tion. It will be noted that the line coming from the left is dead-ended on the upper insulator, and continued by means of a cross-over connector to the neighbouring line, its mate. This line is also dead-ended on the other upper insulator. In the same way the other two sides are joined so that the position of the conductor on each side of the cross-arm is reversed.

The present line carries two cross-arms, which will eventually carry 10 wires each. The line passes through, or is connected by short branches and loops with, the most important cities between New York and Chicago.

Credit must be accorded to the enterprise and management which has made the New York-Chicago line a possibility, but we cannot close this description without a brief mention of those who have had immediate charge of the work and have brought it to a successful completion. Mr. E. P. Meany, assistant general manager of the Long-Distance Company, has had charge of the construction work of the entire line, and F. A. Pickernell, engineer of the Company, has had general charge of the electrical and mechanical working out of the system ; while Mr. A. S. Hibbard, the general superintendent, has had charge of its operation and maintenance. The Company is to be congratulated on the possession of the services of men so thoroughly competent, and whose work will, no doubt, prove of permanent value to the profession at large.

THE OBJECTIVE REPRESENTATION OF HERTZ'S RESEARCHES ON ELECTRICAL RADIATION.*

BY L. ZEHNDER.

The small sparks which Hertz obtained in the secondary conductor in his experiments on rays of electric force are not immediately suitable for representation to numbers of people, because they emit very little light. It is true that sparks can be obtained about 6m. away from the reflector and about $\frac{1}{2}$mm. long, and these sparks can be seen about 3m. further off in a darkened room, but these can only be seen by a very limited number of people. Many devices have, therefore, been employed to make the Hertz effect visible.† The author has endeavoured to attain this object by making the Hertz sparks cause the discharge of a high-pressure set of accumulators through a Geissler tube. The brilliant light of the tube, which continues so long as the primary discharge is continued, is a very impressive method of showing the experiments of electric radiation and reflection. Hertz has himself lately published an account of an experiment in which he has caused the discharge of such a high-pressure battery through a minute air gap by means of ultra-violet light-rays, a method which has some analogy with the experiments about to be described.

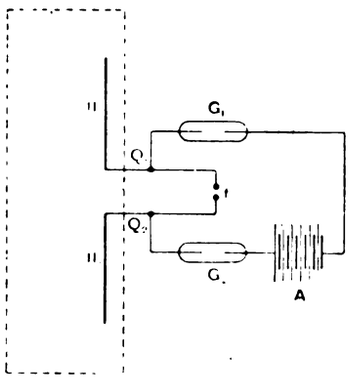

FIG. 1.

The author employed in his researches a reflector with its primary and secondary conductors in the position described by Hertz ; the secondary conductor consisted of two brass plates, each of 50cm. long, 5cm. wide, and 1mm. thick. The secondary of the Ruhmkorff coil gave very good sparks of 0·7cm length when worked with the very rapid Deprez interruptor. The battery consisted of a set of 600 small Planté cells, and was coupled in series with a megohm, so that very small currents passed through the Geissler tube, which could thus be worked for hours together.

The results of a few preliminary experiments may be of interest. The first successful experiment in obtaining effects of the electric oscillations in the secondary conductor on the discharge in a Geissler tube, was with the arrangement shown in Fig. 1. II II are the secondary conductors in the focal line of the reflector. Q_1 Q_2 are mercury cups, G_1 G_2 are small Geissler tubes about 4cm. diameter, having their electrodes fairly close together ; f is the Hertz spark gap, and A the battery. The spark gap was so regulated that, when the battery was cut off, small sparks jumped across ; then the battery was put on and adjusted to such a potential difference that another cell or two caused sparking through the circuit G_1 f G_2, the potential difference being thus just too little to start the current. If, now, the Hertz spark was started at f, the current from the battery immediately broke down the resistance of G_1 and G_2, and the glowing of the tubes showed that the Hertz spark had occurred.

The spark gap was now introduced into the tubes themselves. First, a tube containing a spark gap of definite length was slowly exhausted and the behaviour of the spark noted at intervals ; the brilliancy of the spark appeared to diminish with the pressure of air. Then the pressure was reduced to 1mm. of mercury : and in order to produce a very small sparkgap, thick platinum-tipped copper wires of about 5cm. length were sealed into the tube and made to touch when hot. On cooling, the copper wires contracted more than the glass, and caused an almost infinitesimal gap between the points, which, of course, increased as the tube cooled. While cooling the secondary, sparks were passed through the gap in the exhausted tube. At first the spark looked just like the ordinary Hertz spark, but, as the wires drew further and further apart, there came a critical point at which the bright spark disappeared. If, now, the tube was looked at in a darkened room the space in the neighbourhood of the electrodes was found to be aglow, the phosphorescence being greatest at the electrodes, and spreading several millimetres on every side. This glow is no doubt the well-known kathode light, and it appeared to be very nearly symmetrical with regard to both electrodes. The anode light could probably not be seen, as it was so near as to be masked by the brighter kathode. It was remarkable that the change from spark to glow occurred quite suddenly when the electrodes reached the critical distance apart. The glow could be made between electrodes further and further apart as the Hertz reflectors were put nearer and nearer together.

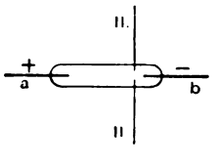

FIG. 2.

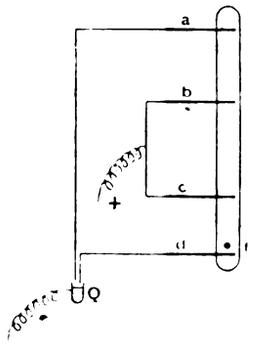

FIG. 3.

The author then proceeded to seal in the same tube electrodes both for the direct-current discharge and the Hertz spark, as shown in Fig. 2. a and b are the electrodes, II II the Hertz secondary conductor. The spark gap was placed near the kathode, since it is known that in the neighbourhood of this lies the greatest resistance of the air path ; and by breaking this down by means of the Hertz spark the greatest possible diminution of resistance would be obtained. It was found that if, as before, the potential difference between a and b was adjusted to be just too small to start the current, the Hertz spark would cause it to start if the spark was taking place in a gap sufficiently wide to cause it to take the form of the glow described above, but not otherwise. The Geissler tube continued to glow until its circuit was broken. It is, therefore, only the glow discharge of the Hertz secondary which is capable of so diminishing the resistance of the air path in the Geissler tube as to start the battery current.

The next experiment is shown in Fig. 3. Two sets of electrodes, a b and c d, were sealed into the same tube, a and b being slightly wider apart than c d. Between this latter pair was the spark gap f. By means of a mercury cup, Q, either pair of electrodes could be coupled up to the battery. If a b were coupled to the battery, so that a discharge was set up, no current would pass from c to d if also coupled up ; but if, and so long as, Hertz sparks were passing at f, the glow took place between c and d. Thus, by concealing the tube a b from sight, the part c d would light up whenever a Hertz spark was passing at f. The tube gradually became useless, as after a time the resistance of the gap a b became less than c d.

Many experiments were made with the arrangement shown in Fig. 4 The secondary conductors II II were fastened to the tube B, whose electrodes a b served for the accumulator discharge. A is the accumulator, W_1 and W_2 high resistances, m and n switches.

* Abstract from *Wied. Ann.*, No. 9, 1892.

† *See* Lucas and Garrett, *Phil. Mag.* (5) 33, p. 299, 1892, and *Wied. Ann.*, Vol. XL. and XLIII.

The tube was 0·8cm. diameter inside, and the electrodes were 5cm. apart. The spark gap was at *f*, near the electrode *b*, which generally served as kathode, and the gap was estimated at $\frac{1}{50}$mm. In order to prevent the change of resistance of the tube described in the last paragraph, a certain amount of metallic sodium was passed into the tube by means of the electrode *e*, which absorbed the oxygen remaining in the tube after exhaustion.* The pressure was 1·2mm. of mercury. The resistances W_1 and W_2 were tubes containing a solution of cadmium iodide in amyl

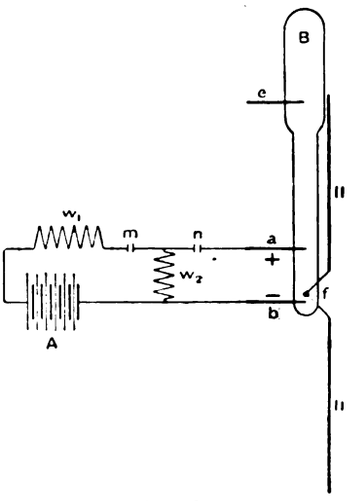

FIG. 4.

alcohol, and were adjustable. W_1 in series adjusted the strength of current, W_2 in parallel adjusted the potential difference on the electrodes. By means of this arrangement the passing of the Hertz spark can be shown very well, using reflectors up to 8m. off. The battery discharge, which is started by the Hertz spark, can be seen easily in a room into which no direct sunlight enters, fully 10m. away. By use of the resistances W_1 and W_2 the potential can be so accurately adjusted that the battery discharge both starts and stops with the Hertz discharge.

The author describes some experiments which tend to show that, owing to the variability of the potential difference of an induction coil, it is not equally as well suited for these experiments as a high potential battery; but he says it may be used where the battery is not available.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *December* 2, 1892.

The Westinghouse Glow Lamp.—It has just been announced that the Westinghouse Electric and Manufacturing Company has fixed its prices for the new two-part lamps, the manufacture, sale and use of which, it is claimed, do not infringe the Edison patents. The list prices will be 35 cents for 25 and 20 c.p. lamps, and 30 cents for 16, 10 and 8 c.p. lamps. The discounts will be from 2½ to 10 per cent., according to the quantity ordered at one time, and 10 per cent. regularly to its central stations. The allowance for delivery at its factories of the glass parts of such lamps will be 10 cents each, so that the net price of the 16, 10 and 8 c.p. lamps, which form nine-tenths of those used, will be about 17 cents each. It is estimated that the saving to a central station by the return of the glass parts of the lamps and the low prices of the new lamps will equal nearly 1 per cent. dividend on its capital stock. Although the time set for the placing of this lamp on the market has arrived, it has not yet appeared. That the prices for it have been fixed, however, is taken to be sufficient indication that the arrangements for its manufacture are pretty well settled. A good deal of interest has been aroused among lamp experts regarding the possibility of maintaining a sufficiently good vacuum by means of the processes which outsiders have been given to believe are to be used by the Westinghouse people. An interesting point has been brought up in connection with the advent of the separable lamp. It seems that the original application for a patent on this device was rejected a number of times by the United States Patent Office, on the ground that the idea was not new, and that it was in constant use in such well-known apparatus as glass-stoppered bottles. Later, however, a number of patents were issued on a variety of lamps embodying this principle, but it is claimed that no patent has yet been granted on the fundamental idea. Such patents as were issued, however, are now controlled by the Westinghouse Company, but it has been intimated by reliable authorities that the General Electric Company may take the matter up and endeavour to secure a patent on the original application for a separable lamp. This, it is claimed, it is possible to accomplish, on the ground that the device has not been in public use. This is an interesting point which may have considerable bearing on the future of the lamp industry in this country.

* *See* Warburg, *Wied. Ann.*, Vol. XL., 1890.

NEW YORK, *December* 9, 1892.

Electrical Literature.—Dr. John Hopkinson's "Collected Papers on Dynamo Electric Machinery and Allied Topics" has just appeared from the press of an American publishing house. It is a little strange that these papers have not been published in this form in England, as the demand for them must have been considerable, judging from the frequency with which they are quoted by writers on electric lighting machinery. An Electrical Encyclopædia is proposed in this country by Mr. Park Benjamin, who, as is well known, has for some time been the Editor-in-Chief of Appleton's Mechanical Dictionary. It is proposed to make a volume of about 1,000 pages, and it would probably be strictly an American book. Mr. Park Benjamin has just received from his agent in Italy a unique book; it is a copy of the first edition of Galvani's essay, "De Viribus Electricitatis in Motu Musculari," published at Bologna in 1791. It contains, in Galvani's own handwriting, the revisions and corrections which were incorporated in the second edition, published the following year. The work is, in any form, of extreme rarity, and a copy with the author's own corrections is, of course, of very great interest.

The Edison-Westinghouse Case.—The Edison-Westinghouse case has been going on this week in the United States Circuit Court of Appeals, before Judges Shipman, Lacomb, and Wallace. The arguments of the attorneys occupied three days, and were finished yesterday. It is expected that a decision will be handed down at an early date, probably before the end of the month or early in January. The case is attracting considerable attention, and the point at issue as to whether or not the General Electric Company's organisation is a violation of the anti-trust law is conceded to be an important one for that company. The case is watched with an interest second only to that shown in the big lamp suit, in which the decision was handed down by the same Court. It is asserted that a very strong point has been made by the Westinghouse Company in this matter, and that had it not already been admitted by this Company that it had an incandescent lamp to place on the market which would not infringe the Edison patent, the Court would undoubtedly regard the tactics of the General Electric Company, in seeking to control other branches of the electrical business by its monopoly of the incandescent lamp business, as injurious to general trade. The fact, however, that the Westinghouse people claim to have a lamp of their own, may convince the Court that the present methods of the General Electric Company will not, after all, injure the general business to any extent.

A Large Westinghouse Alternator.—A large alternating dynamo, said to be the largest alternating-current dynamo used in central station work in this country, is now in operation and under test at one of the stations in this City. It is a Westinghouse machine of 6,000 lights capacity. This, of course, will be exceeded by the World's Fair machines constructed by the Westinghouse Company, which are to be sufficient for a load of 10,000 lamps.

NEW YORK, *December* 17*th*, 1892.

The Edison Lamp Decision.—The chief event of the week in electrical circles is the handing down of the decision in the Edison lamp case by Judges Lacombe, Shipman, and Wallace. This decision, as was expected, is again in favour of the