Dec. 12, 1939. W. C. McWHIRTER ET AL 2,183,164

RAILWAY SWITCH OPERATING APPARATUS

Filed June 17, 1937 9 Sheets-Sheet 1

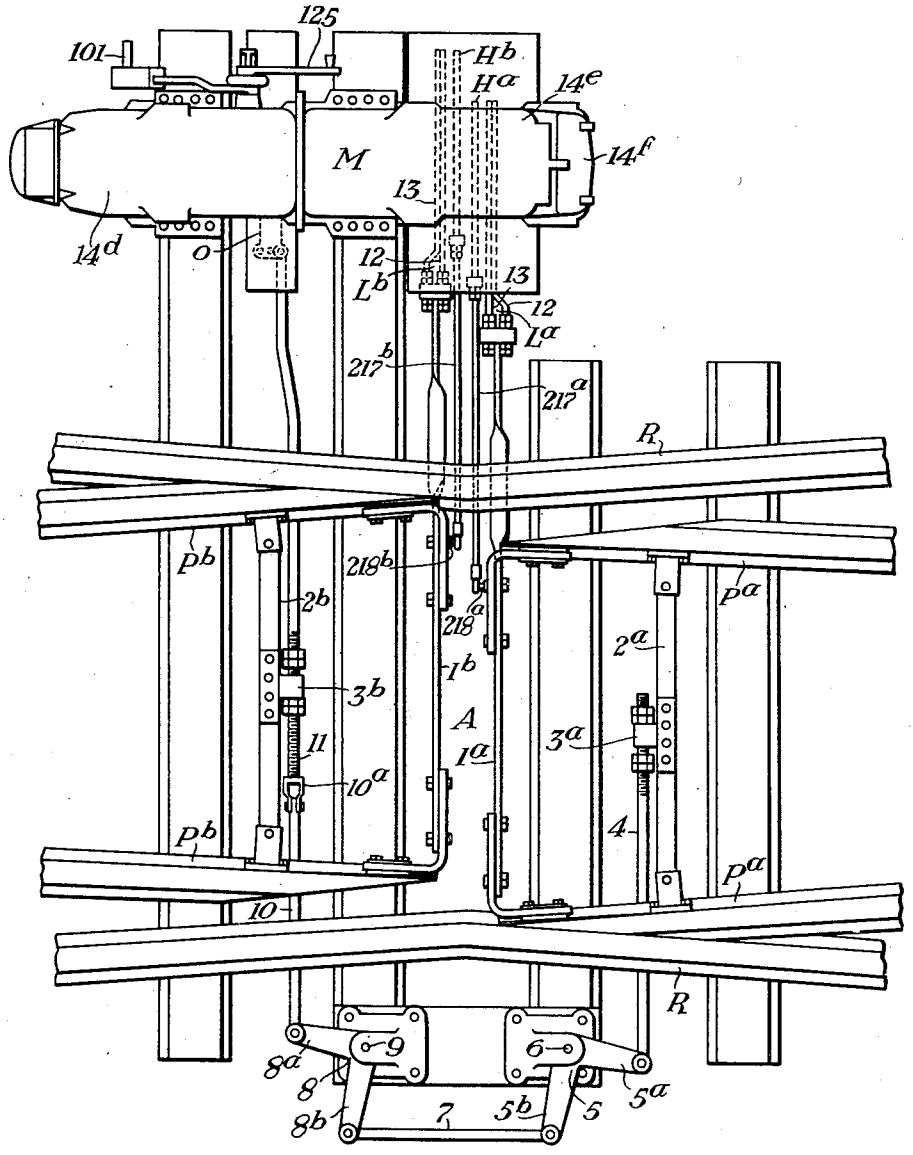


Fig. 1.

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RAILWAY SWITCH OPERATING APPARATUS

Filed June 17, 1937 9 Sheets-Sheet 2

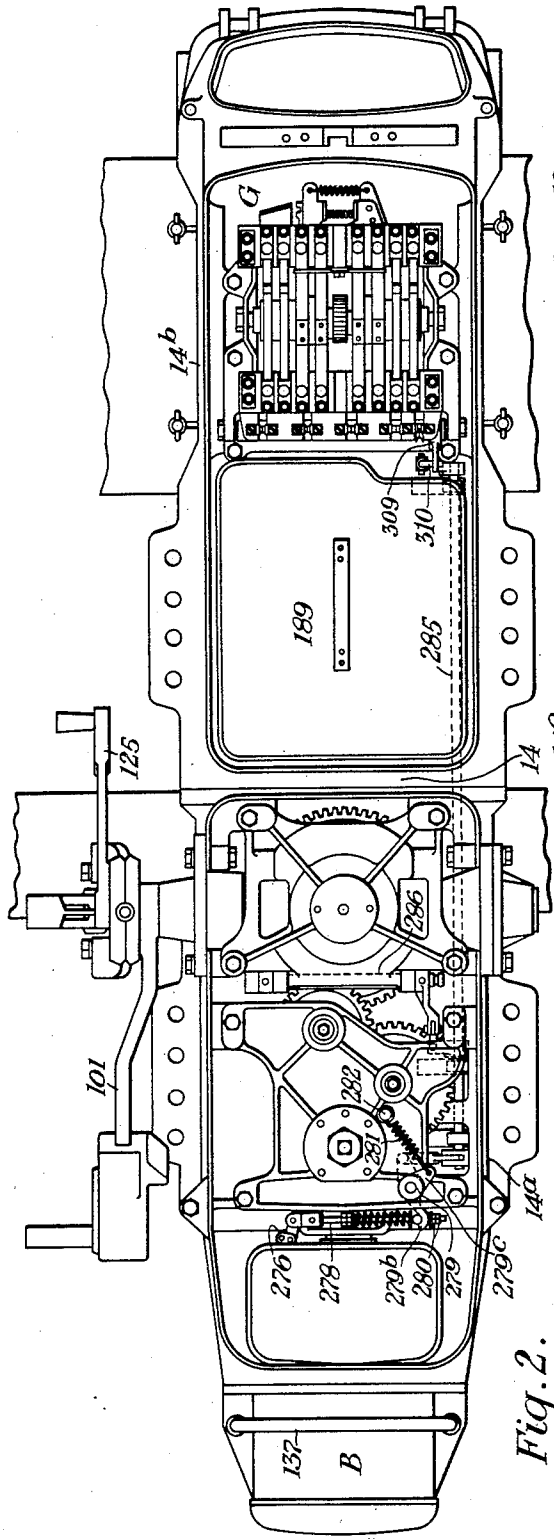


Fig. 2.

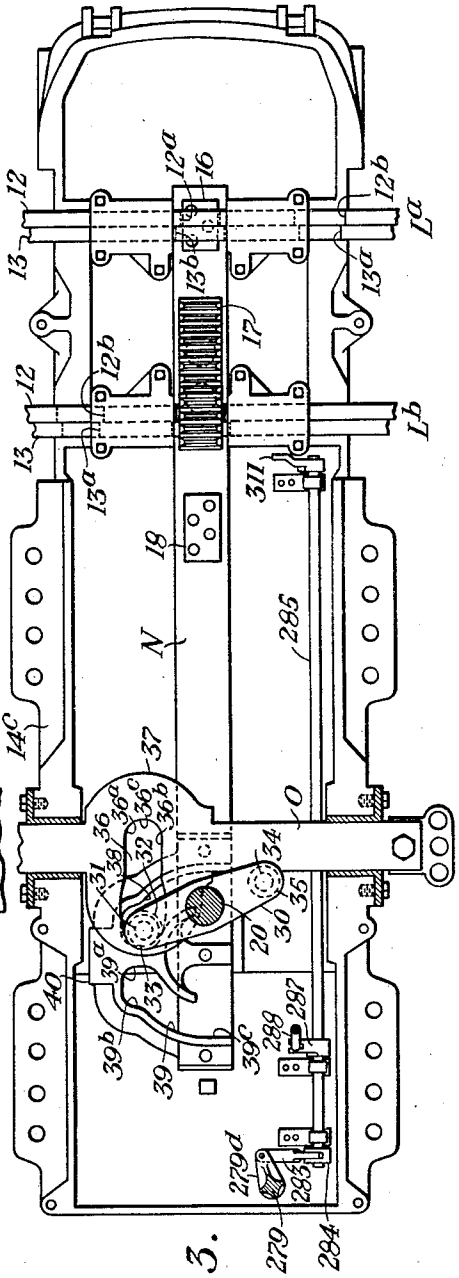


Fig. 3.

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RAILWAY SWITCH OPERATING APPARATUS

Filed June 17, 1937 9 Sheets-Sheet 3

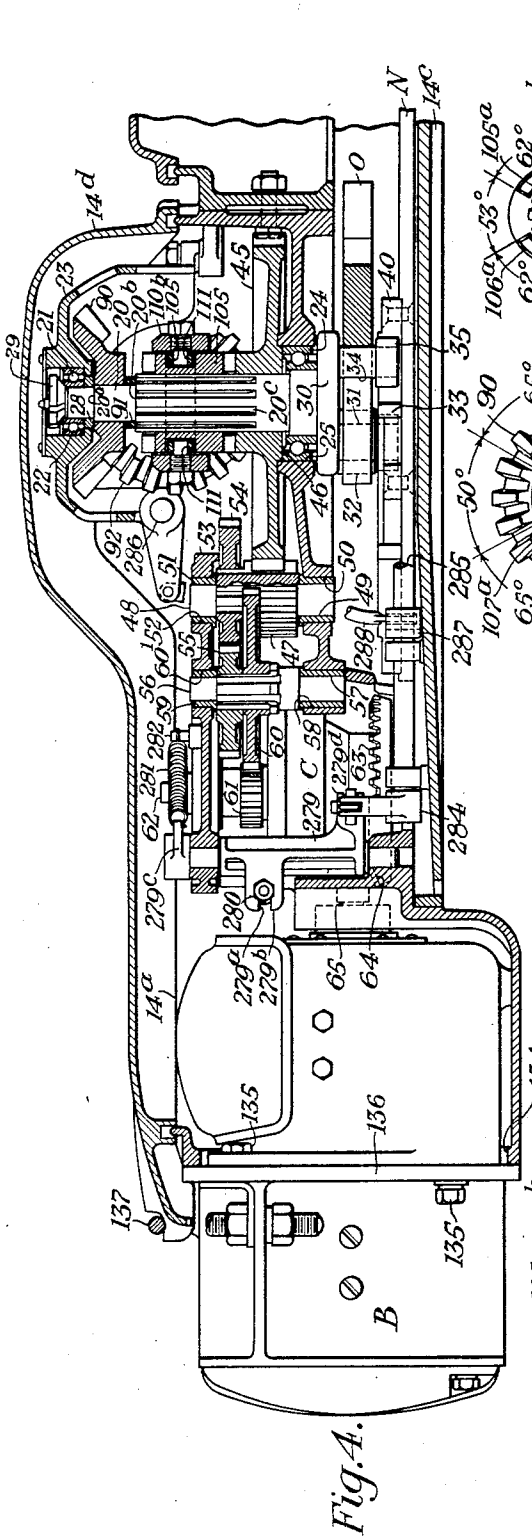


Fig. 4.

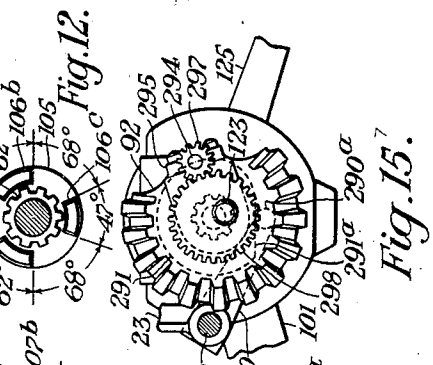


Fig. 12.

Fig. 15.

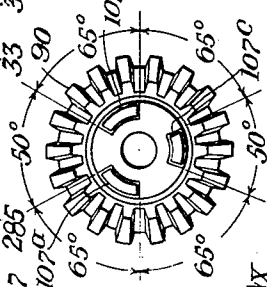


Fig. 11.

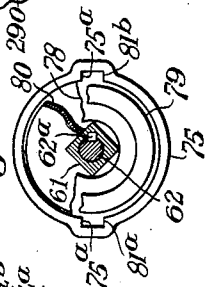


Fig. 10.

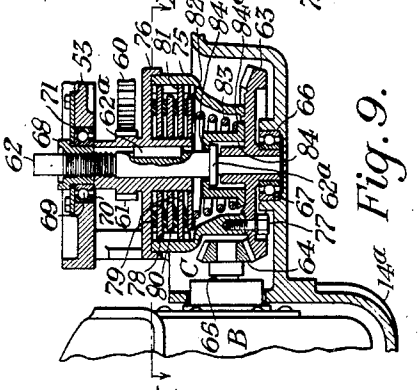


Fig. 9.

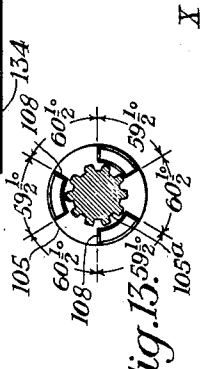


Fig. 13.

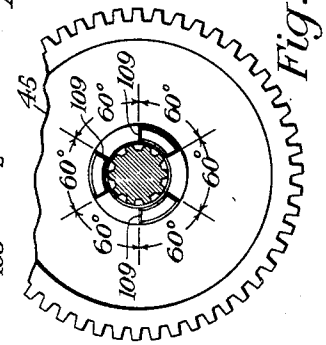


Fig. 14.

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Dec. 12, 1939. W. C. McWHIRTER ET AL 2,183,164

RAILWAY SWITCH OPERATING APPARATUS

Filed June 17, 1937 9 Sheets-Sheet 4

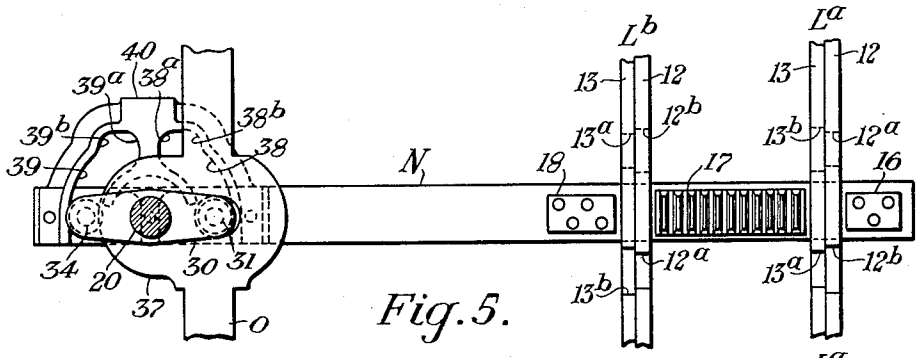


Fig. 5.

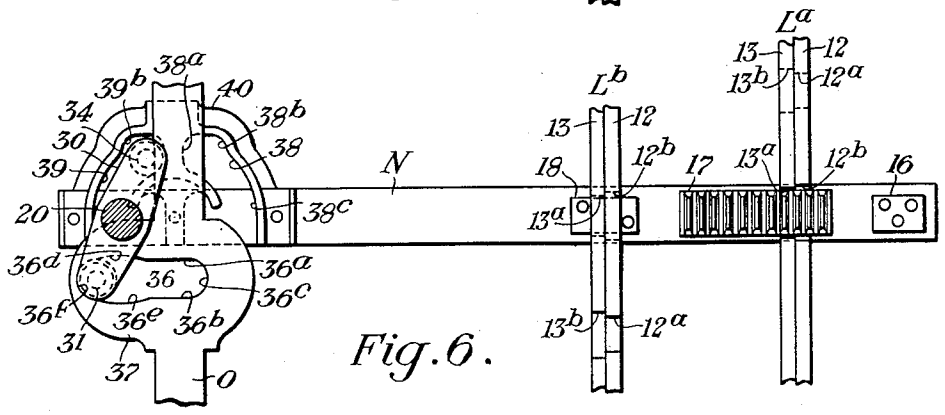


Fig. 6.

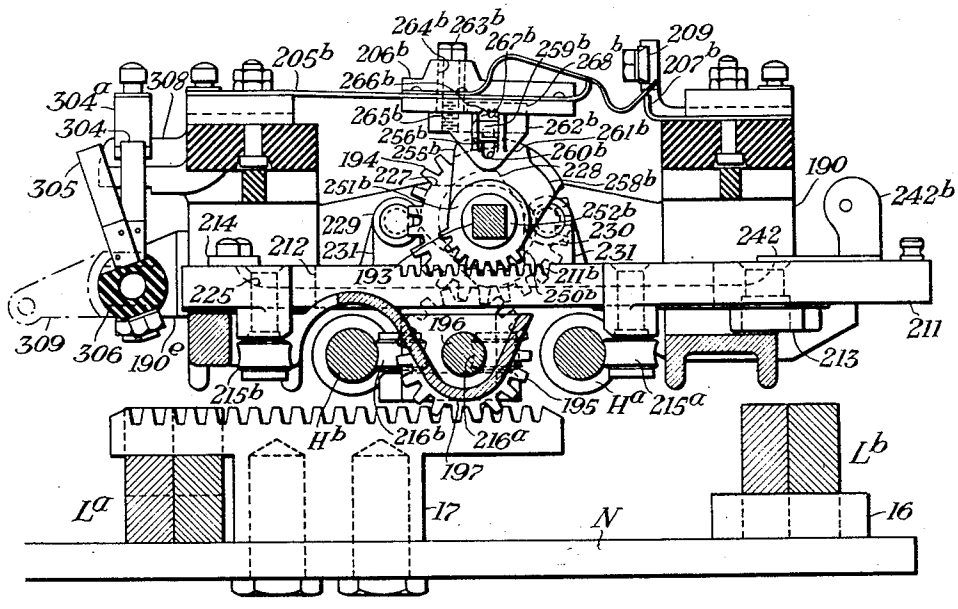


Fig. 23.

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Dec. 12, 1939. W. C. McWHIRTER ET AL 2,183,164

RAILWAY SWITCH OPERATING APPARATUS

Filed June 17, 1937 9 Sheets-Sheet 5

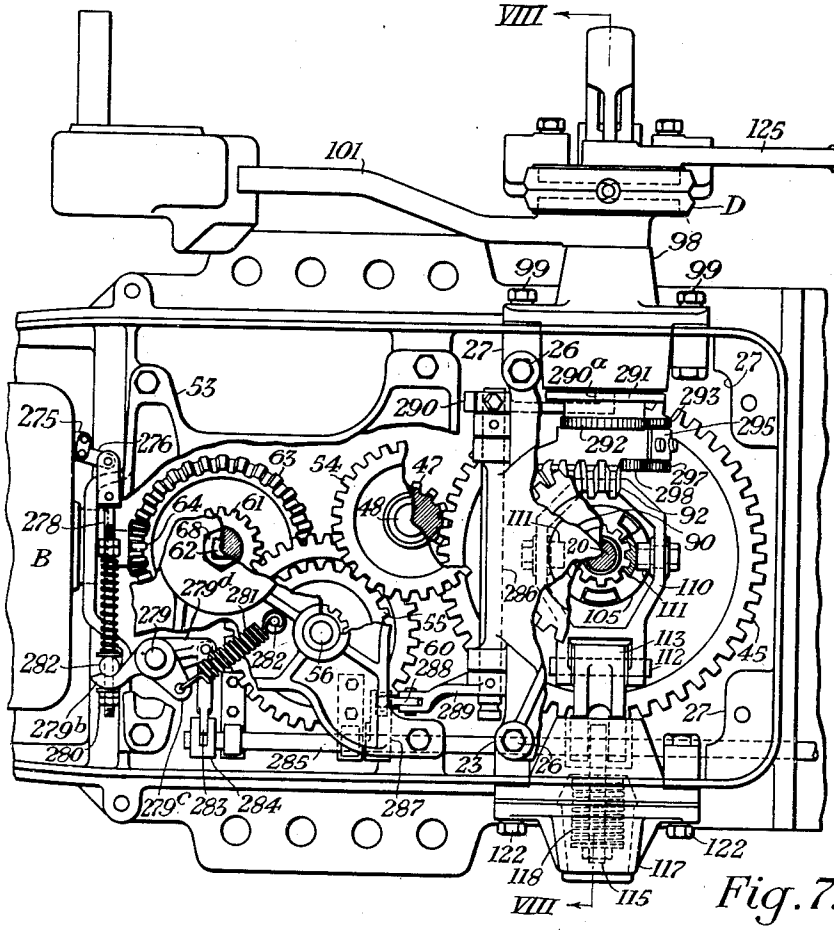


Fig. 7.

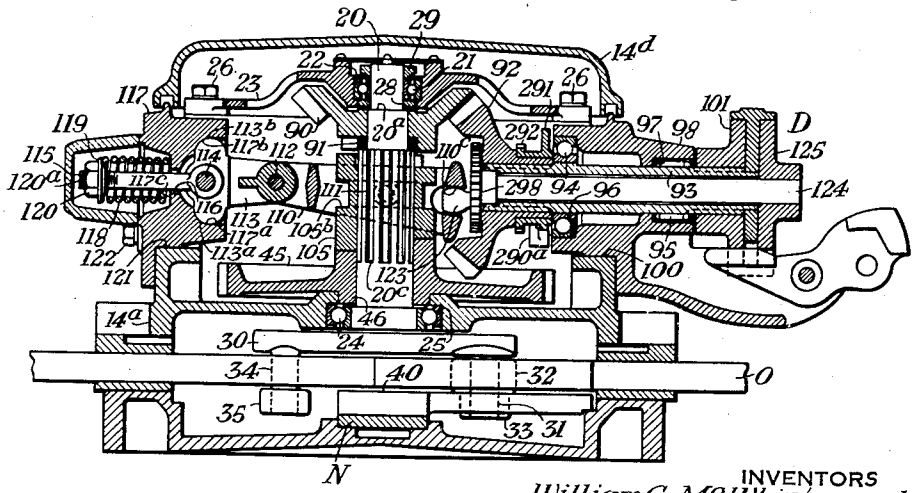


Fig. 8.

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RAILWAY SWITCH OPERATING APPARATUS

Filed June 17, 1937 9 Sheets-Sheet 6

Fig. 16.

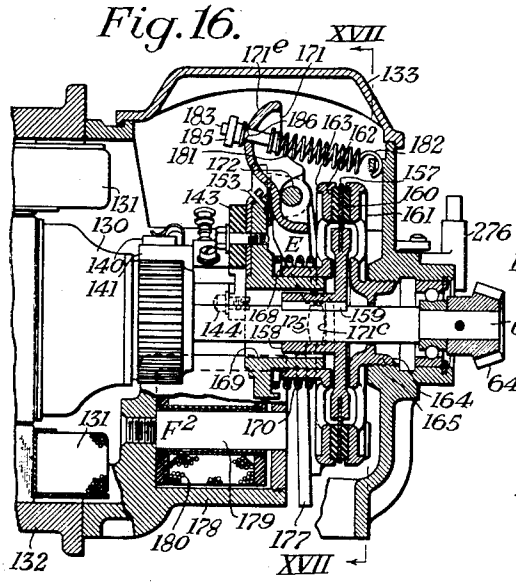
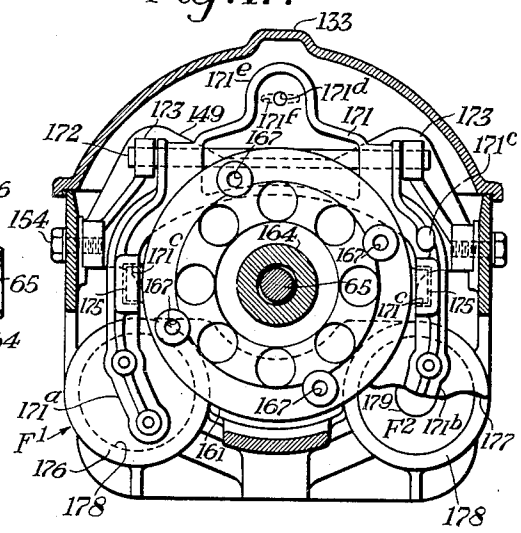


Fig. 17.



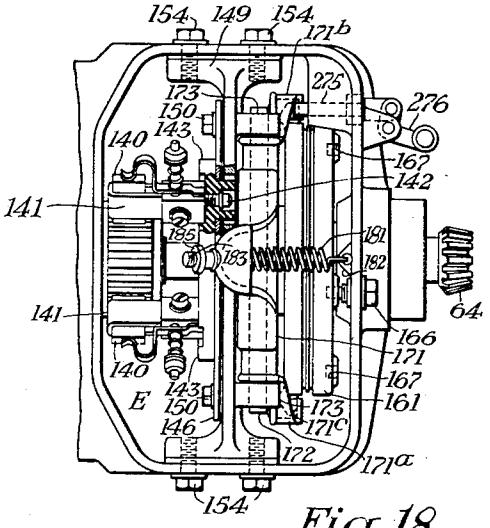


Fig. 18.

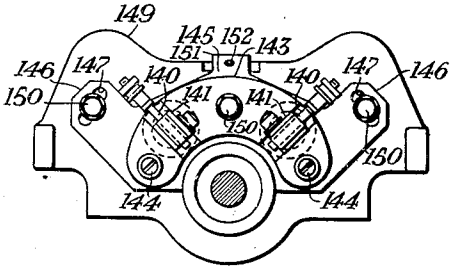


Fig. 19.

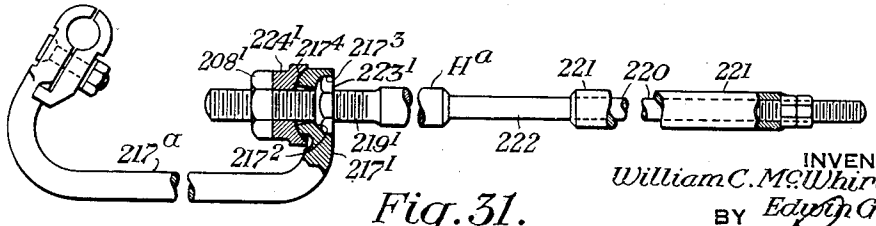


Fig. 31.

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RAILWAY SWITCH OPERATING APPARATUS

Filed June 17, 1937 9 Sheets-Sheet 7

Fig. 20.

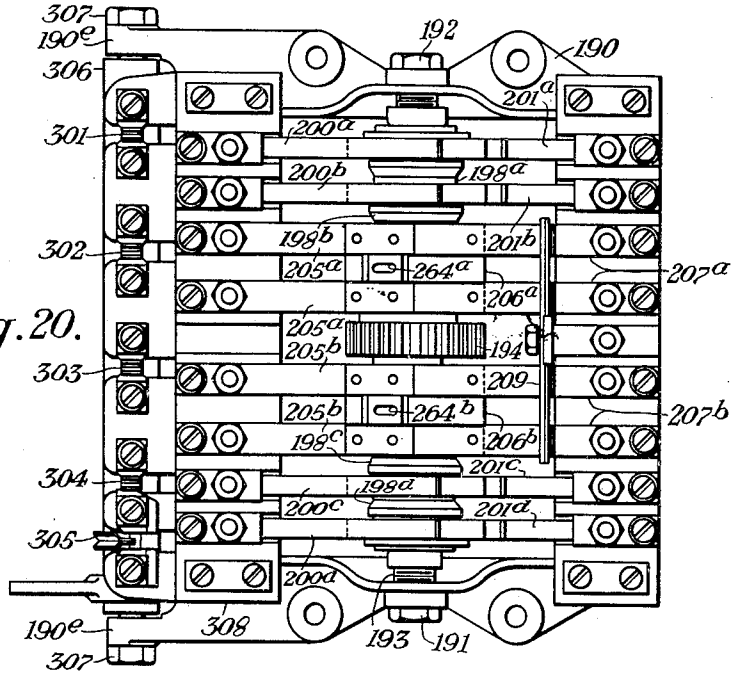
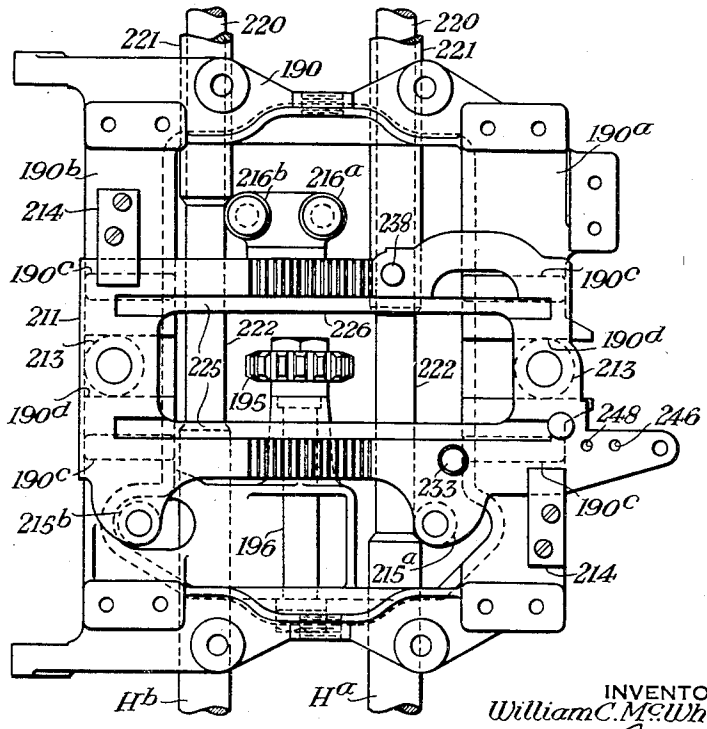


Fig. 21.



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RAILWAY SWITCH OPERATING APPARATUS

Filed June 17, 1937 9 Sheets-Sheet 8

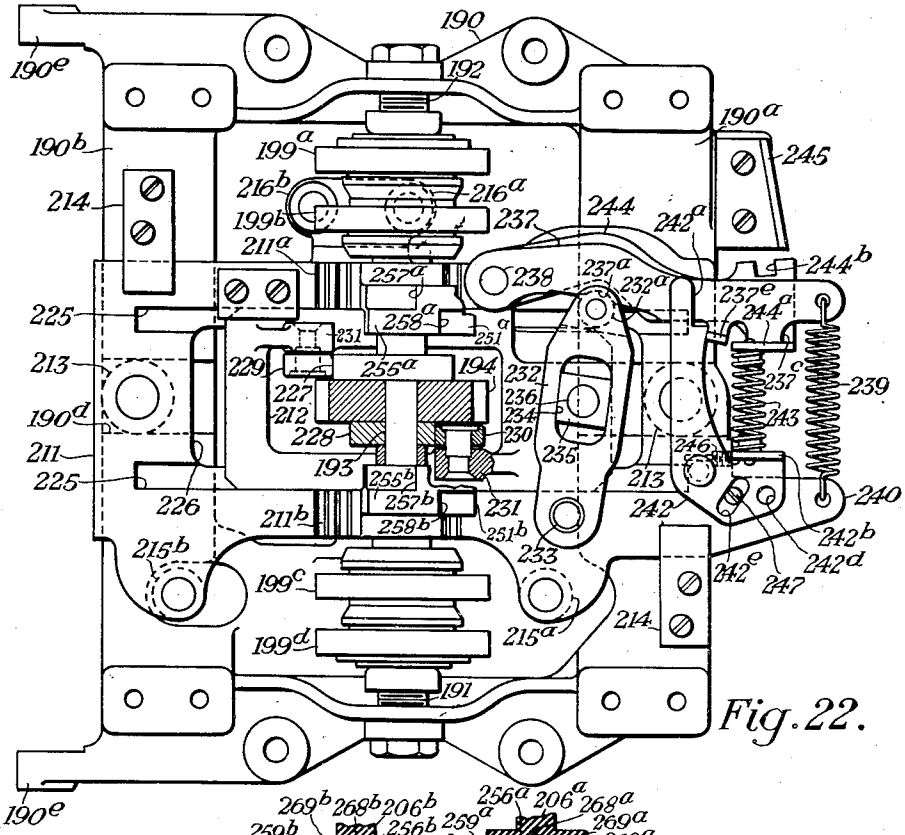


Fig. 22.

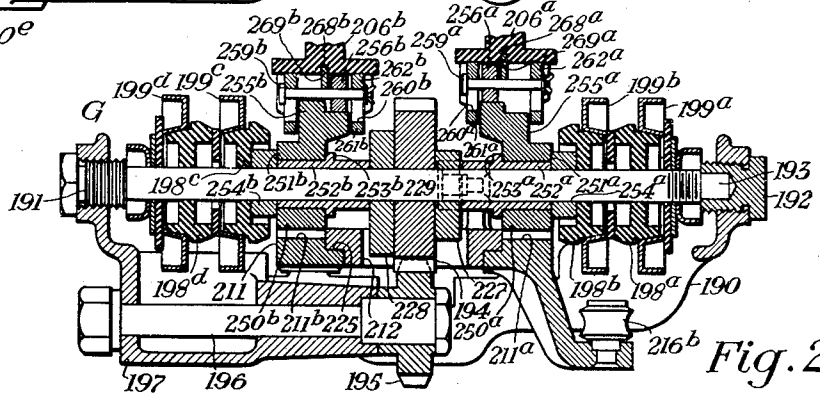


Fig. 24.

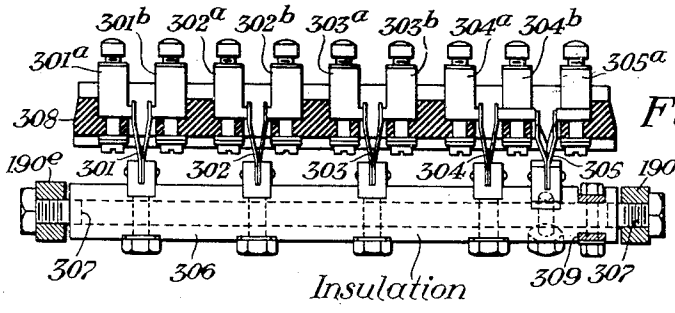


Fig. 25.

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RAILWAY SWITCH OPERATING APPARATUS

Filed June 17, 1937 9 Sheets-Sheet 9

Fig.26.

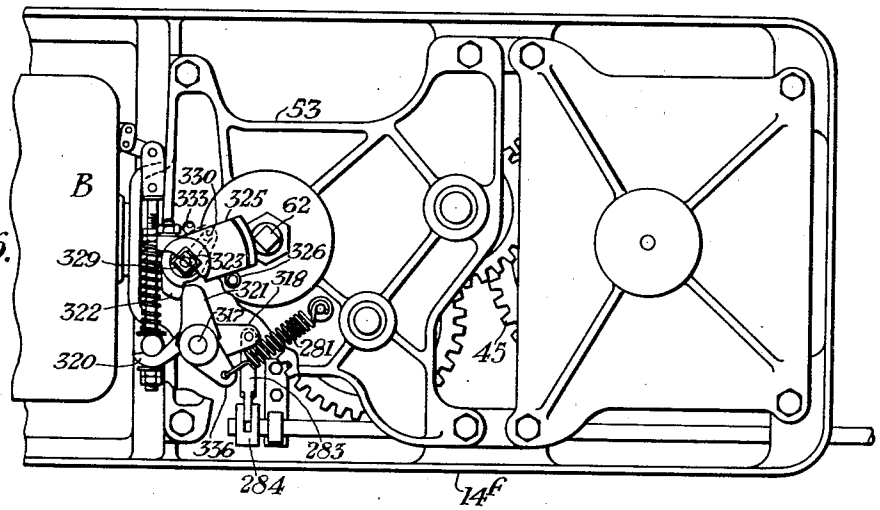
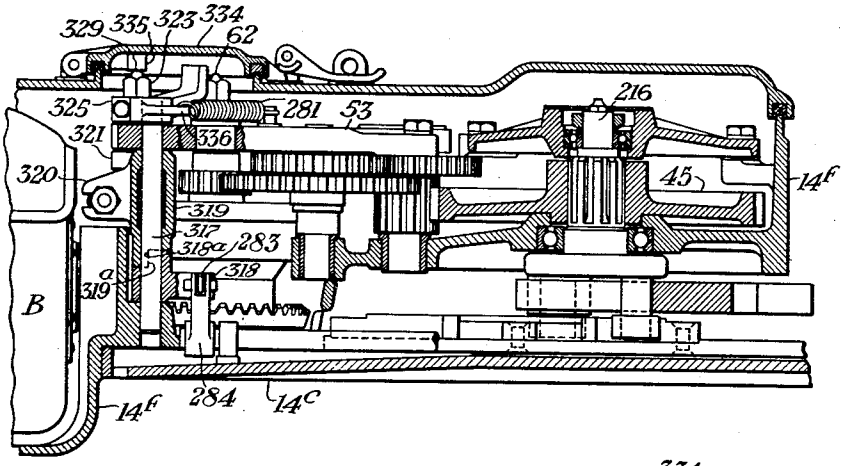


Fig.27.



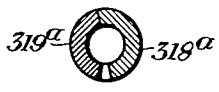


Fig.29.

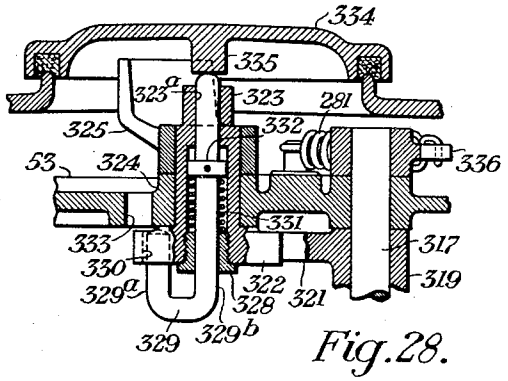


Fig.28.

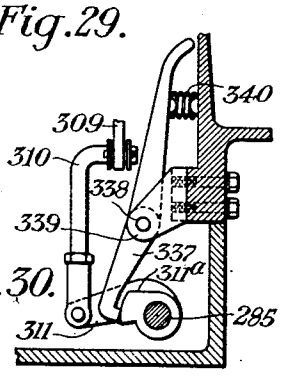


Fig.30.

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Patented Dec. 12, 1939

2,183,164

UNITED STATES PATENT OFFICE

2,183,164

RAILWAY SWITCH OPERATING APPARATUS

William C. McWhirter and Edwin G. Little, Wilkinsburg, Pa., assignors to The Union Switch & Signal Company, Swissvale, Pa., a corporation of Pennsylvania

Application June 17, 1937, Serial No. 148,706

27 Claims. (Cl. 246—242)

Our invention relates to railway switch operating apparatus.

One object of our invention is the provision of an efficient and improved mechanism for operating and locking a railway switch, to meet the requirements of heavier track equipment and rolling stock.

Another object of our invention is the provision of a novel and improved circuit controller for detecting any failure of the switch points to occupy their proper positions relative to the stock rails in either extreme position of the switch.

Another object of our invention is the provision of a novel and improved latching mechanism which may be incorporated into the circuit controller when desired, and which when utilized, provides means whereby, if the indication contacts of the circuit controller are improperly forced open, as by a train trailing the switch, when the switch points are locked in either extreme position, these contacts will be positively held open by the latching device until the latching device is manually operated to release the contacts.

Another object of our invention is the provision of novel and improved means for permitting manual operation of a power operated switch.

Another object of our invention is the provision, in connection with a switch operating motor, of a novel and improved brake including means for normally biasing the brake to a braking condition, electromagnetic means for releasing the brake when the motor becomes energized, and means for at times manually releasing the brake.

Other objects and characteristic features of our invention will appear as the description proceeds.

We shall describe two forms of apparatus embodying our invention, and shall then point out the novel features thereof in claims.

In the accompanying drawings, Fig. 1 is a top plan view showing a frog layout A operated by a switch machine M embodying our invention. Fig. 2 is a top plan view on an enlarged scale of the switch machine M shown in Fig. 1, the covers of the machine being removed to better illustrate the construction and arrangement of the operating mechanism. Fig. 3 is a longitudinal sectional view showing a portion of the operating and locking mechanism of the switch machine illustrated in Fig. 2. Fig. 4 is an enlarged vertical longitudinal sectional view of a portion of the switch machine shown in Fig. 2. Figs. 5 and 6 are detail views showing the operating and locking mechanism illustrated in Fig. 3 in different operating positions. Fig. 7 is a plan view on an enlarged scale of a portion of the operating mechnism of the switch machine shown in Figs. 1, 2, and 3, the cover for the mechanism being removed and certain of the parts being broken away to more clearly illustrate the construction thereof. Fig. 8 is a sectional view taken on the line VIII—VIII of Fig. 7. Fig. 9 is a vertical sectional view of the clutch mechanism C forming part of the switch machine illustrated in the preceding views. Fig. 10 is a sectional view taken substantially on the line X—X of Fig. 9. Fig. 11 is a bottom view of the gear wheel 90 forming part of the mechanism shown in Figs. 7 and 8. Fig. 12 is a top view of the clutch member 105 forming part of the mechanism shown in Figs. 4, 7, and 8. Fig. 13 is a bottom view of the clutch member 105 shown in Figs. 4, 7, and 8. Fig. 14 is a top view of the gear wheel 45 shown in Figs. 4, 7, and 8. Fig. 15 is an end view of the hand-throw and shifter lever mechanism as it appears when viewed from the bottom in Fig. 7. Fig. 16 is a fragmentary vertical sectional view of the motor B and associated brake mechanism forming part of the switch machine shown in Figs. 2 and 4. Fig. 17 is a sectional view taken on the line XVII—XVII of Fig. 16. Fig. 18 is a top plan view with cover removed, of the brake mechanism shown in Fig. 16. Fig. 19 is a detail view showing the brush assembly for the motor illustrated in Fig. 16. Fig. 20 is a top plan view showing, on an enlarged scale, a portion of the circuit controller G forming part of the switch machine M illustrated in Figs. 1 and 2. Fig. 21 is a top plan view showing some of the details of construction of the circuit controller G forming part of the switch machine M. Fig. 22 is a top plan view with the contacts removed, of the circuit controller shown in Figs. 2, 20, and 21. Fig. 23 is an enlarged longitudinal sectional view of the circuit controller G shown in Fig. 2 with certain of the parts removed to better illustrate the construction of the remaining parts. Fig. 24 is an enlarged transverse vertical sectional view of the circuit controller shown in Fig. 2. Fig. 25 is an enlarged end view of a portion of the circuit controller shown in Fig. 2 as it appears when viewed from the left in Fig. 2. Fig. 26 is a top plan view showing a modified form of switch machine embodying my invention. Fig. 27 is a vertical sectional view of the switch machine shown in Fig. 26. Fig. 28 is a detail vertical sectional view of latch mechanism forming part of the modified form of switch machine illustrated in Figs. 26 and 27. Fig. 29 is a detail horizontal

sectional view of a portion of the latch mechanism forming a part of the modified form of switch machine illustrated in Figs. 26 and 27. Fig. 30 is a detail view showing other latch mechanisms forming part of the modified form of switch machine illustrated in Figs. 26 and 27. Fig. 31 is a detail view showing on an enlarged scale the detector rod H^a and associated connecting rod 217^a forming part of the switch operating apparatus illustrated in Fig. 1.

Similar reference characters refer to similar parts in each of the several views.

Referring first to Fig. 1, the reference character A designates a movable point frog, and the reference character M designates a switch machine embodying our invention for operating the frog A.

The frog A is of standard construction, and comprises the usual stock rails RR between which are movably mounted two pairs of switch points P^a P^a and P^b P^b, respectively, such pairs being disposed in opposed relation and having their confronting ends connected by front rods 1^a and 1^b, respectively. The switch points P^a P^a are also connected together by the usual head rod 2^a, and the switch points P^b P^b are similarly connected together by the usual head rod 2^b. The head rod 2^a, in turn, is connected through the usual switch basket 3^a with one end of a throw rod 4, the other end of which is pivotally connected to one arm 5^a of a bell crank lever 5. The bell crank lever 5 is pivotally supported in the trackway at 6, and the other arm 5^b thereof is connected, by means of a connecting link 7, with the corresponding arm 8^b of a similar bell crank lever 8 which is pivotally supported in the trackway at 9. The remaining arm 8^a of bell crank lever 8 is connected, by means of a connecting rod 10 and a screw jaw 10^a with a throw rod 11, which throw rod, in turn, is connected with the head rod 2^b by means of a switch basket 3^b. The throw rod 11 extends under one switch point P^b and the one stock rail R, and is connected at its free end with the longitudinally movable operating rod O of the switch machine M. It will be apparent, therefore, from an examination of the drawing that when the operating rod O is actuated by the switch machine, the switch points P^a P^a and P^b P^b will be simultaneously reversed.

The upper ends of the front rods 1^a and 1^b extend underneath the stock rail R and are operatively connected with two lock rods L^a and L^b which project into the switch machine M. These lock rods are of standard construction, and each comprises two longitudinally adjustable bars 12 and 13 arranged side by side. Each bar 12 is provided in its opposite edges with a short notch 12^a and a long notch 12^b and each bar 13 is similarly provided in its opposite edges with a short notch 13^a and a long notch 13^b. The two notches in each bar are spaced apart a distance which is substantially equal to the switch stroke, and the bars are so adjusted that the long notch in each bar is disposed directly opposite the short notch in the other contiguous bar.

Referring now to Figs. 2, 3, and 4, the switch machine, in the form here illustrated, comprises a suitable casing 14 consisting of two separate box-like castings 14^a and 14^b secured to a base plate 14^c. The casting 14^a is closed at its upper end by a removable cover 14^d, and the casting 14^b is closed at its upper end by removable covers 14^e and 14^f (see Fig. 1). The base plate 14^c is secured to two adjacent ties at the outer side of the rail 1, and formed partly in the base plate and partly in the castings 14^a and 14^b are suitable guideways which slidably receive the operating rod O and the two lock rods L^a and L^b. Slidably mounted in the base plate 14^c directly below the operating rod O and the two lock rods L^a and L^b, and intersecting the operating rod O and the two lock rods L^a and L^b at right angles, is a slide bar N. Attached to or formed integral with, the upper side of this slide bar near its right-hand end, as viewed in Fig. 3, are three spaced locking dogs 16, 17, and 18, the two outer ones of which 16 and 18 are in the form of rectangular blocks, and the middle one of which 17 is in the form of a T-shaped block having its upper surface formed with rack teeth for a purpose which will appear hereinafter. The locking dogs 16, 17, and 18 are adapted to selectively enter certain ones of the aligned notches in the bars 12 and 13 to lock the switch points of the movable frog A in their extreme positions in a manner which will be described in detail hereinafter.

For the purpose of actuating the operating rod O and the slide bar N to effect their respective operating and locking functions in the intended manner, we provide an operating mechanism comprising a vertically disposed switch actuating shaft 20, the upper end of which is journaled in a ball bearing 21 (see Figs. 4 and 8) disposed in a bearing recess 22 formed in a bearing plate 23, and the lower end of which is journaled in a ball bearing 24 disposed in a bearing recess 25 formed in the bottom wall of the casting 14^a. The bearing plate 23 is secured by means of bolts 26 to lugs 27 formed on the side walls of the casting 14^a. The portion of the shaft which is journaled in the bearing 21 is reduced in diameter, and interposed between the lower side of the bearing 21 and a shoulder 20^a which is formed at the lower end of the reduced portion of the shaft 20 is a thrust washer 28, the function of which will become apparent as the description proceeds. The bearing 21 rests at its underside on a shoulder formed at the bottom of the bearing recess 22, and screwed onto the shaft above the bearing is a nut 29. It will be seen, therefore, that the shaft 20 is suspended from the bearing plate by means of the bearing and the nut 29. The shaft 20 is disposed with its axis located at one side of the point of intersection of the operating rod O and the slide bar N, and is provided at its lower end with a crank 30 which is formed integrally with the shaft. This crank extends in opposite directions from the shaft, and is provided at one end with a depending pin 31 which carries two rollers 32 and 33, and at the other end with a depending pin 34 which carries a roller 35. The roller 32 cooperates with a slot 36 which extends longitudinally of a cross arm 37 formed integrally with the operating rod O, while the two rollers 33 and 35 cooperate respectively with oppositely disposed arcuate slots 38 and 39 formed in a motion plate 40 which is secured to the upper side of the slide bar N adjacent its left-hand end. The slot 36 is provided with straight side wall portions 36^a and 36^b which extend from its medial portions to its right-hand end where these straight side wall portions merge into a curved end portion 36^c, and with outwardly curved side wall portions 36^d and 36^e which describe an arc, and which extend from the medial portion of the slot to its left-hand end where these curved side wall portions merge into a curved end portion 36^f. The

confronting ends of each of the two arcuate slots 38 and 39 in the motion plate 40 are formed with relatively short straight parallel portions 38^a and 39^a, and with curved offset portions 38^b and 39^b. The opposite ends of the slots 38 and 39 terminate at their outer sides in straight parallel portions 38^c and 39^c.

The operation, as a whole, of the portion of the switch machine thus far described is as follows: When the operating rod O and the slide bar N are in their normal positions in which they are shown in Fig. 3, and the switch points are in their corresponding positions in which they are shown in Fig. 1, the locking dogs 16, 17, and 18 and the lock rods L^a and L^b occupy the relative positions in which they are shown in Fig. 3. That is to say, the locking dog 16 is within the lower pair of notches in the lock rod L^a, and the locking dog 17 is within the upper pair of notches in the lock rod L^b. It will be readily understood that under these conditions, any thrust on the switch points tending to move them away from their normal positions, such for example, as a thrust due to an improper trailing move will be resisted by the dogs 16 and 17, and it follows, therefore, that the switch points are securely locked in their normal positions by the dogs 16 and 17.

When it is desired to reverse the switch points, the shaft 20 is rotated in a clockwise direction to rotate the crank 30 in the same direction. This rotation of the crank 30 causes the roller 33 to engage the arcuate slot 38 at the offset portion 38^b, whereby the slide bar N is moved toward the right, as viewed in Fig. 3 far enough to withdraw the locking dog 16 from the notches 12^a and 13^b in the lock rod L^a, the locking dog 17 being simultaneously withdrawn from the notches 13^b and 12^a in the lock rod L^b, thus unlocking the switch points P^a P^a and P^b P^b. During this movement of the crank the roller 32 whose initial position was at the left-hand end of the slot 36 is moved to the medial portion of the slot, or at the junction of the curved and straight walls thereof, but due to the curvature of the upper curved wall 36^d this movement of the roller does not cause the operating rod O to be moved. It will be seen, therefore, that during the first part of the movement of the crank 30, the slide bar N is moved to unlock the switch points, but the operating rod O, and hence the switch points, remain stationary. However, in the continued movement of the crank 30, the roller 32 engages the straight side wall portion 36^b of the slot 36 in the operating rod O and imparts sufficient movement to the operating rod in the general direction in which the operating rod is being moved to completely reverse the switch points. During the greater part of this portion of the movement of the crank, the roller 33 engages the slot 38 in the motion plate 40 within the curved parallel sides thereof, so that the crank then serves as a locking means for the slide bar N to prevent longitudinal movement of the slide bar. When the switch points have been moved to their midstroke positions, movement of the slide bar N is prevented by engagement of the rollers 33 and 35 with the outer side walls 39^c and 39^c of the two slots 38 and 39 to hold the slide bar N in its intermediate position in which all of the locking dogs are out of engagement with the associated lock rods, as shown in Fig. 5. The movement of the switch points to their reverse positions moves the lock rods L^a and L^b from the relative positions in which they are shown in Fig. 3 to the relative positions in which they are shown in Fig. 6, so that the notches 12^b and 13^a in the lock rod L^a are then in alignment with the locking dog 17, and the notches 12^b and 13^a in the lock rod L^b are in alignment with the locking dog 18. Upon further continued rotation of the crank 30, roller 35 moves into engagement with the straight portion 39^a of the slot 39 in the motion plate 40, and imparts a second movement to the slide bar N in the same direction as the first movement, this latter movement being sufficient to cause the locking dog 17 to enter the notches 12^b and 13^a in the lock rod L^a, and the dog 18 to enter the notches 12^b and 13^a in the lock rod L^b, as shown in Fig. 6, thus locking the switch points in their reverse positions. It should be pointed out that the parts are so proportioned that a sufficient amount of idle travel of the shaft 20 will take place between the time the roller 32 moves out of engagement with the straight side wall portion 36^b of the slot 36 and the time the roller 35 moves into engagement with the straight portion 39^a of the slot 39 in the motion plate 40 to insure that if the locking dogs 17 and 18 are prevented from entering the respective notches in the lock rods L^a and L^b for any reason, due for example, to the lock rods being misadjusted or becoming damaged, the switch movement will not become stalled until after the switch points have reached their full reverse positions and are held in these positions by the coaction between the roller 35 and the slot 39 in the motion plate 40. It should also be pointed out that when the switch points are locked in their reverse positions, any thrust tending to open the points is then taken by the locking dogs 17 and 18, thus insuring an effective locking of the switch points under these conditions. It will be noted from the foregoing that the movement of the operating rod which reverses the switch points is subsequent to the initial movement of the slide bar which unlocks the switch points, but in advance of the final movement of the slide bar which locks the switch points in their reverse positions.

In order to restore the switch points to their normal positions after they have been reversed, as above described, the shaft 20 is rotated in a counterclockwise direction to rotate the crank 30 in this direction. The subsequent movements of the operating rod and slide bar above described are maintained under these conditions, but the directions of the movements are reversed.

A main spur gear 45 (see Figs. 4, 7, and 8) is mounted for rotation coaxially with the switch actuating shaft 20, and is formed with a hub 46 which extends into the bearing recess 25 and cooperates with the upper side of the ball bearing 24 to prevent longitudinal displacement of the spur gear in response to a downward thrust which is at times exerted on this gear in a manner which will appear hereinafter. The gear 45 is driven, through the medium of a train of gears and a friction clutch C, by a motor B which is bolted to the casting 14^a at the left-hand end of the casting. The train of gears in the form here shown comprises a pinion 47 which is formed integrally with a vertical shaft 48, and which drives the spur gear 45. The vertical shaft 48 is journaled at its lower end in a bearing sleeve 49 mounted in a bearing opening 50 formed in the bottom wall of the casting 14^a, and at its upper end in a bearing sleeve 51 mounted in a bearing opening 52 formed in a bearing plate 53 which is bolted to suitable supports provided on

the casting 14a. The shaft 48 is driven by a spur gear 54 which is splined to the shaft 48 above the pinion 47, and which meshes with another spur gear 55 splined to a second vertical shaft 56. This latter vertical shaft is journaled at its lower end in a bearing sleeve 57 mounted in a bearing opening 58 formed in the bottom wall of the casting 14a, and at its upper end in a bearing sleeve 59 mounted in a bearing opening 60[1] formed in the bearing plate 53, and has secured thereto a spur gear 60 which is driven by a pinion 61 keyed to a third vertical shaft 62 by means of a feather key 62a (see Fig. 9). The reduction gearing also comprises a bevel gear 63 which meshes with a bevel pinion 64 keyed to the armature shaft 65 of the motor B.

The vertical shaft 62 supports the friction clutch C, and is rotatably mounted at its lower end within the hub of the bevel gear 63 (see Fig. 9). The hub of the bevel gear 63, in turn, is provided with a depending portion which projects into a ball bearing 66 that is disposed in a bearing recess 67 formed in the bottom wall of the casting 14a, whereby the bevel gear is rotatably mounted in the bottom of the casting 14a. The upper end of the shaft 62 is threaded to receive a vertically adjustable bearing sleeve 68, and mounted on this bearing sleeve is a ball bearing 69 which fits loosely within a bearing opening 70 formed in the bearing plate 53. Secured to the bearing plate 53 above the bearing 69 is a plate 71 which serves to retain grease in the bearing 69. The upper end of the bearing sleeve 68 is provided with a polygonal flange to enable this sleeve to be gripped by a wrench or other suitable tool to facilitate adjusting this sleeve.

The friction clutch C comprises a circular housing 75 which surrounds the shaft 62 in concentric relation thereto between the bevel gear 63 and a clutch plate 76 that is formed integrally with the hub of the pinion 61, and which is secured at its lower end to the bevel gear 63 to rotate therewith by means of cap screws 77. The hub of the pinion 61 extends downwardly beyond the clutch plate 76, and the portion of the hub which is disposed below the clutch plate is formed with a square outer surface. Surrounding this square portion of the hub in superposed concentric relation are a clutch facing 79, a driving plate 78, a clutch facing 79, a clutch plate 80, a clutch facing 79, a driving plate 81, a clutch facing 79, and a clutch plate 82. The driving plates 78 and 81 are free to both rotate and move vertically with respect to the square portion of the hub of the pinion 61, and are also free to move vertically with respect to the clutch housing 75, but are constrained to rotate in response to rotation of the clutch housing by means of diametrically opposite protruding ears 81a and 81b which project with some clearance into vertically disposed channels or offset portions 75a formed in the opposite sides of the housing (see Figs. 9 and 10). The clutch plates 80 and 82 are provided with square openings (see Fig. 10) which receive the square portion of the hub of the pinion 61 in such manner that these clutch plates are free to move vertically with respect to the clutch housing and the hub of the pinion, but are constrained to rotate in response to rotation of the pinion. The clutch facings 79 are free to both rotate and move vertically with respect to the pinion 61, and are also free to rotate with respect to the associated clutch and driving plates, whereby the wear is distributed over both sides of each facing. It will be seen, therefore, that relative rotation of the pinion 61 and bevel gear 63 will cause corresponding relative rotation of the driving plates and clutch plates. The driving plates and clutch plates are urged to the relative positions in which the clutch facings 79 frictionally engage the clutch plates by means of a compressed coil spring 83 which bears at one end against the underside of the clutch plate 82, and at the other end against an outwardly extending annular flange 84a formed on the lower end of a spring seat 84. The spring seat 84 surrounds with some clearance an upwardly extending portion of the hub of the gear 63 and an annular shoulder 62a which is formed on the shaft 62, and is provided at its upper end with an inwardly extending annular flange 84b which overlies and cooperates with the shoulder 62a to limit the lower position with respect to the shaft 62 to which the spring seat is free to move due to the compression of spring 83. The parts are so proportioned that when the flange 84b is engaging the shoulder 62a, the spring will act through the clutch plates and driving plates to bias the pinion 61 to an upper position in which the upper end of its hub engages the underside of the bearing sleeve 68, and it will be seen, therefore, that by adjusting the position of the bearing sleeve the tension of the spring 83 may be varied to thereby vary the force required to slip the clutch, and hence vary the torque which can be transmitted from the bevel gear to the pinion 61 through the clutch. The operation of the clutch as a whole will be readily understood from the foregoing description and from an inspection of the drawing without further detailed description.

A bevel gear 90 is also mounted for rotation coaxially with the shaft 20, and is provided on its upper face with a boss which cooperates with the previously referred to thrust washer 28 to prevent vertical displacement of the bevel gear in an upward direction. Vertical displacement of the bevel gear 90 in the opposite direction is prevented by a bushing 91 which cooperates at its upper end with the underside of the bevel gear and at its lower end with a shoulder 20b (see Fig. 4) formed on the shaft 20. The bevel gear 90 meshes with a segmental gear 92 splined to the end of a horizontally extending sleeve 93 (see Fig. 8) which sleeve is rotatably mounted in a ball bearing 94, and in a needle bushing 95 disposed in bearing recesses 96 and 97, respectively, provided in a bearing support 98. The bearing support 98 is bolted to the side of the casting 14a by means of machine bolts 99, and extends partway into the casting through a suitable opening 100. Secured to the outer end of the sleeve 93 is a hand lever 101 by means of which the sleeve 93, and hence the bevel gear 90 may at times be rotated between two extreme positions.

The spur gear 45 and the bevel gear 90 are adapted to be selectively connected with the shaft 20 by means of a clutch member 105 which is mounted on the shaft 20 for vertical sliding movement, but which is constrained to rotate with the shaft by means of integral splines 105a (see Fig. 13) which cooperate with corresponding splines 20c formed on the shaft 20.

As best seen in Fig. 12, the upper end of the clutch member 105 is provided with a plurality of teeth, two of which 106a and 106b in the particular embodiment illustrated are 62° in length and are spaced 53° apart, and the remaining one of which 106c is 47° in length and is spaced 68°

from each of the teeth 106a and 106b. The lower end of the bevel gear 90 is likewise provided with a plurality of teeth, two of which 107a and 107b (see Fig. 11) are 65° in length and are spaced 50° apart, and the remaining one of which 107c is 50° in length and is spaced 65° from the other two teeth 107a and 107b. It follows that the teeth 106 on the clutch member 105 will fit between the teeth 107 on the bevel gear 90 when and only when the space between the teeth 106a and 106b is opposite the tooth 107c on the bevel gear. The parts are so proportioned that this relation will exist when and only when the hand lever 101 and the frog occupy corresponding extreme positions.

Of course, the described dimensions of the teeth on the clutch member 105 and the bevel gear 90 are not essential, as any other proportioning of parts can be employed which will permit mating of the gear and clutch member when and only when the hand lever 101 and the frog A occupy the proper relative positions.

The lower end of the clutch member 105 is also formed with teeth 108 (see Fig. 13). These teeth are evenly spaced about the end of the clutch member, and are arranged to cooperate with similar teeth 109 formed on the upper end of the spur gear 45, as shown in Fig. 14.

It follows from the foregoing, that when the clutch member 105 is in one longitudinal position on the shaft 20, the teeth on the lower end of the clutch member 105 will connect the spur gear 45 with the shaft 20, whereas, when the clutch member 105 is in another longitudinal position on the shaft 20, the teeth on the upper end of the clutch member 105 will connect the bevel gear 90 with the shaft 20. The clutch member 105 is moved longitudinally on the shaft 20 in order to effect the desired connection between the spur gear 45 and the bevel gear 90 by means of shifting mechanism comprising a shifter yoke 110 which surrounds the clutch member, and which is provided on opposite sides of the clutch member with a pair of rollers 111 that extend into and cooperate with an annular groove 105b formed in the clutch member intermediate its ends. The shifter yoke 110 is pivotally attached at one end by means of a pin 112 to a floating fulcrum block 113, and the floating fulcrum block, in turn, is pivotally attached by means of a pin 114 to an eye bolt 115. The eye bolt 115 extends with considerable clearance through an opening 116 provided in a supporting casting 117, and is provided on its outer end with a compressed coil spring 118, a spring seat 119, and a castellated nut 120. The spring 118 bears at its outer end against the spring seat 119 and at its inner end against the inner end of a recess 117c formed in the casting 117, and serves to constantly bias the eye bolt, and hence the fulcrum block 113 toward the left, as viewed in Fig. 8, to a position in which rounded bearing surfaces 113a and 113b formed on the bottom and top of the fulcrum block engage rounded seats 117a and 117b provided on the casting 117. It will be apparent that the force with which the fulcrum block is held into engagement with the rounded seats 117a and 117b will depend upon the compression of the spring 118, and that the compression of the spring 118 may be varied by screwing the castellated nut 120 to different positions on the eye bolt 115. The nut 120 may be locked in its adjusted position by means of a cotter key 120a in the usual and well-known manner. The casting 117 extends into the casting 14a through a suitable opening 121 provided in the side wall of the casting 14a, and is secured to the casting 14a by means of suitable bolts 122. The right-hand end of the shifter yoke 110, as viewed in Fig. 8, is formed with an elongated slot 110c, and cooperating with this slot is a rounded pin 123 which is formed on the inner end of a shaft 124 in eccentric relation with respect to the axis of the shaft. The shaft 124 extends through, and is rotatably mounted in, the sleeve 93, and is provided at its outer end with a selector lever 125 by means of which the shaft 124 may at times be oscillated.

The operation of the shifting mechanism is as follows: Normally, the selector lever 125 occupies the extreme position in which it is shown in the drawings, which is the position for motor operation, and under these conditions, the pin 123 is at the lowest point in its path of movement. When the pin occupies this position, it engages the underside of the slot 110c in the shifter yoke 110, and the parts are so proportioned that if the teeth 108 on the lower end of the clutch member 105 are then in position to enter the recesses between the teeth 109 on the spur gear 45, the yoke 110 will be rotated downwardly about the pivot pin 112 as a fixed pivot to its lowermost position, and will act through the rollers 111 to move the clutch member 105 downwardly to, and hold it in, its lowermost position in which the teeth 108 on the clutch member mesh with the teeth 109 on the spur gear. If, however, the teeth on the lower end of the clutch member do not align with the recesses between the teeth 109 on the spur gear 45 when the pin 123 on the shaft 124 occupies its lowermost position, so that the clutch member 105 is prevented from moving to its lowermost position by engagement of the two sets of teeth at their confronting ends, the engagement of the pin 123 with the bottom of the slot 110c will cause the shifter yoke to rotate in a clockwise direction, as viewed in Fig. 8, about the rollers 111 as fixed pivots, and this rotation, in turn, will cause the fulcrum block 113 to rotate in a counterclockwise direction about the surface 113b as a fulcrum, and will thus cause the spring 118 to become compressed beyond its initial compression. It will be seen, therefore, that under the conditions last assumed, the spring 118 will act through the fulcrum block 113 and shifter yoke to bias the clutch member 105 to its lowermost position, with the result that as soon as the spur gear 45 is rotated by the motor B to the position in which the teeth 108 on the clutch member align with the recesses between the teeth 109 on the spur gear 45, the parts will immediately snap to the positions in which they are shown in Fig. 8. When the parts occupy these positions, the spur gear 45 is operatively connected with the switch actuating shaft 20 so that the apparatus is then in condition for operation of the frog by the motor B. At such times, the bevel gear 90 is disconnected from the switch actuating shaft 20, with the result that the hand lever 101 is disconnected from the frog. In order to disconnect the motor from, and connect the hand lever with, the frog, the selector lever 125 is rotated through an angle of approximately 210° from the position shown, thereby rotating the pin 123 through a corresponding angle. This rotation of the pin 123 causes the shifter yoke to rotate in a counterclockwise direction, as viewed in Fig. 8, and hence causes the clutch member 105 to move upwardly on the shaft 20. When the clutch

member 105 is moved upwardly under these conditions, if the position of the switch and the hand lever 101 then correspond, so that the teeth 106 on the clutch member align with the spaces between the teeth 107 on the bevel gear 90, the shifter yoke 110 will rotate about the pin 112 as a fixed pivot, and will thus move the clutch member 105 to its upper extreme position in which the teeth on the clutch member and the teeth on the bevel gear mesh. The bevel gear 90 will then be connected with the shaft 20, so that the switch may be operated between its two extreme positions by swinging the hand lever between its two extreme positions. If, however, the position of the switch and the hand lever do not correspond when the selector lever 125 is rotated to the hand-throw position, so that the teeth 107 on the bevel gear 90 are opposite the teeth 106 on the clutch member, as soon as the clutch member has been moved upwardly a comparatively short distance, the flat ends of the teeth 106 on the clutch member will engage the flat ends of the teeth 107 on the bevel gear and will thus prevent further upward movement of the clutch member, with the result that the balance of the movement of the selector lever to the hand-throw position will cause the shifter yoke 110 to rotate in a counterclockwise direction about the axis of the rollers 111, and will thus cause the fulcrum block 113 to rotate about the rounded surface 113a, thereby causing the spring 118 to become compressed beyond its initial compression. It will be apparent, therefore, that under these conditions, the hand-throw lever 101 will not become connected with the switch until the hand lever is moved to the position corresponding to the position of the switch, at which time the energy stored in the spring 118 will complete the upward movement of the clutch member, thereby causing the teeth on the clutch member to mesh with the teeth on the bevel gear 90, and hence permitting manual operation of the switch in the manner previously described.

When it is desired to restore the apparatus to condition for operation by the motor, the selector lever 125 is restored to its normal position in which it is shown in the drawing. The operation of the apparatus under these conditions is just the reverse of that described hereinbefore, and will be readily understood from an inspection of the drawings without describing it in detail.

It will be apparent, therefore, from the foregoing that with apparatus embodying our invention, the selector lever 125 may be thrown to its operating position for either hand or motor operation of the frog regardless of whether there is an agreement or disagreement between the position of the frog and the position of the operating mechanism. It will also be apparent that if the hand lever is thrown to the operating position for either hand or motor operation of the frog when a disagreement between the position of the frog and the position of the operating mechanism exists, then when the position of the operating mechanism is brought into agreement with that of the frog, the desired connection between the frog and the operating mechanism will be automatically effected.

Associated with the hand-throw lever 101 and the selector lever 125 is a mechanism D including means for locking the levers against movement by unauthorized persons and means for interlocking the levers in such manner that the hand-throw lever cannot be operated unless the selector lever occupies the hand-throw position. This mechanism forms no part of our present invention, and may, for example, be similar to that described and claimed in Letters Patent of the United States No. 1,887,376, granted to G. V. Jefferson and E. G. Little, on November 8, 1932, for Railway switch operating apparatus. Inasmuch as the mechanism D forms no part of our present invention, it is deemed unnecessary to describe it in detail herein.

It should be pointed out that the parts are so constructed that the bearing support 98 and the supporting casting 117 can be reversed to enable the switch machine to be assembled for either a right-hand or a left-hand installation.

The motor B may be of any suitable type, and may have any desired construction which will provide the proper operating characteristics. As here shown, this motor is a direct current motor and comprises the usual armature 130 and field coils 131 disposed in an enclosing casing 132, one end of which is provided with a removable cover 133 through which convienient access to the commutator and brushes, as well as to a magnetic brake E which is disposed in one end of the casing 132 may be had. The shaft 65 which carries the armature 130 is mounted in ball bearings, in the usual manner, and one end thereof projects through the one end wall of the casing 132 and carries the previously referred to bevel pinion 64. The motor B projects partway into the casing 14a through an opening 134 in the end of the casting in such manner that the commutator and brushes are disposed wholly within the casting 14a, and the motor is secured to the end wall of the casting 14a by means of tap bolts 135, some of which pass through clearance holes in the end wall and are screwed into tapped holes provided in a flange 136 formed on the casing 132 at or near its medial portion, and the remainder of which bolts pass through clearance holes provided in the flange 136 and are screwed into tapped holes provided in the end wall of the casting. A U-bolt 137 is secured to the top of the casing 132 outside of the casting 14a, and this U-bolt serves as a convenient means for securing one end of the cover 14d in place and also as a means for lifting the motor when assembling it to or disassembling it from, the switch machine, as well as a means for lifting one end of the switch movement as a whole when the motor has been assembled to the remainder of the mechanism.

The motor brushes 140 are disposed in brush holders 141 which are secured by means of screws 142 to an arcuate insulating plate 143. The insulating plate 143, in turn, is secured by means of tap bolts 144 to a mounting strap 145. The mounting strap is provided with ears 146 containing arcuate slots 147, and is attached to a supporting bracket 149 by means of screws 150 which pass through the arcuate slots 147 and are screwed into tapped holes provided in the bracket 149. The arcuate slots 147 are so disposed that when the screws 150 are loosened, the strap 145, insulating plate 143 and brush holders as a unit may be rotated through a limited angle to enable the brushes to be shifted to the proper positions to provide sparkless commutation. The upper end of the strap 145 is formed with a lug 151 provided with a hole 152 and after the brushes have been adjusted to the proper positions and the screws 150 have been tightened, a hole is drilled in the bracket 149 in alignment

with the hole 152, and a dowel pin 153 is driven into the two aligned holes to prevent the brushes from shifting in the event that the screws 150 subsequently become loosened. The supporting bracket 149 is secured to the opposite sides of the casing 142 of motor M by means of tap bolts 154, as shown in Figs. 17 and 18.

It should be particularly pointed out that with electric switch machines as they have heretofore generally been constructed, trouble has been experienced in certain exposed locations under adverse weather conditions due to accumulations of frost on the motor commutator. With the motor constructed and arranged in the manner just described, due to the relatively large amount of air space which is provided within the casing 132 at the commutator end of the motor, and to the fact that the commutator is enclosed both within the motor casing and also within the gear box casting 14*a*, the tendency for frost to collect on the motor commutator has been practically eliminated.

The previously referred to magnetic brake E comprises a brake disk 157 secured to a die casting 158 which is mounted for longitudinal sliding movement on the armature shaft 65, but which is constrained to rotate with the armature shaft by means of a feather key 159. One side of the brake disk 157 cooperates with a brake lining 160 secured to a stationary brake shoe 161, and the other side of this brake disk cooperates with a brake lining 162 secured to a movable brake shoe 163. The stationary brake shoe 161 is formed with an externally screw threaded hub 164, which hub is adjustably screwed into the inner end of the bearing opening 165 in the end wall of the motor casing 132. After the stationary brake shoe has once been adjusted to the desired position, it is subsequently maintained in this position by means of a locking screw 166 which is screwed through a threaded hole formed in the end wall of the motor casing, and which projects at its inner end into one of a plurality of holes 167 provided in the outer face of the stationary brake shoe 161 in a position to receive the screw. The movable brake shoe 163 is provided with a hub 168 which is slidably mounted on a tubular support 169 formed on the bracket 149 in concentric relation to the shaft 65. Surrounding the hub 168 and the tubular support 169 between the movable brake shoe and the support is a compressed coil spring 170 which constantly biases the movable brake shoe and the brake disk 157 toward the stationary brake shoe to braking positions in which the two brake linings 160 and 162 frictionally engage the brake disk 157. It will be apparent that when the brake linings are engaging the brake disk, rotation of the motor armature will be resisted.

The magnetic brake E also comprises an operating yoke 171 which is pivotally suported adjacent its upper end on a rod 172 mounted in spaced lugs 173 provided on the bracket 149, and the arms 171^a and 171^b of which extend downwardly past the opposite sides of the movable brake shoe 163 and are operatively connected intermediate their ends with the brake shoe by means of recesses 171^c which are formed in the arms 171^a and 171^b, and which cooperate with diametrically opposite laterally projecting lugs 175 provided on the brake shoe at its outer edge. Secured to the lower ends of the arms 171^a and 171^b are armatures 176 and 177, respectively, which cooperate with magnets F^1 and F^2 located in the bottom of the motor casing. As will be seen from an inspection of Fig. 17, the magnets F^1 and F^2 are of the ironclad type, and each comprises a suitable cup-shaped shell 178 formed integral with the motor casing, a central core member 179 secured at one end to the shell, and a winding 180 which surrounds the associated core member within the associated shell.

A tension spring 181 is hooked at one end onto a lug 182 provided on the one end wall of the motor casing 130, and the other end of this spring is secured to a bolt 183 which extends with clearance through a hole 171^d provided in a channel-shaped offset portion 171^e formed on the upper end of the operating yoke 171. An adjusting nut 185 is screwed onto the outer end of the bolt 183, and formed on the inner end of this nut is a wedge-shaped surface 186 which cooperates with a notch 171^f provided in the adjacent face of the offset portion, whereby when the nut 185 has been rotated to any position in which the wedge-shaped surface 186 aligns with the notch, the tension of the spring 181 will act to hold the wedge-shaped surface in the notch, and will thus prevent the nut from becoming unscrewed and destroying the adjustment. The spring 181 exerts a force on the operating yoke 171 which rotates the yoke in a clockwise direction, as viewed in Fig. 16, about the rod 172 to the position in which the recesses 171^c on the arms 171^a and 171^b receive the lugs 175 on the movable brake shoe 163, and it will be seen, therefore, that the spring 181 serves to take up any clearance surrounding pin 172 in such a way that the air gap between the armatures 176 and 177 and the associated magnets F^1 and F^2 is held to the minimum. It will further be seen that due to the connection between the yoke 171 and the movable brake shoe 163, the force due to the spring 181 opposes the force which is exerted on the movable brake shoe by the spring 170, and it follows, therefore, that by adjusting the nut 185 to different positions, the resultant force which is exerted on the movable brake disk 157, and hence the braking force exerted by the brake, may be quickly and conveniently varied to any desired value within the limits of the apparatus.

The windings 180 of the two magnets F^1 and F^2 are adapted to be connected in series in the operating circuit for the motor M in such manner that the motor current will flow in these windings, and it will be apparent that whenever the motor is deenergized, the spring 170 will actuate the brake to its braking position, and will thus cause the brake to oppose rotation of the motor armature. When, however, the motor becomes energized, the magnets F^1 and F^2 will attract the armatures 176 and 177, and will thus rotate the operating yoke 171 in a clockwise direction as viewed in Fig. 16. This rotation will act through the recesses 171^c and lugs 175 to slide the movable brake shoe 163 toward the left, in opposition to the bias of the spring 170, to a position in which the pressure of the brake linings against the brake disk 157 is removed, thereby releasing the brake, and hence permitting the motor armature to rotate without opposition from the brake.

It will be readily understood that when the armatures 176 and 177 are moved to their attracted positions, the reluctances of the flux paths for the fluxes set up by the energized windings will be considerably reduced due to the decreased air gaps between the armatures and the magnets, and that, as a result, the current required to hold the armatures 176 and 177 in

their attracted positions will be considerably less than that required to move them to their attracted positions. It is desirable that the magnets should not become energized at current values below that flowing in the motor circuit under starting conditions, in order to prevent improper operation of the switch machine due to stray currents which might be supplied to the motor, and it follows that by properly adjusting the air gaps which exist between the armatures and the magnets when the armatures occupy their deenergized positions, the characteristics of the brake may be so adjusted that it will be necessary for a current to flow in the windings 180 corresponding to the current which flows in the motor under normal starting conditions in order to release the brake, but that the brake will be maintained in its released position by a reduced current which is equal to the normal operating current for the motor. The necessary adjustments to accomplish this desired result may be made by unscrewing the locking screw 166 and rotating the stationary brake shoe 161 in one direction or the other. This rotation will move the stationary shoe in an axial direction toward or away from the frame 149, which movement, in turn, will cause a corresponding movement of the movable brake shoe 163, thereby causing the operating yoke 171 to rotate to a new position in which the armatures 176 and 177 are closer to, or farther away from, the magnets, as the case may be. After the necessary adjustment has been made, the stationary brake shoe may again be locked against rotation by means of the locking screw 166.

One advantage of a magnetic brake embodying our invention is that due to the fact that it moves to its braking position as soon as the motor becomes deenergized, it tends to reduce the shock upon the switch operating mechanism as it comes to rest following a reversal of the switch.

Another advantage of a magnetic brake embodying our invention is that it is effective to prevent creepage of the mechanism due to track vibrations when the motor is deenergized, which insures that the switch operating mechanism will not become unlocked due to creepage in the event of a power failure.

A further advantage of a brake embodying our invention is that adjustments which may be necessary due to wear of the brake linings, and to adapt the brake to different operating conditions may be quickly and conveniently made.

Resiliently supported in the right-hand end of the casting 14^{b} of the switch machine is an inner casing 189 which is adapted to house an electromagnetic control device for controlling the switch machine. This control device forms no part of our present invention, and may, for example, comprise a polar relay of well-known construction. Inasmuch as this control device forms no part of our present invention, it is deemed to be unnecessary to describe it in detail herein.

Mounted in the right-hand end of the casting 14^{b} above the lock rods L^{a} and L^{b} and the slide bar N is a circuit controller G which also embodies our invention. As best seen in Figs. 20 to 25, this circuit controller comprises a suitable supporting framework 190 provided with end members 190^{a} and 190^{b}, and having adjustably mounted in its sides aligned bearings 191 and 192 in which a horizontal camshaft 193 is journaled. The camshaft 193, which is of rectangular cross section except for a rounded portion at each end which fits into the associated bearing, is adapted to be rotated or oscillated in response to the longitudinal movements of the slide bar N, and for this purpose the shaft 193 has fixed thereto a gear wheel 194 which meshes with an intermediate idler gear 195 driven by the rack teeth provided on the upper face of the locking dog 17 of the slide bar N. The idler gear 195 is journaled on a pin 196 (see Figs. 23 and 24) mounted in a depending portion 197 of the frame 190. Mounted on the camshaft 193 on opposite sides of the gear wheel 194 are a plurality of driving collars of insulating material, each designated by the reference character 198 with a suitable distinguishing exponent. Each driving collar 198 is provided with a square hole which has a sliding fit on the camshaft 193, and as clearly shown in Fig. 24, each driving collar comprises a comparatively narrow web and peripheral flange extending in each direction from the outer edge of the web. A portion of the peripheral flange of each driving collar is tapered, and the tapered portion is provided with serrations or teeth (not shown) around its entire circumference. Each driving collar 198 carries a contact segment of electroconductive material designated by the reference character 199 with the same distinguishing exponent as the exponent for the reference character of the associated collar. Each contact segment 199 is in the form of the segment of a ring, the bore of which is tapered to fit the tapered portion of the periphery of the associated driving collar. The bore of each driving collar is also provided with serrations or teeth (not shown) which match the teeth on the periphery of the insulated driving collars. Each contact segment 199 cooperates at its periphery with two contact fingers designated by the reference characters 200 and 201, respectively, with the same distinguishing exponent as the reference character for the associated contact segment. For example, the contact segment 199^{a} cooperates with the contact fingers 200^{a} and 201^{a} to at times close a contact 200^{a}—199^{a}—201^{a}. The periphery of each contact segment may have any desired length, and due to the mating teeth on the driving collars, the segment may be turned to any desired position relative to the camshaft 193. As here shown, the parts are so proportioned and the contact segments are of such length and are so disposed on the shaft 193 that the contacts 200^{a}—199^{a}—201^{a} and 200^{b}—199^{b}—201^{b} will be closed at all times except when the slide bar N is in the extreme position in which it locks the switch points in their normal positions in which they are shown in Fig. 1, and that the contacts 200^{c}—199^{c}—201^{c} and 200^{d}—199^{d}—201^{d} will be closed at all times except when the slide bar N is in the extreme position in which it locks the switch points in the positions reverse to that in which they are shown in Fig. 1. The contacts 200^{a}—199^{a}—201^{a}, 200^{b}—199^{b}—201^{b}, 200^{c}—199^{c}—201^{c}, and 200^{d}—199^{d}—201^{d} may be used in a well-known manner to control the circuits for the motor M, or for any other desired purpose.

The circuit controller also comprises a pair of contact fingers 205^{a} which are connected together for simultaneous movement by an insulating bridge 206^{a}, and a pair of contact fingers 205^{b} which are connected together for simultaneous movement by an insulating bridge 206^{b}. The fingers 205^{a} and 205^{b} are biased by their

own resiliency to lower positions in which they engage associated lower stationary contact members 207[a] and 207[b] to close a pair of contacts 205[a]—207[a] and a pair of contacts 205[b]—207[b], but are adapted to be at times moved upwardly, by means of a point detector mechanism which we will now describe, to upper positions in which they engage an upper stationary contact member 209 to thereby close a contact 205[a]—209—205[b].

The point detector mechanism is controlled jointly by the slide bar N and by a pair of detector rods H[a] and H[b] which are slidably mounted in the casting 14[b] of the switch machine for movement in directions parallel to the operating rod O, and in the form here shown comprises a detector plate 211 and a driving plate 212. The detector plate 211 is slidably mounted on machined surfaces 190[c] (see Fig. 21) formed on the end members 190[a] and 190[b] of the frame 190, for movement at right angles to the camshaft 193 in parallel spaced relation thereto, and is guided laterally by means of two rollers 213 which are mounted on depending pins secured to the detector plate, and which ride in guideways 190[d] formed in the end members 190[a] and 190[b], Vertical displacement of the detector plate is prevented by a pair of hold-down pieces 214, which hold-down pieces are fastened to bosses formed on the end members 190[a] and 190[b] adjacent the opposite corners of the detector plate, and which project over the upper surface of the detector plate with some clearance. Mounted on the underside of the detector plate are four rollers, two of which 215[a] and 216[a] cooperate with the point detector rod H[a] (see Fig. 21), and the remaining two of which 215[b] and 216[b] cooperate with the point detector rod H[b]. The detector rods H[a] and H[b] are adjustably connected by means of connecting rods 217[a] and 217[b] (see Fig. 1) and point lugs 218[a] and 218[b] with the front rods 1[a] and 1[b], respectively, and it will be apparent, therefore, that any movement of the switch points will cause corresponding longitudinal movement of the detector rods. Each of the detector rods is provided at the end which is connected to the associated connecting rod with a reduced portion 220 (see Figs. 21 and 31), and adjustably mounted on this reduced portion is a sleeve 221 which forms, with the portion of the detector rod which is not reduced, an annular recess 222. The parts are so adjusted that the recess 222 in the detector rod H[a] will align with the roller 215[a], and the recess 222 in the detector rod H[b] will align with the roller 216[b], when and only when the switch points occupy their normal positions in which they are shown in Fig. 1; and that, the recess 222 in the detector rod H[a] will align with the roller 216[a], and the recess 222 in the detector rod H[b] will align with the roller 215[b] when and only when the switch points occupy the extreme position opposite to that in which they are shown in Fig. 1. It is obvious that when the recesses 222 in the detector rods H[a] and H[b] align with the rollers 215[a] and 216[b], the detector plate 211 is free to move to the left to a normal position in which the rollers 215[a] and 216[b] enter the associated recesses, in which position the detector plate is shown in the drawings, and that when the recesses 222 in the detector rods H[a] and H[b] align with the rollers 216[a] and 215[b], the detector plate 211 is then free to move toward the right to a reverse extreme position in which the rollers 216[a] and 215[b] enter the associated recesses. The parts are so proportioned that when either one of the recesses is out of alignment with both of the associated rollers, these rollers will cooperate with the associated detector rod to force the detector plate to, and hold it in, a position approximately midway between its two extreme positions.

In order to allow for slight variations which are likely to occur between the position of the switch points and the position of the switch machine, due, for example, to the shifting of the ties, without interfering with the free operation of the point detector rods, and at the same time permit a limited amount of movement between the connecting rods and the detector rods to prevent binding of the detector rods in their guideways due to the necessary movement of the connecting rods caused by the movement of the switch points between their two extreme positions, we prefer to secure each of the detector rods to the associated connecting rods in the manner shown in connection with the detector rod H[a] and connecting rod 217[a] shown in Fig. 31. Referring to Fig. 31, as here shown, an upturned portion 217[1] of connecting rod 217[a] is provided with an eye 217[2] which loosely receives a screw threaded portion 219[1] of the connecting rod H[a] with some clearance. One side of the eye 217[2] is formed with a hexagonal recess 217[3] having a concave inner surface, and the other side of the eye 217[2] is provided with a convex surface 217[4] which is parallel to the concave inner surface of the eye. A nut 223[1] is screwed onto the threaded portion 219[1] of the connecting rod H[a] on the side adjacent the recess 217[3], and this nut fits loosely into the recess 217[3] and is provided at its inner end with a convex surface having the same radius of curvature as the contiguous concave surface of the eye. Mounted on the screw threaded portion of the rod on the other side of the eye 217[2] is a nut 224[1] provided on the side adjacent to the eye with a concave surface having the same radius of curvature as the contiguous convex surface of the eye. The nuts 223[1] and 224[1] are so adjusted that relative longitudinal movement of the connecting rod and detector rod is prevented, but that, a limited amount of angular movement of these two rods is permitted, and the nuts are then locked in place by a jam nut 238[1] which is screwed onto the threaded portion 219[1] of the detector rod and which engages the outer face of the nut 224[1].

The driving plate 212 is slidably mounted in guideways 225 provided on the detector plate 211 on opposite sides of a rectangular opening 226 formed therein, and is arranged to be moved between an intermediate and two extreme positions in response to the movement of the slide bar N between its intermediate and two extreme positions, by means of two cams 227 and 228 which are mounted on the cam-shaft 193 on opposite sides of the gear wheel 194, and which cooperate with two rollers 229 and 230 secured to uprights 231 formed on the driving plate. A driving arm 232 (see Fig. 22) is pivotally attached at one end to the detector plate 211 by means of an upstanding pin 233, and is provided intermediate its ends with a rectangular slot 234 which slidably receives a cross-head block 235 pivoted on an upstanding pin 236 secured to the driving plate. The free end of the driving arm 232 carries a roller 232[a] which cooperates with a radial notch 237[a] provided in an operating arm 237. The operating arm 237 is pivoted at one end on a pin 238 secured to the detector plate 211, and is op-

eratively connected at the other end with a tension spring 239 which is stretched between the arm and a projecting lug 240 formed on the detector plate. The tension of the spring 239 is such that under normal operating conditions the roller 232a will remain in the notch 237a, and it will be apparent that as long as the roller remains in this notch the detector plate will move in response to, and in unison with, the driving plate 212, but that, if the roller 232a is forced out of the notch 237a in the arm 237, the detector plate can then move independently of the driving plate, or vice versa.

An L-shaped latch dog 242 is pivotally attached intermediate its ends to the detector plate 211, and is biased by means of a coil spring 243 to a latching position in which a notch 242a in the arm receives a latch lug 237e formed on the operating arm 237 provided the operating arm is then moved outwardly to the position which it occupies when the roller 232a is forced out of the notch 237a in the arm 237. The spring 243 abuts at one end against an upstanding lug 242b formed on the short arm of the latch dog 242, and at the other end against an upstanding lug 244a formed on a latch arm 244. The latch arm 244 is pivotally mounted at one end on the pin 238 underneath the operating arm 237, and is constantly biased by means of the compressed spring 243 to a latching position in which a notch 244b formed in its outer side is adapted to receive a latch catch 245 secured to the frame 190. The tension spring 239 is somewhat stronger than the compression spring 243 and provided on the operating arm 237 is a vertically offset laterally projecting portion 237c which cooperates with the lug 244a at its outer side to prevent the latch arm from moving to its latching position except when the roller 232a is forced out of the notch 237a in the operating arm 237. The parts are so proportioned that the notch 244b will align with the latch catch 245 when and only when the detector plate 211 occupies its intermediate position.

As will appear hereinafter, it is desirable to be able to at times prevent the latch dog from moving to its latching position, and for this purpose the latch dog is provided with a hole 242d which, when the latch dog is rotated in a counterclockwise direction through a slight angle from the position shown to a position in which the lug 237e is clear of the side of the latch dog 242, aligns with a tapped hole 246 provided in the detector plate. The hole 246 is adapted to receive a screw 247, and it will be apparent that when the screw 247 is in place in the two aligned holes, the latch dog 242 will be held in a fixed position in which it is out of engagement with the latch lug 237e on the operating arm 237. In order that the screw 247 will always be available, the detector plate is provided with a second screw threaded hole 248 (see Fig. 21) in which the screw 247 is normally kept, and the latch dog 242 is provided with an arcuate slot 242e which, when the screw 247 is in the hole 248, receives the head of the screw with sufficient clearance to permit the normal intended movement of the latch dog.

The upper side of the detector plate 211 is provided on opposite sides of the driving plate 212 with rack teeth 211a and 211b, respectively, which mesh with gear segments 250a and 250b formed on cam members 251a and 251b. The cam members 251a and 251b are journaled on bushings 252a and 252b which are mounted on the camshaft 193 on opposite sides of the cam members 227 and 228, and are maintained in the proper longitudinal positions to engage the rack teeth by means of annular flanges 253a and 253b formed on the bushings, and washers 254a and 254b which are interposed between the bushings and the adjacent driving collars 198b and 198c. The cam member 251b is provided, in addition to the gear segment 250b with an upwardly extending cam segment 255b which is adapted to cooperate with a roller 256b carried by the insulating bridge 206b, and the cam member 251a is likewise provided, in addition to the gear segment 250a, with an upwardly extending cam segment 255a which is adapted to cooperate with the roller 256a carried by the insulating bridge 206a. The upper portion of the cam segments 255a and 255b, as here shown, are curved, and are slightly more than twice as wide as the rollers 256a and 256b. Formed in the upper surface of the cam segment 255b adjacent the opposite ends therein in laterally spaced relation are two recesses or notches 257b and 258b (see Figs. 22 and 23) of such length and size that when either one of these notches is in alignment with the roller 256b, the contact fingers 205b will be free to move, due to their bias, to their lowermost positions. The roller 256b is loosely mounted on a laterally extending pin 259b which is slidably mounted at its opposite ends in vertical slots 260b formed in depending lugs 261b provided on a roller support 262b, and the roller support 262b, in turn, is secured to the insulating bridge 206b by means of a tap bolt 263b (Fig. 23). The tap bolt 263b extends downwardly through an elongated vertical slot 264b (Fig. 20) formed in the bridge 206b, and is screwed at its lower end in a tapped hole 265b provided in the roller support. Formed on the upper side of the roller support 262b are serrations 266b which cooperate with serrations 267b formed on the underside of the bridge 206b in such manner that by loosening the bolt 263b the roller supports may be shifted longitudinally relative to the fingers 205b through a limited distance to take care of manufacturing variations in the assembled parts, and to obtain the proper timing of the contacts. The pin 259b is of sufficient length, and the parts are so proportioned that when the pin is at the lower end of the slots 260b, the roller 256b can be slid longitudinally along the pin from a position in which it will enter the notch 258b in the cam segment 255b when this cam segment is rotated to one extreme position, to a position in which it will enter the notch 257b in the cam segment 255b when the cam segment is rotated to its other extreme position. When, however, the pin is in the upper ends of the slots 260b, the roller 256b is held in the proper position to cooperate with the one notch or the other, as the case may be, by a vertically disposed wall 268b (Fig. 24) which is provided on the roller support for this purpose. The upper end of the wall 268b extends into a groove 269b formed in the underside of the insulating support 206b and acts as a guide to position the roller support laterally with respect to the insulating bridge. The parts are further so proportioned that when the roller 256b is out of both of the notches 257b and 258b, the fingers 205b will be lifted by engagement of the roller with the upper surface of the cam segment 255b to their upper positions. The cam segment 255b is similar in construction to the cam segment 255a, and the parts of this cam segment are designated by the same reference characters as the corresponding parts of the cam segment 255b, but with the exponent *a* added thereto in place of the exponent *b*. The means for securing the roller 256a to the insulating bridge 206b

is likewise similar to the means for securing the roller 256b to the bridge 206b, and the parts of these two means are designated by the same reference characters with suitable distinguishing exponents.

The operation as a whole of the portion of the circuit controller thus far described is as follows: As shown in the drawings, the switch points occupy their full normal positions and are locked in these positions by the slide bar N, and under these conditions, the camshaft 193 is rotated in a counterclockwise direction, as viewed in Fig. 23, to what we shall term its normal extreme position, so that the motor control contacts 200c—199c—201c and 200d—199d—201d are closed, and the motor control contacts 205a—199a—201a and 200b—199b—201b are open. Furthermore, under these conditions, the driving plate 211 is moved to its left-hand or normal extreme position by the cam 227 and rolier 229, and since the notches 222 and the point detector rods Ha and Hb are then in alignment with the rollers 215a and 215b, so that the detector plate 211 is free to move to its left-hand extreme position, the detector plate is moved to its left-hand or normal extreme position through the medium of the driving arm 232 and the operating arm 237. When the detector plate 211 occupies its normal extreme position, the cam members 252a and 252b are rotated in a clockwise direction to their normal extreme positions, and the rollers 256a and 256b are disposed in such positions on the associated pins 259a and 259b that, under these conditions, the contacts 205a—207a are open and the contacts 205b—207b are closed.

We will now assume that with the parts in the positions just described, the switch machine is operated to move the switch points from their normal positions to their reverse positions. During the first or unlocking part of the resultant movement of the slide bar N, no motion of the switch points takes place for the reasons pointed out hereinbefore, but during this movement, the camshaft 193 is rotated in a clockwise direction to its intermediate position, and this movement causes the contacts 200a—199a—201a and 200b—199b—201b to become closed. This movement also causes the driving plate 212 to move to its intermediate position due to the coaction between the cam 228 and the roller 230, and this latter movement, in turn, moves the detector plate 211 to its intermediate position, thereby causing the cam members 251a and 251b to rotate to their intermediate positions. The rotation of the cam members 251a and 251b to their intermediate positions causes both rollers 256a and 256b to ride on the high portions of the cam members, thus causing the contacts 205b and 207b to become opened and contact 205a—209—205b to become closed. The movement of the detector plate 211 to its intermediate position also moves the rollers 215a and 215b out of the recesses 222 in the point detector rods Ha and Hb and it will be apparent, therefore, that during the movement of the switch points to their reverse positions, all of the rollers 215a, 215b, 216a, and 216b are clear of the point detector rods so that the resultant movement of the point detector rods will not cause any movement of the detector plate. After the switch points have reached their full reverse positions, the final or locking movement of the slide bar N which then takes place will rotate the camshaft 193 in a clockwise direction, as viewed in Fig. 23, from its intermediate to its reverse extreme position, thereby opening contacts 200c—199c—201c and 200d—199d—201d. This rotation of the camshaft 193 will also act through the cam 228 and the roller 230 to move the driving plate 212 to its reverse extreme position, and since the notches 222 in the point detector rods will then be in alignment with the rollers 216a and 215b, so that the detector plate is free to move to its reverse extreme position, the movement of the driving plate 212 will act through the driving arm 232 and the operating arm 237 to move the detector plate to its reverse extreme position in which the rollers 216a and 215b are disposed within the aligned notches 222. The movement of the detector plate will rotate the cam members 251a and 251b in a counterclockwise direction, as viewed in Fig. 23, from their intermediate to their reverse extreme positions, and when the cam member 251a reaches its reverse extreme position, the roller 256a will enter the notch 258a, and will thus allow the contact fingers 205a to drop to their lowermost positions, thereby opening contact 205a—209—205b and closing contacts 205a—207a. It should be noted that inasmuch as the driving and detector plates move in unison in the manner just described during reversal of the switch points by the switch machine, all parts of the latch mechanism will remain in the relative positions shown under these conditions, and the latch mechanism does not, therefore, have any effect on the operation of the circuit controller under these conditions.

If, after the switch points have been moved to their reverse extreme positions, the switch machine is subsequently operated to restore the switch points to their normal positions, the operation of the circuit controller will be exactly the reverse of that just described, and it is believed, therefore, that this operation will be apparent from the foregoing and from an inspection of the drawing without further detailed description.

We will now assume that with the parts in the positions in which they are shown in the drawing, the detector rod Ha is moved upwardly, due, for example, to a train trailing the switch. This movement will force the roller 215a out of the recess 222 in the detector rod, thereby forcing the detector plate 211 toward the right, as viewed in Fig. 21, to its intermediate position, and since the driving plate 212 is now held stationary by the cam 227 and the roller 229, the driving arm 232 will be rotated in a counterclockwise direction, as viewed in Fig. 22, about the pin 233 an amount which is approximately twice the distance that the detector plate is moved. This rotation will force the roller 232a out of the notch 237a in the operating arm 237 and onto the curved side of this arm adjacent the notch, thereby causing the operating arm to rotate in a counterclockwise direction, as viewed in Fig. 22, about the pin 238, and hence causing the spring 239 to become stretched beyond its initial tension. The operating arm 237 on each side of the notch 237a has a curved surface having a radius whose center is the pin 233, so that when the roller 232a engages this surface, the force due to the spring 239 does not tend to drive the detector plate 211 longitudinally. The counterclockwise rotation of the operating arm 237 under these conditions moves the lug 237e upwardly, as viewed in Fig. 22, to a position in which it aligns with the notch 242a in the latch dog 242, whereupon the latch dog rotates in a clockwise direction, as viewed in Fig. 22, due to the bias of the spring 243, to its latching position in which the notch 242a receives the lug 237e, thereby causing the operating arm to be subsequently retained in its displaced position.

The movement of the operating arm 237 also permits the spring 243 to drive the latch arm 244 to the position in which the latch catch 245 enters the notch 244^b. The movement of the detector plate 211 to its intermediate position further causes the cam members 251^a and 251^b to rotate to their intermediate positions, thereby causing the contacts 205^b—207^b to become opened.

After the parts have once been moved to their latching positions, they will subsequently remain in these positions until the latch mechanism is operated to restore these parts to their normal positions. This may be done provided the switch points have not been damaged, or if they have been damaged provided they have been subsequently repaired, by applying a squeezing action against the lugs 242^b and 244^a by means of the thumb and fingers. This squeezing action will rotate the latch dog 242 in a counterclockwise direction, as viewed in Fig. 22, to an unlatching position in which the lug 237^e is clear of the notch 242^a, and will also move the side of the latch arm 244 into engagement with the roller 232^a, and will rotate the latch arm to the position in which the notch 244^b is clear of the latch catch 245. The side of the latch arm 244 adjacent the roller is so shaped that a reasonable pressure applied by the fingers to the latch arm will restore the roller 232^b to its normal position in which it aligns with the notch 237^a by causing the detector plate 211 to move longitudinally. When the roller 232^a reaches the position in which it aligns with the notch 237^a in the operating arm 237, the spring 239 will move the operating arm to a position in which the roller 232^a enters the notch 237^a, after which the spring will then become effective to hold the plates 211 and 212 in their normal relative positions until the next trailing move occurs.

If the detector rod H^b had been displaced downwardly instead of the detector rod H^a being displaced upwardly, under the conditions just described, the operation would have been identical with that just described except for the fact that the motion of the detector plate 211 toward the right under these conditions would have been due to the coaction between the roller 216^b and the recess 222 in the detector rod H^b.

Under some conditions, it is desirable to be able to reset the latch mechanism by operating the switch machine from one extreme position to its other extreme position, and when this is the case, the latch dog 242 will be rendered inoperative by removing the screw 247 from the hole 248 and placing it in the aligned holes 242^d and 246. Assuming that the screw has been placed in the aligned holes 242^d and 246, and that the latch mechanism has been operated due, for example, to a train trailing the switch, the detector plate 211 will be held in its intermediate position by the roller 216^b until the driving plate 212 is moved to its intermediate position by operation of the switch machine, at which time the roller 232^a will drop into the notch 237^a in the operating arm 237, whereupon the force of the spring 239 acting through the operating arm 237 and the lug 244^a will rotate the latch arm to the position in which the notch 244^b is out of engagement with the latch catch 245. When this happens, the detector plate will then be free to move in response to the movement of the driving plate 211, providing the switch points have not been damaged, or if they have been damaged and have been subsequently repaired, so that the rollers 215 and 216 are then free to enter the proper recesses 222 in the detector rods.

It is desirable in order to avoid changes in wiring for right-hand and left-hand installations to always have the normal indication circuits, which circuits are usually controlled by the contacts 205^a—207^a and 205^b—207^b of the circuit controller, completed over one particular contact. In order to permit this to be done, it is necessary to be able to readily reverse the operation of the contacts 205^a—207^a and 205^b—207^b. With apparatus embodying our invention, this can be done by merely lifting the fingers 295^a and 295^b far enough to permit the pins 259^a and 259^b which support the rollers 256^a and 256^b to drop to the bottom of the slots 260^a and 260^b in the roller supports 262^a and 262^b, and then sliding the rollers 256^a and 256^b along the pins 259^a and 259^b from the one end of these pins to the other end of these pins and then releasing the fingers. This change in the position of the rollers will cause these rollers to cooperate with the other notches in the cam members 251^a and 251^b, thereby effecting the desired reversal in the operation of the contact fingers. It should be noted that this change does not affect the adjustment of the contacts so that no further adjustment of the contacts need be made after the change has been made.

The switch machine also comprises means for automatically releasing the magnetic brake E whenever the selector lever 125 is moved away from the motor operating position. As here shown, these means comprise a push rod 275 (Fig. 18) which is slidably mounted in one end of the casing 132 of motor B, and which cooperates at its inner end with a boss 171^c provided on the depending arm 171^b of the clutch operating yoke 171 in such manner that by moving the rod 275 inwardly the yoke 171 can be rotated in a clockwise direction, as viewed in Fig. 16, in opposition to the bias of the spring 170, to the same position to which this yoke is moved when the electromagnets F^1 and F^2 become energized. The outer end of the push rod 275 is pivotally attached to one arm of a bell crank lever 276 which is pivotally secured to the motor casing, and the other arm of the bell crank lever 276 is pivotally attached to one end of a connecting rod 278 (Fig. 7). The connecting rod 278 extends through a slot 279^a (see Fig. 4) formed in a curved arm 279^b (Fig. 7) provided on a vertical crank 279, and is yieldably connected with the arm 279^b by means of nuts 280 which are screwed onto the connecting rod 278 on one side of the arm, and a spring pressed pin 282 which is slidably mounted on the connecting rod on the other side of the arm. The crank 279 is journaled at its upper and lower ends, respectively, in suitable bearings formed in the bearing plate 53 and in the bottom wall of the casting 14^a, and is biased in a counterclockwise direction, as viewed in Fig. 7, by means of a tension spring 281 which is stretched between an arm 279^c provided on the crank 279 and a pin 282 secured to the bearing plate 53. A third crank arm 279^d is formed on the crank 279 adjacent its lower end, and this latter crank is operatively connected by means of a link 283 with a vertically disposed crank arm 284 secured to one end of a rockshaft 285. The rockshaft 285 extends longitudinally of the switch machine (see Figs. 2 and 3) at one side thereof from a point adjacent the arm 279^d to a point adjacent the left-hand end of the circuit controller C, and is operatively connected intermediate its ends with a transversely

extending rockshaft 286 by means of a laterally extending arm 287 which is secured at one end to the rockshaft 285, a vertical connecting rod 288 which is pivotally connected at its lower end to the free end of the arm 287, and a horizontally extending arm 289 which is pivotally connected at one end to the upper end of the connecting rod 288, and is secured at its other end to the rockshaft 286. The rockshaft is journaled in suitable lugs formed on the bearing plate 23, and is provided at the end opposite to the arm 289 with an arm 290 (Figs. 7 and 15) provided with a cam follower 290a which cooperates with a cam 291. The cam 291 is journaled on the hub of the previously described segmental bevel gear 92 and has formed integral therewith a gear wheel 292 which meshes with a pinion 293 mounted on one end of a jackshaft 294. The jackshaft 294 is journaled in a bearing 295 secured to the hub of the segmental gear 236, and is provided at the end opposite to the pinion 293 with a similar pinion 297 which meshes with a gear wheel 298 formed on the inner end of the shaft 124.

The parts are so proportioned that the spring 281 will act to bias the cam follower 290a into engagement with the cam 291, and that when the selector lever occupies its motor operating position, the cam follower will then engage the cam at a low portion 291a. The parts are further so proportioned that when the cam follower is engaging the cam at the low portion 291a, the push rod 275 will be moved outwardly far enough to permit the parts of the magnetic brake to occupy their normal braking position.

In operation, when the selector lever 125 is rotated away from the position shown, the hand-throw lever will be locked in the position shown due to the previously referred to interlocking mechanism, and as a result the rotation of the selector lever will act through the shaft 124, gear wheel 298, pinion 297, shaft 294, pinion 293, and gear 292 to cause the cam 291 to rotate in unison with the selector lever, and as soon as the cam has been rotated through a relatively small angle, the high portion of the cam will move into engagement with the cam follower 290a. This will cause the cam follower, and hence the cam arm, to rotate in a clockwise direction, as viewed in Fig. 15, which rotation, in turn, will act through the rockshaft 286, the arm 289, the connecting rod 288, the arm 287, the rockshaft 285, the arm 284, the link 283, the crank 279, the connecting rod 278, the bell crank lever 276, and the push rod 275 to release the brake. The brake will then be held in its released position until the selector lever is subsequently restored to the position shown.

When the selector lever 125 occupies its hand-throw operating position and the hand-throw lever 101 is operated, the gear wheel 298 will remain stationary, and under these conditions, the pinions 297 and 293 will ride idly around the gear wheels 298 and 292 without causing any rotation of the cam 291. It will be seen, therefore, that operation of the hand lever 101 will not have any effect upon the brake releasing mechanism.

It should be pointed out that the rockshaft 286 is so arranged that in the event the switch machine is assembled with the hand-throw and selector levers on the oposite side of the switch machine to that in which they are shown in the drawing, the cam arm 290 can be removed from the upper end of the rockshaft, as viewed in Fig. 7, and placed on the lower end, whereupon it will then be in the proper position to cooperate with the cam 291 in its new position.

One advantage of providing means for releasing the brake automatically when the selector lever 125 is rotated away from the position shown is that it permits free movement of the gear train prior to any movement of the clutch member 105, thereby relieving any tension which might exist between the teeth on the clutch member and the teeth on the spur gear 45 caused by the force necessary to force the switch points to their full extreme positions, and hence insuring that the clutch member will be free to move readily from its lower position to its upper position in response to the movement of the selector lever.

The switch machinery further comprises auxiliary contact mechanism for interrupting the motor circuit whenever the hand lever is moved away from the motor operating position to insure that the motor cannot be operated in a manner to cause injury to a person who is attempting to operate the switch machine by means of the hand lever, as well as for conditioning circuits for indicating at a remote point that the switch movement is in condition for manual operation. As here shown, this auxiliary contact mechanism comprises a plurality of forked contact fingers 301, 302, 303, 304, and 305 secured to an insulating rockshaft 306 journaled at its end on trunnion screws 307 mounted in suitable lugs 190e provided on the frame 190. The finger 301 cooperates with two contact members formed integral with terminal posts 301a 301b, secured to one of the insulating members 308 comprising part of the previously described circuit controller to form a contact 301a—301—301b and the fingers 302, 303, and 304 similarly cooperate with contact members formed integral with the terminal posts 302a 302b, 303a 303b, 304a 304b, to close contacts 302a—302—302b, 303a—303—303b, and 304a—304—304b. The finger 305 cooperates with two contact members formed integral with the terminal posts 304b and a terminal post 305a to form a contact 304b—305—305a. The rockshaft 306 is connected by means of an arm 309 (see Fig. 2), a link 310, and an arm 311 (see Fig. 3) with the previously described rockshaft 285 in such manner that the rockshaft 306 will be rotated to the normal position shown when the cam follower 290a is engaging the cam 291 at the low portion 291a, but that, when the cam follower 290a is engaging the cam 291 at the high portion, the rockshaft will then be rotated in a clockwise direction, as viewed in Fig. 23 from the position shown to a reverse position. The contact fingers are so arranged that when the rockshaft occupies its normal position, the contacts 301a—301—301b, 302a—302—302b, 303a—303—303b, and 304a—304—304b will be closed and the contact 304b—305—305a will be open, whereas, when the rockshaft is rotated to its other extreme position, the contact 304b—305b—305 will then be closed and the remaining contacts will be open. It follows, therefore, that when the selector lever occupies its motor operating position, the contacts 301a—301—301b, 302—302—302b, 303a—303—303b, 304a—304—304b will be closed and the contact 304b—305—305a will be open, but that, as soon as the selector lever is moved away from the motor operating position, the contact 304b—305—305a will become closed and the remaining contacts will become open.

In some installations of switch machines it is not necessary to operate the switch machine

manually except in cases of emergency, or for purposes of test and adjustment, and when this is the case, the gear mechanism described hereinbefore may be replaced by the simplified form of gear mechanism shown in Figs. 26 and 27. This gear mechanism is enclosed in a casting 14f which can be bolted to the base plate 14c in place of the casting 14a, and differs from the previously described gear mechanism in that it does not include the hand-throw lever 101, the selector lever 125, and associated parts for selectively connecting the switch actuating shaft with the hand lever or with the gear wheel 45. Furthermore, the gear wheel 45 instead of being loosely mounted on the switch actuating shaft 20 is splined to a switch actuating shaft 216, the upper end of which is considerably shorter than the upper end of the switch actuating shaft 20. It will be seen, therefore, that when the switch machine is modified in the manner just described, the motor B is constantly connected with the switch actuating shaft.

With the gear mechanism constructed as shown in Figs. 26 and 27, when it is desired to operate the switch machine by hand, a hand crank, not shown, is placed onto the upper end of the shaft 62 and this shaft is then rotated by means of the hand crank. When the switch machine is being operated by means of the hand crank, it is desirable for obvious reasons that the magnetic brake E should be released, and for this purpose we provide mechanism which we will now describe. As here shown, this mechanism comprises a vertical shaft 317 which is journaled at its upper end in the bearing plate 53, and at its lower end in the base of the casting 14f. Secured to this shaft adjacent its lower end is a crank 318, the function of which will be made clear presently, and rotatably mounted on this shaft above the crank 318 is a sleeve 319 provided with a laterally projecting arm 320, which arm is operatively connected with the yoke 171 of the magnetic brake E in the same manner that the arm 279b of the crank 279 shown in Figs. 4 and 7 is operatively connected with the yoke 171. It will be seen, therefore, that by rotating the sleeve 319 in the proper direction, the brake E can be released. The upper end of the sleeve 319 is provided with an integral cam follower 321, and this cam follower projects toward and cooperates with a cam 322 formed integrally with the lower end of a short shaft 323 (see Fig. 28). The short shaft 323 is journaled intermediate its ends in a bearing 324 formed in the bearing plate 53, and has secured to its upper end a guard plate 325 which serves to hold the shaft 323 in place in the bearing 324. The shaft 323 is rotatable between a normal position in which the lower edge of the guard plate, as viewed in Fig. 26, engages a stop pin 326 secured to the upper side of the bearing plate 53, and an upper or brake releasing position, and the guard plate 325 is so constructed that it will prevent the hand crank from being placed onto the shaft 62 to rotate this shaft except when the short shaft 323 occupies its brake releasing position. The parts are so proportioned that when the shaft 323 occupies its normal position and the brake occupies its brake applying position, a slight amount of clearance will exist between the cam 322 and the cam follower 321, but that, when the shaft 323 is rotated to its brake releasing position, the cam 322 will engage the cam follower 321, and will thus rotate the sleeve 319 in a clockwise direction, as viewed in Fig. 26, in a manner to release the brake. To enable the short shaft 323 to be readily rotated to its brake releasing position, the upper end of this shaft is made square in such manner that the hand crank which is used to rotate the shaft 62 may be placed on the upper end of the shaft 323.

The shaft 323 is hollow, and slidably mounted in a guide bearing 323a formed in the upper end of the shaft and in a plug 328 which is screwed into the lower end of the shaft, is a J-shaped latching dog 329. The latching dog 329 is constrained to rotate in response to rotation of the shaft 323 by means of a hole 330 which is formed in the cam 322 and which slidably receives the short leg 329a of the latching dog, and the latching dog is biased, by means of a spring 331 which surrounds the long leg 329b of the latching dog between the plug 328 and a collar 332 secured to the long leg 329a, to an upper or latching position in which the short leg 329b of the dog enters a hole 333 provided in the underside of the bearing plate 53. The hole 333 is so positioned that it will align with the short leg 329a of the latch dog when and only when the short shaft 323 is rotated to its brake releasing position, and it will be seen, therefore, that when the shaft 323 is rotated to its brake releasing position, the short leg 329a of the latch dog will enter the hole 333 due to the bias of the spring 331, and will thus cause the shaft 323 to automatically become latched in its brake releasing position until the latch dog is operated to release the shaft. This may be done by pressing downwardly on the upper end of the long leg 329a of the latch dog, which will automatically be done if a cover 334 which must be removed in order to obtain access to the shaft 62 is replaced, the downward motion of the latch dog in this latter event being caused by a boss 335 which is provided on the underside of the cover, and which cooperates with the upper end of the long leg 329a of the latch dog.

The crank 318 referred to hereinbefore is operatively connected with the sleeve 319 by means of a lost motion connection comprising a depending arcuate lug 319a formed on the lower end of the sleeve, and cooperating with an upstanding arcuate lug 318a formed on the hub of the crank 318. The crank 318 is also pivotally connected with the link 283 described hereinbefore, whereby the sleeve 319 is operatively connected with the previously described auxiliary circuit controller. The auxiliary circuit controller is biased to its normal position in which the contacts 301a—301—301b, 302a—302—302b, 303a—303—303b, 304a—304—304b are closed and the contact 305a—305—305b is open, by means of the previously described spring 281 which in this instance is secured to an arm 336 which is secured to the upper end of the vertical shaft 317. The parts are so proportioned that when the short shaft 323 is rotated to its brake releasing position, the resultant rotation of the sleeve 319 will act through the medium of the lugs 319a and 318a to actuate the circuit controller from its normal position to the position in which the contact 304b—305—305a becomes closed and the remaining contacts become open, but that, due to the lost motion connection, the short shaft 323 and associated parts are free to return to their normal positions in which the brake is released without restoring the contacts of the auxiliary circuit controller to their normal positions.

Under some conditions of operation, it is desirable, when the auxiliary circuit controller is

operated to its hand-operating position to permit operation of the switch machine by the hand crank, to latch this circuit controller in its hand-operating position until it is subsequently manually released, and when this is the case, the crank 311 is formed with an integral latch segment 311a (see Fig. 30) which cooperates with a latch 337. The latch 337 is supported in a vertical position on a pin 338 which is mounted in a pair of lugs 339 secured to the side of the case, and is biased to a latching position by means of a spring 340. The parts are so proportioned that when the short shaft 323 is rotated to its latching position, the latch 337 will move into engagement with the latch segment in a manner to retain the latch segment in the position which it occupies when the short shaft occupies its brake releasing position, and it will be seen, therefore, that when the auxiliary circuit controller is once operated to the position in which the contacts 301a—301—301b, 302a—302—302b, 303a—303—303b, 304a—304—304b are open and the contact 304b—305—305a is closed the circuit controller will be retained in this position until the latch 337 is manually operated, at which time the spring 231 will act to return the contacts of the auxiliary circuit controller to the positions in which they are shown in the drawings.

Although we have herein shown and described only two forms of apparatus embodying our invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of our invention.

Having thus described our invention, what we claim is:

1. In railway switch operating apparatus of the type in which a slide bar is moved to an intermediate position prior to the movement of the operating rod which reverses the switch points and to one or the other of two extreme positions after the completion of the movement of the operating rod depending upon the extreme position to which the switch points have been moved, the combination of two spaced locking dogs secured directly to the upper side of said slide bar and one having an overhanging portion, and a lock rod secured to the switch points to move therewith and provided with two spaced notches one located in the upper edge of the lock rod and adapted to receive the overhanging portion of said one dog when said slide bar is moved to its one extreme position and the other located in the lower edge of the lock rod and adapted to receive the other dog when said slide bar is moved to its other extreme position.

2. In combination, a movable point frog comprising two pairs of switch points movable simultaneously in opposite directions, means including an operating rod for reversing said switch points, a slide bar, means for moving said slide bar to an intermediate position prior to the movement of said operating rod which reverses the switch points and to one or the other of two extreme positions upon the completion of the movement of the operating rod depending upon the extreme position to which the switch points have been moved, three spaced locking dogs secured to the upper side of said slide bar, the two outer dogs being in the form of rectangular blocks and the middle dog being T-shaped to provide oppositely extending overhanging portions, and two lock rods one secured to each pair of switch points to move therewith, the one lock rod being provided in its lower edge with a notch which is adapted to receive the one outer dog when said slide bar is moved to its one extreme position and in its upper edge with another notch which is adapted to receive the one overhanging portion of said middle dog when said slide bar is moved to its other extreme position, and the other lock rod being provided in its lower edge with a notch which is adapted to receive the other outer dog when the slide bar is moved to said other extreme position and in its upper edge with another notch which is adapted to receive the other overhanging portion of said middle dog when said slide bar is moved to said one extreme position.

3. A switch operating mechanism comprising a switch operating rod having a cam slot therein, a slide bar, a motion plate secured to said slide bar and having two cam slots therein, a crank, and three rollers secured to said crank on the same side of said crank and each cooperating with a different one of said slots for alternately and intermittently moving said bar and said rod.

4. A switch operating mechanism comprising a switch operating rod having a cam slot formed therein, a slide bar intersecting said operating rod at right angles below said slide bar, a motion plate secured to said slide bar and having two cam slots formed therein, a crank disposed above said slide bar and said operating rod at one side of their point of intersection, and three rollers secured to the underside of said crank and each cooperating with a different one of said slots for alternately and intermittently reciprocating said rod and said bar.

5. A switch operating mechanism comprising a switch operating rod movable between two extreme positions corresponding to the two extreme positions of a railway switch and having a slot formed therein, a switch locking slide bar intersecting said operating rod at right angles below said operating rod and movable between an intermediate and two extreme positions, a motion plate secured to said slide bar and having two cam slots therein, a crank, and means secured to the underside of said crank and cooperating with said slots for moving said operating rod between its two extreme positions and said slide bar between its intermediate and its two extreme positions, said means being arranged to move said slide bar to its intermediate position prior to any movement of said operating rod and to one or the other of its extreme positions upon the completion of the movement of the operating rod depending upon the extreme position to which the operating rod is moved.

6. A switch operating mechanism comprising a switch operating rod having a cam slot formed therein, a slide bar intersecting said operating rod at right angles below said slide bar, a motion plate secured to said slide bar and having two cam slots formed therein, a crank disposed above said slide bar and said operating rod at one side of the point of intersection, a first roller secured to the underside of said crank and cooperating with the slot in said rod for moving said rod between two extreme positions, a second roller secured to the underside of said crank and cooperating with one of the slots in said motion plate for moving said bar between an intermediate and one extreme position, and a third roller secured to the underside of said crank and cooperating with the other slot in said motion

plate for moving said bar between its intermediate position and another extreme position.

7. A switch operating mechanism comprising a switch operating rod having a cam slot formed therein, a slide bar intersecting said operating rod at right angles below said slide bar, a motion plate secured to said slide bar and having two cam slots formed therein, a crank disposed above said slide bar and said operating rod at one side of the point of intersection, a first roller secured to the underside of said crank and cooperating with the slot in said rod for moving said rod between two extreme positions, a second roller secured to the underside of said crank and cooperating with one of the slots in said motion plate for moving said bar between an intermediate and one extreme position, and a third roller secured to the underside of said crank and cooperating with the other slot in said motion plate for moving said bar between its intermediate position and another extreme position, the parts being arranged to move said slide bar to its intermediate position prior to any movement of said operating rod and to one or the other of its extreme positions upon the completion of the movement of the operating rod depending upon the extreme position to which the operating rod is moved.

8. A switch operating mechanism comprising a switch operating rod having a cam slot formed therein, a slide bar intersecting said operating rod at right angles below said slide bar, a motion plate secured to said slide bar and having two cam slots formed therein, a crank disposed above said slide bar and said operating rod at one side of the point of intersection, a first roller secured to the underside of said crank and cooperating with the slot in said rod for moving said rod between two extreme positions, a second roller secured to the underside of said crank directly below said first roller and cooperating with one of the slots in said motion plate for moving said bar between an intermediate and one extreme position, and a third roller secured to the underside of said crank and cooperating with the other slot in said motion plate for moving said bar between its intermediate position and another extreme position.

9. A switch operating mechanism comprising an operating rod movable between two extreme positions and having a slot formed therein, a slide bar movable between an intermediate and two extreme positions and intersecting said operating rod at right angles below said operating rod, a motion plate secured to said slide bar and having two oppositely disposed arcuate slots formed therein, a rotatable crank disposed above said slide bar, a first roller secured to said crank and cooperating with the slot in said operating rod to move said operating rod between its two extreme positions in response to rotation of said crank between two extreme positions, a second roller secured to said crank and cooperating with the one slot in said motion plate for moving said slide bar between its intermediate and one extreme position in response to movement of said crank between an intermediate and its one extreme position, and a third roller cooperating with the other slot in said motion plate for moving said slide bar between its intermediate and other extreme position in response to movement of said crank between an intermediate and its other extreme position.

10. A switch operating mechanism comprising an operating rod movable between two extreme positions and having a slot formed therein, a slide bar movable between an intermediate and two extreme positions and intersecting said operating rod at right angles below said operating rod, a motion plate secured to said slide bar and having formed therein oppositely disposed arcuate slots, a crank disposed above said slide bar and said operating rod and having oppositely extending projections, means for rotating said crank between two extreme positions, two depending pins secured to said projections, a first roller mounted on one pin and cooperating with the slot in said operating rod to move said rod between its two extreme positions in response to rotation of said crank between two extreme positions, a second roller mounted on said one pin below said first roller and cooperating with the one arcuate slot in said motion plate to move said slide bar between its intermediate and its one extreme position in response to movement of said crank between an intermediate and its one extreme position, and a third roller mounted on the other pin and cooperating with the other arcuate slot in said motion plate to move said slide bar between its intermediate and its other extreme position in response to movement of said crank between an intermediate and its other extreme position.

11. A switch operating mechanism comprising an operating rod movable between two extreme positions and having a slot formed therein, a slide bar movable between an intermediate and two extreme positions and intersecting said operating rod at right angles below said operating rod, a motion plate secured to said slide bar and having two oppositely disposed arcuate slots formed therein, a rotatable crank disposed above said slide bar, a first roller secured to said crank and cooperating with the slot in said operating rod to move said operating rod between its two extreme positions in response to rotation of said crank between two extreme positions, a second roller secured to said crank and cooperating with the one slot in said motion plate for moving said slide bar between its intermediate and one extreme position in response to movement of said crank between an intermediate and its one extreme position, and a third roller cooperating with the other slot in said motion plate for moving said slide bar between its intermediate and other extreme position in response to movement of said crank between an intermediate and its other extreme position, said cam slots in said motion plate having surfaces which coact with the associated rollers to lock the slide bar while the operating rod is being moved.

12. Railway switch operating apparatus comprising a rotatable switch actuating shaft, a power operated and a manually operated gear wheel mounted for rotation coaxially with said shaft, a clutch member slidably mounted on said shaft for movement between an extreme position in which teeth on said clutch member mesh with teeth on one of said gear wheels to connect such one gear wheel with said shaft and another extreme position in which teeth on said clutch member mesh with teeth on the other gear wheel to connect such other gear wheel with said shaft, a floating fulcrum block, an eyebolt secured to said block, a casting provided with an opening which receives said eyebolt with clearance and with seats which cooperate with seats on said fulcrum block, a spring on said eyebolt engaging said casting at one end for biasing said fulcrum block to the position in which it engages the seats

on said casting, whereby said fulcrum block is normally held in a fixed position but is free to move away from said fixed position in response to abnormal forces, and operating means for said clutch member including a shifter yoke pivotally attached at one end to said fulcrum block and provided intermediate its ends with rollers which project into an annular groove formed in said clutch member at opposite sides of said clutch member, whereby said shifter yoke is pivoted to said clutch member, and means for moving the other end of said shifter yoke for pivoting said yoke about its pivotal connection with said fulcrum block while moving said clutch member, and on encountering sufficient resistance for pivoting said yoke about said movable clutch member while moving said fulcrum block, whereby to positively inter-engage the teeth on said clutch member with the teeth on said gear wheels if they be in registering position, and to bias them toward each other if they be out of registering position.

13. In a switch machine, in combination, an electric motor provided with a magnetic brake which automatically releases when the motor becomes energized, a hand-throw lever, manually operable means for selectively connecting the motor or the hand-throw lever with the switch machine to permit operation of the machine by the motor or the hand-throw lever, and means actuated by said manually operable means for releasing the brake during operation of the switch machine by the hand lever.

14. In a machine for operating railway traffic controlling devices, in combination, an electric motor provided with a magnetic brake which becomes released when the motor becomes energized, a hand-throw lever, clutch mechanism for selectively connecting said motor or said hand-throw lever with said machine, a selector lever for operating said clutch mechanism, and means controlled by said selector lever for releasing said brake prior to operation of said clutch mechanism to disconnect said motor from said machine.

15. In a machine for operating railway traffic controlling devices, in combination, an electric motor provided with a magnetic brake which becomes released when the motor becomes energized, a hand-throw lever, clutch mechanism for selectively connecting said motor or said hand-throw lever with said machine, a selector lever for operating said clutch mechanism, a cam operatively connected with said selector lever, and means controlled by said cam for at times mechanically releasing said magnetic brake.

16. In a switch machine, in combination, a switch actuating shaft, an electric motor including a brake biased to a braking position and electromagnetic means effective for releasing said brake when said motor becomes energized, a hand-throw lever, a clutch for selectively connecting said motor or said hand-throw lever with said switch actuating shaft, a selector lever for actuating said clutch, a cam actuated by said selector lever, and means controlled by said cam for mechanically releasing said brake.

17. In a switch machine, in combination, a switch actuating shaft, an electric motor including a brake biased to a braking position and electromagnetic means effective for releasing said brake when said motor becomes energized, a hand-throw lever, a clutch for selectively connecting said motor or said hand-throw lever with said switch actuating shaft, a selector lever for actuating said clutch, a cam actuated by said selector lever, a circuit controller, and means controlled by said cam for mechanically releasing said brake and for actuating said circuit controller.

18. In combination, a switch actuating shaft, an electric motor including a magnetic brake which becomes released when said motor becomes energized, a rotatable sleeve, a segment gear secured to one end of said sleeve, a first lever secured to the other end of said sleeve for rotating said sleeve to actuate said segment gear, a clutch for selectively connecting said segment gear or said motor with said switch actuating shaft, a first shaft journaled in said sleeve and operatively connected at its inner end with said clutch, whereby said clutch may be operated by rotation of said shaft, a second lever secured to said first shaft for rotating said first shaft, a cam mounted on the hub of said segment gear for rotation coaxially with said sleeve, a second gear secured to said cam, a jackshaft journaled in a bearing secured to the hub of said segment gear, two pinions secured to said jackshaft and meshing with said second and third gears respectively, and means for operatively connecting said cam with said magnetic brake in such manner that said brake will become mechanically released whenever said second lever is operated to disconnect said motor from said switch actuating shaft.

19. In combination, a switch actuating shaft, an electric motor including a magnetic brake which becomes released when said motor becomes energized, a rotatable sleeve, a segment gear secured to one end of said sleeve, a first lever secured to the other end of said sleeve for rotating said sleeve to actuate said segment gear, a clutch for selectively connecting said segment gear or said motor with said switch actuating shaft, a first shaft journaled in said sleeve and operatively connected at its inner end with said clutch, whereby said clutch may be operated by rotation of said shaft, a second lever secured to said first shaft for rotating said first shaft, a cam mounted on the hub of said segment gear for rotation coaxially with said sleeve, a second gear secured to said cam, a jackshaft journaled in a bearing secured to the hub of said segment gear, two pinions secured to said jackshaft and meshing with said second and third gears respectively, a circuit controller, and means controlled by said cam for at times mechanically releasing said magnetic brake and for operating said circuit controller.

20. In a switch machine, in combination, an electric motor including a magnetic brake which becomes released when said motor becomes energized, a switch actuating shaft, a gear train connecting said motor with said switch actuating shaft having one gear secured to a second shaft which is adapted to receive a hand lever for manually operating the switch actuating shaft, an auxiliary shaft rockable between two extreme positions, means for mechanically releasing said brake when said auxiliary shaft is rotated to one extreme position, and means secured to said auxiliary shaft for preventing a hand crank from being placed on said second shaft except when said auxiliary shaft is rotated to its one extreme position, said auxiliary shaft being biased to its other extreme position.

21. In combination, a switch actuating shaft, an electric motor connected with said switch actuating shaft and including a magnetic brake which becomes released when said motor becomes energized, a second shaft connected with said

switch actuating shaft and adapted to receive a hand crank for manually operating said switch actuating shaft, an auxiliary shaft operatively connected with the magnetic brake for at times manually releasing the brake and movable between a brake applying and a brake releasing position, and means for preventing a hand crank from being placed on said second shaft unless said auxiliary shaft occupies its brake releasing position.

22. In combination, a switch actuating shaft, an electric motor connected with said switch actuating shaft and including a magnetic brake which becomes released when said motor becomes energized, a second shaft connected with said switch actuating shaft and adapted to receive a hand crank for manually operating said switch actuating shaft, an auxiliary shaft operatively connected with the magnetic brake for at times manually releasing the brake and movable between a brake applying and a brake releasing position, latch mechanism effective when said auxiliary shaft is rotated to its brake releasing position for latching it in such position until said latch mechanism is manually operated to release said auxiliary shaft, and means for preventing a hand crank from being placed on said second shaft unless said auxiliary shaft occupies its brake releasing position.

23. In combination, a switch actuating shaft, an electric motor connected with said switch actuating shaft and including a magnetic brake which becomes released when said motor becomes energized, a second shaft connected with said switch actuating shaft and adapted to receive a hand crank for manually operating said switch actuating shaft, an auxiliary shaft operatively connected with the magnetic brake for at times manually releasing the brake and movable between a brake applying and a brake releasing position, means for preventing a hand crank from being placed on said second shaft unless said auxiliary shaft occupies its brake releasing position, and a circuit controller operatively connected with said auxiliary shaft.

24. In combination, a switch actuating shaft, an electric motor connected with said switch actuating shaft and including a magnetic brake which becomes released when said motor becomes energized, a second shaft connected with said switch actuating shaft and adapted to receive a hand crank for manually operating said switch actuating shaft, an auxiliary shaft operatively connected with the magnetic brake for at times manually releasing the brake and movable between a brake applying and a brake releasing position, means for preventing a hand crank from being placed on said second shaft unless said auxiliary shaft occupies its brake releasing position, a circuit controller having two positions and biased to one position and operatively connected with said auxiliary shaft by means including a lost motion connection in such manner that said circuit controller will be operated to its other position in response to operation of said auxiliary shaft to its brake releasing position but that said auxiliary shaft is free to return to its brake applying position without moving said circuit controller to its one position, and other latch mechanism effective whenever said circuit controller is moved to its other position for latching it in such position.

25. In combination, a switch machine including a switch machine casing, a switch actuating shaft journaled in said casing, an electric motor secured to said casing and connected with said shaft and provided with a magnetic brake which becomes released when the motor becomes energized, a second shaft in said casing connected with said switch actuating shaft and adapted to receive a hand crank for manually operating said switch actuating shaft, an auxiliary shaft in said casing operatively connected with said magnetic brake and movable from a normal position to a brake releasing position, an opening in said casing through which access to said second and said auxiliary shaft may be had, means in said casing for preventing a hand crank from being placed on said second shaft unless said auxiliary shaft occupies its brake releasing position, latch mechanism effective when said auxiliary shaft is rotated to its brake releasing position for releasing said brake, and a cover for the opening in said casing provided with means for automatically releasing said latch mechanism when said cover is placed over said opening.

26. In a switch machine, in combination, a switch actuating shaft, power means for actuating said shaft including an electric motor provided with a magnetic brake which releases when the motor becomes energized, other means for releasing said brake, manually operable means for at times actuating said shaft, and means for preventing said manually operable means from becoming operatively connected with said shaft until after said other means is first operated to release said brake.

27. In a switch machine, in combination, a switch actuating shaft, an electric motor for at times actuating said shaft, a manually operable member for at other times actuating said shaft, braking means for the motor biased to braking position, means for automatically releasing the braking means when the motor receives operating power, separate manually operable release means for the braking means, and means for preventing said manually operable member from becoming operatively connected with said shaft until after said braking means has first been released by said manually operable release means.

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