

of M. Holtz or the sectors of M. Piche. Each of them has in its centre, and perpendicular to its plane, a metallic handle terminating in a comb. At a short distance from these combs, and supported on the same prolonged axis of rotation, turns a second disc, similar to the first, before two different plates, equally distinct and separate. Finally, the balls of the collectors are respectively connected by metallic wires with the two last plates."

"It is only necessary to give a rapid rotary motion to the axle of the machine; when it is so arranged a continuous jet of powerful electricity should continually flash between the poles of the collectors."

"You can electrify one of the inductors. However, according to Faraday's theory, the two inductors finally electrify themselves directly, by the intervention of the middle moving part. The movable disc receives contrary electricity, and the collectors are charged."

A mathematical discussion of the subject, which we do not think likely to interest our readers, here follows, after which—

"It is then seen that in this condition the inductor would not fail to polarize the electricity, the multiplying discs would be constructed of partially isolated material, the machine would not be less charged, and the longer it was worked the better it would become. The experiments which we have made with an imperfect model give us these results."

Some remarks of a controversial rather than scientific character, here follow, which we do not think it worth while to reprint.

ED.

AN IMPORTANT ADJUNCT TO THE INDUCTION COIL.

By HENRY MORTON, Ph.D.

THE use of Leyden batteries with the Induction Coil seems to me not to have received the attention which the subject deserves. The enormous quantity of electric force set in motion by this machine, and the splendid effects produced, (especially in the eyes of the operator, who is moderately near the apparatus,) have probably diverted attention from those means which might be enlisted for yet greater development of these effects.

The requirements of lectures delivered in large buildings have, however, led me to study those means by which the most brilliant effect

possible might be secured to various experiments, and as the results obtained have, to the best of my knowledge, never as yet been published, I proceed to put them on record for the benefit of all who may be interested in the subject.

As a starting point, I would remark that, as is well known to all, the introduction of a Leyden jar into the secondary circuit of the Coil, shortens the spark and increases greatly its brightness. This increase of brightness is due to the concentration of the entire discharge into a single and instantaneous spark of intense temperature, as shown in the spectrum investigations of Plucker. It might, therefore, be expected that the light obtained by this discharge would be richer in actinic rays than that developed by the unaided coil, even if its luminous character was (by reason of diffusion in rarified gases, or the like,) but little increased. These actinic rays, however, are exactly those which develop the beautiful phenomenon of fluorescence; hence, we ought, by the addition of a Leyden jar, to increase, in a marked manner, the beauty of experiments in which this fluorescence plays an important part. The first instrument tried with this view, was the Electric Egg of Canary glass, made by Mr. Ritchie, of Boston, and which, within a range of twenty feet, is so beautiful an object, even with the simple current. It was found that the fluorescent light of a rich emerald green from the glass vessel (18 inches in height by 7 inches in diameter) was at least doubled by the use of a jar; though the flame-like discharge within, showed little increase in brightness, suffering, however, a change in color, from peach color to pink, with a diminution of the blue glow on the negative pole.

To secure the action described above, it is necessary to make some break in the circuit beside that in the exhausted vessel; as otherwise, the discharge would take place so readily that the fluid would not accumulate in the jar, and thus acquire volume and concentration.

The above arrangement has, without doubt, been used by many; in fact, I find, on inquiry, that Professors Robert E. Rogers and John F. Frazer, of this city, have both employed it. As, however, I also find others who have not so done, and do *not* find any notice of it even in works treating especially on the Induction Coil, such as Du Moncel's book of 400 pages, (*Notice sur l'Appareil d'Induction Electrique de Ruhmkorff*), and Noad's 'Inductionium' of 109 pages, I have thought it best to give the foregoing description.

The arrangement above recorded, though entirely satisfactory in the case named, is limited in its sphere of application by the reduced

length of the spark. Thus, with the apparatus I possess, whose spark length is 8 inches, no discharge can be obtained in an Aurora tube of 5 feet, when the jar is introduced. So, also, with the longer Geissler tubes, whose spiral passages develop a length of some feet.

To overcome this difficulty, resource was had to the following expedient: Several jars were arranged so as to be charged by cascade. This plan was first devised by Benjamin Franklin, to save labor in charging a large battery, and is mentioned in his *Philosophical Essays*, as well as by many others who have written since; among whom Mr. Boggs seems first to have pointed out that the spark length was in this way greatly increased. *Silliman's Journal*, II., 7. 418.

In the case of the coil I find, that, while sparks of but one inch are obtained with a single jar in connection, six jars arranged for "cascade" increase the striking distance to 4 inches.

By this means, therefore, the difficulty as to spark length may be overcome, but not with convenience, as few things could be more unwieldy and fragile than such a combination of jars. I had, therefore, resource, at once, to a battery of plates identical in principle with that described by Franklin in the essay before quoted, but differing in detail of construction, and in various appliances.

The simplest way to make such an arrangement is to procure a photographic negative box, capable of holding two dozen 8 by 10 inch plates. (This is the minimum size for an 8-inch coil.) Place in the grooves provided in this box, 8 plates of glass, (8 by 10 inches,) having sheets of tinfoil, 6 by 8 inches, with rounded corners, pasted upon each side. The plates should be equally spaced, and about $\frac{3}{4}$ inch apart. Then connect the adjacent coatings of successive plates by balls of rough paper wrapped with a strip of foil, and pass a copper wire, enclosed in a glass tube, through the lid of the box at each side, so as to make connection with the outside coatings of the extreme plates. These terminal wires being connected with the coil, sparks of $5\frac{1}{2}$ inches are easily procurable, and are characterized by the white light and loud report peculiar to the Leyden jar discharge.

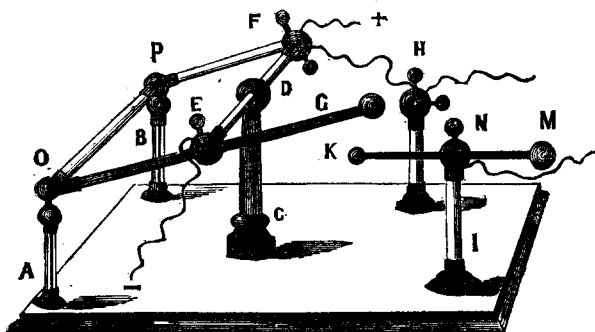
With such an apparatus, all the usual vacuum experiments are easily managed, and the beauty of most, wonderfully increased. Thus the Aurora tube, in place of showing a stream of light half an inch wide, is *filled* throughout its length and diameter of three inches. The large goblets of Canary glass supplied by Mr. Ritchie, for the cascade experiment of Gassiot, eight inches high and six inches across the bowl, in place of shining faintly, with a dark green, almost

invisible, at thirty feet seem so luminous as to be opaque with their own light, like white-hot glass, and give an emerald color, which is even brilliant at a distance of fifty feet.

So with other similar experiments. With the Geissler tubes of small diameter, however, this apparatus produces no improvement, but rather a loss of effect. The small size of the passage seems to occasion a resistance (due to induction in the material of the tube) which it requires time to overcome, and against which, therefore, this instantaneous flash acts at a disadvantage.

To throw the *battery* above described, in and out of connection, and at the same time make the required changes in the continuity of the circuit, the following plan has been found very convenient.

The base-board in the figure represents the top of the box containing the *battery*; A and B represent the terminals of this battery,



being connected with the outside coatings of the extreme plates, by wires inclosed in the supporting tubes. The frame F P O E G, consists of brass rods and balls, F P and O G, and of cross-pieces, P O and F E, of vulcanite or glass, of which F E turns with friction in the wooden upright, C D. By this means the balls, O P, may be put in contact with the battery terminals, as in the cut, or raised from them. The caps H and N, on glass supports, hold wires leading to the apparatus to be exhibited, while the wires from the coil are attached at E and F; F and H are also permanently connected by a flexible wire.

When the ends of the frame are depressed, as in the cut, and the *battery* is consequently in connection, a break in the circuit to the apparatus is introduced, between G and K. This can be regulated as to its amount, by sliding K M through N.

When, however, the connection with the battery is broken, by

raising $o p$ from $A B$, G comes in contact with K , and the connection between coil and apparatus is rendered perfect.

I find a *battery* of greater surface, more effective with large experiments than that described before. Its construction is, however, identical with the former, except that glass plates eleven by fourteen inches, with tin-foil coatings eight by eleven inches, set one inch apart in a box of the required size, are employed.

There is another point in connection with the coil and Leyden jars, which is of great importance to experimenters in electricity, namely, that all the ordinary experiments in attraction and repulsion, the chime of bells, sportsman and birds, electrical umbrella, orrery, flyer, &c., may be operated with perfect ease, by connecting the apparatus in question with a Leyden jar or battery, and then charging this latter as usual, with the coil; that is, by connecting the outer coating with the negative pole, and throwing sparks from the positive pole at the knob.

This seems so simple a plan, that I hesitate to mention it as a novelty, though I find no word to this effect in any of the many books which describe the experiments that can be performed with the coil, or in the catalogues of manufacturers, who would hardly omit so important a feature, and so strong an inducement to purchasers, if they were aware of the fact.

Others, however, may, like myself, until lately, have been prevented from trying, by the general impression that nothing was to be done in this direction, and if so, will be profited by the suggestion.

From the London Mechanics' Magazine, January, 1866.

ON SOUNDING AND SENSITIVE FLAMES.*

By PROFESSOR TYNDALL.

THE sounding of a hydrogen flame when enclosed within a glass tube was, I believe, first noticed by Dr. Higgins in 1777. The subject has since been investigated by Chladni, De La Rive, Faraday, Wheatstone, Rijke, Sondhauss and Kundt. The action of unisant sounds on flames enclosed in tubes has been investigated by Count Schaffgotsch and myself. The jumping of a naked fish-tail flame in response to musical sounds was first noticed by Professor Lecomte at a musical party in the United States. He made the important observation that the flame

* Read before the Royal Institution of Great Britain, January 18th, 1867.