putting it to earth at any point. Having induced currents of small quantity to deal with, it was evident that coils having primaries of the usual thick wire and small resistance would not answer. Coils with primaries and secondaries of equal gauge and resistance were therefore tried, but it was afterward proved that the best results were obtained from coils having a resistance ratio of 1 to 2.6. The connection between the metallic circuit and the single wires may be understood from the annexed figure:

A leads to switchboard and subscribers. B indicates Glasgow Exchange. C C' is a metallic loop 50 miles long. G indicates Greenock Exchange. H leads to switchboards and subscribers.

One of the coils of the translator at the Glasgow Exchange is connected by means of the metallic trunk loop, which in this case has a total length of 50 miles, with one of the coils of the translator at the Greenock Exchange. When a Glasgow subscriber wishes to speak to a Greenock subscriber, their respective single wires are joined to earth through the switch-boards and the disengaged coils of the translators. The speaking is then transmitted in the following manner:

- (1) The current arriving at the Glasgow Exchange from the first subscriber's wire, A, passes through the coil D D, of the translator to earth; and,
- (2) Induces in the other coil, B, of the translator similar currents, which pass over one wire of the metallic loop through the coil, G, of the Greenock translator, and back to Glasgow by the other wire of the loop; and,
- (3) Induces similar currents in the other coil, F F, of the Greenock translator, which pass away to the second subscriber's wire, H, via the switch board, and to earth through his telephone, the other end of the coil, F F, being to earth at the exchange.

M and M' are magneto-electric calls and bells, inserted one in each wire of the metallic loop, for the purpose of enabling the exchanges to attract each other's attention.

Although some diminution in the loudness of the speaking results from the double transfer by induction to and from the metallic loop, this can be compensated for by speaking closer to the transmitter, or more distinctly than is usual on local lines; or by using two or more cells joined for quantity on the transmitter instead of the ordinary single cell. Curious features of this apparatus are that the current is changed no less than four times between the speaker's transmitter and the listener's telephone, and that induction is successfully used in one form to combat the evil effects of the same phenomenon in another. In the Glasgow district, the invention, which is now the property of the Electromotive Force Company (limited), has been working successfully for about nine months, and for a shorter period in Staffordshire, Warwickshire, and Yorkshire. Its sphere of usefulness will, doubtless, enlarge as telephonic intercommunication between distant towns becomes more common.—*The Electrician*.

ON THE THERMIC PHENOMENA OF THE INDUCTION SPARK.

By A. NACCARI.

A BRASS tube of 12 centimeters in diameter, introduced into the middle aperture of a Woolf's bottle, was closed below hemispherically; it contained 8 grms. of water and a thermometer. In a lateral aperture of the Woolf's bottle a wire was fitted by means of a cork, and terminated in a brass ball, 10.1 millimeters in diameter below the tube, and at a distance of 3.5 millimeters from its lowest part.

The Woolf's bottle was exhausted and the heating of the water in the tube, on passing the currents of an inductorium in one or the other direction, was observed by means of the intercalation of a thermometer.

The circuit had to be interrupted by an extent of air 2 mm. in length, in order that the discharges might be entirely directed in one way; otherwise the results would have been irregular.

With the decrease of pressure the heating of both electrodes diminished.

The proportion of the heating of the negative and the positive electrode increases thereby from 3 at the pressure of the atmosphere to 4 at a pressure of 11 millimeters of mercury. If an interruption is present in air sufficiently rarefied, the indirect induction current antagonistic to the inducing current preponderates, if the electromotive force is sufficiently great.

In further experiments at the pressure of the atmosphere, a condenser was introduced into the circuit. For this purpose the positive pole of the inductorium was connected with a ball, opposite which was placed another ball, connected with the coating of a condenser (a Leyden battery). The same coating was connected with one electrode, a hollow brass ball, 5 centimeters in diameter, filled with petroleum; while the other coating was in communication, by means of the galvanometer, with the other similar electrode, and the other pole of the inductorium.

In these experiments the proportion of the heating of the negative and positive electrode diminished with the increasing capacity of the condenser down to 1, after which changes had no effect. Up to a certain capacity the heat produced in both electrodes is differently distributed. If the capacity is greater, the heat increases to a maximum and then declines again.

Finally, into a thin glass globe, with two small tubulures, there were introduced two copper wires 3 millimeters in thickness, the very even end surfaces of which were at the distance of 7.8 millimeters from each other. The ball was placed in a calorimeter full of water (75 cubic centimeters), through which the copper wires are led, insulated. As the intensity of the current increased, the potential difference between the electrodes, derived from the heating, decreased. A condenser introduced into the circuit reduces the mean potential difference of the electrodes the less as the capacity is greater. This potential difference derived from the heating is very much smaller than that recognized by Thomson and others at the commencement of the discharge.—*Wiedemann's Beiblätter*.

THE MAGNETIC MUSIC TEACHER.

THIS small apparatus for teaching has appeared to us to be very ingenious, very practical and well worthy of being called attention to. It consists of a box, which, in Fig. 1, is represented one-half actual size. When the cover is opened, there is seen glued to a pane of glass a diagram which we reproduce in Fig. 2. A small movable cardboard disk in the center carries the questions connected with the teaching of music: "How many notes are there?" "What is an octave?" etc. When it is desired to have an answer to the question, the disk is revolved so that the question is at the upper extremity of the diagram. For example, we ask, "How many notes are there?" and we revolve the disk until it has the position shown in Fig. 2. This done, we at once see under the glass a small hand-shaped cardboard index point out the answer, "seven."

FIG. 1.—THE MAGNETIC MUSIC TEACHER.

If we place the question "What is an octave?" at the top of the diagram, the hand will again revolve and point out the answer, "The interval between a note and its most perfect concord."

This curious apparatus operates as follows: The hand-shaped index is fixed to the extremity of a small magnetized needle which is pivoted like the needle of a compass. The movable disk that carries the questions contains internally another magnetized needle. When this disk is revolved, the magnetized needle of the box follows it in its rotation, and the two needles tend to place themselves parallel with each other, their poles of contrary name superposed. This principle being admitted, the manufacturer has combined his diagrams, that is to say, the external series of answers and the inner series of questions, so that the first shall correspond with the second through the position of the two magnetized needles.

There are two sets of questions and two of answers for the instrument, but there might be several.

LITHIUM.

DR. TOMMASI concludes from recent experiments that the atomic weight of lithium ought to be 14 instead of 7, at least in its salts. In *Les Mondes* of January 13, 1883 (p. 51), he acknowledges that its specific heat, which is 0.9408, points very clearly to 7 as the atomic weight of the metal, and also that lithium in a free state resembles one of the alkaline metals. But its salts, he continues, have no analogy to the salts of potassium or sodium, while, on the contrary, they closely resemble the salts of the dyad metals of the alkaline earths, and particularly the compounds of magnesium.

One of the most characteristic properties of the alkalis is that their sulphates unite with the sulphate of alumina to form alums; but the sulphate of lithium does not form an alum. The alkalis form bisulphates, as well as neutral sulphates, but lithium does not form a bisulphate. The alkaline carbonates are very soluble in water, while the carbonate of lithium is nearly insoluble. [Carbonate of lithium dissolves in 100 times its weight of cold water.] The alkalis form anhydrous chlorides, which are not deliquescent, and can be melted without decomposition; this is not true of the chloride of lithium, which is highly deliquescent, and readily decomposes if heated in contact with air.

On comparing the compounds of magnesium with those of lithium, the resemblance is so striking that I am persuaded, he says, that, ignoring the specific heat of lithium, there could be no doubt that the atomic weight of this metal ought to be doubled, and its salts represented by formulæ analogous to those of the dyad metals. Consequently there is nothing to prevent our doubling its atomic weight, except the specific heat. And can we not admit, for the sake of hypothesis, that lithium, when in combination, has an atomic weight twice as large as it possesses in the free state?

On this supposition the chloride, nitrate, and sulphate of lithium would have the following formulæ respectively:

These new formulæ show the great resemblance of lithium and magnesium, the corresponding salts of which are written:

Under our hypothesis the metal lithium will continue to have the atomic weight of 7, and it will only be in the compounds that it will have an atomic weight of 14.

There is nothing impossible in the same element having two different atomic weights according as it is free or combined, for at least one other metal shows the same anomaly, viz., aluminum. For example, the atomic weight of this metal, deduced from its specific heat, is 27.5, but in its compounds it always has double this atomic weight, which is expressed by writing Al_2 in formulæ. Thus we have Al_2R_3 , Al_2R_4 , etc. (R representing a haloid or acid radical), or what would be better, as I suggested some years ago, the formulæ AlR_6 , AlR_8 , by doubling the atomic weights of aluminum. The very smallest quantity of aluminum that is able to enter into a compound is 55, never 27.5, consequently 55 really represents the atomic weight of aluminum, not in a free state but in combination.

A few years ago I proposed to verify this double atomic weight of lithium in its compounds by determining the vapor density of a volatile compound of lithium; for example, lithium ethyl. but to my great regret I have been unable to undertake this very expensive experiment.

Some recent experiments of F. M. Raoult on the congel-

FIG. 2.—DIAGRAM OF QUESTIONS AND ANSWERS.

This system might be extended to any other branch of teaching than that of music. It might, for example, serve as a basis for a multiplication table, for questions in geography, etc. The idea, in fact, is an original one, capable of numerous applications.—*La Nature*.

THERE seems to be a general opinion among naval engineers, that no iron passenger steamship can be said to be constructed upon the best design, which insures safety in case of collision or running upon a rock, unless she is provided with a double bottom. But the space which is thus taken up is under existing laws measured as tonnage carrying area, and there is practically a premium for the neglect of an essential means of security. Few shipowners like to be taxed for a costly effort in itself to preserve the lives of others.

ing of different saline solutions, have induced me to put forth at this time my hypothesis on the atomic weight of lithium. Raoult believes that he has discovered the following law:

"One molecule of any compound, when dissolved in 100 molecules of any unlike liquid, lowers the freezing point of that liquid by a (nearly) constant quantity, which is in the vicinity of 0.62° Cent. (1.12° Fahr.)."

If this law be accepted as true, nothing is easier than to accept or reject my hypothesis of doubling the atomic weight of lithium in compounds. For this purpose it is only necessary to dissolve 1 molecule of chloride of lithium (42.5 grammes) in 100 molecules (1,800 grammes) of water and ascertain the melting point of this solution. If my hypothesis is true, we ought to find that this quantity of chloride of lithium would lower the freezing point only 0.31°, which