No. 682,818. Patented Sept. 17, 1901.

R. A. SLOAN & J. E. L. BARNES.

SWITCH FOR ELECTROMOTORS.

(Application filed June 19, 1900.)

(No Model.) 3 Sheets—Sheet 1.

FIG. I

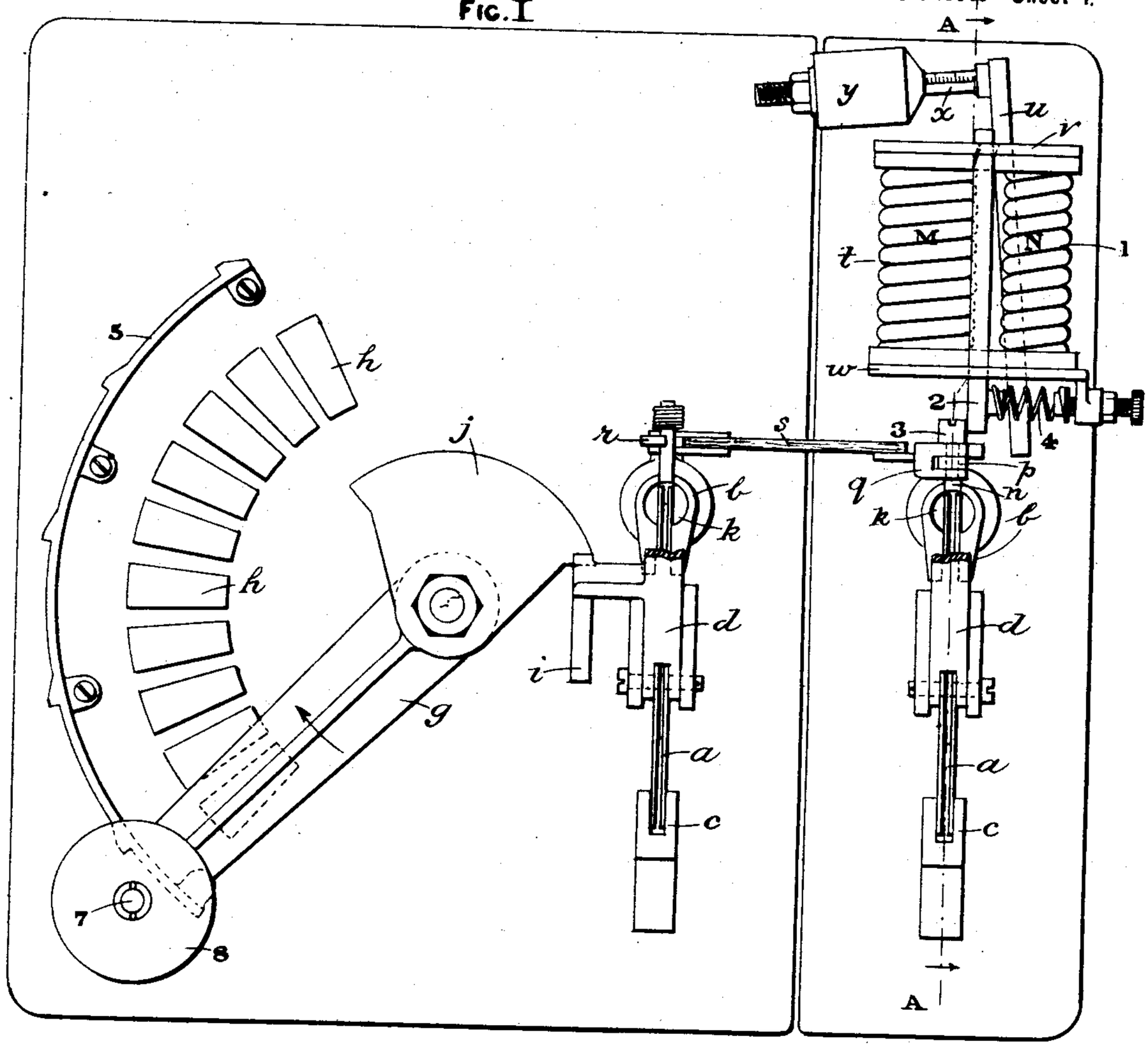

FIG. II

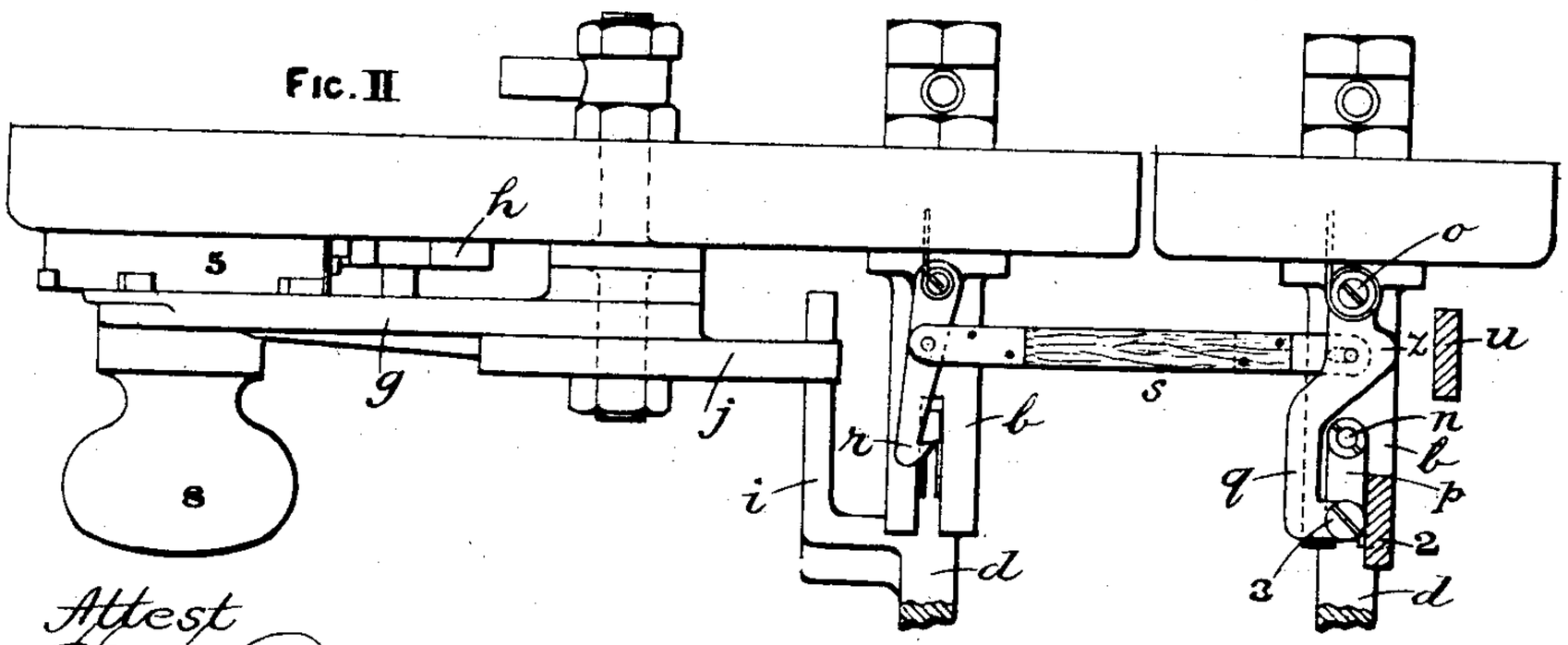

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FIG. III

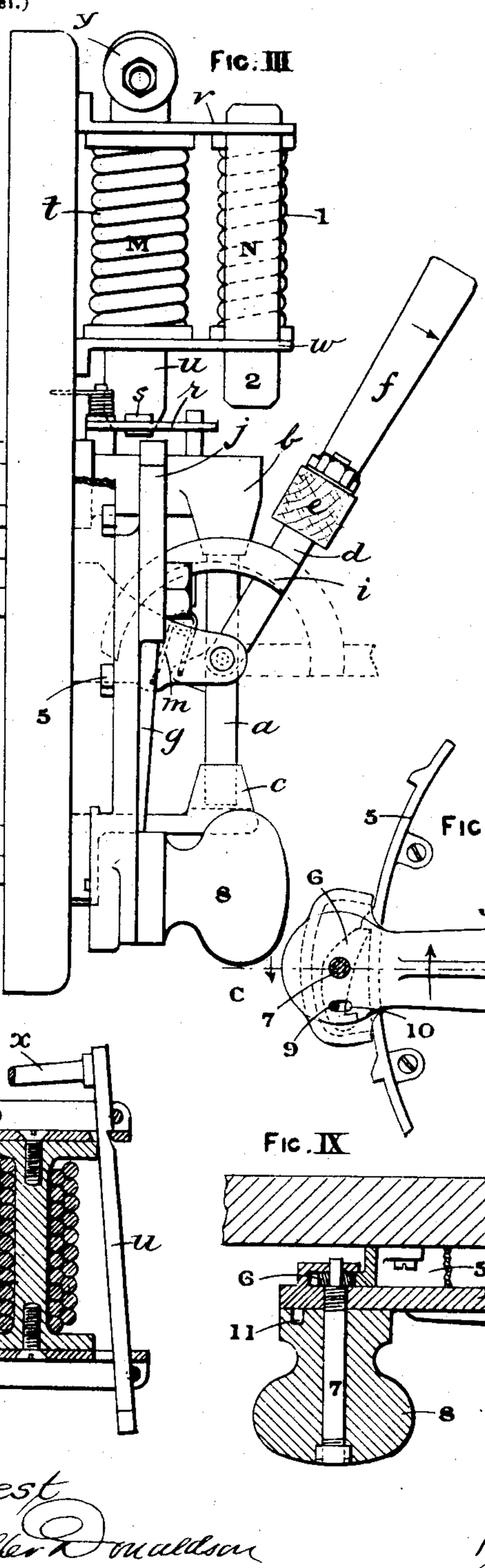


FIG. IV

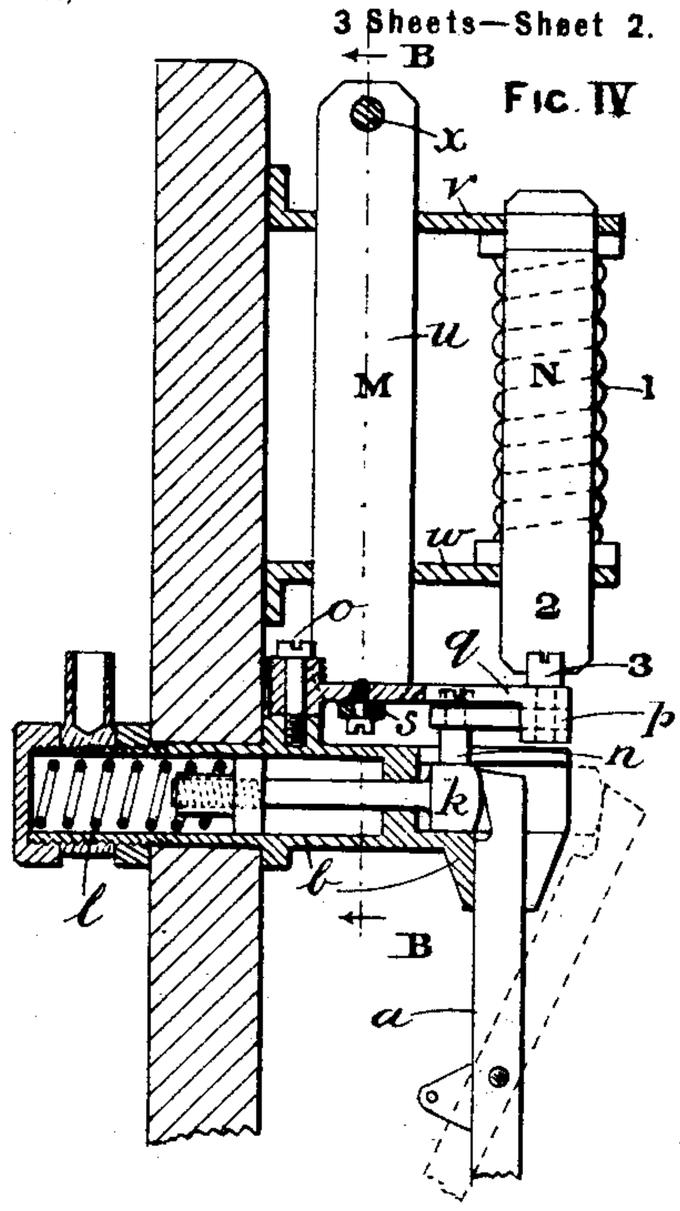


FIG. VIII

FIG. V

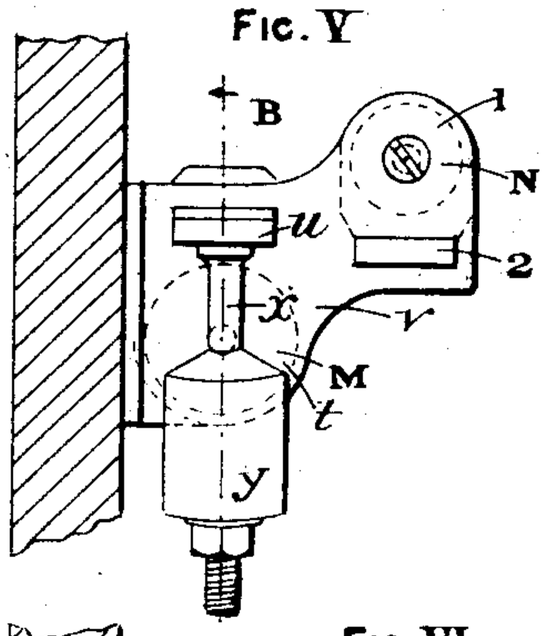
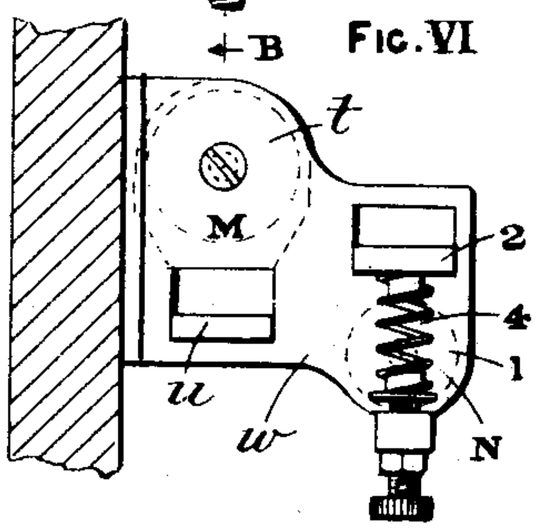


FIG. IX

FIG. VII

FIG. VI



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R. A. SLOAN & J. E. L. BARNES.

SWITCH FOR ELECTROMOTORS.

(No Model.) (Application filed June 19, 1900.)

3 Sheets—Sheet 3.

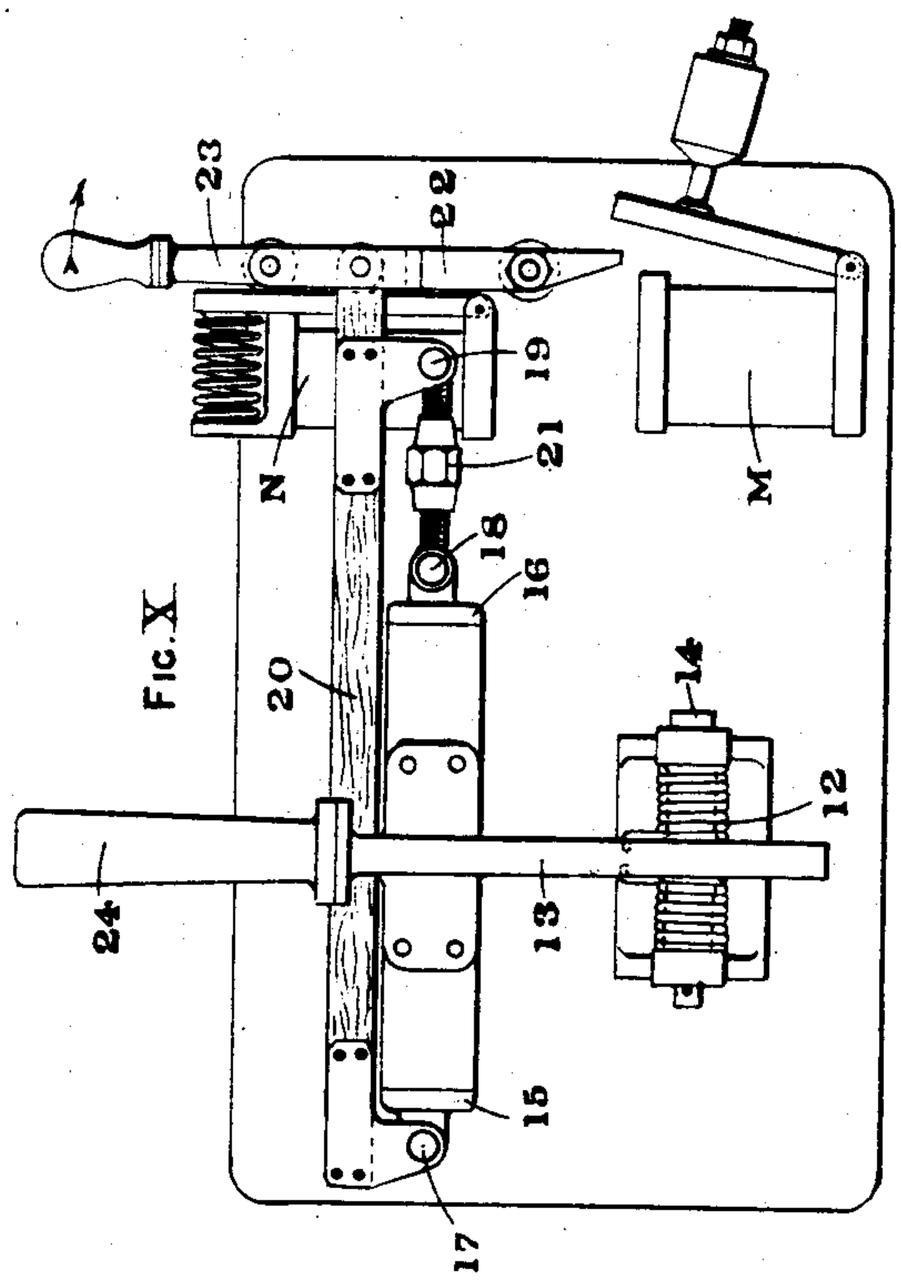

FIG. X

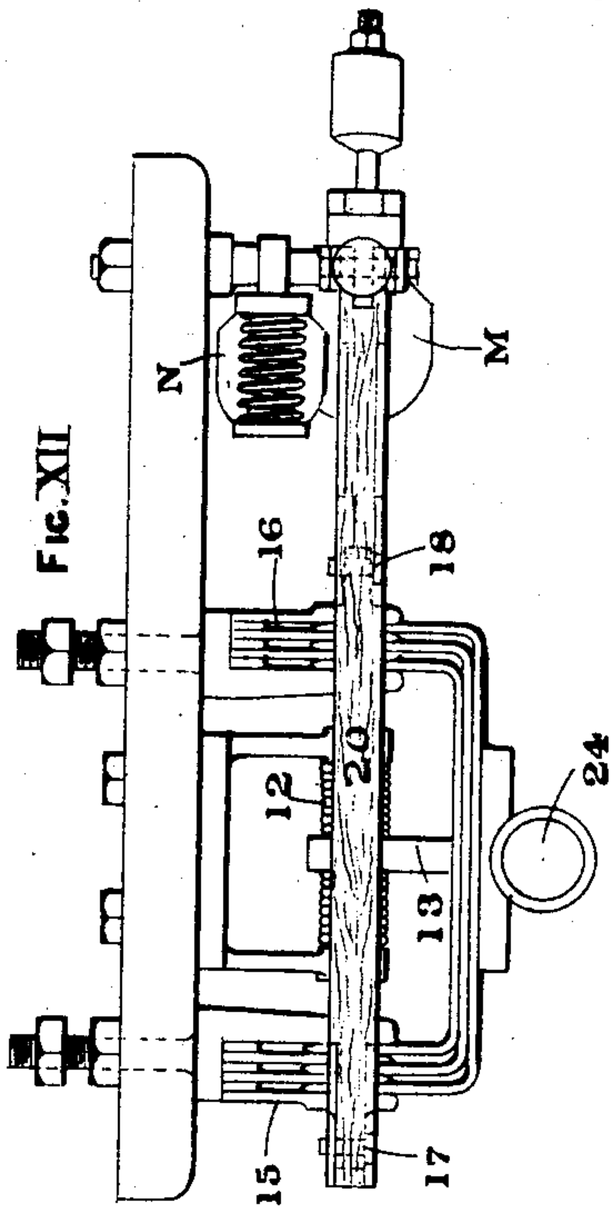

FIG. XII

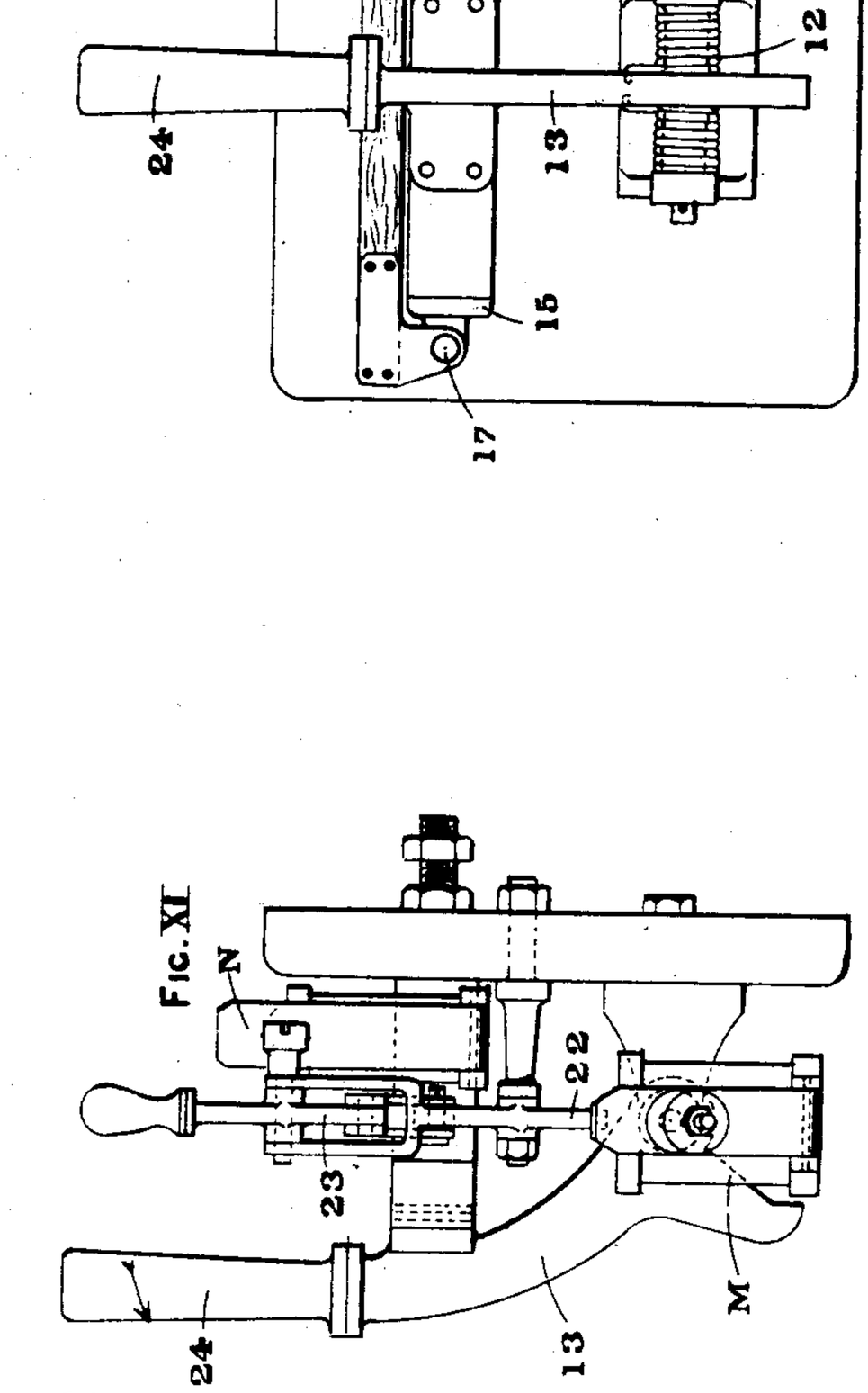

FIG. XI

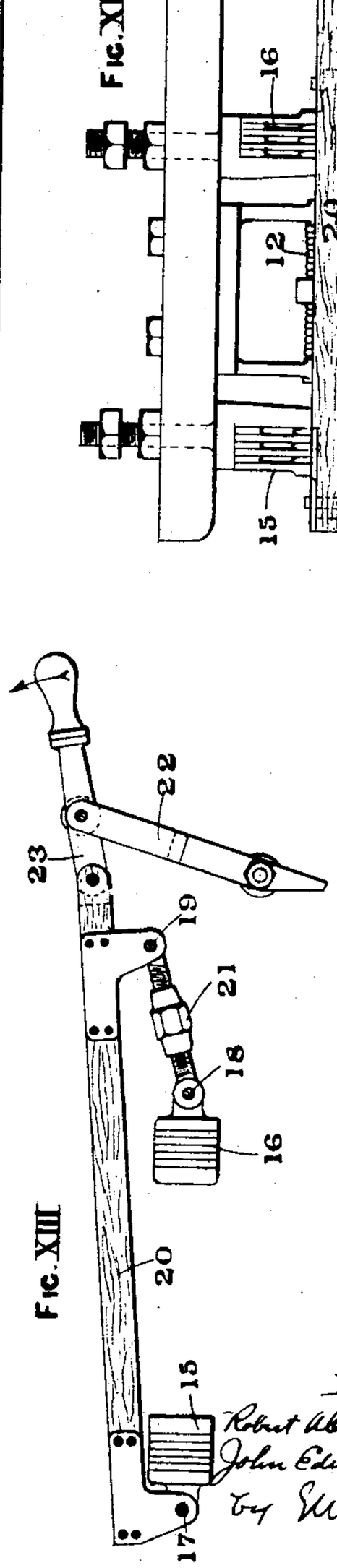

FIG. XIII

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UNITED STATES PATENT OFFICE.

ROBERT A. SLOAN AND JOHN E. LLOYD BARNES, OF LIVERPOOL, ENGLAND.

SWITCH FOR ELECTROMOTORS.

SPECIFICATION forming part of Letters Patent No. 682,818, dated September 17, 1901.

Application filed June 19, 1900. Serial No. 20,877. (No model.)

To all whom it may concern:

Be it known that we, ROBERT ALEXANDER SLOAN and JOHN EDWARD LLOYD BARNES, subjects of the Queen of Great Britain, residing in Liverpool, in the county of Lancaster, England, have invented certain new and useful Improvements Relating to Switches, Specially Applicable to Switches for Electromotors and the Like, of which the following is a specification.

This invention relates chiefly to starting-switches for electromotors, and more particularly to such switches as comprise a main switch and a resistance or regulating switch mutually interlocked after the manner described in the complete specification to our British Letters Patent, dated the 16th of January, 1899, and numbered 1,044.

Our objects in the present invention are to provide suitable automatic devices by means of which the main switch is opened when the current rises above or falls below predetermined limits and to so construct the regulating-switch as to prevent its being rapidly moved from the starting position to the normal running position.

It will be seen on reference to our prior specification referred to that in virtue of the mode of interlocking there described the handle of the main switch must be moved so as to be clear of the main-switch bars before the regulating-switch can be moved from the starting position and that this feature renders this type of switch particularly suitable to those cases in which it is desired to fit automatic circuit-opening devices.

We have illustrated our invention in the accompanying drawings, in which—

Figure I is a front elevation, and Fig. II is a plan, the magnets being removed in the latter view for the sake of clearness. Fig. III is a side elevation, and Fig. IV is a fragmentary section on the line A A of Fig. I. Figs. V, VI, and VII are fragmentary views showing details of the magnets for effecting the automatic opening of the main switch, Fig. V being a plan as seen from above, Fig. VI a plan as seen from below, and Fig. VII a sectional elevation on the line B B of Figs. IV and V. Figs. VIII and IX are detail views of the device for insuring that the resistances cannot be cut out too quickly, Fig. VIII being an elevation with the hand-knob removed and Fig. IX a sectional plan on the line C C of Fig. VIII. Figs. X, XI, and XII show a modification of the switch suitable for heavy currents, the views being, respectively, front elevation, side elevation, and plan. Fig. XIII is a fragmentary view showing the positions of the toggle-joints when the switch is open.

Referring in the first instance to Figs. I to IX, we provide a double-pole main switch comprising switch-bars *a*, which are adapted when the switch is closed to connect the contacts *b* and *c* and which are operated by levers *d*, connected by an insulating-bar *e* to a handle *f*. The handle *f*, the bar *e*, and the levers *d* thus form a loose or disconnected handle by means of which the switch may be opened and closed. The poles of this switch are preferably mounted on separate slates, as shown, the negative on, say, the right-hand or narrow slate and the positive on the left-hand slate. We also mount on this latter slate a regulating-switch, comprising an arm *g*, moving over a series of contacts *h*, and means (to be hereinafter described) for preventing the arm *g* being moved too rapidly as it is pushed over to cut out the resistances inserted between the successive contacts *h*. The main switch and the regulating-switch are also interlocked by means of a segmental locking-piece *i* on one of the levers *d* (the positive one in the arrangement illustrated) and a quadrantal locking-piece *j* on the switch-arm *g*. From an inspection of the drawings, Figs. I, II, and III, it will be seen that the interlocking of these two locking-pieces renders it impossible either, first, to close the main switch when the regulating-arm is in any position other than the one in which it is shown in Fig. I, which is the starting position, or, second, to move the arm *g* from this position till the handle *f* has been drawn back (after the switch is closed) clear of the switch-bars, as indicated in dotted lines in Fig. III, thus leaving the latter quite free to open. We also provide a maximum device M and minimum device N. The former causes the main switch to open when there is an overload and the latter causes it to open when there is an underload or when the supply is cut off.

It will be convenient before describing the

devices M and N to revert to the main switch and describe the details of its construction.

The contact-pieces *c* are of ordinary construction; but the others, *b*, as will be seen more particularly from Fig. IV, are hollow and are provided with plungers *k*, normally pressed outwardly by the springs *l*. The latter springs when compressed and free to act are of sufficient strength to overcome the frictional resistance between the switch-bars *a* and their contacts, so that unless the springs are held in their compressed state it is impossible to leave the switch closed. The bars may each be provided with a smaller spring *m*, adapted to carry the switch-bar over to its full "off" position after the spring *l* has reached its outward limit, as indicated in dotted lines in Fig. IV. The mode of holding the spring *l* in its compressed position is as follows: We attach to the plunger *k* (see Figs. II and IV, negative contact *b*) a pin *n*, which is articulated to the fixed pivot *o* by means of the two links *p* and *q*, which, as will be seen clearly in Fig. II, form a toggle-joint, the arrangement being such that when the plunger is pushed in and the spring compressed in the act of closing the switch the three pivots of the toggle-joint are brought into line, or approximately so. If, however, a very slight force be applied to turn the link *q* clockwise, the pivotal friction being very small, such slight force will turn it past the dead-center, when of course the spring *l* again becomes operative and pushes the switch-bars clear of the contacts. An exactly similar arrangement may be adopted in the case of each of the contacts *b;* but we have shown in connection with the positive contact *b* an arrangement which we find works well in practice. The plunger *k* in this case is held in its retracted position by an ordinary detent *r*, which is articulated to the link *q* of the toggle by a rod *s*, the connection being such that the link *q* can move from its "dead-center" position for some distance before it begins to operate the detent *r*. The object of the latter provision is to make use of the energy stored up in the spring *l* of the contact *b* to operate the detent *r*, and this is of course done in the arrangement illustrated, inasmuch as the link *q* as soon as it is just clear of the dead-center position is deflected by the full force of the spring *l* acting with an increasing leverage. We have found that with any form of ordinary detent the force required to disengage is so considerable and variable that the action is very uncertain when only comparatively small forces are available, and we attach considerable importance to what we term the "pivotal" form of detent described, which forms such a delicate trigger that the force necessary to operate it may be very small. Moreover, we find the resistance to be overcome by such operating force is exceedingly constant.

Returning now to the maximum and minimum devices M and N, the maximum device comprises a magnet *t*, having suitable pole-pieces and an armature *u*, which form a fairly-complete magnetic circuit. The mode of carrying the armature is shown in Figs. V, VI, and VII. The magnet and its pole-pieces are attached to non-magnetic cheeks *v* and *w*, in the upper one of which, *v*, there is a slot shaped as shown in Fig. VII, and the armature is undercut, as indicated in this latter figure, and is carried by a knife-edge formed in the cheek *v* and is thus very freely suspended, and its lower end is guided in a slot formed in the lower cheek *w*. The armature *u* has a screwed rod *x*, on which a counterbalance *y* fits as a nut. This counterbalance keeps the armature *u* in its off position away from the lower pole-face, as shown in the drawings, and the force to be overcome in order to move it from this position may be varied by varying the position of the counterbalance *y* on the screw *x*. When, however, the current circulating around the coils of the maximum-magnet *t* reaches a predetermined limit and pulls the armature over, the lower end of the latter engages with the abutment *z* on the link *q* (see Fig. II) and moves it from its dead-center position with the result already described. In the case of the minimum device N the action of course requires to be such that it operates the link *q* when the current is less than a predetermined limit. The construction of the magnet, pole-pieces, armature, and cheeks of the minimum device is similar to that described in connection with the maximum device, except that the minimum-magnet 1 tends to draw the armature 2 away from engagement with the pivot 3 of the toggle and that a spring 4 is now provided, which normally tends to push the armature into engagement with the pivot 3 of the toggle or of course with any convenient part of the link *q*. It will be seen, therefore, that unless the current flowing around the minimum-magnet coils is sufficient to overcome the spring 4 the switch cannot be left closed. In this way the two devices described by their action on the link *q* cause the switch to open when the value of the current falls below or rises above assigned limits. It may be pointed out here that a considerable incidental advantage of the pivotal detent results from the fact that as the switch is closed and the toggle straightened the armature of the minimum-magnet is pushed automatically almost into contact with the pole-face, thus materially reducing the reluctance of the magnetic circuit, and therefore necessitating a much smaller magnetizing-current than would have been necessary had there been a considerable air-gap.

We will now describe the means for preventing the arm *g* of the regulating-switch from being too rapidly moved over its contacts.

We provide a circular toothed arc 5, (see Figs. I, II, VIII, and IX,) over which the end

of the arm *g* moves, and in a cavity in the under side of this arm we pivot a double engagement-pawl 6. This pawl is pivoted on but is free to move about the spindle 7, which serves also to pivotally connect the knob 8 to the arm *g*, and it will be seen from the shape of the pawl that when it is partly rotated to cause the one end to clear an engaging tooth of the arc 5 it has to be moved into such position as insures the engagement of the opposite end of the pawl with the same or the next tooth. Thus to move the arm in the direction indicated by the arrow it becomes necessary to vibrate the pawl 6 after the manner of an escapement, giving a step-by-step movement. If the pawl were directly connected to the knob 8, it would be simply necessary to vibrate the knob through a comparatively small angle, while maintaining the directional pressure, to insure a fairly-rapid movement of the arm *g*. We find, however, that if instead of making a direct connection between these two we carry a pin 9, secured to the pawl through a slot 10 in the arm *g* (see Fig. VIII,) and provide the knob with an annular groove 11, into which the pin 9 projects, we can by making the annular slot extend through nearly three hundred and sixty degrees and rendering it necessary to rotate the knob through nearly three hundred and sixty degrees each time the pawl is to be vibrated make it impossible to move the arm rapidly in the direction of the arrow from one extreme position to the other. It will be seen also that by altering the number of the teeth in the arc or by altering the length of the groove 11 in the knob the time taken to move the arm from the one extreme position to the other may be varied within wide limits.

Reverting again to the main switch, it will be seen that the spring *l* must be sufficiently strong to overcome the frictional resistance of the contacts, and although in switches of moderate size it is quite practicable to use such springs, especially where there is one spring for each switch-bar, we find in very large switches that it is desirable to modify the arrangement, as shown in Figs. X to XIII, to which reference will now be made.

Instead of placing a spring *l* in each contact to act through a plunger we use a coiled spring 12, which tends to turn the switch-bar 13 about its spindle 14, so as to withdraw it from the contacts 15 16, and the spring is made strong enough to overcome the normal frictional resistance. In order to keep the switch closed, the friction is increased by increasing the normal pressure between the surfaces. This is accomplished by making one of the extreme side pieces of each contact rigid and making the other side (or where the contact is multiple, as shown in the drawings, the other portions) flexible and so connecting the extreme flexible portions by means of pivots 17 and 18 and links 20 and 21, pivoted together at 19, that the links form a toggle, which when it is straightened, so that the pivots are in line, increases the normal pressure between the contacts. The main toggle is held in its straightened position by a pivoted detent 22 23, similar in its action to the one already described. This pivoted detent is controlled by a maximum device M and a minimum device N, similar to those already described, except that in this arrangement the maximum device acts on the tail of the link 22. The short link 21 of the main toggle consists of two screws—one left-handed and one right-handed—united by a nut, by means of which the length of this link may be adjusted to take up wear. The short link 23 of the pivoted detent is prolonged to form a handle, which forms a very convenient device for closing the main toggle. The action in this respect will be clearly understood from Fig. XIII.

For the sake of clearness the handle 24 of the switch is shown as being fixed directly to the switch-arm; but of course when the main switch is interlocked with a regulating-switch the handle is loosely connected like the handle *f* and is interlocked like the latter.

It may be well here to draw attention to the following features of our invention: It is possible, notwithstanding the interlocking devices and the releasing devices, to always open the switch by hand. The regulating-switch cannot be moved to the position in which the resistance is cut out until the switch-bars are left quite free for the operation of the releasing devices, and the switch cannot be held closed against a dead short circuit on the motor, inasmuch as it can only be held closed when all the resistance is in circuit. Moreover, the minimum-armature is, as already described, automatically brought into engagement with the magnet-pole as the switch is closed. The electrical connections can of course be varied. For instance, the minimum-magnet may be wound with a shunt-coil, or it may be put in series with the shunt-coil of a shunt-motor. It will also be noticed that the slow-movement device for the regulating-switch is operative in one direction only, so that the resistance may be put in quickly, and that part of our invention may be applied to those forms of motor-switches in which the arm is held in the running position—that is, where the resistance is all cut out—by an electromagnet which is deënergized when the current falls below or rises above the limits, in which case a spring pulls the arm back to the starting position, the pawl tripping over the teeth and offering no resistance.

Having now fully described our invention, what we claim, and desire to secure by Letters Patent, is—

1. In combination: a switch-bar, a handle by which the bar is operated, insulated contacts adapted to be electrically connected by the bar, a spring which is compressed when the contacts are so connected and which tends to force the bar out of the contacts, a detent for

holding the said spring compressed but which leaves the switch-bar free to be opened by the handle, and means for releasing the said detent when the current carried by the switch falls below or rises above a predetermined limit; substantially as described and illustrated.

2. In combination: a main switch-bar, contacts therefor, a spring which is compressed when the switch-bar is in its contacts and which tends to force the said bar out of its contacts; a detent for holding the said spring compressed but which leaves the switch-bar free to be opened by hand, means for releasing the said detent when the current falls below or rises above predetermined limits, a loose handle, adapted to open and close the switch-bar, and provided with a locking-piece; a regulating-switch provided with a locking-piece which, when the regulating-switch is in any position other than the starting position, locks the main-switch handle in its off position, and which, when the latter is in contact with the closed-switch bar, is locked in the starting position; substantially as described and illustrated.

3. In combination: the switch-bar, the contacts, the spring tending to force the bar out of its contacts, the pivoted links whose opposite ends are connected respectively to a fixed pin and to a pin holding the spring, and which are adapted, when closed so that their centers are in line, to hold the said spring compressed, and the means for releasing the said spring by pushing the links out of line; substantially as described and illustrated.

4. In combination: the switch-bar, the contacts, the spring carried in one of the contacts, the detent and the means for releasing the detent; substantially as described and illustrated.

5. In combination: the switch-bar, the contacts, the spring, the plunger, the latter two carried in one of the contacts, the detent and the means for releasing the detent, substantially as described and illustrated.

6. In combination, in a double-pole switch, two sets of fixed contacts, a switch-bar for each set, a lever for each bar, means for moving each bar to close the switch, independent means for each bar tending to open said switch, independent devices for retaining the switch closed, said devices moving in unison in releasing said switches, and means for controlling said devices.

7. In combination in a double-pole switch, two sets of fixed contacts, a switch-bar for each set, a lever for each bar for moving said bars to close the switch, independent means for each bar tending to open said switch, independent pivoted devices for retaining the switch closed, said devices moving in unison in releasing said switch, and means for controlling said devices.

8. In a double-pole switch, in combination; the switch-bars, the contacts, the springs and the two detents, one of the latter consisting of pivoted links, and the other of a detent connected to the said links by a rod which, when the links are opening under the influence of the spring which they control, transmits the force of the said spring to the detent to release it; substantially as described and illustrated.

9. In a regulating-switch, in combination; the switch-arm, the toothed arc, the double-acting pawl, and the pivoted handle adapted to move the pawl in opposite directions, when the extremities of an annular slot therein engage with a pin attached to the pawl; substantially as described and illustrated.

10. In a regulating-switch, in combination; the switch-arm, the toothed arc, the double-acting pawl and a handle adapted to oscillate the said pawl and to move the switch-arm; substantially as described and illustrated.

In testimony whereof we have hereunto set our hands in the presence of two subscribing witnesses.

ROBT. A. SLOAN.
J. E. LLOYD BARNES.

Witnesses:
JOSEPH E. HIRST,
WALTER A. LOADMAN.