they now seem to be developing a taste for all these kinds of food.

Farmers do not engage in poultry raising to a sufficient extent to provide the eggs needed for home consumption, these being imported from China to the value of over \$500,000 per year. Fruit raising, under the stimulus of government encouragement, has advanced considerably, but it is not yet an important branch of farming in this country. Bee culture is engaged in to a limited extent, but the industry is still in a primitive condition.—E. C. Bellows, Consul-General, Yokohama, Japan.

SOME NEW EXPERIMENTS WITH CATHODE RAYS.

MR. A. BROCA a short time ago stated that in a powerful field there are produced simultaneously both ordinary cathode rays, around the field according to well-known laws, and another kind of rays following the lines of force. These phenomena have likewise been investigated by Mr. Pellat, who accounted for them on the hypothesis of an anisotropical friction the cathode ray particles undergo in the magnetic field.

The existence of two kinds of rays, as pointed out by P. Villard in a paper recently presented to the French Academy of Sciences, may be easily shown by means of an apparatus similar to that used by Broca. To the same effect a narrow cylindrical bulb may be used, placed obliquely in a field either uniform or convergent. The beam directed along the lines of force and the fluorescent spots produced on the wall by the deflected ordinary rays will then be seen simultaneously. The simplest means is to observe the rays in pure oxygen, which shows a brilliant yellow illumination. The helicoidal beam of the ordinary rays and the beam shaped like a tube of force will then be clearly distinguished.

The so-called magneto-cathode rays, being those of the second kind, are produced under otherwise equal conditions with potential differences smaller than ordinary rays. Their production will set up a tension fall at the electrode and accordingly a noticeable weakening or even a complete disappearance of the cathode rays proper.

The main properties of the two kinds of rays are strictly different. With respect to magneto-cathode rays the field exerts in addition to the directing effect a motive action. In fact, if the emission of these rays be counteracted by placing in the neighborhood of the cathode a diaphragm with a small opening, an emission of rays through this opening is found to take place on the field when increased sufficiently. Similarly, the fluorescence excited on the glass, and especially the luminescence of the gas traversed by the rays will augment in intensity with the field. Magneto-cathode rays are not found to be electrified.

In fact, the shadow of a wire will not be broadened as the wire is charged negatively (Perrin's experiment). The wire may easily be connected with the cathode without broadening the shadow or causing a disappearance of the rays passing near the wire.

The method of the Faraday cylinder which since Perrin's investigation has become classical, renders it possible to confirm this non-electrification directly. It would be necessary only to avoid a mixture of the rays by placing in front of the cathode a diaphragm with a small opening. Under the conditions, no field being produced, no rays will reach the cylinder, and if the apparatus be electrically tight, the electroscope will not show any charge. There may then be directed into the cylinder either ordinary rays, by means of a small magnet, or else magneto-cathode rays, by giving the bulb a convenient orientation in a powerful field. Some fluorescent powder, being laid on the cylinder jacket, will facilitate regulation. Now, the arrival of ordinary rays in the cylinder will result instantaneously in a divergence of the gold leaves, corresponding to some hundreds of volts, whereas the divergence is absolutely nil in the case of magneto-cathode rays. The electric charge of the latter, provided there be any, is accordingly quite insignificant as against the one of ordinary rays. Most likely, however, this charge is nil and the rays are non-electrified. In fact, if a thin beam of magneto-cathode rays be allowed to enter an electric field, a deflection will be observed, but in opposition to the case of ordinary cathode rays, this deflection will be perpendicular to the lines of electric force. The direction, moreover, changes along with that of the electric or magnetic field; the latter being directed from the right to the left, an observer inspecting in the direction of the electric force will see the rays wind themselves up in the direction of the hands of a clock. The magnitude of the electric deflection is the higher as the generated magnetic field is smaller, this being analogous to the magnetic deviation of ordinary cathode rays.

The properties of the magneto-cathode rays are accordingly quite the opposite of those of Hittorf rays; electric fields acting on the former as magnetic fields on the latter and *vice versa*. This by the way seems to be the first instance of an action of an electric force according to Laplace's law.

MAGNETIC ALLOYS OF NON-MAGNETIC METALS.

WHILE investigating manganese bronzes in the Isabella-hütte at Dillenburg, near Wiesbaden, Fr. Heusler noticed that a piece of an alloy of manganese, tin, and copper adhered to a tool which had accidentally become magnetized. The further study of this fact by Fr. Heusler, in conjunction with W. Starck, E. Haupt, and F. Richarz, has led to results which, though not apparently of direct practical importance, are scientific-

cally of high interest. The original bronze with which Heusler had started consisted of copper with 30 per cent of manganese. As this alloy was, in itself, non-magnetic, even when containing 1.2 per cent of iron, the magnetism could only be due to the further presence of tin, and it was interesting to inquire whether tin alone conferred magnetic properties on this alloy. It was found that while carbon, silicon, and phosphorus could not call forth magnetism, arsenic, antimony, bismuth—all three diamagnetic metals, it will be remembered—did so, and aluminium to a higher degree. As the alloys with antimony and bismuth were difficult to work with, the investigators have studied copper-manganese-aluminium were applied in atomic proportions. The induction B increased for the same strength of magnetic field $H=100$, from 3,200 for a copper alloy containing 28.8 per cent of MnAl to $B=5,300$ for 39.7 per cent of MnAl. Higher alloys with manganese and aluminium proved too brittle.

Another curious point is that the addition of small quantities of lead increased the magnetic induction from 5,600 to 6,500 in an alloy containing 36 per cent of MnAl, while additions of other metals generally proved injurious. The addition of lead further has a remarkable influence on the critical temperature above which magnetic properties vanish. We know that iron loses its magnetism at red-heat. For the 39 per cent alloys of MnAl, the critical temperature is about 300 deg. C. But when a little lead is added to a 24 per cent alloy (i. e., copper with 24 per cent of MnAl), the critical temperature drops from 160 deg. C. down to 60 deg. or 70 deg. C. Thus a piece of this alloy will be

ing at Edinburgh. It was known then that 12 per cent of manganese rendered iron practically non-magnetic, and he showed that an addition of 20 per cent of aluminium also deprived iron of its magnetic properties, but that alloys containing about 11 per cent of iron, 55 per cent of manganese, and 25 per cent of aluminium, or 3 per cent of Al to 15 per cent of Fe, were highly magnetic. Mr. Hogg does not appear to have carried his researches, of which Mr. Heusler became aware during his work, much further, however.—Engineering.

THE JANUS TELEPHONE SYSTEM.*

By DR. ALFRED GRADENWITZ.

THE Janus telephone system, designed by the Mix & Genest Actien Gesellschaft, of Berlin, Germany, enables each telephone of a private network to be used simultaneously with those belonging to the system of the telephone company (that is, in Germany, of the State telephone lines), the private network being identified completely with the circuits of the latter lines. This arrangement warrants an efficient supervision on the part of the State company, eliminates the risk of unlawful connections, and makes the private lines the last continuation and ramification of the company's telephone system. By using the same telephone apparatus for both interior and exterior communications, any desired connection, either in the private or public telephone systems, may be readily effected from the working place. Moreover, in the case of a telephonic inquiry in the interior service becoming neces-

FIG. 1.—THE JANUS TELEPHONE APPARATUS, SHOWING DISTRIBUTING SWITCH ("LINE SELECTER"), JANUS SWITCH, MAGNETO, AND CALL BELLS.

magnetic when placed in cold water, in a test tube; when the water is heated, the magnetism disappears before the water boils, and reappears as the water cools. Too high temperatures destroy the magnetism more or less permanently; but annealing at 110 deg. C. (boiling point of toluol) restores it partially in many of the alloys investigated. Careful tests made at the Reichsanstalt demonstrate that while the permeability of the manganese alloys is high for weak fields ($H=1.6, \mu=700$; $H=5, \mu=570$), in fields of 150 cast iron shows already a greater permeability, and consequently higher inductions than the new alloys ($B=5550$ —e. g., for $H=147$ in the alloy, against $B=9900$ for $H=154$ in cast iron), so that dynamo-makers would find these rather expensive alloys, inferior even to cast iron. But the high ohmic resistance which promises low Foucault currents and the limited temperature range of the alloys might be utilized. On the other hand, the observations imply a caution that we need not always look for iron alone in alloys which seem to be magnetic against all expectation. The chief interest, however, lies in the fact that these alloys will help to bridge over the gap which now separates ordinary magnetic or paramagnetic bodies—iron, nickel, cobalt, and, to a very slight degree, manganese, platinum, palladium, etc.—which place themselves along the lines of a magnetic field, from the very feebly diamagnetic bodies—bismuth, antimony, zinc, tin, lead, silver, arsenic, etc.—which place themselves at right angles to the lines of force of a magnetic field. The diamagnetic effects can only be shown in very powerful fields, while the magnetic alloys occupy an intermediate position. It is rather surprising that these discoveries should not have been made before. In 1892 T. W. Hogg presented magnetic alloys of aluminium and ferro-manganese to the British Association meet-

sary during the course of a conversation with the public telephone, this will be possible by a short interruption of the conversation and by simply switching the Janus telephone on to the interior circuit. The conversation may be resumed again immediately after the telephone has been switched back. The safety of operation, which is susceptible of any desired supervision, is insured by means of fixed switches conveniently arranged, instead of by loose plug switches. With these so-called Janus switches any unlawful connections would be possible only by considerably damaging the apparatus, which would of course be readily noticed by the supervising official.

The principle of the Janus system is represented in Fig. 5, where Iab and $IIab$ are two lines leading to the exchange, the private lines ($1ab$, $2ab$, and $3ab$) being led transversally to the exchange wire. Switching is effected by the double Morse keys called Janus switches, represented in Fig. 4, and consisting of two contact springs arranged to be lifted from the arrest contacts and applied to the working contacts in front, by means of pressure exerted on a button. A short rotation will then place the keys in position. These Janus switches are represented in Fig. 6 by A, B, C, D, E, F.

The connection with an exchange line is made as follows: If the Janus switch, B, be pressed down, the levers are removed from their points of rest and applied to the working contact, the a wire of the exchange circuit I, being thus connected to the a wire of the private circuit, 2, while $1b$ is connected with $2b$. Both circuits, 1 and 2, will now be connected, while the catch corresponding to the circuit, 2, is switched off. It thus becomes impossible to effect any connec-

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

tion of the private station with any other public circuit by means of a plug.

The calling apparatus is intended for effecting the calling of the exchange as well as of the public subscriber's station and of private telephones. In order to eliminate any possibility of inadmissible connections by means of the calling plug, the latter, during a conversation on a public line, has to be switched off the private system. Janus switches of the same construction as those represented in Fig. 4 will also serve for this purpose, the connection of the calling apparatus with these switches being represented in Fig. 5. *Iab* and *IIab* are also the public lines, being branched off in parallel from the line represented in Fig. 5. The wires of the calling apparatus lead to the levers of the first Janus switch, thence to the levers of the second switch, and so on. The plug wires are first connected to the "off" contact of the last switch, the *a* wires of the apparatus being always placed in front of the *a* wire of the public line and terminating in the top of the switch, while the *b* wire terminates in the neck

Physical Laboratory, and it is now the regular practice to take the effect into account in framing the certificates. The author fully describes the testing method.—C. Chree, *Phil. Mag.*, January, 1904.

ROTATION OF LINES OF FORCE.—The question as to whether the lines of force of a magnet revolve with it has been answered by Hoppe in the affirmative. He found that the lines of force show a slight drag in the direction of rotation. K. Düsing has endeavored to reply to the further question as to whether the lines of force revolve with a rotating armature when the magnets remain fixed. Here, also, he found a slight drag. He laid a flat iron ring between the poles of a permanent magnet, covered it with paper, and dusted iron filings upon it. With a proper field-strength he obtained a slight tracing of the lines of force within the ring, in spite of its shielding action. He then substituted a piece of photographic paper for the ordinary paper, and made the ring revolve about its own axis. The tracing of the lines of force obtained during the rotation was fixed by holding a lighted match over the

this result with the fact that the distance between the carbons in an electric arc can be increased while the arc is playing to lengths at which an arc cannot be ordinarily formed.—E. Castelli, *Nuovo Cimento*, July-August, 1903.

CALORIMETRY WITH PLATINUM THERMOMETERS.—In the course of their previous determination of the water value of a Berthelot combustion calorimeter in electrical units, W. Jaegers and H. von Steinwehr obtained a limit of error of 0.1 or 0.2 per cent. On that occasion they used mercury thermometers, and they expressed the hope that with platinum thermometers it would be found possible to reach a far higher degree of accuracy. This expectation has been fulfilled, and they now report upon the method adopted. The platinum thermometer owes its advantage chiefly to the fact that it is possible to operate with intervals of temperature as small as 1 or 2 deg., which means that it is possible to use large quantities of water and that Newton's law of cooling is strictly fulfilled. A point to be considered is that the thermometer must have as large a cooling

FIGS. 2, 3, AND 4.—THE JANUS TELEPHONE APPARATUS.

of the latter. In the case of a Janus switch being pressed down, the levers are taken off the rest contacts, that is to say, off the connections leading to the switch, and applied to the exchange line, the calling apparatus thus being placed in parallel with the latter.

CONTEMPORARY ELECTRICAL SCIENCE.*

BENDING OF MAGNETOMETER BARS.—C. Chree deals with the source of error found in the bending of magnetometer deflection-bars. In magnetometer measurements, the deflecting magnet is carried by the deflection-bar at an appreciable height above the center of gravity of the cross-section, and the bending of the bar when in use, under its own weight and that of the magnet with its carriage, results in an increase of the distance between the deflecting and the deflected magnets. To keep the instrument properly level, there ought to be a counterpoise on the other arm of the deflection-bar, at the same distance as the deflecting magnet from the center. In the absence of such a counterpoise, supposing the instrument originally level, the weight of the magnet and carriage causes a slight tilting. In consequence of this, the point of suspension of the deflected magnet moves toward the deflecting magnet, thus reducing the horizontal distance between them. Measurements of the bending effect have been made on over 20 magnetometers at the National

* Compiled by E. E. Fournier d'Albe in the *Electrician*.

paper. The tracing showed a distinct but slight inclination of the lines of force both within the ring and outside it in the direction of the rotation. The ring must, therefore, have dragged the lines of force with it to some extent.—K. Düsing, *Ann. der Physik*, No. 13, 1903.

AN OSCILLATOR WITH VARIABLE CAPACITY.—The measurements hitherto made on the constants of electric oscillations have shown that the dielectric constant and the damping ratio depend not only upon the medium in which the oscillations are produced and transmitted, but also upon the principal wave-length emitted by the oscillator, which in turn depends upon the arrangement and dimensions of its various parts. E. Castelli has designed an oscillator in which the various systems of electric oscillations can be produced, and their wave-lengths varied continuously within wide limits. The primary and secondary plates consist of sheets of tinfoil suspended by pulleys and counterpoised, so that they are in equilibrium at any level. They can also be slid forward or backward, so that their distance apart and the amount of surface in direct opposition can be varied at will. In the course of his measurements with this oscillator, the author made an observation which he believes to be new. If a vacuum tube is used for discovering the nodes, and is gradually shifted beyond the node, it remains alight even in places where it would not light up if it approached it from the outside. The author compares

FIG. 5.—CIRCUITS OF THE CONTROLLING KEYS.

constant as possible, in order to render the heating due to the measuring current harmless. The authors used a platinum wire 30 centimeters long and 0.01 millimeter in diameter, drawn through a capillary glass tube bent into a straight loop, the two ends being fastened side by side in a block of ebonite. The loop was surrounded by a guard of wire netting. The temperature inertia was only about one-twentieth of that of a mercury thermometer. The authors used 10 kilogrammes of water, so that the water value of the metallic masses was only one per cent of the total, and only had to be known to within one per cent. The electric energy introduced was about 250 watts per second. The results did not differ among themselves by more than one part in 5,000.—Jaegers and von Steinwehr, *Verh. d. Physik. Ges.*, May 20, 1903.

MAGNETISM OF VOLCANIC ROCKS.—P. David gives some further results of his observations on the per-

FIG. 6.—CIRCUITS OF THE JANUS TELEPHONE.

manence of the magnetism of volcanic rocks, and on the inferences which may be drawn therefrom. He studied various building materials dating from the Gallo-Roman epoch, which had been in their places for two thousand years. They showed all kinds of magnetizations, thus showing that the long period during which they had been under the influence of the earth's magnetic field since they were put in their places, had not sufficed to give them a uniform magnetization. It was, of course, impossible to deduce anything from their magnetization as to the magnetic conditions which obtained at the epoch of their formation, since their original situation was quite unknown. The author, therefore, turned his attention to some flagstones in the ancient Temple of Mercury on the summit of the Puy-de-Dôme, which also dates from the Gallo-Roman epoch. He had some cubes cut out of the flagstones and determined their direction of magnetization. He found that the declination was different in every stone, but the dip had the same numerical value, though positive in one case and negative in two cases. The obvious explanation of this is that the flagstones all had the same magnetization, but that on laying them down they were oriented in various directions horizontally. But vertically, they could only be laid in one direction, though they might be inverted and thus produce the inversion of the sign. The dip observed was about 55 deg. The author hopes that these observations will shed some light on the quarry from