THE ELECTRICAL PLANT OF THE JEFFERSON PHYSICAL LABORATORY.

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The Jefferson Physical Laboratory of Harvard University has at present the most extensive plant for the study of high tension electricity in the world. It consists of 20,000 storage cells with transformers which can exalt the normal voltage of these cells—44,000 volts—to 6,000,000. A higher voltage could be obtained, but I have discovered that even 3,000,000 volts is not realized in the length of the electric discharge which should be—10 feet—as long as the apparatus is enclosed in a room with walls of brick. It will be necessary, if the effects of high voltage are to be studied in regard to their full disruptive effects, to place the apparatus in an open field, and at least 30 feet above the surface of the ground.

In a previous article in the SCIENTIFIC AMERICAN I described the type of cell and the peculiarities of my transformer. I wish to describe in this article some new results I have obtained with the greatly increased size of the battery.

The plant occupies a room in the laboratory approximately 30 by 60 feet. The battery is contained in closets with doors to protect from the dust. Fig. 1 gives a general view of these closets with the racks of cells.

Glass condensers serve the function of Leyden jars. There are twelve of these trays, carrying twenty-five glass plates each, there being thus three hundred plates in all. The condensers are made one-eighth of an inch in thickness, and they have a coated surface of tinfoil, 16 × 20 inches; the capacity of the entire condenser in multiple is about 1·8 microfarads. When the condensers are charged to twenty thousand volts and discharged in series a spark six and one-half feet in air is produced. As I have previously said, a longer spark cannot be produced as long as the apparatus is situated in a room and not in an open space.

I have lately made some interesting experiments in regard to the question, "Can lightning pass through a small orifice?" And I mention these experiments in this connection to illustrate the character and behavior of these powerful discharges. A plate of glass five feet square and one-quarter of an inch thick was placed between the spark terminals. The plate was necessarily of this size to prevent the sparks from passing around the edges of it. The plate had a small hole bored through it at its center. This orifice could be made much smaller by filling the hole with paraffine and making a needle hole in the paraffine. It was found that when the discharge terminals were in line with the hole and five feet apart the discharge would pass through the minutest orifice; but the portion which passed through the hole was only a fraction of the entire discharge, for there was an inductive action over the entire surface of the glass. This inductive action could be shown by hanging a large sheet of paper in front of the glass. After the discharge it was found closely adhering to the glass, while its presence did not modify the general appearance of the spark shown by the photograph; furthermore, when the hole in the plate is entirely closed by paraffine and the spark terminals are placed opposite each other, about four feet apart, with the glass plate midway between them, a spark will jump from one terminal to the surface of the glass, while no spark is seen on the opposite side of the glass. On close inspection, however, a faint brush discharge can be detected on the sparkless terminal; the discharge has been continued by an inductive action over the entire surface of the glass.

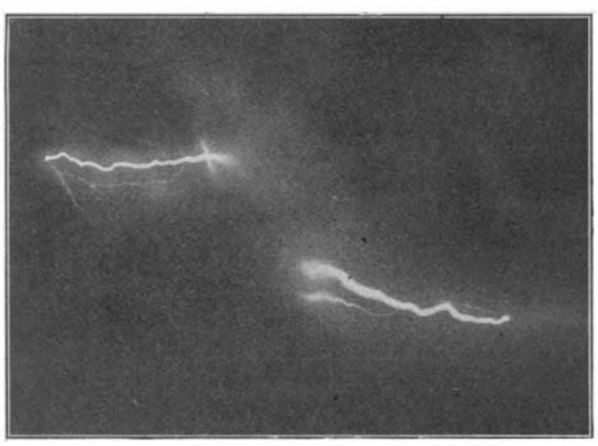


Fig. 2.—DISCHARGE AT HIGH POTENTIAL.

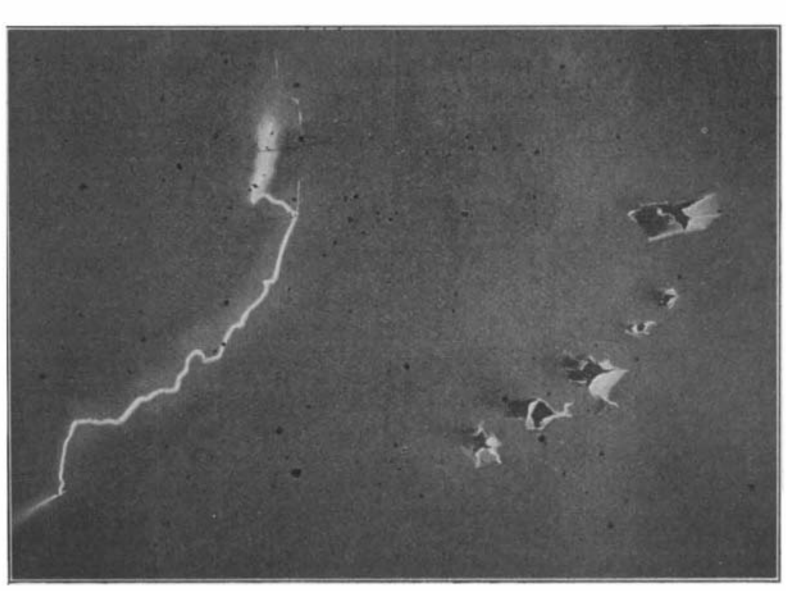
When the spark terminals were not opposite, the spark also sought the orifice, but in general the discharge jumped to the nearest point of the glass and then pursued a devious way to the hole. I was interested to study the electrical action at these forks or sinuosities, and accordingly hung up a large sheet of paraffined paper on the glass and photographed the discharge through the translucent paper. After the discharge the paper was found to be blown out in rents at points corresponding exactly to the forks or sinuosities of the discharge. I have arranged a photograph of the spark and a photograph of the rents in the paper near each other, and it will be seen how closely the explosions correspond to the forks. Is it not possible that the peculiar rolling of thunder coming apparently from a single discharge of lightning may be due to successive explosions along the same spark many hundred feet apart? The discharge of the condensers in multiple, however, has more scientific interest than the discharge in series, for by its means great heat can be generated in a confined space, giving probably the highest instantaneous temperature which has been attained. The following experiment illustrates the quantity of this discharge; a fine iron wire about six inches long was stretched around the spark gap serving as a shunt to the latter. It was found that the wire was deflagrated, Fig. 5, at the instant that a spark passed across the air gap. This leads me to think that a small spark could occur under certain conditions inside a metallic cage and in the case of very powerful lightning discharges a wire cage would not be a perfect protection for a powder magazine.

Fig. 1.—AISLE OF BATTERY.

24 × 6 feet; there are eight aisles in all.

I have used the strong current from the entire battery to excite discharges in hydrogen, for the spectroscopic study of this gas is of the highest interest, since it is apparently the chief constituent of the atmosphere of a great number of stars, and it is the constituent of the flames of the sun. From my spectroscopic study I find that aqueous vapor becomes manifest in all glass vessels which I have examined filled with apparently pure dry nitrogen or hydrogen. The powerful discharges drive off the aqueous vapor from the glass, notwithstanding the glass has been subjected to a long process of heating to expel the vapor during the exhaustion of the tubes.

The most interesting result, however, I have obtained with this great battery is the production of the X-rays for the first time by a steady current. An X-ray tube is simply connected to the terminals of the battery and a water resistance of perhaps a million ohms resistance is inserted in the circuit, the tube is then heated by an external source of heat. In an instant the tube lights with a most brilliant exhibition of X-rays, and photographs taken by means of them show unmistakable evidences of the tendons and muscles. I believe that when the right conditions are reached I shall obtain satisfactory photographs of these objects.



Spark. Explosion.

Figs. 3 and 4.—DISCHARGE THROUGH PARAFFINED PAPER.

The Schweitzer System of Bread-Making in Paris.

There has recently been established in Paris a company for the formation in all the populous centers of France of combination milling and baking houses worked by machinery. The object is to furnish nutritious and digestible white bread at the lowest cost of production. The first establishment began operations in Paris on July 15. The bread is sold to the working class at about 2½ cents per pound, which is considerably less than the usual price. The Villette establishment is 515 feet long and is situated on a canal. The wheat arrives in boats, and it is then elevated into bins, whence it is carried by an enormous elevator to the top of the mill and turned into the different cleaning and separating machines. After all foreign substances have been removed and the grains of wheat have undergone a thorough brushing and washing, they are clean and shiny, but the grooves of the wheat sometimes contain a little dust which is entirely eliminated by a device which seizes each grain lengthwise, splitting it exactly in the groove. The wheat then passes into a mill composed of flat, circular grinders grooved in such a manner that they accomplish the decortication of the kernel, and its granulation into meal at the same time. The grinders are movable and do not touch, so that instead of crushing the grain and producing a flour, the starch only of which is retained, the outer and harder portion is retained in the flour, the bran only being expelled.

Attached to the mill are the works for kneading the meal, water and yeast into bread. All this is accomplished mechanically. Special yeast is prepared in the upper story, in rooms which are heated in winter and cooled in summer. The yeast, flour and salted water and filtered water are carried down by machinery into kneaders in the form of half cylindrical tubs rotated on two pivots placed close to the kneading troughs, so that the tubes may be placed at a lower or higher angle, in order to accelerate or retard the kneading. The wheat, salted water and yeast automatically enter one end of the tub, and the dough, in an endless skein of pale yellow, issues from the opposite end. The dough falls on tables on the ground floor, where it is weighed and made into bread of every shape and size. There is a laboratory in connection with the establishment for the chemical examination of the samples of wheat submitted.

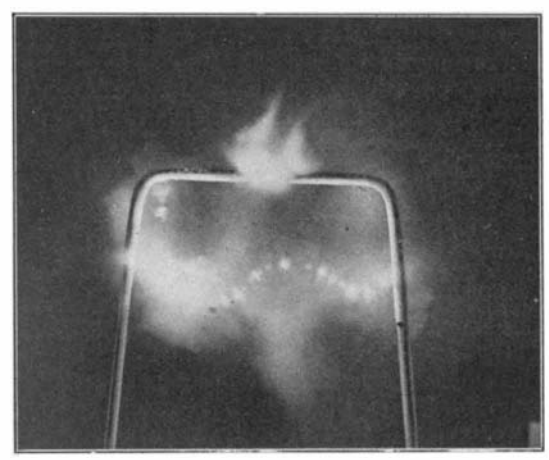


Fig. 5.—DEFLATION OF THE WIRE.

FOR some time past workmen have been engaged in pulling down the mound on the north side of Cardiff Castle, and constructing a massive wall on the site of the Roman foundation, and now three-quarters of the northern rampart has been laid bare. The discoveries made tend to throw a great deal of fresh light upon the condition of Cardiff Castle in Roman times.

Paris Exposition Notes.

The Optical Palace contains the great telescope of 1900 which is the largest yet constructed. It is now in working order, and a number of observations and photographs have been made. It has been constructed by a company called the Société l'Optique ; the idea originated with M. François Deloncle, a former deputy and minister, and the work of construction has been carried out by M. Gautier; the enterprise owes no small share of its success to M. Gaston Laforcade, who is one of the directors. The objective has a diameter of 49·2 inches and weighs 1600 pounds ; the glass disk was cast at the Jeumont works, and eight disks were rejected before a perfect one was found. The tube of the telescope is nearly 200 feet long, being supported horizontally on iron arches, and the image of the star is sent into it by a siderostat whose mechanism revolves a mirror 78¾ inches in diameter and 9 inches thick. The eye-piece is mounted upon rollers and has a screw adjustment for focusing ; at the back is a frame which carries the ground glass to be used in photographic work. The view of the moon as seen on the ground glass is very striking, the image is 21 inches in diameter and is the largest yet obtained; the different details of the moon's surface are shown with great clearness ; when the mirror is stopped the image moves rapidly, and disappears in a few minutes. The building contains a hall of considerable size constructed with a view of making direct projections of the moon's disk upon a large screen. This has not as yet been carried out, owing to the fact that the conditions must be favorable, such as the condition of the weather, phases of the moon, etc. A number of fine photographs have been taken with the telescope, and these have been enlarged and are projected upon the screen, with striking effect. A number of eminent astronomers have made use of the great telescope in making observations, and it is likely to render a considerable service in astronomical work. It is understood that the company wish to dispose of the telescope to one of the large observatories after the Exposition.

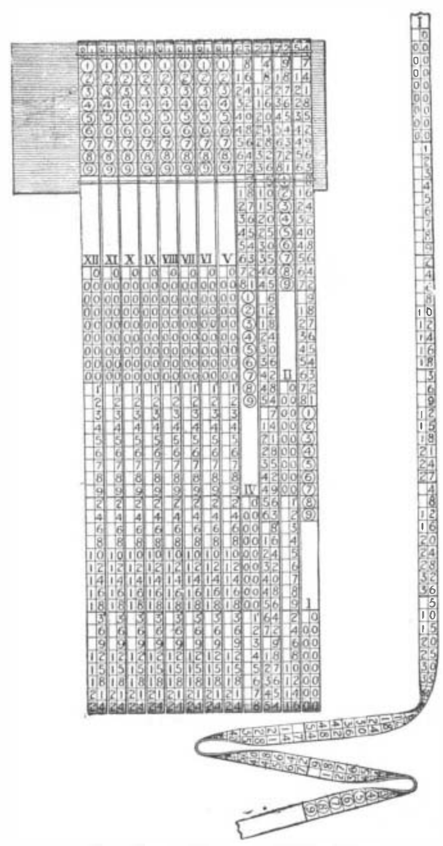
One of the interesting features of the Electrical Palace at the Paris Exposition is the centennial exhibit of historic apparatus installed by the French government. It is situated on the second floor, not far from the United States Pavilion. It occupies a considerable space, the smaller apparatus being placed on the shelves of a number of cases, while the larger pieces, dynamos, etc., occupy the central part. In the cases is shown a great variety of apparatus used by different inventors and early forms of instruments. An interesting collection of books is shown, dating from the seventeenth and eighteenth centuries, and relating to physics or electricity. The oldest of these is an example of Gilbert's famous Latin treatise on magnetism, "De Magnete," published in London in 1600. Among the works of the seventeenth century is a treatise on magnetism by Kircher, 1864, and a work by Otto von Guericke describing his vacuum experiment. It is dated 1672. Among the eighteenth century works the most important is a French translation of Franklin's works, bearing the title "Experiments and Observations on Electricity, made in Philadelphia by Benjamin Franklin, and contained in several letters to M. P. Collinson, of the Royal Society of London." It was published at Paris in 1752. Among the works of the present century are treatises on physics and electricity by Oersted, Becquerel, De la Rive, Arago, and others. That of Ohm bears the title, "The Galvanic Chain, by Dr. G. S. Ohm. Berlin, 1827." Among the most interesting of the apparatus in the cases may be mentioned a number of early forms of dial and needle telegraphs of the Breguet and other types, some of which were loaned by the Society of Postes and Telegraphes. The laboratory of the Sorbonne furnishes a galvanometer of the Nobili pattern, made by Ruhmkorff, with an electroscope. Two incandescent lamps of the Lodyguine type are shown, in which a carbon rod is used, surrounded by a glass globe with imperfect vacuum. One of these was made in Paris in 1874 by Komm, and the second by Fontaine in 1876. An original Clamond thermopile is also shown, this having been presented by the inventor to M. Jamin ; also a bismuth thermopile of Pouillet. A registering telegraph receiver using chemical paper is to be seen ; it was constructed by Pouget in 1852. An interesting collection of Jablockkoff candles is shown, besides a lamp globe containing eight candles mounted upon a base ; it is one of the series used in 1876 for the lighting of the Avenue de l'Opera. Among the larger apparatus may be mentioned an old type of frictional machine of Van Marum with disk, and another of the cylinder type of Naime. A magneto machine constructed by Pixii, under the direction of Ampère, is to be seen ; this has been loaned by the Sorbonne. A number of early types of dynamos are shown, among which is a dynamo for electro-chemical work, claimed to be the first used for this purpose ; it was installed at the Christofle works at Paris in 1872. Several early types of gramme dynamos are also to be seen. The collection, which is not yet completed, will be of great interest.

AN INGENIOUS CALCULATOR.

A calculator remarkable for its simplicity and ingenuity and decidedly different from other machines which employ a series of 57 tapes has been patented by Chow Ling Shang, of 57 Holanyen Street, Macao, China. The device considerably simplifies multiplication and division. Our illustrations show the complete apparatus and one of the tapes employed.

Upon a base of wood or other material guides are secured which form passages for a series of endless tapes. In our illustration the tapes are designated by the Roman numerals I, II, III, IV, etc. Each tape is longitudinally divided into two columns and into groups of nine numerals each. In the first group all the figures are zeroes ; in the second group the numbers "1" to "9" are inscribed ; in the third group the number "2" and its multiples up to "18" are written, the units being in the right hand column and the tens in the left hand column. In the next groups are the multiples of 3, 4, etc., up to the multiples of 9, after which the numbers 1 to 9 appear in the center of the tape, the division of the tape into two columns being abandoned at that point.

When it is desired, for example, to find the product of eight times eight thousand four hundred and ninety-seven, the tapes I, II, III, IV are moved until the numbers "8," "4," "9," "7" of the tapes are on the same horizontal line, the other tapes being left in their normal positions. In the eighth line will be found the number "56" on tape I; in the same line, tape II bears the number "72"; tape III the number "32"; and tape IV the number "64." The product is obtained by noting for each tape the number contained in



A SIMPLE CALCULATOR.

the right hand column of that tape, with the addition of the number in the left hand column of the next tape to the right. In other words, contiguous numbers of different tapes are added. Thus, in the present case, "2" and "5" from tapes I and II are added, "2" and "7" from tapes II and III, and "4" and "3" from tapes III and IV. The result obtained is "67,976," which is the product sought. The figuring of other products is readily understood from this example. To multiply by a number larger than 10, the well-known method of adding the results of partial multiplications is employed.

In division the calculator is employed to find multiples of the divisor and to do away with tedius multiplication. In dividing 212,425 by 8,497, for instance, 21,242 is divided by 8,497, as usual, giving 2 as the first figure in the quotient ; the calculator may be used for this operation, since it shows that 21 (in the thousands) is between the double (16,994) and the triple (25,491) of 8,497. Twice 8,497 is then read off as 16,994 and subtracted from 21,242, leaving 4,248. To this remainder is added the last figure, 5 ; and 42,485 is then divided by 8,497. The machine shows at a glance that 42,485 is equal to 5 × 8,497. The result of the division is therefore 25.

A Telescope Discovers a Theft.

A telescope was recently being tested at the Bausch & Lomb Optical Works, at Rochester, N. Y., and it was turned on a bridge and the observer saw a young thief take a tub of butter from a wagon and conceal it. The police were telephoned to and the thief was captured as he was attempting to carry away his prize a few hours later. This is an interesting use of the telescope.

Science Notes.

A large mushroom has been gathered at Newton, in South Lincolnshire. It measured 38½ inches in circumference and weighed 2¼ pounds.

To accelerate as much as possible the export of Siberian agricultural produce to England, the Russian Minister of Commerce has arranged for a special series of fast trains to convey the produce from Irkutsk to Riga.

The revolt in China has had a serious effect upon ginseng diggers in various parts of the country, particularly West Virginia, where many of the inhabitants of the mountainous districts gain a livelihood by digging out ginseng roots from cliffs and obscure nooks and corners of the dense forests. The price has dropped more than half.

Prof. W. Ceraski, of Moscow, announces in the Astronomische Nachrichten that Mme. Ceraski has found a new variable star on examination of plates taken by M. Blajko. The star has the following position :

Right Ascension, 0 h. 28 m.
Declination + 79° 33′.

The brightness varies from between 8 and 9 to about 12 magnitude. It was increasing in October, 1896, and decreasing in October, 1897, being almost at a minimum during May, 1898, April, 1899, and at the commencement of May, 1900.

The new physical laboratory at Owens College, Manchester, has been recently opened ; it has a larger floor area than any other similar institution in the world, with the exception of the Johns Hopkins and the Strasburg laboratories. Great efforts have been made to provide an equipment of the most modern apparatus for use in every branch of physical science, and to maintain conditions which shall ensure their being used to the best advantage. The research laboratories are to be an important feature of the new buildings, and should attract a large number of students. Another feature is the electro-technical wing, which is to constitute a John Hopkinson memorial ; it is understood that Dr. C. H. Lees, formerly chief assistant lecturer in the physics department of Owens College, will occupy the post of assistant director in the new laboratories, under Prof. A. Schuster, the director, and that Mr. R. Beattie has been appointed lecturer in electrotechnics.

Some notes on the New Zealand volcanoes are contributed to the latest volume of Transactions and Proceedings of the New Zealand Institute, by Dr. B. Friedländer. A description of an eruption of Le Mari witnessed by him is of interest ; the eruption began with an explosion, and masses of ash-bearing steam were ejected. There were at least four different phenomena. 1. The reflection of incandescent matter upon the dark clouds. 2. A large number of red-hot bowlders, which were shot up and fell down in parabolic curves. 3. Lightning, due to electricity produced by friction, the lightning appearing in the masess of ash-bearing steam, the ashes of which were coarse, the grains being about the size of a pin's head. 4. Blue flames, and probably reddish flames. Dr. Friedländer suggests, to account for the flames, that during the explosion there escaped combustible gases which at a certain height above the crater met the oxygen necessary for taking fire. He considers that the phenomena are due rather to vaporized sulphur than to hydrogen, the flame of the latter being less brilliant and less distinctly blue.

Writing in the Physikalische Zeitschrift, Herr R. E. Liesegang describes a mixture of sodium carbonate and hydroquinone which takes a deep blue tint on exposure to the air, and this blue color is rapidly destroyed by radiant heat. Equal parts of hydroquinone and anhydrous sodium carbonate in fine powder are stirred up with a small quantity of alcohol, so that the mixture can just be spread ; and this mixture rapidly acquires a deep blue color. Some of the above-mentioned mixture was spread on thin writing paper, after which all excess was brushed off, when the blue compound was formed in the substance of the paper. So sensitive to heat radiations did this paper prove that when it was exposed to the radiations from a gas stove for five seconds the blue color was bleached, and by interposing such an object as a coin, a definite cutting off of the heat rays could be effected, and, of course, a thermograph was formed on the paper. Ordinary black paper, on the other hand, has but little effect in stopping the radiations ; a wrapping of such paper only necessitating an additional exposure of a few seconds. The sensitive blue substance is assumed by Herr Liesegang to be an intermediate oxydation product of hydroquinone, but if moistened with alcohol or water, it is slowly destroyed. It may be mentioned incidentally that some forty years ago Hesse described the formation of a deep blue compound when quinone in a moistened state is brought into contact with caustic potash or lime, but we are not aware of any recent work being done in the way of following up Hesse's observation ; still, it may now be a matter of considerable interest to isolate Hesse's blue compound.