of dollars have been expended in the work. Now comes the deep waterways commission—a body appointed by Congress several years ago—and declares for a great dam in the Niagara River. The commission makes the assertion that the expenditure of a million dollars for this dam will raise the level of Lake Erie three feet, Lake St. Clair two feet, and Lake Huron one foot. The practicability of the scheme seems to have been fully demonstrated, and a great effort is to be made to induce the next Congress to authorize it.

Even with these two main issues disposed of, other problems come crowding thick and fast. The plan of the railroads to bridge the Detroit River, at Detroit, which has been fought by the shipping interests for years, will soon come up again. A private corporation wishes to divert some of the water of St. Mary's River for power purposes; and, finally, a project has been mapped out for the construction of a canal from Lake St. Clair to Lake Erie, in Canadian territory. Any of these enterprises might seriously endanger navigation interests, and probably the next two or three sessions of Congress will witness some fierce contests with the development of the fresh water marine as their text.

German Sugar Production, 1898-99.

According to a statement published in the Reichsanzeiger of August 12, the quantity of refined and manufactured sugar produced in Germany during the campaign year 1898-99 (August 1, 1898, to July 31, 1899) was 1,186,686 tons, as compared with 1,207,350 tons during the campaign 1897-98. The quantity of raw sugar produced was 1,515,526 tons in 1898-99, against 1,664,268 in the preceding sugar campaign. The quantity of raw beets used in sugar manufacture is stated to have been 12,144,291 tons in 1898-99, and 13,697,891 tons in 1897-98.

AN AUTOMATIC HOOP AND BASKET STRIP CUTTING MACHINE.

The accompanying engraving represents a new automatic machine for cutting hoop and basket strips, which has been designed by the Defiance Machine Works, of Defiance, Ohio. The machine is arranged to prevent backlash and to reduce the noise of the rapidly moving cutter bar.

The machine is supported by a strong frame made of heavy cored sections of sufficient weight to prevent all vibration. Journaled in the frame is a main longitudinal shaft carrying fast and loose pulleys. On this main shaft beveled pinions are secured, meshing with bevel gear wheels, the shafts of which are transversely journaled in the frame. These transverse shafts are provided with eccentrics which support the ends of a sliding cutter bar.

When cutting strips of equal thickness the table is stationary, but when the strips or hoops are to be formed with a beveled side, the table is tilted, so that the blank stands at an angle to the descending cutter.

The table is formed of two transverse bars pivoted at their forward ends and provided with recesses in their sides, engaged by bolts on a link. The link is pivoted to a slide moving in a casing loosely hung on an auxiliary longitudinal shaft connected by gearing with the main shaft. Within each of the casings are cams on the auxiliary shaft. As the auxiliary shaft rotates, each cam raises its slide in order to swing the corresponding table bar into an inclined position for the knife to make a beveled cut. The cam is so formed that the blank on the table is alternately tilted during successive full strokes of the cutter bar, so that each alternate stroke causes the blank to receive a beveled cut.

The gearing connecting the main and auxiliary shafts is so arranged that the table automatically operates in exact time with the cutter.

In order to prevent backlash of the gearing and to diminish the noise, the cutter bar is provided at each end with a spring balance. The cutter bar on a down stroke moves against the tension of the springs so as to assist its return movement and to prevent backlash in the gearing. By using screw plugs attached to the ends of the springs, instead of the usual eyes or loops, the springs are rendered more durable.

THE Chicago City Council has passed an ordinance which provides for the establishment of a board of examining engineers, who will pass upon the qualifications of all applicants for a license to run an elevator. Prior to this action it was shown that most elevator accidents were due to incompetency on the part of the operator.

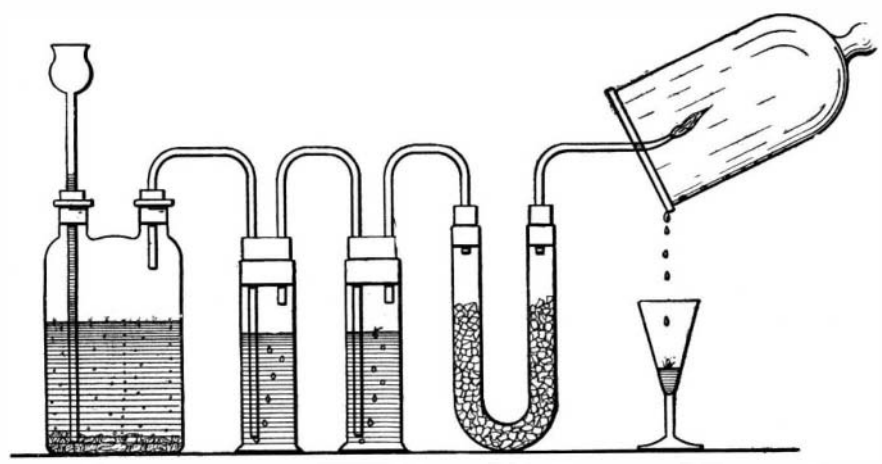


Fig. 1.—FORMATION OF WATER BY THE COMBUSTION OF HYDROGEN.

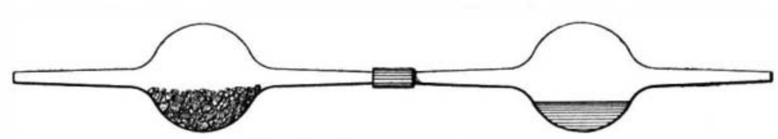
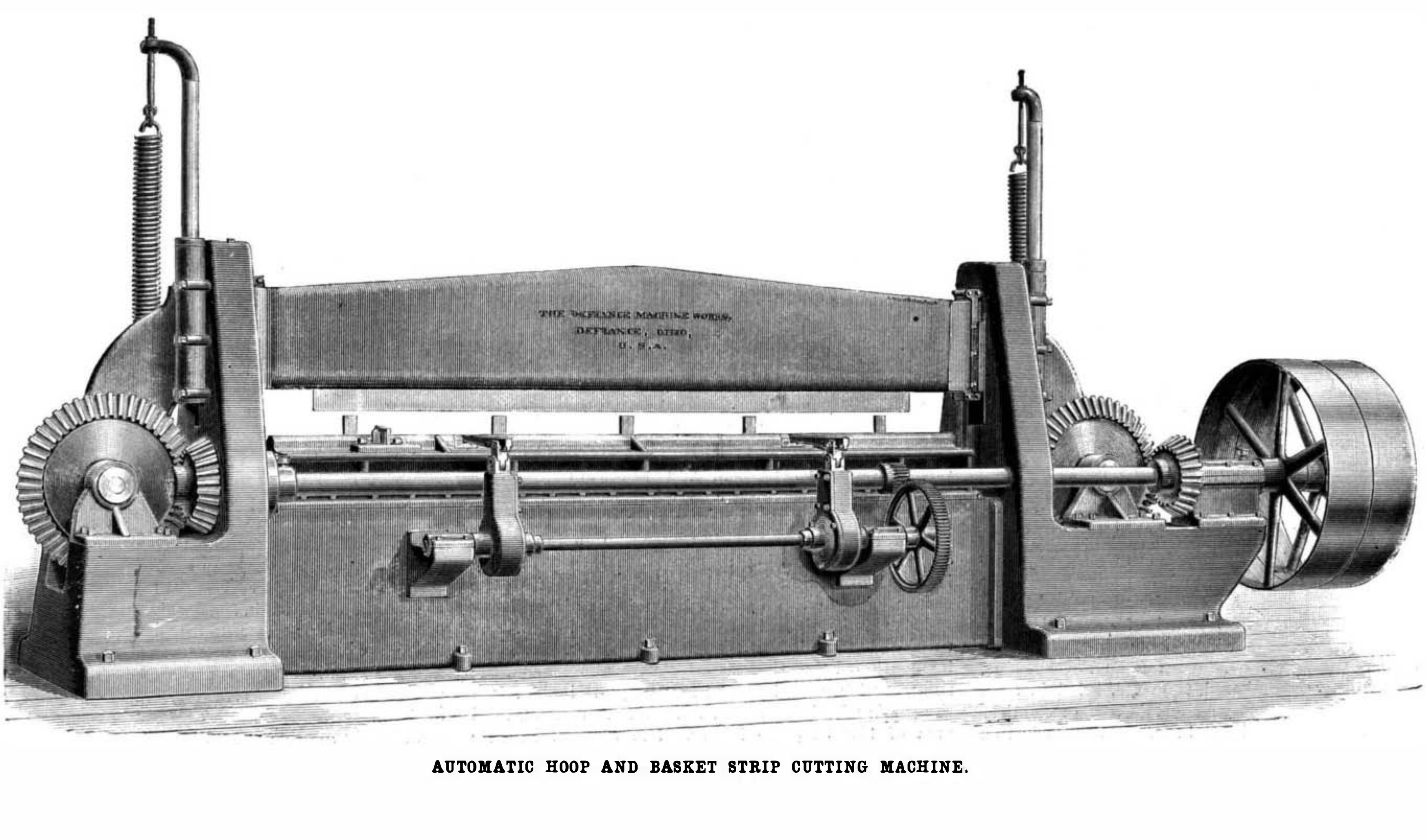


Fig. 2.—SIMPLE ARRANGEMENT FOR ROUGHLY CONDUCTING THE QUANTITATIVE SYNTHESIS OF WATER.

CASES OF "MYSTERIOUS" RUSTING.

BY N. MONROE HOPKINS.

The rusting of iron and steel is a familiar phenomenon to everyone, a source of great trouble and annoyance to those possessing fine instruments, tools, and machinery, and a factor in daily life of no mean economic importance. It is the purpose of this brief writing to point out to those who have not given attention to scientific chemistry the formation of water vapor by the combustion of gas, wood, or coal, and the condensation of the vapor to water when it comes in contact with cold masses of metal. An example will best make the matter clear, and throw light, perhaps, on many cases of apparently mysterious rustings. The writer was shown a screw-cutting lathe completely covered with a coat of rust, and asked to explain, if possible, the cause for the sudden change, and the source of water, when the tool had been in perfect condition ever since its installation, the polished steel work having been bright and apparently beautifully kept only forty-eight hours before. The building was perfectly dry, with no indications of moisture either inside or out, yet the lathe was so thoroughly oxidized that it presented the appearance of iron-work which had been exposed to a dense sea fog. Owing to the suddenness of the change, and to the fact that a number of other smaller tools which had always been in a well polished condition were also badly rusted, the source of water, and the case, seemed surrounded with mystery. It was learned by the writer that a gasoline furnace had been in prolonged use by some plumbers several days prior to the discovery of the rust for the purpose of melting pots of lead for making leaded joints. This furnace had been placed directly upon the floor, 10 or 15 feet from the lathe, with no chimney or other means of ventilation. The water vapor resultant from the combustion of the gas from the gasoline found a most approved condenser in the polished steel of the lathe, the surface of which it immediately converted into rust. As will be shown by the following experiments, water is a definite product of combustion, and should it prove necessary to burn gasoline, wood or charcoal, in the presence of polished steel, it should be protected with a cloth covering, or a coating of oil, and the products of combustion should, in addition, be led to a chimney, or other suitable exit to the atmosphere. Of course in some buildings where there is a good draught of air, the water vapor is less liable to collect, and condense. The writer has had valuable articles, such as large steel plates, badly rusted by leaving them in a badly ventilated room, with the city illuminating gas burning from the common gas fixtures. A couple of experiments on the formation of water by the combustion of gas in the atmosphere may prove of interest to those who have not had opportunity to have observed the synthesis of water in a chemical laboratory. The simplest experiment which any one may perform is to hold a thick, cold metal plate in the flame of a Bunsen burner, or alcohol lamp.



AUTOMATIC HOOP AND BASKET STRIP CUTTING MACHINE.

A coat of moisture forms in an instant, but it is not possible to obtain water in any quantity with this method, as the heat of the flame soon vaporizes the coat of moisture, and leaves the surface of the iron warm, and dry. The flame from a common gas burner will also deposit water, but in addition it will deposit carbon from the hydrocarbon in the city gas, and is consequently less suited to the experiment.

Fig. 1 illustrates an experiment designed to prove the formation of water by the combustion of a simple hydrogen flame in air. The large flask at the left is fitted with two necks as shown, one of which has a funnel tube for supplying dilute sulphuric acid, which falls upon zinc fragments in the bottom. The other neck is provided with a glass tube which siphons down, so to speak, in an upright jar filled with a solution of permanganate of potash for purifying the hydrogen liberated from the sulphuric acid. The second jar contains concentrated sulphuric acid for removing moisture from the gas, and the bent "U" tube fragments of calcium chloride, also for the purpose of removing any traces of moisture. The result of this arrangement is perfectly dry hydrogen gas at the bent outlet tube. Immediately upon pouring the dilute acid upon the zinc fragments, the hydrogen is liberated, and passes through the system. The jet should not be kindled for some few seconds, for fear of an explosion of the mixture of gas and air. A safe plan consists in filling a small test tube with the gas as it issues, and testing that. If it cracks, it indicates a mixture of air and gas. It it burns quietly, it may be used at once to light the jet with. Now, on holding a large, cold bell glass over the flame, the water vapor soon condenses, and falls in drops into a glass provided for the purpose. For a continued production of water, it will be found necessary to keep the bell jar cool from the outside, by cloths wet with ice water.

In order to illustrate the definite formation of water, two glass globes with necks should be employed, as illustrated in Fig. 2. The one at the left is partially filled with cupric oxide, and is attached by means of a short piece of rubber tubing to a similar empty globe. The bulb containing the cupric oxide is now attached to the little burner from the "U" tube by means of a rubber coupling, and the stream of hydrogen allowed to flow through the entire system. After a few moments the bulb containing the cupric oxide is heated by means of a Bunsen burner, or alcohol lamp, lightly at first, then strongly. The oxygen from the cupric oxide is liberated by the heating, and combines with the hydrogen which is passing through. Water is formed by this combination, which collects in the bulb at the right as indicated. In order to prove the definite composition of water by means of this experiment, it is only necessary to weigh the bulb containing the cupric oxide before and after the experiment, in order to ascertain the quantity of oxygen taken up by the hydrogen, and to weigh the second bulb empty and when containing the water resultant from the union. Knowing the weight of water, and the weight of oxygen, it is a most simple matter to calculate the quantity of hydrogen. On these general lines, it was calculated by the writer, using the data available regarding the gasoline furnace, that at least three pints of water had been formed, and evenly "sprinkled" over the polished, unprotected lathe.

NIAGARA FALLS HYDRAULIC POWER PLANT.

In the present number we conclude a series of articles on Niagara, the first of which, on "Niagara as an Industrial Center," appeared in our issue of May 27. On June 17 we illustrated the many handsome bridges which have been thrown across the Niagara gorge in the past fifty years, and on July 22 we gave a lengthy description of the 50,000 horse power electric plant of the Niagara Falls Power Company. In the first-named article it was shown that taking into account all the turbines that are at present in use, big and little, of the total theoretical horse power of 7,500,000 at the falls, only about 50,000 horse power is at present being developed and actually utilized, either as hydraulic or electrical power, for industrial and transportation purposes. This total, however, is constantly being increased, as the various additions which are being made to existing plants are brought into operation; and it will not be many months before the total amount of power developed will have increased by fifty per cent.

So much attention has been directed to the Niagara Falls Power Plant, with its present capacity of 40,000 horse power and actual output of from 20,000 to 30,000 horse power, that the public has not realized the size and rapidly growing importance of the Niagara Falls Hydraulic Power Plant, which has at present a capacity of 13,000 horse power, and has an enlargement under way which will increase its total capacity to 20,000 horse power. The method of developing the hydraulic power differs widely from that which has been employed with the Niagara Falls Power Plant, where, it will be remembered, the water is led in from the river above the falls by a short length of canal to the power house, and delivered through penstocks to a set of turbines which work under a head of 135 feet. The tailrace for the latter consists of a great tunnel with a fall of 50 feet in a length of 7,000 feet, and the water is finally discharged into the lower river at a point below the falls.

In the case of the Niagara Falls Hydraulic Power Plant, the water is taken from the river above the falls by an open canal and led to a point about a mile below the falls, where it passes through penstocks to turbines that are situated within a power house, which is built close to the water's edge at the bottom of the gorge, as shown in the two illustrations on the first page. The advantage of the latter system is that the effective head is considerably increased, the loss of the head in the tunnel being 50 feet and in the canal only 2 feet. By suitably constructing the tailrace, an additional head of several feet is secured below the turbines, with the result that the total effective head of the hydraulic power plant is 210 feet. The total length of the surface canal is 4,400 feet, its present width at the entrance is 250 feet, and in 400 feet the width narrows down to 70 feet. At this width it continues into a basin which is located about 300 feet back from the edge of the gorge above the power house. The basin runs parallel with the edge of the cliff and is about 400 feet long by 70 feet wide. The company owns sufficient right of way to increase the width of the canal to 100 feet, if it desires to do so. For 40 feet of the present width of the canal the channel is 14 feet deep, and for the remaining 30 feet it is 8 feet deep. The work of widening the canal is now in progress.

The power house is a substantial building of stone with a steel truss roof. Water is led down to the power house by means of two penstocks, one of which is 8 feet and the other 11 feet in diameter. The original section of the building was completed in 1896, and an 8-foot penstock serves to convey water to four Leffel turbines, of 2,250 horse power each, which operate eight generators, six of which supply power to the lower works of the Pittsburg Reduction Company, while the other two furnish power for the operation of the Niagara Falls and Lewiston Railway, better known as the "Great Gorge" route, illustrations of which will be found in the SCIENTIFIC AMERICAN of March 28, 1896. The operation of the original installation was so satisfactory that a large addition was immediately commenced, and the building was increased to the size shown in our illustration. It now measures 100 feet by 120 feet. The addition to the plant consists of five wheels of the Jonval-Geyelin type, each of 2,500 horse power. Our illustrations show one of the new wheels in place. These wheels are fed by a new 11-foot penstock, which has a capacity of 12,000 horse power. It leaves the forebay with an elliptical bell mouth which measures about 20 feet by 11 feet, and is carried out horizontally from the cliff, supported on two heavy steel beams for a distance of 60 feet, and then drops vertically nearly 200 feet to the power house. For about fifty feet of its length beneath the power house floor it is 13 feet in diameter, and, after passing beneath two of the wheels, its diameter is reduced to 7 feet, beyond which point it tapers off into a cone 18 inches in diameter, and finally ends in an air-chamber, which is 4 feet in diameter by 15 feet in height. The object of the air-chamber is to cushion the vertical movement of such a great mass of water and prevent injurious shocks to the machinery. The steel used in the construction of the penstock varies from a thickness of $\frac{5}{6}$ of an inch at the top to $1\frac{1}{8}$ inches at the bottom.

Above the horizontal portion of the penstock beneath the floor are carried a series of five 60-inch hydraulic valves which are placed horizontally and serve to conduct the water from the penstock up to the five turbines which are placed immediately above them. These valves, with their supporting girders, are shown in the lower illustration of our first page. The water flows through the valves to the turbines and is admitted by a gate to the guide-wheels, and through them to the runners. From the sides of the turbine the discharge pipes project laterally and then downwardly to connect with draught tubes 22 feet 8 inches in length, the use of which makes it possible to utilize in part the atmospheric pressure, and increase the effective head of the turbines accordingly. The turbine wheels are made of bronze, and they are located in the draught-tube casing, one on each side of the casing proper. The pair weighs 5.095 pounds. They are mounted upon a horizontal shaft and are directly connected to a general electric generator, which supplies current to the new chlorate of potash plant of the National Electrolytic Company, located on the top of the cliff.

A walking-beam, working over the main casing, operates the gate which is connected to the beam by $2\frac{1}{2}$-inch rods extending down through the glands into the casing. Above the walking-beam is an air cylinder 36 inches in height, with a diameter of $20\frac{1}{2}$ inches. The turbine is controlled by a Reynolds governor. It should be mentioned that there are thirty-four buckets on the runners with a total area of 140·25 square inches. On the guide-wheel there are twenty buckets with a total area of 149·53 square inches. The General Electric Company's generator is shown in our illustration. It has fourteen poles and runs at 257 revolutions per minute, giving an output of 5,000 amperes at 175 volts. This represents a capacity of 875 kilowatts or about 1,200 horse power. The current is carried to the chlorate of potash works on aluminium cables, the lower part of which is made in bar form and the upper part in the form of well insulated cables. The dynamo for the Buffalo and Niagara Falls Electric Light and Power Company is of 700 kilowatts output capacity at 2,200 volts pressure.

The completion of the five Jonval Geyelin turbines will raise the total horse power at this station to 20,000, but it is intended to build another 11-foot penstock and increase the total horse power of the plant to 30,000, which will be the maximum that can be developed from the present upper basin. Ultimately, however, it is intended to extend the basin along the cliff beyond the present factories of the small users of the company's water power, and carry down other penstocks to a new power house at the edge of the river. The company has sufficient room to install a total of 100,000 horse power, which is well within their grant of 125,000 horse power. The present capacity of the canal is about 40,000 horse power, but the company has a force of dredges which are continually at work enlarging and deepening it.

Visitors to Niagara will have noticed the cascades of water which fall from the side of the cliff in varying quantities in the immediate neighborhood of the company's power house. These streams are the tailraces of the various smaller factories which are built at the edge of the cliff, and take water from the company's basin behind them. The turbines operate under heads of from 60 to 100 feet In some cases they are sunk in wheel-pits and discharge through tunnels, while in others a cutting is made through the face of the cliff. The total hydraulic power thus developed is about 7,500.

This brings us to the close of a subject which we have treated at considerable length because we believe that there is a great demand for complete information upon a matter of such importance as the utilization of the energy of the falls.

Isolated statements of work done in this or that establishment at Niagara Falls have been published from time to time, but these are not sufficient to give such a comprehensive view of the subject as we have endeavored to set forth in these articles. While the work of developing this great source of hydraulic power has not gone forward with the rapidity which was popularly expected, it must at least be admitted that what has been done has been carried out on conservative lines and with such a measure of success as promises well for the future.

Trouble with a Cycle Path.

A cycle path in the upper part of New York State was opened to the public, and soon after complaints began to pour in from riders whose tires had been punctured on the new track. There was no reason why a perfect riding path should not be obtained. An inspection of the first two hundred yards of the path, where most of the punctures were caused, failed to reveal the cause of the difficulty. No amount of sweeping sufficed to clear away the obstruction. Finally, however, it was learned that the cinders for the first quarter of a mile of the path had been secured at a shoe factory and that there were tacks in the cinders. According to The American Exporter, the head of the factory, when learning the facts, offered to share with the county the expense of laying fresh cinders. Before this was done, however, one of the riders had a framework of wood made and fitted with rollers and a handle so that it could be operated like a carpet-sweeper, and then placed six large and powerful magnets in it. They were so arranged that they would almost scrape the ground when the machine was operated. This was run back and forth over the ground until the last piece of metal was removed from the path.

A Gigantic Megaphone.

An enormous megaphone has been erected at Faulkner's Island, Conn., on the government lighthouse reservation, for testing a new system of fog signals. The megaphone is 17 feet long and 7 feet in diameter at the mouth. Attached to it is a $1\frac{1}{2}$-inch steam siren. The whole contrivance is mounted on a circular platform 28 feet in diameter, so that it can be revolved to any point of the compass. Different signals may be made for each point of the compass. The object of the invention is to throw the sound waves in a certain direction to the exclusion of any other direction, so that any vessel approaching the signaling station in a fog shall hear only the sound which is given when the megaphone is pointed directly at it. That is to say, if the signal means north, the fog signal must be due north of the vessel, or those on the latter could not hear that particular signal. The instrument has been tested and it is found that the sound was heard 10 miles away when the observer was standing in a line with the axis of the megaphone, but nothing could be heard of the sounds sent to other points of the compass when at a distance of a mile or more from the instrument.