the red light may then be taken to indicate the presence of fire-damp.

The wires being within the tube, one or other of the lamps must always be shining so long as there is a current, whether the apparatus be in an atmosphere of fire-damp, choke-damp, or air; and to prevent the mercury being driven out of the tube by too much pressure, bulbs are arranged on either side, as in Fig. 2, which presents a diagrammatic view of the apparatus.

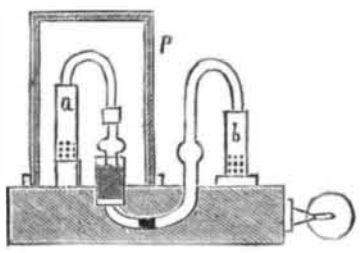


FIG. 2.—*p*, POROUS POT; *a*, *b*, DESICCATORS.

The inventors find an internal diameter of tubing of about 3 mm. best adapted for insuring easy mobility of the mercury. The presence of the wires within the tube has interfered with the perfection of the seal; this, however, has been overcome by the introduction of a little concentrated sulphuric acid. which also serves the purpose of preventing sparking and of lubricating the interior. The use of sulphuric acid necessitates the addition of desiccators, *a* and *b*, Fig. 2, to each end of the tube; but in cases where it has been found advisable not to use sulphuric acid, both the acid and the desiccators have been dispensed with by slightly modifying the arrangement of the wires at the lower part of the tube.

With this form of apparatus one can readily detect the presence of 5 per cent. of coal gas in a mixture of this gas with air, and with a mercury seal of less weight and closer proximity of the wires at T and T', Fig. 1,

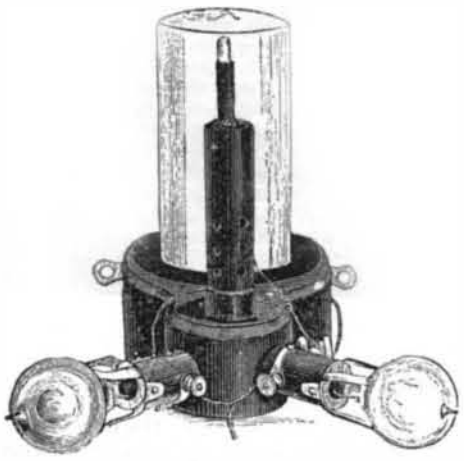


FIG. 3.

it appears possible to get any required degree of sensitiveness.

Fig. 3 is a view of the apparatus about one-third full size.

ELECTRO-MAGNETIC ROTATION OF UNPOLARIZED LIGHT.

By L. SOHNCKE.

ALTHOUGH the phenomenon of the rotation of the plane of polarization by electro-magnetic forces has frequently been investigated since Faraday's discovery, their action on ordinary unpolarized light has not received any attention. Two plane polarized rays of light proceeding from the same source cause interference when they are polarized in parallel planes, but no interference is produced if they are polarized at right angles to each other. Ordinary light behaves as light polarized in parallel planes, and consequently it will lose its power of interference if by means of electro-magnetic forces the plane of undulation of one of two rays proceeding from the same source can be turned through 90°, thus furnishing us with a means of testing the question raised.

The experiment was carried out by causing the rays of unpolarized light, which would produce interference bands, to pass through a double quartz prism, whereby the interference was annulled. They then passed through two cylinders of Faraday's glass which were placed inside two solenoids, and if the current in these latter had any effect, the interference bands would again appear. The experiment was most successful, as always, on closing the circuit of a Schuckert dynamo giving a current of 20 amperes through the solenoids, the interference bands at once became apparent. It was found that not only was the plane of undulation of the light rotated by the electro-magnetic force, but that the rotation was in the same direction for ordinary light as for polarized light.—*Annalen der Physik und Chemie; Jour. Soc. Tel. Eng.*

VOLTAIC CELL WITH A SOLID ELECTROLYTE.

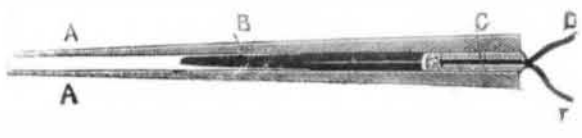
By Mr. SHELFORD BIDWELL.

ITS construction is as follows: Upon a plate of copper is spread a layer of quite dry precipitated sulphide of copper; if on this a clean plate of silver is placed, and the cell joined up to a galvanometer, a slight deflection is observed, due to the unavoidable presence of moisture. If, however, the silver plate be covered with a slight film of sulphide of silver, by pouring on it a solution of sulphur in bisulphide of carbon, and evaporating the free sulphur by heat, and then placed with the prepared side down as before, a deflection is obtained far greater than, and in the opposite direction to, the former. The resistance of the cell was very great, but was enormously reduced by compression; the electromotive force was about 0·07 volt.

AN ELECTRIC FUSE.

THE ignition of mines charged with ordinary powder or dynamite—write MM. Scola and Ruggieri, in *Comptes Rendus*—presents numerous difficulties and dangers which might be entirely avoided by the use of our new electric fuses.

These fuses are composed of two copper wires, D, D, covered with cotton and coiled on a small wooden cylinder, C. Round these wires and their support is glued a paper cartridge filled with a priming composed of chlorate of potash, saltpeter, sulphuret of antimony, and retort charcoal in fine powder; the last-mentioned



ingredient serves to give a slight conductivity to the mass.

The wires thus arranged are fixed at the extremity of a paper tube, A A, which contains a port-fire or a powder-match, B.

If we wish to effect the explosion of a mine charged with common powder, we reserve in the mass a narrow empty cylindrical space, by means of a pin. The fuse described is placed at the upper part of this channel. It is merely necessary to connect the two wires to an induction coil, or, preferably, to the ingenious apparatus known as a "coup de poing," to obtain at the desired moment an extra-current spark which ignites the fuse-paste. The gases produced in this combustion ignite the match, and project it with great velocity into the middle of the mine.

If we use dynamite, we add a fulminating primer, upon which the match impinges at the instant of its projection.

The use of our new fuses secures the ignition of mines, prevents any accident which might result from their hanging fire, and will, we hope, render excellent services in numerous branches of industry.

THE PROPULSION OF ELECTRIC PENDULA.

By P. H. VANDER WEYDE, M.D.

HAVING had experience with electric clocks, and largely investigated the subject, I may be allowed to make a few remarks in addition to what was published on page 261 of the SCIENTIFIC AMERICAN for April 24, and give some important information in regard to this matter.

It appears that Bain was the first who, forty years ago, drove a pendulum by battery power.* In his pendulum the weight was an electro magnet oscillating between two permanent steel magnets, while the motion of the pendulum, by means of varying contacts, caused a reversion of the current, and consequent change of polarity of coil and core at every swing of the same. His motive power was an earth battery, namely, a large copper and zinc plate buried in the ground. As a curiosity, I must here state that this same motive power was used in a clock exhibited by Drawbaugh at the late Electric Exhibition in Philadelphia, under the false pretense that it was a magnetic clock driven by terrestrial magnetism drawn from the earth.

Weare constructed later (1848) a similar contrivance,† which differed from Bain only in the form of the magnets, while he obtained his current from a Daniell battery, as experience had shown that the gradual exhaustion of the battery influenced the amplitude of the oscillations, and caused these to become smaller and the clock to run faster. The Daniell battery is more constant than others, but as it is not absolutely so, the clocks did not keep time, until Liais, in Paris,‡ conceived in 1851 the idea to make the battery current stretch a little metallic spring, which, at the proper moment, was liberated by the contact arrangement, and pushed the pendulum with a perfectly uniform power. By this device the power driving the pendulum became independent from the strength of the battery, and the main difficulty was overcome.

In 1853, Kramer, in Germany, without knowing what Liais had done, made another device accomplishing the same purpose,§ but at the same time a new difficulty offered itself, namely, he found that, notwithstanding he used a current as weak as possible (two or three elements), the secondary current induced in the coil surrounding the iron core at the break of each contact caused sparks visible in the day time, which by their continuous repetition every one or two seconds at last affected the platinum points with which the break had been provided, so that in eight or ten days, or 400,000 interruptions, a great change in the contact points was perceptible, while finally after a few months they were destroyed and required renovation. In order to avoid such results, Fizeau had before that time succeeded to reduce largely these sparks at the break of the vibrators attached to the Ruhmkorf coil, by connecting the circuit with a large condenser of tinfoil, so as to utilize this induced current after the manner of charging a Leyden jar. This remedy could also here be applied, and was attempted by some; but as in the case of electric clocks it is not necessary to make a total interruption of the current, Kramer devised a simpler method. He introduced in the circuit a coil of German silver of a resistance some ten times greater than that of the coil surrounding the core of the electro magnet, and connected in such a way that the circuit was never entirely interrupted, but only increased and decreased for an amount of about 90 per cent.; this gave an exit for the induced currents, and the result was that with help of this device the spark at the break could only faintly be seen in the dark by help of a magnifying glass, while in the course of half a year no change was perceptible.

Some ten years later (about 1858) an electric clock company opened a store in New York city, on Broadway, near Spring Street, and exhibited there a number of electric clocks, each propelled by three or four battery cells. The method of propulsion was primitive and without regard to the improvements made ten years before by Liais and Kramer. It was as follows: To the lower part of the pendulum was attached a horizontal bar of soft iron, at each side of which was a hollow stationary coil, in which the ends of the iron rod could freely enter when the pendulum oscillated. This oscillation caused the making and breaking of contacts, and sent the current of four cells alternately in each coil, by which device the iron bar was alternately pulled in one or the other of the coils, which kept the pendulum in motion when once started. As these clocks did not possess the devices of Liais and Kramer, to make the driving power independent of the strength of the battery, nor any precaution to guard against the final destruction of the platinum contacts, I watched them with some interest, and found that they did not keep time, as was to be expected; while in regard to the preservation of the contact points, I could make no observations, except that I saw the business break up after a short career, the glowing advertisements and testimonials notwithstanding.

In connection with this I may add that there is still another method to make the regularity of the pendulum independent from the strength of the battery power driving it, which as far as I am aware has never been applied to electric pendula. It is based on the discovery of Huyghens that the cycloid is the curve of isochronic descent, which the arc of a circle is not. A pendulum suspended in the usual way from a steel knife edge will describe circular arcs, with the knife edge as center, and oscillations of great amplitude will require more time than those of smaller amplitude, causing the clock to retard, and *vice versa*. When the pendulum is, however, suspended from a flexible connection at each side of which is a stationary curve of solid material, along which the flexible connection will bend when oscillating, and when these curves are evoluted cycloids, the weight of the pendulum will describe a cycloid, the times of oscillation will be uniform, and the movement isochronous, whether the amplitude is large or small. The clock provided with such a pendulum will run at a uniform rate, whatever be the driving power of the battery. As the cycloid is the only curve of which the evolution is also a cycloid, one has only to fix two half cycloids at each side of the flexible pendulum suspension to have an isochronous pendulum.

It is curious that of late years there has been a tendency to return to the primitive method of using electricity for the purpose of moving clocks. Steinheil in Munich was the first who, in 1839, succeeded to apply electricity for the purpose of keeping a number of clocks situated at various localities in time with an ordinary central clock driven by a weight. Wheatstone, independent from this, took in 1840 a patent in England for the same purpose* while Breguet in France experimented in the same line.†

Lamont contrived in 1843 an electric method to equalize the time of various astronomical clocks by one normal time piece, while Jacobi in St. Petersburg improved upon Lamont's method.

Bain brought a great number of clocks in the same circuit, and moved them all with one central battery,‡ attached to the clock driven by a weight.

As the contact repeated every second always acted in the end injuriously upon the platinum points, Froment and Garnier in France made the arrangement to make contacts every six seconds; § while Siemens and Halske in Germany completed their arrangement and made the contacts only once a minute, ‖ so that they were the originators of the electric clocks at present known under the name of "minute jumpers," which are very simple in construction, and for this reason are becoming quite common in large establishments or towns.

The system of Kerikuff differs from all the preceding in that he uses no batteries, but obtains induction currents by causing the pendulum of a central clock, driven by a weight, to move steel magnets in and out of hollow coils, ¶ while the system of Gloesener is a variation upon the same principle.

But one of the most ingenious devices is that of Du Moncel, who causes the sun itself to equalize any number of electric clocks, situated at various distances, daily, at exactly the same time. He does this by causing a mercurial thermometer, situated in the focus of a lens, to close the circuit by the rise of the mercury ** when the sun passes a certain point.

In practice, it has been found that this movement and regulation of many clocks from a central station is limited, and that not as many clocks can be driven in this way as was expected. Kramer goes into a consideration and calculation of this subject, and points out how the failure of one clock out of a hundred will also cause the other ninety-nine to fail when they are in the same circuit, †† which is the only economical arrangement.

So, taking all in consideration, if one wants an electric clock, it is the most satisfactory to drive the pendulum with a battery. The writer has since several years such a clock, and uses a single Daniell gravity cell, in which the top is covered with an inverted flask containing sulphate of copper crystals. Being closed on top, it is less subject to evaporation than any other form, and lasts from six to nine months. The driving power is a little brass ball, of half a gramme in weight. This is suspended from a short cross piece attached at one side to the upper part of the pendulum; at every alternate oscillation, this little weight is lifted up by the armature of a small electro magnet, and dropped at the next move. In this way it keeps the pendulum in motion if once started. The movement of the pendulum alternately magnetizes and demagnetizes the electro magnet by the make and break of contact between two short platinum wires, stretched at right angles one to the other. This simple arrangement has two great advantages, first of not allowing dust to prevent a full metallic contact, as there is no place for dust, and secondly, of being very easily replaced when after a few years the platinum is destroyed, whic sooner or later always will be the case.

* Thellend, Elec. Tel., Braunsw., 1861, p. 374.
† Dingler's Journal, vol. 108, p. 256.
‡ Du Moncel, App. Elec., vol. ii., p. 281.
§ Dubb, Anw. der Elec. Mag., Berlin, 1873, p. 727.

* Bulletin de l'Acad. de Bruxelles, 1840.
† Du Moncel, App. de l'El., vol. ii., p. 236.
‡ Du Moncel, vol. ii., p. 250.
§ Dingler's Journal, vol. 140, p. 423.
‖ Shellen, El. Telegr., p. 371.
¶ Dubb, Anwend. Electromagn., 1873, p. 714.
** Dingler's Journal, 140, p. 425
†† Dubb, Anw. Elect. Mag., p. 719.