W. ELMORE.

Dynamo-Electric Machine.

No. 241,198. Patented May 10, 1881.

Fig: 1

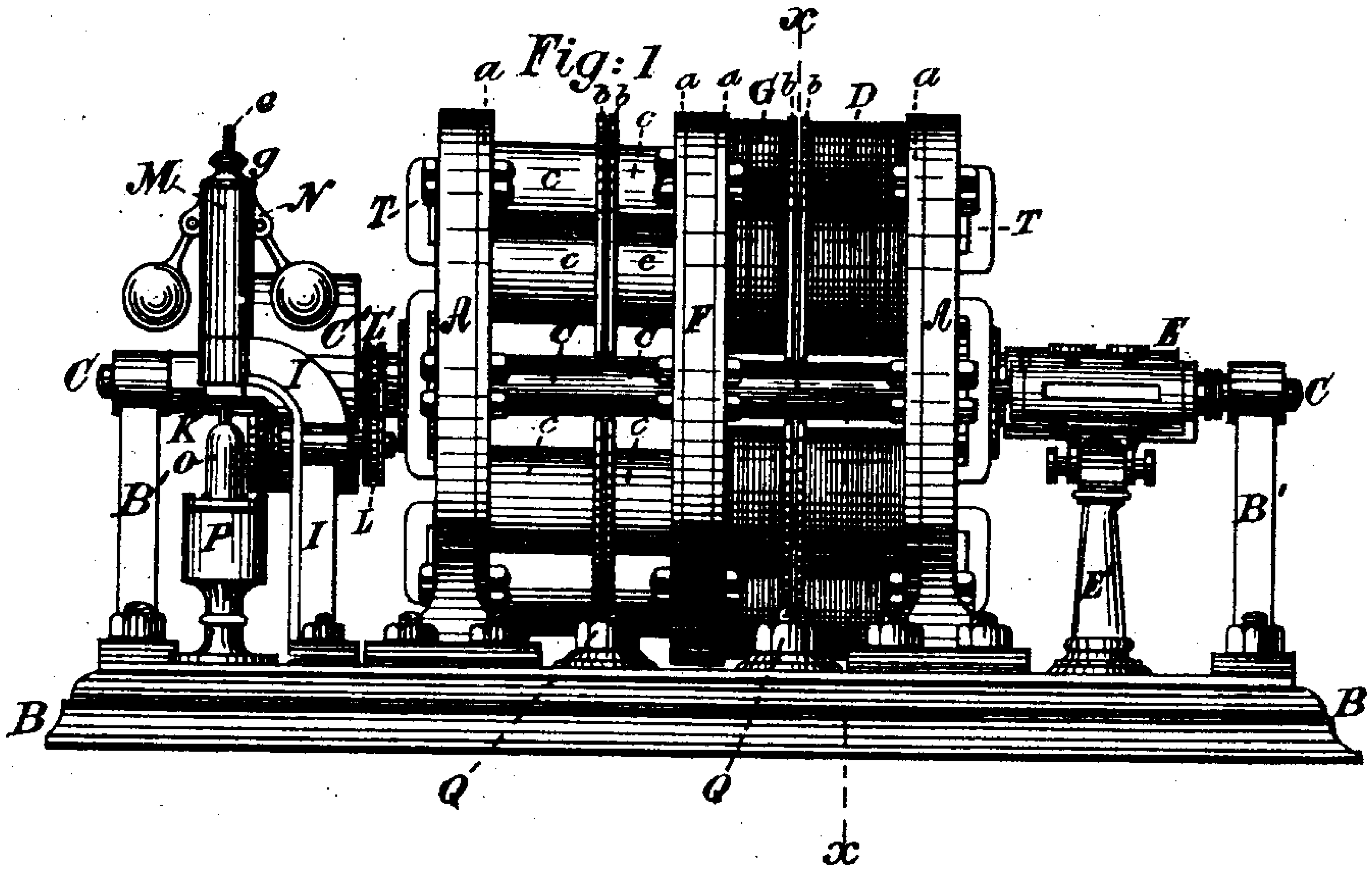
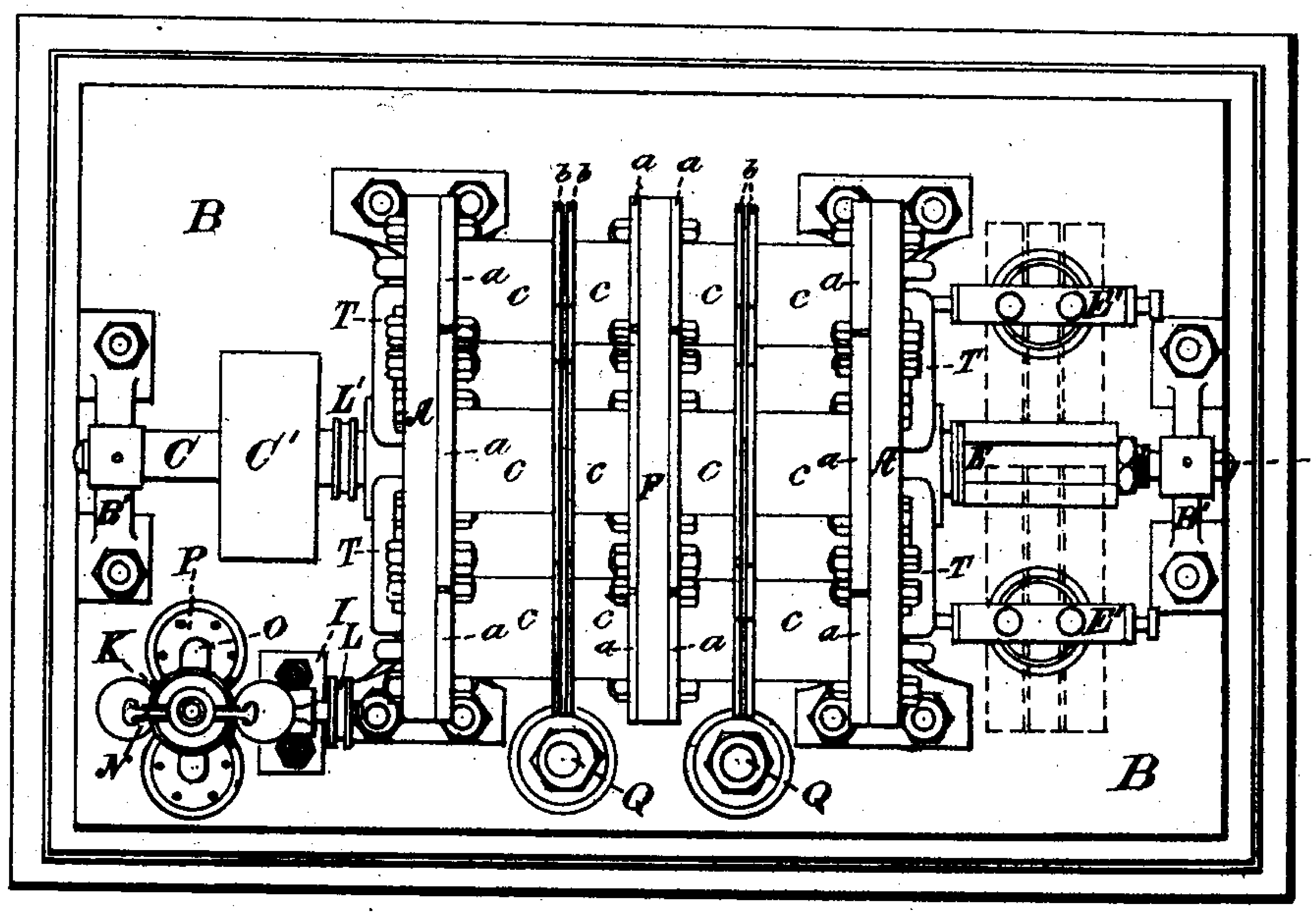


Fig: 2



Witnesses:
Willy G. E. Schultz
John C. Tunbridge

Inventor:
William Elmore
by his attorney
A. v. Briesen

2 Sheets—Sheet 2.

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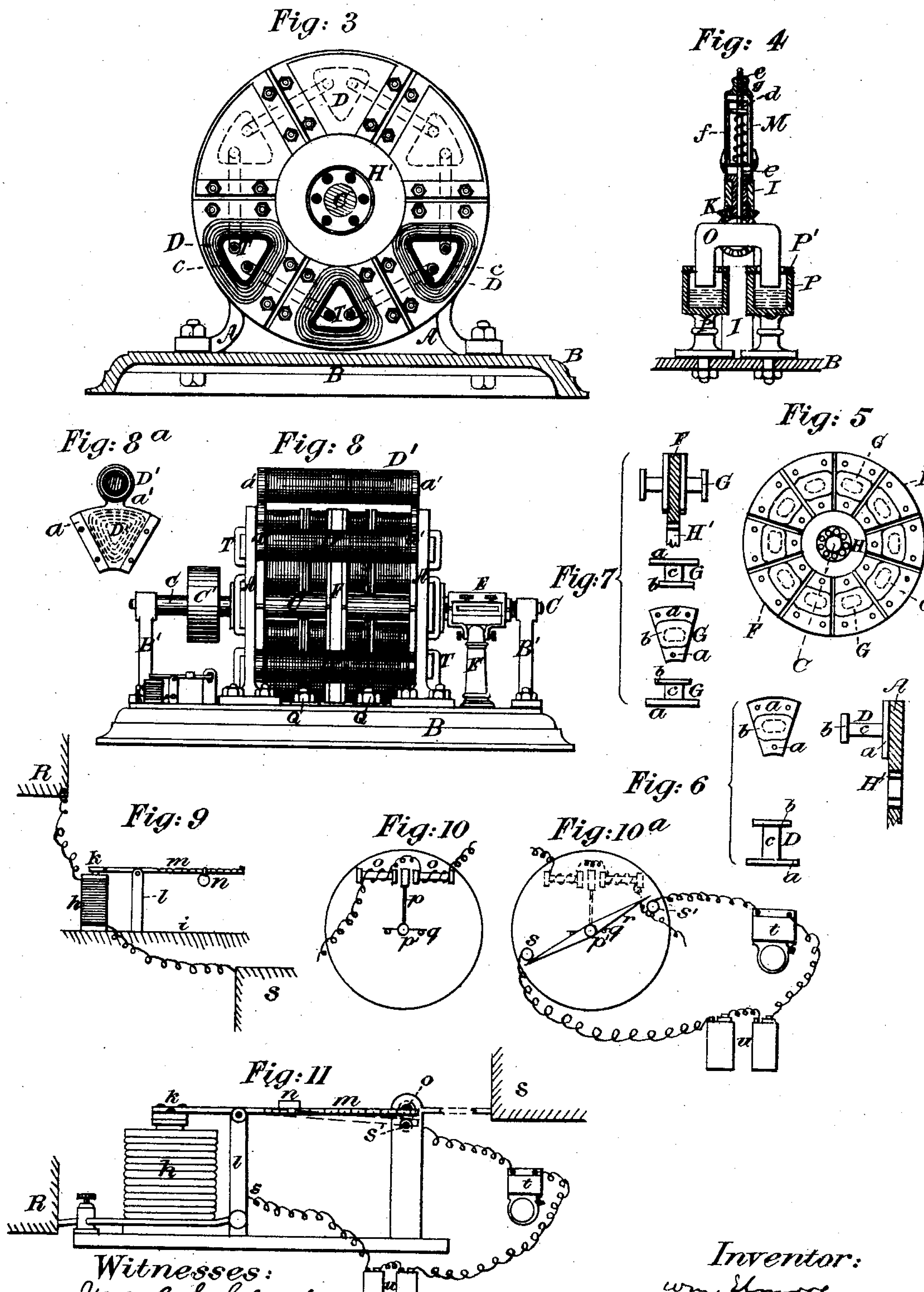

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UNITED STATES PATENT OFFICE.

WILLIAM ELMORE, OF 91 BLACKFRIARS ROAD, COUNTY OF SURREY, ENGLAND.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 241,198, dated May 10, 1881.

Application filed April 3, 1880. (No model.) Patented in England September 4, 1879.

To all whom it may concern:

Be it known that I, WILLIAM ELMORE, of 91 Blackfriars Road, in the county of Surrey, England, electric engineer, have invented a new and useful Improvement in or applicable to Dynamo-Electric Machines, (for which I have received Letters Patent of Great Britain for fourteen years from September 4, 1879, No. 3,565,) which improvement is fully set forth in the following specification, reference being had to the accompanying two sheets of drawings, and to the figures and letters marked thereon—that is to say:

This invention relates to improvements in the construction of dynamo-electric machines, the object being by improved arrangement and construction of parts to obtain a greater extent of the magnetic field of the revolving armature, and so generate a greater amount of electricity than by apparatus of known construction, and also to provide means for governing the current, cooling the magnets, and for instantaneously signaling a reversal of current and for measuring the current passing.

In the drawings, Figure 1 is a side view of the machine, the front whereof is to the right hand, some of the magnets upon the back half being shown uncoiled for purpose of illustration. Fig. 2 is a plan or top view of Fig. 1, wherein none of the magnets are shown coiled; Fig. 3, a transverse section at line *x x*, Fig. 1; Fig. 4, a transverse section of the governor. Fig. 5 represents a revolving armature for machines of this construction, but carrying ten radial magnets, instead of six, as in machine Figs. 1 to 3; Fig. 6, details of stationary magnets; Fig. 7, details of magnets for revolving armature. Fig. 8 represents a machine wherein the stationary magnets are connected by transverse magnets, and Fig. 8ª shows modification in detail of stationary magnets for this purpose. Fig. 9 represents device for ascertaining the strength of current passing into or between a depositing bath or baths. Figs. 10 and 10ª represent, in front and back view, device for indicating and signaling a reversal of current. Fig. 11 represents a combined device for governing, preventing reversal, signaling, and for measuring the strength of current passing.

In constructing the apparatus end standards, A, having broad circular surfaces and serving as stationary disks, are employed and bolted to a suitable bed-plate, B, said standards having centrally therein bosses, through which passes the central main driving-shaft, C, and having thereon, on the inner surface thereof, the stationary magnets D, radially arranged, as more fully hereinafter described; and said shaft C carries a pulley, C′, on one end thereof, (or a pinion to gear with spur-wheel,) for purpose of transmission, and other end carries the commutator E, the extremities of the shaft being supported by bearing-standards B′, fixed to the bed-plate B.

On the main shaft C, between the standards A, is mounted a disk, F, upon both sides of which are bolted radial magnets of number and size required, according to the area of the disk, said disk, when so fitted, constituting a revolving armature.

The magnets of the stationary disks and the revolving armature are constructed as follows: Two soft-iron plates, *a b*, of approximately sector form, are connected by a solid or hollow connecting-piece, *c*, of steel or iron, of corresponding shape to, but smaller than, the plates, one of said plates, *a*, serving as a flange for bolting the magnets G and D, respectively, either to the revolving disk F or to the stationary disks A, and the other plate, *b*, acting as the soft-iron face of the magnet. The connecting-piece *c* of the plates of the magnets is hollow or solid, and serves as the core upon which the wire is wound. In small machines the connecting piece or core may be solid, and the connecting-piece of the stationary magnets D is in all cases longer than that of the revolving-disk magnets G, so as to receive a longer coil of wire. In Fig. 3 the cores of the magnets D are shown hollow. The magnets are bolted in a circle onto and around the revolving and stationary disks F and A, respectively, relatively opposite to each other, so that the revolving disk will carry and be furnished with a circle of magnets upon each face thereof, so as to revolve in face of corresponding sets of magnets on the stationary disks A of the standards.

The center of the revolving disk is fitted with a bush, H, in which are holes lined with insulating material, through which are passed the wires of the coils of the magnets G, said wires being carried along the shaft to the commutator E through a perforated bushing, H′, on the shaft C, and passing through and working in the boss of the standard A, said wires being insulated by passing them through small tubes of insulating material, as will be clearly understood upon reference to Figs. 3 and 5. The magnets are to be wound with wire varying in thickness according to the "intensity" or "quantity" of the current required—that is, according to the purpose for which the machine is to be used. Thus, if the machine is to be employed for producing current for electric lighting, then the magnets will be wound with fine wire to produce "intensity;" but if the machine is to be used for, say, electro-deposition of metals, thick wire will be used to produce "quantity." The wires upon the opposite stationary magnets are wound and connected, as is well understood, in such manner as to give opposite polarity to each magnet facing the other, and so forming pairs between which the armature revolves.

In order to prevent the current from changing or reversing, and so, in the case of plating, to prevent the work in the bath from damage, I have devised a governor, which, for convenience, I place at the driving end or back of the machine, and drive the same from the driving-shaft. An armed bracket, I, is bolted to the bed-plate and insulated therefrom, and in bosses of said bracket are mounted short shafts carrying miter-wheels K, one of said shafts carrying a transmission-pulley, L, to be driven from the pulley L′ of the main shaft C, to communicate motion to the miter-wheels K, and the other rod of the miter-wheel passes up through a cylindrical pillar, M, and supports governor-balls, which are pivoted on snugs N on the upper end of the said pillar M. The ends of the arms of the governor carry hooks or catches *d*, which are so arranged as to act upon a central rod, *e*, passing through the upper miter-wheel shaft, and upon which central rod, within a boxing, *f*, in the cylindrical pillar M, is arranged a spiral spring, and a screw-cap, *g*, is fitted to the upper end of the rod *e*, so as to adjust the tension of the spring when desired.

On the lower end of the central rod, *e*, of the governor is mounted a saddle-shaped or double-armed piston, O, which will, according as the speed of the driving-wheel increases and by action of the catches *d* on the arms of the governor-balls, be depressed. The extremities of the double arms of the said piston O are platinized and extend into two cups, P, screwed upon the bed-plate, and insulated therefrom, and filled with mercury to such height that the arms of the saddle-shaped piston O will only dip into the mercury when the required speed of the machine is attained or exceeded, and by the centrifugal tendency of the governor-balls the catches of the arms thereof do act to depress the plunger.

Secured upon the bed-plate of the machine, and insulated therefrom, are the two terminals Q, placed as shown in Figs. 1 and 2, or in other convenient position.

The wires from the magnet-coils G of the revolving armature F are carried, as before described, to the commutator E, and the current from them is received by the copper brushes resting upon said commutator, said brushes (indicated by dotted lines in Fig. 2) being supported by brush-holder standards E′, provided with binding-screws, springs (not shown) being provided to act from above on the one side and below on the other to hold the brushes evenly against the commutator. One of the brushes is connected by insulated cable directly to one of the terminals Q of the machine, and the other brush is connected with all the inside wires from all the magnets D of the stationary disks A, all the outside wires of the stationary magnets D being connected up with the other terminal Q. When, however, the governor is employed, the outside wires are intercepted thereby—that is, the wires are carried to one of the mercury-cups P and the other mercury-cup is connected with the second terminal of the machine, thus leaving a break between the cups and in the circuit when the machine is not working or when the speed is not sufficiently high to work the machine properly. Contact will only be made by the saddle-shaped plunger O upon the machine attaining the required speed, and so depressing and immersing the extremities of the said plunger-arms one into each cup P of mercury. The mercury in the cup is covered with glycerine, and the ends of the plunger-arms O, which dip into the mercury, are platinized to prevent oxidation and insure instantaneous and perfect contact. A flexible cover of thin rubber cloth, for instance, which is secured by a ring-piece, P′, is provided to keep out dust and dirt from the cups P.

The use of the governor in dynamo-electric machines being to break contact when the number of revolutions of the armature is less than the speed required for the proper working of the machine, it is important that this function should be properly performed; but this is not always the case. With a revolving cup of mercury, as in Weston's machine, even when the speed is very low, the mercury is thrown up in a spiral column from the center, thereby making contact with the disk above, and thus the current is allowed to pass improperly, and in this way the utility of the governor is destroyed. Again, when the armature revolves at too high a speed, the mercury in the revolving cup is thrown upward with great violence against the contact-disk and becomes scattered in more or less minute particles all over the machine and the surrounding floor, and if the machine is situated near the depositing-bath the mercury not unfrequently finds its way into that vessel. In a gilding or plating room the diffusion of myriads of mercury globules would do incalculable mischief if coming in contact with the work. Independent of the loss of mercury thus sustained, and the consequent irregularity of the working of the machine by its absence, the spreading of mercury all round and about the vicinity of the machine would do much harm.

Another defect in the revolving cup is that the stationary pin to which the contact-disk is attached frequently becomes loosened by the vibration of the machine, causing it to slip down and make permanent contact with the mercury, or with the mercury-cup itself, whereby the governor ceases to act, and the work in the bath is likely to be impaired or spoiled.

Another point of importance is that the rapid motion of the mercury within the cup and the constant friction to which it is subject when the machine is in motion cause the mercury to become oxidized, even when glycerine is employed to prevent it. It is not an uncommon circumstance to find as much as a dessertspoonful of oxide and mercury in a finely-divided state in the cup after it has been freely used, and it is needless to say that this would tend greatly to diminish the effective action of the governor.

The advantage of the new governor will be obvious, as all the above-enumerated defects are by its use avoided.

For the purpose of electro-deposition of metals it is desirable, in order to regulate the amount of current passing into the baths from the main circuit, to introduce what is known as a "resistance-coil" on the circuit at the end of each bath in the plating-room; and, further, it is desirable to know and to have indicated the exact amount of current actually passing. Now, to effect this I employ the wire which connects the resistance-board R, and as shown in Fig. 9, with the plating-bath S as follows—that is to say: I give the said wire several turns (more or less) around a soft-iron core, *h*, arranged perpendicularly on a stand, *e'*, and the wire where these turns are made is to be insulated or covered with cotton, silk, or any other insulating material, so as to make of the soft-iron core an electro-magnet. Above this magnet is arranged an armature, *k*, at the end of a lever mounted on a knife-edge support, *l*, the opposite arm of which lever is graduated to a scale, *m*, and fitted with a weight, *n*, as a steelyard. This electro-magnet *h* will exert an attractive power upon the balanced armature *k*, increasing or diminishing with the strength of the current passing to the bath, and the scale of the steelyard will be graduated to indicate the known amount of current generated by any number of cells of known capacity—say Smee or Bunsen cells of three gallons each—and to indicate the weight of metal deposited per hour under equivalent conditions. Each graduation of the scale will also indicate the zinc surface which would be required in an ordinary battery to produce the current. Now, when the baths are at work the strength of the current passing may be readily ascertained by adjusting the weight *n* upon the scale *m* of the armature-lever until the weight overcomes the attractive power exerted by the electro-magnet *h* upon the armature *k* and, so to say, weighing the strength of the current; or I may graduate the arm of the lever in such proportions that it indicates the weight of copper deposited per hour when using, in a depositing-bath, anode and cathode of given surface at given distance apart, from which may be readily obtained the weight of any other metal the same current would under equivalent conditions deposit, and the current passing will be regulated by "putting in" or "taking out" by the resistance-board coil so much resistance as is required, and that by adjusting the handle or contact-piece of the resistance-board, as will be well understood.

I may duplicate the electro-magnet *h* and increase the contact-surface of the armature *k* when this indicator is used with large machines or large currents are being dealt with.

The reversal of current in dynamo-electric machines used for the electro-deposition of metal has heretofore caused considerable loss and difficulty to those employing the same. I have therefore devised a detecter-alarm and indicator device, which I employ and construct as follows, and as shown in Figs. 10 and 10a: I connect the said device in circuit with the machine and bath. This connecting-wire will vary according to the size of the machine, and is to be well insulated and wound around each of two soft-iron cores, *o*, and so as to form part of the continuous wire from the machine to the bath, which cores *o* are placed end to end, but some distance apart, to form electro-magnets, which are placed so that their opposite poles face each other and are bridged or coupled by the continuous wire. Between the space between the electro-magnets, and at right angles thereto, is fitted a pivoted polarized armature, *p*, acted upon by a spring, *q*, to hold same in an intermediate position. Now, when the machine is working and the current is passing this pivoted armature *p* will be attracted to one of these electro-magnets *o* between which it stands, and so long as the current continues to pass in the same direction the position of the armature will remain unaltered; but should a reversal of the main current occur the poles of the electro-magnets will also be reversed, the armature will be repelled from its original position and be attracted by the opposite electro-magnet. The armature *p* will, in its movement, actuate a centrally-pivoted and insulated index-needle, *r*, (the pivot *p'* being common to both *p* and *r*,) which needle *r* also acts as a contact-maker and vibrates between two stops, *s s'*, to and from which wires are attached and carried to an electric bell, *t*, a Léclanché or other battery, *u*, being interposed in circuit between said stops. Upon the current reversing the armature *p* is repelled, as before stated. The pivoted needle *r* is vibrated to make contact between the two stops *s s'*, which completes the circuit between the bell *t* and the Léclanché or other battery, and the bell will continue to ring until stopped by the operator or the machine righted.

Instead of employing the separate devices for governing the current, for preventing reversing, for signaling to the operator, and for measuring the strength of current, as before described, I combine them in one apparatus, as represented in Fig. 11 of the drawings, wherein *h* is a wire-coiled core forming an electro-magnet. *k* is a polarized armature, the support of which armature *k* is connected up by the main-current cable with the perpendicular coil *h*, and said armature *k* reposes, when the circuit is closed against a contact-stud, *o*, immediately above it, and from which stud *o* the continuation of the main-current cable is carried. The repose of the armature-lever against stud *o* is such that the armature *k* does not quite touch the electro-magnet *h*, and is held there with a force proportional to the strength of current passing. If, now, a current in a contrary direction traverses the coil, the armature is at once repelled and breaks the main current, and the lever-arm will fall by its weight and repose against a stud, *s'*, (connected up with an alarm-bell circuit,) immediately below it, placed there to limit its play. At the same time it will close the bell-circuit by contact with stud *s'*, and retain it closed.

The bell-circuit is made by the wire from the post *l* supporting the armature, thence to the battery *u*, thence to bell *t*, and onto stud *s*. Thus the circuit of the alarm-bell *t* will only be complete when the armature-lever is repelled from the magnet *h* on the reversal and consequent breaking of the main current, so that the bell will continue to ring until the reversal is attended to and until such time the bath is out of operation, and no spoiling of the articles under treatment can take place from this cause.

On the bar of the polarized armature *k* are graduations *m*, used in the same manner as described for and shown by the same letter of Fig. 9; and it will be obvious that a loop-current may be employed instead of the main current to magnetize the core of the electro-magnet *h*. One of the said combined apparatus will be placed in the current passing to each bath in a plating-room.

The commutator is constructed substantially as ordinarily, and the ends of the wires from the magnets on the revolving armature, as before described, are brought out through the bush of the stationary disk A; but by preference I make the commutator in sections, insulated from each other by any insulating material, and each wire may in such case be connected with a separate section of the commutator.

In the case of the machine represented in Figs. 8 and 8ª, the plates *a* of the stationary magnets D are made with an enlarged portion, *a'*, and the said magnets D are connected by transverse magnets D', and so the power of the stationary magnets will be increased. Also, in this Fig. 8 it will be seen that the governing arrangement described in reference to Fig. 11 is shown applied instead of the centrifugal governor of Figs. 1, 2, and 4; but this is shown here for illustrative purposes. For electric lighting and telegraphic purposes the machines may be employed without the governor device.

For machines of large construction, and where larger currents are to be developed, the number of the armatures F and stationary magnet-standards A may be increased. Thus, for a machine having two of the revolving armatures upon the shaft C there will be provided three stationary magnet-standards A, and so on.

In order to keep the hollow magnets cool, the stationary disk is perforated at the back of the magnets, and I employ a blast or current of air from a fan, which air may be previously refrigerated, and direct the current by tubes T into the hollows of the magnets, suitable outlets being also provided for circulation of the air through the same.

Having now described the nature and particulars of the said invention, I claim—

1. The combination of the circular revolving armature F, having bush H in the center, with magnets G, the wires of which traverse said bush, and with standards A, magnets D, and transverse magnets D', the whole constructed and arranged substantially as herein shown and described.

2. The magnet-frames D G, with their sector-shaped plates *a* and *b*, connected by the core *c*, the plates *a b* serving as flanges for bolting the magnet-frames to the carrying-disks, substantially as and for the purpose herein set forth and shown.

3. The stationary magnet D, constructed of plates *a* and *b* and of hollow core *c*, in combination with the air-tube T, substantially as shown and described.

4. The centrifugal governor for dynamo-electric machines, operated from the main shaft C through gearing to revolve the pillar M, and through its connections to depress the rod E and saddle O to make or break contact of the current through the mercury-cups P, the whole constructed, operating, and connected substantially as and for the purpose herein set forth and shown.

5. The reversed-current detecter and indicator apparatus, consisting of the electro-magnets *o*, polarized armature *p*, balance-spring *q*, central pivot, *p'*, carrying armature *p*, and needle *r*, operating in connection with the contact-points *s s'* of the electric-bell circuit of battery *u*, the whole in combination with the dynamo-electric machine, substantially as specified.

In testimony whereof I have hereunto set my hand this 13th day of February, 1880.

WILLIAM ELMORE.

Witnesses:

WALTER A. BARLOW,

ALFRED E. WELSH,

His clerk, both of 6 St. Paul's Churchyard, London.