July 4, 1933. M. H. RHODES 1,916,867

SWITCH

Filed Jan. 24, 1931 4 Sheets-Sheet 1

Fig. 1.

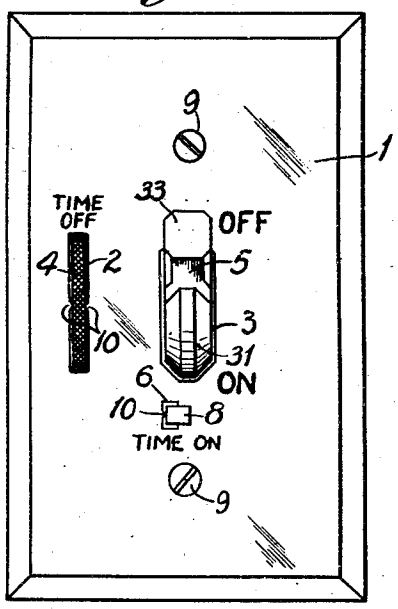


Fig. 2.

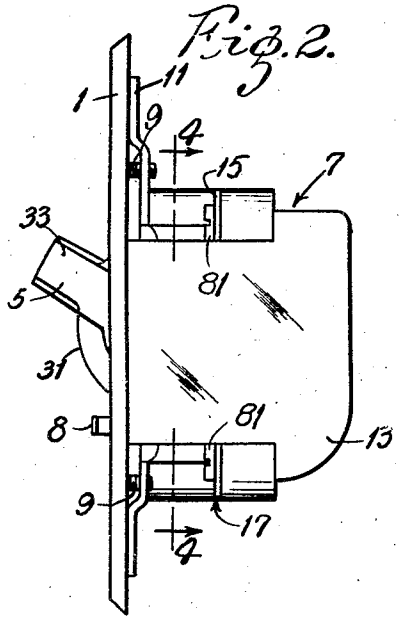


Fig. 3.

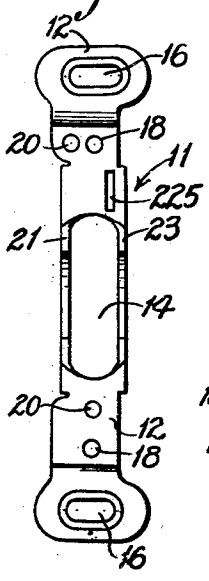
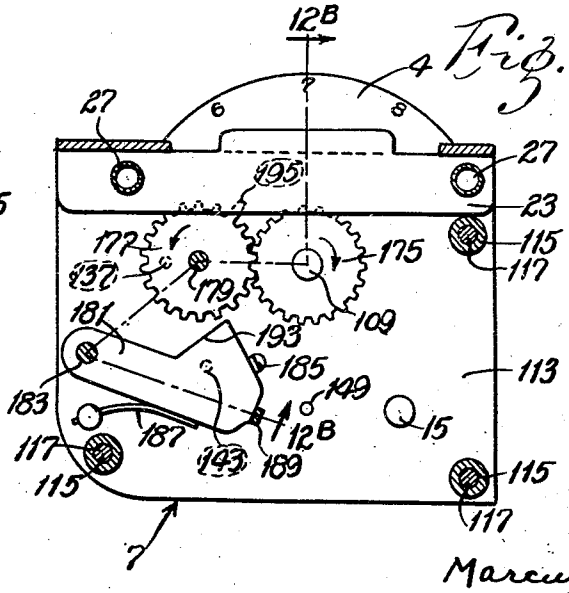


Fig. 10.



Marcus H. Rhodes,
Inventor.
Dale G. Haynes
Attorney

July 4, 1933. M. H. RHODES 1,916,867

SWITCH

Filed Jan. 24, 1931 4 Sheets-Sheet 2

Fig. 9.

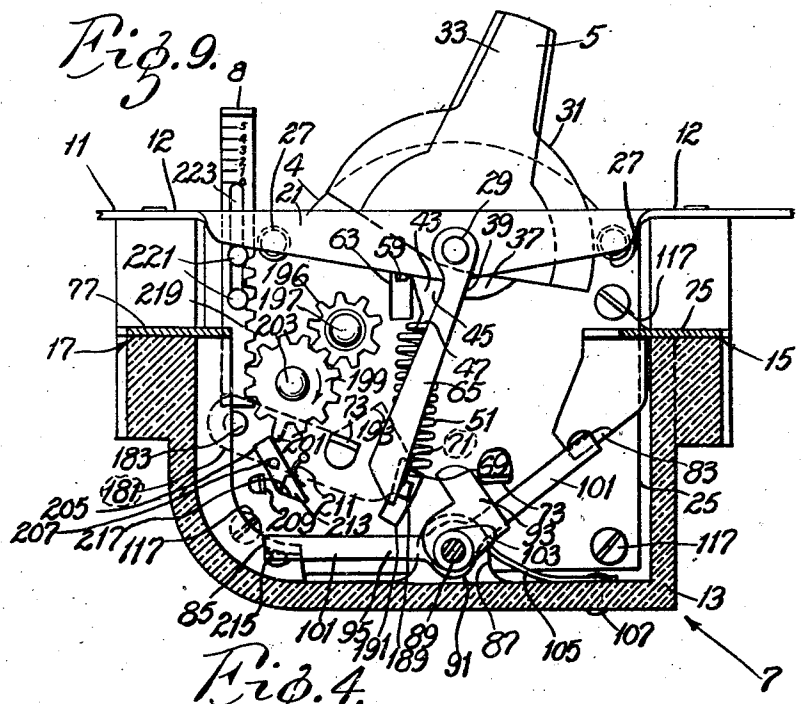
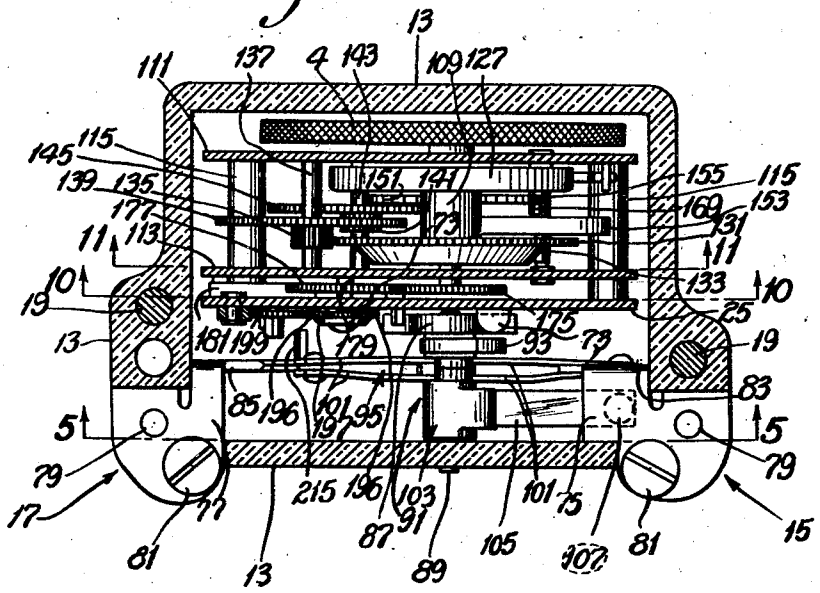


Fig. 4.



Marcus H. Rhodes,
Inventor.
Dale V. Haynes,
Attorney.

July 4, 1933. M. H. RHODES 1,916,867

SWITCH

Filed Jan. 24, 1931 4 Sheets-Sheet 3

Fig. 5.

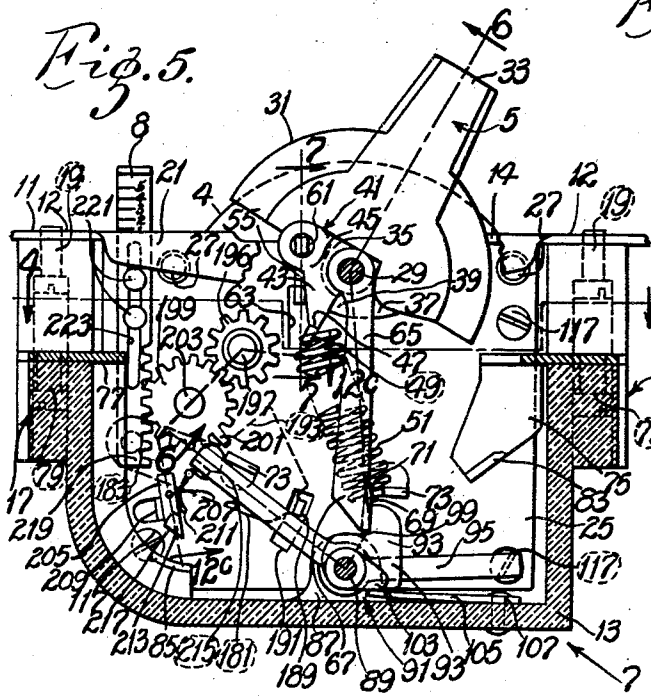


Fig. 6.

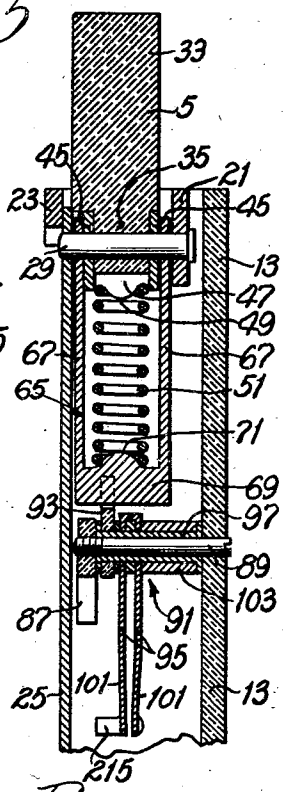


Fig. 8.

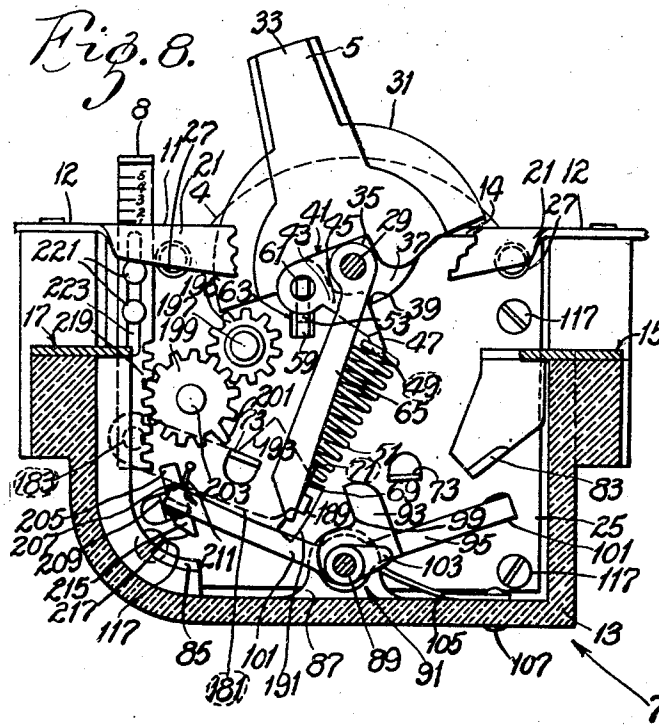
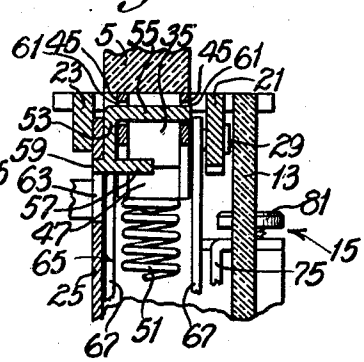


Fig. 7



Marcus H. Rhodes,
Inventor.
Lalor J. Haynes
Attorney

July 4, 1933. M. H. RHODES 1,916,867

SWITCH

Filed Jan. 24, 1931 4 Sheets-Sheet 4

Fig. 12.

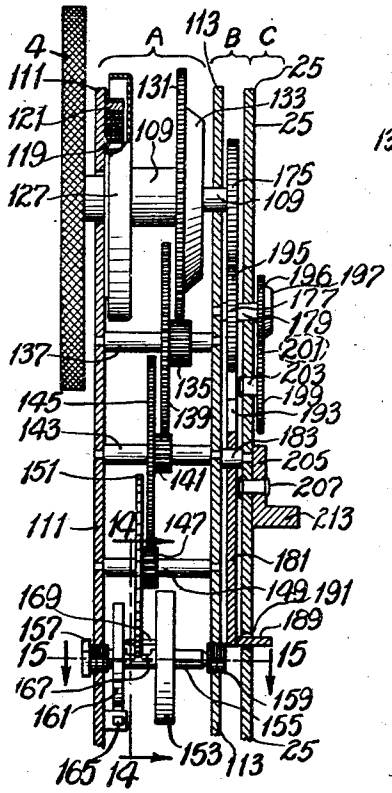


Fig. 11.

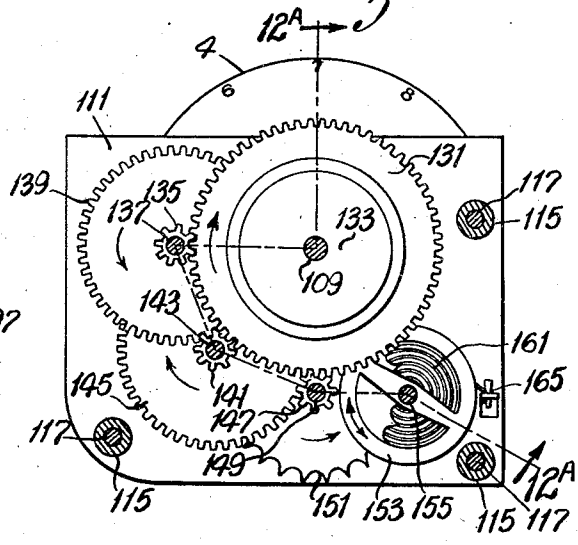


Fig. 14.

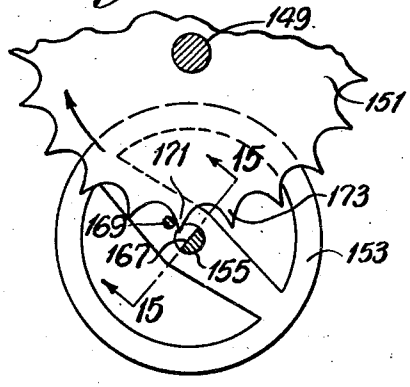


Fig. 13.

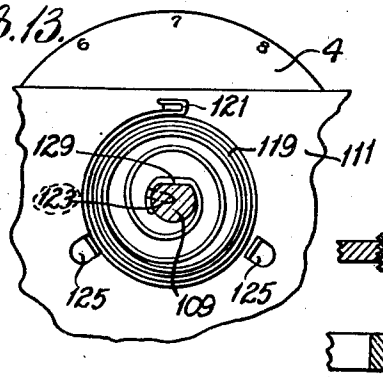
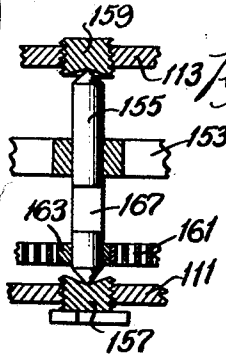


Fig. 15.



Marcus H. Rhodes,
Inventor
Dale J. Haynes
Attorney

Patented July 4, 1933 1,916,867

UNITED STATES PATENT OFFICE

MARCUS H. RHODES, OF NEW HAVEN, CONNECTICUT, ASSIGNOR TO M. H. RHODES, INC., OF NEW HAVEN, CONNECTICUT, A CORPORATION OF DELAWARE

SWITCH

Application filed January 24, 1931. Serial No. 510,305.

This invention relates to electric switches, and with regard to certain more specific features, to timed delayed action switches.

Among the several objects of the invention may be noted the provision of an electric switch having an adjustable delayed contact-making action and a separately adjustable delayed contact-breaking action; the provision of a switch of the class described which may optionally have either of the delay features temporarily thrown out of operation to permit non-delay action; and the provision of a switch of the class described which is rugged and which has improved wearing and operating qualities. Other objects will be in part obvious and in part pointed out hereinafter.

The drawings

In the accompanying drawings, in which is illustrated one of various possible embodiments of the invention,

Fig. 1 is a front elevation of a switch embodying the invention;

Fig. 2 is a side elevation of the switch of Fig. 1;

Fig. 3 is a plan view of a supporting plate;

Fig. 4 is a horizontal cross section taken on line 4—4 of Fig. 2;

Fig. 5 is a vertical cross section taken on line 5—5 of Fig. 4;

Fig. 6 is an ideal section taken along line 6—6 of Fig. 5;

Fig. 7 is a fragmentary cross section taken along line 7—7 of Fig. 5;

Fig. 8 is a vertical section similar to Fig. 5 showing the switch in a condition of operation advanced from Fig. 5;

Fig. 9 is a vertical section similar to Figs. 5 and 8 illustrating the switch set in a further advanced condition of operation from Figs. 5 and 8;

Fig. 10 is a vertical section taken along line 10—10 of Fig. 4;

Fig. 11 is a vertical section taken along line 11—11 of Fig. 4;

Fig. 12 is a composite ideal section taken along lines 12A—12A of Fig. 11, 12B—12B of Fig. 10, and 12C—12C of Fig. 5;

Fig. 13 is a fragmentary elevation illustrating the manner in which a main spring is mounted;

Fig. 14 is a fragmentary horizontal section taken on line 14—14 of Fig. 12, illustrating an escapement mechanism; and,

Fig. 15 is a fragmentary section taken on lines 15—15 of Figs. 12 and 14.

Similar reference characters indicate corresponding parts throughout the several views of the drawings.

The invention in general

Referring now more particularly to Figs. 1 and 2, numeral 1 indicates a flush face plate of the type in general use for wall mounting of electrical switches. A central opening 3 permits a control handle 5 of a switch 7 to extend outwardly to an available manipulating position. Screws 9 hold the face plate 1 to the switch 7.

A second opening 2 in the face plate 1 permits a knurled setting wheel 4 to project through said face plate. A third opening 6 likewise permits an adjustable plunger 8 to extend through the face plate 1. The wheel 4 and the plunger 8 permit adjustment of the time at which electrical connections will be made and broken, as will appear more fully hereinafter. Noses or pointers 10 are provided on the face plate 1 for indicating, by relation to suitable indicia on the wheel 4 and plunger 8, the time at which connections will be made and broken.

From the exterior, the switch 7 will be seen to comprise a mounting plate 11 (with which the face plate screws 9 engage) and a switch housing 13 having exterior connecting terminals 15 and 17 mounted thereon. The housing 13 is preferably formed of an insulating material, such as bakelite (a phenolic condensation product) or the like. The housing 13 is held to the mounting plate 11 by screws 19 (see Figs. 4 and 5).

The mounting plate 11 is illustrated in detail in Fig. 3. It will be seen that it comprises a long, relatively narrow vertical portion 12 having sideward portions 21 and 23 extending at right angles from the general plane of the plate. A central opening 14 permits the passage of the switch handle 5.

Openings 16 at the extremities of the plate 11 permit attachment of the switch as a whole to a permanently installed wall housing or the like. Threaded holes 18 are provided to receive the face plate mounting screws 9 and threaded holes 20 to receive the switch housing mounting screws 19.

The switch 7 per se, as it fits within the housing 13, comprises generally a contactor bar which is actuated to movement by mechanical means, and a timing system which in turn intercepts the operation of the mechanical actuating means. For purposes of description, the mechanical means (including the contactor bar) and the time control means will be described separately and then correlated.

The mechanical actuating means

Referring now more particularly to Figs. 4 and 5, it will be seen that a plate 25, which is shaped with substantially the same contour as the housing 13, is attached to the portion 21 of the mounting plate 11 by means of rivets or spot welding or the like as indicated at numeral 27 in Fig. 5. Supported at one side in the plate 25, and at the other side in the sideward portion 28, is a pin 29, upon which the control hand 5 is rotated.

The switch control handle 5 comprises a semi-circular portion 31 from which extends a knob 33 for manipulation purposes. The back, concealed (in the assembled switch) portion of the switch 5 is reduced in thickness as at numeral 35 (Figs. 6 and 7) and has a contour including a projection 37 having a nose 39 thereon, and a depression, or hollowed-out portion 41. The pin 29 upon which the handle 5 is rotated passes through the thin portion 35, in the region of the projection 37.

Mounted rigidly on the switch handle 5, embracing the thin portion 35 thereof, and extending into the depression 41, is a saddle member 43. This saddle 43 comprises a pair of legs 45, which fit snugly against the sides of the handle 5, and a cross-piece 47 at right angles to the legs 45. The pin 29 passes through the legs 45. The cross-piece 47 engages the nose 39 of the projection 37 of the switch 5, whereby the saddle 43 is, relative to rotation on the pin 29, fixed to the handle 5. That is to say, the saddle 43 is mounted on the handle 5 in a fixed, non-rotatable manner. The cross-piece 47 is provided with a nose 49 which engages one end of a compression spring 51 to be described more in detail hereinafter.

Associated with the saddle 43 is a movement limiting means for the handle 5 (see Fig. 7). The movement limiting means per se comprises a flat H shaped piece 53, having parallel legs 55 and 57, and a single extending leg 59. The leg 55 passes loosely through a pair of holes 61 in the legs 45 of the saddle 43. The single extending leg 59 passes through a slot 63 in the plate 25 having a predetermined length. Considering that the saddle 43 is fixed to the handle 5, and that the plate 25 is relatively a part of the stationary ground wherein the handle 5 rotates, it will be seen that engagement of the single extending leg 59 with the ends of the slot 63 limits the rotation or movement of the handle 5.

Also mounted on the pin 29, in this instance rotatably mounted, is a second saddle 65 embracing the saddle 43. The saddle 65, hereinafter termed the hammer saddle, comprises a pair of relatively long legs 67, through which the pin 29 passes (loosely enough to permit of ready rotation), and a hammer portion 69 at right angles thereto. The hammer portion 69 has a nose 71 thereon which engages the other end of the compression spring 51. Movement of the hammer saddle 65 is limited by a pair of ears 73 struck from the plate 25.

It will be seen that the saddles 43 and 65 together with the compression spring 51 comprise an overcentering toggle. In Fig. 5, motion of the handle 5 in a leftword direction, through the saddle 43, compresses the spring 51 against the saddle 65, which is immovable because of its engagement with the right-hand ear 73, until the saddles 43 and 65 pass the parallel position, at which time the compressed spring reacts to suddenly throw the hammer saddle 65 to the left against the left hand movement-limiting ear 73, as is shown in Fig. 3. A similar reaction and overcentering action causes the hammer saddle 65 to snap sharply from its Fig. 3 to its Fig. 5 position, when the handle 5 is moved to the left from its Fig. 3 position.

In this manner, the switch functions to make and break connections with a quick, positive, snap action, and arcing and sparking are thus avoided.

The electrical connections in the switch will be seen particularly in Figs. 4, 5, 3 and 9. The exterior terminals 15 and 17 comprise, respectively, metallic strips 75 and 77 which are held to the housing 13 by means of screws 79, and which receive in threaded engagement screws 81 (see Fig. 4). By means of the screws 81, exterior connections to the switch are made. The metallic strip 75 extends into the housing 13, spaced from the side wall thereof, and is provided with a slanting knife-edge contacting portion 83. The metallic strip 77 extends into the housing 13, also spaced from the side wall thereof, and is provided with a knife-edge contacting portion 85 similar to the contacting portion 81, but facing in a different direction.

Formed in interior of the back of the housing 13 is a protruding ear 87. A pin or shaft 89 passes through the side of the housing 13 and threadedly engages the ear 87 (see Figs. 4

and 6). On the pin 89 is rotatably mounted a contactor bar-anvil assembly 91. The parts of the assembly 91 are non-rotatable or otherwise movable relative to each other, but the assembly as a whole rotates freely on the pin 89.

The assembly 91 comprises an anvil piece 93, a cam 103, and a contactor bar 95, together with suitable spacing washers, all mounted on a sleeve 97 through which passes the pin 89. The anvil piece 93, preferably formed of insulating material, includes a notch 99 which engages the hammer portion 69 of the hammer saddle 65 (see Fig. 5). The contactor bar 95 comprises a pair of spring-metal strips 101 shaped to engage and disengage, by rotation on the pin 89, the knife-edge contacting strips 83 and 85. The relative shape of the bar 95 and the spacing of the contacting strips 83 and 85 will be apparent from Fig. 5.

Mounted on the back of the housing 13 by means of a rivet or the like 107 is a leaf spring 105 which reacts on the cam 103 (see Fig. 5) to cause the contactor assembly 91 to rotate on the pin 89 in a counter-clockwise direction.

As the hammer saddle 65 snaps from its Fig. 5 position to its Fig. 8 position, as described hereinbefore, it disengages from the notch 99 in the anvil piece 93 and the action of the leaf-spring 105 on a cam 103 causes the contactor bar 95 to rotate into contact with the terminal pieces 83 and 85, thereby electrically connecting the terminals 15 and 17, provided no obstruction is presented for the rotation of the contactor bar 95. (The time controlling means, as will be described hereinafter, in operation intercepts or has a latching effect upon the contactor bar 95 and temporarily prevents it from making contact with the terminal pieces 83 and 85.)

If, now, the switch hand 5 is manually moved from its left hand, Fig. 8 position, to its right hand, Fig. 5 position, the hammer saddle 65 snaps from the left to the right, provided no obstruction is presented for the rotation of said hammer saddle 65. (The time controlling means, as will be described hereinafter, in operation, also intercepts or has a latching effect upon the hammer saddle 65 and temporarily prevents it from swinging to the right.) Assuming for the present that no latching means is interposed, the hammer saddle 65 in swinging to the right engages the notch 99 in the anvil piece 93 and rotates the assembly 91 in a clockwise direction on the pin 89, consequently causing the contactor bar 95 to rotate out of contact with the terminal pieces 93 and 85, thereby to break the electrical connections. It is to be understood that the force on the hammer saddle 65 occasioned by over-centering the compression spring 51 is sufficiently great to overcome the counter force caused by the pressure of the leaf-spring 105 on the cam 103.

It is accordingly seen, considering for the present that no time-controlled latching means is in operation, that making and breaking of an electrical connection between terminals 15 and 17 is effected in a sudden, snap-acting manner by a simple movement of the switch control handle 5.

Time controlling mechanism

The time controlling mechanism is illustrated generally in Figs. 4 and 12.

Referring now more particularly to Fig. 12, it will be seen that the knurled wheel 4 is mounted on a main shaft 109, which is in turn supported in a pair of plates 111 and 113. The plates 111 and 113 are substantially the same shape as plate 25, described hereinbefore in connection with the switch construction. The plates 111 and 113 are supported on the plate 25 in spaced relation by means of spacing collars 115 (see Fig. 4) and screws 117 (see Fig. 5).

Mounted on the main shaft 109 in such a manner as to react against the relatively stationary plate 111 is a main spring 119. The manner of mounting the main spring 119 is illustrated more in detail in Fig. 13, where it will be seen that one end of said spring passes around and hooks upon an ear 121 struck from the plate 111, while the other end of said spring 119 is hooked over a projection 123 formed on the main shaft 109. A pair of ears 125, likewise struck from the plate 111, serve to hold the main spring 119 in coiled form.

In order to prevent the main spring 119 from releasing sidewardly, and in order to provide additional protection against the main spring 119 uncoiling, a main spring protecting cover 127 is provided on the main shaft 109 (see Fig. 12). The knurled wheel 4 and the main spring cover 127 are prevented from rotating on the main shaft 109 because they are formed so as to engage a flattened portion 129 on the main shaft 109 (see Fig. 13).

It will accordingly be seen that turning of the knurled wheel 4 winds up the main spring 119, thereby occasioning a reverse torque on the main shaft 109.

An escapement mechanism is provided to permit the torque so produced in the main spring 119 to expend itself by rotating the main shaft 109 only at a predetermined rate of speed. This escapement is shown in Figs. 11 and 12. A large gear 131 is mounted loosely on the main shaft 109. A friction disk 133 is mounted in a non-rotatable manner on the main shaft 109 in juxtaposition to the large gear 131, in such a manner that the shaft 109 may turn, when winding up the main spring 119, without rotating the large gear 131, but also so that the frictional en-

gagement of the disk 133 with the gear 131 will not permit the main spring 119, after it has been wound up, to unwind without turning the gear 131, which is itself connected to the regulating escapement mechanism. It is thus seen that the gear 131 remains stationary when the main spring 119 is wound before rotation of the knurled wheel 4, but that on unwinding of the main spring 119, the gear 131 is effectively non-rotatable upon the main shaft 109.

Engaging the teeth of the gear 131 is a gear train. In the present embodiment the gear train comprises a pinion 135, driven by a gear 131, and which is mounted on a shaft 137 supported between the plates 111 and 113. Also mounted upon the shaft 137 in an immovable fashion is a large gear 139. The large gear 139 in turn drives a second pinion 141 on a shaft 143 having a second large gear 145 mounted thereon. The pinion 141, shaft 143, and large gear 145 are, respectively, similar to the pinion 135, shaft 137, and large gear 139.

The large gear 145 in its turn drives a third pinion 147, smilar to the pinions 135 and 141, which is mounted on a shaft 149, similar to the shafts 137 and 143. Immovably mounted on the shaft 149 is also a sprocket wheel 151, the shape of which will be more apparent by inspection of Fig. 14. The shafts 137, 143, and 149 are all supported by end bearings in the plates 111 and 113.

It will be seen that there is a large increase in angular motion from the gear 131 to the sprocket wheel 151, or considering it in the reverse manner, there is a large decrease in angular motion from the sprocket wheel 151 to the gear 131. This increase or decrease, considered either way, is controlled by the relative sizes of the gears 131, 139, and 145, and the pinions 135, 141 and 147.

Engaging with the sprocket wheel 151 is the escapement mechanism per se. This escapement mechanism (see also Figs. 14 and 15) comprises a balance wheel 153 mounted on a balance wheel shaft 155, which is pivoted between bearing plates 157 and 159 which are threaded into the plates 111 and 113, respectively. The bearing plate 157 is provided with a square head so that adjustment of the pressure on the shaft 155 may be effected. In general, the bearing plates 157 and 159 are adjusted so that the shaft 155 turns loosely in them.

A hair spring 161 is secured at one end to the shaft 155, as indicated at numeral 163 (Fig. 15), and at the other end to the relatively stationary plate 111, as at numeral 165 (Figs. 11 and 12). This hair spring 161 is arranged to provide a small counter-clockwise torque on the shaft 155, as viewed from the side represented by the plate 111.

The shaft 155 is provided with a notch 167 cut therein, at the region of its engagement with the sprocket wheel 151. The notch 167, when in a proper position, permits the sprocket wheel 151 to turn freely, as will be described hereinafter.

Extending at substantially a right angle from a spoke of the balance wheel 153 is a pin 169. The pin 169 engages teeth of the sprocket wheel 151 and cooperates with the notch 167 to form an intermittent escapement mechanism for the sprocket wheel 151. This escapement operation will be apparent by reference to Fig. 14. In Fig. 14, there is a clockwise torque on the sprocket wheel 151 provided by the main spring 119 acting through the gear train 131, 135, 139, 141, 145 and 147. There is a smaller clockwise torque on the balance wheel 153 provided by the hair spring 161. The torque on the balance wheel 153 forces the pin 169 against the edge of a tooth 171 of the sprocket wheel 151. The greater torque on the tooth 171 causes it to advance, thereby forcing the pin 169, by a cam action, to rotate against the torque of the hair spring 161. Rotation of the pin 169 causes coextensive rotation of the balance wheel 153, and the balance wheel shaft 155. The shaft 155 is thus caused to rotate in such a manner that the notch 167 is turned away from a next-advancing tooth 173 of the sprocket wheel 151. Without the notch 167 in proper position, the tooth 173 cannot pass the balance wheel shaft 155, and is stopped thereby.

Returning to the action of the tooth 171 on the pin 169, the force on said pin exerted by the tooth 171 is sufficiently great to occasion the rotation of said pin 169, against the torque of the hair spring 161, to an extent considerably greater than merely to pass over the crest of the tooth 171. In other words, the pin 169 is snapped away to rotate, say sixty degrees, against the hair spring 161. With the pin 169 out of the way, the sprocket wheel immediately turns until the next advancing tooth 173 is stopped by contact with the smooth, circular portion of the shaft 155. This tooth 173 cannot advance until the shaft 155 turns sufficiently for its to pass through the notch 167.

Meanwhile, the pin 169 reaches its maximum rotation against the hair spring 161, and the hair spring then at once reacts to reverse the direction of rotation of the pin 169 and thus force said pin back towards the sprocket wheel 151. With the tooth 173 against the shaft 155, the pin 169 is rotated into the depression between the teeth 171 and 173. This rotation of the pin 169 by the hair spring 161 occasions coextensive rotation of the shaft 155, with the result that as the pin 169 reaches a position of contact with the forward edge of the tooth 173, the notch 167 is brought into proper position to permit the forward rotation of the tooth 173, acting un-

der the torque of the main spring 119. So advancing, the leading edge of the tooth 173 engages and rotates the pin 169 against the torque of the hair spring 161, and the action of the tooth 171 is thus repeated by the tooth 173.

In such a manner the balance wheel 153 and its attached parts serve to permit only timed, intermittent motion of the sprocket wheel 151, and, through the gear train 147, 145, 141, 139, 135, 131 the main shaft 109. By reason of the reduction effect of the gear train, as described hereinbefore, the main shaft 109 is accordingly permitted to rotate at only a very slow speed, and the main spring 119, after being wound up, thus unwinds only very slowly.

The main shaft 109 extends through the plate 113 into the space between plates 113 and 25, and has immovably mounted on the end thereof a gear 175 (see Fig. 10). The gear 175 meshes with a gear 177, mounted on a shaft 179 which is supported in the plates 25 and 113. The shaft 179 extends through the plate 25 as will appear hereinafter. In the same plane as the gears 175 and 177 is provided a latch lever 181, which is itself rotatably supported on a pin 183 borne in the plates 25 and 113. An ear 185 struck from the plate 113 limits upward movement of the lever 181, while a leaf spring 187 serves to hold said lever normally against said ear 185. A projection 189 is formed at right angles to the plane of the lever 181 and at the outer end thereof. The projection 189 passes through a suitable slot 191 (see Fig. 5) in the plate 25, and functions as a latch for the hammer saddle 65.

The lever 181 is also formed with a sloping upper surface 193, designed to function as a cam to depress the lever 181 on its shaft, and consequently to depress the projection 189, as a special long tooth 195 on the gear 177 rotates into contact therewith.

As indicated hereinbefore, the shaft 179 extends through the plate 25 (see Fig. 5). On the end of the shaft 179 beyond the plate 25 are mounted a gear or pinion 196 and a friction disc 197 (see Figs 5 and 12). The gear 196 is loose on the shaft 179 but the disc 197 is tight. From a functional standpoint, the gear 196 and disc 197 are similar in operation to the gear 131 and disc 133; that is, rotation of the shaft 179 causes rotation of the gear 196, through the friction disc 197, but rotation of the gear 196 from the exterior does not occasion rotation of the shaft 179.

Meshing with the gear 196 is a gear 199 having a long tooth 201. The gear 199 is supported on a shaft 203, which is in turn supported in the plate 25. The tooth 201 is of sufficient length to engage the upper end of a second latch lever 205, which rotates on a pin 207 supported in the plate 25. The lever 205 is limited in its clockwise rotation by an ear 209 struck from the plate 25, and is normally held against said ear 209 by a leaf spring 211.

Extending from the lower end of the lever 205 is a projection 213. The projection 213, in its normal position (with the lever 205 against the ear 209), is in the line of downward rotation of an ear 215 formed on the side of the connecting bar 101, thereby serving as a latch for said connecting bar as indicated hereinbefore. The lower side of the projection 213 is sloped as at numeral 217 so that the ear 215, upon upward motion, pushes said projection aside and no latching effect is had on the connecting bar 101.

In its rotation with the gear 199, the long tooth 201 engages the upper end of the lever 205 and pushes said lever aside, whereby the projection 213 is removed from the line of motion of the ear 215 on the connecting bar 101, thus unlatching said bar.

Adjustment of the angular position of the long tooth 201 of the gear 199 is provided for by means of a rack 219 formed on the edge of the plunger 8, and meshing with said gear 199. The plunger 8 is adjustably held on the plate 25 by means of a pair of rivets or the like 221 cooperating with a slot 223 in said plunger. The plunger passes out of the switch through an opening 225 in the supporting plate 11 (see Fig. 3). It will be seen that vertical movement of the plunger 8 will rotate the gear 199 into different angular positions, which may be suitably designated by indicia on said plunger. The gear 199 is permitted to rotate free of the main shaft 109 by reason of the frictional engagement between the gear 196 and the friction disc 197. It is to be understood, however, that rotation of the main shaft 109 occasions rotation of the gear 199, regardless of the separate rotatability of the gear 199 by itself.

It is thus seen that a time-controlled mechanism is provided which presents two controllable latches for the mechanical switch per se: a latch for the hammer saddle 65 and a separately controlled latch for the connector bar 101. The interrelation of these parts will now be described.

Operation

The conditions of operation of the switch described above are as follows:

(*a*) It is desired to operate the switch as an ordinary switch, without the interposition of time factors for either the making or breaking of the connection.

(*b*) It is desired to operate the switch to make connection after a definite time has elapsed from the time of throwing the manually controlled handle to "ON" position, without any definite time for breaking the connection.

(*c*) It is desired to operate the switch

to make connection immediately upon throwing the manually controlled handle to "ON" position, and to break connection after definite time has elapsed.

(*d*) It is desired to operate the switch to make connection after a definite time has elapsed from the time of throwing the manually controlled handle to "ON" position, and automatically to break connection a definite time after connection has been made.

For brevity, operation as in (*a*) above will hereinafter be termed "ordinary" operation; operation as in (*b*) will be termed "future make" operation; operation as in (*c*) above will be termed "future break" operation; and, operation as in (*d*) above will be termed "future make and break" operation.

Ordinary operation

For ordinary operation, according to "ordinary" the definition given it supra, the contacting bar 95 is permitted to rotate into and out of contact with the terminal pieces 75 and 77 free from interferance, under the controlling influence of the manual control handle 5. Considering that the description of the operation of the mechanical actuating means given hereinbefore presupposed an absence of interposed latches and the like, it will be seen that that description is of ordinary operation.

The latches 189 and 213, operating respectively on the hammer saddle 65 and the contacting bar 95, are, for ordinary operation, moved into inoperative positions in the following manner:

Rotating of the knurled wheel 4 in a direction such that the magnitude of the indicia thereon is decreasing (clockwise rotation in Fig. 10) ultimately, when the indicia reach a "zero" value, turns the gear 177 so that the long tooth 195 engages the sloping surface 193 of the lever 181, and presses said lever 181 downwardly. The projection or latch 189, being a part of the lever 181, is concurrently pressed downwardly in its slot 191 and is thus removed from the path of the hammer saddle 65. If the wheel 4 is left at its "zero" position, the latch 189 is thus held out of operating position with respect to the hammer saddle 65.

Pulling or withdrawing the plunger 8 so that the magnitude of the indicia thereon is decreasing (moving said plunger upwardly in Fig. 5) similarly rotates the gear 199 in such a manner that, when the value of the indicia reaches "zero" on the face plate 1, the long tooth 201 presses against the upper end of the lever 205, thus swinging the lower end of said lever 205 and the projection or latch 213 thereon to the right and carrying said latch out of the line of motion of the projection 215 on the contacting bar 95. If the plunger 8 is left at its "zero" position, the contacting bar 95 is permitted to rotate without interception by the latch 213.

With latches 189 and 213 so removed from operating position, movement of the control handle 5 to "ON" position permits the leaf spring 105 to snap the contacting bar 95 immediately into contacting position with the terminal pieces 75 and 77. Similarly, movement of the control handle 5 from "ON" to "OFF" position causes the hammer saddle 65 to strike against the anvil piece 93 and instantaneously rotate the contacting bar 95 out of contacting position, thus breaking the electrical circuit. Thus is ordinary operation effected.

Future make operation

For future make operation, as defined supra, the latches 189 and 213 are both operated. The operation of the hammer saddle latch 189 is, however, substantially ineffectual, as will appear hereinafter. The contacting bar latch 213 is the effective piece in this future make operation.

For illustrative purposes, the switch is assumed initially to be in the "ordinary" operating position described above, with the control handle 5 at "OFF" position and the knurled wheel 4 and the plunger 8 both at their respective "zero" positions.

The plunger 8 is now depressed until the pointer 10 on the face plate 1 indicates the index corresponding to the length or extent of time predetermined as the interval desired before connection is to be made. It will be seen that by depressing the plunger 8 in such a manner the gear 199 is rotated to carry the long tooth 201 away from the lever 205 to an extent determined by the extent of depression of said plunger 8. With the tooth 201 disengaged from the lever 205, said lever 205, under the influence of the spring 211, returns to normal position against the ear 209, thus bringing the latch 213 into the path of the projection 215 on the contacting bar 95.

The knurled wheel 4 is now rotated until the index figure indicated by the pointer 10 is equal to, or greater than, the index in effect on the plunger 8. Turning of the wheel 4 serves to wind up the main spring 119, and accordingly places a reverse torque (reverse to the manual rotation direction of the wheel 4) upon the main shaft 109, and the large gear 113. This reverse torque places the escapement mechanism in operation and the main shaft 109 is permitted to rotate slowly backwards to the initial or "zero" position of the knurled wheel 4.

Such rotation of the main shaft 109, through the gear train 175, 177, and 196, rotates the gear 199, and with it the long tooth 201. After a predetermined time has elapsed, as controlled by the escapement mechanism, this long tooth 201 is brought into contact with the lever 205, which it then pushes aside,

thus removing the latch 213 from the path of the projection 215 on the contacting bar 95.

Simultaneously with the setting of the knurled wheel 4, the switch control handle 5 is thrown to its "ON" position. This movement causes the hammer saddle 65 to rotate out of contact with the anvil piece 93, and the leaf spring 105, acting on the cam 103, throws the contacting bar in the direction of making contact with the terminals 75 and 77. However, the latch 213 is in the path of the projection 215 on said contacting bar 95, and upon engagement of said latch and said projection, the contacting bar 95 is intercepted in its motion and prevented from completing contact. The switch in this condition is illustrated in Fig. 8.

Ultimately, as described hereinbefore, the long tooth 201 engages the lever 205 to remove the latch 213 from engagement with the projection 215, and when such action occurs, the contacting bar 95, empowered by the leaf spring 105, snaps to a connecting position between the terminals 75 and 77, as shown in Fig. 9.

In such a manner is contact established a predetermined extent of time after the switch handle 5 is thrown.

It is to be noted that the knurled wheel 4 should be turned to a value at least equal to the setting of a plunger 8, otherwise the main spring 119 will not be wound sufficiently to turn the gear 199 far enough to release the latch 213.

After connection has thus been established, it may in general be broken simply by moving the control handle 5 to "OFF" position. This is true in all cases where the time set on the knurled wheel 4 is equal to the time set on the plunger 8, and is also true if the set of the knurled wheel 4 is in excess of the set of the plunger 8, and the excess amount of time has passed. If the knurled wheel 4 has been set to a time value greater than the setting of the plunger 8, it is necessary, in order to break connections, that either (1) the excess be allowed to elapse, or (2) the knurled wheel 4 be manually returned to "zero" position, after either of which a simple motion of the handle 5 to "OFF" position is adequate to effect a disconnection. This attendant action of the knurled wheel 4 will be apparent with the description of the remaining two methods of operation hereinafter.

Future break operation

For future break operation, as defined hereinbefore, the latch 189 is operative while the latch 213 is held in an inoperative position, as in the ordinary operation.

For purposes of description, the switch is again assumed initially to be in the "ordinary" operating position. That is, the control handle 5 is "OFF", and the knurled wheel 4 and the plunger 8 are both at their respective "zero" positions. Throughout the future break operation the plunger 8 remains in "zero" position, so that the latch 213 is ineffective and the contacting bar 95 is at all times free to rotate in an unobstructed manner.

The handle 5 is now thrown to "ON" position, whereby contact is immediately made as described hereinbefore.

The knurled wheel 4 is next rotated until the pointer 10 indicates the index corresponding to the extent of time it is desired to allow to pass before contact is broken. Rotation of the wheel 4 effects two actions, namely, (1) the main spring 119 is wound and the escapement mechanism set in operation as described hereinbefore, and (2) the long tooth 195, by reason of the rotation of the gear 177 (through the gear 175) is rotated away from engagement with the surface 193 of the lever 181, thus permitting said lever 181 to return, under action of the spring 187, to its normal position against the ear 185, thereby carrying the latch or projection 189 into operative position intercepting the path of motion of the hammer saddle 65.

It is to be noted at this point that the operation of throwing the control handle 5 from "OFF" to "ON" position may be made subsequently to, as well as prior to, the setting of the knurled wheel 4. This is because the latch 189 is ineffective as against motion of the hammer saddle 65 from right to left as in Fig. 5. (The sloping rear edge of the hammer saddle 65 pushes the latch 189 downwardly against the spring 187 and out of the way, regardless of the position of the long tooth 195.)

After contact has been made and the wheel 4 has been set, regardless of the respective order in which these two operations have taken place, the control handle 5 is returned from "ON" to "OFF" position, with the result that the compression spring 51 is over-centered and pressure is brought to bear on the hammer saddle 65 tending to throw it back to the right, that is to the Fig. 5 position. The hammer saddle 65 is, however, prevented from moving by reason of its engagement with the latch 189. The general position of the various elements at this stage (excepting the contacting bar latch 213 and its plunger 8) is indicated in Fig. 9.

Meanwhile, the escapement mechanism has been set into operation and the main shaft 109 is slowly turning back to normal position empowered by the unwinding main spring 119. As the predetermined period of time draws near completion, the long tooth 195 returns to engage with the lever 181 and push said lever downwardly. The latch 189 is thus slowly pushed downwardly, and at the expiration of the predetermined interval of time, it moves entirely out of the path of the

hammer saddle 65, and said hammer saddle 65, under the force of the compression spring 51, snaps to the right, engaging the anvil piece 93 and rotating the contacting bar 95 into disconnected position, thus breaking the electrical contact.

It is to be noted that the gear 196, and the gear 199 meshing therewith, remain stationary throughout the period of this future break operation by reason of the frictional engagement of the friction disc 197 and said gear 196.

Future make and break operation

The future make and break operation as defined hereinbefore is essentially a combination of the future make operation and the future break operation, with latches 189 and 213 both in effective operation.

Again, for descriptive purposes, the switch is assumed to be in position for ordinary operation, with the handle 5 at "OFF" and the wheel 4 and plunger 8 at their respective "zero" positions.

First, the plunger 8 is set, as in future make operation, to indicate the interval desired to elapse before it is desired that connections be made. Simultaneously, the wheel 4 is set to indicate the interval, considered from the instant of setting, desired to elapse before connections are broken. It is apparent that the setting of the wheel 4 will be greater than that of the plunger 8, the difference representing the interval during which electrical connections are made.

With the setting of both wheel 4 and plunger 8, it will be seen that both latches 189 and 213 are moved to operative positions. The action is at this point aggregatively those of the future make operation and the future break operation combined.

With both latches in operative position, the control handle 5 is moved, first to "ON" position (Fig. 8), and then substantially at once back to "OFF" position. This occasions the following movements: First, the hammer saddle 65 is thrown to the left, where it is caught by the latch 189. Second, with the withdrawal of the hammer saddle 65, the leaf spring 105 reacts on the cam 103 to force the contacting bar 95 towards contacting position, but it is arrested before contact is made by the latch 213. Third, with the return of the control handle 5 to "OFF" position, the compression spring 51 reacts on the hammer saddle 65 placing thereon a force back to the right; the hammer saddle does not move, however, because of the interposed latch 189.

Meanwhile the escapement mechanism has commenced operation and the main shaft 109 slowly returns to "zero" position. After the interval before connecting has expired, the gear 199 will have rotated so that the long tooth 201 thereon has disengaged the latch 213 and allowed the contacting bar 95 to snap to contacting position across the terminals 75 and 77. At this stage, the elements of the switch are arranged as in Fig. 9. The main spring 119 has not, however, returned completely to its "zero" or normal position, and the escapement mechanism is still functioning. When the intervals before disconnecting has expired, the gear 177 will have rotated so that the long tooth 195 thereon has disengaged the latch 189 and allowed the hammer saddle 65 to snap against the anvil piece 93 to return the contacting bar 95 to disconnected position, thus breaking the circuit.

In the circuit breaking operation, the latch 213, being disengaged from operating position, does not obstruct the disconnecting rotation of the contacting bar 95.

It is thus seen how the present invention is constructed as well as the manner of its operation under several different conditions.

Variations

It is to be understood that the various elements, especially the gear trains and escapement mechanism, may be varied in size and arrangement so that the indicia on the wheel 4 and plunger 8 represent any suitable intervals of time, for example, hours, minutes, or seconds. Further, it is to be understood that, under conditions such as for the systematized control of chemical or bacteriological processes, the adjustability feature may be dispensed with and the wheel 4 and plunger 8 or their equivalents provided with suitable stops to control their settings at predetermined values for each cycle of operations.

Furthermore, it is to be understood that the face plate 1 and housing 13 may equally well be replaced with other cofunctional means, whereby the switch is adapted for other than wall operation, such as, for example, a portable desk or panel mounting encasement.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results obtained.

As many changes could be made in carrying out the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. A time delay switch comprising a control handle, means for effecting electrical connections, and a time delay mechanism, said time delay mechanism including latching means, said latching means cooperating with said handle and said means to control the time of making contact and the time of breaking contact and separate adjusting means for each of said latches whereby said latches may be adjusted independently of said time delay

mechanism, said adjusting means also being adapted to remove said latches from operative position, whereby said switch is conditioned for non-time delay operation, and will remain indefinitely at rest in either circuit-making or circuit-breaking position.

2. In a time-delayed switch, means for controlling the time of making and breaking contacts comprising a time escapement mechanism and at least two latches controlled by said escapement mechanism, and means for independently adjusting said latches, said adjusting means also being adapted to remove said latches from operative position, whereby said switch is conditioned for non-time delay operation, and will remain indefinitely at rest in either circuit-making or circuit-breaking position.

3. In a time-controlled electrical switch, a control handle, a contactor bar, a pair of terminal pieces adapted to be connected by said contactor bar, a hammer saddle on said control handle, and an over-centering spring reacting between said hammer saddle and said control handle, said hammer saddle engaging said contactor bar whereby, by motion of said control handle, said contactor bar is thrown into and out of electrical contact with said terminal pieces, a timing mechanism, a latch associated with said timing mechanism and controlled thereby, said latch being adapted to project into the path of said contactor bar to prevent said contactor bar from connecting said terminal pieces until said latch is removed by said timing mechanism, and a second latch also associated with said timing mechanism and also controlled thereby, said second latch being adapted to project into the path of said hammer saddle to prevent said hammer saddle from removing said contactor bar from contact with said terminals until said second latch is removed by said timing mechanism.

4. In a time-controlled electrical switch, a control handle, a contactor bar, a pair of terminal pieces adapted to be connected by said contactor bar, a hammer saddle on said control handle, and an over-centering spring reacting between said hammer saddle and said control handle, said hammer saddle engaging said contactor bar whereby, by motion of said control handle, said contactor bar is thrown into and out of electrical contact with said terminal pieces, a timing mechanism, a latch associated with said timing mechanism and controlled thereby, said latch being adapted to project into the path of said contactor bar to prevent said contactor bar from connecting said terminal pieces until said latch is removed by said timing mechanism, and a second latch also associated with said timing mechanism and also controlled thereby, said second latch being adapted to project into the path of said hammer saddle to prevent said hammer saddle from removing said contactor bar from contact with said terminals until said second latch is removed by said timing mechanism and separate adjusting means for each of said two latches.

5. In a time-delay electrical switch, a control handle, a contactor bar, and terminal pieces adapted to be connected by said contactor bar, over-centering means operatively connecting said control handle and said contactor bar, a pair of latches, one of said latches being positioned to prevent movement of said contactor bar, and the other of said latches being positioned to prevent operation of said over-centering means, and timing means operating to remove said latches separately from their operative positions upon the expiration of predetermined time intervals.

6. A switch as set forth in claim 5, further characterized in that the first-named latch is operative to prevent movement of said contactor bar only as said contactor bar moves to connect said terminals.

7. A switch as set forth in claim 5, further characterized in that the second-named latch is operative to prevent operation of said over-centering means only when said over-centering means moves to disconnect said contactor bar from said terminals.

8. A switch as set forth in claim 5, including separate adjusting means for each of said latches, whereby the predetermined time intervals associated with said latches may be independently varied.

9. A switch as set forth in claim 5, including separate adjusting means for each of said latches, whereby the predetermined time intervals associated with said latches may be independently varied, one of said adjusting means being connected to said timing means in such manner that manipulation of such adjusting means empowers the timing means for action.

10. In a time-controlled switch having a plurality of operative phases, including circuit-making and circuit-breaking phases, a movable contactor bar and terminals positioned to be engaged by said contactor bar, a spring at all times urging said contactor bar into one operative phase, a time-controlled latch operative to prevent said contactor bar from moving under influence of said spring, an actuating mechanism including a second spring more powerful than said first spring, and means for positioning said actuating mechanism in operative relationship to said contactor bar when in said one operative phase, whereupon said actuating means, impelled by said second spring, forces said contactor bar against the reaction of said first spring, into a second operative phase.

11. A switch as set forth in claim 10, including a second time-controlled latch, said second latch being operative to prevent said

actuating means from forcing said contactor bar into said second operative phase.

12. A switch as set forth in claim 10 including a second time-controlled latch, said second latch being operative to prevent said actuating means from forcing said contactor bar into said second operative phase, and including a single timing train operating both of said latches.

13. A switch as set forth in claim 10 including a second time-controlled latch, said second latch being operative to prevent said actuating means from forcing said contactor bar into said second operative phase, a single timing train operating both of said latches, and separate adjusting means for individually determining the time at which either of said latches shall cease to be operative.

14. In a time-controlled switch having a plurality of operative phases, including circuit-making and circuit-breaking phases, a movable contactor bar and terminals positioned to be engaged by said contactor bar, mechanical actuating means associated with said contactor bar, a timing train, and a pair of latches, at least one of said latches being operated by a gear train cooperating with said timing train, one of said latches being operative to prevent said contactor bar from assuming one operative phase by intercepting the path of said contactor bar, the other of said latches being operative to prevent said contactor bar from assuming a second operative phase, by intercepting the path of at least part of said actuating means.

15. A switch as set forth in claim 14, in which both of said latches comprise levers having fulcrums, and projections, one on one end of each lever, extending into operative positions, said levers being actuated by projecting means associated with said timing train.

16. In a time-controlled switch, a pair of latches for preventing making and breaking of electrical connections for predetermined time intervals, an escapement train having a main shaft, and a pair of gear trains driven from said main shaft, the last gear of each train, respectively, controlling the position of one of said latches.

17. In a time-controlled switch, a pair of latches for preventing making and breaking of electrical connections for predetermined time intervals, an escapement train having a main shaft, and a pair of gear trains driven from said main shaft, the last gear of each train, respectively, controlling the position of one of said latches, and means for predetermining the time at which the said latches are moved, said means comprising, for one latch, means for adjusting the position of said main shaft, and for the second latch, means operating directly upon the respective gear train associated with said latch.

18. A switch as set forth in claim 17, in which the main shaft adjusting means also serves to empower said escapement train.

In testimony whereof, I have signed my name to this specification this 20th day of January, 1931.

MARCUS H. RHODES.