first of these mounds, and then divided into two branches' one of which commenced to flow towards Adernò, and the other towards Biancavilla, but the supply died out at the source, and the new streams solidified at a height of 2,000 metres, having flowed for a mile and a quarter as a stream 400 metres in breadth. This stream did but little damage; it did not penetrate into the cultivated region, and but in short distance into the woody region. It came into contact, however, with a bed of snow, part of which it converted into clouds of steam, while another portion was liquefied and rushed down the sides of the mountain in a foaming torrent, carrying with it a good deal of *débris*.

The outflow of lava ceased on the south side of the mountain, because the lava found a vent at a lower level on the north side. As the one decreased in activity the other increased. On May 28th Silvestri visited the scene of the northern eruption. A great column of smoke appeared about 20° east of north, while a shower of sand descended, producing the "sad leaden light" (*la luce triste plumbea*) observable during an eclipse. More than two pounds of this sand were collected in ten minutes in an inverted umbrella, and the north flanks of the mountain were soon covered with it. Silvestri ascended from Randazzo towards the new craters, and when at a height of about 2,000 metres and near Monte Nero he heard loud subterranean detonations, and perceived severe oscillations of the soil. Soon afterwards he came upon the great rift, together with several smaller ones, converging towards the principal crater. In the immediate neighbourhood of Monte Nero and Timpa Rossa three new craters were seen, from one of which dense clouds of white smoke issued, while the others emitted lava and showers of ashes and incandescent stones. Frequent flashes of lightning issued from the smoke. The stream of lava near its source emitted a very bright light which, when viewed by a direct vision spectroscope, gave the lines of hydrogen, calcium, sodium, and potassium. The lava flowed downwards at a rapid rate: the wood of Collebasso was destroyed, and by the evening of May 29 it had flowed 6¼ miles, destroying the bridge of Passo Pisciaro and crossing the postal road between Randazzo and Linguaglossa. On Sunday the 31st the stream was rapidly approaching Mojo; the inhabitants became frightened, and brought out the figure of their patron Saint Antony, which was carried in procession to the edge of the stream, while the people fell on their knees and besought the Deity to save them from the impending danger. After the evening of June 1 the force of the eruption began somewhat to abate, and by the 6th inst. it was practically at an end. The lava stream ran nearly 7 miles from its source, and ultimately stopped 500 yards from the river Alcantara, and about half a mile from the village of Mojo. At its termination it is 23 feet in breadth and nearly 32 feet in height. The lava stream entered the bed of the Pisciaro torrent with a velocity of from 4 to 5 metres a minute, which was reduced to 2 metres a minute in the lower valley of less inclination. In 76 hours the lava flowed more than six miles from its source.

Indications of a disturbed volcanic condition were manifest last October, when powerful shocks of earthquake were felt in the territory of Mineo, Palagonia, Vizzini, Scordia, Militello, and Caltagirone. Mineo was the centre of disturbance, and here the shocks continued at intervals during the month of October. Loud subterranean noises were also heard at intervals. Two months later an eruption of mud and gas took place near Paternò, on the southern flanks of Etna. The mud was hot, salt, and petroleum-bearing (*fango salato termale petroleifero*), and its ejectment continued for several months. Towards the end of December last the whole eastern sea-board was visited by a strong shock of earthquake; and soon afterwards a great increase of smoke from the central crater of Etna showed that the dynamic activity of the mountain was unusually near the surface.

Even now we cannot regard the eruption as at an end Ten days after the cessation of the flow of lava telegrams from Rome (dated June 17) announced that the neighbourhood of Santa Venere and Guardia had been visited by repeated shocks of earthquake. A telegram on the following day announced that "an earthquake of great violence" had occurred near Aci Reale, destroying five villages. There is evidently a great deal of volcanic energy still pent up not far from the surface, and we must fear that before long a further outburst will relieve the imprisoned Titanic forces. G. F. RODWELL

THE ELECTRIC DISCHARGE WITH THE CHLORIDE OF SILVER BATTERY[1]

II.

THE HISTORY OF A TUBE

No. 129, *Hydrogen*

WE now give an account of the very great variety of phenomena presented by the same tube charged with hydrogen, No. 129 (see Plate), under different conditions of exhaustion when used in connection with batteries of various potentials, and traversed by currents of different strengths.

This tube is 32 inches long and 1·6 inch in diameter, the terminals are a straight wire and a ring, about 1 inch in diameter, both of aluminium; it is furnished with a glass stop-cock at each end, as represented in Fig. 3. The glass stop-cocks are connected with the mercurial pumps (Alvergniat and Sprengel) and with the gas generator respectively, as shown in Fig. 5.

Tube 129, 5*th Charge of Hydrogen.*—A glow at both terminals was first seen when the pressure was 17·2 mm., 22,632 M,[2] with 8,040 cells, and great heat developed in the dark discharge near the middle of the tube. The spectroscope showed faintly the C and F lines.

Pressure 16·5 mm., 21,710 M, 8,040 cells. One luminosity like that on the right hand of Fig. 10, sho out from the positive and approached to within 6 inches of the negative, then receded back and disappeared.

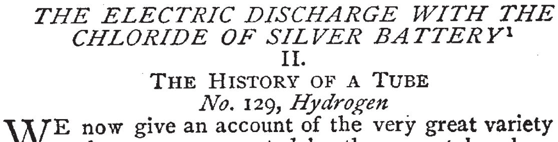

FIG. 10.

Pressure 15·8 mm., 20,789 M, 8,040 cells. 3 luminosities, very steady, which moved slowly and steadily towards the negative. The tube hottest in dark part where there was probably a non-luminous entity.

Pressure 14 mm., 18,421 M, with 6,840 cells, the current was unsteady, but it was perfectly steady with 8,040, and 6 arrow-headed luminosities like that on the left of Fig. 11, were produced and soon disappeared.

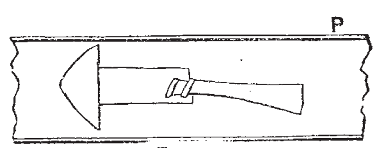

FIG. 11.

Pressure 10·3 mm., 13,552 M, with 8,040 cells. 8 luminosities something like 1, Fig. 12.

Pressure 9·4 mm., 12,368 M, with 8,040 cells. 12 luminosities like those, Fig. 7 in the Plate. The C and F lines seen in the glow around the negative.

Pressure 7·7 mm., 10,132 M, with 8,040 cells. 10 luminosities like Fig. 6 in the Plate; these ran together and disappeared and reappeared in a few seconds.

[1] Continued from p. 178.
[2] M = millionths of an atmosphere

Pressure 6·6 mm., 8,684 **M**, with 8,040 cells. 12 luminosities very similar to those shown at Fig. 5 in the Plate, the last adhering to the positive. The C line not visible in a nebulosity with the spectroscope, but that and the F line were both to be seen in the glow around the negative.

Pressure 5·9 mm., 7,763 **M**, 8,040 cells, C. 0·02056 **W**.[1] 13 luminosities like those Fig. 6 in the Plate. With 100,000 ohms, C. 0·01390 **W**, there were 10 luminosities not so wide as those when there was no resistance.

Pressure 6·1 mm., 8,026 **M**, 8,040 cells, C. 0·01910 **W**. At first 13 luminosities a little unsteady, then 11½ perfectly steady, like Fig. 6 in the Plate. F and C visible in the glow around negative. F was not visible in a luminosity.

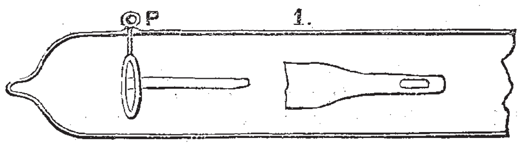

FIG. 12.

Pressure 4·4 mm., 5,789 **M**, 8,040 cells. 12 luminosities as depicted in Fig. 6 in the Plate, which is copied from a photograph[2] obtained in 4 seconds.

Pressure 4·0 mm., 5,263 **M**, 8,040 cells. 15 luminosities as shown in Fig. 7 in the Plate, from a photograph taken in 4 seconds.

Pressure 3·6 mm., 4,737 **M**, 8,040 cells, 30,000 ohms resistance. 15 luminosities almost touching, like Fig. 7 in the Plate.

Pressure 3 mm., 3,947 **M**, 4,800 cells, C. 0·0362 **W**, the resistance of the tube being 88,600 ohms. There were 24 steady blue strata and a space of about 6 inches confused towards the positive; with 200,000 ohms resistance in the circuit the strata became pink, the current being 0·01469 **W**.

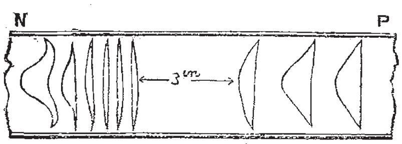

FIG. 13.

Pressure 1 mm., 1,316 **M**, 3,600 cells, C. 0·03896 **W**, the resistance of the tube being 59,170 ohms. The tube was filled to within one inch of the negative with strata all blue, but they turned pink and tongue-shaped when 200,000 ohms resistance was introduced, which reduced the observed current to 0·00782 **W**. The C and F lines visible in the luminosities. When 7,590,000 ohms resistance was introduced, a very close and somewhat agitated pink stratification was produced, like the left of Fig. 13.

Some gas let in, pressure 3 mm., 3,947 **M**, 3,600 cells gave a current of 0·04901 **W**; the resistance of the tube was ascertained by substituting 47,000 ohms wire resistance, which produced the same deflection. The strata were blue, like those of 55 and 56, Fig. 14. For about 10 inches from the negative they took up an axial backwards and forwards steady rotation of about a quarter turn.

With 174,000 ohms resistance, making with the battery and tube a total of 261,000, the current measured was 0·00879 **W**. The strata turned pink and assumed the tongue-form, Fig. 15; with 783,000 ohms in circuit very close strata. In the rotating mirror a flow *towards the positive* was observed until a break occurred in the stratification; the flow was then irregular and backwards and forwards.

Pressure 1·7 mm., 2,237 **M**. The current of 2,400 cells passed; with 3,600 cells the current was 0·03858 **W**, producing perfectly steady strata, of which a photograph was obtained in four seconds; a facsimile of it is given, Fig. 8 in the Plate. The strata were blue, but on introducing 500,000 resistance the current was reduced to 0·00175 **W**, and the strata turned pink and assumed the form Fig. 9 in the Plate, which is a facsimile of a photograph obtained in 19 seconds.

Pressure 0·8 mm., 1,052 **M**, 3,600 cells (C.) 0·19940 **W**. A spiral series of tongues depicted in Fig. 10 in the Plate, from a photograph which, however, could scarcely be exposed long enough in consequence of the screw-like motion of the tongues. This motion appeared to be from positive to negative.[1] On introducing 900,000 ohms resistance, (C.) 0·003414 **W**, the tongues grouped themselves in pairs, of which there were 40, and changed from blue to pink. Examined with the spectroscope, the line C had disappeared. The tube was connected with the condenser of 42·8 microfarads and 3,240 cells, a resistance of 200,000 ohms being in circuit (C.) 0·007461 **W**. At the full potential the same spiral series of blue tongues, quite steady, was produced, and these made a complete rotation in 30 seconds. On breaking connection between the battery and condenser, the strata gradually changed to pink as the charge of the condenser ran down through the tube.

Tube 129, *6th Charge of Hydrogen*.—The tube, at 0·9 mm., 1,184 **M**, was partially charged with hydrogen by letting in 4 small calibrated charges, which increased the pressure each time 1·4 mm., pressure 6·5 mm., 8,684 **M**, the resistance of the tube was found to be 170,000 ohms, and the total resistance of the whole, 8,040 cells, 130,000 ohms, or an average of 16·6 per cell. With 6,960 cells the current, through the tube alone, was 0·02456 **W**, and there were produced 9 luminous entities as shown in Fig. 5 in the Plate, taken from a photograph obtained in 1½ second.

The gas in the tube at the same pressure, namely,

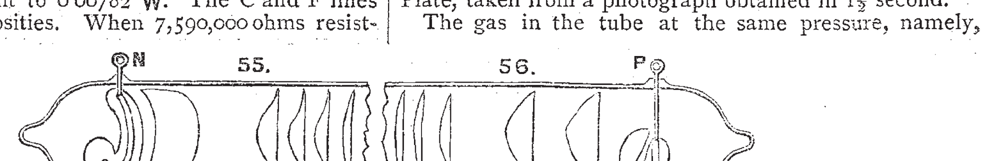

FIG. 14.

6·5 mm., 8,040 cells, C. 0·02634 **W**. There were 7 entities as depicted in Fig. 4 in the Plate, copied from a photograph obtained in one second.

Pressure 6·5 mm., on the introduction of 300,000 ohms resistance with 8,040 cells, C. 0·0138 **W**, making a total resistance, inclusive of the tube and the battery, of 600,000 ohms, two luminosities were produced as seen in Fig. 2 in the Plate, taken from a photograph obtained in 2 seconds, which, however, had to be corrected from a drawing, as there was a slight movement in the luminosities.

Pressure 3·6 mm., 4,737 **M**, 4,800 cells. Strata resembling Fig. 16, but near the negative the strata were

[1] C denotes currents; **W** webers.

[2] Varley, C. F. (*Proc.* Roy. Soc., xix., 1871, pp. 238–239) succeeded in photographing by an exposure of thirty minutes an *arch discharge* in a vacuum tube, so faint that in a perfectly dark room he was "sometimes unaware whether the current was passing or not."

[1] De la Rive (Genève *Mém.* Soc. Phys. xvii., 1863, p. 72) describing the appearance of a nitrogen tube, says: "Ces stries semblent former une hélice animée d'un mouvement de rotation autour de son axe."

indistinct. In the rotating mirror the distinct strata were steady, but in the indistinct portion there was indicated a rapid flow *towards the positive*. The lines C, F, and G seen in the glow around negative terminal, but C and G were not seen in the strata.

Pressure 1·2 mm., 1,579 **M**, 2,400 cells, C. 0·03251 **W**. 11 narrow strata, umbrella-shaped, about $\frac{3}{4}$ of inch wide, followed by two about $1\frac{1}{4}$ inch wide, then a confused discharge, in which the rotating mirror showed a rapid flow *towards the positive*. C, F, and G lines visible in

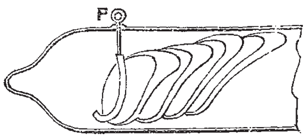

FIG. 15.

the negative glow; G and C disappeared in the strata, and F was very faint.

Tube 139, *Hydrogen*.—Pressure 6·319 mm., 8,314 **M**, 8,040 cells. Three arrow-headed luminosities as depicted in Fig. 3 in the Plate, copied from a photograph and a drawing made at the time. The photograph was obtained in 2 seconds.

Pressure 9·502 mm., 12,526 **M**, 6,960 cells. One luminosity of which a photograph was obtained in 10 seconds but has not been copied. Another photograph obtained

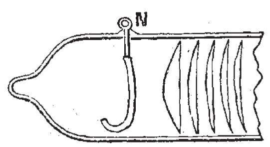

FIG. 16.

in 1 minute is shown in Fig. 1 in the Plate, it will be observed that it has a spear-head continuation towards the negative.

Pressure 0·051 mm., 67 **M**, the current of 3,600 cells passed intermittently; 4,806 cells, C. 0·00191 **W**, produced a continuous illumination from the positive to within 3 inches of the negative, the discharge at the negative licking the inside of the tube.

Pressure 0·01 mm., 13 **M**, the current of 4,800 rod cells just passed: with 6,960 cells the current produced no appreciable deflection of our galvanometer which would indicate 0·00024 **W**. The strata thickened and became much wider. The discharge at the negative licked the side of the tube and was very sensitive to the approach of the finger.

By standing 16 hours the pressure had somewhat increased without leakage having occurred, and was 0·037 mm., 49 **M**, 6,960 cells, current less than 0·00024 **W**; the discharge was milky white and quite different from anything before seen by us with a hydrogen residual charge. The strata had become still broader, the negative discharge hugging the tube and being very sensitive to the finger. The C and F lines could not be seen with the spectroscope, but there was a double green line near *b*.

A charge of hydrogen was let in, the charge being 0·001725 of the capacity of the tube and pump, and increased the pressure to 1·311 mm., 1,725 **M**. 3,600 rod cells produced a stratification composed of umbrella-shaped strata, united in the middle of the tube by a luminosity one-third the length of the tube. The double green line near *b* had disappeared, and the C, F, and G lines were visible in the spectroscope.

Another calibrated charge of hydrogen was let in and raised the pressure to 2·622 mm., 3,550 **M**; the current of 3,600 cells just passed: with 4,800 cells a phase was produced resembling tube 129, Fig. 7 in the Plate.

Another most interesting tube was a favourite of our friend the late Mr. Gassiot, and was presented by him, with many others, to Mr. Spottiswoode. It retains, in a remarkable degree, the record of old stratification by bands of dark deposit with clear spaces between them. It was a matter of interest to ascertain whether the lines of deposit coincided with the position of the spaces or with that of the strata. This tube is composed of a cylinder 13 inches long, and $1\frac{3}{16}$ inch in diameter, having at one end a bulb 2 inches in diameter, from which project at right angles to the main tube two short lengths of tube $1\frac{1}{8}$ inch in diameter, the whole resembling in form the letter T. At the end of the tube opposite the bulb is a straight brass wire $\frac{1}{16}$ inch in diameter screwed on to a wire of platinum, and in the head of the T a brass wire, $4\frac{3}{4}$ inches long, reaching axially right across. The bulb and short tubes attached to it are completely coated with a dense black metallic deposit, and for a space of 5 inches from the bulb, the main tube is stained with eight dark bands. 2,400 cells gave a current 0·02289 **W**, the straight wire being positive, and the cross wire in the bulb

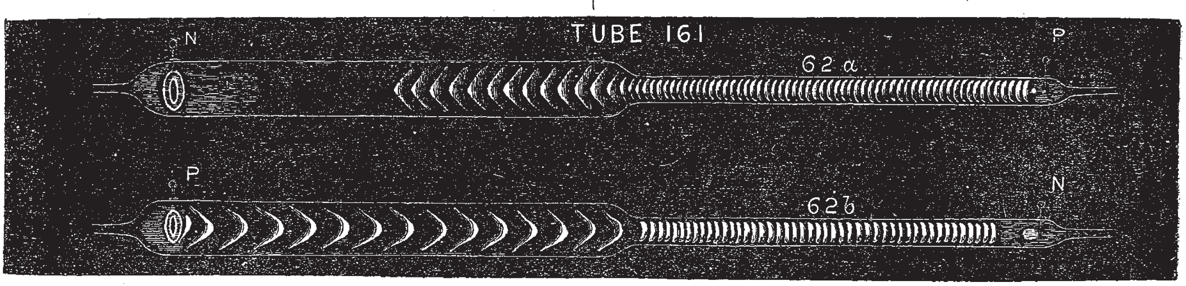

FIG. 17.

negative; there were produced beautiful double strata intensely blue, completely filling the tube. Strips of paper were fastened over these strata in the region of the stains; these were found to occupy the *unstained spaces*; the stains therefore marked the *intervals*, or cooler parts, between former strata.

Tube 161, *Hydrogen*.—The difference of the strata in tubes of different diameter at the same pressure and with the same current is very clearly brought out in tube 161, composed of two portions, one being 18 inches long and 1·65 inch internal diameter, the other 17·5 inches long, and 0·975 inch diameter, the ratio of the sectional areas being 2·864 to 1. The terminal in the small tube is a point, in the large one a ring.

With 4,800 cells, the point (small tube) positive C. 0·02825 **W**, there were produced in the small tube 62 disk-shaped strata, and in the large tube twelve cup-shaped strata occupying half of the length of the large tube; beyond these the discharge was dark. With the point negative, C. 0·02451, there were produced in the small tube 54 disks, and in the large tube thirteen cup-shaped, completely filling it. The number of strata does not, therefore, appear to be in the inverse ratio of the areas. The strata in the small tube were blue, but at times, with a large current, carmine, as in the capillary part of a spectrum-analysis hydrogen-tube, the strata in the large tube being much fainter and pink. The appearance when the point was positive is shown in the diagram, Fig. 17, 62*a*, and when negative in 62*b*, copied from photographs obtained, the former in 15 seconds, the latter in 10 seconds. Another example is shown in Fig. 12 in the Plate.

Tube 160, *Hydrogen.*—This tube was constructed with the object of sending the analogue of a smoke ring through a tube in which a steady stratification had been procured and sustained ; Fig. 18 shows the arrangement.

The tube is 40 inches long and 1·875 inch in diameter, and has a stop cock at each end ; near one of the ends is a small tube, 0·75 inch in diameter, sealed to the main

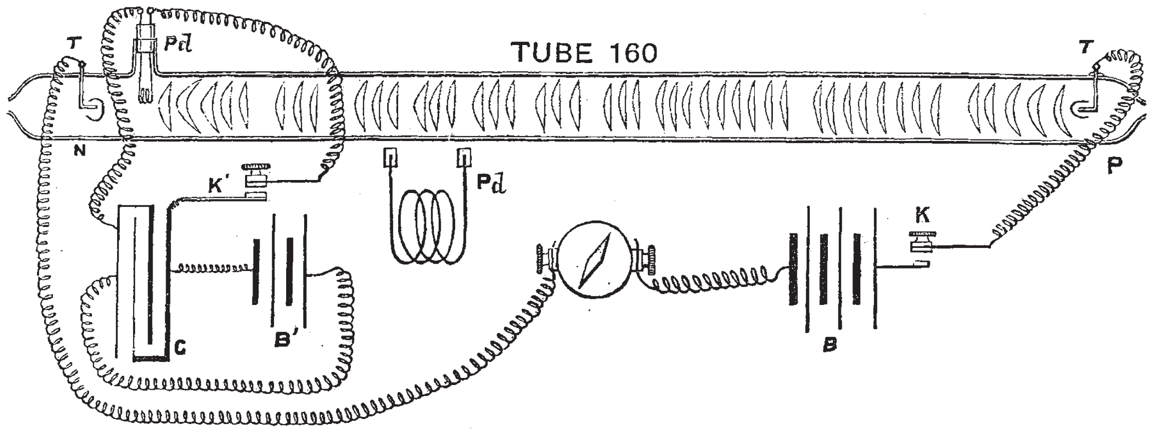

Fig. 18.

tube at right angles, and fitted with a glass stopper, in which two stout platinum wires, 0·043 inch diameter, are melted ; there is soldered, with gold, to the two platinum wires a spiral of palladium made of wire 12 inches long and 0·0125 inch diameter, P*d*, in the diagram. The palladium coil was charged to saturation with hydrogen, by immersing it in dilute sulphuric acid and making it the negative pole of a bichromate battery of six elements ;

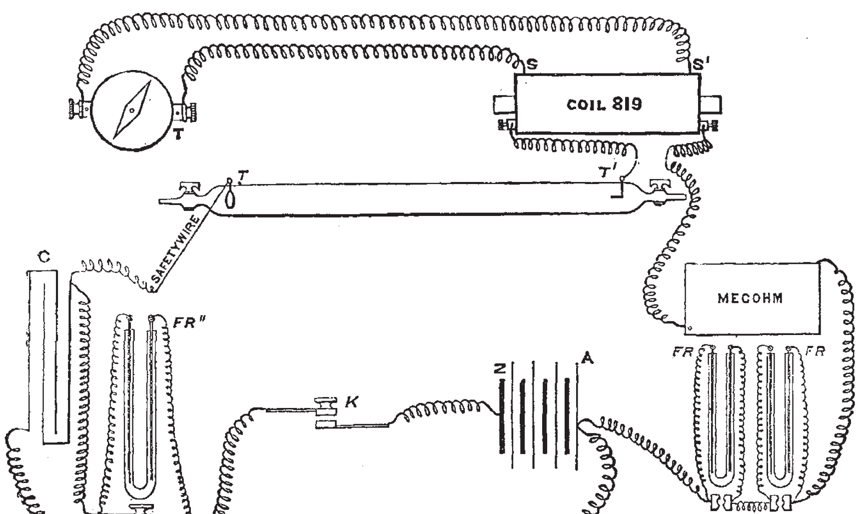

Fig. 19.

after it had been washed in distilled water it was dried and inserted in the tube. The two stout wires of platinum, to which the palladium coil is attached, are connected to a condenser of 10·9 m.f., charged with 3,240 cells. One of the wires leads to the key K', so that no current can pass from the condenser until this key is pressed down; when this is done the charge passes, and by suddenly gniting the wire drives off the hydrogen.

4,800 cells without external resistance :—

Pressure	0·9965 mm.,	before the discharge of the condenser,		
,,	1·0381 ,,	after	,,	,,
Difference	0·0416 ,,	55 M,		

strata were produced from the positive up to the palladium coil which was on the negative side. On liberating hydrogen by the discharge of the condenser these were driven back 14 inches towards the positive, and subsequently only a confused discharge was produced.

When the terminal near the coil was positive the same phenomena were not produced on the discharge of the condenser.

In order to test whether it would be possible to render evident pulsations in the current when perfectly steady strata are produced in tubes containing residual gases, we arranged the detector apparatus as shown in Fig. 19.

A Z is the battery ; A being connected through the fluid resistances F R, F R' (which can be plugged out of circuit by means of P and P'), the megohm wire resistance, and the primary of Apps' induction-coil No. 819, to the terminal T' of the tube ; the terminal A is also connected direct to one plate of the condenser C. Z is connected through the key K to the fluid resistance F R'' (which can be plugged out by pressing down the key K'), thence to the other plate of the condenser, and through the safety-wire to the other terminal T of the tube. The secondary wire of coil 819 is connected to a delicate Thomson galvanometer T.

Many observations were made with coil No. 819, which we had taken to pieces several times during the course of our trials, on account of suspected leakage from the primary to the secondary wire. It was ultimately entirely remade in February, 1878, and the secondary wire coiled on a separate ebonite cylinder to insure efficient insulation, which was accomplished.

In every case where the strata are to the eye or rotating mirror perfectly steady, slight deflections of the needle are seen; these generally indicate a resultant *direct* current (break-contact), and in the fewer number of cases an *inverse* current indicating, in the first case, a *sudden* decrease and *slow* increase of current through the tube. These deflections, though very manifest, do not amount to more than about three or four divisions of the galvanometer scale, a deflection which indicates a current of only 0·00000000023 W. At the advent or retreat of a stratum at the positive pole there is frequently produced a deviation of 300 divisions, indicating a current of 0·000000001812 W; before a stratum leaves the positive terminal or dies out on it, there is usually a tremulous motion of that stratum visible to the eye and indicated by rapid pulsations of the galvanometer.

On the suggestion of Prof. Clerk Maxwell we have recently introduced the telephone into the primary current, as shown in Fig. 20, and also in the secondary current of coil 819.

In all cases where the condenser C was discharging itself gradually through the tube, a low rustling sound was distinctly audible to sensitive ears so long as the stratification remained *apparently* perfectly steady. When the phase of confused stratification which immediately precedes extinction was reached, the sound in the telephone became very loud and rose in pitch, with some tubes becoming quite shrill. These results, therefore, confirm the conclusion already arrived at from other experiments, namely, that the discharge in vacuum tubes is intermittent; but we do not pretend that they make it manifest that stratification is *dependent* upon intermittence.

In the course of our experiments, using sometimes 11,000 cells, we have arrived at the following facts:—

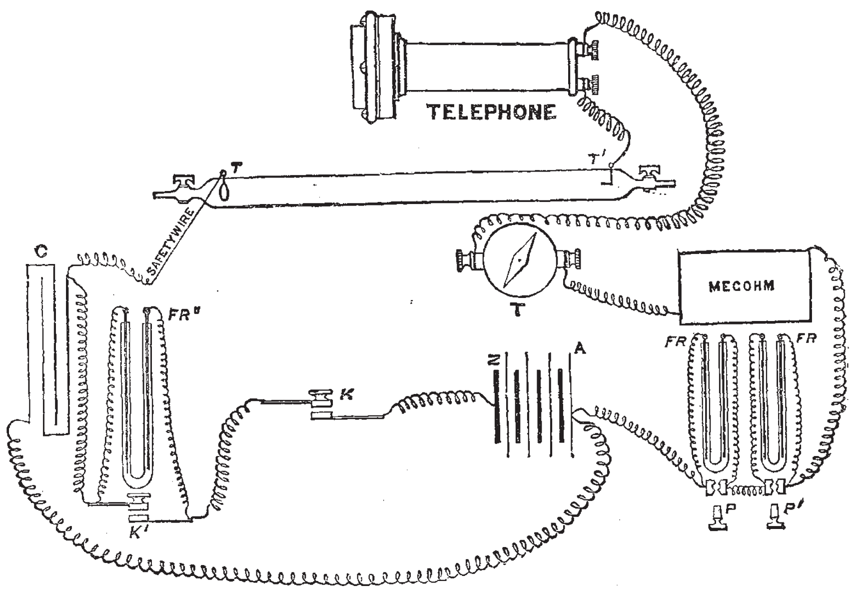

FIG. 20

1. *The discharge in a vacuum tube does not differ essentially from that in air and other gases at ordinary atmospheric pressures; it cannot be considered as a current in the ordinary acceptation of the term, but must be of the nature of a disruptive discharge, the molecules of the gas acting as carriers of electrification. The gases in all probability receive impulses in two directions at right angles to each other, that from the negative being the more continuous of the two. Metal is frequently carried from the terminals and is deposited on the inside of the tube, so as to leave a permanent record of the spaces between the strata.*

2. *As the exhaustion proceeds, the potential necessary to cause a current to pass diminishes up to a certain point, whence it again increases, and the strata thicken and diminish in number, until a point is reached at which, notwithstanding the high electromotive force available, no discharge through the residual gas can be detected.* Thus, when one pole of a battery of 8,040 cells was led to one of the terminals of tube 143, Fig. 21, which has a radiometer attached to it, the other terminal of the tube, distant only 0·1 inch, being connected through a sensitive Thomson galvanometer to the other pole of the battery (earth), the current observed was not greater than that which was found to be due to conduction over and through the glass. Although no current passed, the leading wires acting inductively stopped the motion of the radiometer, as has been observed by Sir William Grove.

3. *All strata have their origin at the positive pole.* Thus, in a given tube, with a certain gas, there is produced at a certain pressure, in the first instance, only one luminosity which forms on the positive terminal, then, as the exhaustion is gradually carried further, it detaches itself, moving towards the negative, and being followed by other luminosities, which gradually increase in number up to a certain point.

4. *With the same potential the phenomena vary irregularly with the amount of current.* Sometimes, as the current is increased, the number of strata in certain tubes increases, and as it is diminished their number decreases; but with other tubes the number of strata frequently increases with a diminution of current. If the source of the current is a charged condenser, the flow being from one of its plates through resistances and the tube to the other; then, as the potential of the condenser falls and the current diminishes, the number of strata alters; if the strata diminish in number with the fall of potential, then the stratum nearest the positive wire disappears on it, the next then follows and disappears, and so on with others; if, on the other hand, the charge of the condenser is very gradually increased, the strata pour in, one after the other, in the most steady and beautiful manner from the positive.

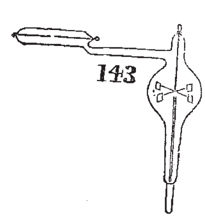

FIG. 21.

5. *A change of current frequently produces an entire change in the colour of the strata:* for example, in a hydrogen tube from a cobalt blue to a pink. It also changes the spectrum of the strata; moreover, the spectra of the illuminated terminals and the strata differ.

6. *If the discharge is irregular and the strata indistinct, an alteration of the amount of current makes the strata distinct and steady.* Most frequently a point of steadiness is produced by the careful introduction of external resistance; subsequently the introduction of more resistance produces a new phase of unsteadiness, and still more resistance another phase of steady and distinct stratification.

7. *The greatest heat is in the vicinity of the strata.* This can be best observed when the tube contains either only one stratum, or a small number separated by a broad interval. There is reason to believe that even in the dark discharge there may be strata, for we have found a development of heat in the middle of a tube in which there was no illumination except on the terminals.

8. *Even when the strata are to all appearance perfectly steady, a pulsation can be detected in the current; but it is not proved that the strata depend upon intermittence.*

9. *There is no current from a battery through a tube divided by a glass division into two chambers, and the tube can only be illuminated by alternating charges.*

10. *In the same tube and with the same gas, a very great variety of phenomena can be produced by varying the pressure and the current. The luminosities and strata, in their various forms, can be reproduced in the same tube, or in others having similar dimensions.*

11. *At the same pressure and with the same current, the diameter of the tube affects the character of the discharge and the form and closeness of the stratification.*

THE ROYAL SOCIETY OF EDINBURGH

THE goodly volume of the proceedings of this Society for the session 1877-78 witnesses to the zeal and success with which scientific problems, whether of general or of more specially local interest, are attacked by our northern *savants*.

The fascination in which the public mind has been held by those remarkable instruments, the telephone, phonograph, and microphone, here matures in fruitful study of them. Prominent among the researches referred to are those of Prof. Fleeming Jenkin and Mr. Ewing on the wave-forms of articulate sounds, as obtained from the phonograph (already described in our columns), and the thoughtful investigations of Dr. Ferguson on the indications of molecular action in the telephone, leading to the conclusion that at the sending-station the evidence of molecular action, though suggestive, is by no means conclusive, whereas at the receiving-station, the existence of molecular as well as mechanical action amounts to demonstration, and it is shown to be considerable in amount. Several striking observations in the same field are recorded by Professors McKendrick, Tait, and Forbes, Mr. Blyth, and others. In a paper on beats of imperfect harmonies, Sir William Thomson develops the theory of the phenomenon, and affirms (as a result of experiment) that in every case the ear distinguishes the two halves of the period of each beat, represented respectively by a sharp-topped and flat-hollowed curve and by a flat-topped and sharp-hollowed curve.

The Fourth Report of the Boulder Committee communicates many instructive facts, especially as regards transport of boulders. In his appended remarks Dr. Home shows reason for thinking that two notable spherical balls of marcasite found in the boulder clay at Leith, came from the westward, one from Campsie or Kilsyth (not less than thirty miles), the other from Humbie, nine or ten miles due west of Edinburgh. A geological study of the district indicates the agency of deep-sea currents loaded with ice, which flowed upon the Campsie Hills from the west-north-west, scooping out the present valley and breaking up, to a large extent, the coal strata in it. Thus some of the nodules in these strata would find their way to Leith, where they were embedded Several cases are noted in which boulders, to reach their present sites, must have crossed arms of the sea (*e.g.*, boulders in Staffa, at Appin, and in Loch Creran, from Mull, and others in Nairn, from Ross-shire). The high position of many boulders is explained by Prof. Judd's supposition, that in pliocene times there were mountains in Skye, Mull, Ardnamurchan, and even in Rum, some of which reached a height of at least 14,000 feet. In another geological paper Prof. Geikie traces out the limits of the different basins in which the old red sandstone of the British Islands was deposited, distinguishing the basins as Lakes Orcadie, Caledonia, Cheviot, Lorne, and the Welsh Lake. Dealing with the first alone, he examines the evidence for Murchison's three-fold arrangement of the old red sandstone (finding the middle division only in the north of Scotland), and describes the various districts of Lake Orcadie *seriatim*.

From experiments on suspension, solution, and chemical combination, Mr. William Durham concludes that these phenomena differ only in degree, and are manifestations of the same force. The attraction of chemical affinity is not, in all cases at least, exhausted when a definite compound is formed, but has sufficient power left to form solution or suspension compounds. The same force operating in chemical combination and solution, explains the powerful effects of solution in promoting chemical reaction and electric conductivity. Among chemical subjects treated, are the action of heat on some salts of trimethyl sulphine (Brown and Blackie), the action of chlorides of iodine on acetylene and ethylene (McGowan), and the crystallisation of isomorphous salts (Robinson).

In physiology, we note an extension of Prof. Rutherford and Messrs. Vignals' experiments on the biliary secretion, with reference to the action of cholagogues. The effects of fifty-two medicinal agents on the liver (of dogs) have been investigated, and the great majority of the conclusions are in complete harmony with the results of clinical observation, while many new facts are given to the physician.—Mr. Newman successfully imitates in a physical experiment, the function of the kidney.—Mr. Stirling furnishes some notes of the fungus disease affecting salmon.

A sketch is given by Mr. Edward Lang, of the arrangement of tables of ballistic curves in a medium resisting as the square of the velocity, and of the application of these tables to gunnery.

Without further enumeration, we may direct attention to some interesting accounts of that rare phenomenon, a white sunbow, witnessed at Edinburgh on January 10 last year.

OUR ASTRONOMICAL COLUMN

THE SATURNIAN SATELLITE HYPERION.—Prof. Asaph Hall has investigated the elements of this satellite, first from thirty of the best observations made at Washington in 1875, and again from thirty observations by Mr. Lassell at Malta, in 1852-53. In the former case the approximate elements in *Astron. Nach.* No. 2137 were used in the calculation of equations of condition, which were solved by the method of least squares. The resulting orbit is as follows:—

Passage through perisaturnium, 1875, Oct. 27·8380 Greenwich M.T.

Perisaturnium	172° 59′·7	For 1875,82.
Ascending Node ...	120 12·0	Referred to the plane
Inclination	6 12·1	of the earth's equator.
Excentricity	0·11885	
Semi-axis major	216″·56	

Assuming these values for the node and inclination, Mr. Lassell's observations were discussed and gave the elements:—