No. 618,175. Patented Jan. 24, 1899.

J. HOPKINSON.

AUTOMATIC SWITCH FOR DISTRIBUTION OF ELECTRICITY.

(Application filed Apr. 18, 1895.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 2,

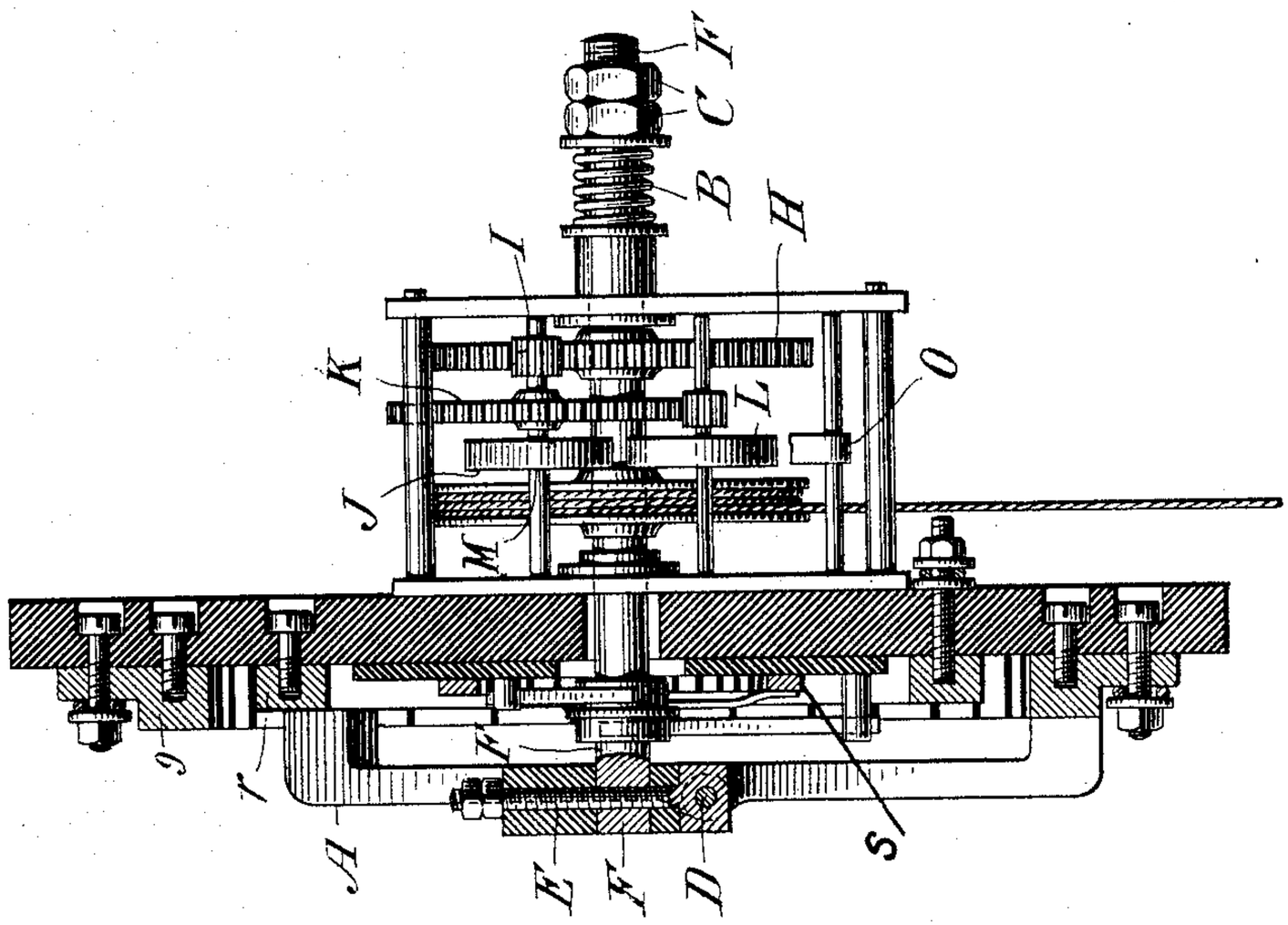
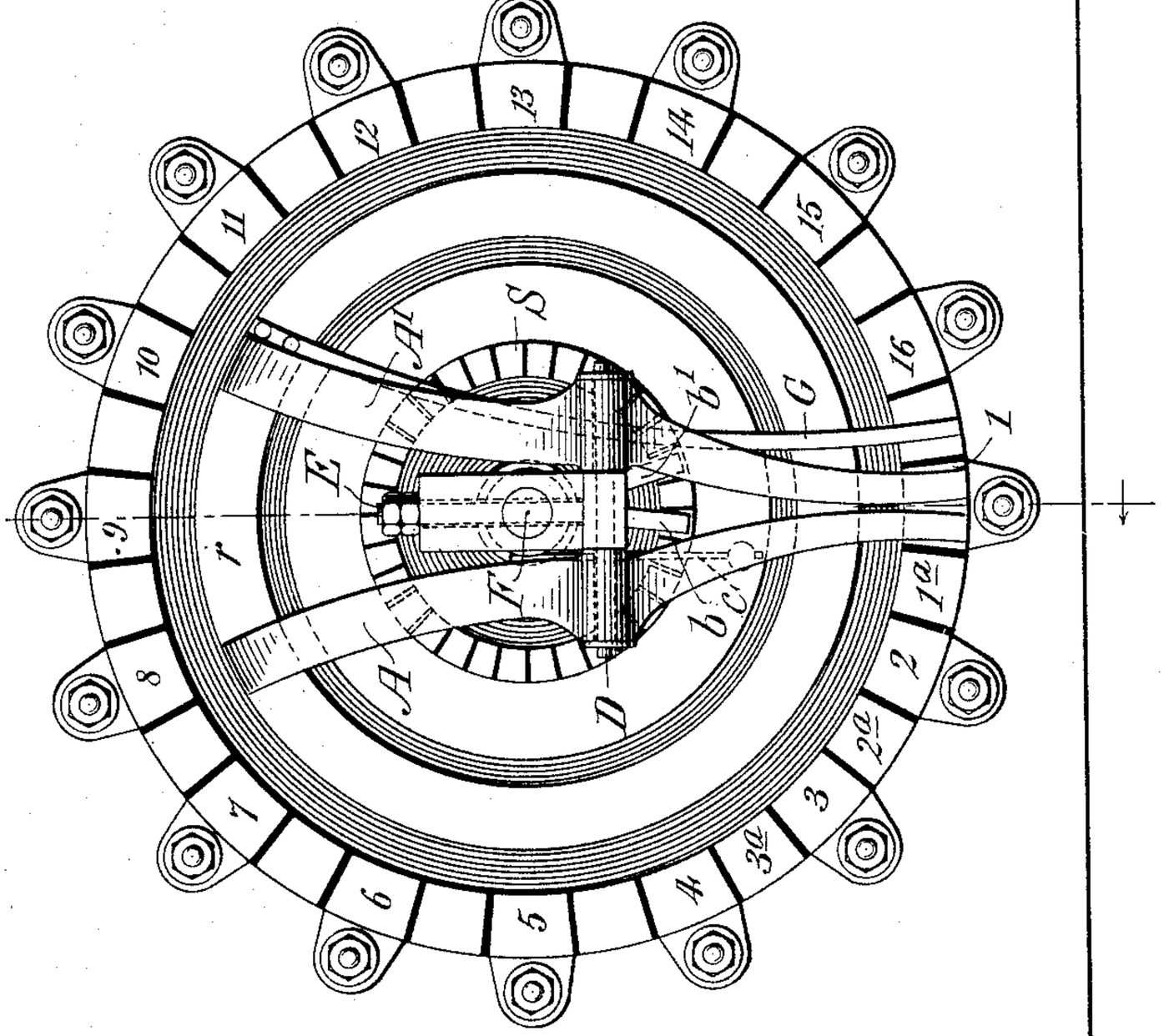


Fig. 1,



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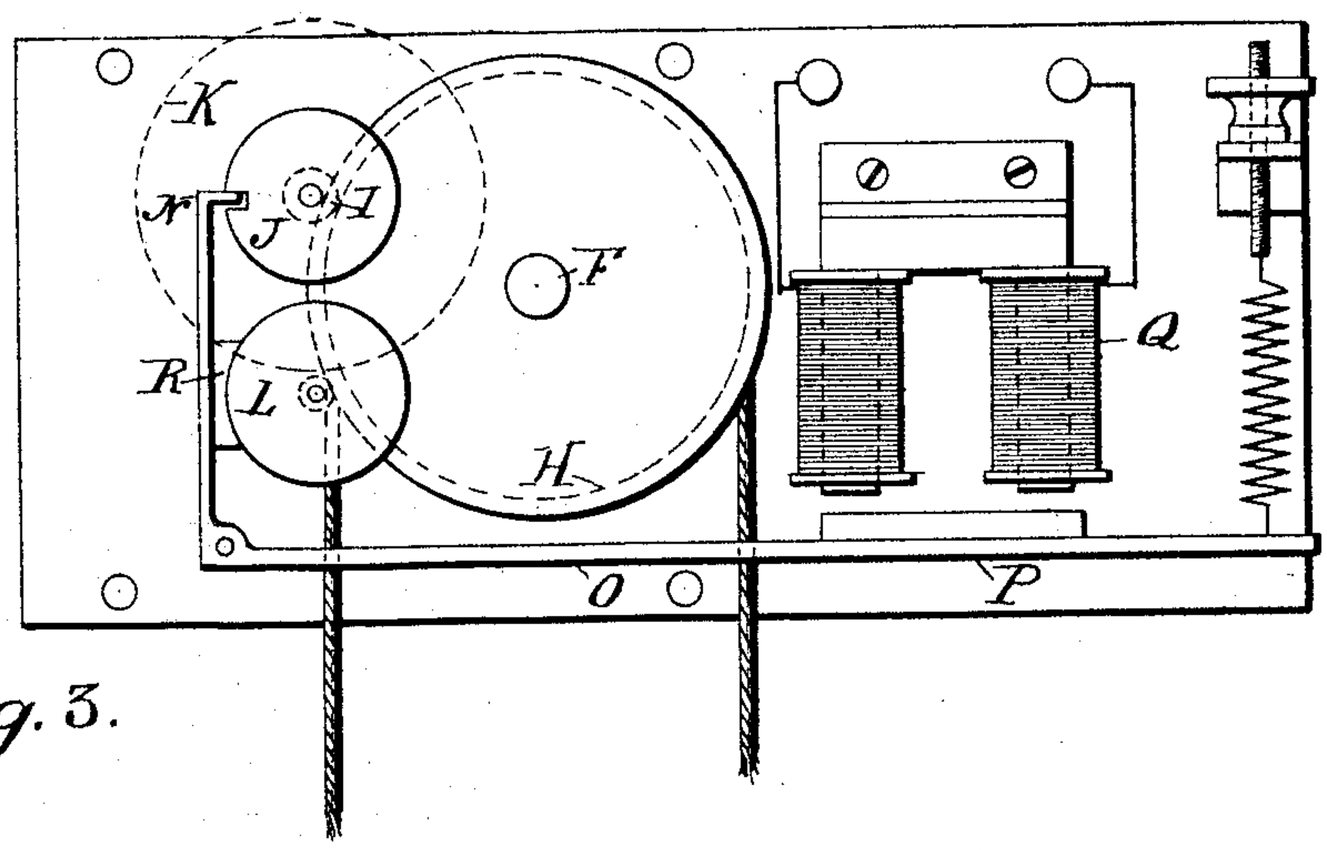


Fig. 3.

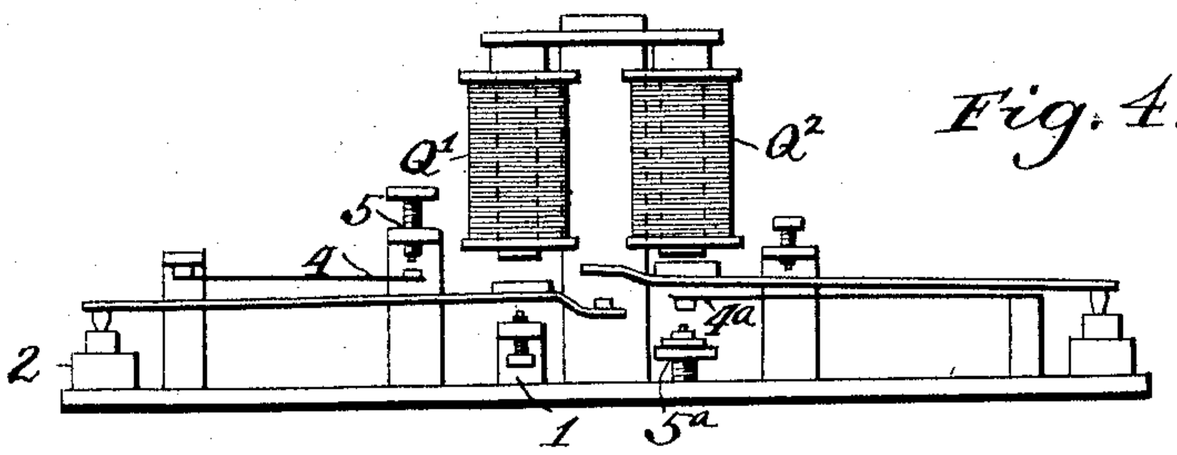
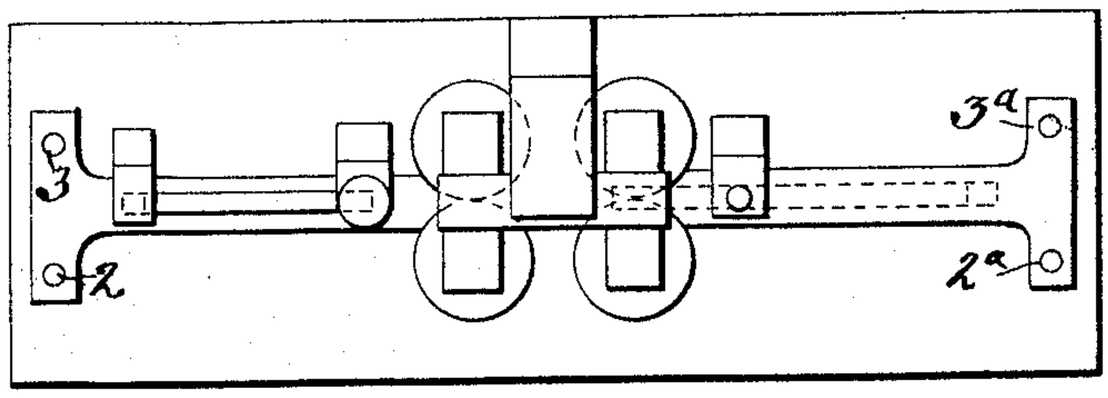


Fig. 4.

Fig. 5.



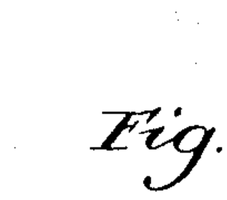


Fig. 6.

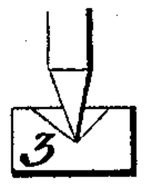
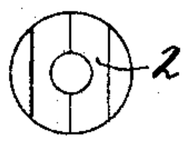


Fig. 7.

Fig. 6a



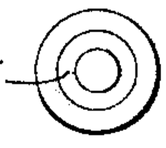


Fig. 7a

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No. 618,175. Patented Jan. 24, 1899.

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Fig. 8.

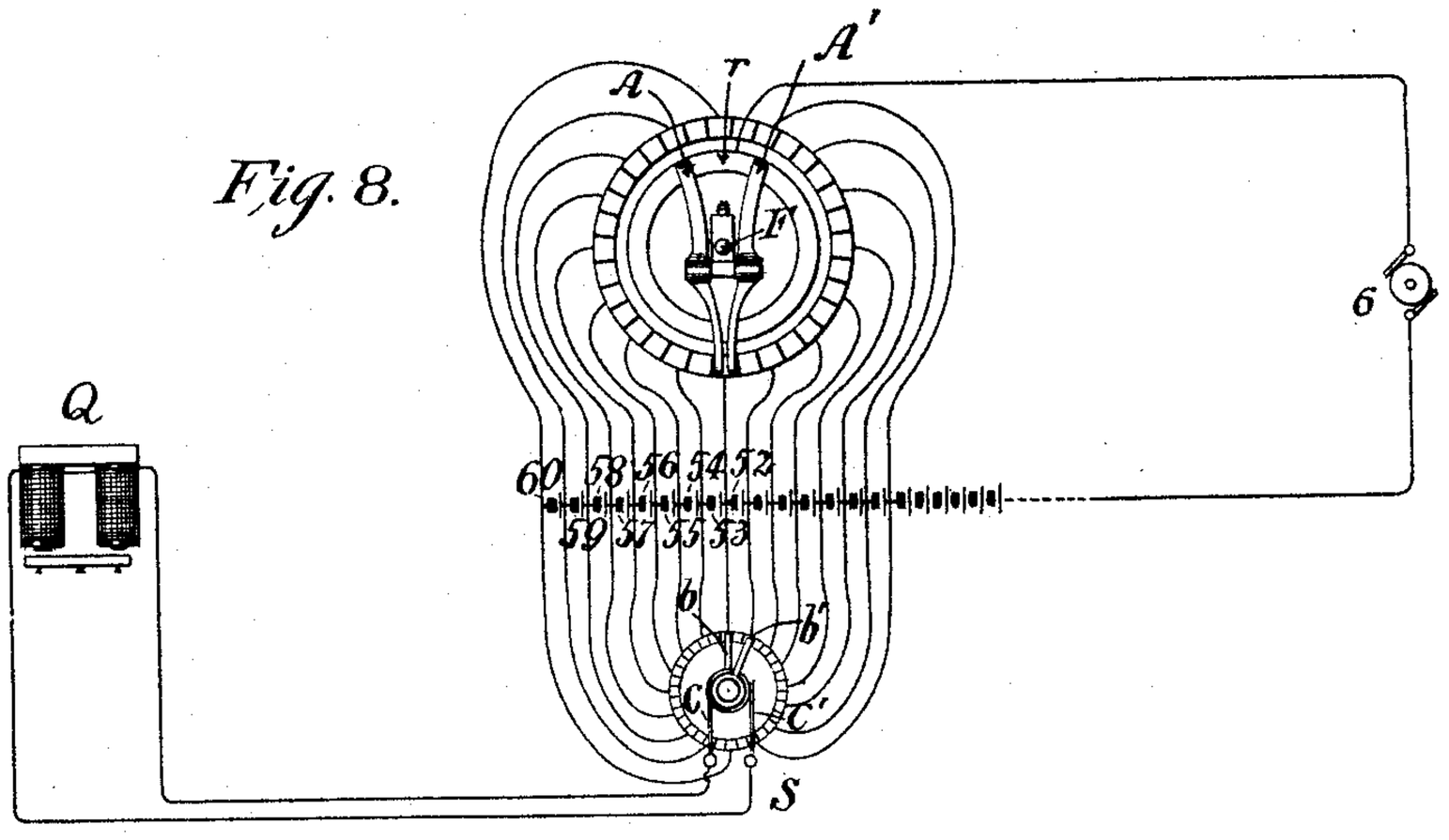

Fig. 9.

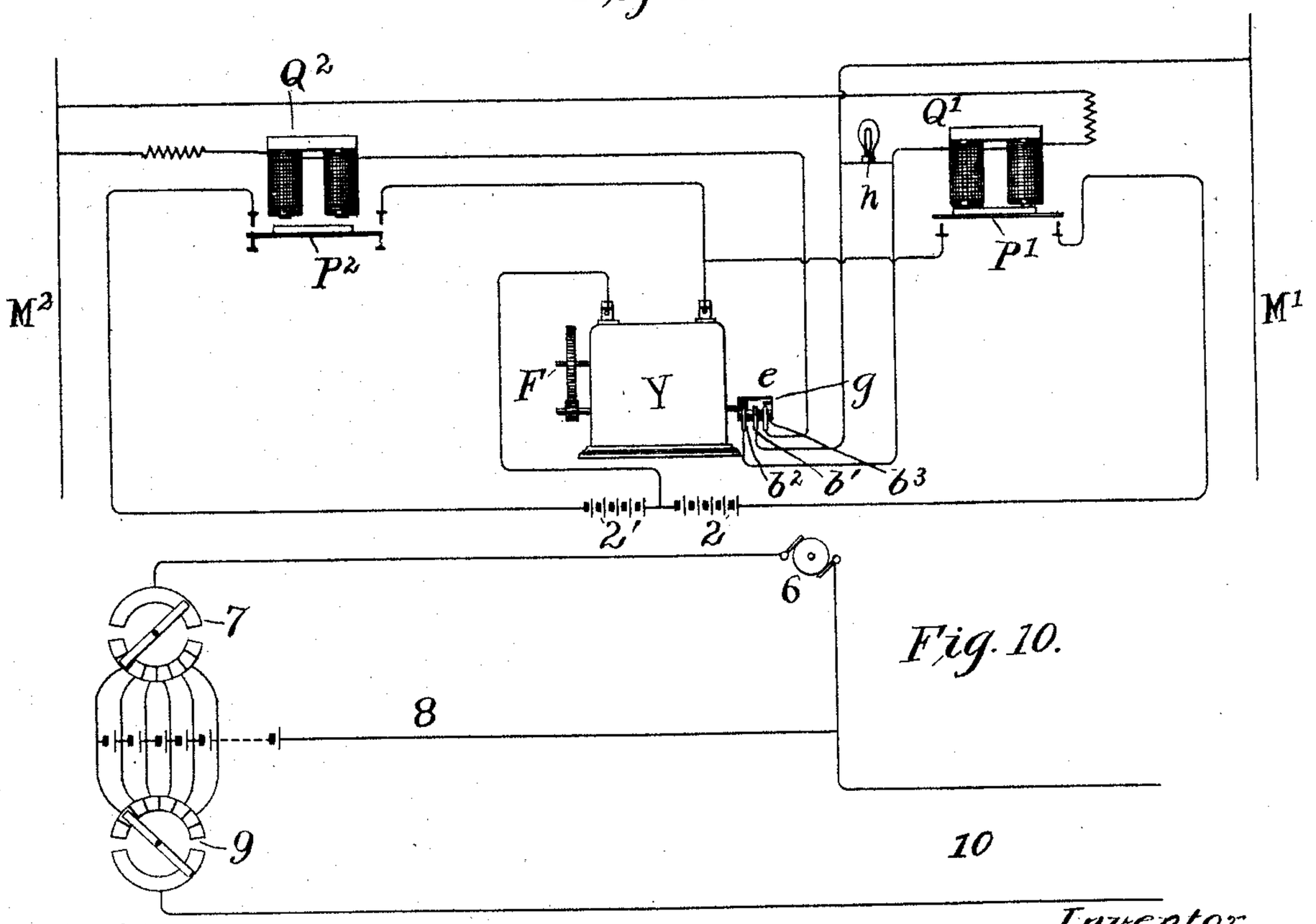

Fig. 10.

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UNITED STATES PATENT OFFICE.

JOHN HOPKINSON, OF LONDON, ENGLAND.

AUTOMATIC SWITCH FOR DISTRIBUTION OF ELECTRICITY.

SPECIFICATION forming part of Letters Patent No. 618,175, dated January 24, 1899.

Application filed April 18, 1895. Serial No. 546,269. (No model.)

To all whom it may concern:

Be it known that I, JOHN HOPKINSON, a subject of the Queen of Great Britain, residing at 5 Victoria street, London, England, have invented certain new and useful Improvements in Automatic Switches and in their Use for Distribution of Electricity, (for which I have obtained Letters Patent in Great Britain, Nos. 22,876 of 1893 and 2,064 of 1895,) of which the following is a specification.

My invention relates to automatic switches for charging or discharging secondary or storage batteries or accumulators. In switches for regulating the connections of such batteries to external circuits it is essential that the contacts of the switch shall be made in definite positions and that it shall be impossible for the switch to rest in intermediate positions. If the switch be automatic, it is also necessary that the switch shall move when certain conditions, such as a given potential of battery-cell, occur, undisturbed by other accidental conditions—such, for example, as mechanical vibration. It is also desirable that the switch to be automatically moved shall offer a constant and small frictional resistance to motion consistently with a reliable contact. It is also desirable to control the operations of the switch by electromagnetic agencies very sensitive to changes of potential. I attain these ends by providing a motor-driven train of wheel work operative upon switch-arms sweeping over a series of contacts connecting with the several cells, an auxiliary set of brushes also driven by the motor-train controlling the movement of the switch upon change of potential to cut in or out the cells.

The several features of novelty of my invention will hereinafter be more fully described and will be definitely indicated in the claims appended to this specification.

In the accompanying drawings, which illustrate the invention, Figures 1 and 2 are front elevations and vertical sections, respectively, of a switch embodying my improvements. Fig. 3 is an elevation with parts removed to show the parts of the mechanism of a motor-train controlling the movements of the switch. Figs. 4 and 5 are an elevation and plan of a controlling-magnet to actuate the releasing devices. Figs. 6, 6^a, 7, and 7^a are details of the armature-mounting of the controlling-magnet. Fig. 8 is a diagrammatic view of a system embodying my improvements. Figs. 9 and 10 are diagrammatic views of a charging and discharging system.

Referring to the drawings, 1 2 3 are blocks of metal, preferably mounted in circular order and provided with clamping devices or binding-posts, as indicated, for connecting them with the several cells of the secondary battery to be controlled. They connect in successive order with the cells, as clearly indicated in Fig. 8.

1^a 2^a 3^a, &c., are intermediate spacing-blocks insulated from the blocks 1 2 3, &c., and serving to mechanically support the brushes A A′ when the latter are shifted around the circle and serving also to prevent short-circuiting of any cell during the cutting in or out of an adjacent cell. The brushes A A′ connect the contact-block on which they rest with an annular contact *r*, forming one terminal of the charging or discharging circuit, as clearly indicated in the diagram Fig. 8. The two brushes are mounted so that the pressure on all points or surfaces of contact shall be uniform. They are forced into firm engagement with the blocks and ring *r* by a spring B, the tension of which may be adjusted by nuts C, and the pressure is equally divided among the four contact-surfaces by pivoting each brush on an axis D and again pivoting this axis on another axis E perpendicular to it, the axis E being mounted in a bearing fixed to the shaft F. In this way the known pressure of the spring or weight is equally divided among the four bearing-surfaces of the brushes. If desired, a spring or resistance G may be fixed to the brushes to prevent cutting the battery out of circuit while the brushes are being shifted from one block to the next. This spring may be given such a resistance as to prevent short-circuiting the cell whose terminals it momentarily bridges. The shaft F may be driven by a weight or any desired motive power. It carries the spur-wheel H, gearing with pinion I, mounted on the same shaft as a cam-wheel J. The shaft also carries a gear-wheel K, operating upon a shaft carrying a brake-wheel L. In the cam-wheel is a recess, or a plurality of recesses, if desired, in which

normally rests a detent N, carried by the lever O, controlled by the armature P of the electromagnet Q. A brake-block R to engage the brake-wheel is also mounted on the lever O. When the switch and gearing move so that the switch advances from one block to the next, the wheel J turns one revolution, if there be one recess M, or turns so that the next recess comes into engagement with the detent. It will be seen that the switch cannot move unless the brake is lifted off the brake-wheel and that if once the switch moves the cam keeps the brake-block out of contact with the brake-wheel until the motion of the switch from one of the contact-blocks to the next is complete. The cam-wheel J thus constitutes a locking device to prevent the switch remaining in an improper position.

In a charging-switch such as I am now describing I regulate the movement of the switch by the potential of the cell of battery which the switch by its next movement would cut out. In order to make sure that the potential used for regulation is really the potential of the cell, it is necessary to secure a connection to the cell through which no appreciable current flows. This is accomplished by means of a small auxiliary switch S. (Shown separately in Fig. 8.) As in the large or main switch, the alternate blocks of the auxiliary switch are also connected to the junctions of the cells and the intermediate blocks are insulated. Two insulated brushes *b b'* make contact with neighboring blocks and are connected with insulated rings mounted on the shaft F. Fixed brushes *c c'* make contact with the rings, and thus take the potential of the cell which is next to be cut out. Further, when the switch is moving and half-way between its positions of rest the brushes *b b'* touch insulating-segments, and their difference for a short time is *nil*. The brushes *c c'* may lead to the releasing-electromagnet Q, which actuates a wheel-train, or, as I prefer, lead to a controlling-magnet of a type shown in Figs. 4, 5, 6, and 7, which is particularly adapted for prompt and delicate response to definite changes of potential. In this device the armature or armatures of the controlling-magnet rest or are adapted to rest upon three points of support, being controlled solely by gravity and the action of the magnet. The armature carries on its under face three pins or studs, the coöperative anvils of which, 1 2 3, are provided, respectively, with a smooth or plane surface, a slot or groove, and a cone-shaped depression. The grooved support is shown in Figs. 6 and 6ª and the conical support in Figs. 7 and 7ª. Thus the armature of the magnet is absolutely free to obey the attractive impulses of its controlling-magnet without the opposition of retractile springs and when released will be restored to its original position without possibility of displacement. The movements of the armatures control contacts 4 5 4ª 5ª, connecting with the releasing-magnet Q, which controls the wheel-train. The magnets are connected through the brushes *b b'* with the battery-cell whose change of potential is to determine the movement of the switch.

When the system is designed only for charging, a single controlling-magnet should be employed; but when used for simultaneous charging and discharging, as will be hereinafter more fully described, two magnets Q' Q^2 should be employed, one normally attracted to respond to the fall of potential and the other normally against its anvils to respond to rise of potential. When the potential becomes too high, magnet Q' will attract its armature and actuate the motor-train in one direction. An electric motor may be used to drive the shaft F, as will be hereinafter set forth. When the potential becomes too low, the magnet Q^2 will permit its armature to drop and reverse the motor. In such an organization the armatures are interlocked, as indicated, to prevent contradictory action.

In Fig. 8 is shown a charging or discharging organization where a group of cells 1 2 3, &c., are connected in series with the charging or discharging switch and with a generator or other source of direct current 6. As shown, the main brushes of the switch bear upon the contact-block connecting with the terminal of the fifty-second cell. These fifty-two cells will therefore be undergoing charge or discharge and the fifty-second cell will be the next to be cut in or out. The two brushes *c c'* of the auxiliary switch are connected to the respective terminals of the fifty-second cell, as shown in the diagram. Thus electromagnet Q will be energized by the fifty-second cell. The adjustment of the magnet is such that when the potential rises to, let us say, 2.6 volts the force of the magnet overcomes the weight of the armature, which at first moves absolutely freely and with increasing force as it approaches the poles. The motor-train is then released and the brushes A A' shifted to take in an additional cell. The auxiliary switch S, Fig. 8, as it moves breaks the circuit of the magnet and allows the armature to drop, thereby resetting it to cut out the next cell, when its potential in turn attains 2.6 volts. When the movement of the main switch has been completed, the detent end of the lever O drops into the recess and allows the brake-block to engage the brake-wheel and stop further motion.

It is evident that my invention may be applied in other ways than by means of the specific mechanism set forth. For example, instead of driving the switch by weight it may be driven by a motor, the armature of which is either upon the shaft F or in gear therewith. In this case the lever O instead of carrying a brake-block makes a contact and causes current to pass through the armature of the electromotor. The cam may be dispensed with and the momentum of the motor-armature be relied upon to carry the switch

over the point at which the circuit of the controlling-electromagnet is broken. Two automatic motions in opposite directions may also be given to the switch, one occurring when the potential is too high and the other when it is too low. A second electromagnet is then required to determine the reverse motion. Both electromagnets act in the manner already described and are reset by altering the current traversing their coils during the movements of the switch. Fig. 9 shows an organization of this character and is intended for use when the potential is to be kept approximately constant, as in the case of a discharging-switch supplying distributing-mains. Q' Q^2 represent the two controlling-electromagnets, the former determining the movement of the switch when the number of cells is to be increased and the latter when the number is to be decreased to maintain the uniformity of potential on the mains. The armatures P' P^2 of the electromagnets coöperate with three adjusting-screws arranged to give a geometrical support on the cone, slot, and plane principle already described. It is evident that when the attraction of the electromagnet Q' diminishes to a point at which the armature leaves its bearing-points the force of attraction will rapidly decline, and when it drops upon the contact-stops it will make a good electrical contact. The contact-stops are connected with the terminals of an electric motor Y and with one or more cells Z of a battery, which may be part of the battery being regulated, in such wise that when contact is made between them the motor-armature will revolve in one direction. The corresponding stops of the other electromagnet are connected with the armature of the motor and with other cells, Z', of the battery in such wise that when contact is made between them the motor-armature will revolve in the other direction. The electromagnets Q' Q^2 are normally connected to the main conductors of supply M' M^2; but they are so connected through the switch *e*, which is in gear with the battery regulating the switch, (both being controlled by the motor-armature.) The battery-switch may be mounted upon the shaft, (indicated at F,) so geared to the motor-armature that for one revolution of the switch *e* the battery-switch will move but one step. Switch *e* has bearing upon it three brushes f' f^2 f^3 and in turning makes one complete revolution. The blackened parts indicate insulating material. When the number of cells becomes too great, the armature P^2 of the electromagnet Q^2 will rise, closing the circuit of the motor, and the main switch will move in a direction to diminish the number of cells. When its motion is nearly completed, the circuit of the electromagnet will be broken by the insulating-spot *g* and the armature will drop into its initial position ready to give or refuse to give a further signal, as may be required. On the other hand, if the number of cells becomes too few the armature of the electromagnet Q' will fall and will close the motor-circuit. A current will then pass, actuating the motor in a reverse direction, thus causing the battery-switch to cut out one or more cells. Near the end of its movement brushes f' f^2 of the switch *e* will be short-circuited and will cut out of circuit the resistance *h*, thus strengthening the current in the electromagnet Q' and restoring its armature to its initial position.

The organization just described may be applied to other purposes than the regulation of a battery—for example, in introducing or cutting out of circuit a resistance. Fig. 10 represents a system of distribution embodying a charging and discharging switch operating as hereinbefore set forth. A dynamo-electric generator 6 leads through a charging-switch 7 to a group of cells and then to a return-main 8. The cells discharge through a discharging-switch 9 into a consumption-circuit 10, in which may be included translating devices of any desired character and in which it is desired to maintain a constant difference of potential. The two switches may be controlled as hereinbefore described with reference to Fig. 9. As will be understood upon inspection of the drawings, switch 7 will act to charge the cells to their proper potential while switch 9 is simultaneously discharging.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. An automatic switch provided with a range of contacts connecting with the several cells of a battery, a brush for cutting in or out the several cells, a motor for controlling the switch, an electromagnet for releasing the motor, and an auxiliary switch in fixed relation and movable with the main switch connecting part of the battery with the magnet.

2. An automatic switch provided with a movable, rigid brush for making engagement with a range of contacts, said brush having a plurality of contact-surfaces, and a pivotal connection with its axis for distributing the contact-pressure in a definite ratio among the several surfaces of contact.

3. An automatic switch provided with a two-part movable, rigid brush having its two parts independently pivoted to equally distribute the contact-pressure among four contact-surfaces.

4. An electromagnet having its armature free from mechanical restraint and provided with three points of support upon which it normally rests by the influence of gravity, several of said points coöperating with a guide-surface on the armature-anvil to assist in restoring the armature to its normal position after having been operated, the core of the magnet being placed on the side of the armature opposite the points of support.

5. An electromagnet having an armature free from mechanical restraint and provided with three points of support namely a cone, a slot, and a plane.

6. An electromagnet provided with an armature which rests absolutely free to move with an accelerating force, a switch controlled by said magnet on change of its magnetic condition, and a circuit-controller operated by the switch-impelling mechanism for restoring the armature to its normal position after the switch has been operated.

7. An automatic switch for secondary batteries provided with a movable brush coöperating with a range of contacts connecting with the several battery-cells, a motor controlling the brush, controlling-magnets operated by change of current strength to operate the motor in one direction or the other, and an auxiliary brush movable with the main brush for connecting part of the battery into the circuit of the controlling devices.

In testimony whereof I have hereunto subscribed my name this 21st day of March, 1895.

JOHN HOPKINSON.

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