(No Model.)

4 Sheets—Sheet 1.

J. J. WOOD.

SELF REGULATING DYNAMO.

No. 406,493.

Patented July 9, 1889.

FIG. 1.

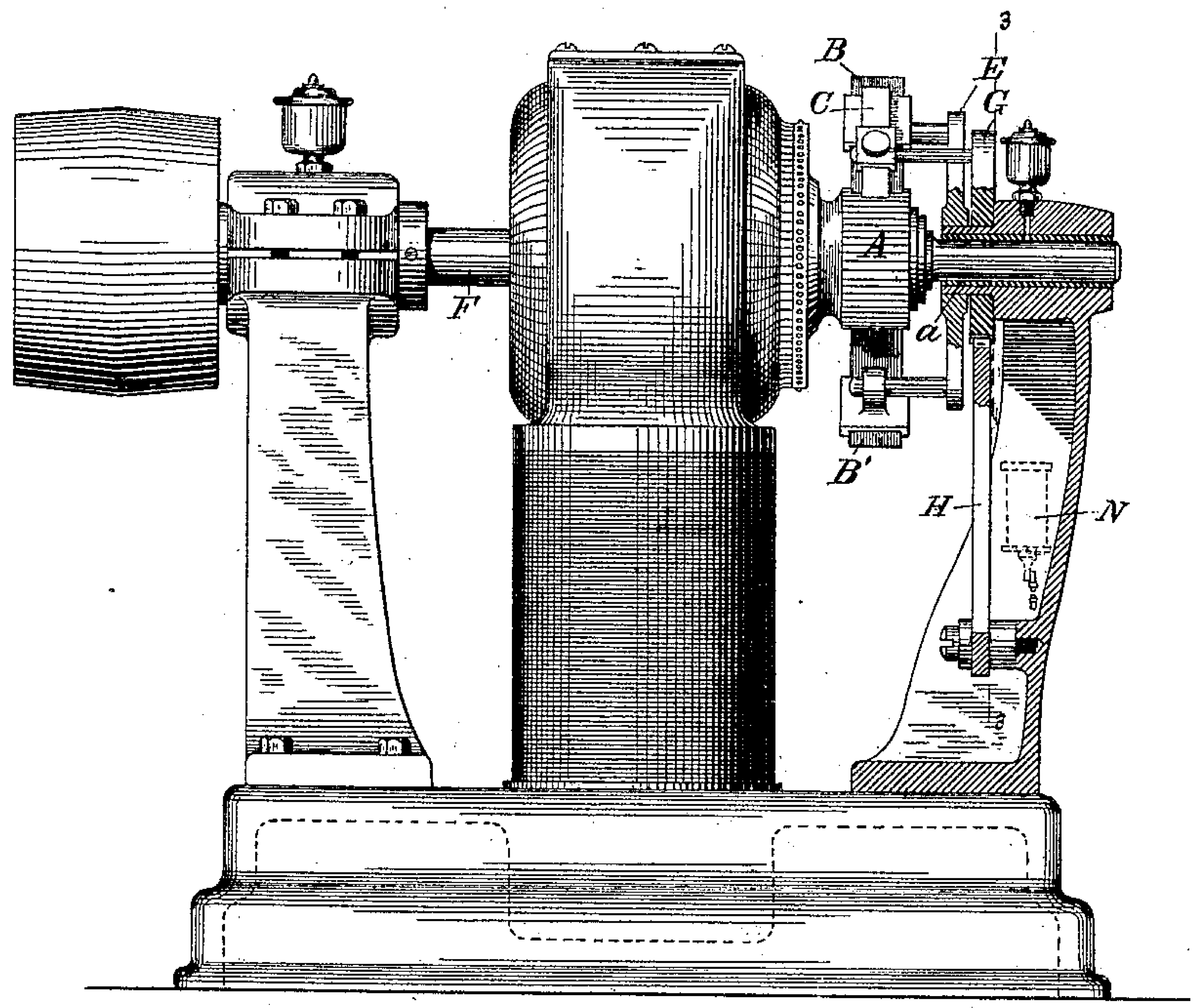


FIG. 2.

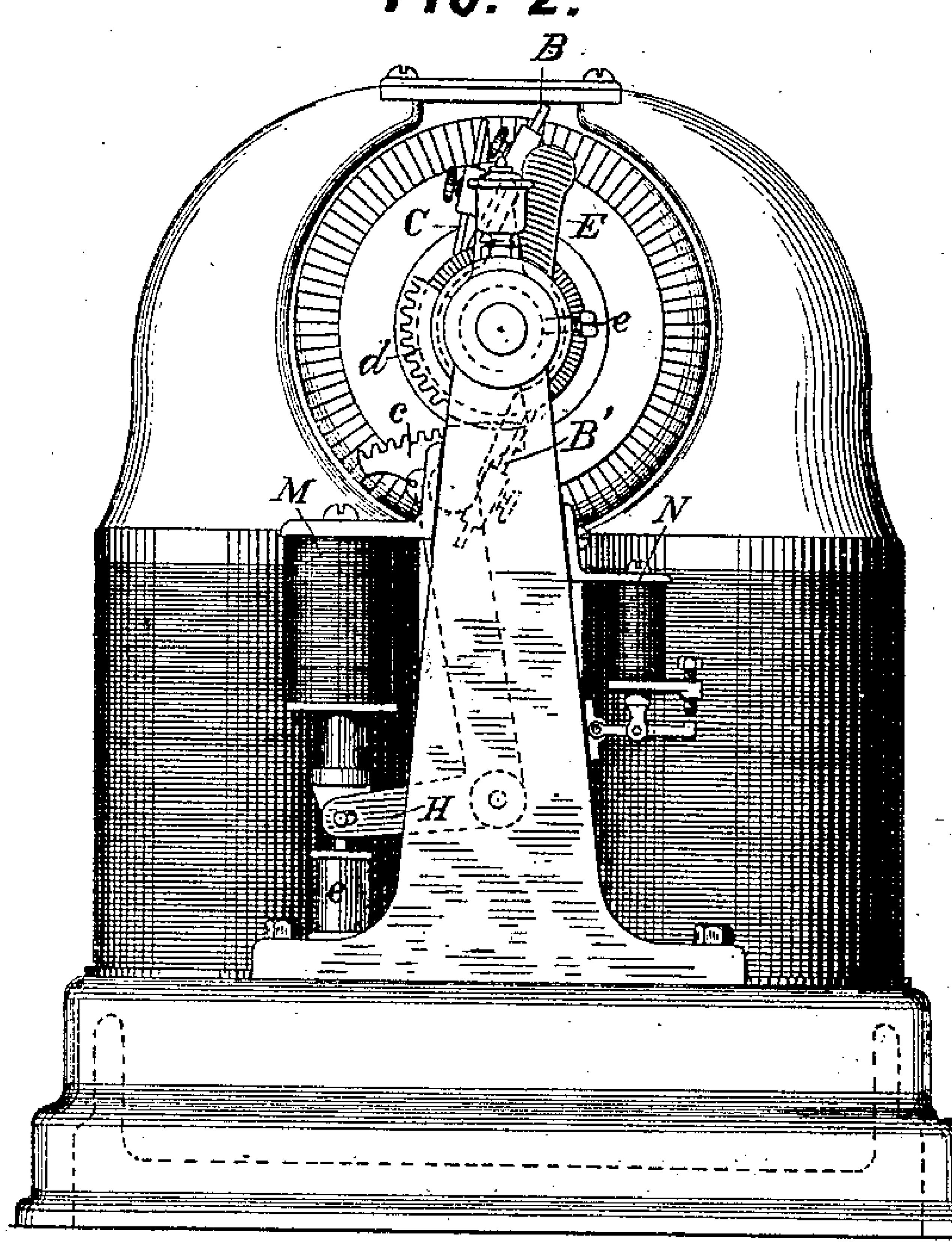
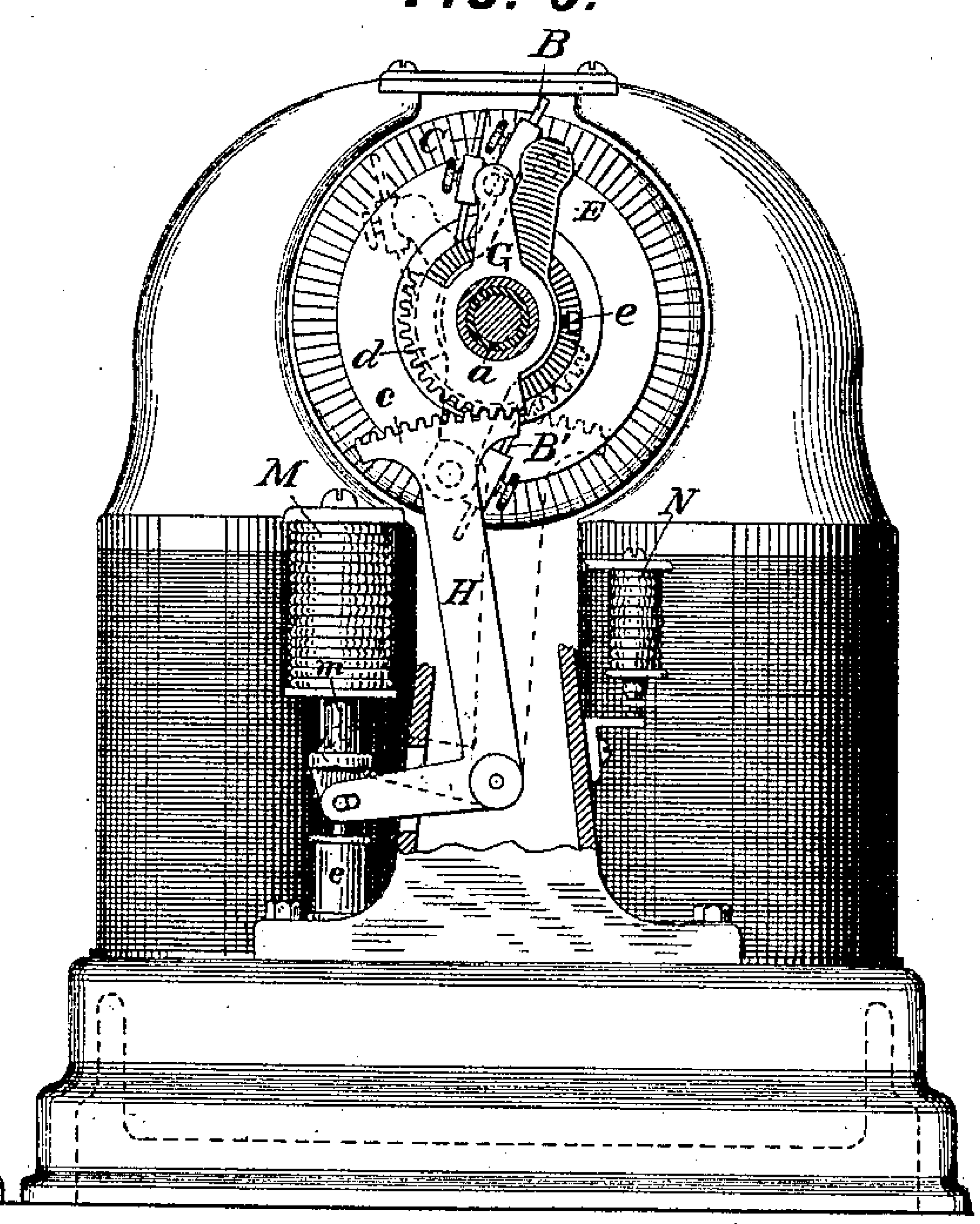


FIG. 3.



WITNESSES:

J. A. E. Criswell.

George Dixon.

INVENTOR:

James J. Wood,

By his Attorneys,

Arthur C. Fraser & Co.

N. PETERS. Photo-Lithographer. Washington. D. C.

(No Model.) 4 Sheets—Sheet 2.

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FIG. 4.

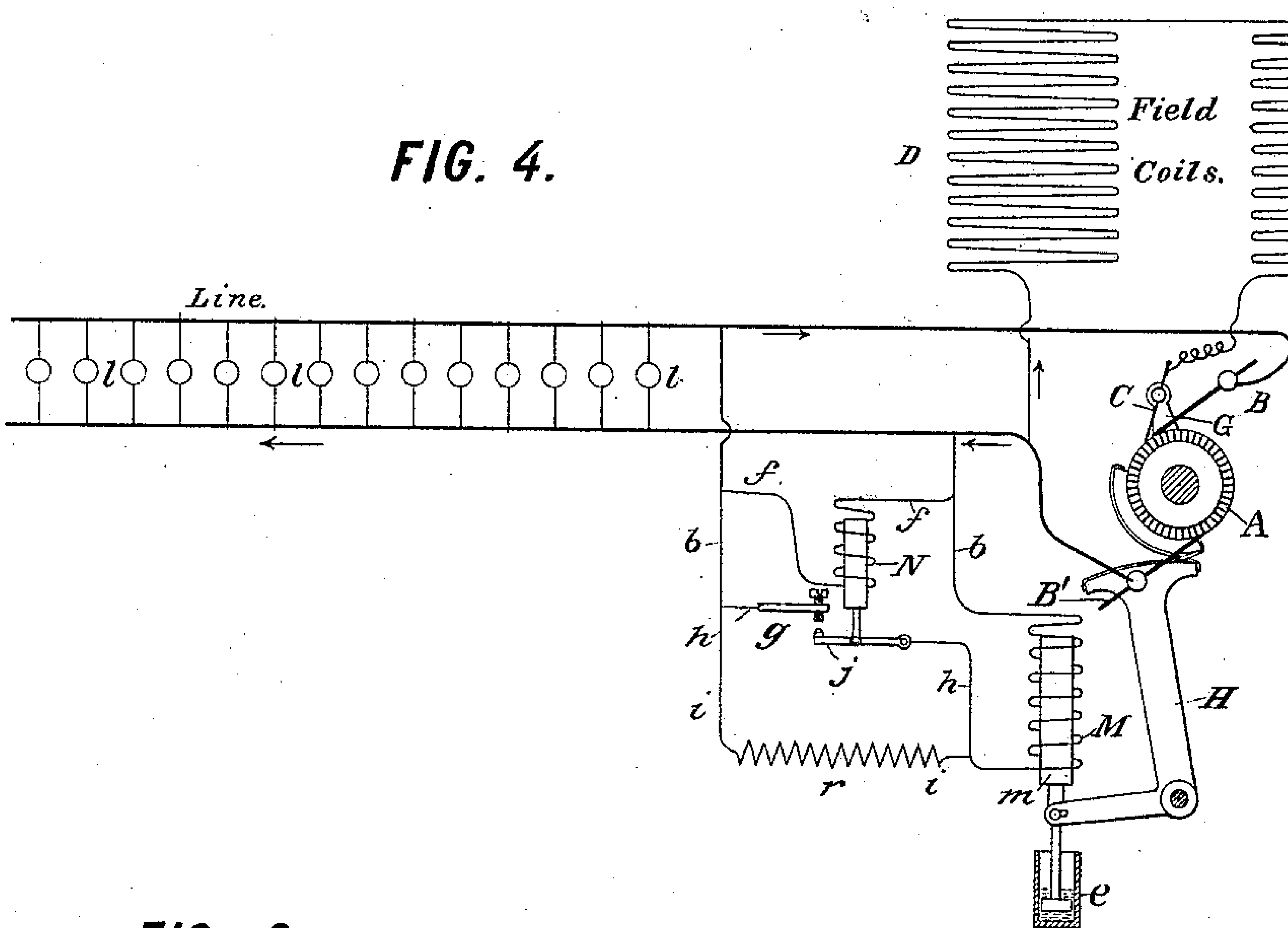


FIG. 6.

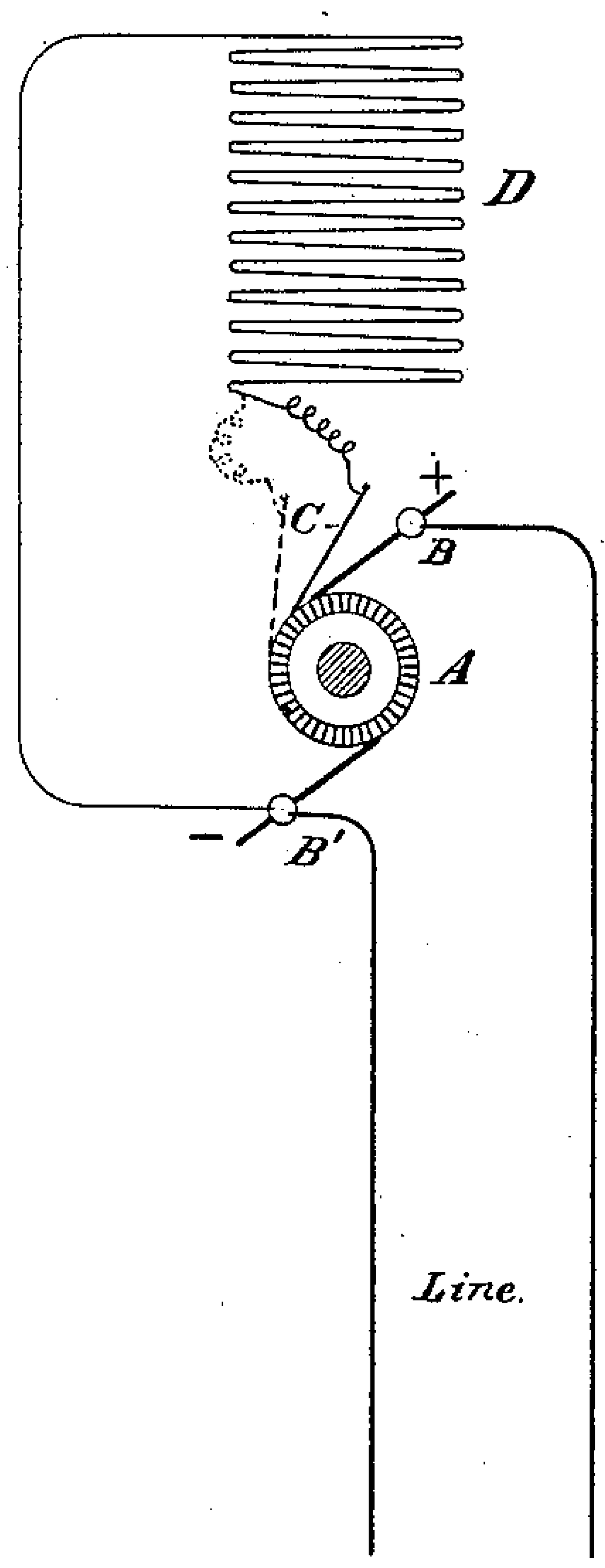


FIG. 5.

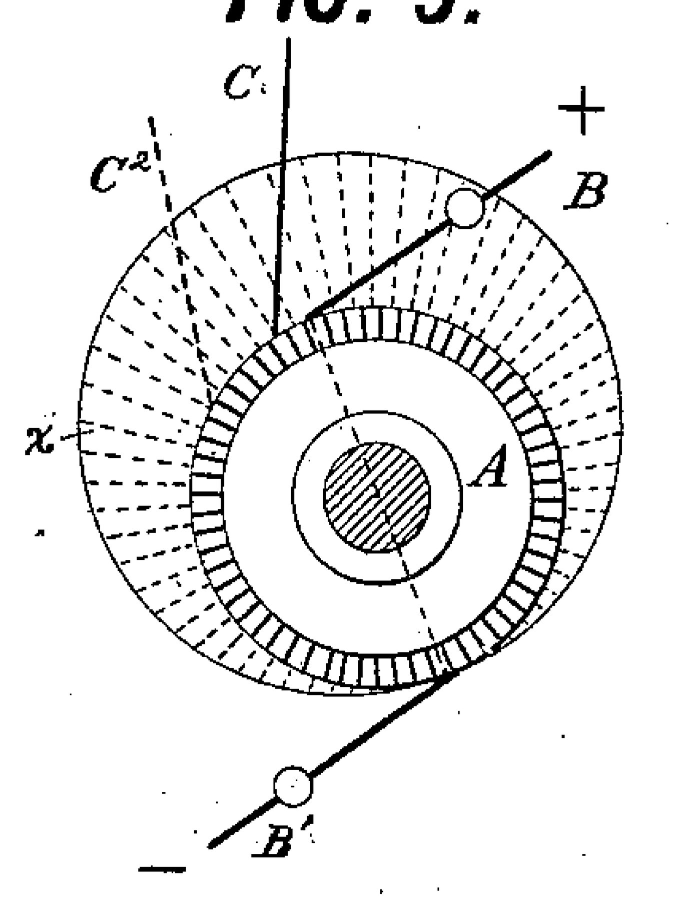
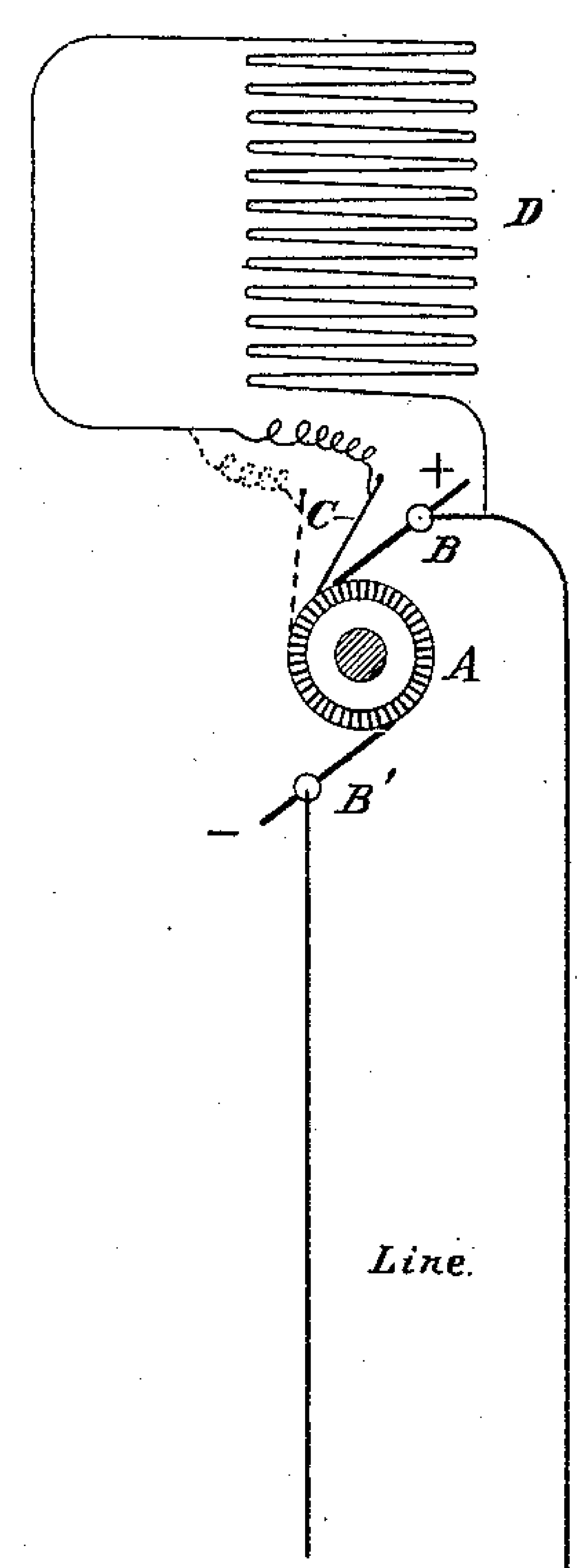


FIG. 7.



WITNESSES:
J. A. C. Criswell.
George Dixon

INVENTOR:
James J. Wood,
By his Attorneys,
Arthur C. Fraser & Co.

(No Model.)

4 Sheets—Sheet 3.

J. J. WOOD.

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FIG. 8.

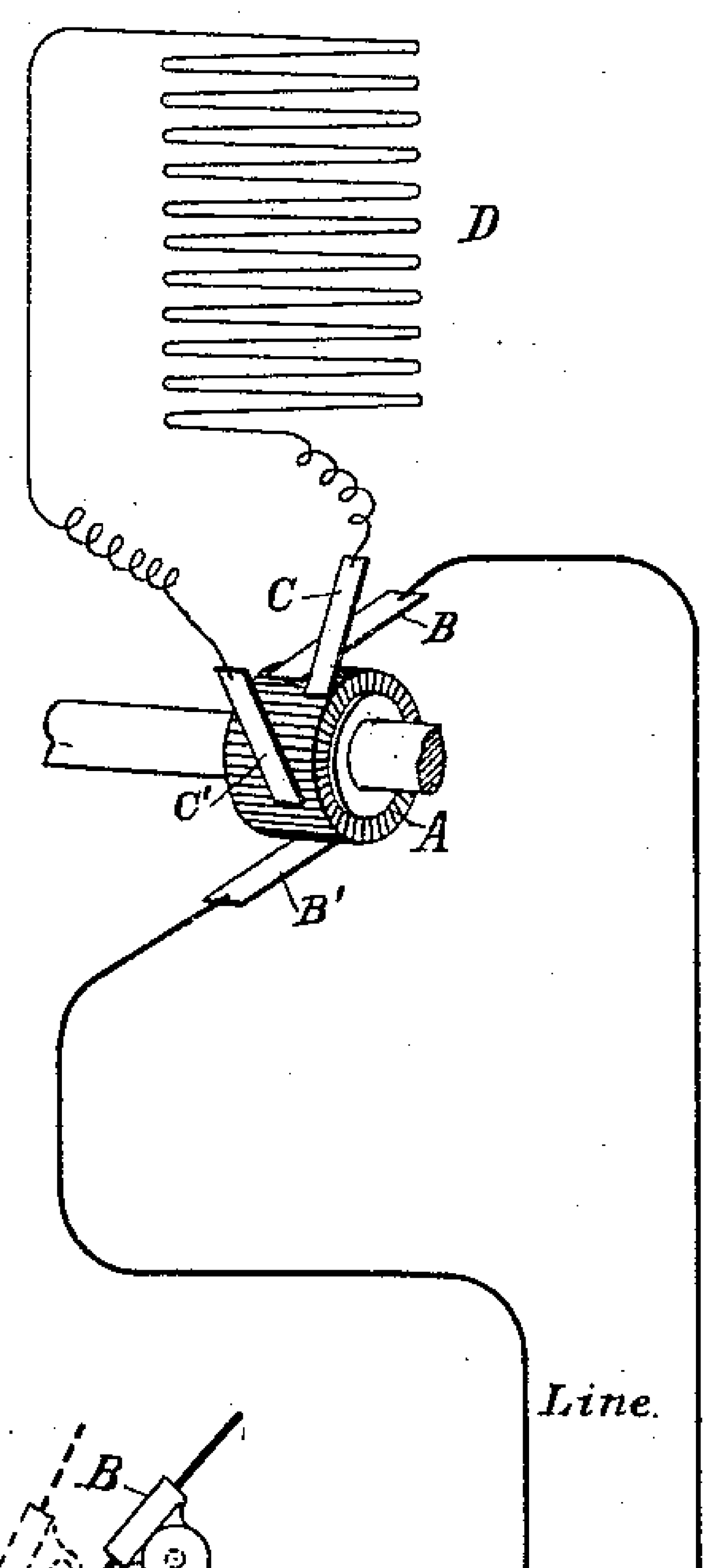


FIG. 9.

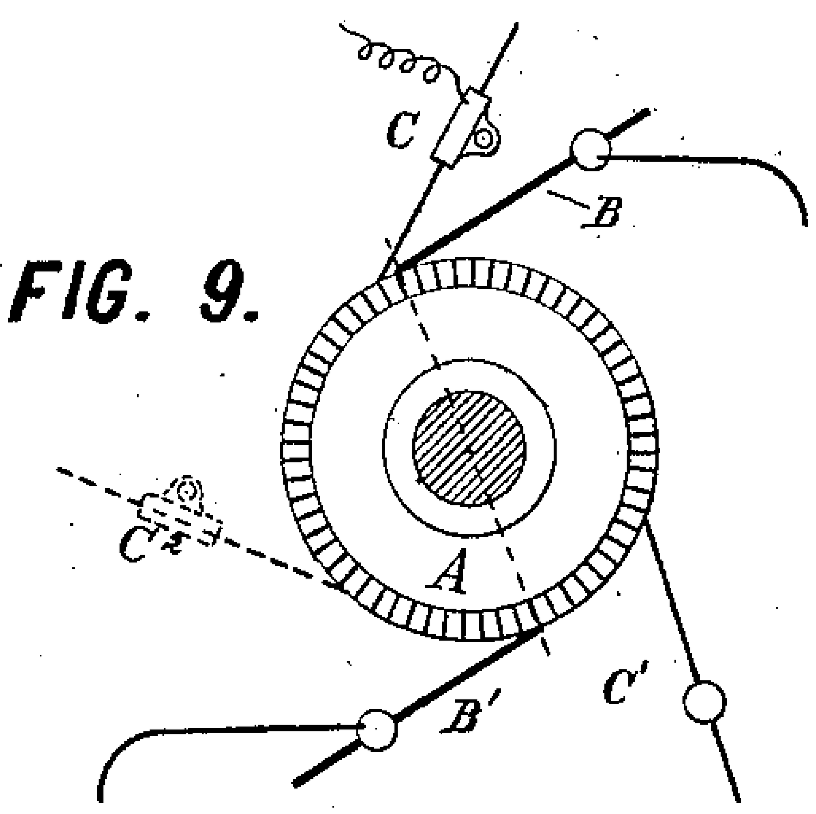


FIG. 11.

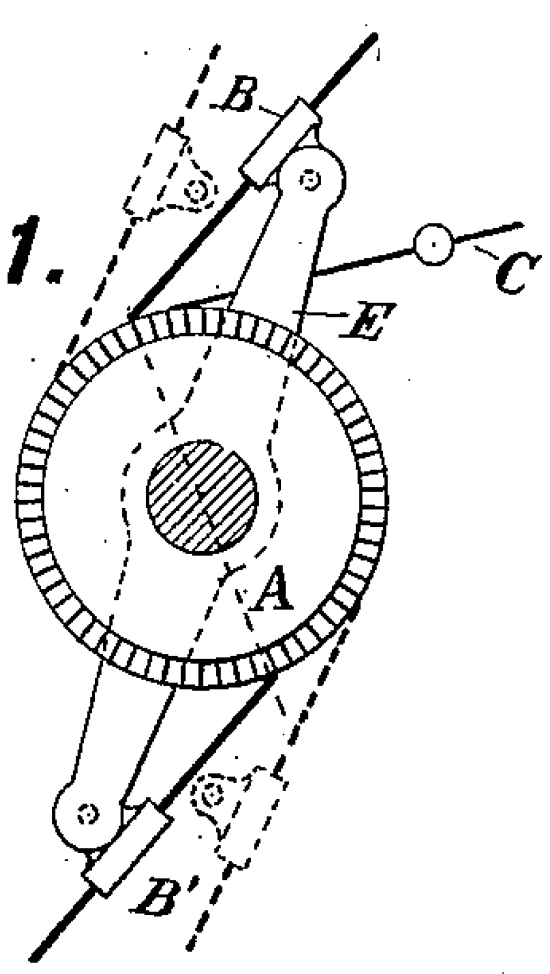


FIG. 10.

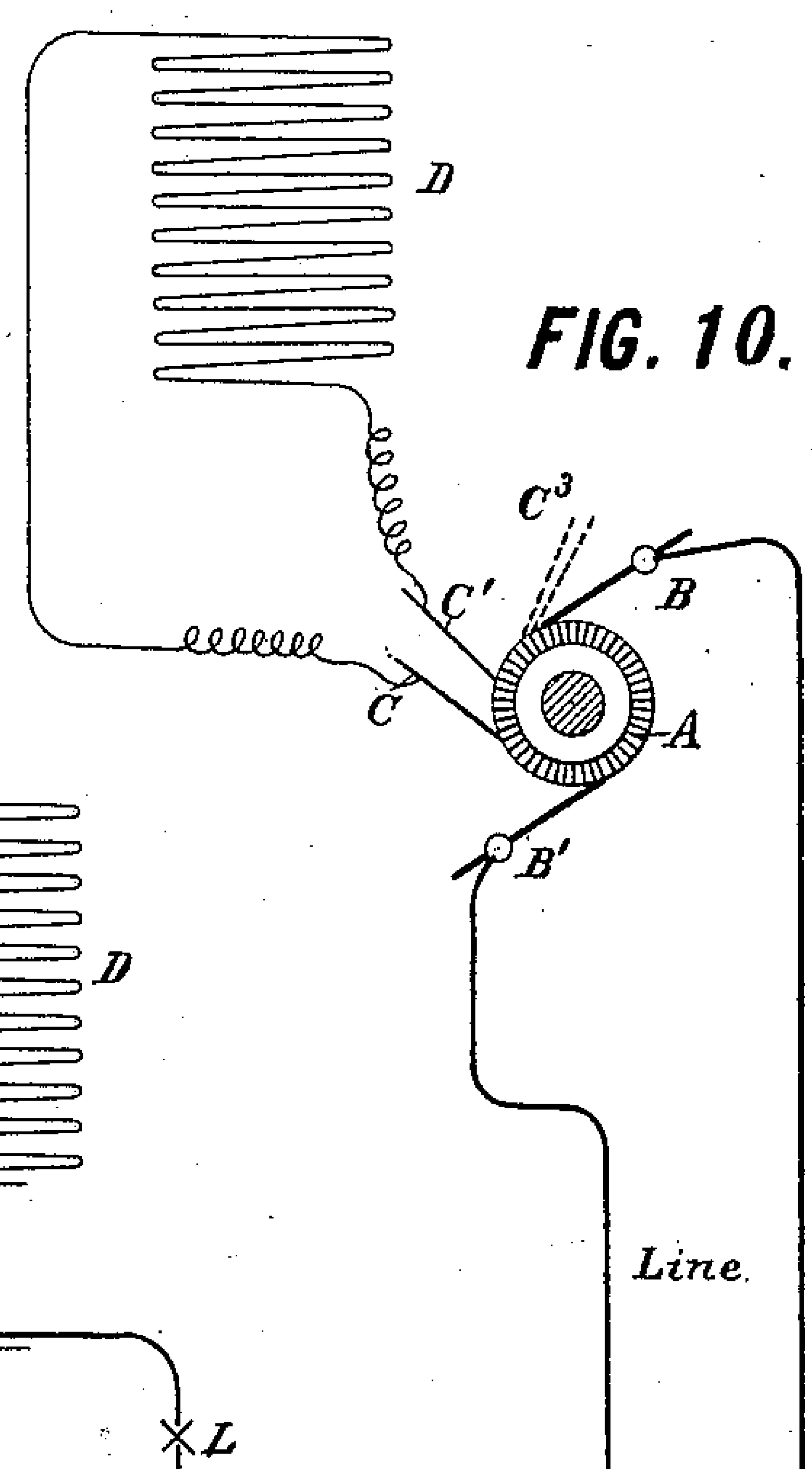
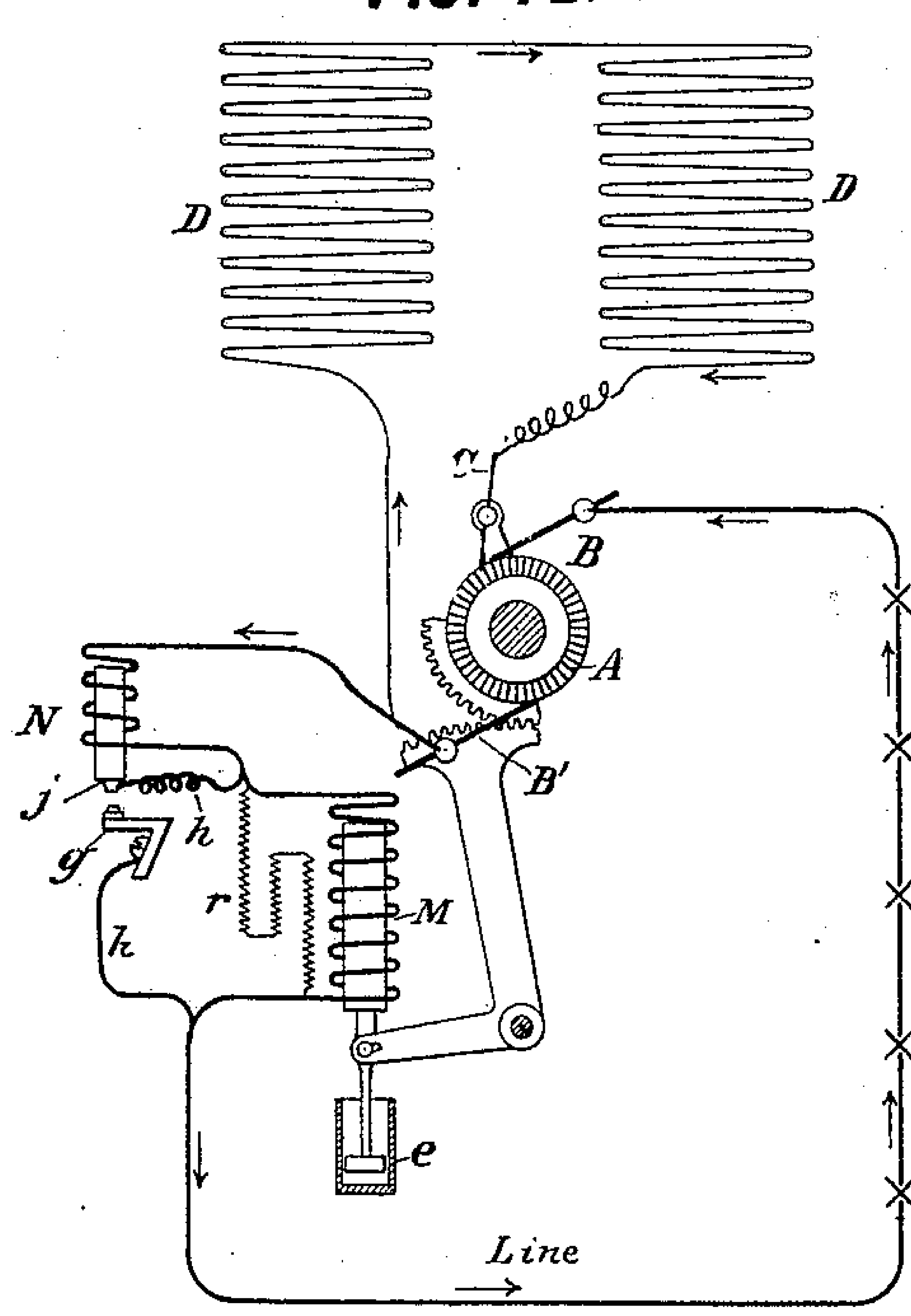


FIG. 12.



WITNESSES:

J. A. C. Criswell

George Dixon

INVENTOR:

James J. Wood,

By his Attorneys,

Arthur C. Fraser & Co.

N. PETERS, Photo-Lithographer, Washington, D. C.

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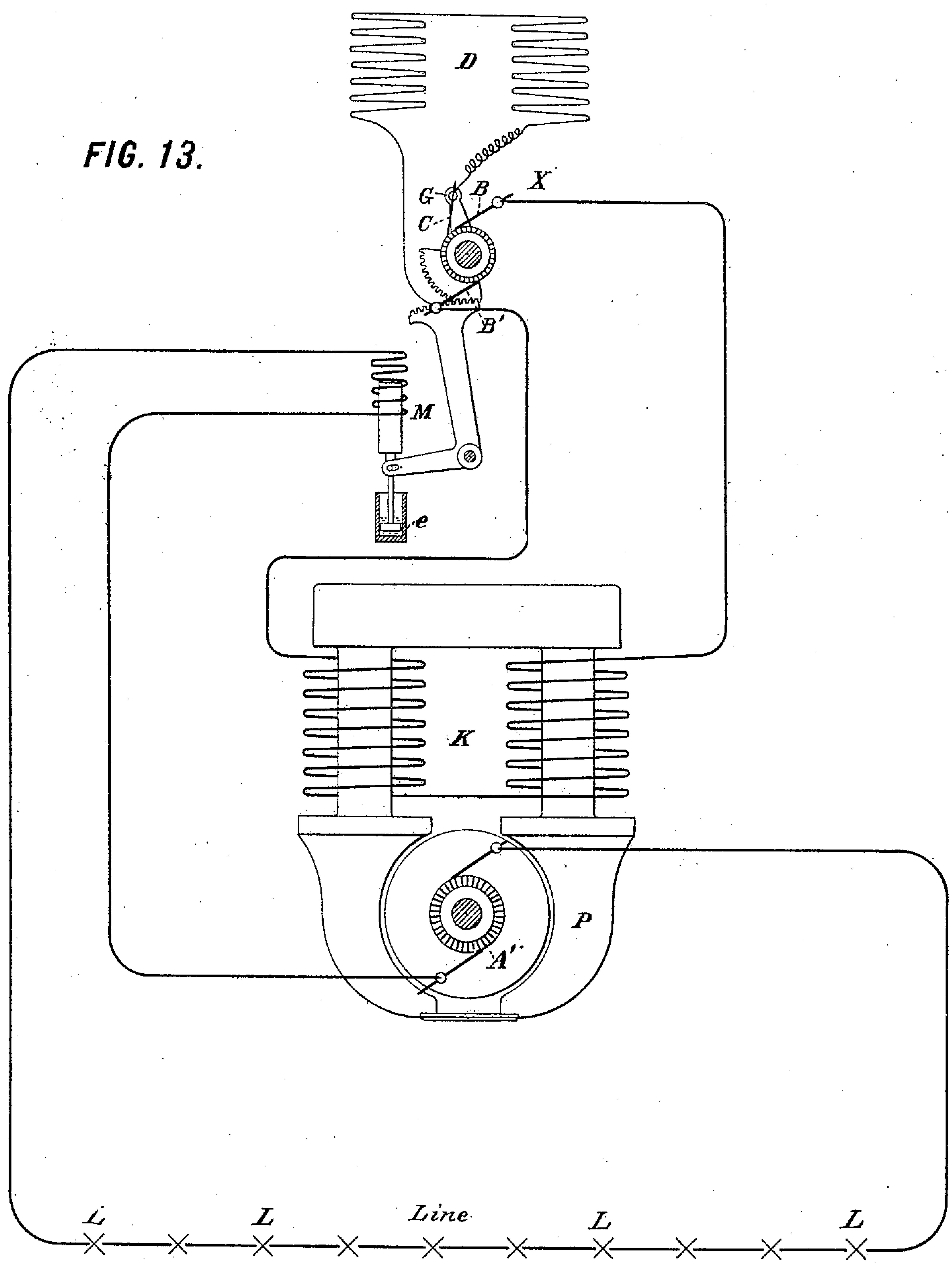
FIG. 13.



WITNESSES:

J. A. E. Criswell.

C. K. Fraser.

INVENTOR:

James J. Wood,

By his Attorneys,

Arthur C. Fraser & Co.

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

JAMES J. WOOD, OF BROOKLYN, NEW YORK.

SELF-REGULATING DYNAMO.

SPECIFICATION forming part of Letters Patent No. 406,493, dated July 9, 1889.

Application filed November 20, 1888. Serial No. 291,354. (No model.)

To all whom it may concern:

Be it known that I, JAMES J. WOOD, a citizen of the United States, residing in Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Self-Regulating Dynamos, of which the following is a specification.

This invention relates to self-regulating dynamo-electric machines or those which automatically adapt their generation of current to variations in the "load" or resistance on the line in order to maintain the current of uniform volume, or in other instances to maintain a uniform difference of potential at the terminals of the machine or at other points in the circuit.

The invention has reference to dynamo-machines having armatures of the Gramme ring or Siemens drum or Pacinotti type, such as are known as "closed-coil armatures."

The particular system of regulation to which my invention pertains is that wherein the magnetization of the field-magnet is varied from time to time in order to increase or decrease the inductive effect upon the armature, and consequently vary the electro-motive force of the generated current. In machines of this type the field-magnet is wound wholly or in part with a shunt-coil, the terminals of which are connected to brushes bearing on the commutator and adjustable to different positions thereon in order to make contact with segments having varying relative differences of potential, so that by the relative adjustment of the brushes the current through the shunt-coil may be increased or diminished. The terminal brushes of the shunt-circuit may be entirely independent of the brushes which feed the main circuit, or only one of them may be so independent.

In machines regulated according to this sytem, as heretofore proposed, the adjustment of the shunt-terminal brushes has been effected either by hand from time to time, or in the case of an automatic regulator has been effected through the instrumentality of oppositely-acting electro-magnets communicating motion to the brushes in one direction or the other through the medium of a ratchet device giving a step-by-step movement to the brushes, a circuit-interrupter being provided to insure the alternate excitation of such electro-magnets. Such a device is slow in its operation, being incapable of responding quickly to changes in the condition of the circuit in order to instantaneously compensate therefor, and its action is independent of the varying energy of action at different times of the regulating-magnet in the main circuit, which directly responds to changes occurring therein. Such devices are also objectionable by reason of their complication and the sparking which occurs at the circuit-breaking points, which renders them inapplicable to machines generating high potential.

My invention aims to provide a simplified means for the automatic regulation of dynamos on the principle above outlined.

According to my invention one or both of the terminal brushes of the shunt field-coil are mounted on a yoke independently of the main-circuit brushes, which are fixed in position, and said yoke is connected through the medium of a suitable mechanical connection with the movable member of an electro-motive device so connected electrically to the main or external circuit as to be responsive to changes occurring therein of the character for which the dynamo is designed to compensate. Such electro-motive device will be usually an electro-magnet, either of the ordinary type having a fixed core and a movable armature, or of the solenoid type wherein the core is movable. The mechanical connection between the movable member of such magnet and the shunt-terminal brush-yoke may consist of any mechanical device adapted to transmit the movements of the moving member proportionally to the yoke, so that the shunt-terminal brush or brushes shall be adjusted around the commutator with a rapidity and to an extent dependent upon the energy of excitation or demagnetization of the magnet, so that the compensating action shall be instantaneous and shall be of such extent as to restore the external circuit to its normal condition by effecting an immediate inverse and proportionate change in the excitation of the field-magnet of the dynamo.

My invention may be applied either in the construction of dynamo-machines generating currents of constant volume—such as are used for arc lighting or to machines generating currents at constant potential—such as are used for incandescence lighting in multiple arc.

Figure 1 of the accompanying drawings is a side elevation of a dynamo-machine for generating constant potential, constructed according to the preferred form of my invention. Fig. 2 is an end elevation thereof. Fig. 3 is an elevation similar to Fig. 2, but partly in vertical section, cut on the line 3 3 in Fig. 1 and showing a machine for generating a constant current. Fig. 4 is a diagram showing the circuit connections and regulator for a machine generating constant potential. Fig. 5 is a diagram showing the integrated curve of potentials around the commutator of a well-proportioned Gramme ring or closed-circuit dynamo. Figs. 6 and 7 are illustrative diagrams. Figs. 8, 9, 10, and 11 are circuit-diagrams illustrating modifications. Fig. 12 is a diagram (similar to Fig. 4) showing the circuit connections and regulators for a machine generating a constant current such as shown in Fig. 3. Fig. 13 is a diagram showing the application of my invention to a separately-excited constant-current dynamo.

Referring to the drawings, let A designate the commutator; B and B′, the positive and negative brushes thereof feeding the main circuit; C, an auxiliary or secondary brush; D, the field-magnet coil or one of the field-magnet coils; E, the yoke carrying the main brushes B B′; F, the armature-shaft; G, the yoke carrying the supplementary or auxiliary brush C, and M the regulating electro-motive device, as a magnet or solenoid.

Referring first to Figs. 6 and 7, it is seen that the opposite terminals of the field-magnet coil D are connected the one with the supplemental brush C and the other with one of the main-circuit brushes B B′. Assuming a uniform resistance in the shunt-circuit, the current through the coil D will be proportionate to the difference in potential of the brushes constituting the terminals of the shunt, and this difference may be varied by moving the brush C toward or from the other shunt terminal brush. Thus in Fig. 6, where the terminals are respectively the auxiliary brush C and the negative main brush B′, the movement of the brush C from the position shown in full lines to the one shown in dotted lines reduces the relative difference of potential, and decreases the current through the coil D. In Fig. 7, where the shunt terminal brushes are respectively the main positive brush B and the auxiliary brush C, the movement of the latter from the full to the dotted line position increases the difference of potential, and augments the current in the field-coil. The variations of potential are graphically illustrated in Fig. 5, where the curve x indicates the rise of potential from the negative to the positive brush developed circularly around the commutator. Thus by this adjustment of the brush C the current in the coil D may be adjusted to any strength between zero when the brush C is in contact with the opposite terminal brush, and the maximum current when the brush C is diametrically removed from the opposite terminal brush. If the coil D is the sole field-magnet coil, the excitation of the field will increase as the current therein is augmented, and vice versa, while, on the contrary, if the field-magnet is otherwise excited the effect of the coil D will be either to increase or reduce the magnetism of the field as the current in the coil D is increased, according as this coil is connected directly or inversely to the main field-exciting coil. Such is the principle of regulation on which my invention is founded.

I will now proceed to describe the preferred application of my invention, with reference to Figs. 1, 2, and 4. These figures show a dynamo for generating a constant potential suitable for supplying a circuit of incandescent lamps in multiple. The arrangement of brushes relatively to the shunt-circuit is the same as that shown in Fig. 6, the coil D being the sole exciting-coil of the field-magnet.

Referring to Figs. 1, 2, and 4, let A designate the armature; B B′, the main collecting-brushes; C, the auxiliary brush; D, the field-magnet exciting-coil; L, the line-circuit, and l l incandescent lamps installed therein in multiple arc. The brushes B B′ are carried in holders of any usual construction mounted on opposite arms of a yoke E, which is fixed by a set-screw e, Fig. 2, to an inwardly-prolonged boss a on the bearing in which the armature-shaft F turns, as shown in Fig. 1, so that the yoke E is stationary, the brushes B B′ being adjusted to bear on the commutator at the points of maximum current. The auxiliary brush C is held by a brush-holder, which is borne by the arm of a yoke or carrier G, which is pivotally mounted on the projecting bearing-boss a. One terminal of the field-coil D is connected to the brush B′ and the other terminal to the auxiliary brush C. A regulating magnet or solenoid M is connected to the external circuit, so as to be responsive to changes therein, in this instance being connected in derivation in a shunt b between the main-line conductors. The armature or core m of this magnet or solenoid is connected through any suitable connecting mechanism with the auxiliary brush-carrier G, so that the movements of the armature m may be communicated proportionally to, or induce corresponding proportional movements of, the brush-carrier, and consequently of the auxiliary brush.

Let us assume that the machine is running under maximum load, all of the lamps l l being in circuit or lighted. In such case the auxiliary brush C will be at its greatest normal distance from the brush B′, so as to divert the normal current through the field-coils D. (By this expression it is not meant that the brush C is necessarily diametrically opposite to the brush B′ or in contact with the opposite brush B, but merely that it is at the greatest distance from the brush B′, to which it ever moves under normal conditions.) Suppose, now, that a number of lamps is turned out. The resistance on the circuit is thereby increased, the current decreases, and the potential rises. Simultaneously an undue proportion of current is diverted through the shunt *b*, the resistance of which has remained uniform. The magnet M is thus unduly excited and lifts its armature *m*, which acts through the intervening mechanism to shift the brush C toward the brush B′, thereby reducing the current through the field-coils D. Consequently the magnetism of the field-magnet is reduced and the potential of the armature is correspondingly diminished until an equilibrium is reached and the normal potential on the line is restored. The lighting of more lamps on the line, thereby reducing the resistance and reducing the current through the shunt *b*, produces the contrary effect, moving the brush C away from the brush B′ and increasing the current through the shunt field-coil. The same result follows from the slowing down of the machine.

In the particular construction shown the intervening connection between the armature *m* and auxiliary brush-carrier G consists of an elbow-lever H, one arm of which is connected to the solenoid-core *m*, and the other arm of which is formed with a sector *c*, gearing with a sector *d*, formed on the auxiliary brush-carrier G. A dash-pot *e* is provided to prevent too sudden movements of the solenoid-core.

It will be understood that any connecting mechanism may be employed for communicating the movement of the armature or other movable member of the magnet or other electro-motive device M to the auxiliary or shunt-terminal brush C, provided the intervening mechanism be of such character as to induce a movement of the brush proportional to the action of the regulating-magnet—that is, proportional either to the extent or the energy, or both, of its movement.

In order to render the regulating mechanism sensitive and capable of compensating for slight variations in the circuit, it is important, practically, to provide means for intensifying the action of the magnet M; or, in other words, for magnifying the fluctuations of current in the exciting-coil of this magnet. To this end I have shown in connection with it one means for accomplishing that purpose, and which I will briefly describe with reference to the diagram, Fig. 4. A relay magnet or solenoid N is connected between the line-conductors in a shunt *f*. This magnet N is very sensitive, responding to very slight changes in the potential on the line and much more minute changes than those necessary to actuate the magnet M, which has comparatively heavy work to do. In the shunt *b* there is included a variable resistance *r*, suitably proportioned to the resistance of the coil of the magnet M, according to the extent to which it is required to magnify the effect upon this magnet of the fluctuations on the line. The shunt *b* has a branch *h h*, which, when closed, short-circuits the resistance *r*, and in this branch are contacts *g j*, operated by the relay N to open or close the branch *h h*.

The operation is as follows: Upon a rise of potential in the main conductors the increased current through the relay N excites it and causes it to pull up the contact-lever *j* into contact with the stop *g*. This closes the branch *h*, short-circuiting the resistance *r*, and to that extent reducing the resistance in the shunt *b*, and causing an increased current to traverse the magnet M, which is hence excited and causes the auxiliary brush C to approach the brush B′. The machine then develops a decreasing difference of potential until the relay-magnet N suffers a sufficient loss of magnetism to drop the lever *j* and break contact with *g*. The resistance *r* being thus thrown into series with the magnet M in the shunt *b*, the current through the magnet M is greatly reduced, so that it releases its armature, and the auxiliary brush C moves backward and increases the current in the field-coils D, thereby augmenting the potential developed by the machine. There will be, hence, a continual rise and fall of potential sufficient to actuate the sensitive relay-magnet N intermittently, so that this relay will in fact open and close the branch *h* at momentary intervals. Thus the regulating device is kept in constant movement, instantly checking its movement in either direction when there is no change in the condition of the circuit, and responding with great sensitiveness when such change occurs.

It is not essential to my invention that the terminal brushes of the shunt-circuit shall consist respectively of one of the main-current brushes and an auxiliary brush, nor that such auxiliary brush shall alone be movable. All that is essential is that the two brushes constituting the terminals of the shunt shall be adjustable relatively to each other or to the commutator in such manner that their relative differences of potential may be increased or diminished. Although, for the sake of simplicity, I prefer to utilize one of the main-current brushes as one terminal of this shunt, yet this is not essential, since both shunt-terminals may be independent of the main brushes, as shown in Fig. 8, where C and C′ designate the respective shunt-terminal brushes, either or both of which are adjustable around the commutator when the main brushes B B′ remain fixed. The brushes C C′ may be placed on opposite sides of the commutator, as shown in Fig. 9, where the brush C′ is supposed to be fixed and the brush C to be movable from the position shown in full lines to that indicated in dotted lines at C^2.

In Fig. 10, B and B′ are the main brushes, which are fixed in position, and C C′ are the auxiliary brushes, which are adjustable around the commutator from the positions shown in full lines to those shown at C^3 in dotted lines. The full-line position is that of maximum difference of potential and the dotted-line position that of minimum difference. The difference is due both to the fact that in the full-line position the brushes are farther apart and to the fact that they are here on the intermediate portion of the commutator where the rise of potential between successive segments is greater than it is adjacent to the neutral line, as is well known.

Fig. 11 shows a single auxiliary brush C, mounted in a fixed holder so as to occupy an invariable position—as, for example, at or adjacent to the neutral line—while the main-current brushes B and B′ are carried by a yoke E, by the oscillation of which they are adjusted around the commutator from the position of maximum current (shown in full lines) to the position of minimum current. (Shown in dotted lines.) Thus the adjustment of the main-circuit brushes accomplishes simultaneously two effects—viz., the brushes take off a reduced current from the commutator as they are moved away from the maximum position, while at the same time the movement of the brush B or B′, which forms the opposite terminal of the shunt field-magnet coil leading from the auxiliary brush C, so changes the relative potentials of the respective brushes of this shunt-coil as to reduce the magnetism of the field-magnet and thereby decrease its inductive action on the armature. The same results may be reached by the adjustment only of the brush B or B′, which forms the terminal opposite to C of the field shunt-coil.

Fig. 12 is a diagram illustrating the modification of my machine shown in Fig. 3, which adapts it for use as a constant-current dynamo for an arc-lamp circuit. The only difference between this construction and that shown in Fig. 4 is in the regulator-connections. The magnet M is arranged in the main circuit instead of in a shunt. The relay N is also in the main circuit and in series with the magnet M. The contacts *j* and *g* of the relay are arranged to operate a short circuit *h* around the magnet M, so that when the relay N is not excited above the normal this short circuit is closed and the magnet M is short-circuited. A rheostat *r* is introduced as a bridge between the contacts *j g* to prevent sparking. The operation of this construction is as follows: Suppose the maximum number of lamps to be in circuit, so that the machine is operating under maximum load and that it is running at full speed. The auxiliary brush C is then at its farthest normal position from the brush B′, so that the normal current is circulated in the shunt field-coils. If now one or more lamps are extinguished by short-circuiting, the circuit-resistance is reduced and the current momentarily increases, thereby increasing the excitation of the relay-magnet N, parting the contacts *j g*, and causing an increased current to circulate through the coils of the magnet M, which accordingly lifts its armature at a speed governed by the dash-pot *e* and shifts the brush C toward the brush B′, thereby decreasing the current through the shunt field-coils, reducing the magnetism of the field, and hence weakening the inductive action thereof, so that a current of less volume is generated. When the current has been thus reduced sufficiently to cause the relay N to relax its armature, the contacts *j g* again touch, the magnet M is short-circuited and relaxes its armature, and the auxiliary brush C moves back a little way from the brush B′, thereby increasing the current output of the machine. This alternate action takes place intermittently at momentary intervals at all times, being suspended only while the machine is recovering from or compensating for a change in the resistance of the external circuit.

My invention as applied to constant-potential dynamos has the advantage that it is applicable to any existing shunt-coil machine. It has the further advantage of dispensing with the resistance-coils heretofore used for governing the field. It will be understood that the wires of the shunt *b* may take the place of the "pressure-wires" of an incandescent lighting-plant, being connected to the conducting-mains at any point on the circuit where it is desired to maintain constant potential.

In Figs. 1, 2, 3, and 12 I have shown the lever H, geared to the brush-carrier G by intermeshing cog-teeth. In Fig. 4 an equivalent gearing is shown, consisting of two flexible strips or bands working on arc-shaped faces on the respective parts, the one band being connected at its left-hand end to H and at its right-hand end to G, and the other being inversely connected, so that they serve to transmit motion in both directions.

My invention is readily applicable to separately-excited dynamos, either to those generating constant current or to those generating constant potential. Fig. 13 shows its application to a constant-current dynamo. The exciter-dynamo X has the commutator A, main brushes B and B′, and auxiliary brush C, with its field-coil D in a shunt between brushes B′ and C, as already described. The main circuit between brushes B B′ includes the field-exciting coils K of the main dynamo P. The commutator-brushes on the armature A′ of this dynamo are fixed in the position of maximum current, and supply the external or line circuit in which the coil of the regulating-magnet M is arranged. Any decrease of resistance in the line increases the excitation of this magnet, shifts the brush C toward B′, reduces the current in coils D, and decreases the magnetism of the exciter-field, and the current generated by the exciter is consequently reduced, thereby decreasing the excitation of the coils K, so that the current given out by the main dynamo P is restored to the normal.

I claim as my invention, in dynamo-electric machines, the following defined improvements, substantially as hereinbefore specified, viz:

1. In a dynamo-electric machine, the combination, with the field-magnet and armature, of main-current brushes connected to the line-circuit, the field-magnet coil in a shunt-circuit, terminal brushes for said shunt relatively adjustable around the commutator to positions of different relative potentials, whereby a variable continuous current is fed to the shunt field-coil, a regulating magnet or solenoid connected with the main circuit and responding to variations therein, and a mechanical connection between the movable member of said magnet and the movable shunt-terminal brush or brushes, whereby the movements of the former due to changes in the circuit are communicated proportionally to the latter and the current to the field-coil is thereby varied to alter the magnetization of the field in compensation for the variations in the external circuit.

2. In a dynamo-electric machine, the combination, with the field-magnet and armature, of main-current brushes connected to the line-circuit, the field-magnet coil in a shunt-circuit, terminal brushes for said shunt relatively adjustable around the commutator to positions of different relative potentials, whereby a variable continuous current is fed to the shunt field-coil, a regulating magnet or solenoid connected with the main circuit and responding to variations therein, a lever to which the movable member of said magnet is connected, formed with a sector, and a movable yoke carrying the movable shunt-terminal brush or brushes, and formed with a sector gearing with the sector of said lever, whereby the movements of said magnet are communicated proportionally to the shunt-terminal brush.

3. In a dynamo-electric machine, the combination, with the field-magnet and armature, of main-current brushes connected to the line-circuit, the field-magnet coil in a shunt-circuit, terminal brushes for said shunt relatively adjustable around the commutator to positions of different relative potentials, whereby a variable continuous current is fed to the shunt field-coil, a regulating magnet or solenoid responsive to variations of electrical condition in the main circuit, a mechanical connection between the movable member thereof and the movable shunt-terminal brush or brushes for communicating the movements of the former proportionally to the latter, the main circuit formed with a branch in which said magnet or solenoid is connected, and a comparatively sensitive relay-magnet in connection with the main circuit adapted to govern the flow of current through said branch, and arranged when excited by an increased current to disproportionately augment the current through said regulating-magnet, whereby the action of the latter is intensified.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

JAMES J. WOOD.

Witnesses:
ARTHUR C. FRASER,
JNO. E. GAVIN.