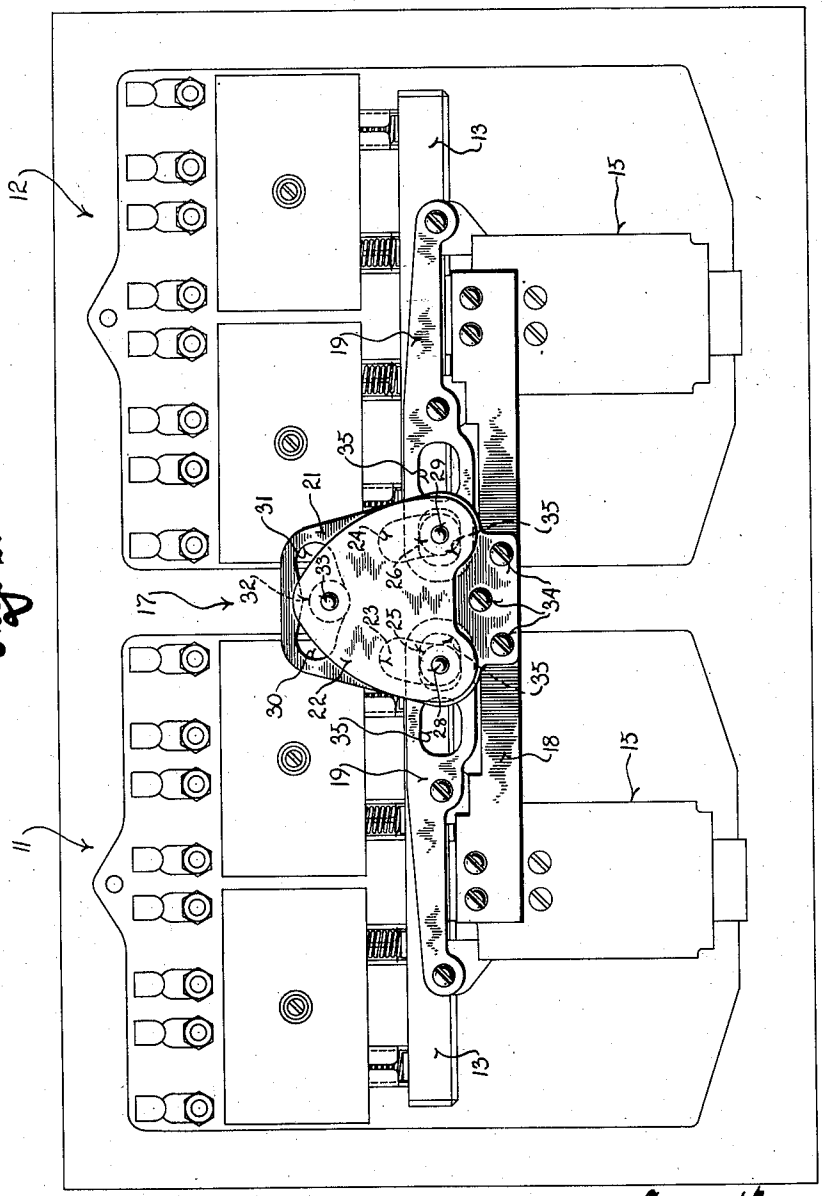
Oct. 7, 1952 J. BIERENFELD 2,612,789

INTERLOCKED ELECTRIC SWITCH

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Fig. 1.




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INTERLOCKED ELECTRIC SWITCH

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Fig. 2.

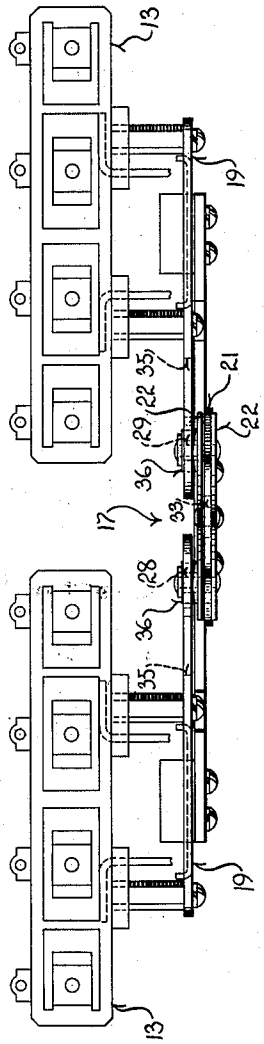
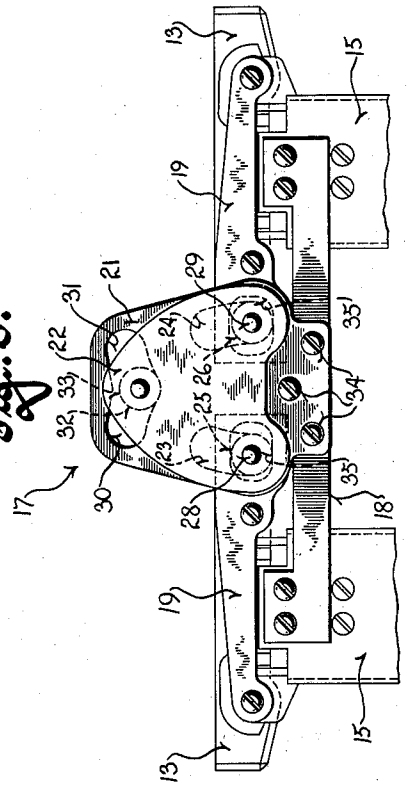



Fig. 3.




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INTERLOCKED ELECTRIC SWITCH

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Fig. 5.

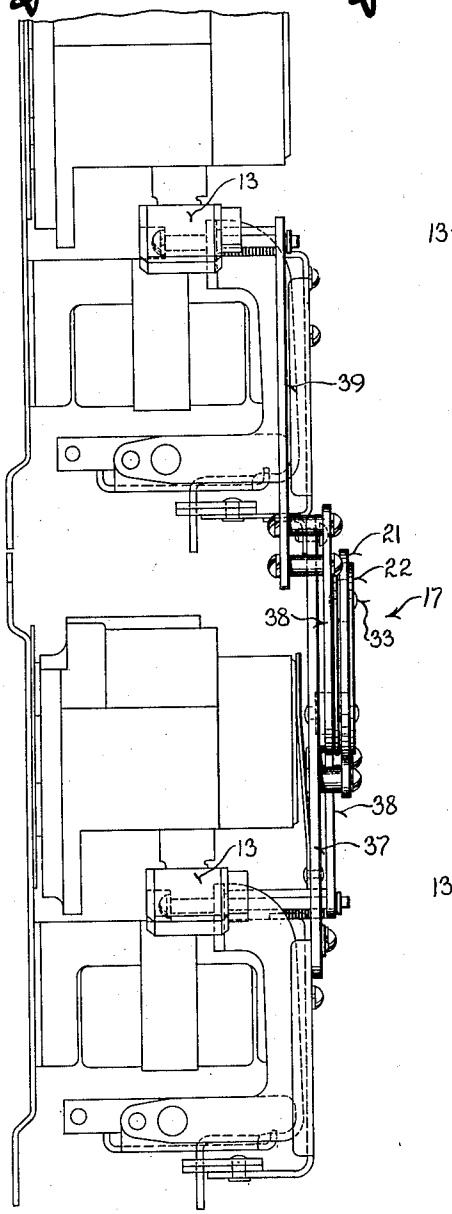
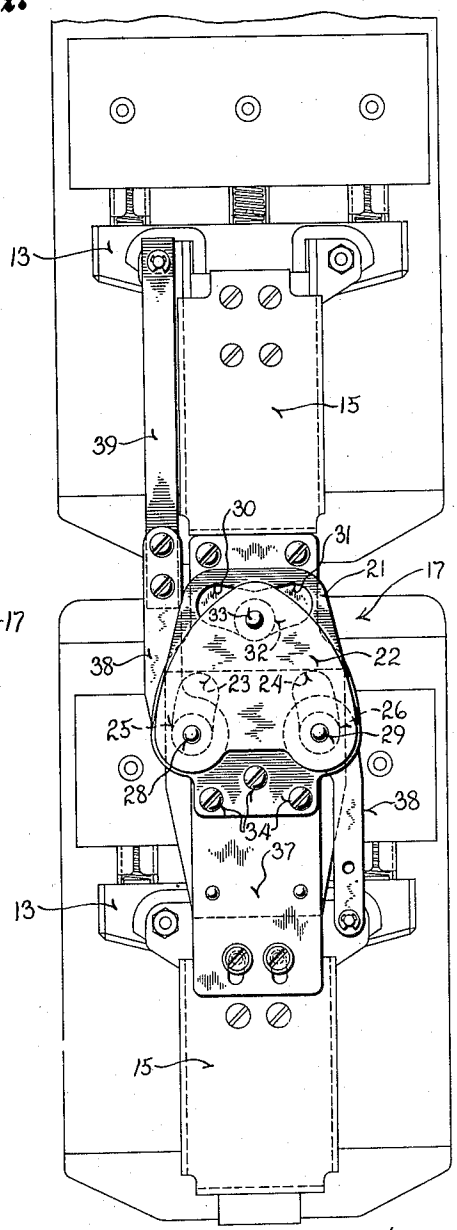



Fig. 4.




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INTERLOCKED ELECTRIC SWITCH

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Fig. 6.

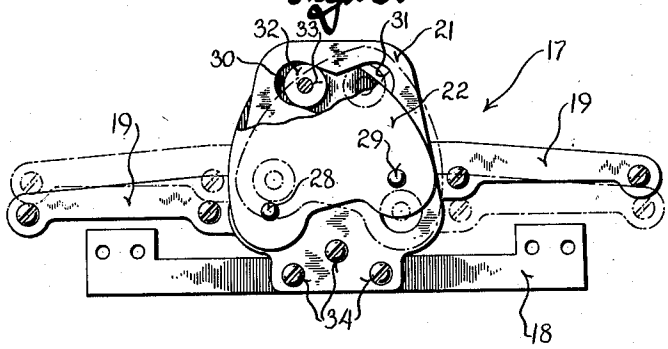
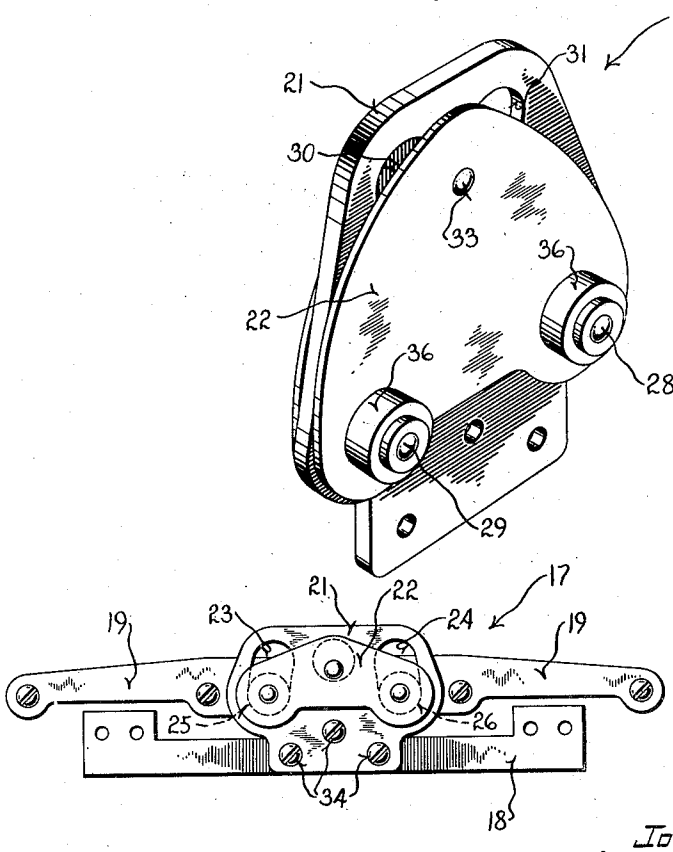



Fig. 7.



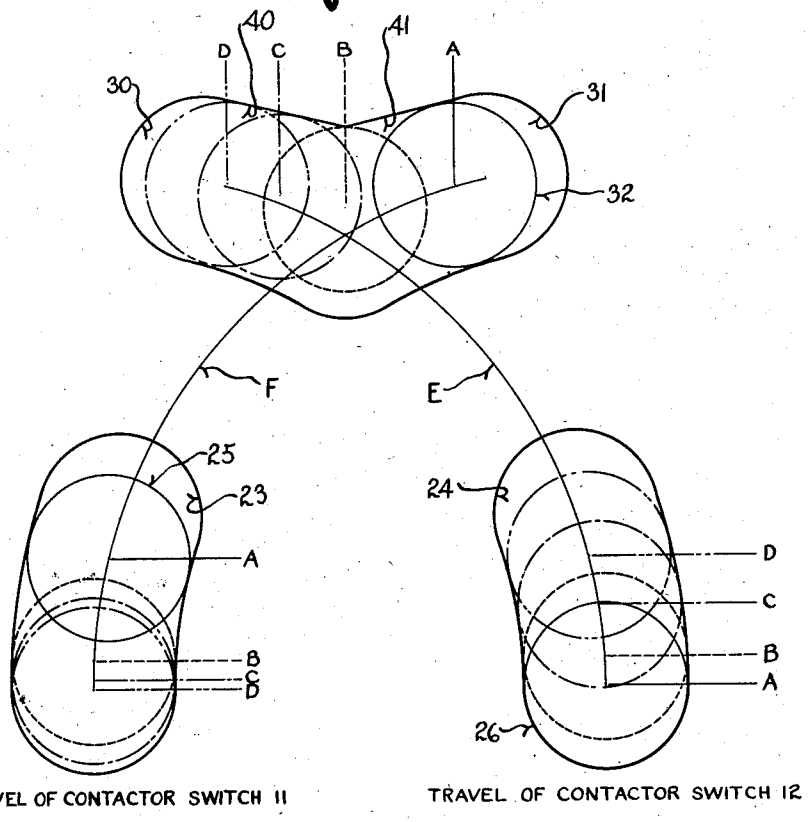

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INTERLOCKED ELECTRIC SWITCH

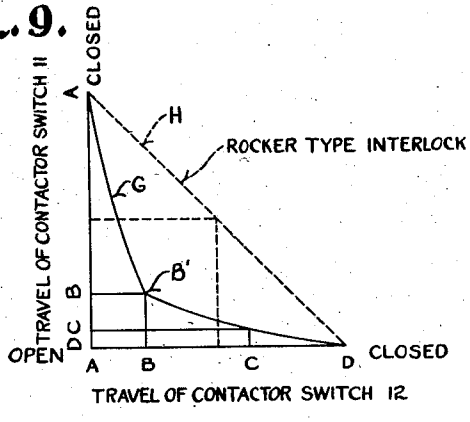
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Fig. 8.




TRAVEL OF CONTACTOR SWITCH 11 TRAVEL OF CONTACTOR SWITCH 12

Fig. 9.




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Patented Oct. 7, 1952

2,612,789

# UNITED STATES PATENT OFFICE

2,612,789

## INTERLOCKED ELECTRIC SWITCH

Josef Bierenfeld, Milwaukee, Wis., assignor to Square D Company, Milwaukee, Wis., a corporation of Wisconsin

Application January 9, 1950, Serial No. 137,590

9 Claims. (Cl. 74—483)

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This invention relates broadly to interlock mechanisms and refers more particularly to interlocked electric switches of the type illustrated in Patents Nos. 2,262,071 and 2,363,912 issued to H. L. Van Valkenburg November 11, 1941, and November 28, 1944, respectively.

As brought out in the aforesaid Patent No. 2,262,071 it is desirable in an interlock for a pair of companion switches to assure substantial opening of the closed switch before the open switch can be closed. This is especially important in electromagnetically operated switches having relatively short opening and closing strokes.

In the most elementary form of mechanical interlock in which a rocker arm connects the contactor assemblies of the two switches, the contactor assembly of the switch being opened travels the same distance per unit of time as the contactor of the switch being closed. The optimum condition is one wherein the closed switch must be fully open before the open switch can begin to close. While the interlock of the aforesaid patents approaches this optimum condition, it is a purpose of the present invention to provide an improved mechanical interlock which not only requires the closed switch to be nearly fully opened before the open switch can begin to close, but in which binding or jamming of the mechanism is entirely precluded.

It is also very important that the interlock mechanism be so designed and constructed that the force imposed thereon by energization of the electromagnet of the open switch will not restrain the closed switch from freely dropping open. The possibility of such restraint is an objection to the so-called "interfering-bar" type of interlock wherein a locking bar slides horizontally to "lock out" the open switch. In such interlocks the friction between the parts will sometimes prevent the closed switch from opening if the electromagnet of the open switch is energized slightly before that of the closed switch is deenergized.

In recognition of this defect the present invention provides an interlock wherein such binding due to friction is entirely impossible.

It is, therefore, a purpose and object of this invention to provide an improved mechanical interlock especially adapted for interlocking two companion electric switches wherein these desirable advantages are attained with a simple mechanism.

Another object of this invention is to provide a mechanical interlock of the character described which may be readily applied—without change—to a pair of switches arranged either side-by-side or in tandom one above the other.

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Another object of this invention is to provide an interlock of the character described which may be applied without change to switches of different sizes; and more especially to switches having different length strokes. Thus, for instance, the interlock of this invention can, without change, be used on a switch having a $\frac{3}{8}$'' stroke as well as on a switch having a $\frac{9}{16}$'' stroke and moreover can be used to interlock switches of such unequal strokes.

A further object of this invention is to provide a mechanical interlock which is rugged and fully capable of withstanding the stresses that may be imposed thereon in effectuating its purpose of preventing simultaneous closure of two switches.

A still further object of this invention is to provide an interlock which while especially adapted for use with two electromagnetically actuated switches is equally useful for preventing simultaneous movement in one direction of any two movable members.

With the above and other objects in view, which will appear as the description proceeds, this invention resides in the novel construction, combination and arrangement of parts substantially as hereinafter described and more particularly defined by the appended claims, it being understood that such changes in the precise embodiment of the hereindisclosed invention may be made as come within the scope of the claims.

The accompanying drawings illustrate two complete examples of the physical embodiments of the invention constructed according to the best modes so far devised for the practical application of the principles thereof, and in which:

Figure 1 is a front elevational view of two side-by-side electromagnetically actuated switches with the interlock of this invention applied thereto;

Figure 2 is a top plan view of the contactor assemblies of the switches shown in Figure 1 and of the interlock applied thereto;

Figure 3 is a front elevational view of the interlock mechanism per se but illustrating the manner in which the device may be applied to two switches smaller than those shown in Figure 1, by merely reducing the length of the switch carried operating arms and the mounting bar upon which the interlock is mounted;

Figure 4 is a front elevational view of two electromagnetically actuated switches arranged in

tandem and illustrating the interlock of this invention applied thereto;

Figure 5 is a side view of the tandem arranged switches of Figure 4 and the interlock applied thereto;

Figure 6 is a front elevational view of the interlock per se illustrating the action thereof;

Figure 7 is a perspective view of the main elements of the interlock mechanism shown detached from the remainder of the device;

Figure 8 is a diagrammatic view illustrating the action of the interlock; and

Figure 9 is a diagram illustrating the relative travel of the switch contactors in moving to closed and open positions, with the different positions of the contactors indicated by the same indicia employed in Figure 9 to show the different positions of the interlock.

Referring now particularly to the accompanying drawings in which like numerals indicate like parts throughout the sevaral views, the numerals 11 and 12 indicate generally two electromagnetically actuated switches each having a contactor assembly including a yoke 13 constrained to vertical motion and movable upwardly to close the switch upon energization of its solenoid 15.

Simultaneous closure of the two switches is prevented by the interlock of this invention, indicated generally by the numeral 17. The interlock is mechanical in action and is mounted upon a cross bar 18 fixed at its opposite ends to a suitable stationary part of each switch as, for instance, the solenoid frame.

An operating arm 19 is fixed to the yoke 13 of each switch or to any other suitable part thereof which is movable with a translating motion along with the contactor assembly of the switch. These operating arms are identical and, when both switches are open, are directly opposite each other. At this time the entire mechanism may be said to be in neutral.

Obviously upon closure of one of the switches its operating arm moves upwardly with the contactor assembly of the closed switch. This upward movement of the lifted operating arm sets the interlock mechanism to secure the other operating arm and consequently the switch contactor assembly to which it is connected against upward switch closing movement, and as will be hereinafter more fully described in this blocking or operative condition of the interlock the then open switch is positively held against closure and cannot begin to close until the closed switch is either fully open or almost fully open. The interlock per se comprises two cooperating stationary and movable elements 21 and 22 respectively. The stationary element 21 is a flat guide plate having two opposite upwardly converging arcuate slots 23 and 24 in its lower portion and two connected substantially arcuate upwardly diverging slots 30 and 31 formed in the upper part thereof. Rollers 25 and 26 carried by the movable element 22 are received in the lower slots 23 and 24 respectively to ride up and down therein, and the movable element has a third roller 32 thereon received and movable in the upper slots 30 and 31.

The movable element 22 consists of two identical rocker plates overlying the opposite faces of the guide plate and connected together by the axles 28, 29 and 33 of the rollers 25, 26 and 32 respectively. The rollers 25, 26 and 32 operating in their respective slots connect the stationary and movable elements together for relative movement in a defined manner as will be hereinafter more fully described.



The two thus connected elements are securely mounted upon the cross bar 18 by means of screws 34. So positioned the connected stationary and movable elements which may be considered the heart of the interlock mechanism overlie the adjacent inner end portions of the operating arms 19 and to effect the necessary connection between the interlock and the two switches, the movable element 22 is connected to each arm by means of rollers 36 journalled on the axles 28 and 29 and received in elongated slots or openings 35 in the inner end portions of the arms.

To enable the interlock mechanism to be applied to switches of different sizes the operating arms 19 are provided in maximum lengths to accommodate the largest size switch for which the device is designed and have two endwise spaced roller receiving slots 35 as shown in Figure 1. The horizontal mounting bar 18, of course, also must be long enough to span the distance between the switches. Thus to apply the interlock to a pair of smaller switches it is only necessary to provide a shorter mounting bar 18 and cut off the operating arms 19 between their two roller receiving slots as shown in Figure 3. In all other respects the mechanism is the same whether the switch be two, three or four pole.

As will be brought out hereinafter the same interlock also can be used to interlock companion switches each of which has a different length stroke.

The interlock mechanism is also readily applicable to installations in which the companion switches are arranged in tandem one above the other. In this case, as shown in Figures 4 and 5, a vertical mounting bar or plate 37 is substituted for the cross bar 18. The upper and lower ends of the plate 37 are secured to suitable stationary portions of the switches, and as before the cam plate 21 is secured to this mounting plate 37. Different operating arms are, of course, needed but here again the two arms 38 are identical; one of which—in this case the lower one—is connected directly to the contactor assembly of the lower switch, while the other is connected to the contactor assembly of the upper switch through an extension arm or link 39.

Since the lower arm 38 and the extension arm or link 39 are pivoted to their respective contactor assemblies, the operating arms may be directly pivoted to the movable element of the interlock.

Whether the switches to which the interlock is applied are arranged side-by-side or one above the other, the action of the interlock is the same. In each case closure of one switch is accompanied by rocking movement of the movable element 22 from a neutral position to a blocking position preventing closure of the other switch and vice versa.

Thus, assuming that both switches are open so that the interlock is in neutral, in this condition the rollers 25 and 26 are horizontally opposite each other at the bottoms of their respective arcuate slots 23 and 24. In this condition of the interlock the rollers 25 and 26 provide trunnions engageable with bearing seats provided by the bottom portions of their respective slots to afford two transient pivotal connections between the stationary and movable elements of the interlock about either one of which the movable element may fulcrum. To enable this rocking movement, the arc of each slot 23 and 24 is struck

from the center of the bottom portion or bearing seat of the other slot.

It is important to observe, however, that the only functions of the slots 23 and 24 are to provide bearing seats in their bottom portions for the rollers or trunnions 25 and 26, to preclude lateral shifting of the movable element relative to the stationary element beyond the extent permitted by normal operating clearances between the trunnions 25 and 26 and the edges of their slots, and to cooperate with the roller 32 riding in the upper slots 30 and 31 in guiding the rollers 25 and 26 to their lower pivot forming positions. These functions could be accomplished just as well either by the inwardly facing concave edges of the slots alone, or by the outwardly facing convex edges of the slots alone. For example, the entire medial portion of the stationary member 21 between the slots 23 and 24 could be cut away to leave only a single large opening having inwardly facing concave edges cooperable with the roller in the upper slots 30 and 31 to guide the rollers 25 and 26 to pivot forming positions engaging bearing seats at the bottom of the opening; or the opposite side edges of the stationary member 21 could have the metal defining the concave edges of the slots 23 and 24 cut away to leave only the inner convex edges thereof to cooperate with the roller 32 in the upper slots 30 and 31 in guiding the rollers 25 and 26 to pivot forming positions at the lower bearing seat ends of the notches thus formed. Though either expedient would be satisfactory, it is preferable to employ the slots 23 and 24 so that the resulting greater area of surface to surface engagement between the flat movable elements 22 and the flat stationary element 21 therebetween minimizes wear of the parts and assures longer trouble-free operation of the interlock.

In the absence of the top roller 32 and the slot 30—31 in which it rides, and despite the presence of the necessary working clearance between the trunnions 25 and 26 and the sides of their slots 23 and 24, there would be danger of the trunnions becoming wedged in their slots by a lifting force applied to one of the trunnions in consequence of energization of its associated switch before the other trunnion completed its descent in consequence of deenergization of its associated switch. Under these conditions, the force tending to lift the first mentioned trunnion into the converging portion of its slot can be resolved into a frictional force on the axle of the other trunnion greater than the opening force which can be brought to bear upon it by the contactor of its associated switch when the latter is deenergized.

Although there is clearance between the roller 32 and the edges of the slot 30—31 in which it rides, just as there is between the trunnions 25 and 26 and the edges of their slots, and the fact that the top edges 40 and 41 of the slot 30—31 lie athwart the direction which movement of the roller 32 would have to take during attempted closure of the open switch, this clearance is taken up and further movement of the movable element 22 toward concurrent closure of both switches is limited and prevented before wedging engagement of both trunnions with the outer edges of their slots can take place. Hence, the engagement of the roller 32 with the tracks provided by the edges 40—41 effectively prevents jamming of the trunnions between the outer edges of their slots 23—24 which would occur upon concurrent energization of both switches



if the roller 32 and the slot 30—31 in which it rides were not present.

It will be seen, therefore, that the upper edges 40 and 41 of the slots 30 and 31 constitute blocking surfaces cooperable with the roller 32 to not only limit simultaneous upward movement of the two trunnions 25 and 26 from their fulcruming or neutral positions, but that these edges may also be considered as cam tracks which, in either lock-out position of the movable element constrain it to rock to the opposite lock-out or to neutral position.

In other words, with the switch 12 closed so that its associated operating arm and the trunnion 26 are in their raised positions, the roller 32 has been swung counterclockwise about trunnion 25 into the outer portion of the slot 30, and the track portion or edge 40 of this slot coacts with the roller 32 to block such lifting of the trunnion 25 off of its seat as would result in the trunnions becoming wedged in their slots, so that the movable element 22 is constrained against any movement other than clockwise rocking motion about the trunnion 25 toward its neutral position.

Hence the switch 11 is effectively locked in its open position as long as the switch 12 remains closed, and until the roller 32 is carried off of the track 40 by the contactor of the switch 12 during opening thereof.

Similarly if the switch 11 is closed so that the movable element of the interlock has been rocked about the transient pivot provided by the engagement of its trunnion 26 in the bottom portion or bearing seat of the slot 24, and the roller 32 has been swung clockwise into the outer portion of its slot 31, the switch 12 will be locked against closure as long as the roller 32 is in position to engage the track 41 of slot 31 to block upward movement of the trunnion 26 which accompanies closure of the switch 12.

Theoretically, therefore, it is possible for the interlock of this invention to require substantially full opening of one switch before closure of the other switch can begin; but the operating clearances required for the trunnions and rollers in a mechanism of this type will permit some slight concurrent elevation of the two trunnions or rollers 25 and 26 so that closing motion of the open switch may begin slightly before the other switch is fully open.

As indicated in Fig. 8, the substantially arcuate slots 30 and 31 in a sense are continuations respectively of the slots 24 and 23 so that as the movable element rocks in either direction from its neutral position, the top roller 32 may move freely into the outer end of the slot 30 or 31 depending upon the direction in which the element 22 is rocked, and without any restriction due to the swinging of either trunnion 25 or 26 in its slot.

If the top edges or tracks 40 and 41 of the slots 30 and 31 followed concentrically the arcuate center lines of their respective slots, substantially complete opening of one switch would be necessary before closure of its companion switch could begin, at least to the extent that operating clearances would permit such close control. In other words, the bottom trunnion 25 or 26 about which the movable element rocked during opening of the closed switch could not leave its neutral position until the other trunnion had been returned to its neutral or fulcruming position.

However, a desirable result is achieved by hav-

ing the top edges or tracks 40 and 41 of the slots 30—31 recede from the arcuate center lines E and F of their respective slots as these edges approach each other. By such recession of the tracks 40 and 41 declivities are provided along which the roller 32 may run more easily during rocking movement of the movable element of the interlock in either direction toward the neutral position thereof, under the influence of the opening switch. Such recession of the edges or tracks 40 and 41 of course also increases slightly the extent of the permitted or possible simultaneous elevation of the trunnions 25 and 26 and consequently the switch contactors or other members controlled by the interlock. However, it will be appreciated that the normal clearance for the trunnions 25 and 26 in their slots 23 and 24 is ample to accommodate simultaneous upward travel of the trunnions the extent necessary to bring the top roller 32 into engagement with either track 40 or 41 or the junction of the divergent portions of the tracks, before the trunnions can engage the outer side edges of their slots and become wedged therein.

Figure 8 shows the three rollers 25, 26 and 32 in four different positions, designated A, B, C and D, but does not attempt to show the necessary working clearances for the rollers in their slots. This diagram should be considered in conjunction with Figure 9 wherein the extent of the opening and closing movement of the switches is illustrated.

In the full line positions A of the rollers shown in Figure 8 the movable element of the interlock is in the lockout position it occupies when the contactor of switch 11 is in its raised or closed position, and the contactor of switch 12 is in its lowermost or open position. In this position of the parts, the top roller 32 is in the narrow end of its slot 31, nearly directly above the fulcruming trunnion 26, so that the upper edge or track 41 of the slot 31 precludes upward movement of the roller 32 and trunnion 26 beyond the extent permitted by the working clearance for the roller 32 in the narrow end of its slot 31; and the switch 12 is effectively locked out.

Assuming now that the solenoid of switch 12 is energized just before the solenoid of switch 11 is deenergized, the roller 32 is brought against the track portion provided by the edge 41 of its slot 31 to block closing of the switch 12. This blocking, i. e., lock-out of switch 12, obtains until the solenoid of switch 11 is deenergized and the weight of its contactor then swings the movable element in the counter-clockwise direction far enough to carry the roller 32 off the track portion 41 and onto track portion 40. At this instant, the closing motion of switch 12 begins.

During such changeover of the switch positions the travel of roller 32 along the declivity provided by the track portion 41 of slot 31 allows the fulcruming roller 26 to rise slightly off of its seat as a result of energization of the solenoid of switch 12. During this time the roller 26 moves, for instance, from its position A to its position B. This distance A—B represents the maximum recession of the edges or track portions 40 and 41 from concentricity with the arcs E and F.

As the fulcruming roller 26 moves from A—B the roller 25 travels down the much greater distance A—B as shown at the left in Figure 8 and the roller 32 moves to its position B which is directly at the apex formed by the meeting track forming top edges 40 and 41 of the slots 30 and 31.

With continued counterclockwise rocking of the movable element 22 from the B positions of the rollers, the roller 25 becomes the fulcruming roller even though it has not reached the bottom of its slot 23, and the rollers 26, 32 and 25 move from B to C and then from C to D which represents the fully closed position for the switch 12 in which the switch 11 is locked out in its fully open position. During this changeover, it is noteworthy that the roller 32 engages continuously with the track provided by the edges 41 and 40 of the slots 31 and 30, respectively, to assure smooth and quiet operation of the interlock.



In the diagram shown in Figure 9 the ordinates indicate the travel of the contactor of the switch 11 while the abscissas indicate the travel of the contactor of the switch 12. The curve G represents the relative movement of the contactors as controlled by the interlock, the operation of which is diagrammatically illustrated in Figure 8. The point B' represents the travel which both contactors may have simultaneously from their open positions. The dotted line H represents the motion of similar contactors under the control of an ordinary rocker-type interlock.

Not only is the interlock of this invention especially well suited for interlocking two electro-magnetically operated switches, but the length of the slots 23, 24, 30 and 31 in the stationary element 21 enables the interlock to be used with companion switches having closure strokes varying in length, for example, from $\frac{3}{8}$'' to $\frac{9}{16}$''. For the same reason the interlock is not restricted to use with a pair of companion switches both of which have closing strokes of the same length. One of the companion switches may, for example, have a closing stroke of $\frac{3}{8}$'' while the closing stroke of the other switch may be any length from $\frac{3}{8}$'' to $\frac{9}{16}$''.

From the foregoing description taken in connection with the accompanying drawings it will be readily apparent to those skilled in the art that this invention provides an interlock especially well adapted for use with a pair of companion electro-magnetically actuated switches since it can be applied without change to switches arranged side-by-side or in tandem one above the other and in either case enables maximum safe approach to the optimum condition at which full and complete opening of the closed switch must take place before closure of the open switch can begin. It will also be evident that the interlock of this invention, though especially well suited for use with electric switches, is not limited thereto but also may be used to control the motion of other companion instrumentalities or movable members wherein simultaneous operation in one direction is to be precluded.

What I claim as my invention is:

1. An interlock for preventing simultaneous operation of a pair of independent electro-magnetic switches by requiring substantially complete opening of a closed switch before closure of the open switch can commence, comprising: cooperating movable and stationary elements; means on the stationary element for mounting the interlock in fixed relation to two switches to be interlocked; pivot forming parts on said elements cooperating with one another to provide spaced transient pivotal connections between said elements about either of which the movable element may be rocked from a neutral position to one of two lock-out positions; cooperating means on said elements separate from the pivot forming parts thereon for constraining

the movable element when in either of its lock-out positions to retrograde rocking movement toward its neutral position, said cooperating means comprising a roller on one of the elements and a track on the other of said elements positioned to be engaged by the roller upon rocking of the movable element about either pivotal connection to a lock-out position to preclude all but returning motion of the movable element to a neutral position before it can be rocked about the other of its pivotal connections; and means on the movable element providing for connecting the same with each of two switches to be interlocked.

2. In a device for preventing the simultaneous operation of two movable members: a rocker member constrained to movement substantially in a fixed plane; three rollers mounted on the rocker member at the points of a triangle; a stationary member overlying the rocker member, said stationary member having spaced bearing seats cooperable with two of the rollers and track means thereon coacting with the third roller and disposed to constrain the rocker member substantially to rocking motion to either of two defined lock-out positions about a fulcrum provided by the engagement of either of said two rollers in its bearing seat and to constrain the rocker member to retrograde swinging movement to return one of said two rollers to fulcruming position when the rocker member has been rocked about the other of said two rollers; and means on the rocker member providing for connecting the same with two movable members to have motion imparted to the rocker member thereby, so that movement of either movable member in one direction rocks the rocker member about one of said two rollers thereof to a position blocking movement of the other movable member in one direction.

3. A mechanical interlock of the character described comprising: a stationary plate cut-out to provide two arcuate converging slots arranged symmetrically about an axis passing longitudinally through the stationary plate, the divergent ends of said slots terminating on a line substantially normal to said axis and the radii of the arcs defined by said slots being substantially equal to the distance between their divergent ends, the center lines of said slots intersecting on said axis at a point substantially equispaced from the divergent ends of the slots, said stationary plate also being cut out to provide two other substantially arcuate slots joined with each other at the point of intersection of the center lines of the first two slots and having their center lines substantially coinciding with those of said first two slots; a rocker plate overlying the stationary plate; three rollers mounted on the rocker plate at equispaced points thereon, two of which rollers ride in the first two designated slots and seat in the divergent ends thereof to provide alternate transient pivots about which the rocker plate may fulcrum, while the third roller rides in either of said other two connected slots to guide the rocking motion of the rocker plate and constrain the same to retrograde swinging movement to return one of said two rollers to fulcruming position when the rocker member has been rocked about the other of said two rollers; and means on said rocker plate at opposite sides of said axis for connecting the same to two movable members to be interlocked.

4. In an interlock of the character described: a stationary element; a movable element coacting with said stationary element and connectible with parts to be interlocked; alternate transient pivotal connections between said elements including a pair of spaced apart trunnions on one of the elements cooperable with bearing surfaces on the other element to define fulcrums about either of which the movable element is free to rock to a lock-out position; and a third connection between said stationary and movable elements including a roller on one of said elements and track means on the other of said elements cooperable with said roller to limit translatory motion of the movable element in the direction to effect simultaneous disengagement of said trunnions from their bearing seats, said third connection constraining the movable element to rock first in one direction to a lock-out position and then in the opposite direction about one of its fulcrums before rocking of the movable element about the other of its fulcrums to the other lock-out position is possible.

5. The interlock set forth in claim 4 further characterized by the provision of means on said other element engageable by the trunnions to preclude shifting of the movable element in the direction of a line joining the two pivot axes of the movable element.

6. The interlock set forth in claim 4 wherein said roller and the two trunnions are carried by the movable element, and the track means and bearing seats are on the stationary element; and wherein said track means faces the trunnions and has portions lying substantially crosswise of the direction in which the latter move off of their bearing seats, rocking of the movable element about one of the trunnions carrying the roller into engagement with the track portion facing the fulcruming trunnion to block motion thereof off of its seat.

7. The interlock set forth in claim 6 wherein said track portions are divergent and the junction therebetween is opposite and spaced a slight distance from the periphery of said roller when both trunnions are engaged with their bearing seats to allow a limited degree of translatory motion of the movable element in the direction to carry its trunnions simultaneously off of their bearing seats.

8. A mechanical interlock for preventing concurrent closure of two switches, comprising: a movable element; means constraining said movable element to motion in a defined plane; a pair of spaced apart connectors on said movable element substantially equispaced at opposite sides of a median plane perpendicular to the plane of motion of the movable element, said connectors providing for the connection of the movable element to the movable contactors of the switches to be interlocked and for the application of forces to the movable element, by closure of the switches, in a common direction along lines substantially parallel to said median plane, whereby the application of such force to one of the connectors by closure of its associated switch effects tilting motion of the movable element in one direction out of a neutral position to a lock-out position preventing closure of the other switch, and the application of such force to the other of said connectors by closure of its associated switch effects tilting motion of the movable element in the opposite direction out of a neutral position to a lock-out position preventing closure of the first designated switch; a pair of joining angularly disposed stationary cam tracks facing in the direction from which force is applied to

said connectors during closure of either switch with the apex defined by the junction of said tracks lying on said median plane when the movable element is in its neutral position and with the tracks extending to opposite sides of said median plane toward the lines along which force is applied to the connectors and lying substantially crosswise of said lines with one track opposite each connector; and a roller on the movable element cooperable with said cam tracks and positioned between the tracks and said connectors with its axis normal to the plane of motion of the movable element and substantially in said median plane so that in the neutral position of the movable element the roller is opposite the apex at the junction of said tracks so that the force applied to either connector as a result of closure of its associated switch tilts the movable element to a lock-out position in which the roller is interposed between the other connector and the stationary cam track opposite the same and substantially in line with the force which would be applied to said other connector by a tendency to close its associated switch to thereby block concurrent closure of both switches.

9. A mechanical interlock for preventing concurrent closure of two switches, comprising: a movable element; means constraining said movable element to motion in a defined plane; a pair of spaced apart connectors on said movable element substantially equispaced at opposite sides of a median plane perpendicular to the plane of motion of the movable element, said connectors providing for the connection of the movable element to the movable contactors of the switches to be interlocked and for the application of forces to the movable element, by closure of the switches, in a common direction along lines substantially parallel to said median plane, whereby the application of such force to one of the connectors by closure of its associated switch effects tilting motion of the movable element in one direction out of a neutral position to a lock-out position preventing closure of the other switch, and the application of such force to the other of said connectors by closure of its associated switch effects tilting motion of the movable element in the opposite direction out of a neutral position to a lock-out position preventing closure of the first designated switch; a stationary cam track facing in the direction from which force is applied to said connectors during closure of either switch, having portions extending to opposite sides of said median plane when the movable element is in its neutral position, toward the lines along which force is applied to the connectors and lying substantially crosswise of said lines with each of said portions lying opposite one of said connectors; and a roller on the movable element cooperable with said cam track and positioned between the track and said connectors with its axis normal to the plane of motion of the movable element and substantially in said median plane so that in the neutral position of the movable element the roller is opposite the mid-portion of the cam track so that the force applied to either connector as a result of closure of its associated switch tilts the movable element to a lock-out position in which the roller is interposed between the other connector and the portion of the stationary cam track opposite thereto and substantially in line with the force which would be applied to said other connector by a tendency to close its associated switch to thereby block concurrent closure of both switches.



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