use a few years since. For one thing, the hammer is much longer for given weight than the older forms, thus avoiding the sidewise throw when the hammer strikes near one edge, and it is so guided that instead of striking directly on the pile it works on an independent piece of wood which is inserted in an iron socket, so that the stroke of the hammer falls on the intermediate block, which transmits its force to the pile. This intermediate piece of wood can be changed when it splits, and by its use the head of the pile is preserved. The drop hammers range in weight from 75 to 5,200 pounds. In most cases they are concave in the bottom, although flat hammers are sometimes provided.

In the case of what is known as the "township" pile driver—a machine designed for use on small bridges and other light driving and fitted with a drop hammer weighing from 500 to 1,200 pounds—the hammer is usually raised by horse power, the smaller sizes being hoisted direct, that is, without a purchase block, and the larger sizes having one end of the line fastened to a suitable post, driven into the ground, when the other end is passed through a tackle-block which is fastened to the main hoisting line and leads to the whiffletree direct. In some instances use is made of a winch which is bolted to the ladder. Tackle-blocks can also be used instead of sheaves at the top and bottom.

The more powerful drop hammer outfits have usually of late years been used with friction engines. In an up-to-date equipment of this kind it is customary to provide woodwork of Norway pine and a head block of Georgia pine, oak or maple. In connection with drop hammers there is now used extensively a protecting cap which displaces the familiar pile band and has the advantage over the latter in that no time is consumed in its removal and there is practically no danger of the breakage of the device.

Many contracting engineers predict that the steam hammer will ere long almost entirely displace the drop hammer for pile-driving operations. While the stroke of the steam hammer is limited, yet the frequency of the blows, together with the constant weight of the machine on the pile, gives results that are surprising to persons whose experience has been limited to drop-hammer pile drivers. As an indication of the economy of time rendered possible by a steam hammer under certain conditions, it may be cited that recently, while contractors were driving piles for the L. & N. Railroad at Pensacola, Fla., fifty minutes' time was required to drive with a drop hammer a pile 75 feet in length, there being utilized 120 blows from the top of 75-foot leaders. The next pile, the same length and located but three feet from the one mentioned, was driven to the same depth by a steam hammer, which delivered the 130 blows required in ninety seconds.

SOME NEW DETECTORS FOR WIRELESS TELEGRAPHY.

BY A. FREDERICK COLLINS.

Invention, like all evolutionary progress, travels in cycles. Wireless telegraphy is no exception to this rule, as a review of the results achieved will show, for yesterday the workers were madly striving for syntonic effects, while to-day electric wave detectors are engaging their attention, and to-morrow—only to-morrow will reveal the popular thought.

Of electric wave detectors there are two distinct types: (1) The familiar coherer in its many and varied forms; and (2) devices which depend upon the increase and decrease of magnetic permeability by the impinging electric waves setting up oscillating currents in the resonator system.

Mr. Marconi, Prof. Fessenden and others have taken up this latter type of detectors, since it offers not only a wide field for research, but it has been shown from theoretical considerations that in magnetic detectors as they are called, all the energy could be utilized, whereas in the coherer type only that portion of the energy could be utilized which is required to raise the potential to the critical point necessary to break down the maximum resistivity and the rest of the wave value is therefore lost.

To. Prof. Elihu Thomson is given the credit of having first proposed the general principle embodied in electric wave detectors of the magnetic type. In Fig. 1, *A*, the simplest arrangement is shown in outline representing an elevation, and in Fig. 1, *B*, a plan of the magnetic detector is shown. In this form a silver ring, 1, is suspended by a quartz fiber, and above the ring is attached a small mirror, 2, so that readings may be taken by means of a lamp and telescope just as in an ordinary reflecting galvanometer. The system is thus free to revolve between the parallel coils of wire, 3 3′, which are connected in series. The opposite and free terminals of 3 3′ of the coils are extended to or connected with the vertical wire, 4, and the ground wire, 5.

When the electric waves impinge on the antenna or vertical wire, 4, they set up high-frequency oscillatory currents, and these passing through the coils, 3 3′, join a rapidly-alternating field between them; these magnetic lines cut through the suspended ring, and currents are induced in it, and these have a tendency to turn at right angles to the coils creating the magnetic field; and in following out this law of repulsion the ring describes an arc equal to the opposing forces. This was the form of detector Prof. Fessenden employed in his tests prior to his work for the government.

To bring this detector into a more practicable form, so that a telephone receiver could be employed instead of the reading telescope, the instrument is somewhat differently designed and constructed than that shown in Fig. 1, though the principle is the same.

In this case the metal ring, 1, Fig. 2, rests upon three inverted wedges, 2 2′ and 3; 2 2′ are of metal, but 3 is of carbon. One terminal of a non-inductive resistance, 4, is connected to the inverted metal wedges, 2 2′, and the opposite terminal is connected in series to a telephone receiver, 5, and this in turn to the carbon wedge, 3. The electric wave system is formed by connecting the vertical wire to the metal wedges and the earthed wire to the carbon wedge. With these

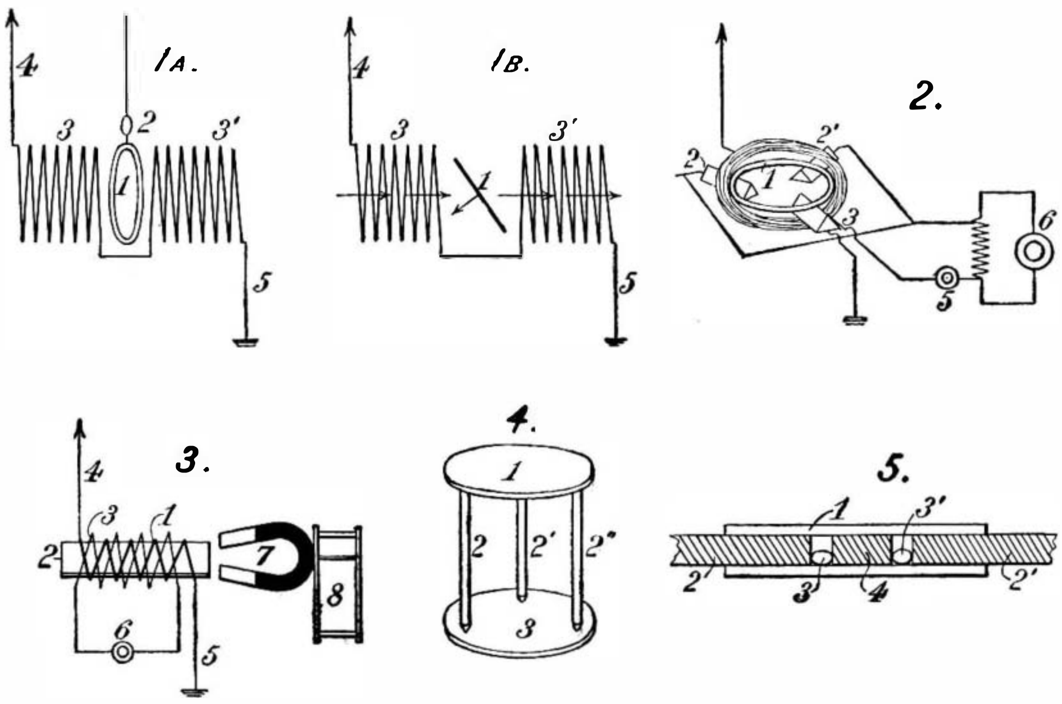

Fig. 1 A.—Fessenden Detector (Elevation). Fig. 1 B.—Fessenden Detector (Plan). Fig. 2.—Magnetic Detector. Fig. 3.—Marconi Magnetic Detector. Fig. 4.—Branly's Tripod Coherer. Fig. 5.—Castelli's Coherer.

arrangements completed an alternating current from the dynamo, 6, is switched through the circuits; this produces a continuous vibration of the diaphragm of the telephone receiver, but when the electric waves impinge on the vertical wires the resistivity of the carbon wedge is varied and any change in it is registered by the telephone.

In Mr. Marconi's recent paper he describes a new form of detector which likewise depends upon a varying magnetic field produced by high-frequency oscillations transmitted from a distant point in the form of electric waves; but the electrical feature which places the stamp of originality on this new detector is the fact that it calls into action magnetic hysteresis.

In mechanical construction the Marconi detector is comparatively simple, consisting as it does of a layer of fine insulated copper wire, 1, Fig. 3, wound on a core, 2, made of thin iron wires; a second layer of fine insulated wire, 3, is wound over the first, forming a secondary coil. The ends of the inner coil are connected with the vertical wire, 4, and to the earth, 5. The terminals of the secondary coil are connected in series with a telephone receiver, 6, or other suitable receiving instrument. Up to this point it will be observed that there is but little difference in Marconi's device and those heretofore described, and all of them are based on the researches of Prof. Joseph Henry, who produced with a single spark from the prime conductor of a frictional machine an oscillatory current at a distance of 30 feet, sufficient to magnetize steel needles. But in applying the principle of hysteresis an entirely different detector results, and to understand this process the better, let it be known that the ascending and descending curves described in magnetic tests of iron do not coincide, and this being true it is self-evident some work is done, and this takes the form of heat; although practically it is so small as to be negligible; this process of hysteresis, it now appears, has the curious property of accentuating mightily every charge, however small, in oscillatory currents, set up in a resonator by the incoming electric waves.

Now in order that the bundle of fine iron wires forming the core of his detector may be constantly following a cycle of increased and diminished magnetization or continued hysteresis, Marconi causes a horseshoe magnet, 7, to revolve before the pole of the core by clockwork, 8. The magnet should be revolved very slowly—at the rate of one revolution every two seconds; the speed of course varying for the different qualities of iron employed; and in this way a slow and constant change with successive reversals of the magnetization results.

It might be supposed that the changes of polarity of the core would induce currents in the secondary coil of the detector which would be rendered audible by the slow motion of the magnet, and that if it were revolved at a high rate of speed better results would be obtained. This, however, is diametrically the opposite of what takes place in practice. The writer had occasion to make some experiments with an inductor type of alternator. With a telephone receiver in series with one of the windings, it was noted that when the rotor was turned by hand the reversals of the current were not noticeable and articulate speech exceedingly clear; but when the rotor was coupled to a gas engine and revolved rapidly a continuous hum in the receiver was apparent. These cases are identical.

The great advantage of the magnetic detector, as Mr. Marconi has pointed out, lay in its self-restorative qualities, and that its resistance is practically the same at any moment, whereas in a coherer before and after tapping there is always a wide and variable resistivity affecting the working of the registering instruments. It is claimed for this new detector that it is exceedingly sensitive and more reliable than the coherer, the latter being especially desirable in connection with syntonic wireless telegraphy.

While these points are advantageous, yet it would seem that the wide divergence between resistivity and its reciprocal, which is necessary in a detector to enable a relay to be operated, is in the magnetic detector lacking, and the limit of its usefulness will be confined to the telephone as a receiver; this may be of greater advantage than otherwise, since by means of the telephone wireless message may be read more rapidly and at a greater distance than when the more cumbersome, costly and slower Morse register is used. Let this be as it may, experimental research is still going on with the type of detector that first made wireless telegraphy possible—the coherer.

Mr. Edouard Branly, of Paris, in his paper on "Variations of Conductivity," published in 1900, showed for the first time the effect of electric sparks on powdered metal inclosed in an ebonite tube; this tube he termed a *radio-conductor*, and was the first real coherer; and now he has given the results of his further researches in the form of a new coherer. To a metal disk, 1, are attached three metal rods, 2 2′ 2″, Fig. 4, with their points resting on a second disk of polished steel, 3. The points of the rods are oxidized. The success of the Branly coherer depends entirely on the oxidation of the metal points and the polish of the steel disk. The film of oxide may be preserved for a considerable length of time. Like Marconi, Branly has searched for a detector of stability greater than that offered by the ordinary coherer, in which the multiplicity of contacts gives rise to miniature trains of electric waves; in the Branly tripod form this is largely avoided. It requires a slight tapping to decohere it.

The details of another new coherer, designed by Signor Castelli and used in the Italian navy, and which is said to have been employed by Marconi in his recent transatlantic tests, have been made public. The Castelli coherer consists of a tube, 1, Fig. 5, having its two terminal conductor plugs, 2 2′, oppositely disposed in the coherer tube and separated by two pockets, 3 3′, the interior plug being made of iron, 4. Into the pockets are inserted globules of mercury. The tube is self-restoring and in practice stands up well for regularity and rapidity.

The recent developments in wireless telegraph instruments would not seem to indicate the need of electric wire detectors of any greater sensibility than those already in use; but a detector having a range of variability sufficient to operate a sensitive relay at ordinary distances from the transmitter with certainty, and having the added quality of being self-restoring, is a thing much to be prized.

In this a new field is opened in wireless telegraphy, in which the favored one who invents it will be highly rewarded.

THE MANUFACTURE OF TIN PLATE.—I.

In the last two decades of the industrial development of the United States there have been some remarkable instances of the creation of new industries within incredibly short periods of time, and among these perhaps the most striking is the birth and growth of tin-plate making. Less than a dozen years ago, the United States were dependent entirely upon the tin-plate makers of South Wales, England, for their supply of this invaluable commodity; but under the stimulus of a protective tariff, several tin-plate works were laid down early in the nineties, and we entered upon the experiment of supplying our own markets with the home-made product. The experiment was pre-eminently successful; for by the use of improved machinery, and by the application of our own system of shop management, we have developed an absolutely new industry to such proportions that to-day the supply is in excess of the demand.

The manufacture of tin plate divides itself naturally into two main parts. First, the manufacture of the sheet-iron plate, and secondly, the tinning of the plates. The present article is devoted to the first of these processes.

For a description of this new American industry, we have chosen the Laughlin Works of the American Tin Plate Company, which are situated at Martin's Ferry, Ohio. These works are the latest and among the largest of those controlled by this corporation, and they represent the most advanced practice in this country.

Hot Rolling.—The raw material comes to the works in the shape of sheet bars, which are 8 inches in width and vary from ¼ to ¾ of an inch in thickness, according to the desired thickness of the finished plates. The steel is a soft Bessemer, carrying from 0.08 to 0.10 per cent of carbon. The bars are cut into lengths equal to the width of sheets desired—¼ to ½ inch being allowed for side scrap. We will follow, in explaining the process, the execution of an order for size 20 by 28 inches; in rolling other sizes the figures differ proportionately. The rolling is always done across the bar, that is to say, the flow of the metal is in the cross direction to that which took place when the bar itself was being rolled at the steel mills, and all the rolling at the tin-plate mills is done in one and the same direction. The process of rolling is as follows: The bars are heated in a furnace to a cherry red, and are then rolled singly, each being given five passes through the rolls, until they have increased to sheets about 28 inches in length. These are then put in the sheet furnace in pairs and heated, and the pairs then given two or three passes through the rolls, until they are drawn down to about 56 inches in length, the width remaining about the same, or 20¼ inches. They are then taken over to the doubling shears, which are located conveniently to the rolls and the furnace, and doubled over, making four thicknesses. At the same time the ends are trimmed and the pack of four is returned to the furnace, heated, and again drawn out, this time to a length of about 54 inches. It should be mentioned that between each rolling, the plates, which have become more or less stuck together, are opened while they are hot, there being a tendency for the plates to weld together from pressure. This allows formation of oxide on the surface, which assists in preventing further sticking. The four-fold 54-inch plates are then put under the doubling shears, doubled again, and the ends trimmed. The pack of eight sheets is now put back in the same furnace and given its fourth rolling, under which it is drawn out to the finished standard length of 56 inches. The packs are then piled on the floor ready for the shears. An eight-hour shift will turn out from 5,500 pounds to 7,000 pounds, according to the gage of the plate that is being rolled. This forms the completion of the hot-rolling process.

Shearing.—The plates are then carried to the squaring shears, where each pack of eight is cut through the center, and the two halves are placed with their cut edges against a gage and sheared to the desired length of 28 inches, the edges being also squared up against a gage set at 90 degrees from the shears. The result is sixteen 20 x 28 perfectly square black plates.

Opening and Black Pickling.—The packs of eight sheets as they come from the shears are passed on to long benches in front of which stand the openers, as the hands are called whose duty it is to open the sheets, which have become somewhat stuck together under the process of rolling and shearing. The openers have stout leather half-gloves on their hands and, standing the plates on edge, by a deft movement of the hand, they quickly strip the plates one from the other. From this time on, each plate is handled separately throughout the whole process, and to this fact is to be attributed a great deal of the expense of its manufacture. As they are opened, the sheets are piled on carriers and taken to the black picklers, where they are treated in a bath of hot sulphuric acid to remove all scale and oxide from the surface; for to secure a perfect coating of tin plate it is necessary to have an absolutely clean surface. The pickler consists of a large hollow vertical shaft, which carries at its top three horizontal arms. From each arm is hung by chains a crate for holding the black plates during the pickling process. The central shaft is provided with piston rings, and moves in a steam cylinder that is bolted to the floor of the building. By means of a trip valve, the operator is able to give the shaft, with its burden of black plate, a vertical oscillating movement. After a load of plates has been placed in one of the crates, it is picked up, swung around and lowered into a bath of hot sulphuric acid, where by the vertical movement of the crate it is thoroughly agitated, and the acid given a chance to act on every portion of the plates. After from four to ten minutes of this washing, according to the condition of the plates, the crate is lifted from the acid vat, swung around, and lowered into the "swill" or fresh-water vat, into which a constant stream of water is kept flowing. In the meantime another crate has been loaded and swung into the pickle vat, thus giving a continuous operation.

Annealing.—The pickled plates are then taken from the fresh-water vat, removed from the crates, and packed in the annealing stands. The latter, as shown in one of our accompanying engravings, consist of a lower tray and an upper cover or box. The wet plates are piled on the stand, the heavy cast or wrought iron box is then lowered over them, and sand is carefully packed in between the edges of the tray and the bottom of the covering box to exclude all air. The annealing stand with its load of plates is then picked up by a huge, counterbalanced, gooseneck, charging crane, and run into the furnace in the manner shown in our illustration. Under the old system of handling these heavy annealing stands, it was customary to use a heavy wrought-iron, hand-operated truck, which required several men to work it; but by means of the ingenious counterbalanced crane herewith shown, one man is able to swing the crane and its load, and direct it into the proper position in the furnace. The black plates are piled up in the annealing stands to a height of from 20 to 48 inches. They are subjected in the annealing furnace for from twelve to eighteen hours to a temperature of 1,500 degrees. The annealing is one of the most particular steps in the manufacture of tin plate, since overheating would make the plates stick, and if they are underheated the plates would not be thoroughly cleared and softened. The effect of the annealing is to soften the plates and to take out the uneven strains which have been produced during the rolling, and also to remove all stains from the plates. As the latter enter the furnace thoroughly wet, the moisture is converted into steam and they are subjected to a very effective steam bath, which serves to remove the acid and other stains from the plates, and give them the desired clear, white appearance. After the plates are removed, they are allowed to stand until they are cold.

Cold Rolling.—When they are cold, the plates are carried in the stands to the cold rolls, where they are passed singly into the rolls. The object of this rolling is to close the pores and give a smooth, hard surface to the plates. Each plate is given two or three passes, which is usually sufficient to produce the desired finish. Since the cold rolling has the effect of stiffening the plate, another annealing becomes necessary. For this purpose they are packed in the same way as for the first annealing, with the exception that in this case the plates enter the furnace perfectly dry. The temperature, moreover, is lower, 1,200 as against 1,500 degrees, and the plates are not kept in the furnace for over six or eight hours.

White Pickling.—As soon as the plates have been removed and cooled, they are treated to what is known as white pickling, which is similar to the black pickling except the acid solution is weaker. The white pickling is necessary for the removal of the small amount of oxide which has accumulated during the annealing and cold rolling. After the white pickling great care is taken to protect the plates from the action of the atmosphere, for it is important to preserve the clear white surface which is produced by the pickling until the plates have entered the tinning pot. Hence, the instant they are taken from the white pickling vats, the plates are loaded into wheeled tanks, known as waterboshes, and in these are taken to the tinning house, a description of which will be given in a later issue.

The only musk ox in captivity in this country died recently at the New York Zoological Gardens. There is only one other musk ox in captivity, and that one is to be found in the Zoological Gardens of Hamburg, Germany.

Correspondence.

Soft Coal for Domestic Use.

To the Editor of the Scientific American:

I have just read your article relative to the use of soft coal, in your last issue. It sounds odd to those who live where we use soft coal for all purposes, to be told that we cannot depend on banking fires to keep over night. We find no trouble; all that is needed is a large piece of coal and a door a little ajar. In the morning knock apart the chunk and your fire freshens up. The large piece is preferable but not absolutely necessary, for plenty of small coal can be treated in the same way. If your people will put in good down-draft furnaces for soft coal, they can burn so much of the smoke as to have very little if any trouble from soot. H. C. Hammond.

Olathe, Kans., September 22, 1902.

Soft Coal for Domestic Use.

To the Editor of the Scientific American:

I notice that in the Scientific American of the 20th instant you say on page 182: "Owing to the rapidity of combustion of bituminous coal, it will not be possible to bank up the furnace for the night and leave it with the certainty that there will be a live fire remaining in the morning."

I have had nineteen years' experience in the exclusive use of soft coal for domestic purposes, and for about thirteen years my home has been heated with a hot-air furnace in which soft coal has been used almost exclusively. My experience is that there is no more difficulty in keeping a fire over night with bituminous coal than with anthracite. Indeed, I have several times kept a fire for forty-eight hours in my furnace without any attention whatever. If the lower and upper drafts are both left a little open, and there is a good body of coal, and especially if a pretty brisk fire is well covered with fine coal, a furnace fire will keep as long with bituminous coal as with anthracite.

I have also kept a fire for weeks at a time in an open grate with bituminous coal, simply taking care to have a good fire at bedtime and cover it with fine coal or ashes, preferably the latter. It will not go out for twelve hours, and at the end of that time it may be raked down and broken up on the top, and it will soon give you a cheerful blaze. The same stoves that are used for anthracite coal can be used for bituminous. Of course in this country the soft coal is so very much cheaper than the anthracite that the latter is a rarely used luxury. This section of the State of West Virginia can also furnish a cannel coal almost equal to the best imported, if not, indeed, quite equal to it.

J. O. Thompson.
Sec. West Virginia Farm Review.

Charleston, September 23, 1902.

The Trial of Spencer's Airship.

Stanley Spencer is the latest foreign aspirant to aeronautical honors. On September 20 he traveled nearly 30 miles over London in an airship of his own construction. He seems to have had a rather hard time of it during his flight, for he was in constant danger of an explosion of the balloon and of ignition of the hydrogen gas by the motor. He states that his machine could be easily controlled. As he sped over London the inventor dropped balls. Spencer's airship is said to differ from Santos-Dumont's in being constructed on the Hiram Maxim system. The machine is pulled along instead of being propelled from the rear. The framework is of bamboo, the parts being lashed and bolted together. The total weight of the contrivance is less than 300 pounds, of which 125 pounds fall on the frame. The driving power is furnished by a Simms petrol-motor of 35 horse power. The gasbag is 75 feet in length. During his flight over London, Spencer attained a speed of 7½ miles an hour.

The Passing of the Fire Engine.

At a convention of the International Association of Fire Chiefs, held in New York city, the Chief of the Baltimore Fire Department read a paper on the fire departments of the future in large cities. The paper started a discussion on the merits of mobile fire engines as compared with stationary pumping plants, stand pipes, and sprinkler systems. The Chief of the Chicago Fire Department declared that ninety-two steam engines in Chicago could be dispensed with if twelve pumping stations were at hand. A representative from Boston gave it as his opinion that the clang of the engine through the cities' streets will soon be as out of date as the old vamp brake pump.

Chullapata Volcano Active.

A dispatch from Lima, Peru, states that Mont Chullapata, 18 miles from Celendin, has been vomiting volcanic dust and smoke for the last fortnight. Several earthquakes have been felt around the mountain, and great chasms are said to have been opened in its sides.