E. M. HEWLETT.

ELECTRIC SWITCH.

APPLICATION FILED SEPT. 2, 1905.

960,324.

Patented June 7, 1910.

6 SHEETS—SHEET 1.

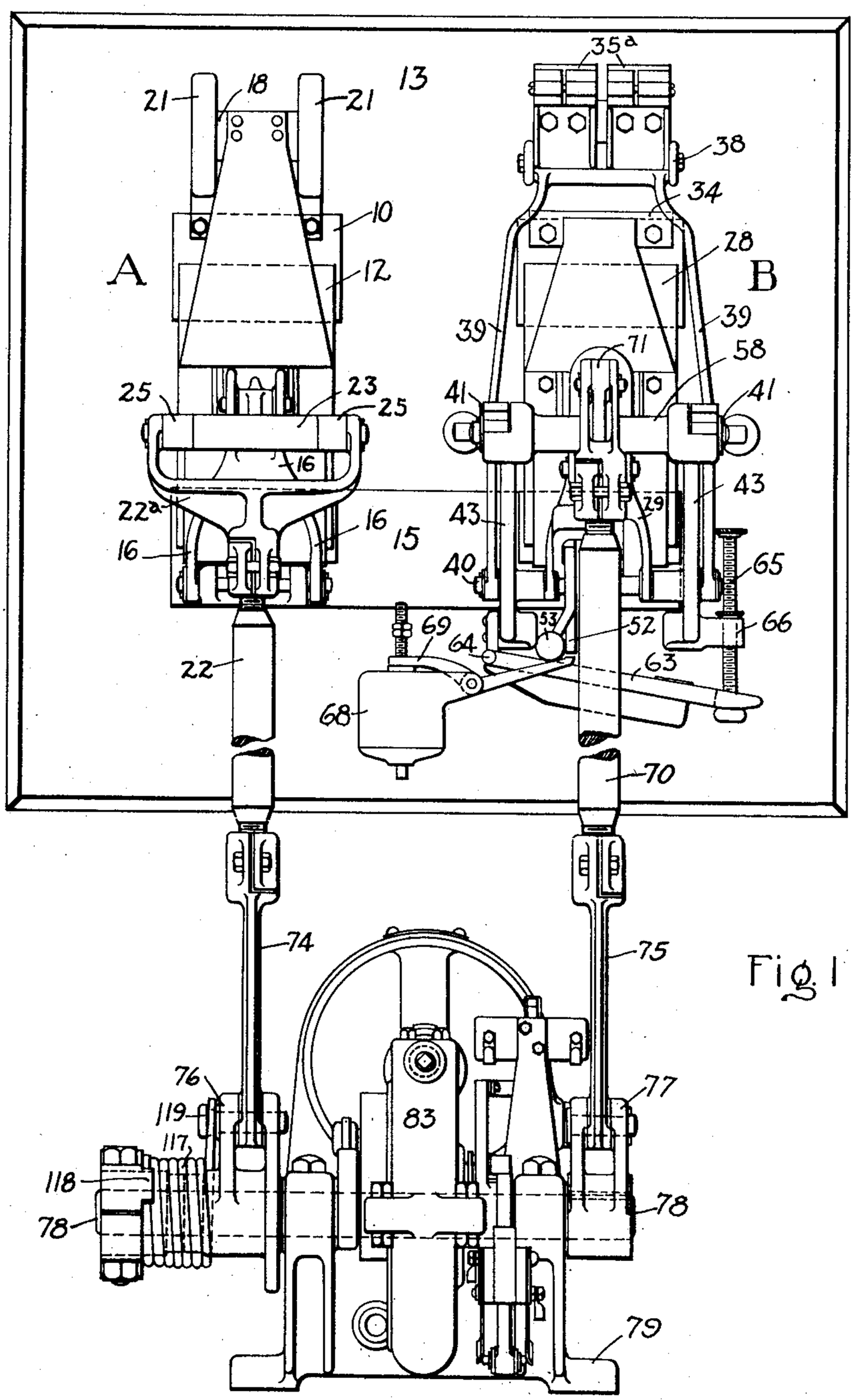

Fig. 1

Witnesses

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Helen Orford

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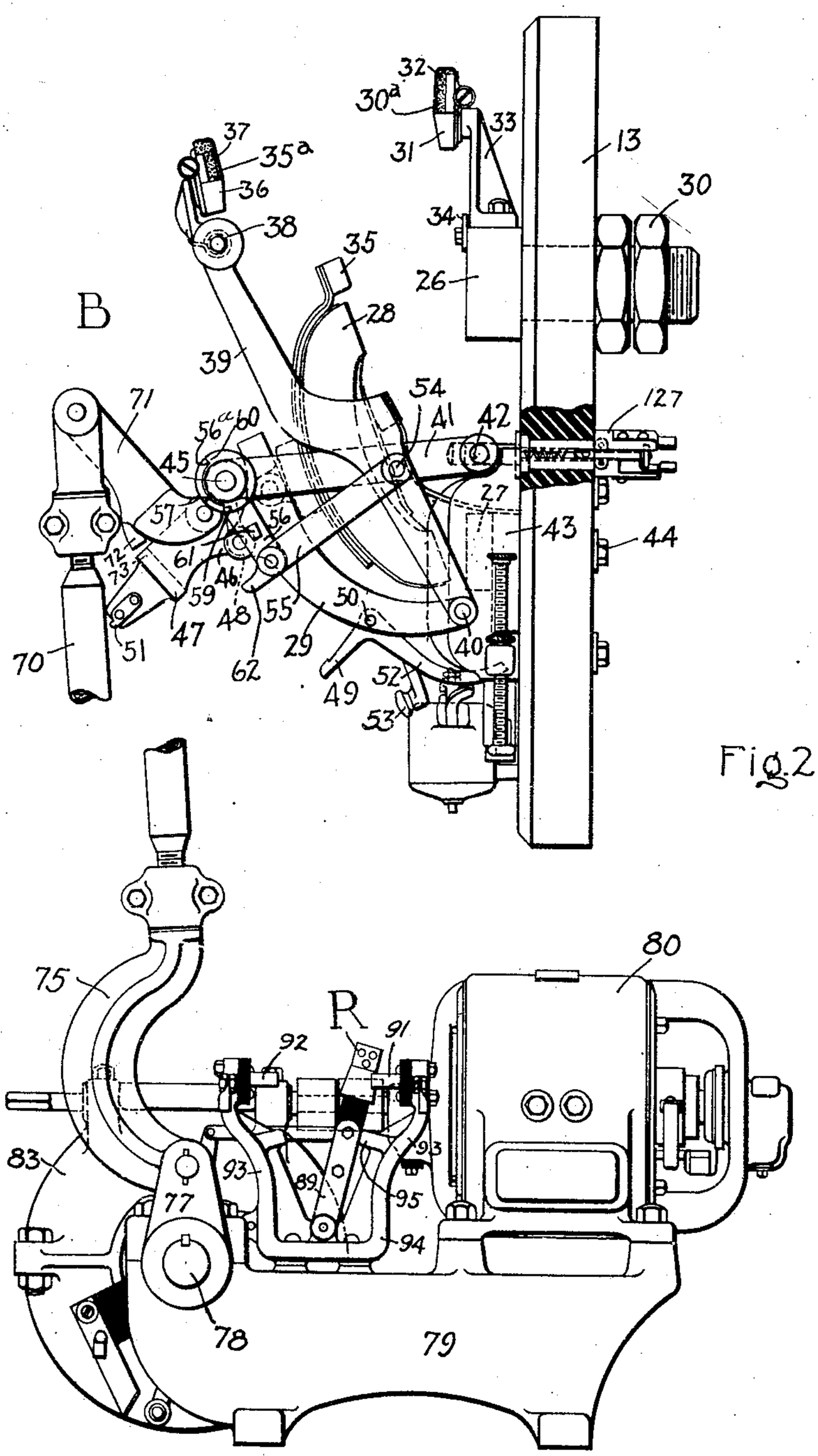

Fig. 2

Witnesses

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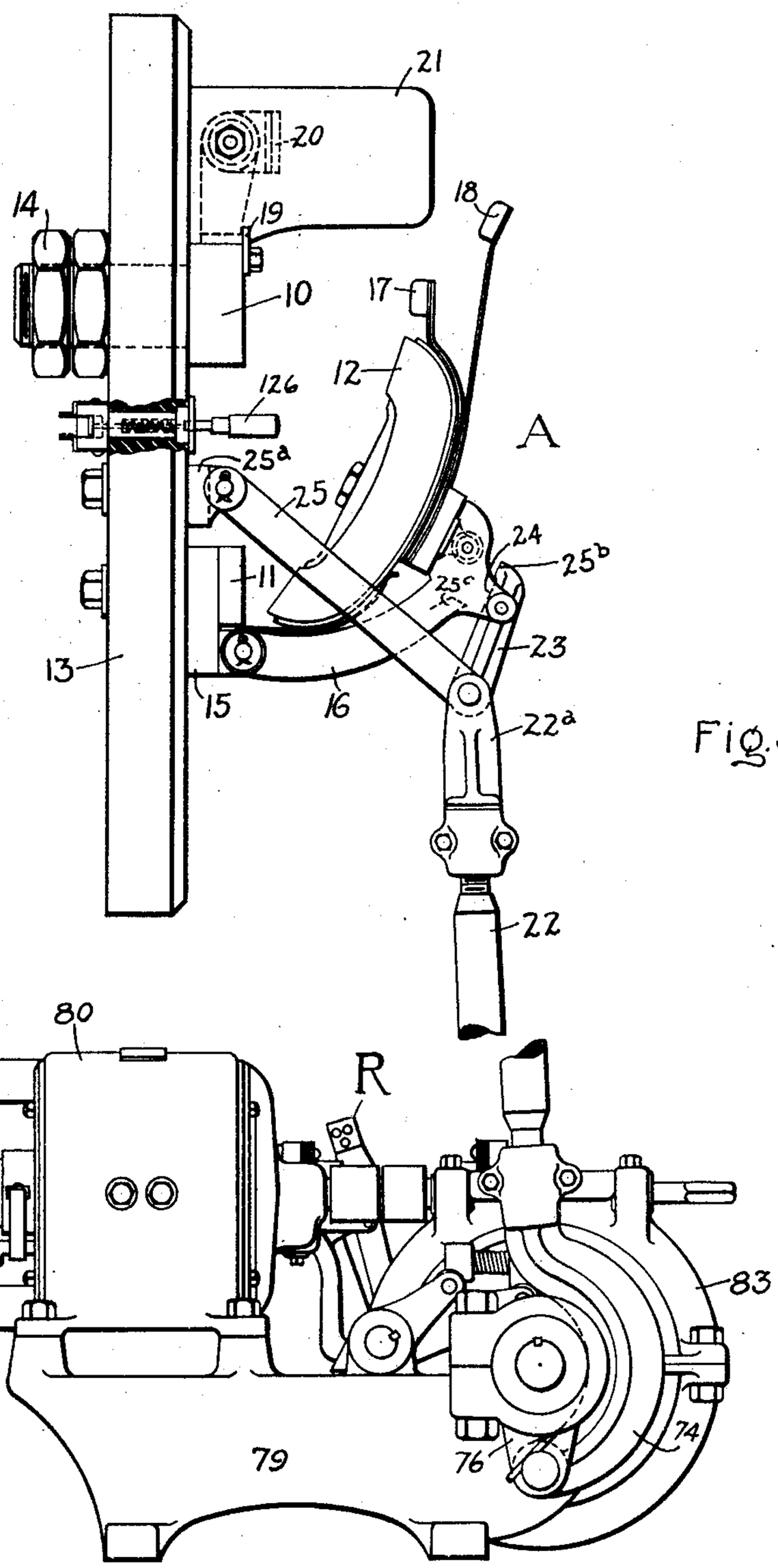

Fig. 3

Witnesses

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6 SHEETS—SHEET 4.

Fig. 4

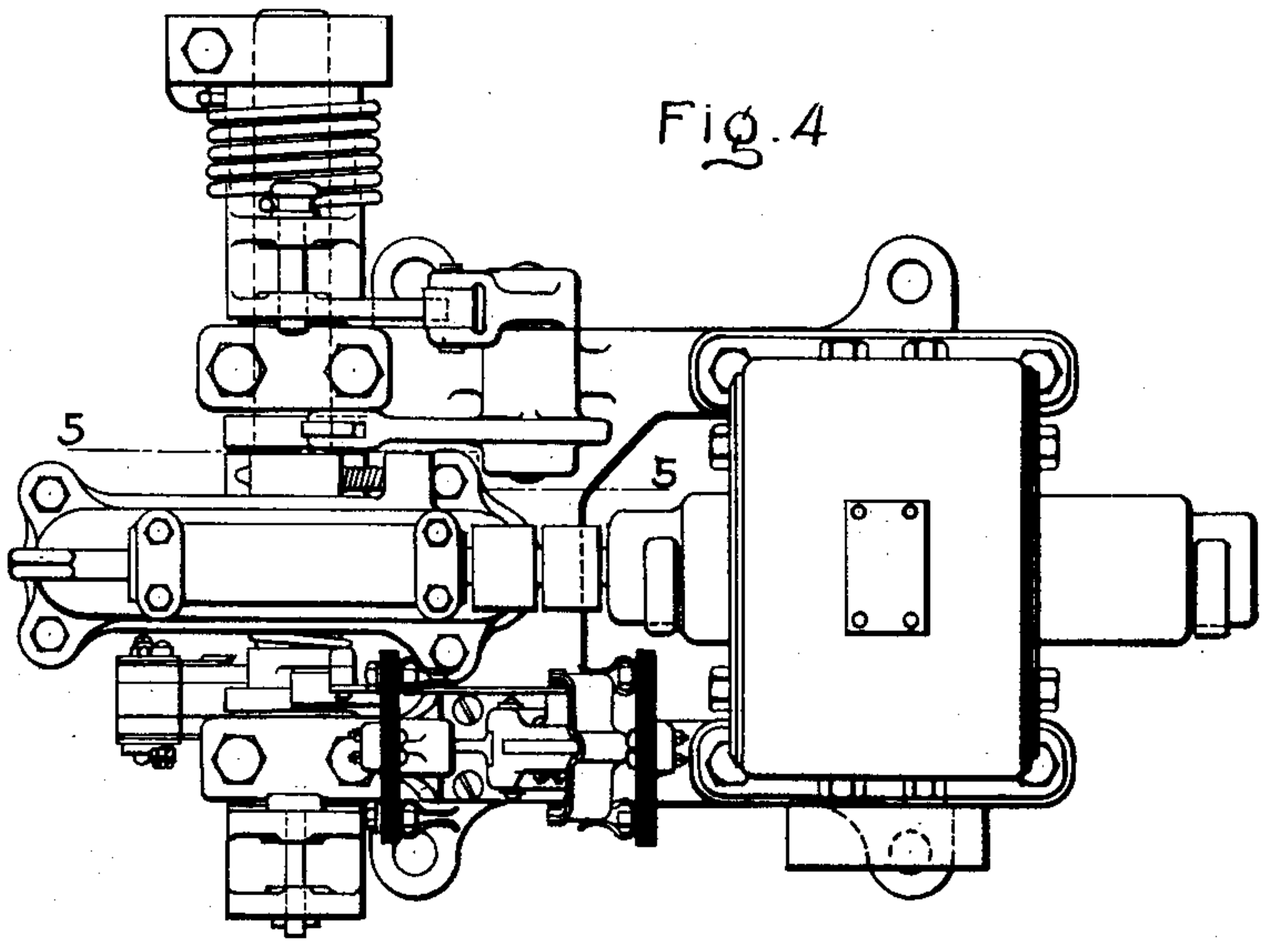


Fig. 5

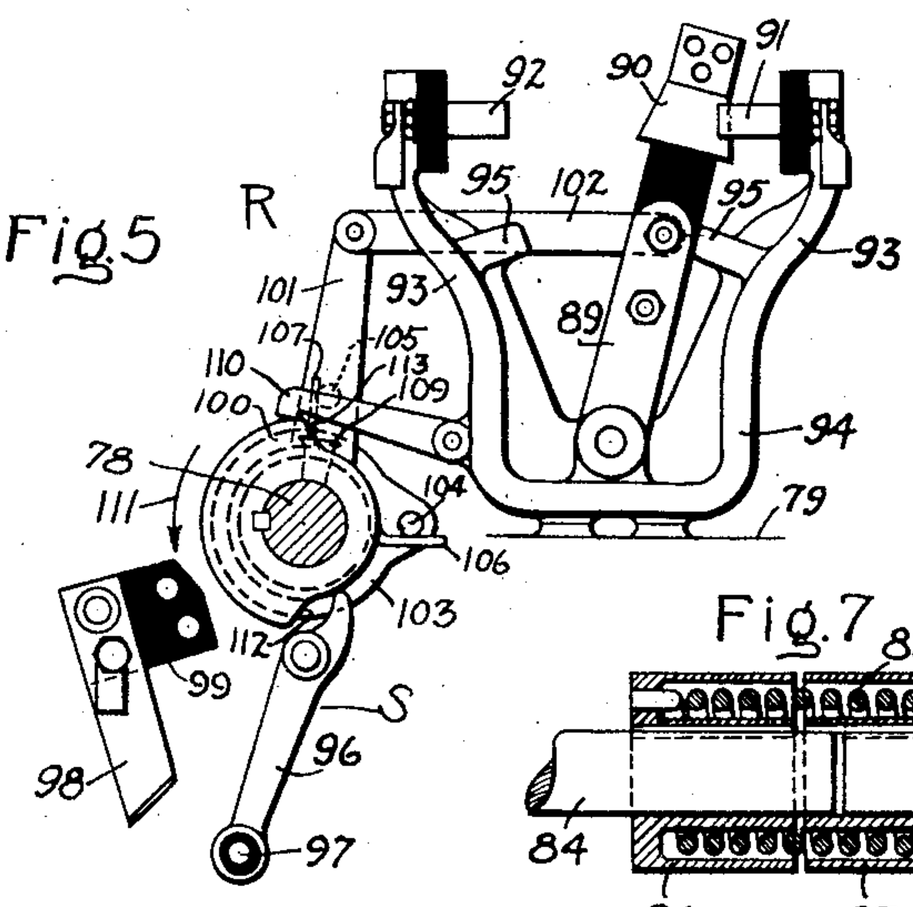


Fig. 6

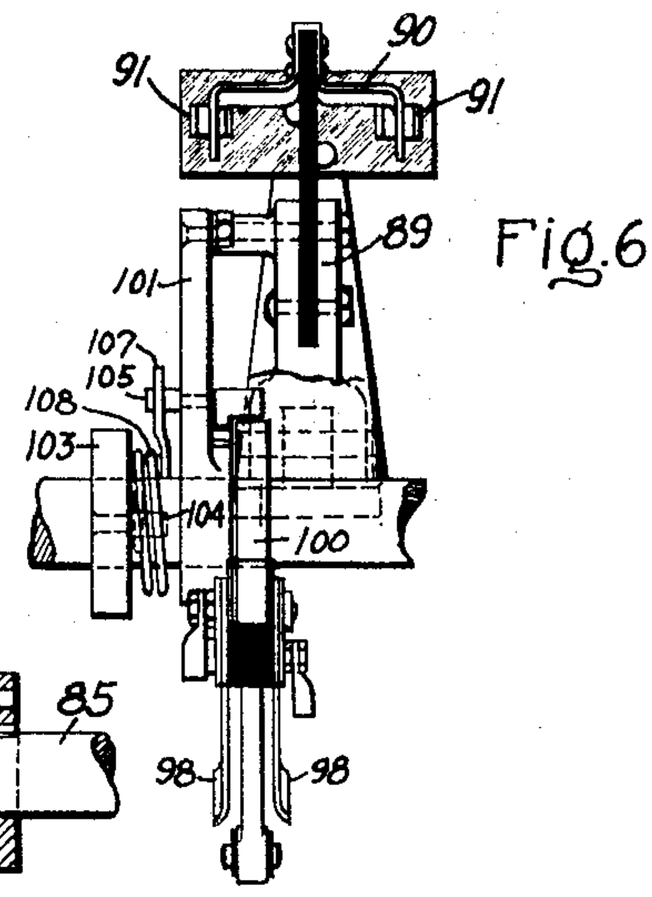


Fig. 7

Fig. 8

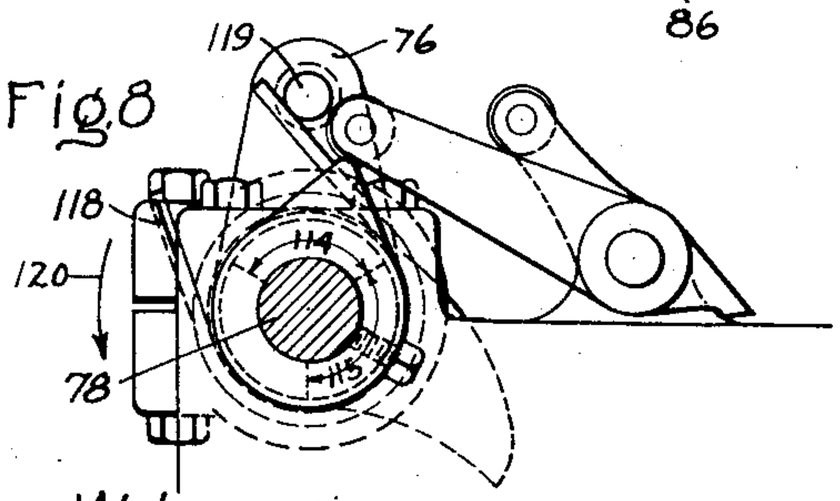
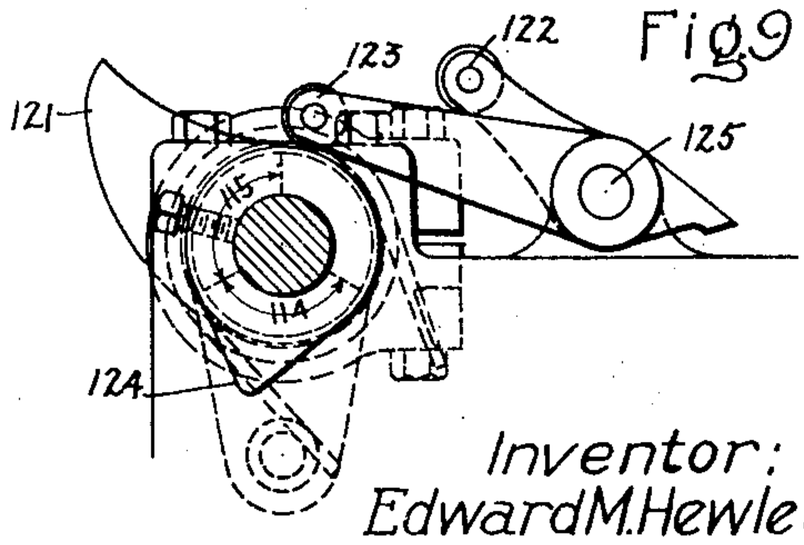


Fig. 9



Witnesses

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6 SHEETS—SHEET 5.

Fig. 10

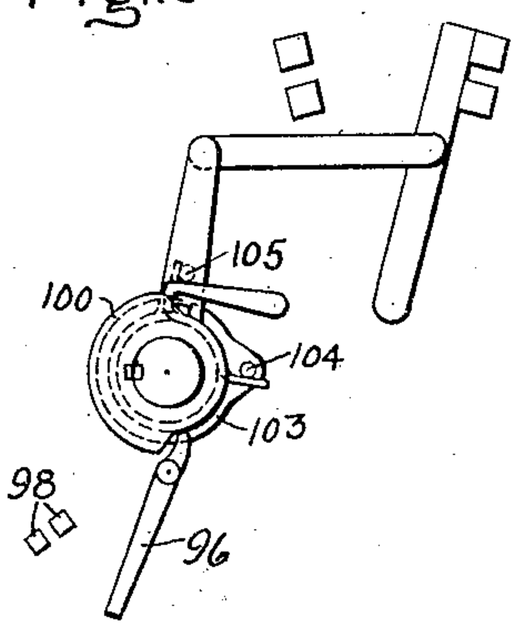


Fig. 11

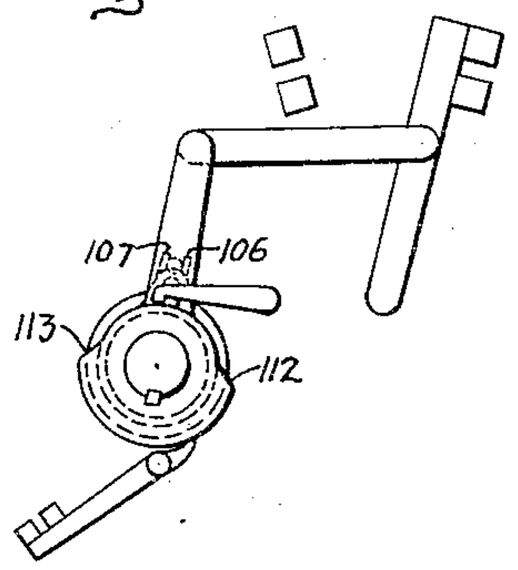


Fig. 12

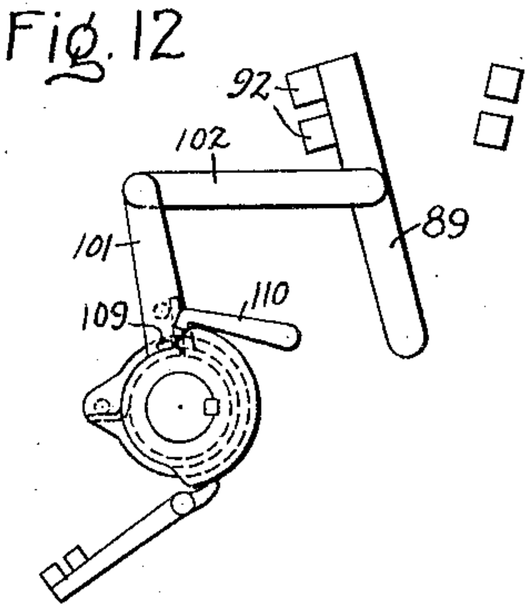


Fig. 13

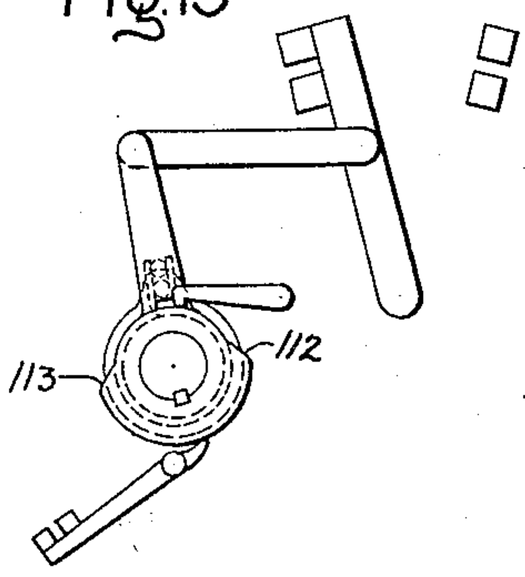


Fig. 14

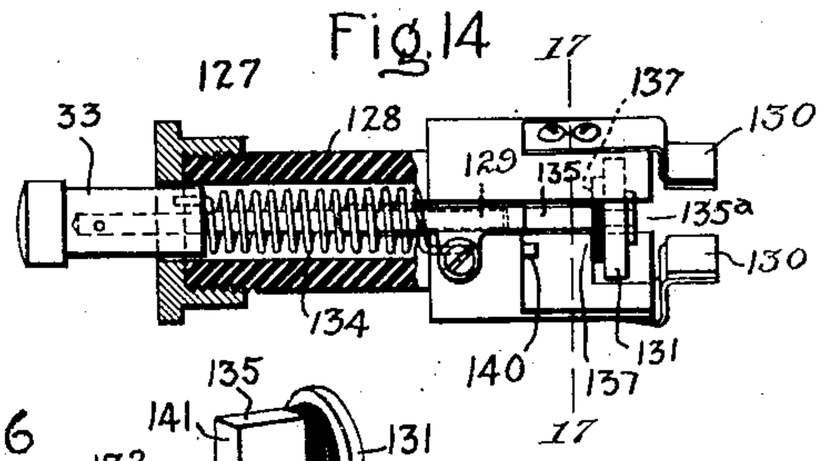


Fig. 15

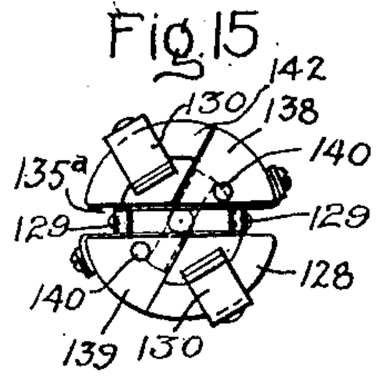


Fig. 16

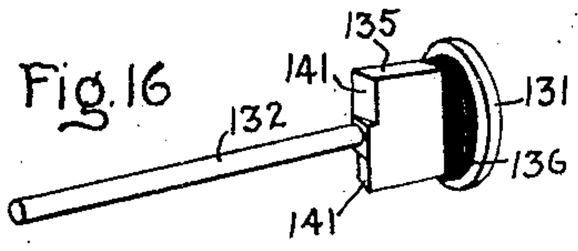


Fig. 17

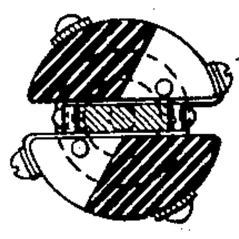
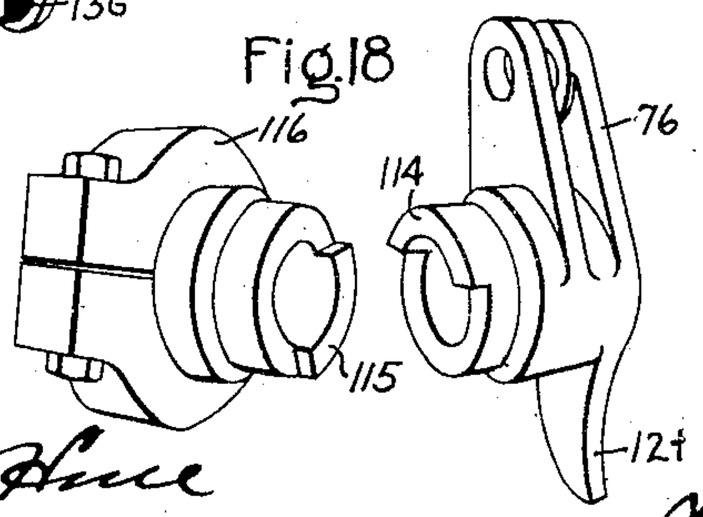


Fig. 18



Witnesses:

Benjamin B. Lucas

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E. M. HEWLETT.

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6 SHEETS—SHEET 6.

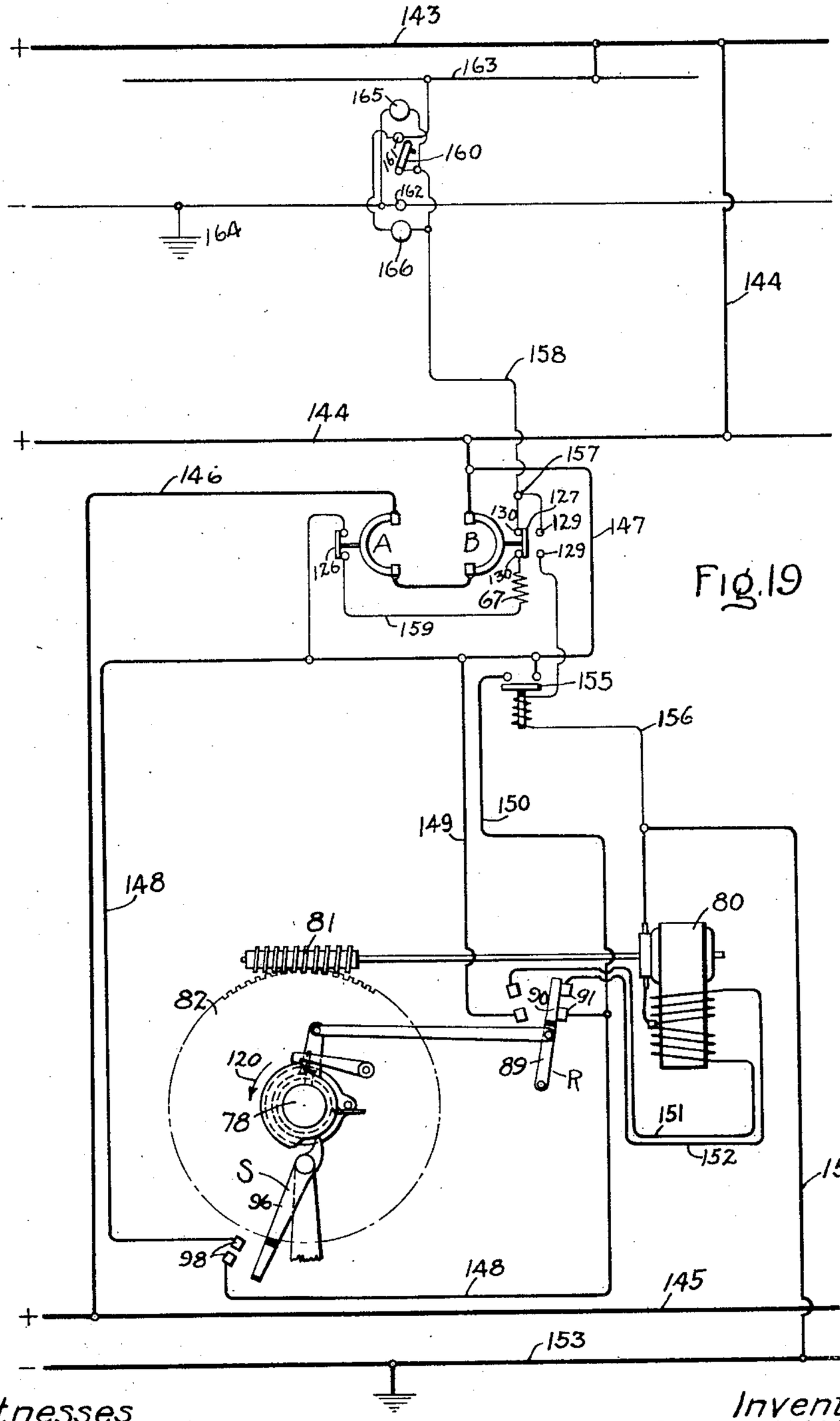

Fig. 19

Witnesses

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UNITED STATES PATENT OFFICE.

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ELECTRIC SWITCH.

960,324. Specification of Letters Patent. Patented June 7, 1910.

Application filed September 2, 1905. Serial No. 276,780.

To all whom it may concern:

Be it known that I, EDWARD M. HEWLETT, a citizen of Schenectady, county of Schenectady, and State of New York, have invented certain new and useful Improvements in Electric Switches, of which the following is a specification.

The present invention relates to electric switching apparatus and has particular reference to motor operated switches controlled from a distant point.

It is usual in direct current electric railway distributing systems to supply alternating current to substations located at various points along the railway line and then by means of transformers and rotary converters at these sub-stations to transform the alternating current to direct current at the desired voltage, finally distributing it by means of feeders to the sections of trolley wire or third-rail to be supplied. With this arrangement a large number of feeders must be run from the substation; and where a large amount of energy is to be supplied this is extremely objectionable because of the cost of the feeders.

One of the objects of the present invention is to reduce the cost of the installation between the substation and the third-rail by running a single feeder from the sub-station along the right-of-way and tapping off from it at suitable points in order to supply the various sections of third-rail. With this arrangement it is necessary to locate the switching mechanism for the control of the various sections of the third-rail in the leads between the single feeder and the third-rail sections instead of the sub-station as has been the practice heretofore. According to my present invention these switching mechanisms are controlled individually by a single control wire running from the sub-station to each of the switches. This control wire is of small size and is consequently inexpensive compared with the cost of feeders which would be necessary were the system installed according to prior practice.

In order to properly protect the system it is necessary that the switching mechanism employed in conjunction with each of the third-rail sections should comprise a circuit breaker and switch connected in series. In operation, in case of overload the circuit is broken by the circuit breaker and upon closing, the circuit breaker is closed first followed by the closing of the switch so that if the overload is still on, the circuit may be ruptured by the circuit breaker.

My invention comprises novel operating mechanism controlled from a distant point for operating a circuit breaker and a switch in this manner.

The invention also comprises certain detailed features including novel circuit connections and structural features and details which will be best understood upon reference to the following detailed description taken in connection with the accompanying drawings.

In said drawings, Figure 1 is a front elevation of the switch and circuit breaker and operating mechanism previously referred to; Fig. 2 is a side elevation of the same viewed in the direction of the arrow 2 in Fig. 1; Fig. 3 is a similar view taken in the opposite direction, as indicated by the arrow 3 in Fig. 1; Fig. 4 is a plan view of the switch and circuit breaker operating mechanism; Fig. 5 is a side elevation of the control switches for the electric motor which drives the operating mechanism; Fig. 6 is a front elevation of the same; Fig. 7 is a sectional view illustrating the clutch connection between the driving motor and the operating mechanism; Figs. 8 and 9 are elevations illustrating in different positions the mechanism by which the switch is given a snap movement when closed; Figs. 10, 11, 12, and 13 are diagrammatic views illustrating the different operative positions of the control switches shown in Figs. 5 and 6; Fig. 14 is a view illustrating partly in section a control switch which is actuated by the movements of the circuit breaker; Fig. 15 is an end view of the same with the bridging disk contact removed; Fig. 16 is a perspective view of the movable element of this switch; Fig. 17 is a section of the switch taken on a plane indicated by the line 17—17 of Fig. 14; Fig. 18 is a view illustrating in perspective the clutch connection between the switch actuating crank and motor driven sleeve shown in Figs. 8 and 9; and Fig. 19 is a diagram of electric circuits.

Throughout these views like characters refer to like parts.

In carrying out the invention any desired

type of switch and circuit breaker may be employed, but for the purpose of the present case I have illustrated a switch A and circuit breaker B of standard construction.

Referring to the switch construction, the same comprises vertically arranged contact studs 10 and 11 adapted to be bridged by a movable contact 12. The studs 10 and 11 are secured to a suitable support 13, the former passing through said support and being provided with terminal clamping nuts 14 by which electrical connection may be made with one leg of the circuit and the latter stud 11 being directly connected to a strip 15 located on the face of the support 13 and connecting with the corresponding stud of the circuit breaker. The movable contact 12 is pivotally connected to the upper end of a supporting frame 16 which in turn is pivoted at its lower end to the lower side of the stud 11 which serves as a support. The movable contact 12 is also provided with two shunt contacts 17 and 18 which are spring mounted and adapted to engage the fixed contacts 19 and 20 respectively, to take the final break and remove all sparking from the main stud 10 as is common and well known in the art. The shunt contact 20 is located between barriers 21 of fiber or other refractory insulating material intended to confine the arc and protect adjacent apparatus. Movement is transmitted to the movable contact 12 from an actuating rod or member 22 through the agency of a toggle connection comprising links 23 and a projection 24 extending outward from the upper end of the frame 16. The rod 22 is pivotally connected through the agency of a yoke 22^a to the outer end of link 23 and to the outer ends of two parallel links 25 which are pivoted at their inner ends to brackets 25^a secured to the support 13. The links 25 extend on the outside of the frame 16 and form, together with their connection at the outer ends, a cramping frame which limits the outward thrust of the toggle and otherwise assists in the closing and opening of the switch in response to the reciprocations of the actuating rod 22. A stop 25^c, shown in dotted lines in Fig. 3, on the member 16, engages a coöperative stop 25^b formed by the extention of the link 23 to limit the movement of the toggle in setting the switch.

The circuit breaker B is of similar construction and comprises in general the fixed contacts 26 and 27 which are adapted to be bridged by the movable contact 28 carried by the supporting frame 29. The fixed contact 26 is secured directly to the support 13 and is provided at its rear with clamping nuts 30 by which electrical connection may be made with the other leg of the circuit. It is also electrically connected to a shunt contact 30^a carried by a bracket 33 and having a metal face 31 and a carbon face 32. A removable contact 34 is also secured to the upper face of the stud 26. These shunt contacts 34 and 30^a coöperate with movable shunt contacts 35 and 35^a, respectively. Of these, the former is yieldingly mounted upon the main bridging contact 28 while the latter is carried by an independent supporting frame. Contact 35^a, like its mate is provided with a metal face 36 and a carbon face 37. It is pivotally and yieldingly connected at the point 38, to the upper end of the supporting frame 39 which in turn is pivoted concentric with the main contact supporting frame 29 at the point 40. In the operation of the breaker the parts are so arranged that the contacts 26 and 28 first separate, then the contacts 34 and 35 and finally the contacts 30^a and 35^a. The pivotal spring mounting of the contact 35^a permits it to engage and disengage its coöperating contact 30^a with a wiping action and to bring the metal faces 31 and 36 into engagement when the circuit breaker is closed and the final break between the carbon faces 32 and 37. The contact supporting frames 29 and 39 are operated through the agency of toggles operatively associated with a cramping frame 41 which consists of parallel links pivotally connected at their inner ends to the frame 43 secured to the support 13 and at their outer ends to a transverse pin 45. The bridging contact 28 and its supporting frame lie wholly within this cramping frame, while the shunt contact supporting frame 39 straddles the cramping frame as clearly illustrated in Fig. 1. The toggle connection between the cramping frame 41 and the supporting frame 29 is provided ~~by~~ an inward projection 46 on an operating member 47 and an outward projection 48 on the frame 29. The operating member 47 in turn is pivotally supported on the pin 45. As clearly illustrated the parts are symmetrically disposed, the projection 46 lying between the projections 48 so that strain imparted in forcing the contacts into engagement is taken up equally by the parallel links of the cramping frame 41. In closing the circuit breaker the outer end of the operating member 47 is moved downward and inward thereby rocking the frame 29 about its pivotal point until the bridging contact 28 is firmly seated upon the coöperating studs 26 and 27. This movement will be limited by the engagement of the operating member 47 with the frame 29 and this engagement will occur just before the main toggle, formed by the projections 46 and 48, reaches dead center. The parts will be held in this position by the engagement of a latch 49, pivoted at 50 to the frame 29, with a projection 51 on the operating member 47.

This latch is provided with a long rearwardly-extending tail 52 and with a push button 53 either of which may be pressed to release the member 47 and permit the breaker to fly open under the action of gravity. The toggle connection between the cramping frame 41 and the auxiliary supporting frame 39 comprises a pair of toggles located one on each side of the cramping frame and extending between the point 45 on the cramping frame and the point 54 on the supporting frame 39. Each toggle is composed of links 55 and 56. Movement is transmitted from the actuating member 47 to these toggles by means of shoulders 56ª and 57 on the sleeve 58 formed integral with the member 47 and the coöperating shoulders 59 and 60 on the links 56. Upon the downward movement of the member 47 the shoulders 57 and 59 are brought into engagement and the toggles forced so as to bring their links into a substantially right line position, the stops 61 on the links 56 engaging the projections 62 on the links 55 to arrest the toggles in a slightly overset position. From this it will be seen that when the breaker is moved to open position the main toggle, formed by the projections 46 and 48, will first begin to move and the bridging contact 28 will have moved a considerable distance from the studs 26 and 27 before the shoulders 56ª and 60 engage to break the secondary toggles, comprising the links 55 and 56, and allow the circuit to be broken between the shunt contacts 30ª and 35ª. The movement of the member 47 downward and inward will, through the operation of the main and secondary toggles, close all the contacts and the parts will be held in this position through the agency of the latch 49. When this latch is tripped, the circuit will be broken and the parts will assume the position illustrated in Fig. 2. For the purpose of automatically actuating the latch upon an overload in the circuit in which the circuit breaker is connected, the frame 43, to which some of the parts are connected, is composed of iron and forms a magnetic turn about the stud 27 and the lower end of the bridging contact 28, so as to be threaded by the circuit which extends from the contact stud 10, through the bridging contact 12 of the switch, contact 11, strip 15, circuit breaker contact 27, bridging contact 28 to stud 26. This frame 43 forms a U-shaped core which is provided with a weighted armature 63 pivoted to the lower end of one of its legs at 64 and adapted to be drawn upward into engagement with the tail 52 of the latch 49. Through the agency of a calibrating screw 65 extending through an opening in a projection 66 from the other leg of the frame 43 the armature may be set to trip at any desired overload. An auxiliary trip is also furnished by the coil 67, shown diagrammatically in Fig. 19, inclosed in a casing 68 and operating upon an armature 69 to similarly engage the tail 52 of the latch. The casing for this trip device is suitably secured to the face of the supporting panel 13 in any desired manner.

The switch and circuit breaker construction thus far described is in its essentials old and in itself constitutes no part of the present invention.

In the usual construction of circuit breaker the member 47 is manually operated to close the breaker. In the present instance this closing movement is obtained by means of the actuating rod or member 70 and the intermediate member 71 which is pivoted at its outer end to the member 70 and at its inner end to the actuating member 47. In the operation of these parts the upward movement of the rod 70 has no effect upon the actuating member 47 but through the agency of the engaging shoulders 72 and 73 on the members 71 and 47 respectively, its downward movement establishes a positive mechanical connection which is instrumental in giving the member 47 the movement necessary to set the breaker. The lower ends of the rods 22 and 70 terminate in curved connecting members 74 and 75, which are secured to cranks 76 and 77 respectively, carried on the shaft 78 of the operating mechanism. This shaft is suitably journaled in a supporting frame 79 upon which is located the actuating motor 80. This motor may be of any desired type but preferably is an electric motor. It is operatively connected to the shaft 78 by suitable gearing, in the present instance comprising a worm 81 and worm-wheel 82 inclosed in suitable casing 83 carried by the frame 79. In the operation of the mechanism the cranks 76 and 77 are given a to and fro movement by the motor through substantially 180°. This necessitates the reversal of the motor and in order to give the same time to speed up upon reversal and build up a counter electromotive force sufficient to prevent serious sparking at the brushes a yielding mechanical connection is provided between two sections of the motor shaft. This connection is illustrated in detail in Fig. 7 where the sections 84 and 85 of the motor shaft have keyed to their adjacent ends the cylindrical members 86 and 87, respectively. These members are formed so as to leave a chamber for a coiled spring 88 which is connected at its opposite ends to the members 86 and 87. In the operation of this clutch when the motor driven section of the shaft is rotated the energy is first consumed in winding up the spring 88 until it is drawn or forced into engagement with the walls of the containing members 86 and 87. From this point on the rotation of the driven

section is transmitted positively to the other section since the spring is unable to take up more of the transmitted energy. This spring connection also absorbs the mechanical shock due to sudden reversal of the motor.

Any desired switch for reversing the motor connections may be employed. In the present instance the reversing switch R comprises a pivoted arm 89 carrying a bridging contact 90 and adapted to be thrown from engagement with one pair of contacts 91 to a second pair 92. These fixed contacts are carried at the upper ends of arms 93 of a frame 94 mounted upon the base 79 and the movements of the switch-arm 89 are limited by stops 95 carried by the arms 93. The switch arm 89 is operated directly from the motor driven shaft through the agency of suitable connections. These same connections are instrumental in actuating the switch arm 96 of the second control switch S which by means of a bridging contact 97 bridges fixed contacts 98 carried by a suitable insulating support 99 mounted on the base 79. These switch actuating connections comprise a cam 100 keyed to the shaft 78 and a member 101 loosely mounted on the shaft 78 and rotatable in close proximity to the cam 100. The member 101 is connected by a link 102 to the switch-arm 89. A third member 103 is also keyed to the shaft adjacent to the member 101 and these two members are provided with pins 104 and 105 which are adapted to engage the ends 106 and 107 of a spring 108 coiled about the shaft and intended to give a snap movement to the reversing switch. The pins 104 and 105 extend outward from their respective members sufficiently to engage either of the ends 106 or 107 of the spring and they are located at different distances from their center of rotation so that they pass readily by each other without interference. For the purpose of holding the member 101 against the pull of the spring 108 while it is being put under tension said member is provided with a projection 109 which is adapted to engage on either side with coöperating shoulders on the member 110 pivoted to the adjacent arm 93 of the reversing switch frame 94. With the parts in the position shown in Fig. 5 the operating mechanism is at rest. When this mechanism is set in motion the shaft 78 is first rotated in the direction of the arrow 111 and continues rotating in this direction until the reversing switch R is thrown so as to bridge the contacts 92; then the direction of rotation is reversed and the parts are brought back to the position illustrated. The various positions of this mechanism will be best understood from an inspection of Figs. 10 and 13 inclusive. Shortly after the shaft begins to rotate in the direction of the arrow 111 the switch-arm 96 will be engaged by the cam face 112 and thrown into engagement with its fixed contacts 98, and about the same time the latch 110 will ride down over the opposite cam face 113 and drop into engagement with the left face of the projection 109. Further movement will release the tension on the spring 108 by bringing the pins 104 and 105 into alinement. This position is illustrated in Fig. 11. At this point the pin 104 will leave the end 106 of the spring in engagement with the pin 105 and will engage the end 107 and carry it around so as to place the spring under tension. This will continue until the cam 100 has passed far enough to bring the face 112 into engagement with the latch 110, as illustrated in Fig. 12. When this occurs the member 101 will be free to respond to the pull of the spring and will throw the switch-arm 89 of the reversing switch into engagement with the contacts 92. During this entire movement the switch-arm 96 has remained in its engaging position. The throwing of the reversing switch will cause the shaft 78 to rotate in the opposite direction. This will first have the effect of permitting the latch 110 to engage the right-hand side of the stop 109 and thus secure the reversing switch against the pull of the spring 108 while it is being wound up in the opposite direction. Just before the latch 110 is thrown out of engaging position upon this return rotation of the shaft, the switch-arm 96 rides over the face 112 of the cam 110 and drops out of engagement with its fixed contacts 98. When thus disengaged the latch 110 is thrown out of engagement with the projection 109 by the face 113 of the cam and the reversing switch takes the position illustrated in Fig. 5.

The crank 76 which operates the main switch through the agency of the connecting rod 22 is loosely mounted upon the shaft 78 and is provided with a clutch projection 114 which coöperates with a similar projection 115 carried by a sleeve 116 which is keyed to the shaft. A coiled tension-spring 117 is wound about the exterior of the adjacent portions of the sleeve and crank structure and has its opposite ends engaging projections 118 and 119 on the sleeve and crank, respectively. This spring is normally under slight tension and tends to hold the clutch projections 114 and 115 in engagement as illustrated in Fig. 8. During the rotation of the shaft 78, in the direction indicated by the arrow 120, the crank 76 is carried around with it to the position illustrated in Fig. 9 without the clutch projections being disengaged. Upon the return movement of the shaft this engagement is continued, due to the tension of the spring 117, until a projection 121 on the crank structure engages

a stop 122. From this point on, the rotation of the shaft is independent of the crank; the clutch projection 115 moves away from the clutch projection 114 and the spring 117 is placed under greater tension. This action continues until the member 123, which is directly connected to the member 122 and rotatable with it, is engaged by the cam 124 carried by the sleeve 116. When this occurs the members 122 and 123 are rocked about their pivot 125 until the stop 122 passes out of engagement with the projection 121, thereby allowing the crank to respond to the tension of the spring and to complete its rotation. By this means the main switch is given a snap action in closing.

Associated with the main switch and circuit breaker upon the support 13 are two switches 126 and 127, the former being actuated by the movable member 12 of the main switch and the latter by the movable member 28 of the circuit breaker. Any desired form of switch may be employed for this purpose but I prefer a switch of the general construction illustrated in Figs. 14 and 15. The switch 126 is a single throw switch while switch 127 is a double throw switch. These switches are substantially identical in construction except that two of the contacts in switch 126 are omitted. The double throw switch is shown in Figs. 14 and 15. This switch consists essentially of an outer shell 128 composed of wood or other suitable insulating material and carrying two sets of contacts 129 and 130. The contacts 130 are adapted to be bridged by a disk contact 131 carried at one end of, and suitably insulated by an insulating disk 136 from, a reciprocable plunger 132 extending through the interior of the shell 128 and terminating at its opposite end in a push button 133. A spring 134 surrounding the plunger 132 and located within the shell 128 tends to maintain the plunger in the position illustrated in Fig. 14. The two sets of contacts 129 are adapted to be bridged by a rectangular contact 135 secured to the plunger 132 adjacent but insulated from the disk 131. The contact 135 travels in a slot 135ª formed in the shell 128 and under the action of the spring 134 is maintained in bridging position. The outward movement of the plunger 132 under the action of the spring is limited by the engagement of the insulating disk 136 with projecting shoulders 137 formed in the shell 128. As illustrated in Fig. 15, where the parts are shown with the disk 131 removed, the shell 128 in addition to the slot 135ª is cut away at 138 and 139 so that when the disk 131 is moved to substantially mid position the plunger 132 may be rotated into the dotted line position of Fig. 15 and held against return by pins 140 which engage the shoulders 141 of the contact block 135. The rotation of the plunger twists the spring 134 so that when the push button 133 is pressed inward far enough to move the shoulders 141 of the contact block 135 beyond the ends of the pins 140, the plunger and its connected parts will rotate back to their normal position and may then be moved as desired to complete the circuit between either set of fixed contacts. An inspection of Fig. 15 will show that the rotary movement of the plunger 132 is limited by the sides of the contact block 135 engaging the walls 142 of the cut-away portion of the shell.

From an inspection of Fig. 19, in which the parts previously described in detail and their connections are diagrammatically illustrated, the operation of the system may be readily understood. In this diagram 143 represents the main bus-bar from which current is to be supplied to the outlying sections of third rail. This bus-bar in the present instance may be the bus-bar in the substation which is supplied with direct current from rotary converters or other suitable source. From this bus-bar a single feeder runs to the neighborhood of the third rail sections to be supplied with current. In the present instance, with a view to simplicity, a single section of third rail only has been shown together with the switching apparatus and control circuits necessary thereto. This section of third rail, which is designated 145, is supplied with current from the feeder 144 through the circuit breaker B and switch A connected in series in the lead 146. The motor 80 is supplied with current from the feeder 144 by way of the leads 147, 148, 149, 150, 151 and 152 according to the operative positions of the parts of the control mechanism. The circuit is completed from the motor to ground through the track 153 by way of the lead 154. The circuit through the lead 150 is made and broken by an electro-magnetically operated switch 155 whose actuating coil is included in a branch 156 running from the point 157 in the control wire 158 to the lead 154. This branch includes the contacts 129 of the circuit-breaker actuated control switch 127. A second lead 159 extends from the point 157 through the other contacts 130 of this switch, through the trip coil 67 of the auxiliary trip mechanism of the circuit-breaker and thence through the contacts of the switch 126, which is actuated by the main switch A to the lead 148. These control connections as well as the motor circuit are located in proximity to the section of third rail which they control. The single control wire 158 extends from the switch mechanism in the neighborhood of the third rail to a suitable manually operated control switch 160 located at the sub-station or other desired control point.

This manual switch is a double throw switch adapted to engage either of the fixed contacts 161 and 162. The former of these is connected directly to a suitable supply lead 163 which, in the present instance, is of the same potential as the main bus-bar 143. The other contact 162 is connected directly to ground as indicated at 164. The red indicating lamp 165 is included in circuit between the lead 158 and ground while the green indicating lamp 166 is included in the circuit between the lead 158 and the supply lead 163 by way of the contact 161.

In the operation of the system, if it be assumed that the main switch A and circuit-breaker B are closed the operating mechanism will be in the position illustrated in Fig. 1 and the circuit connections will be those illustrated in Fig. 19. In this position current will be supplied to the red lamp 165 from the feeder cable 144 by way of the leads 147, 159 through switch 127, contacts 130 and lead 158 to ground at 164. The resistance of this circuit is such that the current flow will be insufficient to energize the tripping coil 67 enough to trip the circuit-breaker B. At this time the lamp 166 is extinguished since the lead 158 is at the same potential as the lead 143 hence there is no tendency for current to flow through lamp 166, fixed contact 161, lead 163 to the lead 143. If now it is desired to disconnect the third rail section 145 from the feeder 144, the manual switch 160 is thrown into engagement with the contact 162 thereby short-circuiting the indicating lamp 165 and causing it to go out. This action will permit enough current to pass through the trip-coil 67 to cause it to force its armature 69 into engagement with the trip latch 49 and thus allow the circuit-breaker to fly open under the action of gravity. Upon opening, the movable member 28 of the circuit breaker moves away from the push button 133 and thereby permits the spring 134 to move the contact 131 to break the circuit between the contacts 130 and close it between the contacts 129 which are in the branch 156 leading to the motor control switch 155, thus breaking the branch 159 and closing the branch 156. Obviously the circuit-breaker may also be tripped upon an excess of current flow through the lead 146, in this case the breaker being tripped through the armature 63. In either event the control switch 127 performs the same function.

As soon as the circuit is completed between the contacts 129 of the circuit breaker actuated control switch 127, a circuit is completed through the green lamp 166 and the same is caused to burn to indicate that the circuit including the lead 146 is open. This circuit extends from the supply lead 163 through contact 161 of the manual switch 160, through the lamp 166, lead 158, contacts 129, switch 127, coil of the switch 155, leads 156 and 154 to ground by way of the track 153, the amount of current not being sufficient to energize the coil and close the switch 155.

Now if it is desired to again connect the third rail section 145 to the feeder 144, the manual switch 160 may be thrown to the contact 161. This will short-circuit green lamp 166 and thereby extinguish it and at the same time energize the coil of the switch 155 sufficiently to close said switch. The closing of the switch 155 will complete a circuit through the motor as follows: from the feeder 144, through leads 147 and 150 to one of the contacts 91 of the reversing switch, thence through the bridging contact 90 to the other contact 91 and through the motor by way of the leads 152 and 154 to ground at the rail 153. The lead 152 is so connected to the field magnet winding of the motor 180 that its armature will be rotated so as to rotate the shaft 78 in the direction of the arrow 120. This rotation will carry the operating cranks 76 and 77 downward and simultaneously close the circuit-breaker and open the main switch, the two passing each other in mid position. The circuit-breaker will be held in its closed position by means of the trip-latch 49 which will automatically engage the projection 51 on the operating member 47 of the breaker. As previously pointed out, shortly after the shaft 78 begins to rotate, the switch-arm 96 will bridge the contacts 98. This will complete a parallel circuit to the motor from the feeder 144 by way of the branch 148 so that the operation of the motor will continue through its cycle irrespective of further manipulation of the manual switch 160. As previously explained when the cranks 76 and 77 have reached their lowermost position the reversing switch will be thrown and this will reverse the direction of rotation of the motor by completing the circuit through the leads 149 and 151. As the cranks 76 and 77 are returned to their uppermost positions by the reverse rotation of the motor armature, the positive connection between the actuating rod 70 and the circuit-breaker will be broken, and by the upward movement of the outer end of the member 71 the stop 72 will be moved far enough away by the time the crank 77 has reached the end of its movement to permit the circuit-breaker B to open should an overload exist in the circuit. The upward movement of the crank 76 is retarded and then released to close the main switch with a snap, as previously explained. When this position of the cranks is reached the reversing switch and the control switch 96 are thrown to their normal positions and the

circuit through the red indicating lamp 165 is completed by reason of the closure of the circuit-breaker actuated switch 127 upon the contacts 130 thus indicating again the closed position of the switch and circuit-breaker.

It will be apparent from the previous description of the control switch 127 that at any time when the circuit-breaker is open said switch may be set in an open position thereby interrupting the control circuits and preventing interference from the distant control point by the operation of the switch mechanism. In this way the mechanism may be worked upon or repaired without danger of injury.

Obviously many alterations and changes may be made in this specific construction herein disclosed without departing from the spirit and scope of the present invention; I therefore do not wish to be limited to this specific disclosure but aim to cover by the terms of the appended claims all-such alterations and changes.

What I claim as new, and desire to secure by Letters Patent of the United States, is,—

1. The combination with a plurality of switches, of manually-controlled means for opening one of said switches and automatic mechanism subsequently operative first to open another switch and then close both of said switches.

2. The combination with a plurality of switches, of means manually-controlled for opening one of said switches and automatic mechanism subsequently operative first to open another switch and then close both of said switches one after the other in a definite order.

3. The combination with a plurality of switches, of means for opening one of said switches and additional means operative first to open another of said switches, then close one of said switches and finally close the other with a snap movement.

4. The combination with a circuit breaker and a switch, means for opening said breaker, and automatic setting mechanism operative first to open said switch and then close said breaker and switch.

5. The combination with a circuit breaker and a switch, of an electric circuit, an electroresponsive device in said circuit for opening said breaker, and automatic setting mechanism operative first to open said switch then close said breaker and finally close said switch.

6. The combination with a circuit breaker and a switch, of an electric circuit, an electroresponsive device in said circuit for opening said breaker, and setting means operative first to open said switch and then close said breaker and finally close said switch with a snap movement.

7. The combination with a circuit-breaker and a switch, of means for opening said circuit-breaker, and an automatic setting mechanism operating first to open said switch, then close said circuit-breaker and switch in succession.

8. The combination with a circuit breaker and a switch, of an electric circuit, an electroresponsive device in said circuit for opening said breaker, and setting means operative first to open said switch then close said breaker and finally close said switch with a snap movement.

9. The combination with an electric circuit, of an automatic circuit breaker and a switch in series in said circuit, means for tripping said circuit breaker open in advance of the opening of said switch and motor operated means for setting both said breaker and switch so as to make the final closure always at the switch.

10. The combination with a plurality of switches, of a reversible shaft, connecting means between said shaft and switches for closing one switch and opening another upon a rotary movement of the shaft in one direction and for closing the latter upon a further rotary movement in the other direction, and means for rotating the shaft.

11. The combination with a plurality of switches, of a reversible crank-shaft, connecting means between said shaft and switches for closing one switch and opening another upon the partial rotation of said shaft in one direction and for closing the latter upon a reverse rotary movement, and means for rotating said shaft.

12. The combination with a plurality of switches, of a reversible operating motor therefor, and connecting means between said motor and switches for closing one and opening another upon the operation of said motor in one direction and for closing the latter switch upon the operation of said motor in the reverse direction.

13. The combination with a circuit breaker and switch, of a reversible operating motor therefor, means for tripping said circuit breaker, and connecting means between said motor and said circuit breaker and switch for closing said breaker, and opening said switch upon the operation of said motor in one direction and closing said switch upon a reverse operation.

14. The combination with a circuit breaker, of means for tripping said breaker, an actuating member, means for giving said member a to and fro movement, and means actuated by the movement of said member in one direction to engage and set said breaker and by its movement in the other direction to disengage the breaker and render the same free to respond to the tripping means.

15. The combination with a circuit breaker, of means for tripping said breaker, an actu-

ating member, means for giving said member a to and fro movement and means operative to establish a positive mechanical connection between said member and breaker to set said breaker upon the movement of said member in one direction and to break said positive connection upon its movement in the other direction.

16. The combination with a movable switch element, of a power driven crank and connecting means between said element and crank operative to establish a positive mechanical connection to set said switch upon a partial rotation of said shaft and to break said positive connection upon a reverse rotary movement of said crank.

17. The combination with an electric switch, of an electric motor for operating said switch, a manual switch for closing a circuit through said motor and means actuated by the initial closing of said circuit to reverse the direction of rotation of said motor.

18. The combination with an electric switch, of an electric motor for operating said switch, a manual switch for closing a circuit through said motor and means actuated by the initial closing of said circuit to close a branch circuit through said motor and subsequently to reverse the direction of rotation of said motor.

19. The combination with an electric switch, of an electric motor for operating said switch, a manual switch for closing a circuit through said motor, means operated by the rotation of said motor to close a branch circuit through said motor and subsequently to reverse its direction of rotation.

20. The combination with an electric circuit breaker and a switch, of an electroresponsive device for tripping said breaker, a control circuit for said electroresponsive device, a manual switch in said circuit, and additional switching means in said circuit actuated by said switch.

21. The combination with an electric circuit breaker and a switch, of an electroresponsive device for tripping said breaker, a control circuit for said electroresponsive device, a manual switch in said circuit, and switching means operative to maintain the control circuit in condition to be closed by the manual switch only when both the circuit breaker and switch are closed.

22. The combination with an electric circuit breaker and a switch, of an electroresponsive device for tripping said breaker, a control circuit for said electroresponsive device, a manual switch in said circuit and means for maintaining the control circuit in condition to be closed by the manual switch only when the circuit breaker and switch occupy a definite relative position.

23. The combination with an electric circuit breaker and switch, of an electroresponsive device for tripping said breaker, a motor for closing said breaker, control circuits for said electroresponsive device and said motor, manual switching means in said circuits, and additional switching means for controlling said circuits in response to the movements of said switch and circuit breaker.

24. The combination with an electric circuit, two cut-outs included in series therein, control circuits for said cut-outs, lamps and lamp circuits operatively related to said control circuits, and means operated by said cut-outs to change the lamp circuits so as to indicate by the condition of the lamps the condition of the main circuit.

25. In a switch, the combination with operating means for said switch, of an electric motor for actuating said operating means, an elastic power transmitting connection between said motor and said operating means arranged to rotate said motor in the reverse direction by the recoil of said connection, and means actuated by the recoil of said connection for reversing the direction of rotation of said motor during the recoil of said connection.

26. The combination with an electric switch, of an actuating member, a motor, operating means actuated by said motor for giving said member a to-and-fro movement on each closure of the switch, a spring-connection between said motor and said operating means arranged to drive said motor in the reverse direction by its recoil, and means actuated during the recoil of said connection for reversing the direction of rotation of said motor.

27. In a switch, the combination with an electric motor, of an elastic connection between said motor and said switch yielding under the torque of the motor and driving the motor in a reverse direction by its recoil, and a reversing switch controlled by the motor before the recoil of the elastic connection is expended.

28. In a switch, the combination with an electric motor, of an elastic connection between said motor and said switch yielding under the torque of the motor and driving the motor in a reverse direction by its recoil, and a reversing switch controlled by the motor shaft to automatically reverse the motor before the recoil of the elastic connection is expended.

29. The combination with a reversible electric motor, of a reversing switch having two running positions for causing said motor to move in opposite directions, and means for automatically driving said motor in the reverse direction during the movement of said switch from one position to the other.

30. The combination with a reversible electric motor of a reversing switch for said motor, automatic means for driving said motor in the reverse direction, when said switch is opened, and means for automatically moving said switch to close the circuit to drive said motor in the reverse direction while the motor is being driven in the reverse direction by said automatic means.

31. The combination with a circuit breaker, of a switch, toggle operating mechanism for each, a common operating means, and means for setting them closed only in a determined order, the toggle of the breaker being latched and underset and that of the switch being overset when both are closed.

In witness whereof, I have hereunto set my hand this 31st day of August, 1905.

EDWARD M. HEWLETT.

Witnesses:

BENJAMIN B. HULL,

HELEN ORFORD.