No. 658,064. Patented Sept. 18, 1900.

B. HOPKINSON.

SWITCH FOR ALTERNATING ELECTRIC CURRENTS.

(Application filed Dec. 22, 1899.)

(No Model.) 3 Sheets—Sheet 1.

FIG. 2.

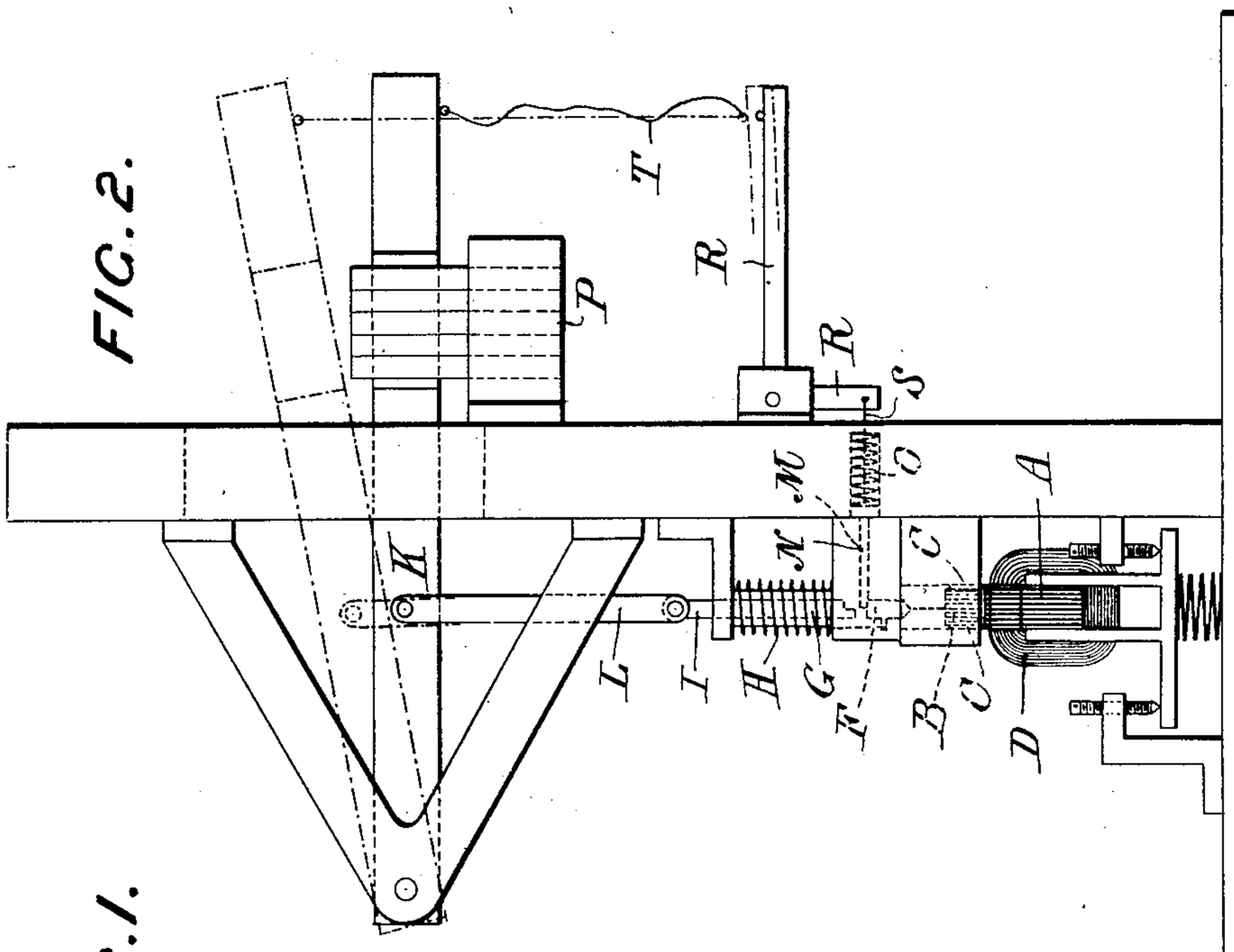

FIG. 1.

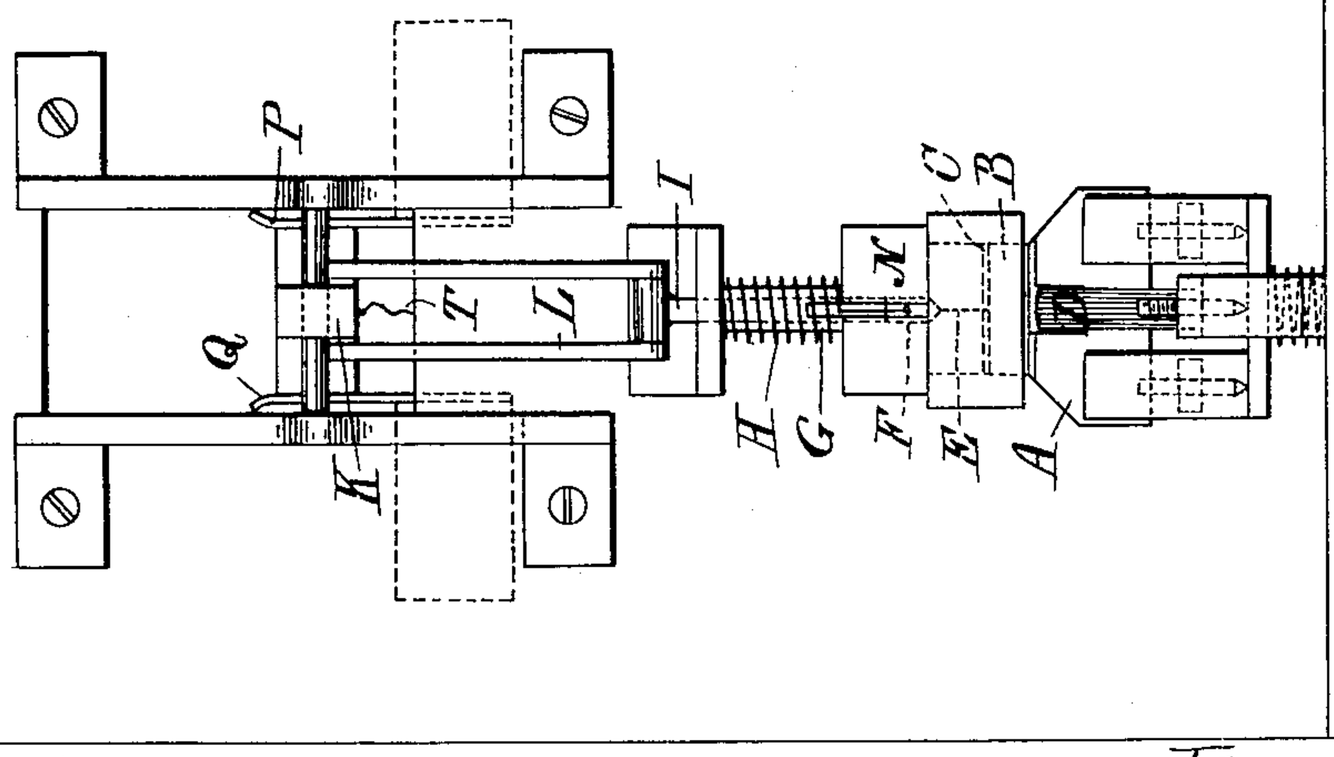

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FIG. 6.

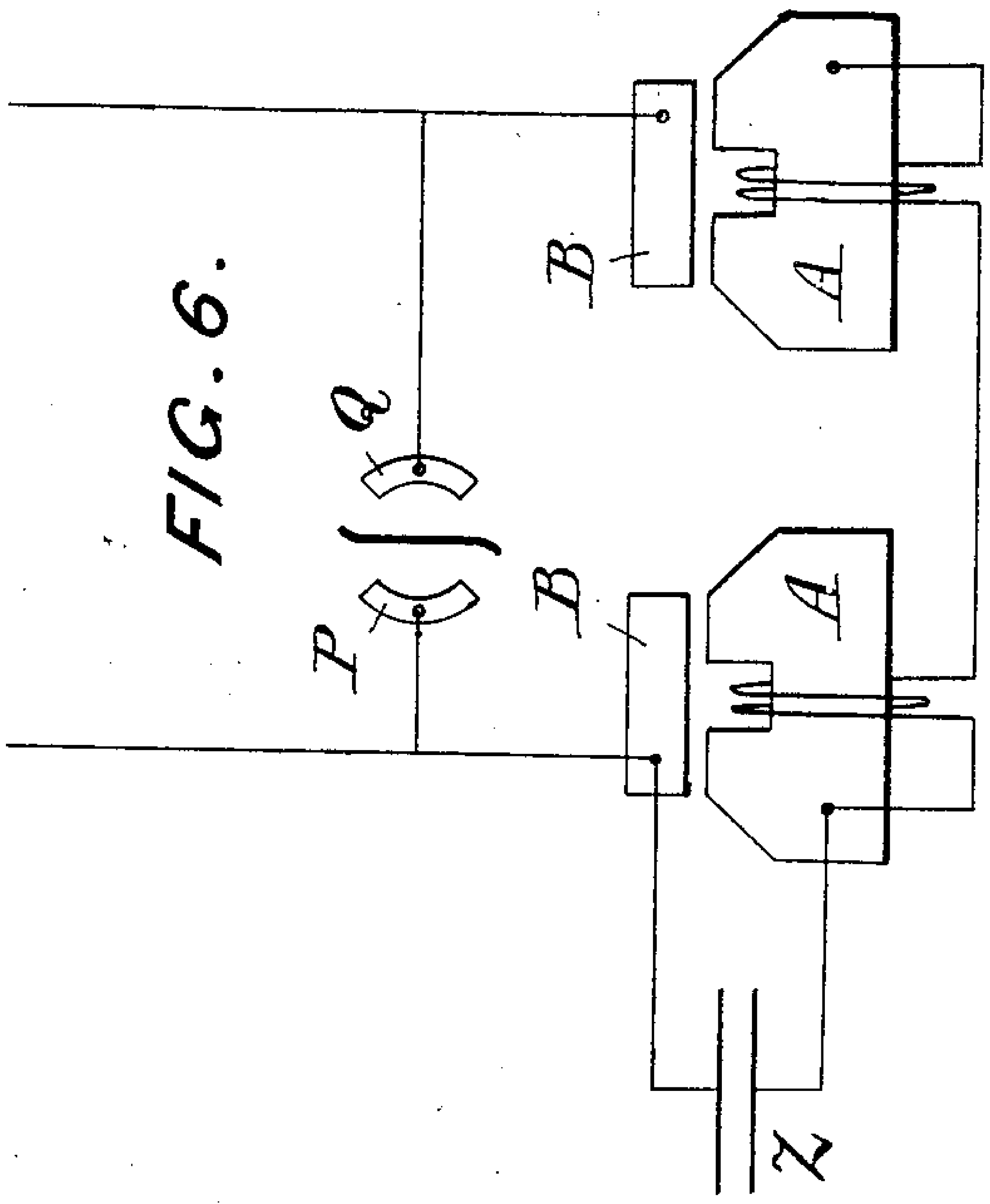
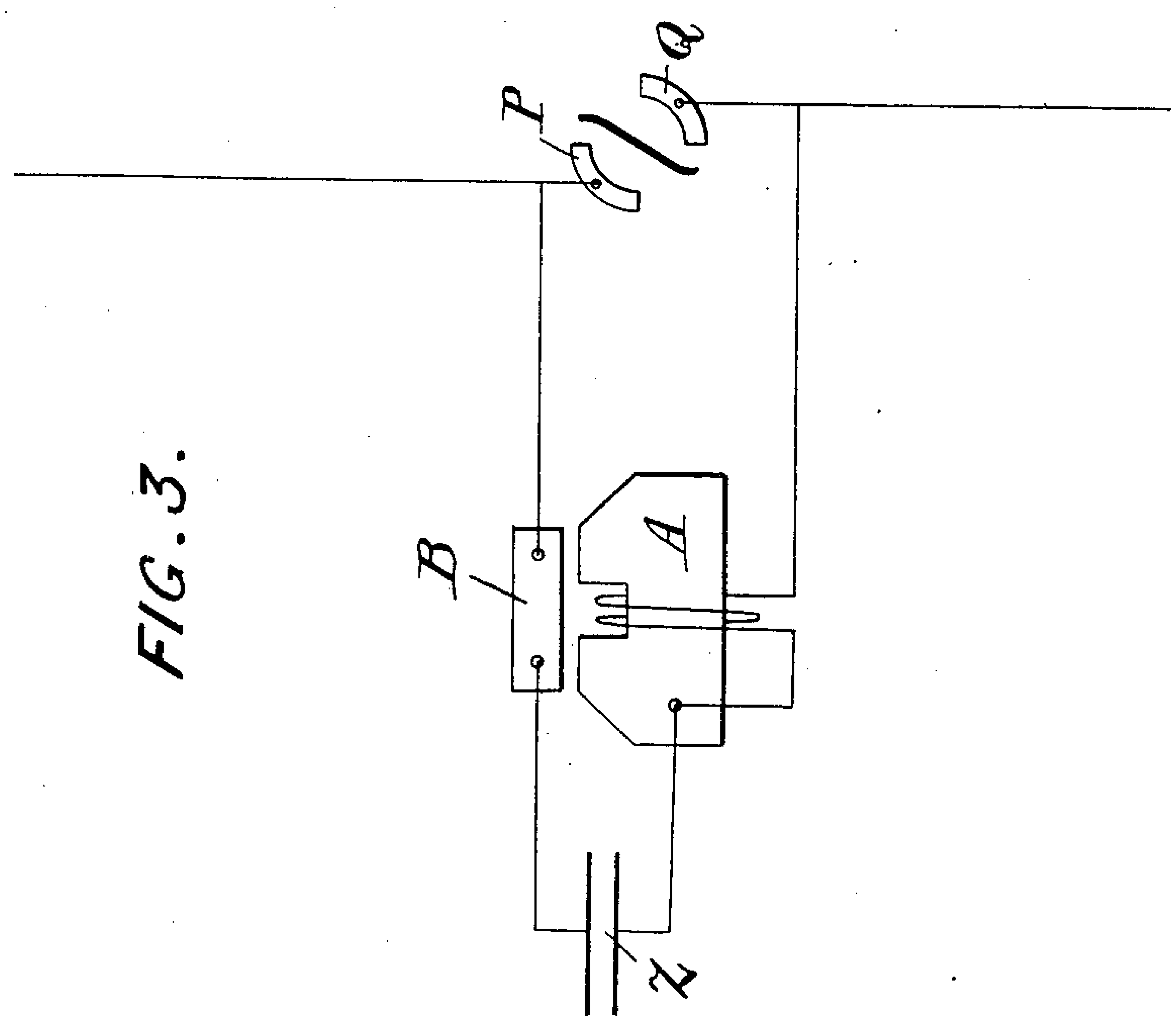


FIG. 3.



Witnesses.

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No. 658,064. Patented Sept. 18, 1900.

B. HOPKINSON.

SWITCH FOR ALTERNATING ELECTRIC CURRENTS.

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(No Model.) 3 Sheets—Sheet 3.

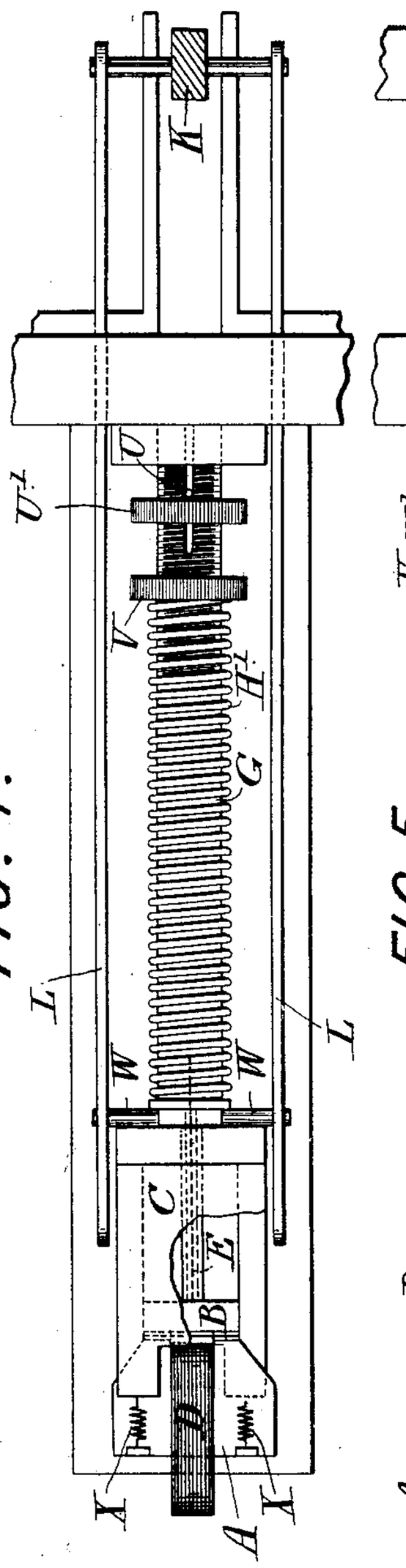

FIG. 4.

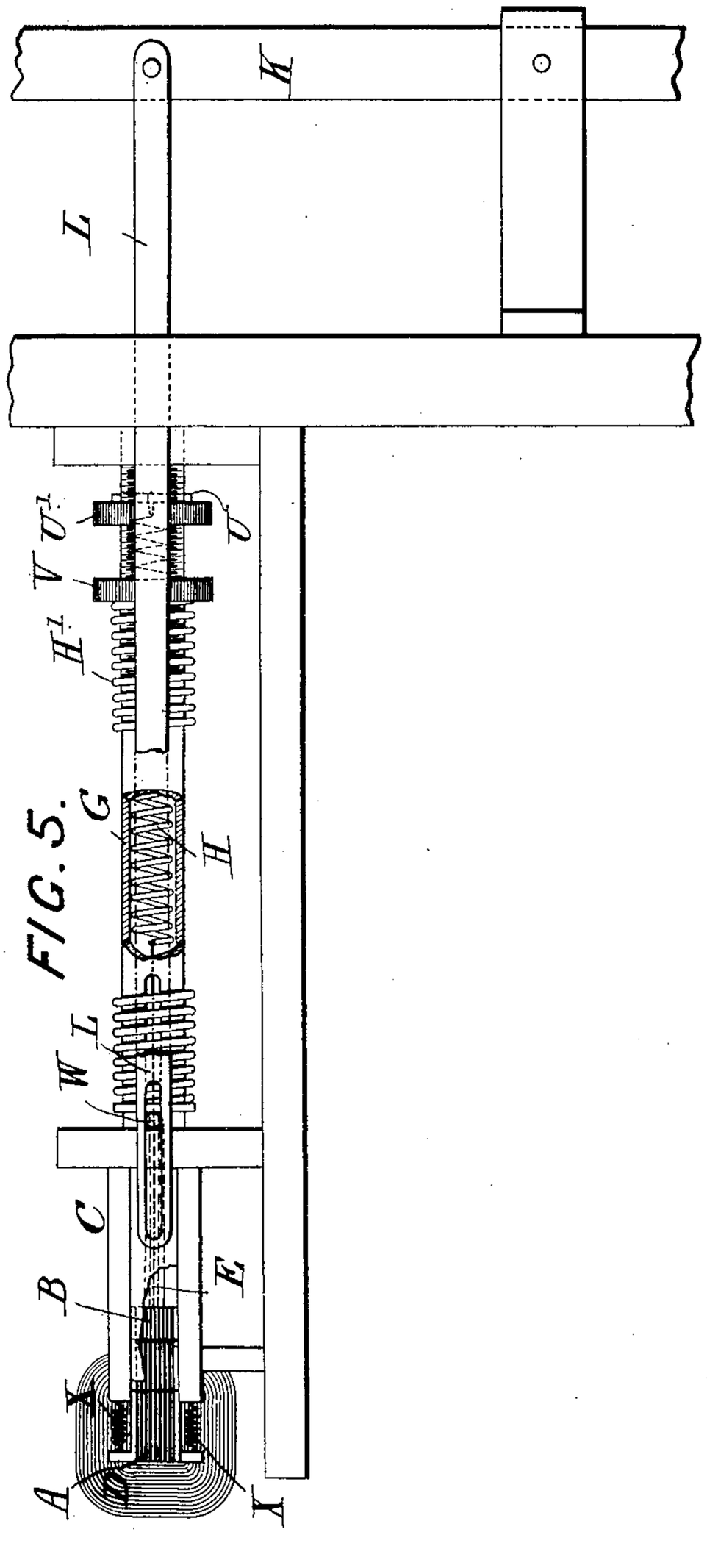

FIG. 5.

Witnesses.
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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

BERTRAM HOPKINSON, OF LONDON, ENGLAND.

SWITCH FOR ALTERNATING ELECTRIC CURRENTS.

SPECIFICATION forming part of Letters Patent No. 658,064, dated September 18, 1900.

Application filed December 22, 1899. Serial No. 741,252. (No model.)

To all whom it may concern:

Be it known that I, BERTRAM HOPKINSON, civil engineer, a subject of the Queen of Great Britain and Ireland, and a resident of 26 Victoria street, Westminster, London, England, have invented certain new and useful Improvements in Switches for Alternating Electric Currents, (for which I have applied for a British Patent, No. 10,863, dated May 24, 1899,) which invention is fully set forth in the following specification.

Considerable difficulty is experienced in the interruption of large electrical currents when such currents are also associated with high potentials. Sometimes the interruption is effected comparatively slowly, in which case a large space and a very long break are necessary in order to deal with the arc, which is drawn out often to a length of several feet. In other cases an attempt is made by interrupting the current quickly in a closed space or under oil to suppress the arc and to limit the space occupied by the switch. If the interruption happens to occur at an instant when the current is large, the latter method involves great danger to insulation, besides producing an almost explosive manifestation of energy at the point of interruption. When the current is alternating, there are two instants in every cycle at which its value is zero, and if the circuit be interrupted sufficiently rapidly at such an instant there will be no strain on the insulation of any part of it and there will be no arc or other manifestation of energy at the point of interruption.

According to my invention I provide means whereby the interruption of an alternating electric current is effected automatically at or about an instant at which its value is zero. This can be effected, for example, by providing a switch having very light moving parts rigidly attached to the armature of an electromagnet, the electromagnet being of divided iron and its winding being traversed by the current which traverses the switch. A spring tends to pull the armature away from the magnet, but is normally prevented from acting either by a catch or by a spring of greater strength pressing on the armature and holding it in contact with the magnet. On pulling away the catch or suddenly removing the pressure on the armature, so as to release the first-named spring, the switch is held closed by the attraction of the electromagnet during that portion of the cycle in which the attraction is strong enough to overcome the power of the spring; but when the current falls in the course of its cycle to a sufficiently-small value the said spring acts and pulls open the switch with very great rapidity, so that by the time the potential has risen in the course of the next cycle to any considerable value the opening is sufficient to prevent the passage of a spark. I prefer that the armature shall itself form the moving part of the switch, the current being taken through the core of the magnet and through the armature. If the moving part of the switch be separate from the armature, the connection between the two should be very rigid, so that the switch commences to open as soon as the armature begins to move. The switch is used as a shunt to a hand-switch or circuit-breaker which may be of the ordinary type and the moving part of which is so connected to the shunt-switch that when just open it pulls away the catch of the shunt-switch or by its momentum suddenly removes the pressure on the armature. The shunt-switch is then opened by the spring at or about the instant next following when the current is zero.

In order that my invention may be well understood, I will describe, with reference to the accompanying drawings, how it may be carried into practical effect.

Figures 1 and 2 are views at right angles to each other of a switch arranged in accordance with my invention, in which a catch is used to retain the circuit closed normally. Fig. 3 is a diagram of the electric connections, and Figs. 4 and 5 are views at right angles to each other of a modification, in which a stronger spring is used to retain the circuit closed normally. Fig. 6 is a diagram showing switches arranged in series, as hereinafter described. In the arrangement Figs. 1 and 2 the electromagnet A is made up of soft-iron plates arranged in a plane at right angles to the winding and riveted between end plates or otherwise secured together. The poles are tapered to concentrate the induction and increase the tractive force. The

winding D consists of about two hundred turns of No. 25 S. W. G., and the magnet is supported by a spring against three set-screws, whereby its position can be adjusted. The armature B is similarly laminated and slides inside guides C C of ebonite. The opposing faces of the armature and magnet-poles are worked to a good fit. The armature is attached by a flexible wire E to the cylinder F, which slides in the tube G. The cylinder F is attached, through a slot in the tube, to the spring H, which tends to draw it, and with it the armature, away from the magnet. The plunger I, sliding in the tube G, is connected to the moving part K of the main switch through the link L. On closing the main switch the plunger pushes the cylinder F down until it gets low enough for the catch *n* to engage it. The catch slides in a hole in the block N and is forced inward by a spring in the tube O. The end of the cylinder F is coned, so that it pushes the catch aside in its descent. The main switch being closed, the set-screws determining the position of the magnet A are adjusted until the flexible connection between the armature and the cylinder F is just slack, the armature resting on the magnet-poles by its own weight. The spring H and (through it) the armature are electrically connected to one terminal P of the main switch. The winding of the electromagnet is electrically connected at one end to the other terminal Q of the main switch and at the other end to the body of the electromagnet. The armature, the electromagnet, and the winding thus form a shunt to the main switch in the manner shown diagrammatically in Fig. 3. The inside of the tube G is of insulated material, so as to insulate the moving part K. On opening the switch either automatically or by hand, the catch M is withdrawn by means of the lever R and the strings S T. The length of the string T is so adjusted that the catch is withdrawn when the main switch is just clear of its contacts, as shown by the dotted lines in Fig. 1. The whole current is then traversing the coil of the electromagnet, and the armature is held down only by magnetic attraction. On the latter falling sufficiently low the armature is pulled away by the spring and the circuit finally broken.

In the arrangement according to my invention shown in Figs. 4 and 5 the spring H for pulling the armature away from the magnet is contained within a tube G, which is screw-threaded on its outer side and is attached by the flexible wire E to the armature at one end and to the cross-bar U at the other end, the said cross-bar projecting through holes in the tube and engaging with the milled nut U′ outside the tube, whereby the tension of the spring H can be adjusted. Outside the tube G is another spring H′, which bears at one end against the nut V and at the other end against the T-piece W, the arms of which project through holes in the side of the tube G. The leg of the T-piece W bears against the armature B and is hollow to admit of the passage of the flexible wire E. The pressure exerted by the spring H′ is adjusted by the motion of the nut V, so as to be slightly greater than the tension of the spring H, so that by means of the T-piece W the armature is ordinarily kept pressed against the electromagnet with a small amount of force. The main switch K must in this case be of the circuit-breaker type—that is, its moving part must be forced away from the contacts by a spring upon the withdrawal of a catch either by hand or by the strength of the current exceeding a certain value.

The operation of the switch is as follows: The link L, connected to the moving part K of the main switch, has in it a slot in which slide the arms of the T-piece W. The length of the slot is so adjusted that the arms of the T-piece W engage with its ends immediately after the moving part of the main switch has left its contacts. By that time the moving part of the main switch will have acquired sufficient momentum to jerk the T-piece W sharply into motion, thus removing the pressure of the spring H′ from the armature B and leaving the latter under the influence only of the spring H and the electromagnet A. The circuit is then finally broken by the withdrawal of the armature, when the current falls to a sufficiently-small value. The spring actuating the main switch must be sufficiently strong to hold it open against the balance of force exerted by the springs H and H′, and its moving parts must be of such mass that they are not sensibly checked by the engagement of the T-piece with the bottom of the slots. The armature B, as before, slides in an ebonite box C, into the mouth of which the electromagnet is driven by light springs. On closing the main switch the spring H′ forces the armature through the T-piece W against the electromagnet, correct seating being insured by the springs X X.

A switch such as that just described will insure that the current shall not be broken unless its value is less than one ampere. This current, though small, may produce a spark between the surface of the armature and the magnet sufficient with high potentials to start an arc, and in such cases the spark must be killed by placing a condenser or a fluid-resistance, as a shunt, across the terminals of the switch. (Z in Fig. 3.) For very high potentials it may be necessary to use two or more shunt-switches, placing them in series as a shunt across the terminals of the main switch, as shown in Fig. 6. In such a case the catches of the several switches would each be connected to the moving part of the main switch, so that on opening the latter they would all be withdrawn at the same time.

The mechanical connection between the main switch, the catch, (or the spring,) and the armature may be arranged in many different ways and is not of the essence of my

invention. The form of the magnet and the size of the winding may also be varied; but the following principles govern the design.

I claim—

1. A switch for alternating electric currents comprising two terminals in a circuit, actuating means for separating said terminals to break the circuit, and means controlled by the alternating current for rendering the actuating means inert until the instant in the cycle of said current when its value is zero.

2. In a switch for alternating electric currents the combination with a main switch comprising terminals and means for opening and closing the circuit between said terminals, of a shunt connection between said terminals, and means associated with said shunt-circuit and adapted to open the same at the zero-point of any one alternation of the current.

3. In a switch for alternating electric currents, actuating means tending to open the circuit and means whereby magnetism induced by the current acts to render said actuating means inert and hold the circuit closed until the current reaches the zero-point of an alternation, whereupon the actuating means act to break the circuit.

4. In a switch for alternating electric currents, actuating means tending to open the switch, means whereby magnetism induced by the current acts to render said actuating means inert and hold the switch closed until the current reaches the zero-point of an alternation, whereupon the actuating means act to open the switch, and a movable catch or retaining device for preventing the operation of the actuating means irrespective of the action of the current.

5. In a switch for alternating electric currents, means for holding it closed by magnetism induced by the current, and a spring (or its equivalent) retained out of action by a catch which, when withdrawn allows the spring to break the circuit at the instant in the cycle when the value of the current is at, or about, zero; substantially as hereinbefore described.

6. In a switch for alternating electric currents, the combination of a laminated electromagnet one end of whose coil is electrically connected to one terminal of the circuit, the other end being connected to the core of the magnet; a laminated armature electrically connected to the other terminal of the switch; and a spring which pulls the armature away as soon as the current falls to a certain small value substantially as hereinbefore described.

7. The combination with a circuit carrying alternating electric currents, of a main switch comprising terminals connected in said circuit and means for opening and closing the circuit between said terminals, a shunt or auxiliary connection between the terminals of the main switch, an auxiliary switch in said shunt, an electromagnet having its coil connected in said shunt and acting when energized to a sufficient strength to prevent the opening of the auxiliary switch, actuating means for opening the auxiliary switch when the energization of the magnet is at or about zero due to the alternation of the current, a movable detent or catch adapted to prevent the opening of the auxiliary switch by said actuating means, and means for throwing said detent to an inoperative position by the opening of the main switch.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

BERTRAM HOPKINSON.

Witnesses:

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GEORGE WILLIAM SMITH.