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3,401,364

MECHANICAL INTERLOCK FOR THREE OR MORE SWITCHES

Filed June 22, 1966

2 Sheets-Sheet 1

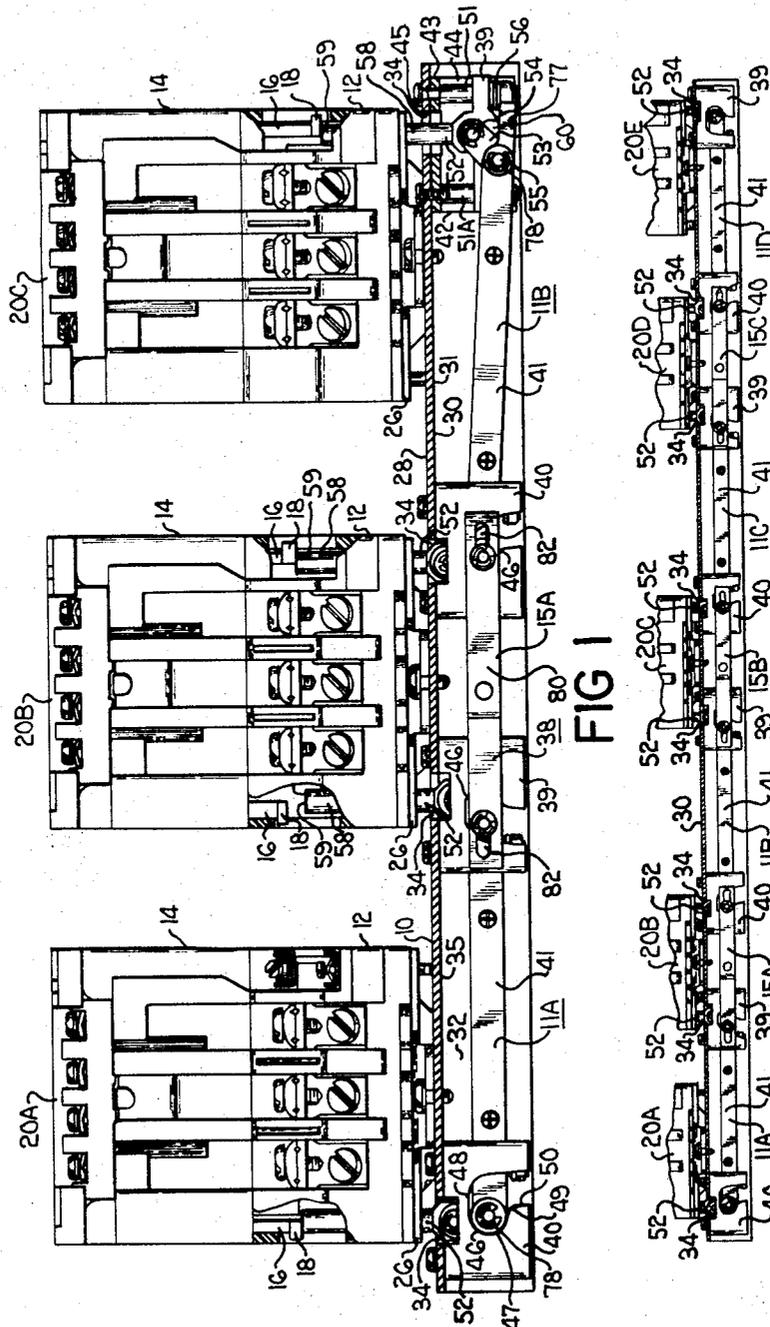


FIG 1

FIG 4

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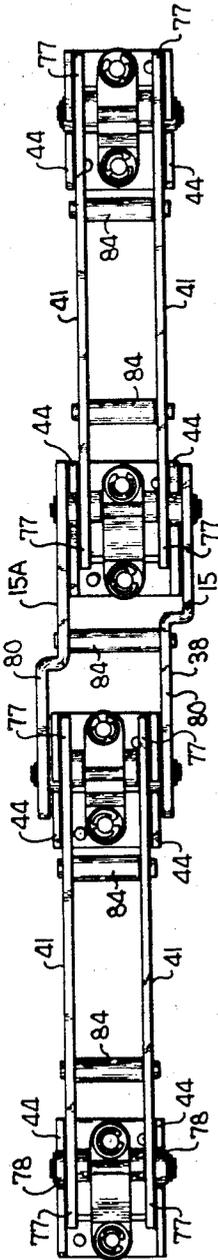


FIG 2

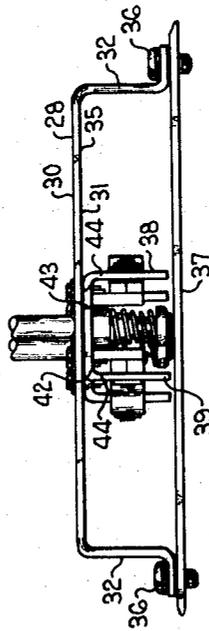


FIG 3

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3,401,364

MECHANICAL INTERLOCK FOR THREE OR MORE SWITCHES

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10 Claims. (Cl. 335-160)

This invention relates to interlock mechanisms and is more particularly concerned with a mechanism which will provide a mounting base and prevent simultaneous operation of three or more devices.

While the interlock disclosed herein may be used to be prevent simultaneous operation of a variety of devices other than electromagnetically operated switches, it is particularly suited for use with the type illustrated in an application for U.S. patent, Ser. No. 473,299, filed July 20, 1965, now Patent No. 3,354,415, issued Nov. 21, 1967, and assigned by the inventors Joseph J. Gribble, Kenneth J. Marien and Harold E. Whiting to the assignee of the present invention. The electromagnetically actuated switch, as disclosed in the Gribble et al. application, has a base positioning a plurality of pairs of stationary contacts and a plurality of movable contacts carried by a movable element or carrier to bridge the pairs of stationary contacts when the carrier is moved along an axis perpendicular to the base. An electromagnet motor carried above the base causes the carrier to move from an inoperative position, wherein the movable contacts are separated from the stationary contacts, to an operative position wherein the bridging engagement between the stationary and movable contacts occurs. The base is provided with openings axially aligned with the axis of the carrier to expose a portion of the carrier to a bottom mounting surface for the base.

In its preferred form, the interlock mechanism according to the present invention provides both a support for mounting at least three devices in spaced relation to a mounting panel and a mechanism, positioned between the devices and the mounting panel, which prevents simultaneous movement of the carriers of more than one of the switches along an axis perpendicular to the panel. Also, the interlock will require that all of the switches are in the contact opening position prior to a movement of any of the switches to the contact closing position and will preclude bridging or jamming of the mechanism when more than one of the switches are simultaneously energized.

It is, therefore, an object of this invention to provide an improved mechanical interlock especially adapted for interlocking three or more switches with a mechanism which may be readily applied without change to the switches when the switches are mounted side by side in a row on the interlock structure.

A still further object is to provide an interlock which, while especially adapted for use with three or more electromagnetically actuated switches, is equally useful for preventing simultaneously movement in one direction of any one of three movable members.

An additional object is to provide an interlock mechanism that will prevent the simultaneous operation of three or more independently operable electric switches when the switches are supported by the mechanism side by side in a row on a mounting panel to have the bases of the switches spaced from the panel and to provide a means for preventing the simultaneous operation of the switches in the space between the switches and the panel so the interlock mechanism will not interfere with free access to the wire connecting terminals of the switches or the components of the switches which require inspection and service.

Further objects and features of the invention will be readily apparent to those skilled in the art from the speci-

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cation and appended drawings illustrating certain preferred embodiments in which:

FIG. 1 is a side elevational view of three switching units mounted side by side on a mechanical interlock structure according to the present invention with portions of the interlock structure and the switches broken away to illustrate constructional details of the mechanical interlock structure and the engagement between the plungers of the interlock mechanism and the movable member of the switches.

FIG. 2 shows, as detached in a bottom plan view, the operating mechanism for the interlock mechanism in FIG. 1 so the portions thereof may be more readily identified.

FIG. 3 is an end view of the interlock mechanism in FIG. 1 with the switching units removed.

FIG. 4 is a view similar to FIG. 1 showing in reduced size how five switch units may be mounted on the interlock assembly according to the present invention.

In FIG. 1 of the drawings, three switches, indicated by numerals 20A, 20B and 20C are shown as mounted on a mechanical interlock assembly 10. The switches shown are of the type disclosed in the Gribble et al. patent and each includes a base 12 of insulating material which positions a plurality of pairs of spaced stationary contacts, not shown. Positioned above and carried by the base 12 is a housing 14 for a magnet motor, not shown, which moves a movable element or member 16 from a position shown by the switches 20A and 20B downwardly along an axis perpendicular toward the base 12 to an operated position illustrated by the switch 20C, when magnet is energized to operate the switch 20C. The member 16 of each switch carries a plurality of movable contacts, not shown, that are arranged to engage the stationary contacts on the base 12 to complete an electric circuit therebetween when the member 16 is positioned as shown by the switch 20C and to be moved out of engagement with the stationary contacts and interrupt the circuit through the stationary contacts when the member 16 is positioned as shown by the switches 20A and 20B. The member 16 has a ledge 18 formed thereon presenting a bottom surface aligned along the axis of movement of the member 16 with an opening, not shown, in the bottom wall of the base 12. The switches 20A-20C are also provided with suitable metal mounting plates 26 secured to the bases 12. The plates 26 also have openings aligned with the openings in the base 12 to expose the bottom surface of the ledges 18 to the bottom of the switch assemblies 20A-20C.

The switch assemblies 20A-20C each have their respective mounting plates 26 secured to a top surface 28 of a support 30 of the mechanical interlock assembly 10. The support 30 is formed as a U-shaped channel member having a web portion 31 equal in width to the plates 26 and a pair of spaced arms 32 downwardly extending from the web portion 31. The web portion 31 is sized to permit the switches 20A-20C to be mounted side by side in a row on the top surface 28 and is provided with openings 34 aligned with the opening in the bases 12 and similarly located openings in the mounting plates 26 so the bottom surfaces of the ledges 18 of the switches 20A-20C are exposed to a bottom surface 35 of the web 31. As shown in FIG. 3, the spaced arms 32, formed to extend along the marginal edges of the web portion 31, have suitable openings to receive screws 36 for attaching the entire assembly including the switch assemblies 20A-20C, as well as the support 30 to a panel 37. The arms 32 are formed to extend downwardly sufficiently to provide a space between the bottom surfaces of the switches 20A-20C wherein the operating mechanism 38 of the mechanical interlock assembly 10 is received.

As shown in FIG. 1, operating mechanism 38 includes a pair of identical interlocking mechanisms 11A and 11B,

carried by the bottom surface 35, interconnected by means indicated as a link 15A. Each of the interlocking mechanisms 11A and 11B are identical and are preferably of the type disclosed in an application for United States patent, Ser. No. 473,311, filed July 20, 1965, now Patent No. 3,303,300, issued Feb. 7, 1967, and assigned by the inventor Merlin Y. Turnbull to the assignee of the present invention. As disclosed in the Turnbull application, each interlocking mechanism 11A and 11B includes a pair of units 39 and 40 interconnected by a pair of lever bars 41. As each of the units 39 and 40 are identical and are arranged to face on opposite direction on the bottom surface 35, only the unit 39 will be specifically described. The unit 39 includes a channel member 42 having a web portion 43 and a pair of spaced arms 44 extending in a plane through the spaced arms 44 of the actuator 40 and perpendicular to the bottom surface 35. The web portion 43 is provided with an opening 45 centered between the arms 44 and aligned with the opening 34. Each of the arms 44 has a notch 46 shaped to have a semicircular portion 47 having a radial center located in a plane perpendicular to a common centerline passing through the centers of the openings 34 and 45. The notches 46 further are shaped to provide a horizontal edge 48 extending tangentially of the portion of the semicircular portion 47 adjacent the web 43 and a curved surface 49 extending tangentially of the portion of the semicircular portion 47 remote from the web 43. The curved surface 49 has a relatively small radius compared to the radius of the semicircular portion 47 and extends to an edge 50 that is slightly inclined toward the horizontal edge 48. Secured to the web 43 on opposite sides of the opening 45 along a centerline passing through the openings 45 are a pair of guide members 51 and 51A, each of which extends perpendicular to the web 43 and parallel to the spaced arms 32.

The unit 39 also includes a plunger 52, a pair of arms or levers 53, a pair of pivot pins 54 and 55 and a pair of return springs 56. The plunger 52 has a stem portion 58 extending upwardly in alignment with the vertical axis of movement of the member 16 to an upper free end 59 which is positioned to engage the bottom surface of the ledge 18. Formed on the lower end of the stem portion 58 is a base portion 60. The base portion has a bore extending perpendicular to the axis of the stem portion 58 and provides a bearing journal for the pivot pin 54. Spaced on the base portion 60 are downwardly extending guide portions that are slideable on the guide members 51 and 51A. The guide members 51 and 51A are located on the web 43 to have the guide portion guide member 51A spaced at a greater distance from the stem 58 than the guide member 51.

The levers 53 each have an opening on one end receiving an end of the pivot pin 54 and are guided in a straight line path of pivotal movement by suitably formed flat surfaces on the base portion 60. The other end of each of the levers 53 has an opening to receive the pivot pin 55. The levers 53 are sized to have the pivot pin 55 roll on a curved bottom surface of the base portion 60 when the levers 53 rotate about the pivot pin 54. The return springs 56, positioned between spring seats on the free end of the guide members 51 and 51A and the portion 60, normally urge the plunger 52 upwardly to a position wherein the base portion 60 engages the web 43.

The lever bars 41 each have openings at their opposite ends receiving an end of the pivot pins 55 projecting beyond the outer surface of the levers 53 on the units 39 and 40. The lever bars 41, levers 53 and the pivot pin 55 are maintained assembled by suitable retainers receiver in suitable grooves formed on the free ends of the pivot pins 55. The openings in each lever bar 41 receiving the pivot pins 55 are spaced from each other to have the levers 53 inclined from a vertical centerline passing through axis of the stem 58 of the plunger 52.

The incline of the levers 53 is arranged so the distance between the pivot pins 55 is less than the distance between the pivot pins 54 of the units 39 and 40.

Each of the lever bars 41 has guide portions 77 thereon. The guide portions 77 are formed as projections extending beyond the notches 46 and are arranged to slidably engage the inner surfaces of the spaced arms 44. Additionally positioned on the pivot pins 55 are rollers 78. The rollers 78 have a slightly smaller diameter than the semicircular portions 47 and are arranged to engage and roll upon the horizontal edge 48 when the assembly of the foregoing parts is completed.

The interlock mechanisms 11A and 11B are interconnected by the means including the link 15A formed of two parallel members 80, each of which is provided with a slot 82 at its opposite ends. The slots 82 extend perpendicular to the axis of movement of the members 16 and receive the pivot pins 55 on the adjacent units 39 and 40 of the mechanisms 11A and 11B and to interconnect the mechanisms 11A and 11B through a lost motion connection. As most clearly shown in FIG. 2, a parallel relation between the links 15A as well as the lever bars 41 is maintained by members 84.

In view of the foregoing description, the operation and advantages of the mechanical interlock assembly 10 is as follows.

When switch assemblies 20A-20C are all deenergized, the return springs 56 of the mechanisms 11A and 11B urge all of the plungers 52 upwardly thereby maintaining an engagement between the free end 59 on each plunger 52 and the ledges 18 on each of the switches 20A-20C. Also, the levers 53 on the mechanisms 11A and 11B will be inclined at substantially equal angles toward each other, thereby positioning the rollers 78 of all of the units 39 and 40 equidistantly from the bottoms of the semicircular portions 47. When the rollers 78 are thus positioned, a vertical line of centers through the axis of all of the pivot pins 55 will lie forwardly of their associated inclined edge 50 while a portion of all of the rollers 78 will be vertically aligned with their associated curved surfaces 49.

When any one of the switch assemblies 20A-20C is energized, e.g., the switch assembly 20C in FIG. 1, the member 16 of the switch 20C is moved vertically downwardly. The vertical downward movement of the member 16 of the switch assembly 20C moves the plunger 52 of the unit 39 of the interlocking mechanism 11B downwardly against the forces exerted by the springs 56 and causes the following operation of the components of the interlocking mechanism 11B.

The initial downward movement of the plunger 52 causes the pivot levers 53 of the unit 39 to move clockwise to a more inclined position while the pivot levers 53 of the unit 40 move clockwise toward a more vertical position relative to a centered line passing through the axis of the stem 58 of the unit 40. The clockwise movement of the levers 53 of the units 39 and 40 is accompanied by a horizontal movement to the left of the lever bars 41 to a limiting position wherein the rollers 78 seat within the semicircular portions 47 of the unit 40 thereby preventing movement of member 16 of switch 20B to its actuated position. When the lever bars 41 are thus positioned, the rollers 78 of the unit 39 will be external of the semicircular portions 47. During the foregoing movements, the rollers 78 of the unit 40 will roll upon the horizontal edges 48 and the pivot pins 55 of the units 39 and 40 will roll on the rounded bottom surface of the base portions 60.

A continued downward movement of the plunger 52 of the unit 39, after the rollers 78 of the unit 40 are seated in the semicircular portions 47, causes the rollers 78 of the unit 39 to move in a generally vertical path as the lever bars 41 pivot about the pivot provided by the seated rollers 78 in the semicircular portions 47 of the unit 40. When the switch 20C is fully energized, the

ledge 18 will be at its lowest downward position and the rollers 78 of the unit 39 will be moved to their final interlocking position wherein they are horizontally aligned with the inclined edges 50 of the unit 39.

During the movement of the rollers 78 to their final position, the guide portions 77 will guide the movement of the lever bars 41 and the curved surfaces 49 will prevent any interference to movements of the rollers 78 to the interlocking position.

If the switch 20B should be energized while the rollers 78 of the unit 39 are in an interlocking position, the downward movement of the plunger 52 of the unit 40 will be prevented because the lever bars 41 are prevented from movements to the right by an engagement of the rollers 78 with the inclined edges 50 of the unit 39. This arrangement will maintain the seating engagement of the rollers 78 in the semicircular portions 47 of the unit 40 and prevent downward movement of the plunger 52 of the unit 39 to thereby prevent movement of the member 16 of the switch assembly 20B to its energized position.

The movement of the lever 41 of the interlocking mechanism 11B is transmitted through the link 15A to the interlocking mechanism 11A and causes the lever 41 of mechanism 11A to move to the left to a position wherein the rollers 78 become seated in the semicircular portions 47 of the unit 40 of the mechanism 11A. Thus the plunger 52 of the unit 40 will prevent the movable member 16 of the switch 20A from moving to an actuated position. During the foregoing movement, the slots 82 will be positioned to have the pivot pin 55 of the unit 40 of mechanism 11B seating in the left end of the slot 82 at one end of the link 15A and the pivot pin 55 of the unit 39 of the mechanism 11A in the right end of slot 82 at the other end of the link 15A. Thus an effective solid link will be formed between the unit 39 of mechanism 11B and the unit 40 of the mechanism 11A and the rollers 78 will be maintained in the semicircular portion 47 of unit 40 of mechanism 11A to prevent movement of the member 16 of the switch 20A to an actuated position as long as the switch 20C is energized.

In view of the foregoing description it is obvious that energization of the switch assembly 20A will prevent movement of the members 16 of the switch assemblies 20B and 20C to an energized position should either of the switch assemblies 20B or 20C be energized subsequent to the energization of the switch assembly 20A.

In the event both switch assemblies 20B or 20C are simultaneously energized, the members 16 of both of the switch assemblies 20B and 20C will be prevented from moving to their energized position as follows. When the switches 20B and 20C are simultaneously energized, the plungers 52 of both of the units 39 and 40 of the mechanism 11B will move downwardly to a position wherein the rollers 78 of the units 39 and 40 engage the curved surfaces 49 and thereby prevent a continued downward movement of the plungers 52 of the units 39 and 40. When the switch assemblies 20B and 20C are simultaneously deenergized, the interlock assembly, including the rollers 78 of units 39 and 40, will return to their at-rest position previously described. Alternately, if one of the switch assemblies 20B and 20C is deenergized, and the other switch assembly remains energized, e.g., switch assembly 20B is deenergized while the switch assembly 20C remains energized, the interlock mechanism, including the rollers 78 will move to the position previously described wherein the rollers 78 of the unit 40 are seated in the semicircular portions 47 while the rollers 78 of the unit 39 are positioned adjacent the inclined surface 50.

The movements to the proper positions of the interlock mechanism upon simultaneous energization of both of the switches 20B and 20C and then a subsequent deenergization of one of the switches 20B or 20C is accomplished without frictional interference between any

of the moving parts of the entire interlock mechanism which would normally prevent such movements.

It is to be noted that when both switch assemblies 20B and 20C are simultaneously energized, the parts of the interlock assembly are essentially moved to a "jammed" condition. Frequently, in other types of mechanical interlocks, when this condition is encountered, a subsequent deenergization of either one or both of the switch assemblies 20B and/or 20C will not restore the operative condition of the interlock mechanism. Rather, the interlock mechanism can be returned to an operative condition only if tools are used to force the interlock mechanism from its jammed state.

In contrast, the interlock mechanism according to the present invention will not only relieve itself of its jammed condition but will instantly move to its proper interlocking position.

As previously stated, the levers 53 of the units 39 and 40 are positioned by the lever bars 41 so the levers 53 of the units 39 and 40 are inclined toward each other. Thus when both of the switches 20B and 20C are simultaneously energized, the levers 53 of both of the units 39 and 40 will move vertically downwardly without rotational movement about the pivot pins 54 and 55 to a position wherein the rollers 78 of the units 39 and 40 engage the curved surfaces 49. When the rollers 78 are thus positioned, a circumferential portion of the roller 78 of the unit 40 to the left of a vertical centerline through the pivot pin 55 will engage the curved surface 49 of the unit 40 while a circumferential portion of the roller 78 of the unit 39 to the right of a vertical centerline through the pivot pin 55 will engage the curved surface 49 of the unit 39. Thus any further movements of the rollers 78 of both of the units 39 and 40 is prevented as the rollers 78 and inclined levers 53 of the units 39 and 40 constantly apply forces in opposite directions.

When one of the switch assemblies 20B or 20C is deenergized while the other switch assembly, e.g., switch assembly 20C remains energized, the interlock mechanism will move without assistance to prevent reenergization of the switch assembly 20B as long as the switch assembly 20C remains energized. When the switch assembly 20B is deenergized, the downward vertical force causing an engagement of the rollers 78 of the unit 40 with the curved surfaces 49 is removed, while the downward vertical force which causes the rollers 78 to engage the curved surface 49 of the unit 39 continues. The continued force on the unit 39 causes two phenomena to occur for moving the lever bars 41 to the proper interlocking position. The incline of lever 53 of the unit 39 to the left causes the levers 53 of the unit 39 to move downwardly and to the left to an interlocking position with the inclined edge 50 as the rollers 78 of the unit 39 roll over the curved surface 49. Similarly, the curved surface 49 permits the rollers 78 of the unit 40 to rotate and move upwardly without frictional binding into a seating position in the semicircular portions 47 where the rollers 78 thus prevent switch assembly 20B from being energized.

As the operation of the interlocking mechanism 11A for preventing the simultaneous operation of the switches 20A and 20B is identical to the manner in which the interlocking mechanism 11B prevents the simultaneous operation of the switches 20B and 20C as described, further description of the details of operation of the interlocking mechanism 11A is not believed necessary.

In the foregoing description the switch assemblies 20A-20C are indicated as energized and deenergized. These terms are used to indicate the operational movements of the members 16 and without consideration of the electrical condition of the magnet motors of the switch assemblies. Further, it will be seen that as the interlocking mechanism 10 is positioned between the switching assemblies 20A-20C and the panel 37, the switching assemblies are completely accessible from the front of the panel

37. This arrangement will permit the switching assemblies 20A-20C to be readily wired and serviced without disturbing or interference from the interlock mechanism 10.

The members 16 of the switches 20A and 20C will be prevented from moving to an actuated position when the member 16 of switch 20B is in an actuated position as follows. It will be observed that the plunger 52 of the unit 39 of the interlocking mechanism 11A and the plunger 52 of the unit 40 of the interlocking mechanism 11B each engage the movable member 16 of the switch 20B and are moved downwardly when switch 20B is energized. The downward movement of the plungers 52 will cause the lever 41 of the interlocking mechanism 11A to move to the left to a position wherein the rollers 78 become seated in the semicircular portions 47 of the unit 40 to prevent movement of the member 16 of the switch 20A, as previously described. Similarly, the downward movement of the plungers 52 will cause the lever 41 of the interlocking mechanism 11B to move to the right to prevent movement of the member 16 of the switch 20C, as previously described. The foregoing movements of the lever 41 of the interlocking mechanism 11A to the left and the movement of the lever 41 of the interlocking mechanism 11B to the right is achieved by the lost motion connection between the levers 41 of the mechanisms 11A and 11B and the link 15A as provided by the slots 82.

When the member 16 of the switch 20B moves downwardly to move both plungers 52 downwardly, as described, the distance between the pivot pins 55 of the units 39 and 40 of mechanisms 11A and 11B will increase as the pins 55 move in opposite directions. This movement is made possible by the slots 82 in link 15A which permit the pivot pins 55 of the units 39 and 40 to move in opposite directions without hinderance to cause the interlocking of the switches 20A and 20C as described.

FIG. 4 illustrates how any number of switching units may be interlocked with the interlocking mechanism according to the present invention when the switching units are mounted side by side in a row on the support member of the interlock assembly. It will be observed in FIG. 1 that three switches 20A, 20B and 20C are interlocked with a mechanism that includes a pair of interlocking mechanisms 11A and 11B and a single link 15A and that four plungers 52 are required to extend through four suitable openings 34 in the support 30. Thus if N equals the number of switches, then $N-1$ interlocking mechanisms, $N-2$ links and $2N-2$ openings are required to achieve the interlocking of N number of devices, such as an N number of switches. Similarly, in FIG. 4, the five switches 20A, 20B, 20C, 20D and 20E are mounted side by side in a row on the support 30. The switches 20A and 20E, at the opposite ends of the row of switches, each is positioned above a single opening 34 in the support 30 and the remaining switches 20B, 20C and 20D each positioned above a pair of spaced openings 34. Thus if N equals 5 switches, then $2N-2$ equals the required number of openings 34 in the support 30. Also the interlocking mechanism 11A interlocks the adjacent switches 20A and 20B. Similarly, the interlocking mechanism 11B interlocks the adjacent switches 20B and 20C, the interlocking mechanism 11C interlocks the adjacent switches 20C and 20D and the interlocking mechanism 11D interlocks the adjacent switches 20D and 20E. Thus $N-1$ interlocking mechanisms are required. The adjacent interlocking mechanisms 11A-11D are interconnected by means including links 15A, 15B and 15C. That is, link 15A interconnects interlocking mechanisms 11A and 11B. Similarly, link 15B interconnects interlocking mechanisms 11B and 11C while link 15C interconnects mechanisms 11C and 11D. Thus $N-2$ links are required.

The interlock assembly 10 in FIG. 4 operates in the same fashion to interlock the operation of five switches

20A-20E as the interlock assembly 10 in FIG. 1 functioned to interlock three switches 20A-20C. When the switch 20E is energized and its member 16 moves downwardly, the plunger 52 of the unit 39 of the mechanism 11D will move downwardly and the lever bar 41 of the mechanism 11D will move to the left. The movement of the lever 41 of the mechanism 11D causes the links 15C, 15B and 15A as well as the levers 41 of the mechanisms 11C, 11B and 11A to move to the left to an interlocking position because of the effective solid connection therebetween as described. When the levers 41 of the mechanisms move to the left to the interlocking position, the rollers 78 of the units 40 of each of the mechanisms 11A-11C will seat in their associated semicircular portions 47 and prevent downward movement of the plungers 52 of the units 40 of mechanisms 11A-11C and elements 16 of the switches 20A-20D to an actuated position.

Similarly, when the switch 20A is energized and its member 16 moves downwardly, the plunger 52 of the unit 40 of the mechanism 11A will move downwardly and the lever bar 41 of the mechanism 11A will move to the right. The movement of the lever 41 of the mechanism 11A causes the links 15A, 15B and 15C as well as the levers 41 of the mechanisms 11B, 11C and 11D to move to the right to an interlocking position because of the effective solid connection therebetween as described. When the levers 41 of the mechanisms move to the right to the interlocking position, the rollers 78 of the units 39 of each of the mechanisms 11B-11D will seat in their associated semicircular portions 47 to thereby prevent downward movement of the plungers 52 of the units 39 of the mechanisms 11B-11D and the elements 16 of the switches 20B-20E to an actuated position.

When one of the intermediate switches 20B-20D is energized, the members 16 of the remaining switches 20A-20E will be prevented from moving to an actuated position as follows. Each of the switches 20B-20D have a movable member 16 engaging the plungers 52 of adjacent units 39 and 40 of two different interlocking mechanisms 11A-11D. For example, the member 16 of switch 20B engages the plunger 52 of unit 39 of mechanism 11A and the plunger 52 of unit 40 of mechanism 11B. Similarly, the member 16 of the switch 20C engages the plunger 52 of unit 39 of mechanism 11B and the plunger 52 of unit 40 of the mechanism 11C. The member 16 of the switch 20D engages the plunger 52 of unit 39 of the mechanism 11C and the plunger 52 of the unit 40 of the mechanism 11D. Thus when any one of the switches 20B-20D is energized, two different interlocking mechanisms will be positively actuated. Thus if the switch 20B is energized, the plungers 52 of units 39 and 40 of mechanisms 11A and 11B are moved downwardly, causing the lever 41 of mechanism 11A to move to the left and the lever 41 of the mechanism 11B to move to the right, while the link 15A remains substantially stationary because of the lost motion connection provided by the slots 82 as previously described. The movement to the left of the lever 41 of mechanism 11A prevents switch 20A from being actuated and the movement to the right of lever 41 of mechanism 11B causes a similar movement of the levers 41 of the mechanisms 11C and 11D and the links 15B and 15C to prevent switches 20C-20E from being actuated.

When the switch 20C is energized, the plungers 52 of units 39 and 40 of mechanisms 11B and 11C are moved downwardly causing the lever 41 of mechanism 11B to move to the left and the lever 41 of the mechanism 11C to move to the right while the link 15B remains substantially stationary because of the lost motion connection provided by the slots 82 as previously described. The movement to the left of the lever 41 of mechanism 11B causes a similar movement of the lever 41 of mechanism 11A and the link 15A and thereby prevents the switches 20B and 20A from being actuated. The movement to the right of lever 41 of mechanism 11C

causes a similar movement of the lever 41 of the mechanism 11B and the link 15C to prevent switches 20D and 20E from being actuated.

Finally when the switch 20D is energized, the plungers 52 of units 39 and 40 of mechanisms 11C and 11D are moved downwardly causing the lever 41 of mechanism 11C to move to the left and the lever 41 of the mechanism 11D to move to the right while the link 15C remains substantially stationary because of the lost motion connection provided by the slots 82 as previously described. The movement to the right of the lever 41 of mechanism 11D prevents switch 20E from being actuated and the movement to the left of lever 41 of mechanism 11C causes a similar movement of the levers 41 of the mechanisms 11B and 11A and the links 15B and 15A to prevent switches 20A-20D from being actuated.

While certain preferred embodiments of the invention have been specifically disclosed, it is understood that the invention is not limited thereto, as many variations will be readily apparent to those skilled in the art and the invention is to be given its broadest possible interpretation within the terms of the following claims.

What is claimed is:

1. An interlock assembly for preventing simultaneous operation of three or more independently operable devices wherein N equals the number of devices and each of said devices has an element movable along a linear axis, comprising:

(1) a support having $2N-2$ spaced openings extending between a top surface and a bottom surface of the support and the devices mounted side by side in a row on the top surface to have the movable element of $N-2$ devices each aligned with two adjacent openings and the element of the devices at the extreme opposite ends of the row each aligned with one of the openings,

(2) $N-1$ interlock mechanisms with each of said mechanisms having:

(a) a pair of movable plungers with each plunger having a base portion and a stem portion,

(b) means mounting the pair of plungers so the plungers are spaced from each other and have the base portions carried in a space between the bottom surface and a panel for mounting the support and the stem portions extend through adjacent openings into engagement with the elements of adjacent devices, said plungers each being guided by the mounting means for movement along the axis of movement of the element which it engages, and

(c) means interconnecting the base portions of the pair of plungers for preventing simultaneous movement of the pair of plungers, and

(3) $N-2$ link means, with each of said link means including a link interconnecting the interconnecting means of a pair of adjacent interlock mechanisms for transmitting movements of the interconnecting means of one of the pair of adjacent interlocking mechanisms to the interconnecting means of the other of said adjacent pair of interlock mechanisms.

2. The combination as recited in claim 1 wherein the means interconnecting the base portions of the plungers includes: an arm carried by each of said plungers, each of said arms having an end pivotally mounted on the base portions and a free end extending from the base portion, a roller rotatably mounted on a bearing carried on the free end of each of the arms and means including a link having an end pivotally mounted on the bearings of the arms and interconnecting the arms and causing the arms on the pair of plungers to be inclined toward one another.

3. The combination as recited in claim 1 wherein the means interconnecting the base portions of the plungers includes: a pair of parallel arms carried by each of said plungers, each of said parallel arms having an end pivotally mounted on the base portion and a free end extending from the base portion, a roller rotatably mounted on a bearing carried on the free end of each of the arms, and a pair of parallel links each having opposite ends pivotally mounted on the bearings of the arms and interconnecting the arms and causing the arms on the pair of plungers to be inclined toward one another.

4. The combination as recited in claim 1 wherein the means interconnecting the base portion of the plungers includes: an arm carried by each of said plungers, each of said arms having an end pivotally mounted on the base portions and a free end extending from the base portion, a roller rotatably mounted on a bearing carried on the free end of each of the arms, a link having its opposite ends pivotally mounted on the bearings of the arms and interconnecting the arms and causing the arms on the pair of plungers to be inclined toward one another, and a member adjacent each of said openings, each of said members having a notch portion wherein one of the rollers is positioned, each of said notch portions having an edge extending generally parallel to the axis limiting movement of the roller along an axis parallel to the surface in one direction and a semicircular portion limiting movement of the roller in a direction opposite said one direction.

5. The combination as recited in claim 1 wherein the means interconnecting the base portion of the plungers includes: a pair of parallel arms carried by each of said plungers, each of said parallel arms having an end pivotally mounted on the base portions and a free end extending from the base portion, a roller rotatably mounted on a bearing carried on the free end of each of the arms, a pair of parallel links each having an opposite end pivotally mounted on the bearings of the arms and interconnecting the arms and causing the arms on the pair of plungers to be inclined toward one another, and a pair of members spaced on opposite sides of each of said adjacent openings, each of said pair of members having a notch portion wherein one of the rollers is positioned, each of said notch portions having an edge extending generally parallel to the axis limiting movement of the roller along an axis parallel to the surface in one direction and a semicircular portion limiting movement of the roller in a direction opposite said one direction.

6. The combination as recited in claim 1 wherein each of the devices is an electromagnetically operated switch and the support is a channel-like member.

7. The combination as recited in claim 1 wherein the means mounting the plungers also resiliently urges the stem portions toward the elements of the devices.

8. The combination as recited in claim 2 wherein each link means includes a pair of parallel members each of which has slots at its opposite ends.

9. The combination as recited in claim 5 wherein each link has slots at its opposite ends.

10. The combination as recited in claim 1 wherein a lost motion connection is provided by slots in the opposite ends of the link.

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