

which many hundred words are transmitted and recorded in a minute, and also the abolition of the duplex and quadruplex instruments (by means of the latter four messages are sent over one wire at one time, thus answering the purpose of four distinct wires), and the duplex answering for two distinct wires, and last of all, which has suddenly come upon us, the telephone, with its still more sensitive apparatus.

After all these electrical difficulties are overcome or dispensed with, the practical difficulties still remain, the main one being that of cost, while convenience must also be considered.

In this practical age convenience is regarded more than cost in many instances. In this instance the cost of placing all telegraph lines under ground in cities and towns with anything like the present convenience and facilities will be such as to make it too expensive for popular use, which in the end would be a practical prohibition of its use.

Without detailing the manner of its construction in London, which is on the elevated railroads and taken down at stations, and Paris, which is in its sewers, we can say that none of the advantages and modes of its construction in those cities exists in any of our American cities.

We will take New York city as an example. In Paris there are only 80 miles of underground lines. In New York city there are 9,000 miles of line in the streets and on house-tops. Of these over 3,500 belong to and are used by the Metropolitan Telephone Company. The Gold and Stock Telegraph Company have many miles upon which the automatic instruments are used. The Western Union has 1,200 miles of wire, of which only about 300 miles are on the main trunk lines, and the remaining 900 supply the little local offices. It is the many local offices and places where instruments are set that is to be considered in this question of laying underground cables. If one man in a block desired communication by telephone, or the use of the Messenger Telegraph or Stock Indicator, the whole expense of digging a trench from the main office must be considered. This would greatly narrow their use. The expense for digging the trench for one wire only would be almost as great as for many of them. Then again there must be places near together on the lines by which any wire could be taken out for repair and replaced if necessary.

The Western Union Telegraph Company has now three lines of underground cables in New York city. They are in three iron tubes about three inches in diameter each, and lead from the main office of the company to Pier 18, foot of Cortlandt street, North River. In these three tubes is a cable of thirty wires each. These are conducted under the Hudson River to Jersey City.

When first laid, about five years ago, there were only the two tubes and the two cables in them. The expense of laying them from the main office to the river was at the rate of \$15,000 per mile, the cables each costing at the rate of \$5,250 per mile. About one year ago some of the wires in the cable failed to act, and one cable was entirely taken out and replaced by a new one. Another tube and cable was also then placed in the trench. The expense of often replacing must also be considered, for if some of them fail it may be necessary to entirely renew the cable. The sum of \$7,500 per mile for laying underground cables is great when compared with the cost of a line of poles in the city, which rarely exceeds \$150 per mile, capable of carrying many wires. In places where smaller and shorter poles can be used the expense is very much less, even as low as \$75 per mile in cities, and much less in the country. Increase of expense implies a necessary increase of rates. The interest on the cost of a mile of underground line will be sufficient to build at least four new lines the same length every year, which will last from twelve to fifteen years each, the wire costing only \$15 per mile.

The popular objection urged against the present system is that the poles and wires are "unsightly." When this is closely examined it shows it to be mere clap-trap and without any reasonable foundation, and it will more strongly apply to every means of economical and convenient carrying of merchandise and passengers in cities, without any of the chief annoyances which appertain to the latter.

Surely, the means of the conveyance of intelligence is as important and as great convenience in a community as the conveyance of persons and of merchandise. Indeed, this mode of carrying news saves much personal travel by messenger or otherwise.

The day has not yet arrived when underground telegraph lines in American cities will prove a convenience and be a popular success, as some will try to make others as well as themselves believe. The facts of science are stubborn things and cannot be removed or dispensed with by popular opinion or legislation.—*Journal of the Telegraph.*

M. GaiFFE's Sulphate of Copper Battery.

This is an improvement on the Daniell element, and is intended to put a stop to the reaction of the zinc on the sulphate of copper when the circuit is open. The apparatus consists of a glass cell, at the upper part of which is the zinc, constructed as in a Calland element. The central vessel has a porous upper portion fixed upon a non-porous lower portion, which may consist of an ordinary drinking glass. The copper cylinder placed in the central cell has a prolongation which is bent down so as to reach down to the bottom of the outer cell, where it terminates in a ring. This element is charged by means of a concentrated solution of zinc sulphate of magnesium sulphate, while some crystals of copper sul-

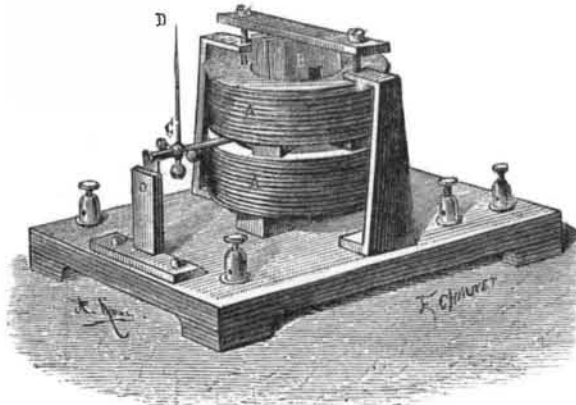
phate are placed in the bottom of the central cell. On dissolving, the copper sulphate first saturates the liquid in the non-porous part of the central cell, and when the copper solution reaches above the top of the non-porous part it traverses the porous cell, and falls, in virtue of its superior density, to the bottom of the outer cell, beyond the reach of the zinc. This passage of the copper sulphate is effected slowly, and the circuit may be left open for weeks without any deposit of copper being perceived on the zinc. When the circuit is closed this element first reduces the sulphate of copper which has fallen to the bottom of the outer cell, the liquid in which soon resumes its original purity, and the action then continues as in an ordinary Daniell element.

RHEOMETRIC APPARATUS.

BY MARCEL DEPREZ.

As an example of the arrangements of rheometric apparatus belonging to the different classes cited in a preceding article, I shall describe two instruments that I had constructed some time ago. The first of these (Fig. 1) consists of a soft iron needle mounted on a horizontal axis movable

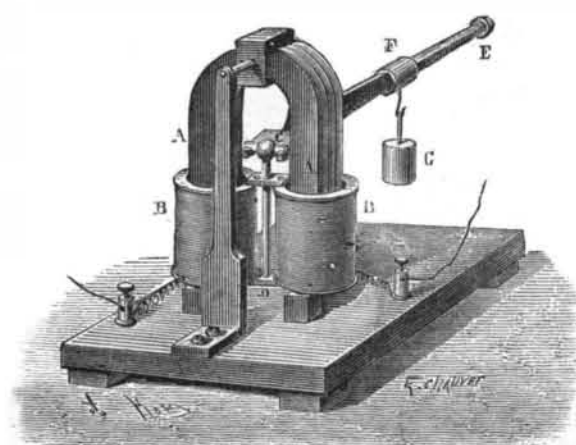
Fig. 1.



about two knife edges, and inclosed within a galvanometric helix, B B. The helix is placed within a pair of large bobbins, A A, wound with a wire of pretty large diameter, into which is sent a current from a Bunsen pile. The axis of the iron needle terminates at C in an index, and in a system of small masses movable on screws, the purpose of which is to balance the whole.

To employ this instrument, there is first sent into the wire of the bobbins, A A, a current from some energetic and constant source, such as a Bunsen element. The result is that the soft iron needle becomes magnetized to saturation, and places itself spontaneously in such a manner as to coincide with the axis of the bobbins, A A; but it is proper to remark, also, that it is directed at the same time as magnetized. If, afterwards, the galvanometric helix, B B, be put in relation with any source whatever, the needle will behave like the magnetized needle of an ordinary galvanometer, and its deflection will depend upon the intensity of the second current and of the directing force developed on it by the bobbins, A A. Now, this directing force may be rendered as feeble as may be desired in two ways: (1) by increasing the diameter of the bobbins, A A; and (2) by acting upon one of the regulating masses in such a way as to place the center of gravity over the axis of rotation until the equilibrium is almost indifferent, when the bobbins, A A, will be traversed by a magnetizing current, while the bobbins, B B, will be traversed by none at all.

Fig. 2.



It will be seen, then, that this instrument is a galvanometer in which the needle may be magnetized with great energy, while the directing force may be rendered very feeble, these being conditions that we always try as much as possible to obtain.

It will also be seen that it constitutes likewise a *comparer of currents*; that is to say, an apparatus giving the relation of the intensities of two currents and not their absolute value. In fact, if two currents are simultaneously sent, one into the bobbins, A A, and the other into the galvanometric helix, B B, and if care has been taken to destroy every species of foreign directing force, by causing the center of gravity of the movable system to coincide with the axis of the knife edges, and by placing the latter in the magnetic meridian, the soft iron needle will assume a position of equilibrium, which will not change whether each of the cur-

rents be doubled, tripled, or quadrupled. But this position of equilibrium will change, on the contrary, if the intensity of a single one of the currents be altered. In order to demonstrate this property experimentally, the two bobbins, A A, B B, may be united in derivation on a same curve: when, the law of the division of the current between the two bobbins depending only on their respective resistances, the deflection of the needle will be seen to remain the same as long as these respective resistances are not altered, whatever be the intensity of the total current. If, on the contrary, by any means whatever, the resistance of one of them be altered, the position of equilibrium of the needle will immediately change. Owing to this property, this instrument might become a measurer of resistance which should indicate, by a simple reading, the resistance of a wire into which was sent a current of any intensity whatever.*

Becquerel's Balance, modified.—The second instrument is based on the same principle as the Becquerel balance. It consists (Fig. 2) of a powerful magnet, A A, whose arms are surrounded by the two bobbins, B B, in such a way that the distance between the pole of each arm and the lower armature of the corresponding bobbin is equal to about a third of the total length of the latter. The two bobbins are mutually interdependent, and are connected with a knife edge, C, supported by the small lever arm of a steel yard, C F, whose long arm carries a weighing slide, F, to which may be hooked a supplementary weight, G. The magnet is stationary and the bobbins movable, and receive the current, either through mercury cups or through a very fine and flexible wire, wound in the shape of a helix, whose elastic force is altogether feeble and yet constant. This apparatus possesses an advantage over the Becquerel balance in having a very intense magnetic field, while in the latter the magnets are formed of small iron bars 4 to 5 millimeters in diameter. It might be objected that the weight of the bobbins being much more considerable than that of the bars of the Becquerel balance, there would be lost, as a consequence of this surcharge imposed on the balance, the benefit resulting from the increase of the mechanical action of the current. But it is necessary to remark that the weight of the entire movable portions of the balance is greater than that of the movable bobbins, and that, consequently, in these two instruments, the balance is placed perceptibly under the same conditions of sensitiveness, while the absolute mechanical effort, at an equal intensity with the current, is much greater in this apparatus than in that of Becquerel. The model shown in Fig. 2, although roughly constructed, has in fact exhibited a remarkable sensitiveness. I think, then, that this apparatus, when better made, might render genuine services.—*La Lumière Electrique.*

MECHANICAL INVENTIONS.

An improvement in machines for making dough into cakes has been patented by Mr. Daniel M. Holmes, of Cincinnati, O. The object of the inventor is to secure an even and constant feed and pressure to the valves and cutters. With the use of the ordinary dough box and plunger in cake machines considerable time is lost in the intermittent action of the feed. Mr. Holmes has, therefore, provided means of accomplishing an even and constant feed and delivery, whereby the time usually consumed in recharging the machine is saved, and a consequently larger yield of goods in a given time is effected.

Mr. Henry H. Norrington, of West Bay City, Mich., has patented an improvement in the class of punches or perforating stamps designed for use in banking and other similar establishments for the purpose of puncturing or cutting out portions of a check or other written instrument to prevent fraud by alteration. This inventor has obtained Letters Patent of the United States for stamps or punches of this class, and the present invention is in the main an improvement upon that which forms the subject of patent No. 223,161, granted to the same inventor December 30, 1879.

Messrs. Levi L. Lukens, of Chester, and Henry Holcroft, of Media, Pa., have patented an improvement in shuttle boxes for looms which consists in a peculiar construction and arrangement of the parts, by which the second spindle, as ordinarily used, is dispensed with, which permits of an increasing width of the picker strap. There are other points in the invention which cannot be described without an engraving.

An improvement in the class of machines adapted for soldering the heads of paint cans and other cylindrical vessels to their bodies has been patented by Mr. Henry R. Robbins, of Baltimore, Md. It is more particularly an improvement in machines which are adapted for using solder wire, the latter being wound upon a reel, from which it may be drawn off as required and fed into contact with the heated soldering irons and can seams. In this machine the wire reels and mechanism for drawing off the wire are operated simultaneously with the rotation of the can by means of friction gearing, which is put in operation by treadle mechanism. The soldering appliances are also arranged for a certain simultaneous and automatic action. The soldering irons are pivoted and adapted to vibrate between the can-holders and an open furnace, so that they may be swung forward to press on the can seams, and backward to enter the furnace, where they are heated preparatory to the next operation.

An improved car brake, patented by Messrs. William A. Kearney and Joseph G. Davis, of Logansport, Ind., consists in a novel arrangement of a cam for drawing the brake chain

* Mr. Carpentier has recently constructed a resistance measurer based on an analogous principle.