Sept. 4, 1923. 1,466,903

W. K. HOWE

SWITCH MACHINE

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FIG. 1.

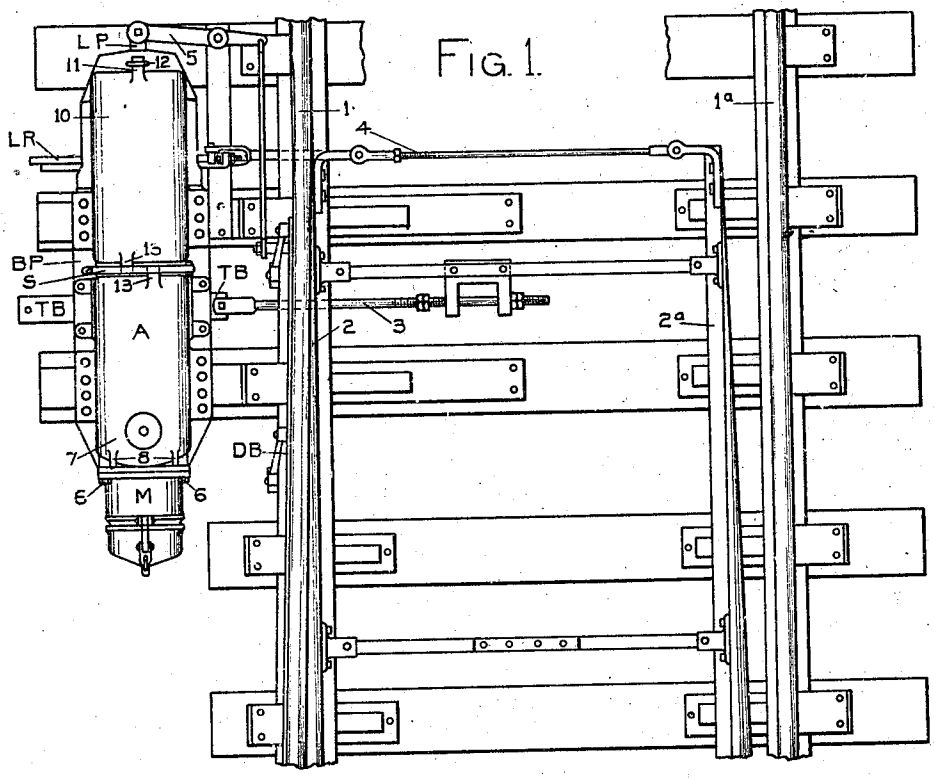
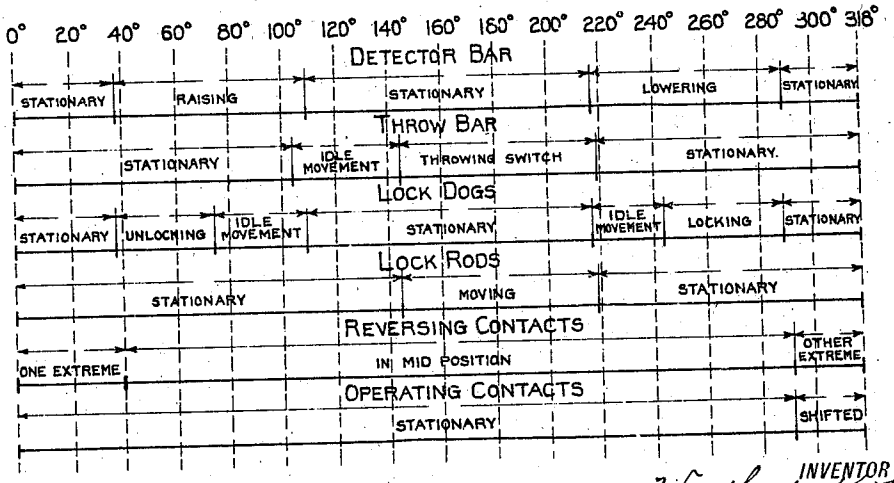


FIG. 2.



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SWITCH MACHINE

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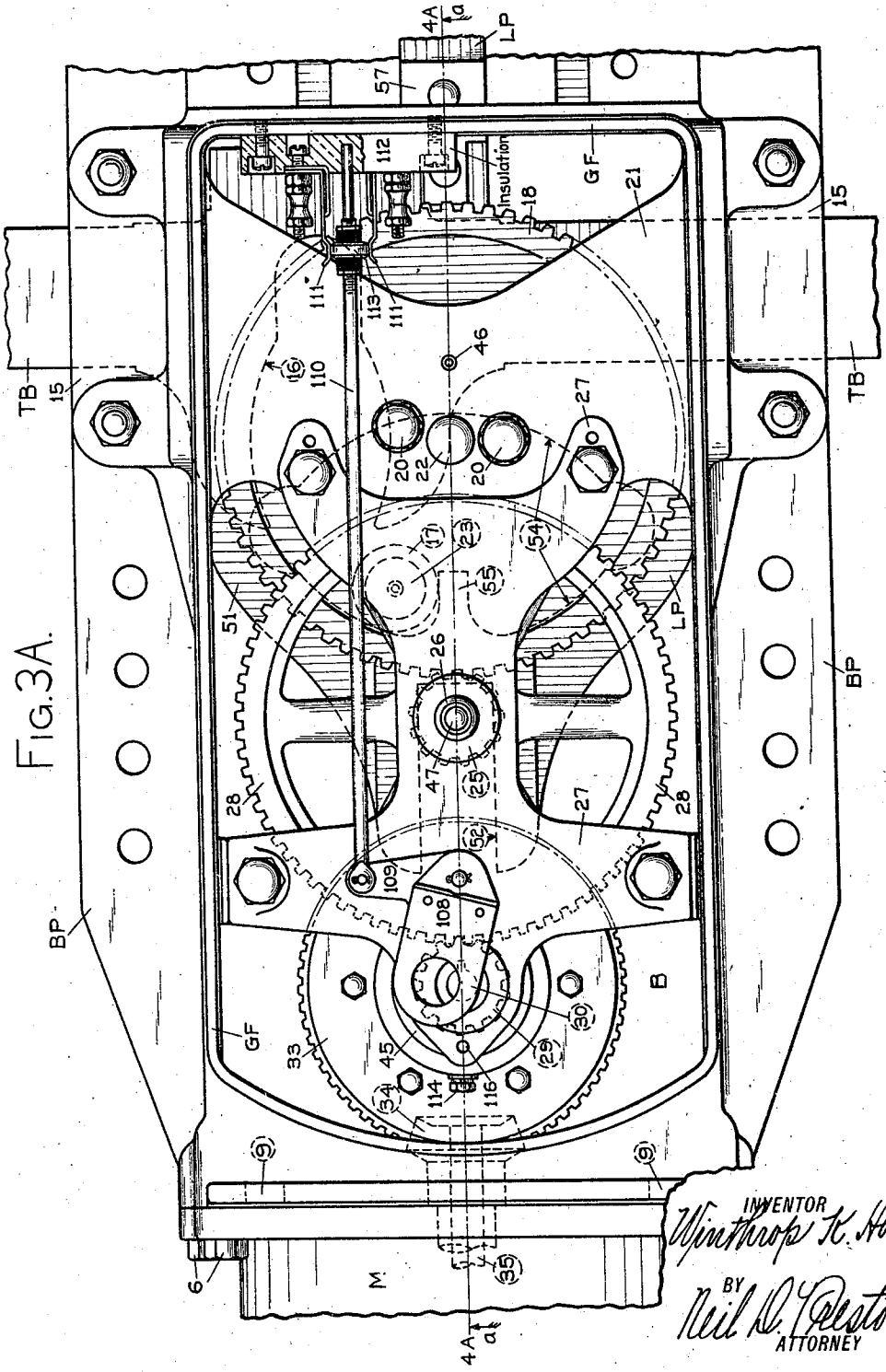


FIG. 3A.

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W. K. HOWE

SWITCH MACHINE

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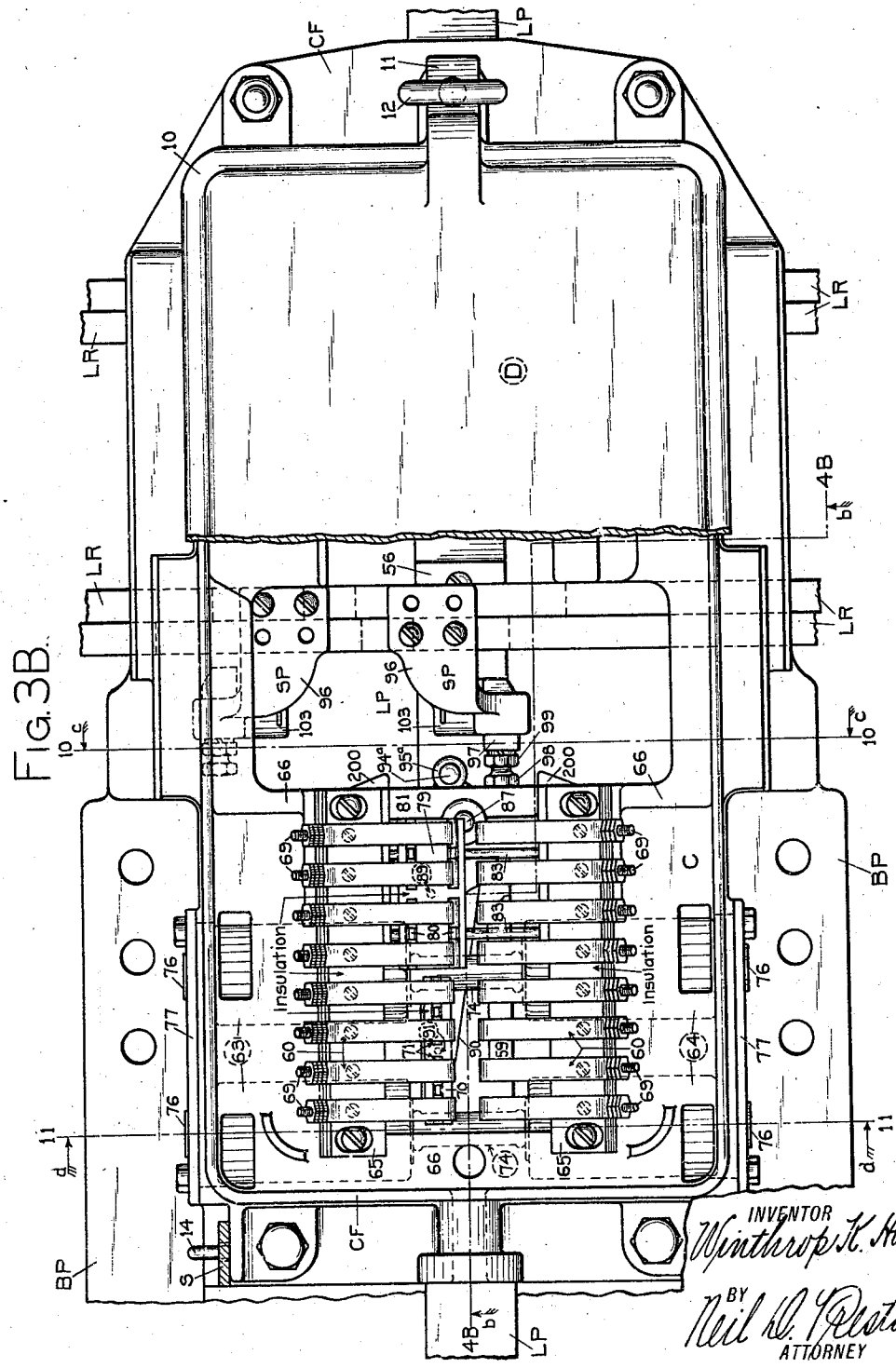


FIG. 3B.

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SWITCH MACHINE

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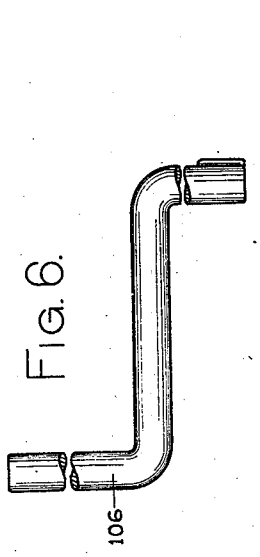


FIG. 6.

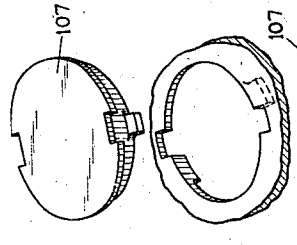


FIG. 5.

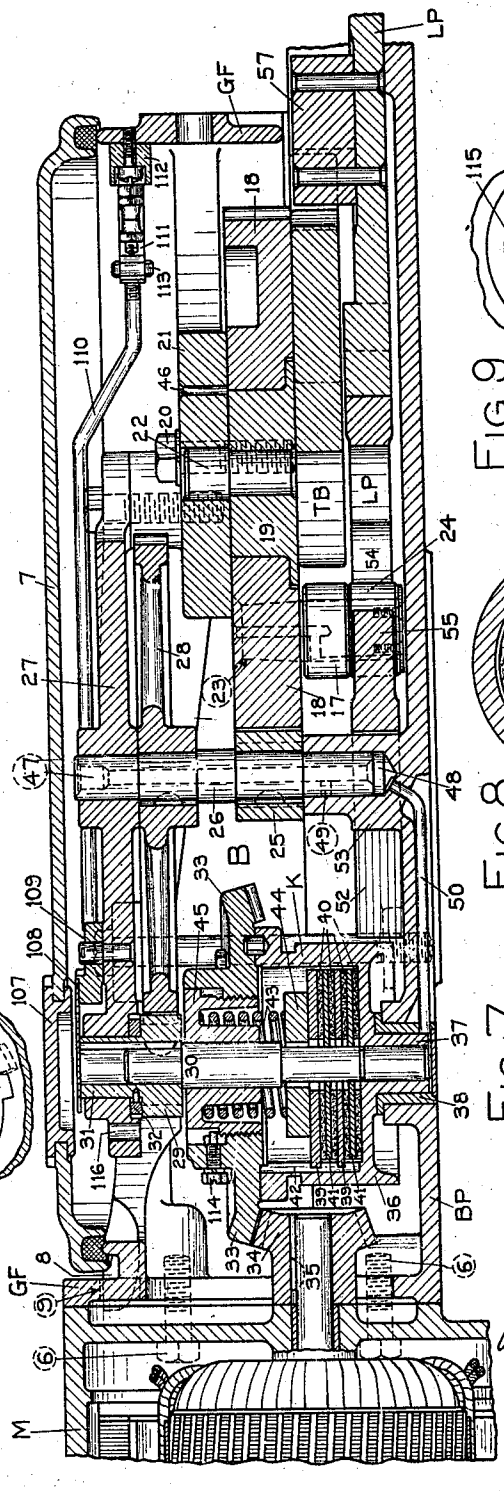


FIG. 4A.

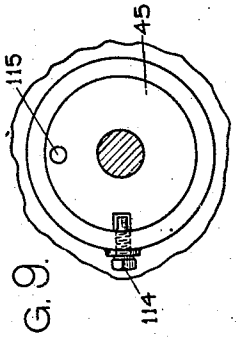


FIG. 9.

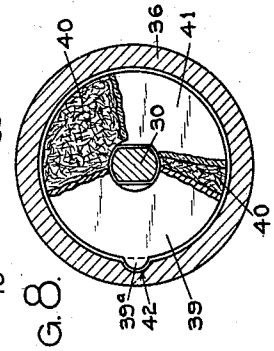


FIG. 8.

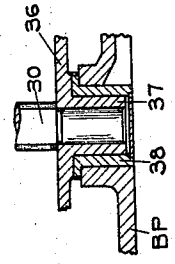


FIG. 7.

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SWITCH MACHINE

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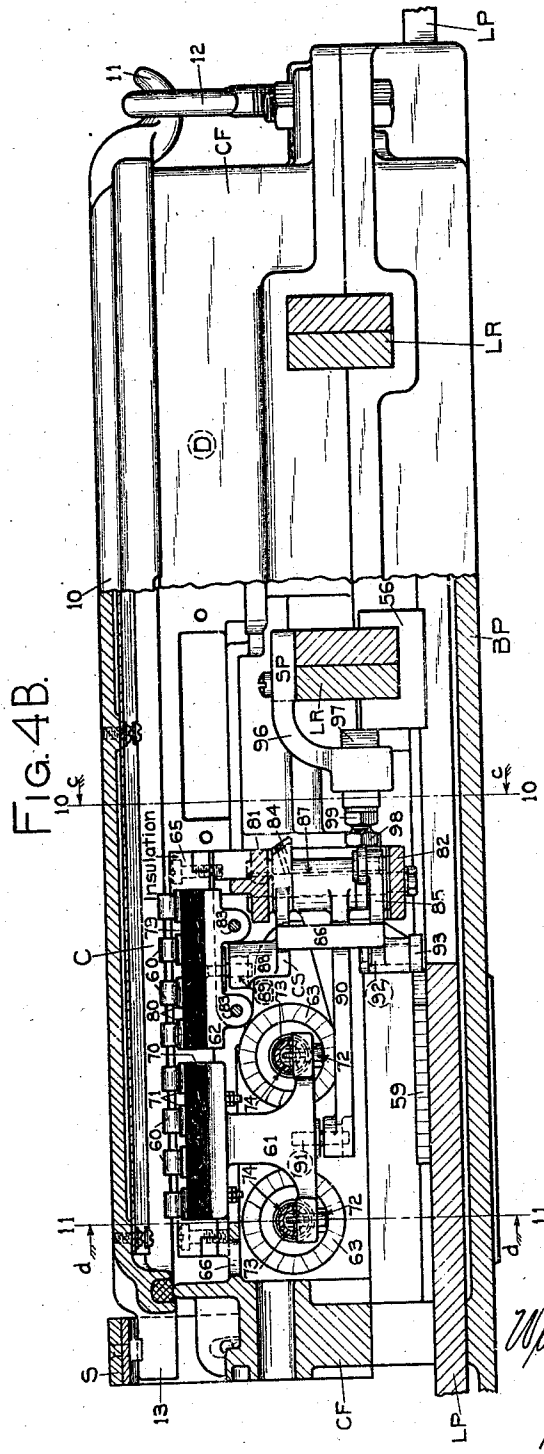


FIG. 4B.

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SWITCH MACHINE

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FIG. 10.

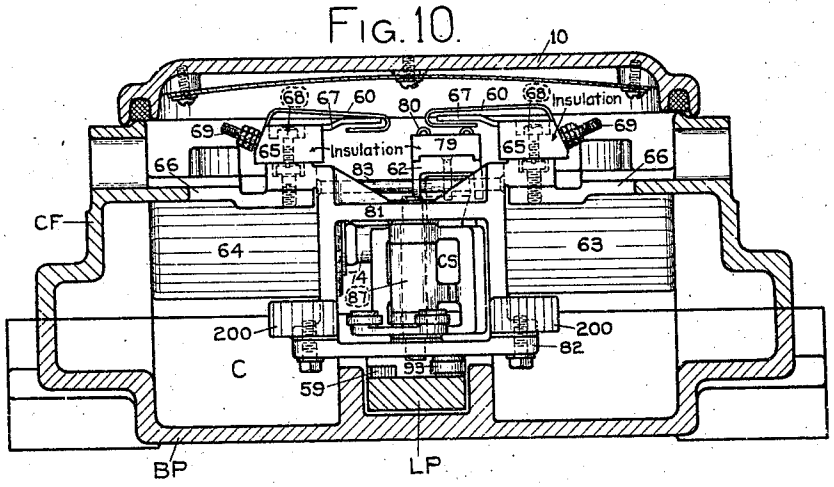


FIG. 11.

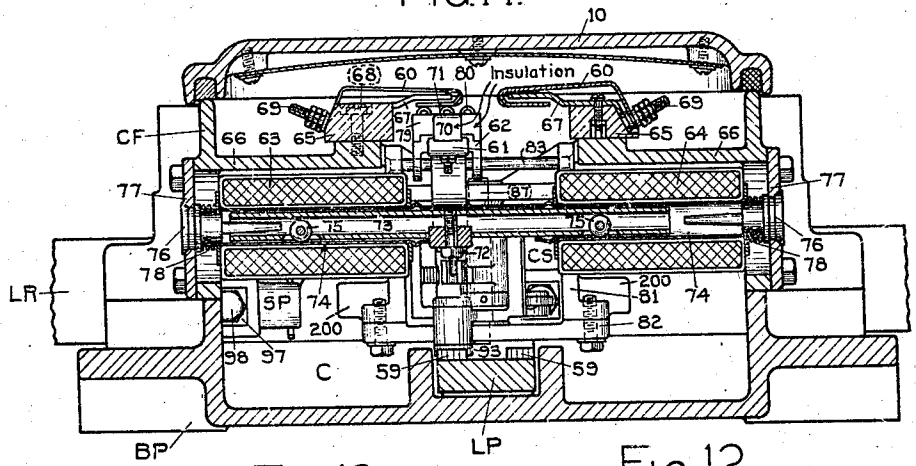


FIG. 13.

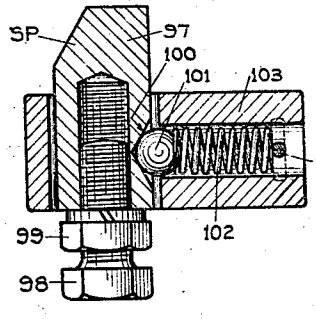
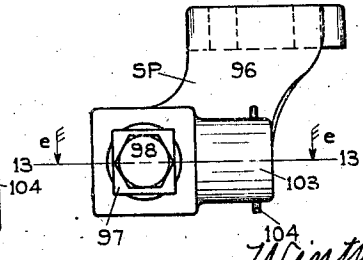


FIG. 12.



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SWITCH MACHINE

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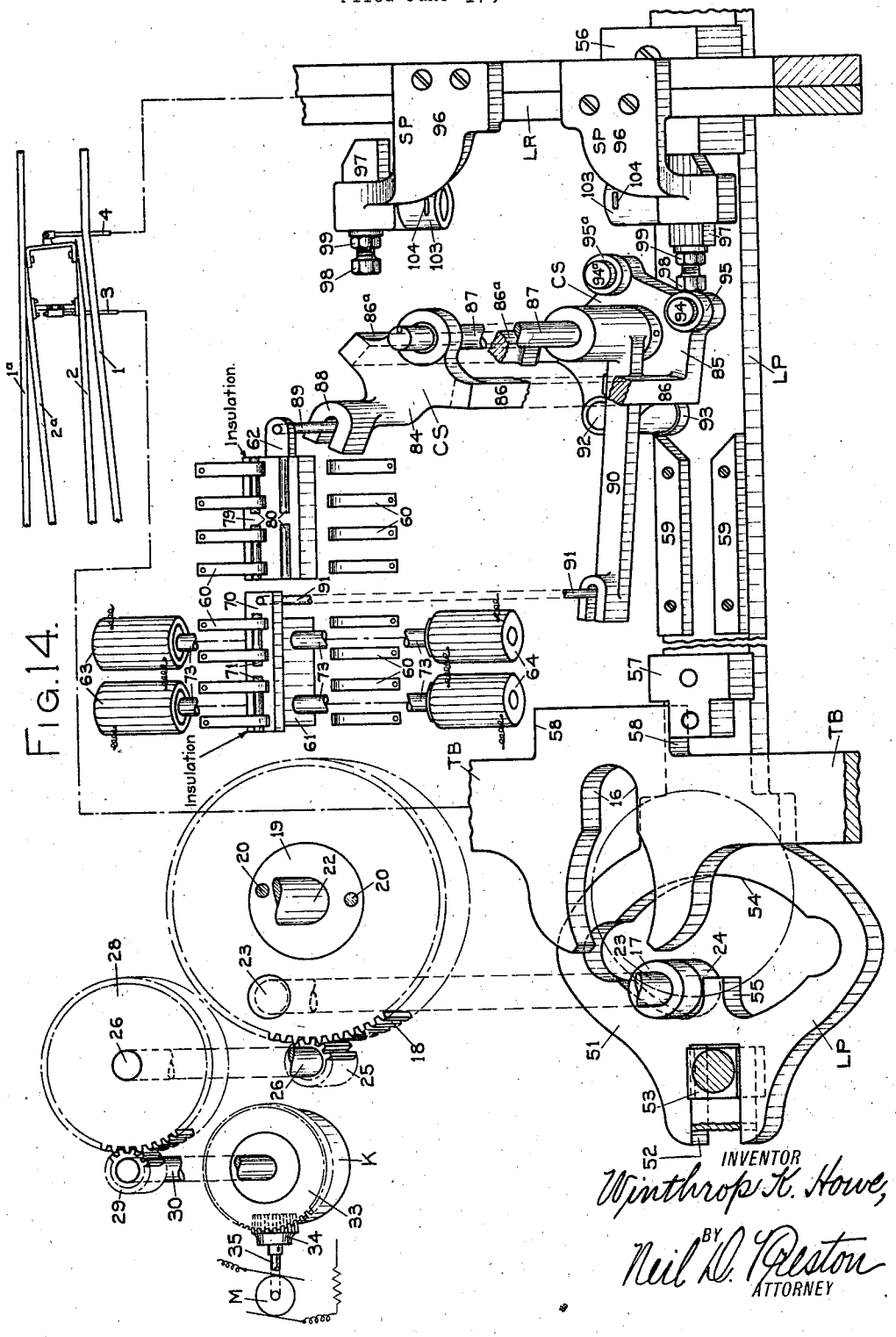


FIG. 14.

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SWITCH MACHINE

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FIG. 15.

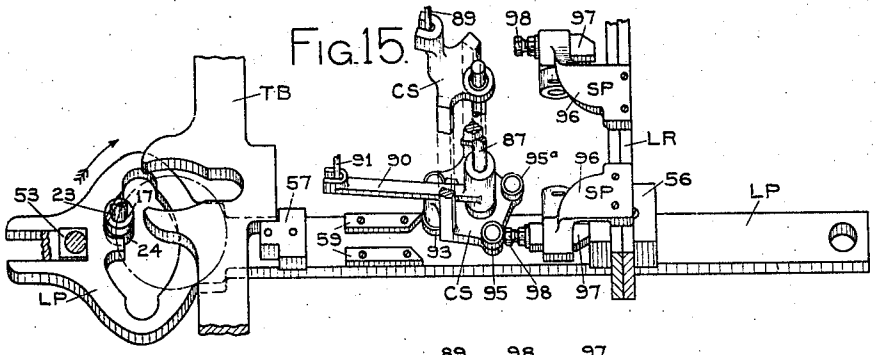


FIG. 16.

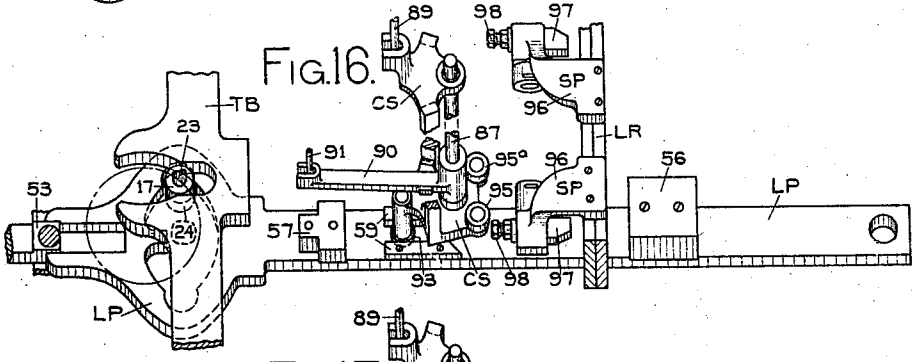


FIG. 17.

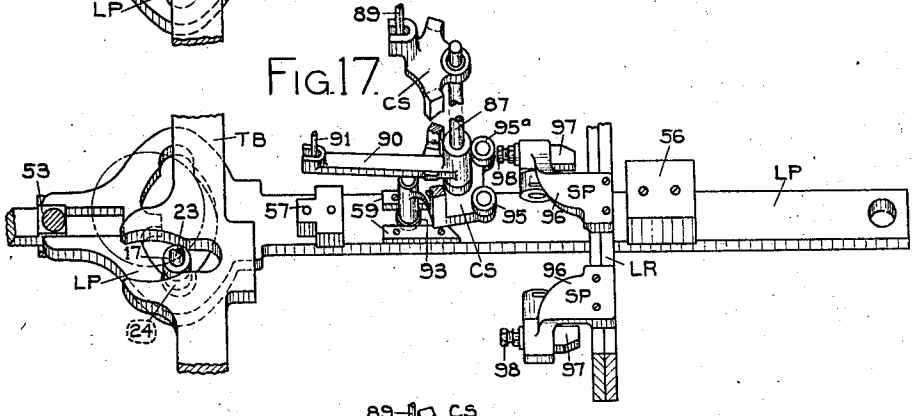
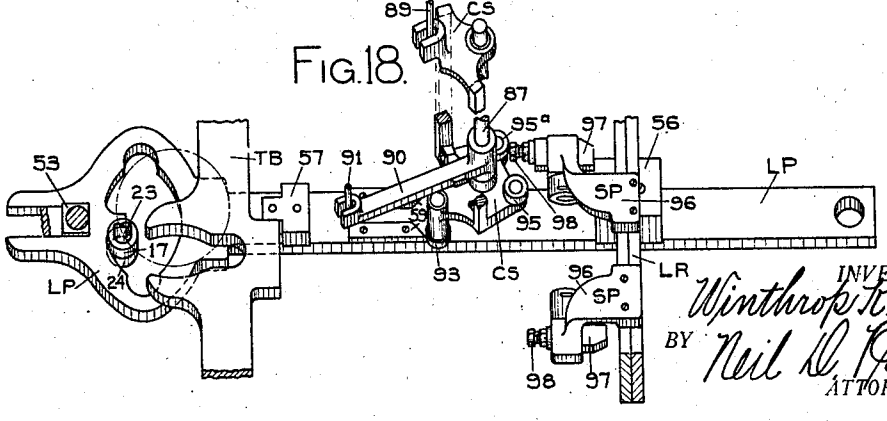


FIG. 18.



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Sept. 4, 1923.

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Filed June 17, 1919

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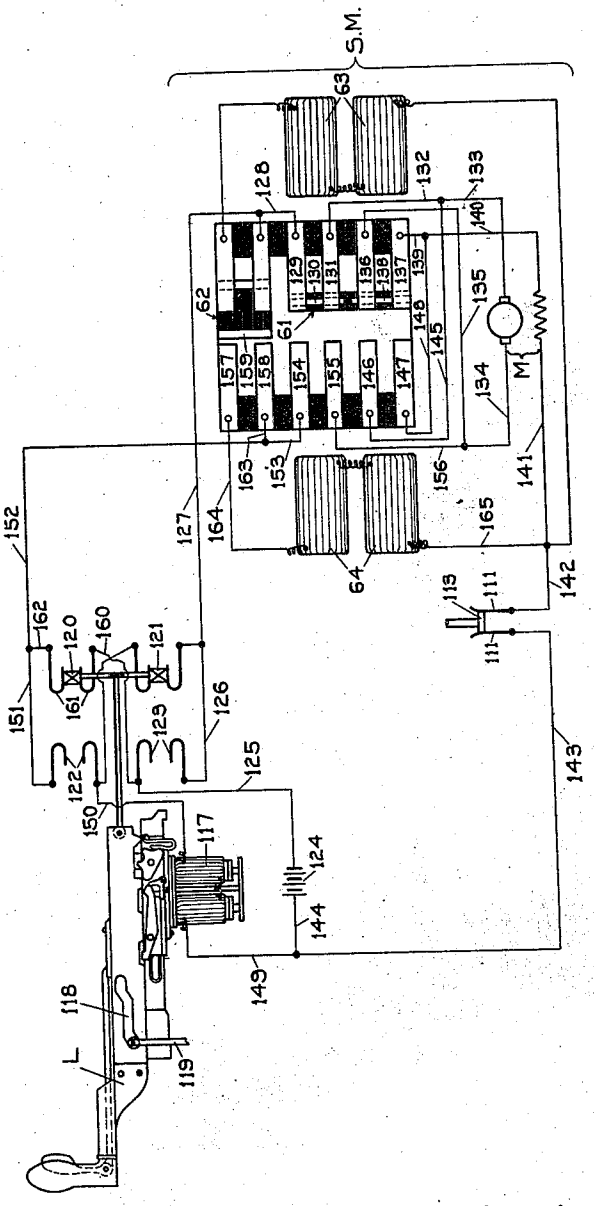


FIG. 19.

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Patented Sept. 4, 1923. 1,466,903

UNITED STATES PATENT OFFICE.

WINTHROP K. HOWE, OF ROCHESTER, NEW YORK, ASSIGNOR TO GENERAL RAILWAY SIGNAL COMPANY, OF ROCHESTER, NEW YORK, A CORPORATION OF NEW YORK.

SWITCH MACHINE.

Application filed June 17, 1919. Serial No. 304,816.

To all whom it may concern:

Be it known that I, WINTHROP K. HOWE, a citizen of the United States, and resident of the city of Rochester, in the county of Monroe and State of New York, have invented a new and useful Switch Machine, of which the following is a specification.

This invention relates to electrically operated switch machines for interlocking systems for railways.

The principal object of this invention is to improve and simplify the construction of switch machines by providing facilities for lubrication, making the parts accessible for adjustment, inspection and repair, constructing and arranging the parts for strength, lightness and durability, and providing a device for protection during hand operation.

Other objects and advantages will appear as the description of the invention progresses, and the novel features thereof will be particularly pointed out in the appended claims.

The invention consists in the parts and in the arrangement and combination of parts which are more fully set forth hereinafter.

In describing the invention in detail, reference will be made to the accompanying drawings, in which like reference characters designate corresponding parts in the several views, and in which:

Figure 1 is a plan view showing the application of a switch machine embodying my invention to a typical switch layout of well known construction;

Fig. 2 is a tabular diagram of the timing of the different operating parts of the switch machine;

Fig. 3^A is a top plan view of one-half of the switch machine, with the cover therefor removed, and shows the parts of the operating mechanism included in the gear compartment;

Fig. 3^B is a top plan view of the other half of the switch machine, with part of the cover therefor broken away to show the circuit controlling mechanism and associated operating parts;

Fig. 4^A is a vertical longitudinal section, taken substantially on the line 4^A—4^A on Fig. 3^A and looking in the direction indicated by the arrows *a*;

Fig. 4^B is a view similar to Fig. 4^A, taken substantially on the line 4^B—4^B on Fig. 3^B, and looking in the direction indicated by the arrows *b*;

Fig. 5 is a fragmentary view in perspective with parts spread apart showing the manner of fastening a detachable cover-plate in a hole in the cover of the switch machine;

Fig. 6 is a side view of the crank used for manually operating the switch machine;

Fig. 7 is a detail view showing the construction for vertically supporting the shaft of the friction clutch;

Fig. 8 is a horizontal section through the friction clutch, with portions of the plates broken away to show their arrangement and connection of the housing and the shaft;

Fig. 9 is a detail view showing the adjusting nut for the friction clutch, and the means for locking said nut;

Fig. 10 is a vertical transverse section, taken substantially on the line 10—10 in Fig. 4^B and looking in the direction indicated by the arrows *c*, the line of this section being also shown in Fig. 3^B;

Fig. 11 is a vertical transverse section, taken substantially on the line 11—11 in Fig. 4^B and looking in the direction indicated by the arrows *d*, the line of this section being also shown in Fig. 3^B;

Fig. 12 is a detail view of one of the selecting plungers;

Fig. 13 is a horizontal section through one of the selecting plungers, taken substantially on the line 13—13 in Fig. 12, and looking in the direction indicated by the arrows *e*;

Fig. 14 is a diagrammatic view, partly in perspective, with certain parts broken away and spread apart, which shows in a simplified form the principal operating parts of the switch machine;

Figs. 15 to 18, inclusive, are perspective views, diagrammatic in their nature, showing the different positions of the throw bar, locking plunger and lock rods, together with the mechanism for operating the circuit controller, at different times during the movement of the switch from one position to another; and

Fig. 19 is a simplified wiring diagram for the switch machine and its lever.

Referring to the accompanying drawings, Fig. 1 shows a typical layout for a single switch, comprising the stock rails 1—1^a of

the main or straight track and their associated movable switch points 2—2ª. This construction is well known and need not be described in detail. The switch machine A is secured to the ties in any convenient way, as by lag screws passed through holes in suitable flanges on the base plate BP (see Fig. 3ᴬ); and the parts of the machine are enclosed in a protecting casing of suitable construction which is provided with weather-tight covers. The switch points 2—2ª are connected by the usual adjustable connecting rod 3 to the throw bar TB of the switch machine, and by a rod 4 to the lock rod LR in the usual way. The detector bar DB (when a detector bar is used with the machine), is connected to a rock-lever 5, which is connected in turn to a locking plunger LP of the switch machine. The electric motor M for operating the switch machine is preferably mounted in a separate casing which is secured to one end of the switch machine casing in any convenient way, as for example, by cap screws 6. For convenience in description, the end of the switch machine A adjacent to the rock-lever 5, and opposite to the motor M, will be hereinafter termed the front end.

The switch machine A in general comprises three compartments mounted on a common base plate BP, namely, a gear or operating mechanism compartment B (see Figs. 3ᴬ and 4ᴬ); a circuit controller compartment C (see Figs. 3ᴮ and 4ᴮ); and a point-detector compartment D. The parts in these compartments will be described in the order named, with the exception of the parts in the point detector compartment D, which form no part of my present invention. Suitable weather-tight covers are provided, one for compartment B and one for compartment C and D. The cover 7 for the compartment B is provided at its rear end with integral lugs or hooks 8 (see Figs. 1 and 4ᴬ), which are adapted to fit into openings 9 formed in the rear end wall of the frame GF of compartment B (see Fig. 3ᴬ). Likewise, the cover 10 for compartments C and D is provided at its front end with an integral lug or hook 11 (see Figs. 3ᴮ and 4ᴮ), adapted to hook into an eye bolt 12, which is screw-threaded into the base portion of the frame CF of the compartments C and D. These covers are clamped down at their adjacent ends by a metal strap S which is hinged at one end to the frame CF and which presses down on two lugs 13 integral with said covers (see Fig 1), said strap being adapted to be fastened at its other end by a padlock, or the like, (not shown) to a lug 14 integral with said frame, in much the same manner as a hasp is fastened.

Operating gearing.—Referring to Figs. 3ᴬ and 4ᴬ, the throw bar TB of the switch machine A extends transversely of said machine and is guided at each end in notches formed in the base plate BP which are covered by lugs or caps 15 (see Fig. 3ᴬ), integral with a gear-frame GF forming the walls of the gear compartment B. The throw bar TB is formed with a U-shaped jaw 16 between its ends with which a roller 17, carried by a main gear 18, cooperates to cause reciprocation of the throw bar TB as said main gear 18 is rotated. This main gear 18 is mounted on a bearing stud 19, (see Fig. 4ᴬ), which is secured by means of cap screws 20 to a cross piece 21 extending transversely of the gear-frame GF and integral therewith. The stud 19 has a horizontal flange or rim around its lower edge for holding the main gear 18 in place, and is centered and firmly secured to the cross piece 21 by a pin 22. The main gear 18 carries a downwardly extending pin 23, on which the roller 17 is journaled; and on the pin 23 below the roller 17 is another roller 24 for operating the locking plunger LP, as hereinafter explained.

The main gear 18 is driven from the motor M by a train of gears and a friction clutch. The main gear 18 is driven by a pinion 25, keyed to a vertical shaft 26. This shaft 26 is journaled at its lower end in the base plate BP and at its upper end in a T-shaped supporting member 27, which is secured at its front end to the cross piece 21 by cap screws and dowel pins (see Fig. 3ᴬ), and which has its arms at its other end fastened to lugs integral with the gear-frame GF by tap bolts. The shaft 26 is driven by an intermediate gear 28, also keyed to said shaft 26 above the pinion 25; and meshing with said intermediate gear is a pinion 29 keyed to a second vertical shaft 30. The pinion 29 is formed with a bearing hub 31 which is journaled in the supporting member 27, a bearing washer or plate 32 being employed to separate the upper face of pinion 29 from said supporting member 27 and also to provide a greater bearing surface for said pinion. This washer 32 is locked to the hub 31 by a pin (see Fig. 4ᴬ). The shaft 30 is driven from a bevel gear 33 through a friction clutch K; and the bevel gear 33 is in turn driven by a bevel pinion 34 keyed to the armature-shaft 35 of the motor M. The motor M is of any suitable or well known type, preferably with series characteristics; and since such motor forms no part of the present invention, it need not be described in detail.

Friction clutch.—The friction clutch K comprises a cup-shaped housing 36 having a downwardly extending hub 37 journaled in a bushing 38 in the base plate BP. The shaft 30 extends through said housing 36 and is journaled at its lower end in its hub 37. The portion of the shaft 30 just above the hub 37 is of larger diameter (see Fig. 7) so

as to form shoulders for supporting said shaft vertically; and this portion of said shaft is flattened on opposite sides (see Fig. 8). On this flattened portion of shaft 30 are arranged alternately, one above the other, a steel plate 39, a friction plate 40, another steel plate 41, and so on, two sets of steel and friction plates being illustrated. The steel plates 39 are loose on the shaft 30 but have a protruding ear 39^a fitting in a groove or keyway 42 formed in the inside face of the housing 36 (see Fig. 8). The steel plates 41 have central holes shaped to fit the flattened portion of the shaft 30, so that these steel plates turn with said shaft. The friction plates 40, which are preferably made of "raybestos" or similar friction material, are loose on the shaft 30. The several steel plates 39—41, and the friction plates 40 are pressed together by a compression spring 43 which bears at one end against a follower block or plate 44, and at its other end against an adjustable nut 45 screwed into the hub of the bevel gear 33. This nut 45 may be turned, as hereinafter explained, to adjust the tension of the spring 43, thereby varying the force required to slip the clutch. The cover for the housing 36 of the friction clutch K is formed by the bevel gear 33 which is attached to said housing by a dowel pin and cap screws (see Figs. 3^A and 4^A).

Oiling arrangement.—In order to prevent wear on the various rotating parts of the switch machine, and also to overcome friction between said parts as much as possible, I have provided holes and passages for conducting oil to said parts, which are readily accessible to the maintainer and which lead directly to the parts to be oiled. Referring to Fig. 4^A, an oil hole 46 is drilled through the cross piece 21 and leads directly to the bearing surface between the bearing stud 22 and the main gear 18. Likewise, an oil passage 47 lengthwise of the shaft 26 facilitates the supplying of oil to the lower bearing of said shaft. This passage 47 leads to a cavity 48 formed at the bottom of the bore in which said shaft is journaled, and an outlet 49 supplies oil to the lower bearing portion of said shaft. Leading from the cavity 48 is a conduit 50 (see Fig. 4^A) which conducts oil to the bushing 38 in which clutch K is journaled. It will be noted that this arrangement keeps oil away from the friction plates of the clutch K, it being desirable to keep said plates dry.

Locking mechanism.—This comprises the lock rod LR (see Fig. 1) and a locking plunger LP operated by the switch machine and arranged to lock said lock rod in the normal or reverse position of the switch points. Referring to Figs. 3^B and 4^B, the lock rod LR extends transversely of the switch machine near the front end thereof, and is guided in notches at both side edges of the base plate BP, and in the frame CF of the circuit controlling compartment C. This lock rod LR comprises two bars arranged side by side, each having long and short notches in its lower edge, and is provided with a suitable device for adjusting said bars longitudinally relatively to each other, in the well known manner.

Referring to Figs. 3^B and 4^B, it will be noted that two lock rods are illustrated, both identical in construction, two lock rods being used when the switch machine is used for operating double-slip switches, movable point frogs or the like.

The locking plunger LP extends longitudinally of the switch machine and rests upon the base plate BP, being guided at different points throughout its length by lugs integral with said base plate BP (see Fig. 10). This locking plunger LP, best shown as a whole in Fig. 14, has an enlarged head 51 at its rear end, which is formed with a notch or jaw 52 guided by a squared projection 53 integral with the base plate BP. In the head 51 of the locking plunger LP is formed a cam slot 54, of a generally elliptical shape, with a projecting tongue or stop 55; and this cam slot 54 is arranged to cooperate with the lower roller 24 on the driving pin 23 of the main driving gear 18. The locking plunger LP carries a locking dog 56 adapted to enter the notches of the lock rod LR, and also another locking dog 57 near its rear end (see Figs. 4^A and 14), which is adapted to cooperate with one or the other of the shoulders (designated 58) on either side of the jaw 16 of the throw bar TB, so as to lock said throw bar in one or the other of its extreme positions. Secured to the locking plunger LP, by means of screws or rivets, are two parallel guiding strips 59, (see Fig. 14), which have sloping or beveled ends for a purpose hereinafter explained.

The circuit controller.—The circuit controller of the switch machine, best shown in Figs. 3^B, 4^B, 10 and 11, is supported and enclosed in the compartment C, and in general, comprises two units, one for controlling the operating and indication circuits, (hereinafter termed the operating circuit controller), and another unit for controlling the circuits of the pole changer coils (hereinafter termed the reversing circuit controller). Each of these units comprises a plurality of fixed contact fingers or springs 60 arranged in rows along opposite sides of the machine, and two separately movable contact carriers or blocks 61 and 62, respectively, arranged to be shifted back and forth from one side of the machine to the other into and out of engagement with said contact fingers 60. The position of the contact carrier 62 of the reversing circuit con-

troller is selected by the lock rod LR in accordance with the position of the switch points, and this contact carrier is moved mechanically to its selected position by the final locking movement of the locking plunger LP. Likewise, the contact carrier 61 of the operating circuit controller has its position selected by the lock rod LR, and is operated mechanically by the locking plunger LP; but this contact carrier 61 may also be shifted electrically, when the switch is in mid-stroke, by the energization of pole changer coils 63—64. These units will be first described separately, and then their inter-action and cooperation pointed out more fully in the description of the operation of the switch machine.

The stationary or fixed contact fingers 60 of the circuit controllers are carried by two bars of insulating material 65 (see Fig. 3B), which are fastened by screws to a bracket or shelf 66 extending along the sides and one end of the circuit controlling compartment C, preferably integral with the walls thereof. Referring more particularly to Figs. 10 and 11, each of these stationary contact fingers 60 includes, in addition to the contact finger or spring proper, a retaining member 67 of relatively stiff material fastened by a screw-bolt 68 to its insulating bar 65. The contact spring 60 is held at one end by a bolt 69, which has its head secured to said retaining member 67, said bolt 69 being provided with clamping nuts in the usual manner to constitute a binding post to connect wires to said contact finger. The other and free end of the contact spring 60 is doubled over and under the free end of the retaining member 67. The retaining member 67 serves to limit the upward and downward movement of the free end of the contact spring 60, and said retaining member, being relatively stiff, prevents the bending of the lighter contact spring out of its proper position.

The movable contact carrier 61 for the operating circuit controller is formed substantially in the shape of an inverted T (see Fig. 4B), and includes a block of suitable insulating material 70 to which a single row of contact pieces 71, connected together in pairs, are fastened, preferably by being moulded therein. As shown, these contact pieces consist of a strip, inverted U-shape in cross section, which is long enough to span two adjacent contact fingers, and which has its middle portion partly cut away, as shown in Fig. 3B. The lower arms of the contact carrier 61 are fastened by bolts 72 to the two parallel cores 73 of the pole-changer coils 63—64 (see Fig. 4B), so that said contact carrier is supported and operated by said cores. The cores 73 and associated parts are duplicates. Each core 73 is hollow (see Fig. 11) and slides in a stationary tube 74 of brass or similar non-magnetic material; and each core is provided with a roller 75 near each end extending through a slot in the core and resting upon the brass tube. The brass tube 74 is supported at its ends by plugs 76 fastened to detachable cover plates 77 secured to the frame CF forming the circuit controller compartment C. Each of these plugs 76 is formed with a tapered spindle (see Fig. 11), which is adapted to enter the hollow core 73, and vary the reluctance of the magnetic circuit for the corresponding pole-changer coil, so as to improve the attractive effort of said coils. The pole-changer coils 63—64 themselves surround the brass tubes 74 and are pressed inward toward the middle of the machine against a circumferential ridge or enlargement on said tubes by springs 78 on the plugs 76. The spring 78 hold the coils in place and prevent them from vibrating and wearing out. The ends of the pole-changer coils, 63—64, which are preferably form-wound, are protected by washers; and the brass tubes 74 are cut away to permit attachment of the contact carrier 61 to the cores 73, all as shown in Fig. 11. It will be observed that this construction permits removal of any one of the pole-changer coils by merely taking off the proper cover plate 77 and sliding out the coil, the lead wires being of course disconnected.

The contact carrier 62 for the reversing circuit controller comprises a similar block of insulating material 79 in which are moulded two rows of contact pieces 80 which are identical with those previously described for the operating circuit controller. This contact carrier 62 is associated with and forms a part of a unit of apparatus including a contact shifter CS for operating both of the contact carriers 61—62 of the entire circuit controller, the construction being such that this unit of apparatus may be disconnected and taken out from the machine as a whole for inspection, adjustment, or repair. This detachable unit comprises a main supporting frame 81, which is hung from the side shelf 66 of the circuit controller compartment C and is fastened thereto by cap screws. This supporting frame 81, best shown in Fig. 10, is substantially H-shaped, with a detachable bottom cross member 82. The contact carrier 62 for the reversing circuit controller is slidably mounted on two rods 83 fastened to said supporting frame 81 (see Figs. 4B and 11).

The contact shifter CS, best shown as a whole in Fig. 14, comprises an irregular shaped part including an upper portion 84, and a lower portion 85 connected by two vertical side members 86—86a. The upper and lower portions 84 and 85 of said contact shifter CS are journaled on a pin 87 fastened to the top and bottom cross members

of the supporting frame 81. The upper portion 84 of the contact shifter CS is provided with an integral arm 88 having a slot or jaw at its end, which straddles a downwardly extending pin 89 secured to the contact carrier 62 of the reversing circuit controller, so that oscillation of the contact shifter CS causes movement of said contact carrier 62 from one extreme position to the other. The contact carrier 61 of the operating circuit controller is actuated by an arm 90, which is journaled at one end on the pin 87 and which extends between the two side members 86—86ª of the contact shifter CS; and this arm 90 is provided with a similar slot or jaw at its free end which cooperates with the downwardly extending pin 91 secured to said contact carrier 61. To the lower portion 85 of the contact shifter CS is fastened a downwardly extending pin 92 carrying a roller 93 which is arranged to cooperate with the guides 59 on the locking plunger LP. Also carried by said lower portion 85 of the contact shifter CS are two other pins 94—94ª, carrying rollers 95—95ª which are arranged on opposite sides of the axis of oscillation of said contact shifter CS.

The contact shifter CS is operated by two selecting plungers SP, one for the normal position and the other for the reverse position of the switch points. Since these selecting plungers are counter-parts, the description of one will suffice for both. Each selecting plunger SP comprises a curved bracket 96 in which is slidably mounted a squared plunger bolt 97, said bolt being arranged to be driven by the lock dog 56 against one or the other of the rollers 95—95ª on the contact shifter CS, as more fully explained hereinafter in the description of the operation. These brackets 96 are curved in opposite directions (see Fig. 3ᴮ), or in other words, are right and left-hand brackets, and are fastened by tap screws, one to one of the two bars of the lock rod LR, and the other to the other of said bars. Each plunger bolt 97 is provided with an adjustable tappet bolt 98 and a locking nut 99, and associated with the plunger bolt is a centering and retaining device, shown in detail in Fig. 13. In this construction, a V-shaped notch 100 is formed in the plunger bolt 97; and arranged to cooperate with this notch is a ball 101 which is urged toward the plunger bolt by a compression spring 102 housed in a casing formed in a lug 103 integral with the bracket 96, said spring being held in place by a cotter pin 104. When the plunger bolt 97 is in the retracted position, the ball 101 is forced into the notch 100 and prevents the bolt 97 being jarred out of this retracted position. When the plunger bolt 97 is moved back toward its retracted position, in a manner hereinafter explained, as soon as it approximately reaches this retracted position, the ball 101 under the pressure of the spring 102 seats itself in a V-shaped notch 100 and forces the bolt to the correct position. Thus, after each operation of the plunger bolt 97, it is returned to the same retracted position and is yieldingly held in that position.

Manual operation.—For cases of emergency, or when it is desirable to adjust or repair the switch machine, a hand crank 106 (see Fig. 6) is provided for enabling the machine to be operated manually. This crank 106, shown in Fig. 6, is arranged to be inserted in the bore in the hub 31 of the pinion 29, said bore being provided with a keyway in which the key-like projection on the crank 106 fits. Provision is made so that the hand crank 106 may be inserted without removing cover for the compartment B, by providing a hole directly over the hub 31 of pinion 29, (see Figs. 4ᴬ and 5), with a detachable cover plate 107 for said hole. This cover plate 107 is provided with a bayonet slot locking arrangement as shown in Fig. 5.

On account of the automatic restoring feature characteristic of this type of switch machine it is dangerous to crank the machine by hand with the power on; and to make it sure that the maintainer will not forget to cut off power before starting to crank the machine, a protective device is provided, such that the maintainer cannot insert the crank 106 until he has operated a circuit controller which acts to open the common return connection for the switch machine. In the particular arrangement illustrated, this protective device comprises a guard plate 108 pivoted to the supporting member 27 which normally prevents the insertion of the crank 106 until moved to bring the hole in said guard plate over the bore in the pinion 29. This guard plate 108 is connected by an arm 109 and a rod 110 to a suitable circuit controller (see Figs. 3ᴬ and 4ᴬ). As shown, this circuit controller comprises contact springs 111 fastened by binding posts to a block of insulating material 112, which is fastened to the end wall of the gear frame GF, said block of insulating material also serving to guide the end of the rod 110. An insulated contact member or disc 113 is attached to the rod 110 and is adjusted to contact with the contact springs 111 when the guard plate 108 is in the normal position shown in Fig. 3ᴬ and to break such contact when said plate 108 is moved to insert the crank 106. Obviously, this protective circuit controller cannot be closed while the crank is in place, so that it is not possible for power to be applied to the switch machine while the maintainer is cranking it over.

The crank 106 is also used in connection with the adjustment of the clutch K. This

adjustment is accomplished as follows: After the crank 106 has been inserted, it is turned to bring the set screw 114 engaging a notch in the adjusting nut 45 (see Fig. 9) into position to be reached and backed off; and then the crank is turned until a hole 115 (see Fig. 9) is directly under a hole 116 in a lug integral with the supporting member 27 (see Fig. 4A). A rod or other appropriate tool is now inserted through the hole 116 into the hole 115 in the nut 45; and while thus holding the nut 45, the crank 106 is turned in either direction, according to the adjustment required, to rotate the bevel gear 33 through the medium of the shaft 30 and the parts of the friction clutch K, to screw the nut 45 into or out of said bevel gear 33 and thus vary the tension of the spring 43. After completing the desired adjustment, the nut 45 is brought to the position where the locking screw 114 again registers with the notch in said nut, whereupon the parts may be locked as before in the new adjusted position. The adjusting nut 45 is preferably provided with a fine thread, so that the desired adjustments may be obtained by turning said nut one or more complete revolutions; but obviously, by the addition of other locking notches still finer adjustments could be obtained.

Operation.—The operating and indication circuits used with my improved switch machine are shown in a simplified and diagrammatic manner in Fig. 19, the well known safety magnet, indication selector, polarized cross-protection relay, and the like, usually employed in a complete system being omitted to avoid complication. The switch machine is controlled from the tower by the usual lever L, which is moved back and forth by the operator. The construction of this lever L, the indication latch mechanism, the indication magnet 117 and other parts associated therewith are well known, and since they form no part of this invention, they will not be described, except in so far as may be necessary to make the operation of the switch machine clear. The controlling lever L has four positions, namely, "normal," "normal indication," "reverse indication" and "reverse," named in the order in which they occur as the lever is pulled outwardly fom the normal position shown in Fig. 19. The indication latch mechanism prevents movement of the lever L beyond either indication position until said latch mechanism is released by energization of the indication magnet 117; and the final movement of the lever L in either direction releases the mechanical interlocking (not shown) through cam slot 118, and up-and-down rod 119.

In describing the operation, reference will be made to the diagram in Fig. 2, which indicates the approximate timing of the different operating parts of the switch machine. In this diagram horizontal distances represent in degrees a complete cycle of movement of the main driving gear 18 and the short vertical lines intersecting the horizontal lines point out when a change is made in the condition of the operating part corresponding to this horizontal line. Figs. 15, 16, 17 and 18 show diagrammatically the various positions which the driving pin 23, the throw bar TB, the locking plunger LP, and the lock rod LR, together with the mechanism for operating the circuit controller assume at different times during the movement of the main gear 18 through one complete cycle of operation.

With the parts of the switch machine in the normal position as shown in Figs. 14, 15 and 19, the operation of the switch machine in throwing the switch from normal to reverse is as follows: The controlling lever L is pulled out, to the left as viewed in Fig. 19, to the reverse indication position, and contact blocks 120 and 121 secured thereto contact with the pairs of contact springs 122 and 123, respectively, thereby establishing a reverse operating circuit for the motor M. In tracing this and other circuits, the several contact fingers 60 and contact pieces 71 of the circuit controller will be given different numbers. This reverse operating circuit may be traced as follows: commencing at one terminal of the operating battery 124, conductor 125, contact springs 123 and contact block 121, conductors 126, 127 and 128, contact springs 129—131 and contact piece 130, conductors 132 and 133, armature of the motor M, conductors 134 and 135, contact springs 136—137 and contact piece 138, conductors 139 and 140, field of the motor M, conductors 141 and 142, contact springs 111 and contact disc 113, and common 143 and conductor 144 back to the other terminal of battery 124.

The motor M, being supplied with electric current, its armature shaft 35 drives the bevel pinion 34, bevel gear 33, friction clutch K, shaft 30, pinion 29, intermediate gear 28, shaft 26, pinion 25, main gear 18 and pin 23. The pin 23 is moved by the main gear 18 in a circular path (indicated by a dot and dash line in Figs. 14 and 15) in a clockwise direction, as indicated by the arrow in Fig. 15. For about the first forty degrees of revolution of the main gear 18, the motor M runs freely without moving any part of the switch machine other than the gears in the gear train, since the roller 24, on the driving pin 23, follows the curved portion of the rear edge of the cam slot 54 which is formed on the arc of a circle concentric with the circular path of the driving pin 23.

After this free run of the motor armature, the lower roller 24 on the driving pin 23 strikes the edge of the cam slot 54 of the locking plunger LP, and during the next part of the movement of the driving pin 23 (from about 40 degrees to about 110 degrees) the locking plunger LP is moved to its unlocked position shown in Fig. 16. During approximately the first half of the forward movement of the locking plunger LP (from about 40 degrees to about 75 degrees) the locking dog 56 is carried out of engagement with the corresponding notches in the lock rod LR, and the locking dog 57 is carried out of engagement with the shoulder 58 of the throw bar TB, thereby unlocking the switch points. During the first part of this forward movement of the locking plunger LP, before the unlocking of the switch is completed, the beveled end of one of the guiding strips 59 (see Fig. 14), engages the roller 93 on the contact shifter CS and causes said shifter to be turned about its supporting pin 87, in a counterclockwise direction, to the middle position shown in Figs. 16 and 17. The contact shifter CS is held in its middle position until the switch has been completely thrown and again locked, for the purpose explained more fully hereinafter. This movement of the contact shifter CS to the middle position moves the contact carrier 62 of the reversing circuit controller to the middle position, to permit reversal of the switch in midstroke, as more fully explained hereinafter, but does not change the contact carrier 61 of the operating circuit controller, merely taking up the lost motion between the side member 86[a] of the contact shifter CS and the operating arm 90 (see Fig. 16). The movement of the contact shifter CS to its middle position also forces the plunger bolt 97 of the normal selecting plunger SP on the lock rod LR back to the retracted position shown in Fig. 16, the lock dog 56 having been moved out of the way; and the cooperation of the spring-pressed ball 101 and notch 100, hereinbefore described, forces the plunger bolt 97 to the proper position and holds it there.

After the throw bar TB and the lock rod LR have been unlocked, the locking plunger LP continues its outward movement to a point (at about 110 degrees) in the travel of the pin 23, in an idle movement which serves to complete the operation of the detector bar. During this idle movement of the locking plunger LP, the upper roller 17 on the driving pin 23 enters the laterally opening jaw 16 in the throw bar TB, and at a point (about 105 degrees) in the travel of said pin, just before the locking plunger LP completes its forward movement, said roller 17 strikes the lower edge of said jaw 16 (see Fig. 16), and starts to move the throw bar. Due to the lost-motion connection between the throw bar TB and the switch points 2—2[a] (see Fig. 1), the first part of the movement of the throw bar TB does not move the switch points; but after this lost motion is taken up, the switch points are thrown.

As the switch points 2—2[a] are moved, the lock rod LR, being connected to them, also moves and causes the normal notches of said lock rod to be moved out of alignment with the locking dog 56 and the reverse notches to be moved into said alignment. Likewise, the normal selecting plunger SP on the lock rod LR is shifted out of alignment with roller 95 on the contact shifter CS, and the reverse selecting plunger SP is brought into alignment with the roller 95[a] on the opposite side of said contact shifter CS (see Fig. 17). If for any reason the plunger bolt 97 of the reverse selecting plunger should fail to be in its retracted position after having been previously actuated, this plunger bolt might strike roller 95[a] and cause premature shifting of the contact shifter CS. To obviate such a difficulty, fixed lugs 200 with inclined faces are provided on opposite sides of the supporting frame 81 (see Figs. 3[B] and 10), and the inclined faces of said lugs engage the tappet bolt 98 and positively force it to its correct position as it moves with the lock rod LR.

Shortly before the throw bar TB has reached its extreme position (at about 218 degrees), the lower roller 24 on the driving pin 23 strikes the rear edge of the cam slot 54 in the locking plunger LP and commences the return movement of said locking plunger; and after the throw bar TB reaches the end of its movement, the locking dog 57 is in position to pass behind the shoulder 58 of the throw bar TB and likewise the locking dog 56 is in position to enter the reverse notch of the lock rod LR so as to lock the switch. The actual locking of the switch starts at about 245 degrees and is completed at about 290 degrees.

During this final locking movement of the locking plunger LP, the contact shifter CS is released from the guiding strips 59, and the lock dog 56 strikes plunger bolt 97 of reverse selecting plunger SP (which is now in alignment with roller 95[a]) and causes a further turning of said contact shifter CS in the counterclockwise direction to the position shown in Fig. 18. This shifts the contact carrier 62 to the extreme reverse position, opposite to that which it originally occupied. The arm 90 and contact carrier 61 are likewise simultaneously rocked by this final movement of the contact shifter CS to the reverse position. This interrupts the supply of current to the motor M at the contact springs 129—131 and 136—137, but the armature of motor

M and the connected gearing continue to revolve, due to the acquired momentum, until its movement is arrested by the generation of the indication current, as hereinafter explained. The tongue 55 on the cam face of the locking plunger LP is provided to limit the movement of the roller 24 and the main gear 18, in case the motor armature should not be snubbed by the generation of the indication current for any reason, in order to obviate any possibility of the roller 24 over-running so far as to strike the other edge of the cam slot in the locking plunger and unlock the machine.

When the operating contact pieces 130 and 138 attain their reverse position, a circuit for the indication current is established as follows: commencing at the right-hand brush of the armature of the motor M, conductors 133 and 145, contact springs 146—147 and contact piece 138, conductors 148 and 140, field of the motor M, conductors 141 and 142, contact springs 111 and contact disc 113, conductors 143 and 149, indication magnet 117, conductor 150, contact springs 122 and contact block 120, conductors 151, 152 and 153, contact springs 154—155 and contact piece 130, and conductors 156 and 134 back to the other brush of the armature of motor M.

This circuit places the motor M in a closed circuit with the indication magnet 117, so that the motor acts as a generator, and sends current through the indication magnet to release the reverse indication latch of the controlling lever L, thereby enabling the operator to move his lever L to its full reverse position and release the mechanical interlocking.

Substantially the same movements of the different parts of the switch machine occur when the switch is thrown from its reverse to its normal position, and these movements can be easily followed by analogy to those described, the only difference being that the armature of the motor M rotates in the opposite direction and drives the driving pin 23 in the opposite direction.

It is sometimes necessary to be able to reverse the switch machine in mid-stroke, for example, when the switch points are jammed by a lump of coal or the like. This is accomplished by moving the lever L back to its former position to energize one or the other pair of pole-changer coils and shift the contact carrier 61 of the operating circuit controller to its other position electrically. Assuming the switch to be normal, the initial unlocking movement of the locking plunger LP puts the contact carrier 62 of the reversing circuit controller RC in the middle position, as previously described. In this position the pair of contact springs 157—158 is bridged by contact piece 159, and if the controlling lever L is now put back to its normal indication position, a circuit is established through the normal pole changer operating coils 64 as follows:—commencing at one terminal of battery 124, conductors 125 and 160, contact springs 161 and contact block 120, conductors 162, 152 and 163, contact springs 157—158 and contact piece 159, conductor 164, normal pole-changer coils 64, and conductor 165 and the common return connection back to the other terminal of battery 124.

Consequently, the operating circuit controller, being free to move, will be shifted to the normal position and thereby establish the normal operating circuit for reversing the direction of rotation of the armature of the motor M which can be readily traced from analogy to the reverse operating circuit. Thus, the switch machine may be reversed at any time in mid-stroke and the parts restored to their former position. The so-called reversing contacts serve to cut current from the pole-changer coils 63—64 while the switch machine is idle in the normal or reversing position, thus economizing in energy and preventing over-heating of the coils. It should be noted that this reversal may be obtained at any time after the locking plunger LP has moved far enough to shift the reversing contacts to their middle position, which is before the switch has been unlocked. In other words, the operating parts of the switch machine may be restored to their former positions before the switch is unlocked, or at any time thereafter. When a detector bar is used and the presence of a train on the switch prevents throwing said detector bar when current is supplied to the operating motor, the clutch K will slip.

In practice, the switch machine A may be placed on the righthand side of the switch, instead of on the lefthand side, as it is shown in Fig. 1; and in such cases the connections from the switch points to the throw bar TB and lock rod LR would have to extend from the opposite side of the switch machine. Referring to Fig. 1, a hole is provided in each end of the throw bar TB, thus making it possible to make connections at either end without removing the bar or requiring additional or substitute parts. The lock rod LR is likewise adapted for right or lefthand operation, it being merely necessary to remove the selecting plungers, take out the bars of the lock rod and put them in from the other side, the same relative position of the bars being maintained. The selecting plungers are then again attached in the same relative position as before but to the opposite bars, the same tapped holes being used in the bars of the lock rod LR with additional holes, which are provided in the brackets of the selecting plungers (see Fig. 3^B). This pro-

vision makes the switch machine applicable to practical working conditions without changing construction, or requiring the use of additional or substitute parts.

Provision is made in the compartment D for the incorporation of a point detector or other devices which may be desirable to employ in connection with the switch machine; but since the point detector forms no part of the present invention, it has not been illustrated and described. The switch machine, together with the point detector, constitute a self-contained unit of apparatus which can be assembled and wired at the factory ready to put on the ties and connect to a switch. By the appropriate selection of the parts, for example, using one or two lock rods, the switch machine is adaptable for operating single-slip switches, double-slip switches, movable point frogs, or the like.

In addition to possessing all of the desirable features of construction and the essential operating characteristics of switch machines of this type, the improved switch machine embodying my invention is constructed and organized so that the parts are strong and yet light, and those parts subjected to stress are designed with generous proportions and shaped to utilize the material to the best advantage. For example, the throw bar, which is required to transmit all of the forces to operate the switch points, and which is at times subjected to severe shocks, is made extra strong and stiff; and the jaw in this throw bar is shaped and positioned so that the thrust from the driving pin acts substantially on a longitudinal line through the middle of the bar, thereby obviating the likelihood of this bar breaking, bending, or becoming distorted in use. The jaw in the throw bar TB is also shaped so that the driving roller 17 holds it in its thrown position until the locking movement of the locking plunger LP is practically completed. This is accomplished by extending the sides of the jaw, having their faces concentric with the main gear 18 (see Fig. 14), sideways of the throw bar as far as can be done and allow the roller 17 to enter and leave the jaw. This feature avoids unnecessary friction between the lock dog 57 and shoulder 58 on the throw bar TB, reduces the wear on the lock dog and said shoulder, and economizes on the power required to lock up the machine, because otherwise the spring of the switch points or stock rails usually found in practice would force the shoulder of the throw bar tightly against the lock dog 57.

The switch machine is economical in its power consumption and possesses unusual wearing qualities, because the parts have been designed to reduce friction to the minimum, rolling contact being provided wherever practicable. Furthermore, special facilities are provided for supplying oil to the various bearing and guiding surfaces, so that with ordinary maintenance the parts will be properly lubricated.

The parts subjected to wear are provided with ample bearing and guiding surfaces. It will be noted that the locking plunger LP is guided centrally at its ends, thus obviating the possibility of said plunger cramping or binding as it is moved back and forth, such as might occur if it were guided at its edges.

On account of the clearances existing in practice, the space ordinarily available for a switch machine is limited; and one important feature of my invention is the fact that, while the parts are strong and capable of withstanding severe service, the whole construction is compact and occupies such little space that the machine may be applied to any practicable working conditions, regardless of how complicated the track layout may be. This is particularly true of the gearing arrangement, which, it will be observed, takes up very little space for the size and strength of the gears and the degree of gear reduction.

My machine is simple in construction, comprises few parts, and can be easily and cheaply manufactured and assembled. Simple and effective adjustments are provided wherever necessary to take up wear or compensate for the slight errors in the size and location of parts which occur in ordinary manufacture. For example, in the case of the circuit controller, the tappet bolts 98 can be easily and quickly adjusted to obtain the desired and proper movement of the contact carriers; and since the adjustment for the normal and reverse positions is separate, the desired correct movement of the circuit controller can be obtained even though the parts are not precisely accurate in size, shape or alignment. The contact shifter CS, together with the other parts associated with the operation of the contact carriers, comprise few and simple parts operating directly upon each other and not likely to become deranged. The different movements of the contact carriers of the operating circuit controller and the reversing circuit controller are obtained in a simple and reliable manner by a lost-motion connection.

Accessibility of parts for inspection, repair or adjustment is another important feature of my switch machine. It will be noted that the various parts or units are enclosed in separate compartments and are arranged so that, so far as practicable, there may be easy access to the various parts. The clutch K may be readily adjusted, as previously explained, without removing any of the gears or other operating parts. The

clutch and the several gears may be removed, after taking off the supporting member 27, with the exception of the main gear 18; and by taking off the gear frame GF, all of the operating gears may be disassembled, and direct access had to the throw bar TB and locking plunger LP. In the circuit controlling compartment, the wires (not shown) can be arranged in an orderly and accessible way on the shelf 66, so that the various wires and their connections may be readily inspected, and in case of trouble, the defective wires or connections may be located. The various contact fingers 60 may be easily replaced singly, or the whole group of contact fingers on one of the insulated blocks may be removed for inspection, adjustment or repair, without requiring disconnection of the wires. The unit, including the contact shifter CS and the contact carrier 62 of the reversing circuit controller, may be readily removed whenever desired, by merely removing the insulated bars 65 and their contact fingers 60, and then disconnecting the supporting frame 81, whereupon the entire unit may be tilted and pulled up and out. Also, the pole changer coils 63—64 may be readily removed by taking off the cover plates 77, and sliding out the coils.

A still further important feature of my invention resides in the provision of a protective device for preventing supply of power to the switch machine while it is being cranked by the maintainer. This protective device, while simple and not likely to get out of order, is effective to prevent the maintainer inserting his hand crank until the power is cut off, and also to prevent power being applied to the machine while the hand crank is in place.

Various changes, additions and adaptations may be made in the construction of the switch machine shown and described without departing from my invention. For example, alternating current may be used instead of direct current for operating the switch machine; and the machine may be employed for operating a single remote switch, as well as switches in an interlocking plant. No attempt has been made to show or describe the various devices and accessories which might be employed in practice in conjunction with the switch machine, such as a detector track circuit and electric lock instead of the detector bar; and it should be understood that this illustration and description of the invention does not illustrate the various modifications and applications of my invention.

Although I have particularly described the construction of one physical embodiment of my invention, and explained the operation and principle thereof; nevertheless, I desire to have it understood that the form selected is merely illustrative, but does not exhaust the possible physical embodiments of the idea of means underlying my invention.

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

1. A switch machine comprising a driving pin operated in a circular path, and a throw bar connected to the switch points and having a laterally opening jaw for receiving said driving pin, said jaw being shaped and positioned to receive the thrust from said driving pin substantially along the longitudinal center line of said throw bar.

2. A switch machine comprising a throw bar, a driving pin operated in a circular path for operating said throw bar, and a locking plunger having a substantially elliptical shaped cam slot arranged to receive said driving pin, said cam slot being formed with a projecting tongue adapted to limit the movement of said driving pin in its extreme positions.

3. A switch machine comprising a main gear carrying a driving pin, a throw bar connected to the switch points and provided with a jaw adapted to receive said driving pin, a motor and gearing for operating said main gear alternately in opposite directions to reciprocate said throw bar, a locking plunger reciprocated by said driving pin, and rigid means for limiting the movement of said driving pin in its extreme positions.

4. A protective device for a power operated switch machine provided with means for facilitating its manual operation, comprising, in combination with means for supplying power to the switch machine, of means for preventing the application of power while the machine is being operated manually.

5. In a power operated switch machine provided with an element adapted to have a hand crank attached thereto to permit manual operation of the switch machine, means for preventing operation of the switch machine by power, and a protective device associated with said element and compelling operation of said means before the hand crank can be attached.

6. An electrically operable switch machine comprising an operating part adapted to have a hand crank attached thereto to permit manual operation of the machine, protective means normally preventing attachment of the crank, and means for preventing application of current to the switch machine when said protective means is shifted to allow attachment of said crank.

7. An electrically operable switch machine comprising a gear train, one gear of said train being provided with a hub adapted to receive a hand crank, a movable guard nor-

mally covering said hub, and circuit controlling means connected to said guard, whereby said circuit controlling means must be operated before the hand crank can be attached.

8. A power operated switch machine comprising means for facilitating the attachment of a hand crank thereto to permit manual operation of the machine, and manually operable means normally preventing attachment of said crank and adapted when moved out of the way to cut off the supply of power to the switch machine.

9. In an electrically operable switch machine, a circuit controller governed jointly by the lock rod and the locking plunger of the machine, comprising a movable contact carrier, and a plurality of contact fingers cooperating therewith and each including a relatively stiff retaining member and a spring having its free end doubled over said member.

10. In an electrically operable switch machine, a circuit controller responsive to the movement of the lock rod and locking plunger, and comprising a movable contact carrier, a contact shifter for actuating said carrier, and two separate plungers carried by the lock rod and alternately moved into position to shift said contact shifter to its extreme positions.

11. A switch machine comprising a train of gears and provided with means permitting manual operation thereof, a friction clutch included in said gear train, said clutch having a casing driven by the gear train and an adjustable nut for varying the friction of the clutch, and means facilitating the holding of the adjusting nut stationary while the gear train is manually operated.

12. In an electrically operated switch machine, a circuit controller comprising a plurality of fixed contact fingers arranged in two separate rows, a movable contact carrier adapted to cooperate with said fingers, a contact shifter loosely mounted on a vertical shaft for operating said contact carrier, said contact shifter having a roller mounted thereon on each side of the axis of said shaft, two selecting plungers shifted in accordance with the movements of the switch points and each adapted to register with one of said rollers in an extreme position of the switch points, and a locking plunger having a lock dog adapted to engage one or the other of said selecting plungers according to the position of the switch.

13. An electrically operated switch machine comprising a locking plunger, a circuit controller comprising two movable contact carriers, a contact shifter loosely mounted on a vertical shaft and directly connected to one of said contact carriers, means actuated by said locking plunger for moving said contact shifter to its middle position upon the initial unlocking movement of said locking plunger, means operated in accordance with the movement of the switch points and actuated by the final locking movement of said locking plunger for moving said contact shifter to an extreme position, an operating arm loosely mounted on said shaft and directly connected to the other of said contact carriers, and a lost motion connection between the operating arm and said contact shifter.

14. An electrically operated switch machine for operating movable switch points comprising a throw bar, a lock rod connected to the switch points, a locking plunger for locking said lock rod and said throw bar, two separate movable circuit controllers governing the operating and indication circuits, and a contact shifter for shifting said circuit controllers to their different circuit controlling positions, said contact shifter being provided with a lost motion device whereby one of said circuit controllers is operated to a middle position by the initial unlocking movement of said locking plunger and both of said circuit controllers are shifted simultaneously to the extreme position by the final locking movement of said locking plunger.

15. In a switch machine, the combination with a main gear having an eccentric driving pin, of a throw bar having a pair of lateral projections with opposing faces shaped to conform with the path of movement of the pin when the throw bar is in a corresponding extreme position, said throw bar having a laterally opening jaw between said projections and near the longitudinal center line of the throw bar for receiving the driving pin.

16. A switch machine comprising a locking plunger mounted to reciprocate longitudinally in a casing, said plunger having one end thereof forked and having an enlarged head near said end, said enlarged end being provided with a cam slot, and a guide block extending from the casing into the forked end for guiding said end of said plunger.

17. A switch machine comprising circuit controlling means included in the power controlled circuits for the machine, means permitting manual operation of the machine, and means for actuating said circuit controlling means when said first mentioned means is effective.

18. In an electrically operable switch machine, a circuit controller comprising a movable contact carrier, said carrier being mechanically shifted from one extreme position to the other by the locking movement of the locking plunger of the machine, stationary

contact fingers arranged in rows and cooperating with said carrier, and a frame supporting the fingers and having shelves along the ends thereof for carrying the wires connected to said fingers.

19. In an electrically operated switch machine, the combination with a motor and a circuit controller for governing the circuit connections thereto, said circuit controller comprising a plurality of stationary contact fingers and a reciprocatory contact carrier, means for mechanically shifting the contact carrier to its extreme positions in accordance with the movement of the switch points operated by the switch machine; and means including opposed pairs of coils for independently shifting the contact carrier to its extreme positions, a casing having detachable cover plates in its side walls opposite said coils, a pair of tubes extending between said plates and supported thereby, each of said tubes having stops near its middle, said coils being individually and detachably supported on said tubes, and springs between said cover plates and coils against the stops on said tubes and thereby retain the coils firmly in place.

20. In an electrically operated switch machine, the combination with a motor and a circuit controller for governing the circuit connections thereto, said circuit controller comprising a plurality of stationary contact fingers and a contact carrier, means for mechanically shifting the contact carrier to its extreme positions; and means including opposing coils for independently shifting the contact carrier to such positions, a casing having detachable cover plates in its side walls opposite said coils, and a tube extending between said cover plates and supported thereby, said tube having stops near its middle, said coils being individually and detachably supported on said tube between said cover plates and said stops.

21. In an electrically operated switch machine, the combination with a motor and a circuit controller for governing circuit connections thereto, said circuit controller comprising a plurality of stationary contact fingers and a contact carrier, means for mechanically shifting the contact carrier to its extreme positions; and means including opposing pairs of coils and hollow cores to which the carrier is rigidly fastened for independently shifting the contact carrier to its extreme positions, a casing having detachable cover plates in its side walls opposite said coils, and non-magnetic tubes surrounding said cores and supported by said cover plates, said tubes supporting said coils and being provided with a slot near the middle to permit movement of the carrier by said cores.

22. In an electrically operated switch machine, the combination with a motor and a circuit controller for governing circuit connections thereto, said circuit controller comprising a plurality of stationary contact fingers and a contact carrier, means for mechanically shifting the contact carrier to its extreme positions; and means including opposing coils and a hollow core to which the carrier is rigidly fastened for independently shifting the contact carrier to such positions, a casing having detachable cover plates in its side walls opposite said coils, tapered plugs on said plates adapted to magnetically cooperate with said hollow core, and a tube of non-magnetic material surrounding said core and supported by said plug, said coils being individually and detachably supported on the ends of said tubes adjacent said cover plate.

23. A circuit controller construction for switch machines of the type shown and described, comprising a box-like casing, a detachable frame supported by said casing, a movable circuit controller element carried by said frame, and means adapted to be shifted by the movement of the locking plunger for operating said element and also carried by the frame, whereby the circuit controller element and its operating means are removable from the machine as a unit for inspection or repair.

24. A circuit controller for switch machines of the type shown and described and which is controlled jointly by the locking plunger and the lock rod of the machine, comprising selecting plungers carried by the lock rod, yielding means tending to cause said plungers to be in a predetermined position, and means on the locking plunger for engaging said selecting plungers alternately.

25. Operating means for circuit controllers of switch machines of the type shown and described, in combination with a lock rod consisting of two relatively adjustable bars, of brackets connected separately to opposite bars of the lock rod, and plunger bolts carried by said brackets and operated by the locking plunger of the machine.

26. In a switch machine of the type shown and described, a selecting plunger comprising a bracket, a plunger bolt guided in said bracket, an adjustable tappet bolt in said plunger bolt, and spring operated means tending to move and hold the tappet bolt in a predetermined position.

27. In a switch machine, the combination with a circuit controller governing the operating and indication circuits for the machine, of a contact shifter for operating said circuit controller, brackets movable with the lock rod of the machine, and adjustable means carried by said brackets and actuated by the locking movement of the machine for operating said contact shifter.

28. In a switch machine, the combination

with a circuit controller governing the operating circuits of the machine, a lock rod consisting of two relatively adjustable bars, and movable elements separately carried by the opposite bars of the lock rod for operating the circuit controller.

29. In a switch machine, the combination with a circuit controller governing the operating circuits of the machine, a locking plunger having a lock dog, a lock rod comprising two relatively adjustable bars each having a long and a short notch to receive the lock dog, and means carried separately by said bars and adapted to be engaged by the lock dog for operating the circuit controller.

30. A switch machine specially adapted to be used in connection with the conventional switch layout having the usual spacing of ties comprising, a unitary base plate fastened directly to a pair of the ties, separate mechanism casings fastened to the base plate, one of said casings containing operating gearing and the other circuit controlling devices, separately detachable covers for said casings, an enclosed operating motor having its frame secured to the base plate and to one end of the casing for the operating gearing, and separable driving connections between the motor armature and the operating gearing, whereby the motor may be quickly detached without disturbing the rest of the machine.

31. A switch machine comprising operating gearing supported and mounted in a closed casing, a motor for operating said gearing, one of the gears of said gearing having a hub to receive a hand crank, a hole in the casing to allow the insertion of the hand crank, a safety device including a guard plate and a circuit controller, said guard plate preventing the insertion of the hand crank when the circuit controller is in its circuit closing position, and a detachable cover for said hole.

32. In an electrically operated switch machine, the combination with a motor and a circuit controller for governing circuit connections therto, said circuit controller comprising a plurality of stationary contact fingers and a contact carrier, means for mechanically shifting the contact carrier to its extreme positions, and means including opposing coils and a hollow core for independently shifting the contact carrier to its extreme positions, a casing having detachable cover plates in its side walls opposite said coils, tapered plugs on said plates adapted to magnetically cooperate with said hollow core, said coils being supported about said core by said cover plates.

33. A switch machine comprising a circuit controller governing the operating circuits of the machine and including a contact carrier, said contact carrier being shiftable mechanically by the final locking operation of the machine and magnetically by opposing pairs of pole changer coils, and an enclosed casing for said contact carrier and its operating means, said pole changer coils being supported by detachable plates fastened to said casing whereby the coils are removable without disturbing the circuit controller or its operating means.

34. In an electrically operated switch machine, the combination of a casing supporting an enclosed operating gearing including a bevel gear rotatable on a vertical axis, said casing having an opening in its end wall opposite the bevel gear, a motor for operating the gearing having a housing and provided with a horizontally disposed shaft and a bevel pinion thereon extending from said housing, and means detachably fastening said housing of the motor to said casing and maintaining said gears in operative relation, thereby forming a weather proof enclosure for said gears and also permitting quick detachment of the motor, said pinion on the motor shaft being movable through the opening in the end wall of the casing into and out of mesh with said bevel gear.

35. An electrically operable switch machine comprising, a motor having an armature rotating on a horizontal axis, an enclosed housing for said motor, the armature shaft of the motor projecting outside of the housing and having a bevel pinion thereon, an enclosed gear casing having an opening in its end wall through which said pinion may pass, operating gearing in said casing including spur gears rotating on vertical axis and a bevel gear driving the spur gears, and bolts detachably fastening the motor housing to said end wall of the gear casing over said opening therein, said bevel pinion being movable into and out of mesh with the bevel gear as the motor housing is attached and detached.

36. In a switch machine, the combination with a circuit controller governing the operating circuits for the machines, means for operating said circuit controller comprising movable members having V-shaped notches therein and spring-pressed balls cooperating with said notches to bias said members to a predetermined position.

37. In a switch machine, operating mechanism for the circuit controller thereof comprising normal and reverse plungers adjustable in length and biased to a predetermined position.

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