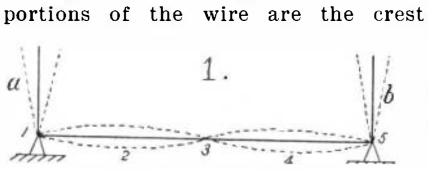
THE SLABY SYSTEM OF WAVE-SELECTIVE WIRELESS DUPLEX TELEGRAPHY.

Hertz found that a spark is capable of exciting an electrical disturbance in a straight wire, which disturbance is propagated in waves through space with the velocity of light, and that these electrical waves were capable of exciting electrical disturbances in other electrical conductors which they encounter. Since the brilliant discovery of Hertz, physicists have succeeded in augmenting these effects. The electrical disturbances set up in a wire by a spark from an induction coil and transmitted ethereally to a second parallel wire through a distance of one meter are such that a spark 5 centimeters in length can be obtained from the second wire. In the dark both wires would glow with equal intensity. Hertz discovered that these phenomena could be explained by physical laws. To the electrician was assigned merely the task of intensifying the phenomena.

The electrical phenomenon exhibited by the two parallel wires is oscillatory in character and is produced by an electrical tension alternating between its positive and negative maximum value some five million times in a single second. These alternations are not equally distributed along the length of the wire. The electrical effect increases toward the free end of the wire.

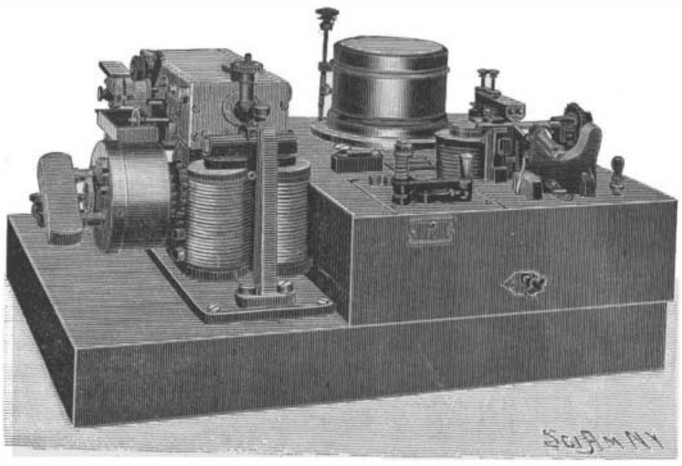
If a straight steel wire be screwed at one end in a threaded socket, and the free end vibrated, oscillations of a similar character will be produced. The amplitude of the waves is greatest at the free end. Exactly the same increase of amplitude occurs in the electrically excited wire. The transmission of the electrical disturbance by wave propagation can also be clearly explained by a mechanical analogue. If the steel wire be bent to form a right angle having equal legs, and if the angle be firmly clamped to a fixed object, the disturbances excited in one end of the wire will be transmitted to the other end. The fixed point is the node, and the more strongly excited portions of the wire are the crest of the wave. The motion set up in the second leg can be further transmitted. If a steel wire of six times the length of the free leg be twice bent so as to form two right angles, then at 2 and at 4 a loop will be formed, and at 3 a node. Through the fixed node, 5, the motion is transmitted to the vertical wire, *b*. Within a short time after *a* has been set in vibration *b* will begin to vibrate in unison. The transmission is effected by so-called stationary waves in the connecting steel wire. The entire length, including a wave-crest and a wave-valley, comprises a wave-length. The length of the freely-vibrating wire must be one-quarter of a wave-length—that is the underlying law of transmission. Similar conditions prevail in the electric wire. The electrical vibrations set up in the vertical wire, *a*, by means of a spark at its lower end, form a vibratory crest at the upper end of the wire, the frequency of which depends upon the length of the wire. These vibrations are propagated in the ether with the velocity of light in the form of waves, the lengths of which are exactly four times those of the electrically vibrating wire.



Vibration of a Steel Wire.

The second wire, *b*, placed at any distance from the first will be electrically oscillated by these waves, the oscillations being strongest if they correspond with the wave-frequency; that is, if the length of the wire be exactly one-quarter of the wave-length, and if the lower end be a node. Both conditions can always be attained; for the length can be varied at will, and the lower point can be made a node by connecting it with the earth.

A spark could hardly be obtained by contact with a metallic object, as in the previous example; for the electrical effect diminishes with the distance traversed. In order to detect this small electrical impulse, a coherer is employed, of the type used in most systems of wireless telegraphy. Evidently the coherer should be connected with that portion of the wire at which the alternations are greatest. It has hitherto been the custom to suspend the wire and to secure the coherer to its lower end, the other pole of the coherer being connected with the earth. It has been proven experimentally that the capacity of the coherer is so great that the lower end of the receiving-wire may be regarded as a node for the electrical oscillations of the wire. But since the effect is dependent upon the tension to which the coherer is subjected this arrangement, according to Prof. Slaby, is radically wrong. No means are provided for the utilization of the maximum tension to which the receiving wire is also subjected. The fairly good results which have been obtained with this arrangement are due only to the fact that the length of the receiving wire is not exactly equal to one-quarter the wave-length and that the transmitter sends forth incidental waves besides the main waves, so that the lower end of the receiving-wire may permit the formation of minor tensions.



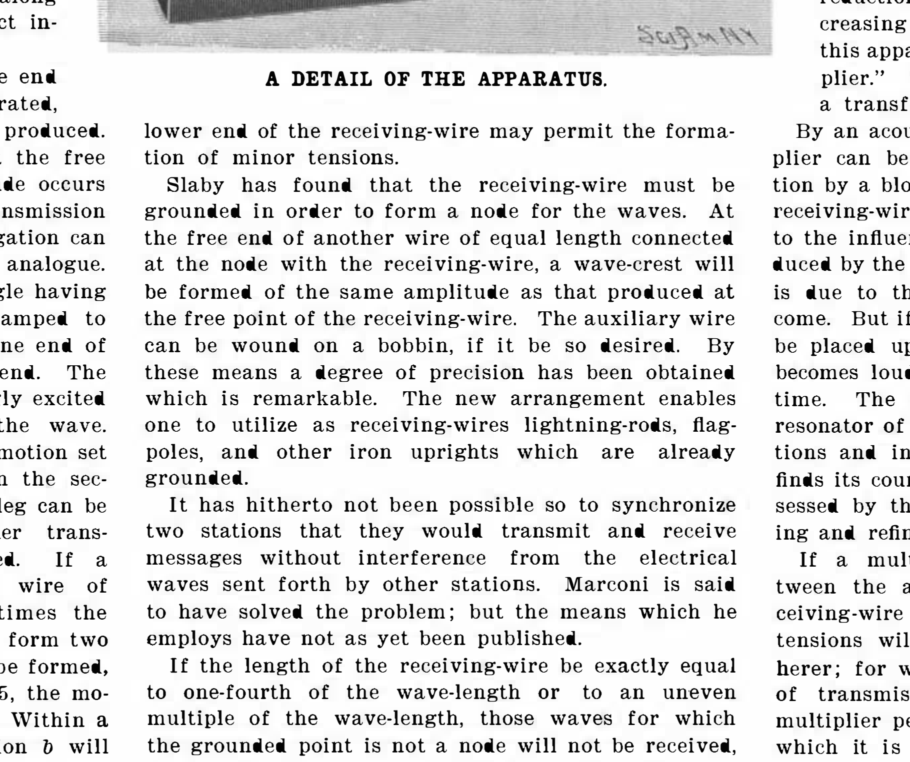
A DETAIL OF THE APPARATUS.

Slaby has found that the receiving-wire must be grounded in order to form a node for the waves. At the free end of another wire of equal length connected at the node with the receiving-wire, a wave-crest will be formed of the same amplitude as that produced at the free point of the receiving-wire. The auxiliary wire can be wound on a bobbin, if it be so desired. By these means a degree of precision has been obtained which is remarkable. The new arrangement enables one to utilize as receiving-wires lightning-rods, flagpoles, and other iron uprights which are already grounded.

It has hitherto not been possible so to synchronize two stations that they would transmit and receive messages without interference from the electrical waves sent forth by other stations. Marconi is said to have solved the problem; but the means which he employs have not as yet been published.

If the length of the receiving-wire be exactly equal to one-fourth of the wave-length or to an uneven multiple of the wave-length, those waves for which the grounded point is not a node will not be received, but will be conducted into the earth. In other words, the electrical waves are sifted, and only those are received which are of the proper length. In this manner Slaby transmits and receives messages in secret.

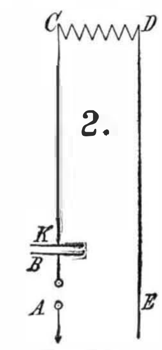
For those waves which are exactly four times as long as the receiving-wire, the ground-point is a node, even though minimum tensions may occur here. If the auxiliary wire be exactly as long as the receiving-wire, then all waves which have not the requisite length will pass through the node into the earth. But these waves can also be received and conducted to an auxiliary wire if the entire length of the receiving-wire (that is, the receiving-wire plus the auxiliary-wire) be made equal to one-half the wave-length. The earth-point is then no longer a true node for these waves, but permits their passage without much diminishing their effect. All other waves, however, are rejected as it were. If, for example, it be desired to receive at a lightning-rod 40 meters in height waves which are not $4 \times 40 = 160$ meters in length, but rather 200 meters in length, then the entire length of the receiving-wire must be 100 meters. In other words, we must add an auxiliary wire 40 meters in length to the lightning-rod. By this simple means it is possible to enable a station to receive waves of various lengths. It is necessary merely to provide a sufficient number of coils or bobbins of auxiliary wire and to set up receivers equal in number to those of the stations with which it is desired to communicate. For the filtering of the waves is so accurate that it is possible to receive several messages from different directions and distances with a single receiving apparatus.



A COMPLETE APPARATUS SHOWING THE MULTIPLIER, INTERRUPTER, RECEIVER, AND MORSE TRANSMITTER.

In order to obtain greater accuracy and to increase the effect of the electrical waves, Slaby employs a simple apparatus consisting of a coil of wire of a size and winding dependent upon the wave-length. The coil has the property of reducing the velocity of an electrical impulse. But such a reduction of velocity results in considerably increasing the tension, for which reason Slaby calls this apparatus, for lack of a better name, a "multiplier." This apparatus is not to be mistaken for a transformer; for it has no secondary winding.

By an acoustic analogue the operation of this multiplier can be explained. A tuning-fork set in vibration by a blow is acoustically oscillated exactly as the receiving-wire is electrically oscillated when subjected to the influence of ethereal waves. But the tone produced by the fork soon fades. This diminution of sound is due to the resistance which the fork must overcome. But if the vibrating tuning-fork be placed upon a resonator, the tone becomes louder and lasts for a longer time. The property possessed by a resonator of sustaining acoustic vibrations and increasing their amplitude finds its counterpart in the power possessed by the multiplier of intensifying and refining electrical oscillations.



The Slaby Receiver.

If a multiplier-coil be placed between the auxiliary wire of the receiving-wire and the coherer, great tensions will be obtained at the coherer; for which reason the certainty of transmission is increased. The multiplier permits the passage only of those waves to which it is attuned, as it were; all other waves, if they should by any possibility pass the node, will be reflected by the coil.

It now remains to be shown exactly how electric waves of definite length are produced at the transmitting station. Wireless telegraphy is essentially the electrical transmission of power. The transmitting apparatus which is capable of translating the largest possible amount of electrical energy into an oscillating form will evidently be the most suitable for the purpose. But to effect such a translation, not only a high tension, but also a large quantity of electricity is necessary. For this purpose a grounded transmitting loop (Fig. 2) instead of an insulated wire is used, which loop is provided with a condenser, *K*, to increase the quantity of electricity. The condenser used consists of Leyden jars. To charge these jars the entire circuit of the ribbon, including the earth, is employed; to discharge the jars only the vertical conductor, *K C*, is utilized. To prevent the passage into the earth of electrical oscillations produced at the discharge, a coil, *CD*, is fitted to the conductor, which coil not being in unison with these electrical vibrations, prevents their escape. We have seen how such a coil can act as a barrier. Electrical waves are then sent forth by the first vertical wire and are not disturbed by any counter influence exerted by the second vertical conductor, *D E*. Electrical waves thus transmitted are proportionate in length to the length of the wire employed and to the size of the condenser. By employing coils, *C D*, of various forms the length of the waves can be changed, such coils serving to vary the frequency of the oscillations. Each frequency corresponds with a certain wave-length.

In a lecture Slaby succeeded in receiving messages from stations of 4 and 14 kilometers distance with a speed of 72 letters per minute. He likewise received messages simultaneously from the two stations. His system has proven so successful that it will be developed by the Allgemeine Elektricitäts-Gesellschaft, of Berlin.

Germany's Two Great Coal Regions.

BY H. L. GEISSEL.

Prof. Schulz, German Privy Councilor of Mines, and a recognized authority on European mining matters, has just given out some interesting figures on the coal deposits of the two great German mining districts. Prof. Schulz says that the Rhenish Westphalian mining region extends over an area of 60 square miles. To a depth of 700 meters there are yet available and exploitable 11,000,000,000 tons of bituminous coal; from that depth to 1,000 meters there remain 18,300,000,000 tons; and in the depth between 1,000 and 1,500 meters, well accessible under present mining conditions, there are another 25,000,000,000 tons, or, altogether to the last-named depth of 1,500 meters, 54,300,000,000 tons. Prof. Schulz expresses the opinion that science will improve our present means to such a degree that in time it will be possible to safely carry on operations at a greater depth than 1,500 meters, whereby another 75,000,000,000 tons of coal would be obtainable. Thus, the total quantity of coal still buried in the Rhenish Westphalian district amounts to 129,300,000,000 tons. Supposing the future annual output of the district should average 100,000,000 tons—that is to say, about twice the present output—the coal deposits available down to a depth of 1,000 meters would still last for 293 years, and to 1,500 meters for 543 years.

The second coal region, the Upper Silesian, is even larger. Here the carboniferous mountains reach a depth of 7,000 meters, on an area of 2,162 square miles, and the 114 workable layers have an average thickness of 170 meters. When calculating the quantity of coal workable to a depth of 1,000 meters, it must be taken into account that the carboniferous mountains generally are covered by younger layers about 200 meters in thickness, and that, when carrying on operations to a depth of 1,000 meters, about 33 1-3 per cent has to be deducted for safety constructions, loss, etc. There would thus remain, according to Prof. Schulz's estimates, a quantity of 62,800,000,000 tons of workable coal down to 1,000 meters. During the period from 1748 to 1900 there have been extracted 500,000,000 tons, thus leaving 62,300,000,000 tons to be mined. According to the Upper Silesian mining returns, the increase in the output from decade to decade has been 43.5 per cent. In 1899, when the deepest shaft was but 594 meters, the output amounted to 23,500,000 tons. Supposing that it reaches within 50 years three times the present output, the deposits down to 1,000 meters would last for 890 years, and would probably not be exhausted until the year 2790. At a depth of 1,000 to 1,500 meters there are further available 101,550,000,000 tons, and from 1,500 to 2,000 meters another 140,800,000,000 tons, the mining of which would require 1,450 and 2,000 years respectively. But, even at that time, there would yet be immense quantities of coal available, as huge deposits extend over the mountains deeper than 2,000 meters.

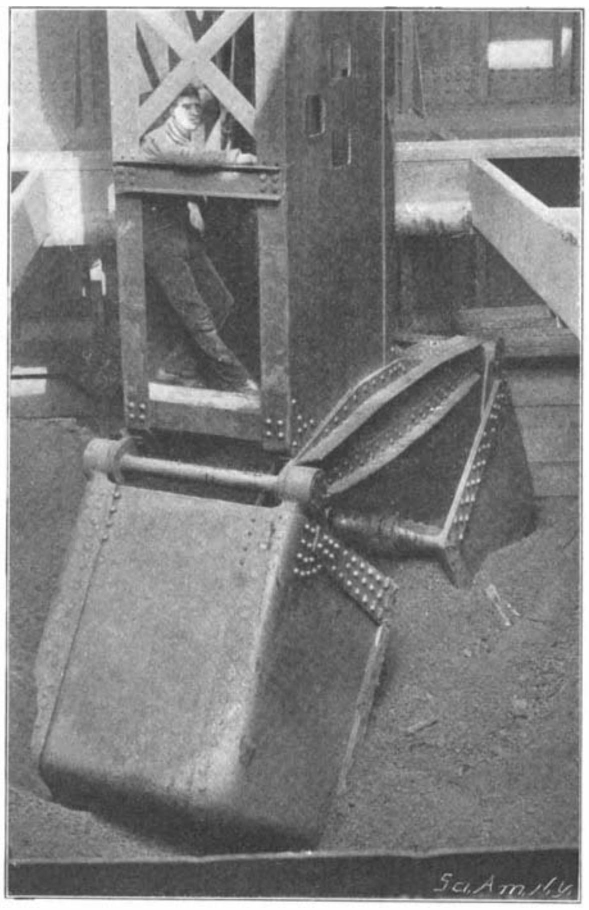
How the Welsbach Mantle is Made.

The "mantle" of the Welsbach light is an ash consisting mainly of the oxides of certain rare metals—lanthanum, yttrium, zirconium, etc., which are rendered incandescent by heating to a high temperature. A six-cord cotton thread is woven on a knitting machine into a tube of knitted fabric of a rather open mesh. This web has the grease and dirt thoroughly washed out of it, is dried and is cut into lengths double that required for a single mantle. It is then saturated in a solution containing the requisite oxides, wrung out, stretched over spools and dried. Next, the double-length pieces are cut into two, the top of each piece is doubled back and sewed with a platinum wire, which draws the top in and provides a means of supporting the mantle, when finished, from the wire holder. After stretching the mantle over a form, smoothing it down and fastening the platinum wire to the wire mantle holder, the mantle is burned out by touching a Bunsen burner to the top. The cotton burns off slowly, leaving a skeleton mantle of metallic oxides, which preserves the exact shape and detail of every cotton fiber. The soft oxides are then hardened in a Bunsen flame. A stronger mantle is made upon lace-making machinery.—The Keystone.

AUTOMATIC ORE UNLOADER.

BY W. FRANK M'CLURE.

Three great automatic iron ore unloaders, the first of their kind in the world, will be in operation upon the docks of the Carnegie Company at Conneaut, Ohio, Harbor the coming season. The complete success of these machines will mean their general adoption along the Great Lakes, and, incidentally, the realization of the fondest hopes of many of the big dock companies. Their use at all the ports will revolutionize the ore-handling industry.



THE SCOOP GATHERING UP ITS LOAD.

For years pessimists have prophesied that a successful automatic iron ore unloader was an impossibility. Futile attempts to build such a machine have been made from time to time in the past decade. The announcement, therefore, that Andrew Carnegie was to build an automatic ore unloader at a cost of $100,000 occasioned no little interest.

On completing the first machine some time ago it was found necessary to rebuild it. Additional bearings in particular were found to be needed. Each test of the machine has been more satisfactory than the former one, and when last year the Carnegie Company ordered two more machines of the same pattern completed for this season's business, at a cost of $100,000 each, it was apparent that the steel king felt sure of their success. The three machines have now been completed. The accompanying photograph shows them, side by side, each in operation but in different positions.

The total weight of the first machine was found to be 400 tons and its height 55 feet. The all-important part of the machine is the bucket, which grasps ten tons at a single lift, or ten times that lifted by the largest ore bucket previously used. This great bucket is attached to a revolving pending leg, which in turn swings from a long and gigantic arm. This arm is carried forward and back upon a track, to a point above the vessel when the bucket is to be filled and to a point above the car when the bucket is to be dumped.

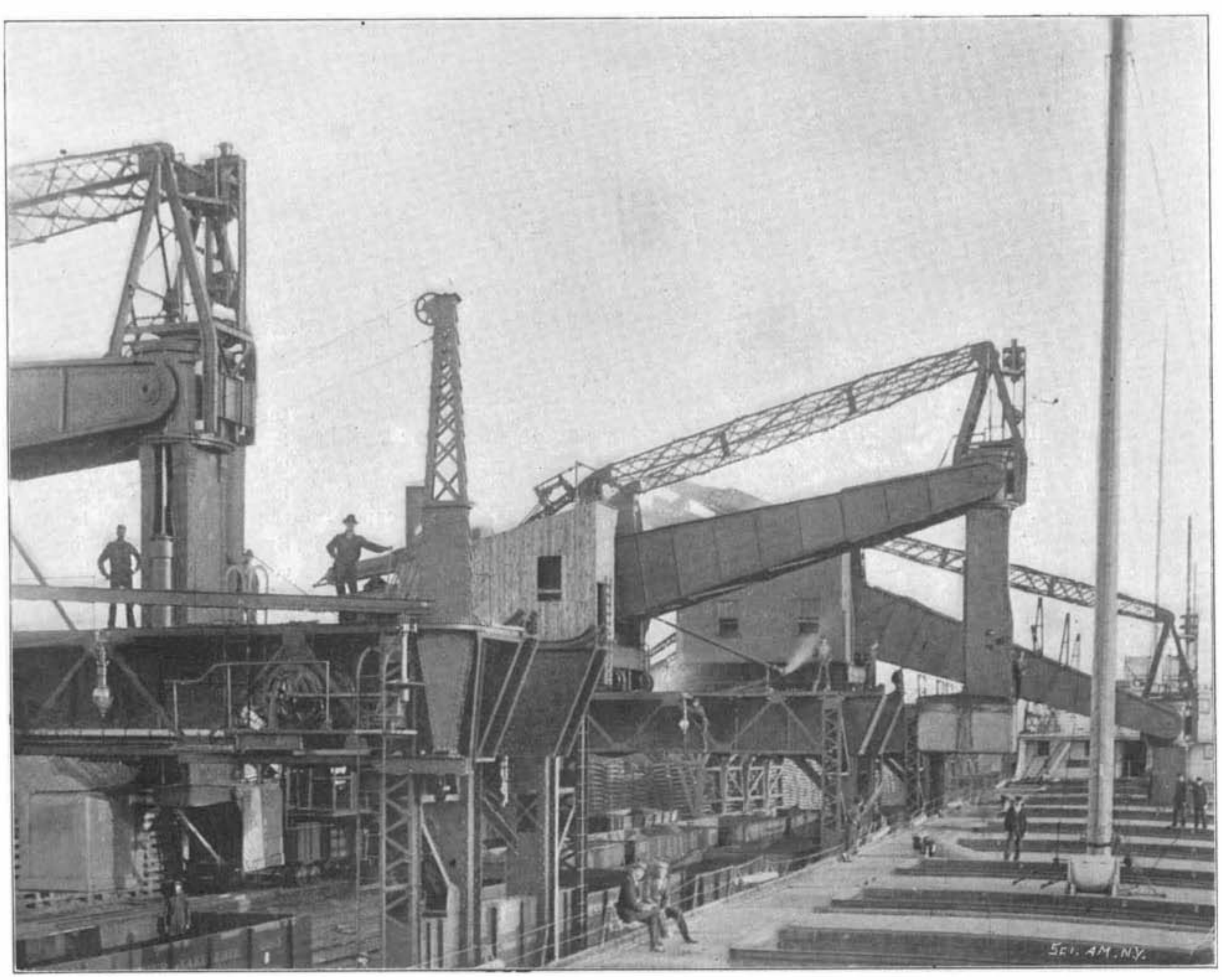
The bucket is first lowered part way into the vessel's hold. Next the scoop is opened and then lowered until it strikes the ore cargo and sinks deep into it. When open, the bucket has a spread of nineteen feet. The scoop is closed upon the ore by hydraulic power. It is then ready to be raised and conveyed to a point over the car into which the ore is to be dropped. Where the ore is to be placed on the stock piles, it is dropped into a trolley car which will convey it.

The automatic ore unloader is expected to take out from 90 to 95 per cent of the ore in a vessel. The bucket when below the hatch of a vessel can be swung around lengthwise, in which case it reaches about nine feet from the edge of the hatch in either direction. The small amount of ore which cannot be reached by the scoop is shoveled by hand to a point within its grasp.

In the accompanying photograph showing three machines, the big scoop or bucket of the machine in the distance is below the hatch of the vessel, reaching into the ore. The scoop of the next machine is raised to a point above the vessel, and the view nearest the reader shows the scoop after it has been conveyed and the contents dumped into a railroad car.

Four machines, side by side, can be used in the average vessel at one time. Each machine is expected to remove 300 tons of ore per hour when fully perfected. Four machines, thus unloading 1,200 tons per hour, would empty the largest vessel on the lakes in a comparatively short time. The largest cargo of ore hauled last year on the Great Lakes aggregated 7,446 gross tons. If such rapid handling of iron ore can be secured, the work of many men will be saved. One of the ore unloaders can be operated by six men. Three of this number remain in the vessel to shovel ore within the reach of the scoop. Three operate the machine. With four machines working in a vessel twenty-four men would thus do the work which usually requires 100 men.

As yet no attempts have been made to establish speed records. Otherwise the tests are reported to be very encouraging. George H. Hulett, a mechanical engineer of Akron, Ohio, is the inventor.



POWERFUL AUTOMATIC ORE UNLOADER IN USE, SHOWING DIFFERENT POSITIONS OF THE MAIN ARM AND BUCKET.

The Sunflower.

Dr. Harvey W. Wiley, Chief of the Division of Chemistry, United States Department of Agriculture, in a special report shows that the sunflower can be grown successfully over large areas in the United States; that it is a crop which makes a considerable drain on the elements of soil fertilizers; that one of the most valuable constituents of the plant is the oil, which exists in large quantities in the seeds; that the economic production of the sunflowers is now confined almost exclusively to Russia, where it is an agricultural industry of considerable importance; that in the United States it is grown as an ornament and for the production of seeds, which are used chiefly for poultry and bird feeding and for condimental and medic-