

March 15, 1966

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3,240,889

MECHANICAL INTERLOCK FOR ELECTRIC SWITCHES

Filed Jan. 25, 1963

3 Sheets-Sheet 1

Fig. 1

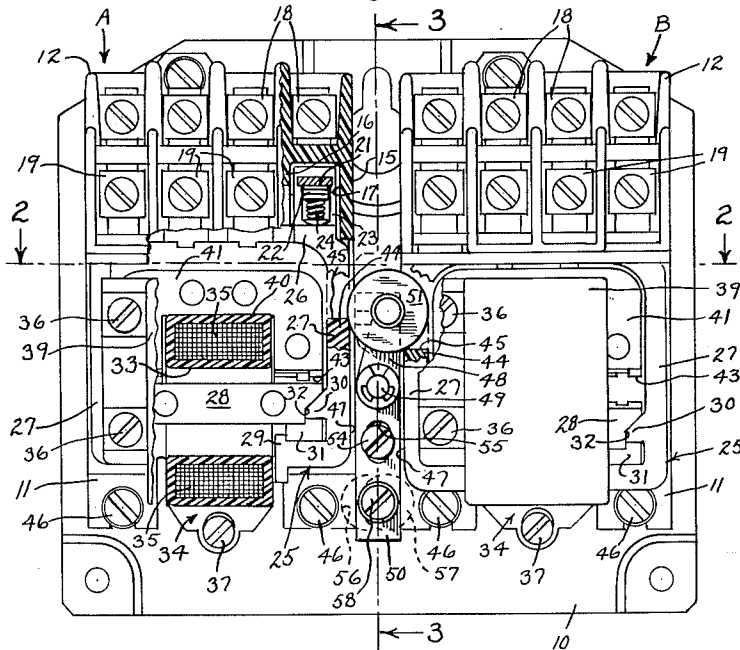
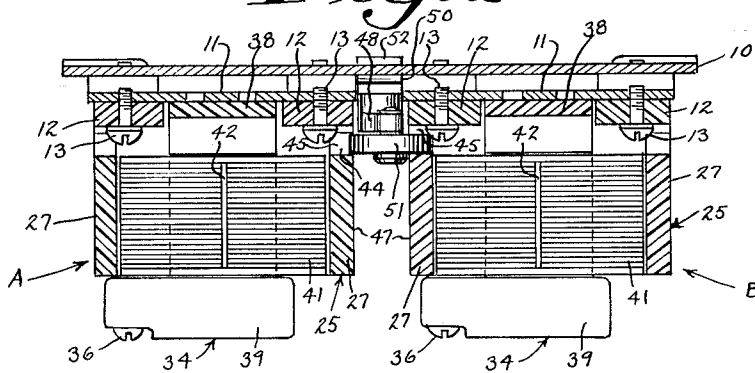


Fig. 2



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Fig. 3

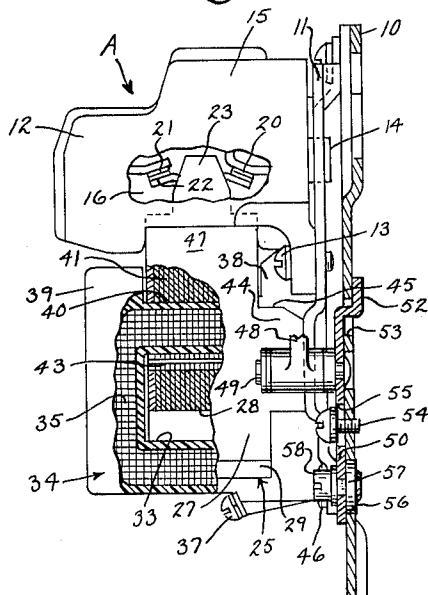
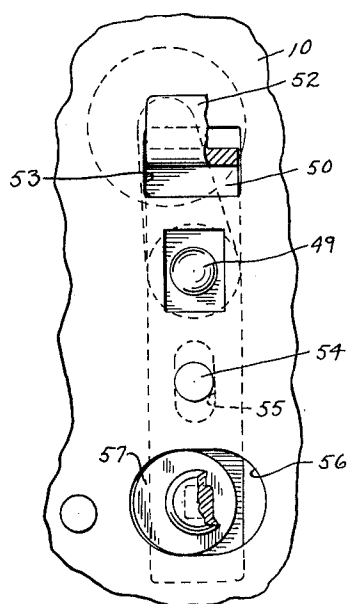


Fig. 4



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Fig. 5

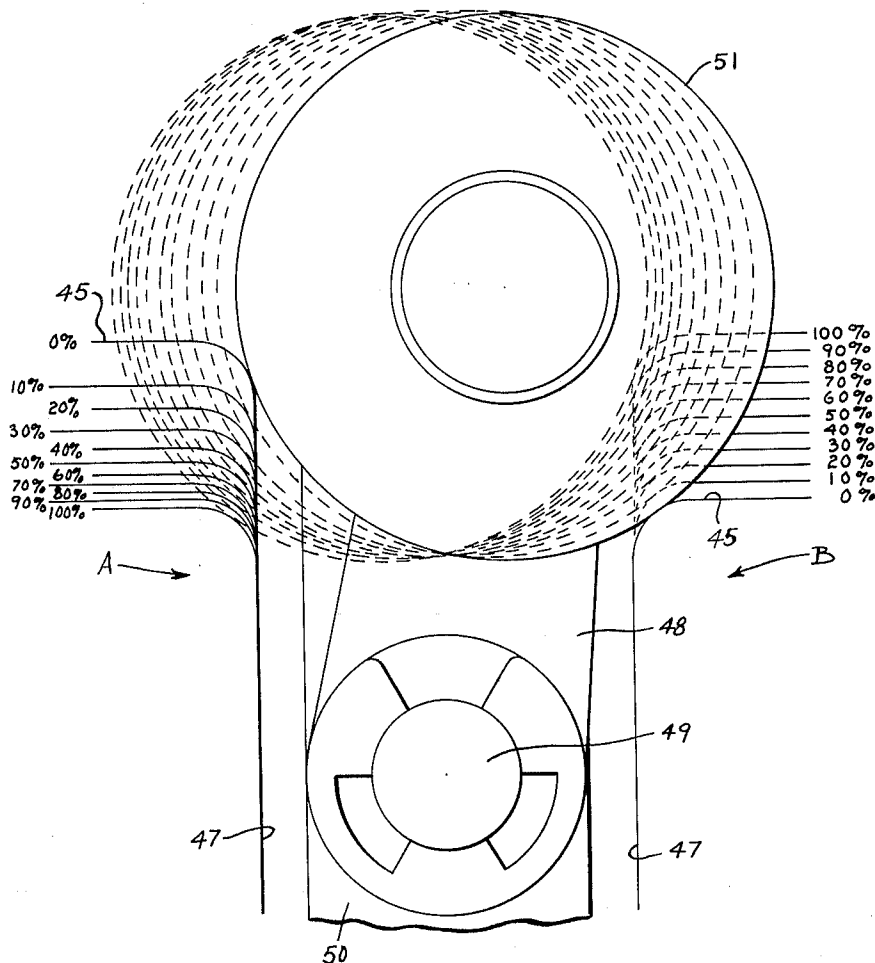
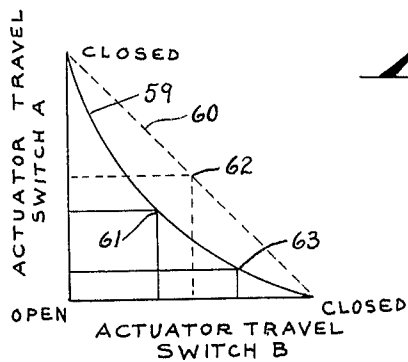


Fig. 6

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3,240,889 MECHANICAL INTERLOCK FOR ELECTRIC SWITCHES

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Filed Jan. 25, 1963, Ser. No. 253,848
2 Claims. (Cl. 200—50)

This invention relates to an interlock mechanism for electromagnetically actuated switches and similar devices characterized by having a movable actuator, and particularly to a mechanical interlock for disposition between a pair of associated switches or devices to be interlocked and having an interlocking member mounted on the end of a pivot arm and which lies in the path of the movable actuators of both switches are devices when the same are deenergized, and which interlocking member is shifted by the movement of one actuator upon energization further into the path of travel of the other movable actuator to thereby positively prevent closure of both switches or devices at the same time.

In certain uses of electromagnetically actuated devices, such as the use of a pair of electromagnetic motor starting switches for either a two speed or a reversible motor in which each switch connects motor windings directly across the power lines, it is necessary to prevent the completion of a circuit through more than one device at a given time. This is normally accomplished by mechanically interlocking the pair of switches so that a circuit through the contacts of one switch must be opened before the other switch is permitted to complete a circuit through its contacts.

It is necessary with such switches to provide for the physical closing of the contacts and the resulting completion of a circuit therethrough before the armature seats with the field piece at the end of the travel of the switch to a closed position. Consequently, a considerable portion of the total travel of the switch from closed to open positions occurs before physical contact engagement is broken and the switch must travel still further before the arc drawn by the contacts is extinguished. Therefore, while the basic requirement of an interlock is the prevention of simultaneous physical contact engagement in the pair of switches, it is also most desirable that the interlock be capable of preventing substantial movement of one switch to a closed position until a previously closed switch has moved substantially toward an open position. This latter function is obtained by providing the interlock with a non-linear action. That is, a small motion in the initial portion of travel of one switch from an open to a closed position is equated by the interlock to large motion in the initial portion of travel of the other switch from a closed to an open position.

Interlocks which have included the feature of non-linearity of action have heretofore been bulky and considerably complex in their construction, utilizing a substantial number of moving parts each subjected to wear. In addition, many such interlocks have required alteration of the switches before the switches could accept and accommodate the interlocks. The interlock of this invention, in comparison, achieves the desirable non-linear action through a very simple structure which has a minimum number of moving parts, which does not require alteration of the switches to be interlocked, and which may be disposed unobtrusively between the pair of switches.

Accordingly, it is an object of this invention to provide an interlock for electromagnetic switches and similar devices which prevents the completion of a circuit through more than one such switch or device at any one time by a direct mechanical blocking, and which is small, simple

in construction and operation, and has a minimum number of moving parts.

It is another object of this invention to provide such an interlock for a pair of switches and which equates a small motion in the initial portion of travel of one switch to a closed position to a large motion in the initial portion of travel of the other switches to an open position.

It is a further object of this invention to provide a mechanical interlock which is simple to mount in association with switches or other devices being interlocked.

It is also an object of this invention to provide a mechanical interlock which is adjustable for proper positioning relative to engagement surfaces of electromagnetic actuators being interlocked.

It is also an object of this invention to provide a mechanical interlock which prevents the simultaneous closing of both switches or other devices but which does not otherwise interfere with the normal operation of the switches.

The foregoing and other objects of this invention will appear in the description to follow. In the description, reference is made to the accompanying drawings which form a part hereof and in which there is shown by way of illustration a specific form in which this invention may be practiced. This form will be described in detail to enable those skilled in the art to practice this invention but it is to be understood that other embodiments of the invention may be used and that structural changes to the embodiment described may be made by those skilled in the art without departing from the true scope of the present invention. Consequently, the following detailed description is not to be taken in a limiting sense and the scope of the present invention is best defined by the appended claims.

In the drawings:

FIG. 1 is a view in elevation of one embodiment of the interlocking mechanism of this invention as applied to a pair of electromagnetic switches with portions of the switches broken away to show their operating parts and with one of the associated switches shown in a closed or energized position,

FIG. 2 is a view in section taken in the plane represented by the line 2—2 in FIG. 1,

FIG. 3 is a view partly in section and taken in the plane represented by the line 3—3 in FIG. 1,

FIG. 4 is a view in elevation illustrating the adjustable mounting of the interlock mechanism,

FIG. 5 is a diagrammatic view of the interlock illustrating the non-linear action of the interlock, and

FIG. 6 is a diagram illustrating the relative travel of the switch actuators in moving to closed and open positions.

Referring to FIGS. 1 through 3, there is shown therein a pair of identical electromagnetically actuated switches A and B attached to a common mounting plate 10. Throughout the drawings, like reference numerals are employed to designate like portions of the identical switches A and B and a description of the switch A will be used as descriptive of both switches.

The switch A includes a base plate 11 upon which is mounted an arc hood 12. The arc hood 12 is secured to the base plate 11 by a pair of mounting screws 13 and is properly positioned upon the base plate 11 by a lug 14 which seats in a cooperating aperture provided in the base plate 11 (see FIG. 3). The hood 12 is formed with side walls 15 and interior partition walls 16 which divide the hood into four open bottomed arc restricting chambers 17. Extending downwardly through the top of the arc hood 12 is a set of four rear stationary contact terminals 18, and a set of four front stationary contact terminals 19 extend through a front surface of

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each of the arc restricting chambers 17. The rear terminals 18 rise above the front terminals 19 for ease of connection with external wiring, and the terminals 18 and 19 terminate at their lower ends in stationary contacts 20 and 21, respectively, as shown in FIG. 3.

Disposed beneath each pair of stationary contacts 20 and 21 is a movable bridging contact 22 that is held in a cage 23 and urged upwardly by a bias spring 24 to insure proper contact pressure between the movable and stationary contacts when the switch A is in a closed or energized position.

The cages 23 are formed as integral parts of a vertically movable molded actuator 25 and they project upwardly from a crossbar portion 26 of the actuator 25 to be received within respective arc restricting chambers 17. Extending downwardly from each end of the crossbar portion 26 is a side arm 27 which carries a laminated magnetic armature 28. For mounting the armature 28, the side arms 27 terminate in pads 29 and are provided with ribs 30 spaced upwardly from the bottom of the side arms 27. Downwardly projecting tenons 31 formed as a part of the armature 28 below slots 32 together form a dovetail connection between the pads 29 and ribs 30 to provide a loose but permanent seating of the armature 28 within the actuator 25.

The magnetic armature 28 extends through a window opening 33 provided in a field support member 34. The field support member 34 functions in part to encapsulate an actuating coil 35. As best seen in FIGS. 1 and 3, the coil 35 is of tubular configuration with the window opening 33 in the field support member 34 corresponding to the central opening of the coil 35. Terminals 36 are mounted on the field support member 34 and are electrically connected to the coil 35 to provide convenient means for attachment of energizing leads, which are not shown.

The field support member 34 is mounted on the base plate 11 by a mounting bolt 37 and is further held in place by a lug 38 which seats within a recess provided in the rear of the arc hood 12. The lug 38 together with an extending portion 39 at the front of the field support member 34 forms a trough-like portion 40. Disposed within the trough-like portion 40 is a stationary inverted U-shaped magnetic yoke 41 having downwardly extending legs overhanging beyond the sides of the field support member 34. The yoke 41 is comprised of a plurality of laminations stacked in two groups that are separated by an air gap 42 extending for the full width of the magnetic portion of the yoke 41 so as to interrupt the flux path. The two downwardly facing end surfaces 43 at the lower ends of the legs of the U-shaped yoke 41 are disposed slightly beneath the middle wall that forms the upper limit of the window opening 33. Each of the surfaces 43 receives a shading coil and the surfaces are ground flat and coplanar to provide a pair of sealing surfaces against which the armature 28 may rest or seal upon attraction of the armature 28 towards the yoke 41.

The pads 29 formed at the end of the side arms 27 of the actuator 25 bear with a freely sliding fit against the sides of the field support member 34 to provide for lower vertical alignment. The side arms 27, as shown in FIG. 3, are provided with guide leg extensions 44 which have a planar surface that bears against a respective seat portion formed on the base plate 11 to properly position the actuator 25 away from the base plate 11. The guide legs 44 are provided on a top surface with a bearing ledge 45, the purpose of which will be described hereafter.

The foregoing brief description of the switch A is not intended as a detailed recital of its construction, but rather to provide an illustration of one form of device with which the interlock of this invention may be employed. A detailed description of the type of switch illustrated may be had by reference to U.S. Patent No. 2,692,314, issued October 19, 1954, to Leland E. Lawrence, for "Electromagnetic Actuator." The opera-

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tion of the switch A is such that when the coil 35 is de-energized the armature 28 will be in the lower position of FIGS. 1 and 3. The actuator 25, which moves in unison with the armature 28, is also in the lower position so that the movable bridging contact 22 is in open position with respect to the stationary contacts 20 and 21. The lowest position of the actuator 25 is determined by engagement of the underside of the armature 28 with the lower face of the window opening 33. This lower position of the armature 28 also dictates the lowest position of the actuator 25 and this deenergized position is that shown for switch B in FIG. 1.

Upon energization of the coil 35 the armature 28 is attracted upward towards the yoke 41. Movement of the armature 28 towards the yoke 41 carries the actuator 25 in an upward path of travel and the movable bridging contact 22 is brought into engagement with the stationary contacts 20 and 21. Such engagement of the bridging contact 22 with the stationary contacts 20 and 21 occurs before the armature 28 has sealed itself with the yoke 41 and occurs after a length of stroke equal to the contact gap. After the contacts are in kiss position, the armature 28 can continue to move upward to seal with the yoke 41 due to the provision of the biasing springs 24 which, while retaining the bridging contact 22 against the stationary contacts 20 and 21, permit further upward travel of the actuator 25. Once the armature 28 has sealed with the yoke 41 the upward inertia of the armature 28 will carry both the yoke 41 and the armature 28 a slight distance upward until the top surface of the yoke 41 contacts the lower edges of the interior partition walls 16. Immediately thereafter, the armature and yoke will drop until the yoke again seats on the top of the trough-like portion 40. The stroke of the switch is, therefore, equal to the distance required to displace the top surface of the armature 28 from its lowermost position to contact with the sealing faces 43 of the yoke 41 when the yoke 41 is seated in the trough-like portion 40. The switch A is shown in FIGS. 1, 2 and 3 in closed or energized position with the armature 28 sealed against the yoke 41.

The switches A and B are mounted on the common mounting plate 10 by screws 46 which secure the base plates 11 to the mounting plates 10. It will be noted that the switches A and B are mounted in close proximity to each other with outer faces 47 of adjacent side arms 27 of the actuators 25 of the switches A and B defining a switch gap. The switches A and B when provided with overload relays which may be mounted to the outside of the switches may be adapted for use as motor starting switches for either a two-speed or reversible motor.

Turning now to the mechanical interlock between switches A and B, a lever arm 48 is pivotally supported on a shaft 49 which extends outwardly from a bracket 50 disposed between the switches A and B. On the free end of the lever arm 48 is rotatably mounted an interlocking member 51 which preferably takes the form of a roller. The bracket 50 is provided at its upper end with a bent portion 52 that extends through an opening 53 in the mounting plate 10 and rests against the rear face of the mounting plate 10 (see FIG. 4). A holding screw 54 is received through a slot 55 provided in the bracket 50 and is threadably received within a cooperating tapped hole provided in the mounting plate 10. An elongated opening 56 defining a cam surface is also provided in the mounting plate 10 and a cam member 57 is disposed within the elongated opening 56 and is held in place upon the bracket 50 by an adjustment pin 58 provided with a screw head.

The operation of the interlock mechanism of this invention is as follows:

In the open deenergized position of both of the switches A and B, the roller 51 occupies a position in which it is in the path of travel of the guide legs 44 of each of the switches A and B. Assuming that the coil 35 of switch A is energized thereby causing the armature 28 to be attracted towards the yoke 41 of such switch A, the up-

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ward movement of the actuator 25 occasioned thereby will bring the bearing surface 45 of its guide leg 44 in contact with the roller 51. Upward travel of the actuator 25 will cause the roller 51 to be displaced towards the actuator 25 of the switch B on the pivotal lever arm 48. At the limit of stroke of the switch A, the roller 51 will assume a position shown in FIG. 1 wherein the roller 51 occupies a substantial area that would be occupied by upward travel of the actuator 25 of switch B upon closure of switch B. Therefore, the switch B cannot close without displacing the roller 51 out of the interfering position which it occupies and this could only be accomplished if the switch A would open. The result is that the switch B cannot close while the switch A is closed. The opposite obviously holds true.

Assume now that the coil of the switch B is energized and the coil of the switch A is deenergized. The interlock will restrict the travel of the actuator 25 of the switch B to a relatively small distance until the actuator 25 of the switch A has traveled a substantial distance from its closed to its open position. This non-linear action of the interlock will insure that the circuit through the contacts of the switch A is broken before it is possible to complete a circuit through the contacts of the switch B. The non-linear action of the interlock is illustrated in FIGS. 5 and 6.

In FIG. 5, various positions of the interlock are shown diagrammatically in association with corresponding positions of the bearing ledges 45 of the actuators 25 of the switches A and B. The lowest position of the bearing ledges 45 of each of the switches A and B shown in FIG. 5 correspond with the lowest position of the respective actuators 25 when the switches A and B are open, and the uppermost position of the bearing ledges 45 corresponds with the position of the respective actuators 25 when the armature 28 has closed with its yoke 41.

The bearing ledge 45 of the switch B is shown in the positions assumed during ten equal increments of travel with the distance between each position representing ten percent of the total travel between open position and the seating of its respective armature 28 against its yoke 41. Positions of the bearing ledge 45 of the switch A are shown which correspond to each of the positions of the bearing ledge 45 of the switch B. Selected positions of the interlock member 51 are also illustrated.

From FIG. 5 it will be seen that for the actuator 25 of the switch B to travel through the first ten percent of its movement to closed position, the actuator 25 of the switch A must travel a distance which is substantially in excess of the first ten percent of its downward movement from closed to open position. Furthermore, when the actuator 25 of the switch B has completed the first half of its stroke, the actuator 25 of the switch A will have approached a fully open position.

The non-linear action of the interlock of this invention is further illustrated in the diagram of FIG. 6 in which the relative travel of the actuators 25 of the switches A and B under the action of the interlock is shown. The ordinate represents the travel of the actuator of switch A and the abscissa represents the travel of the actuator of the switch B. The curve 59 is a plot of the relative movement of the actuators 25 under the action of the interlock of this invention. This curve 59 should be compared with the dotted line 60 which is a plot of the relative movements of the actuators 25 under the action of linear responsive interlocks, such as the ordinary rocker type. The point 61 indicates the travel which both switches A and B may simultaneously have from their open positions before the interlock of this invention acts to prevent the closing of the contacts of both switches A and B at the same time. The point 62 represents the travel which both switches A and B may have under linear responsive interlocks. The point 63 indicates the positions of the actuators 25 of the switches A and B when the contacts

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of the switch B first touch, which, as explained, occurs before the completion of the entire stroke of the switches.

It should first be noted that with both switches A and B in a fully open position, it is possible for the actuators of both switches A and B to travel simultaneously a distance which is substantially less than the travel of one-half of their stroke which is permitted by linear responsive interlocks. When both switches A and B have traveled to the point 61, one switch will dominate and will continue to close while the other switch returns to its open position. At the point 61, a much greater contact gap remains than is possible with linear responsive interlocks. Furthermore, when a previously open switch is energized and a previously closed switch is deenergized, the contacts of the previously open switch are not permitted to close until the other switch has nearly completed its movement to open position.

In FIG. 5, the bearing ledges 45 are shown with rounded edges which engage the interlock member 51. Providing such rounded edges decreases the wear on the interlock member 51 and is not essential to the non-linear action of the interlock. In both FIGS. 5 and 6, the over-travel which is permitted in the switches A and B after the armatures 28 seat with the yokes 41 has been ignored. Actually, clearance between the interlock member 51 and the bearing ledges 45 must be provided when one switch is opened and the other is closed. This does not, however, materially affect the non-linear action of the interlock.

The deenergization of the coil of either switch A or B permits such switch to open by gravity and the force exerted by the contact springs 24 and the interlock does not interfere with this normal action of the switches. Thus, should the interlock be rendered inoperative it will fail-safe since it is not connected to either switch and cannot prevent the opening thereof.

The roller 51 must be of a diameter which exceeds the switch gap defined by the opposing faces 47 of the side arms 27 of the actuators 25 of switches A and B so that in all positions of the actuators 25, portions of the roller 51 may be engaged thereby. Furthermore, the roller 51 must not be of such great diameter that it will not fit in the space allotted to it; namely, the distance between the bearing ledges 45 and the opposing bottom surface of the arc hood 12. The interlock mechanism is made adjustable to present the most desirable position of the roller 51 relative to the bearing ledges 45. Thus, for a given diameter of the roller 51 within the above limits the position of the shaft 49 for the lever arm 48 relative to the bearing ledges 45 must be such that the roller 51 will not touch the actuators 25 of both switches A and B when such switches A and B are both in an open or deenergized position. If the roller 51 would engage both armatures 25 when the switches A and B are in such state, neither of the switches A or B could be closed since the assumed position of the roller 51 would not permit of its displacement upon movement of one actuator 25. Also, the position of the shaft 49 relative to the bearing ledges 45 must be such that the armature 25 of one of the switches A or B can travel through a full stroke before the roller 51 bears against the bearing ledge 45 of the other switch when the same is open. If this circumstance is not met, it will result in an interference with the normal operating stroke of the switches.

For the above reasons, the interlock mechanism is preferably made adjustable by the aforementioned construction to compensate for variations in mounting of the switches, in their strokes, distances and the effects of wear. Adjustment of the relative position of the shaft 49 with respect to the bearing ledges 45 is accomplished by initially loosening the screw 54 so that the bracket 50 is free to move in a longitudinal direction. Then, rotation of the adjusting pin 58, causing the cam member 57 to rotate in the elongated opening 56 provided in the

mounting plate 10, will move the bracket 50 up or down as desired after which the screw 54 is tightened to hold the interlock in the set position.

It has been found that the roller 51 tends to rotate, primarily from the vibrations set up by the opening and closing of the switches, and thereby continuously presents new surfaces for engagement by the bearing ledges 45. This contributes considerably to a decrease in the wear of the roller 51.

The mechanical interlock of this invention is easily associated with the devices to be interlocked and since it does not require attachment directly to the switches, modification need not be made to the switches to accommodate the interlock. All engagement between the interlock and the switches is rolling contact thereby reducing wear. While positive interlocking of the switches is provided there is no interference with the normal operation of the switches or other devices. The extremely desirable non-linear action of the interlock is achieved with a simple and troublefree construction.

We claim:

1. In an interlock for a pair of electromagnets that are spaced from one another and mounted on a support, wherein each electromagnet has an operating magnet and an actuator provided with a bearing ledge, which actuator is linearly movable upwardly in response to energization of the magnet and downwardly upon de-energization of the magnet, the combination comprising:

- a bracket disposed within the space between the pair of electromagnets and slidably mounted on said support;
- a shaft projecting outwardly of said bracket between said electromagnets at a point below the bearing ledges;
- a lever arm pivotally supported at one end upon said shaft and having its other free end disposed at a level above the bearing ledges;
- a roller mounted on said free end of said lever arm, said roller being of a diameter greater than the space between said bearing ledges whereby portions of said roller extend into the paths of travel of the bearing ledges of both electromagnets, said roller being contacted by a bearing ledge of the actuator of one electromagnet upon movement of said actuator in response to energization of its associated magnet to thereby displace said roller in an arc about said shaft further into the path of travel of a bearing ledge of the actuator of the second electromagnet and towards such bearing ledge, whereby said roller blocks movement of the actuator of the second electromagnet in response to energization of its associated magnet until the magnet of the first electromagnet is deenergized;
- and adjustment means for said bracket for adjustment of the position of said shaft relative to the bearing ledges of the actuators of said electromagnets so that said roller will engage a bearing ledge of the actuator of said second electromagnet when the actuator of the first electromagnet has completed its movement in response to energization of its associated magnet.

2. In an interlock for a pair of electromagnetic contactors mounted in spaced side-by-side relation on a support, wherein each has an actuating coil, a magnetic field yoke, an actuator provided with bearing ledges and carrying a magnet armature attractably movable linearly from a lower open position toward an upper closed position with the field yoke upon energization of the coil, stationary contacts, and movable contacts carried by the actuator for closing with the stationary contacts upon movement of the armature toward a closed position with the yoke, the combination comprising:

- a bracket disposed in the space between the pair of contactors and mounted on said support for sliding movement in the direction of travel of the actuators;
- a shaft projecting outwardly of said bracket between said contactors at a point below the bearing ledges when the actuators are in the open position;
- a lever arm pivotally supported at one end on said shaft and having its other free end disposed at a level above the bearing ledges in the closed position of said actuators;
- a circular roller rotatably supported at its center on said free end of said lever arm and being of a diameter sufficient to place portions of said roller in the path of travel of the bearing ledges of the actuators of both contactors, the periphery of said roller being engaged by a bearing ledge of the actuator of one contactor upon movement of the armature of such contactor toward a closed position to thereby displace said roller through an arc about said shaft further into the path of travel of a bearing ledge of the actuator of the second contactor and toward engagement with such bearing ledge,
- wherein said roller blocks movement of the armature of said second contactor toward a closed position while the armature of the first contactor is in closed position,
- and wherein the movement of the armature of said second contactor toward a closed position is limited to a small increment of its total travel until the armature of the first contactor has moved through a substantially greater increment of its total travel from closed to open position;
- and adjustment means associated with said bracket to hold said bracket in a selected position of the support so that said roller is engaged by a bearing ledge of the actuator of the first contactor before the movable contacts of such actuator have closed with their associated stationary contacts.

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