

Aug. 13, 1963

A. P. CHARBONNEAU ET AL

3,100,824

LIMIT SWITCH

Filed May 31, 1960

3 Sheets-Sheet 1

Fig. 1

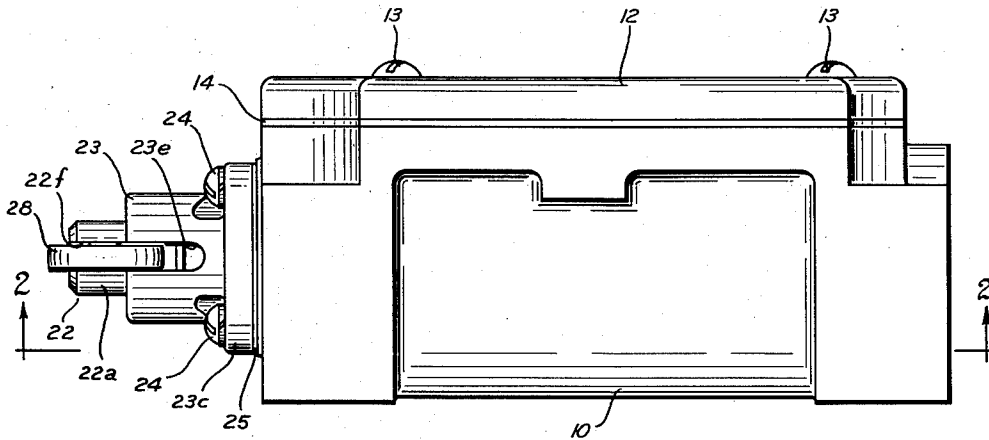
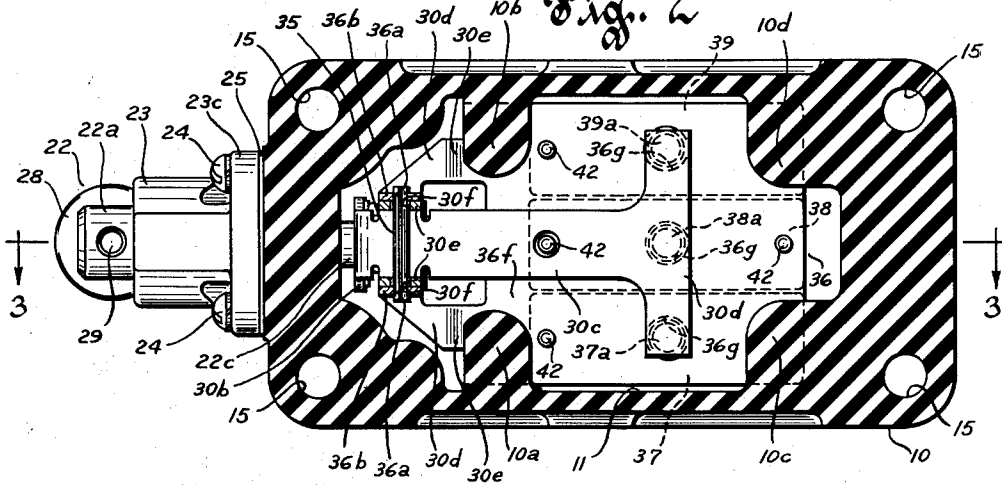


Fig. 2



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Fig. 3

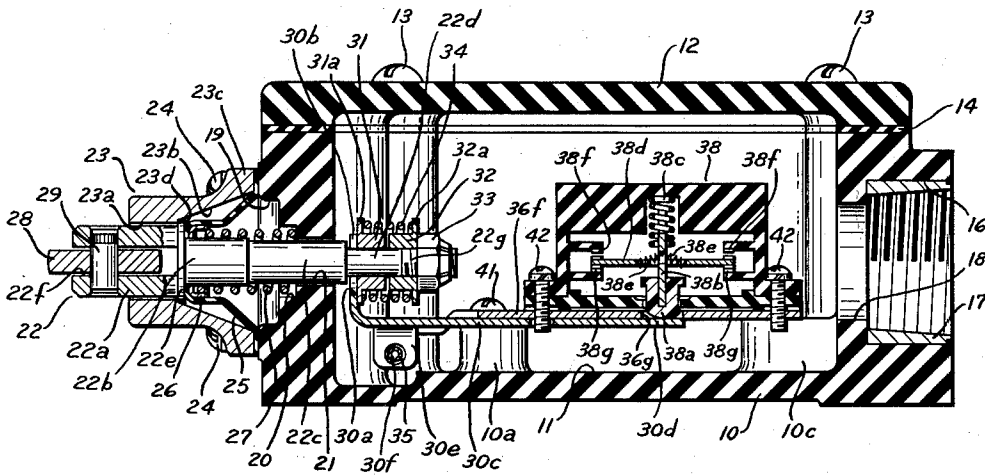
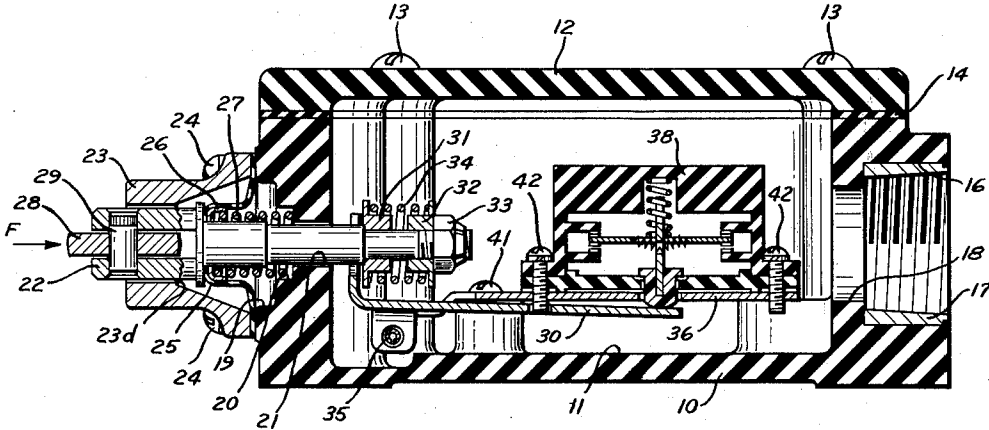


Fig. 4



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Fig. 5

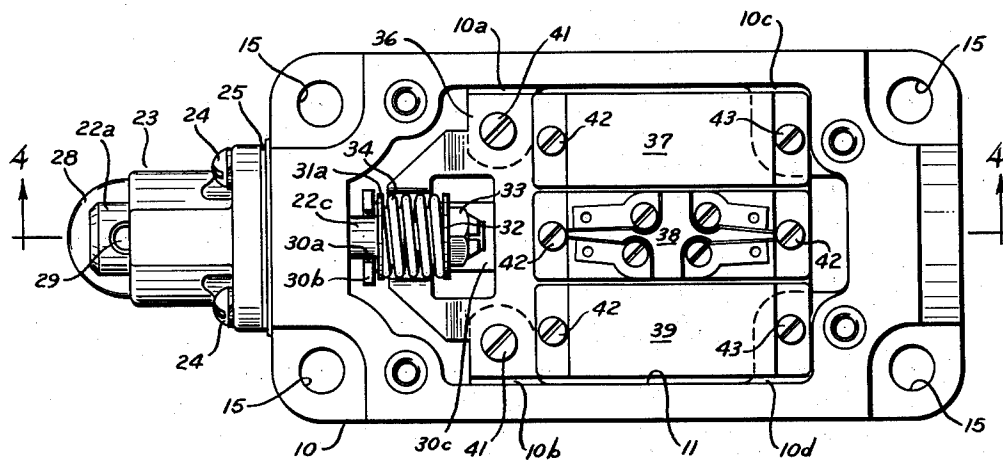


Fig. 6

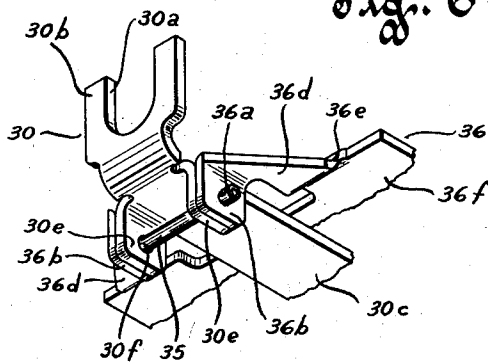
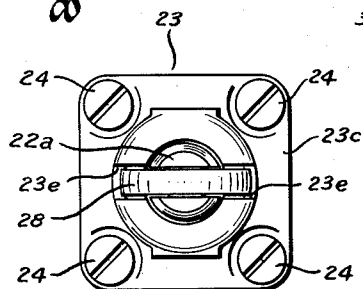


Fig. 7



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LIMIT SWITCH

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9 Claims. (Cl. 200-47)

This invention relates to limit switches, and more particularly to an improved operating mechanism therefor.

In certain applications it is desired that operation of a limit switch provide a plurality of electric circuit controlling functions. Small self-contained precision snap action type switches have heretofore been used individually for limit switch service. However, they are not sufficiently rugged or fluid tight for direct use either singly or multiply for certain heavy duty requirements.

It is a primary object of the present invention to provide a limit switch unit employing a plurality of such switches which is suitable for heavy duty service.

Another object of the invention is to provide an operating mechanism affording simultaneous operation of such switches for either direction of operation of an externally extending operator.

A further object is to provide an operating mechanism of the aforementioned type which is characterized by relatively low travel of the operator required to effect operation of the switches.

A still further object is to provide an operating mechanism of the aforementioned type which has inherent over-travel protection and minimizes shock stresses in its moving parts.

Other objects and advantages of the invention will hereinafter appear.

The accompanying drawings disclose a preferred embodiment of the invention which will hereinafter be described in detail, it being understood that the embodiment illustrated is susceptible of modification without departing from the scope of the appended claims.

In the drawings:

FIGURE 1 is a side elevational view of a limit switch constructed in accordance with the invention;

FIG. 2 is a sectional view taken along the line 2—2 of FIG. 1;

FIG. 3 is a sectional view taken along the line 3—3 of FIG. 2;

FIG. 4 is a view like FIG. 3, but showing another operating condition of the switch;

FIG. 5 is a top plan view of the switch with the enclosing cover removed;

FIG. 6 is an end view of the switch operating plunger assembly; and

FIG. 7 is a fragmentary perspective view of an internal actuator assembly.

Referring in the drawings to FIGS. 1 to 5, numeral 10 designates a housing or casing preferably formed by molding from a phenolic insulating material, which has a large cavity 11 therein. A cover 12 formed of similar material overlies the upper open end of casing 10 and is secured in place by screws 13 which penetrate clearance openings therein and take down into threaded recesses formed in the casing. A gasket 14, preferably formed by punching from a sheet of synthetic rubber, such as

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"neoprene" is disposed between the adjacent surfaces of casing 10 and cover 12 for sealing when the screws 13 are drawn down. At the four corners casing 10 and cover 11 are provided with cutaway portions forming corner recesses, and openings 15 extend from the bottom walls of each recess through casing 10. Suitable mounting screws or bolts can be inserted through openings 15 to secure the switch unit to a panel or other mounting surface.

As shown in FIGS. 3 and 4 at its right-hand end casing 10 is provided with a recess 16 having a metallic insert 17 which is internally threaded to accommodate the threaded end of an electrical conduit or conduit fitting. At its inner end recess 16 is connected by an opening 18 to the interior of cavity 11 to provide for insertion of electrical wires into the latter.

The left end of casing 10 has a cylindrical recess 19 opening to its outer surface and communicating at its opposite end with an end of cylindrical recess 20 of smaller diameter. Recess 20 at its opposite end communicates with an end of a cylindrical opening 21 which at its other end opens into the interior of cavity 11.

An operating plunger 22 having four integrally formed cylindrical portions 22a, 22b, 22c and 22d, which are successively of smaller diameter from the left-hand end as viewed in FIGS. 3 and 4, has its portion 22c extending through opening 21. Portion 22a of the plunger extends through and is guided in a circular opening 23a formed in a bearing block 23. Opening 23a opens at one end to the outer end of block 23 and communicates at its inner end with a frustoconical recess 23b that extends through a flanged base 23c.

Block 23 is secured to the end of casing 10 by screws 24 that penetrate clearance openings in its base 23c and take into threaded recesses formed in the end of the casing about recess 19. A sealing diaphragm 25 preferably formed of a flexible material, such as a synthetic rubber, is secured at its outer peripheral margins between the base 23c of block 23 and adjacent outer wall of casing 10. Diaphragm 25 is provided with a central aperture which elastically engages the periphery of portion 22b of the plunger. On one side the portion of the diaphragm adjacent its central aperture abuts an integral flange 22e formed at the juncture of portions 22a and 22b of plunger 22. A cup-shaped washer 26 bears on the other side of the last mentioned portion of the diaphragm and one end of a compression spring 27 which is concentrically disposed about portions 22b and 22c of plunger 22 seats within the bowl of such washer. The opposite end of spring 27 seats against casing 10 within the recess 20. Spring 27 serves to bias plunger 22 to an outer extreme position depicted in FIG. 3 which is attained when the flange portion 22e engages against the internal circular shoulder 23d formed at the juncture of opening 23a and recess 23b.

The portion 22a of plunger 22 has a rectangular slot 22f opening to its free end. A roller follower wheel 28 is disposed within slot 22f and is rotatably mounted on a pin 29 which is force fitted in aligned openings extending through portion 22a transversely of slot 22f. Roller 28 is preferably formed of a nylon material. Block 23 is provided with diametrically opposed slots 23e which afford clearance for roller 28 when plunger 22 is moved inwardly of block 23 and casing 10.

Portion 22d of plunger 22 extends through a U-shaped

slot 30a formed in the upstanding arm 30b of a bell crank lever 30. A cylindrical bushing 31 is concentrically mounted on portion 22d and is provided with an integral flange 31a at one end thereof, which in the aforementioned outer extreme position of plunger 22 bears on one side against arm 30b of lever 30. A second bushing 32, like bushing 31, is also mounted on portion 22d in oppositely disposed relation to bushing 31. The flange 32a of bushing 32 abuts on one side against a self-locking nut 33 which has threaded engagement with the threaded end portion 22g of portion 22d. A coil compression spring 34 is concentrically mounted on the bushings 31 and 32 and at its ends seats against the flanges of the latter. Spring 34 is selected so that when plunger 22 is free to move to its aforementioned outer extreme position under the bias of spring 27, it will be compressed as depicted in FIG. 3.

As best shown in FIGS. 2, 3, 4 and 7, lever 30 is provided with a central portion 30c which at one end integrally connects with arm 30b at a right angle. At its opposite end portion 30c is integrally connected with a transversely extending arm 30d. Adjacent the point where portion 30c joins arm 30b lever 30 is provided with parallel down-turned lugs 30e which have aligned openings 30f extending therethrough. A longitudinally split spring pin 35 extends with a rotatable clearance fit through the openings 30f and adjacent its opposite ends are non-rotatably fitted within aligned openings 36a formed in parallel, downwardly extending bearing bracket portions 36b of a mounting plate 36. Bracket portions 36b are spaced so the lugs 30e of lever 30 fit therebetween with clearance permitting free rotation of lever 30 on pin 35, but preventing any substantial lateral movement thereon on the pin.

Mounting plate 36 has a pair of spaced arms 36d which are integrally connected at their inner ends with a short inclined connecting portion 36e. Adjacent their free ends each of the arms 36d is integrally connected with one of the bearing brackets 36b. Plate 36 is provided with a flat, rectangular portion 36f that is integrally connected with portion 36e and is disposed in a parallel, but slightly offset relation to the arms 36d. Portions 36e and 36f are provided with a cut-away portion merging with the space between the arms 36d to provide clearance for pivotal movement of lever 30 which has its central portion 30c and transverse arm 30d disposed below portions 36e and 36f of mounting plate 36.

As best shown in FIGS. 3, 4 and 5, three like electric switches 37, 38 and 39 are mounted on the upper side of portion 36f of plate 36 in side-by-side relation. These switches have actuator buttons 38a, 39a and 40a extending downwardly, and clearance openings 36g are provided in portion 36f to permit the ends of these actuators to engage the upper side of arm 30d of lever 30.

The portion 36f of plate 36 adjacent its corners nearest portion 36e is provided with clearance openings to accommodate securing screws 41 that take down into threaded recesses formed in bosses 10a and 10b integrally formed and extending from the inner bottom and side walls of casing 10. Securing screws 42 penetrating clearance openings extending through the casing of switches 37, 38 and 39 at corresponding ends of the latter take into aligned threaded openings in portion 36f of plate 36 to partially secure the switches in mounted position. Another securing screw 42 penetrating the clearance opening in the other end of switch 38 takes into an aligned threaded opening in portion 36f. Somewhat longer securing screws 43 penetrate clearance openings in the other ends of switches 37 and 39 and aligned clearance openings in portion 36f, and take down into threaded recesses formed in bosses 10c and 10d integrally formed and extending from the inner corner side walls and bottom walls of casing 10.

Switches 37, 38 and 39 are of a self-contained, precision snap action type, and in a preferred form are like that shown and described in the Koenig Patent No. 2,918,-

544, issued December 22, 1959. Reference should be made to this patent for details of construction of these switches. As schematically depicted in FIGS. 3 and 4, switch 38 in addition to its actuator button 38a comprises an actuator lever 38b and a coil compression spring 38c biasing lever 38b and actuator button 38a outwardly of the switch casing. It is also provided with a movable contact member 38d which is operatively connected to lever 38b by a snap action over center mechanism, schematically represented by the springs 38e. When button 38a is free to move outwardly to its extended position shown in FIG. 4, the snap action mechanism will be effective to move member 38d into engagement with an upper set of contacts 38f. If button 38a is moved inwardly of its casing a sufficient amount to the position depicted in FIG. 3 the snap action mechanism will move member 38d in the reverse direction into engagement with a lower set of stationary contacts 38g. Switches 37 and 39 will, of course, be of like construction. As will be understood, practice of the present invention does not require use of switches of the aforementioned preferred form. However, the switches employed should be of the same type, and be characterized by: (a) operation to one operating condition by application of a small amount of force acting inwardly on its external actuator, (b) self-return to its other operation condition when such force is reduced a slight amount, and (c) consistent as to the amount of force and reduction in force required on its actuator to provide such operations.

FIG. 3 depicts the operating condition of the switch unit assumed when actuator 22 is free of external force tending to move it inwardly of casing 10. The bias of spring 27 holds actuator 22 in its aforementioned outward extreme position and compresses spring 34 to such an extent that the flange 31a of bushing 31 engages the arm 30b of lever 30 and pivots the latter counterclockwise to cause the arm 30d thereof to move actuator buttons 37a, 38a and 39a of switches 37, 38 and 39 inwardly an amount effecting the operation condition for each depicted for switch 38 in FIG. 3. An electrical circuit will thus be completed in each switch across the lower set of stationary contacts.

Let it be assumed that with the switch in the operating condition depicted in FIG. 3 that an external force F is applied against the roller follower that is sufficient to overpower spring 27 and move plunger 22 inwardly of casing 10. As plunger 22 moves inwardly against the bias of spring 27, spring 34 progressively extends and reduces the force applied on the arm 30b of lever 30. At some point in the inward movement of plunger 22 the force applied on arm 30b through spring 34 will decrease to such a value that the counterclockwise pivoting moment produced thereby will equal the clockwise pivoting moment produced by the actuator button forces of the switches acting through arm 30d and portion 30c. Then a slight additional inward movement of plunger 22 will reduce the counterclockwise pivoting moment sufficiently so that lever 30 will move in a clockwise direction. When the actuator buttons of switches 37, 38 and 39 have moved to a point where one or more of the movable contact members move with snap action to its other operating position the resulting change in bias on lever 30 will cause it to move rapidly in the clockwise direction resulting in self-tripping of the other switches. Because spring 34 provides a resilient driving connection between plunger 22 and arm 30b of lever 30, the partially extended spring 34 will yieldingly recompress slightly as lever 30 pivots clockwise with snap action. This insures that once the over center snap mechanisms of the switches have commenced to move their movable contact members to the operating condition depicted in FIG. 4 they can do so without "hanging" in some intermediate position.

Any further inward movement of plunger 22 beyond that required to release the switches to operate to their operating condition depicted in FIG. 4, results in return

of spring 34 to its extended position, and any additional inward movement of plunger 22 will result in lost motion travel of the latter with respect to arm 30b. While plunger 22 can thereafter be moved inwardly to the limit of compression of spring 27, it will be disengaged from lever 30 thereby affording over-travel protection for the latter.

When the external force F acting on plunger 22 is released the latter, of course, will move outwardly to its normal outward extended position under the bias of spring 27. In so moving, it will cause bushing 31 to reengage with lever arm 30b and compress spring 34 to apply a progressively increasing force on arm 30b. Ultimately the latter force increases to such an extent that the counterclockwise pivoting moment overcomes the clockwise pivoting moment afforded by the switches acting through their actuator buttons, arm 30d and portions 30c of the lever, and causes counterclockwise pivoting of lever 30. Lever 30 in so pivoting will move one or more of the switch actuator buttons inwardly to a point where their movable contact members move with snap action to the position depicted in FIG. 3. This results in a sudden decrease in the clockwise pivoting moment on lever 30, and the latter then pivots rapidly in the counterclockwise direction to complete the tripping of the remaining switch or switches to the operating positions depicted in FIG. 3.

Provision of the threaded end portion of plunger 22 and nut 33 permits some adjustment of the amount of inward movement of plunger 22 required to effect release of lever 30 to permit self-return of the switches 37, 38 and 39 to their operating conditions depicted in FIG. 4 under their internal bias. In assembling the switch unit with bushings 31 and 32 and spring 34 in mounted position on portion 22d of plunger 22 and the latter in its normal outward extreme position, nut 33 is preferably taken down to compress 34 to an extent that will just cause lever 30 to pivot counterclockwise to effect operation of all of the switches to the operating condition depicted in FIG. 3. Nut 33 is then taken down a partial turn more to insure that the switches will always be so operated when plunger 22 reaches its outer extreme position. Such degree of adjustment of nut 33 consistent with such desired operation of the switches in normal extended position of plunger 22 reduces to a practical minimum the amount of inward movement of plunger 22 required to provide the aforementioned release of lever 30. As will be apparent, any further taking down of nut 33 will result in increase of the amount of inward movement of plunger 22 required to release lever 30.

While the present invention has been disclosed in connection with three self-contained switches, its use is not limited to this particular number and can be used one, two or even more than three such switches.

We claim:

1. A limit switch comprising a housing having a cavity therein, a reciprocably movable operating plunger extending through an opening in a wall of said housing into said cavity, means biasing said plunger to an outer extreme position, a self-contained electric switch mounted in the cavity of said housing, said switch having an actuator extending through its casing and a snap action operating mechanism biased to one operating condition when the force applied on its actuator is less than a given amount and operable to another operating condition when such force exceeds said given amount, a bell crank lever pivotally mounted in said cavity and comprising one arm in engagement with the actuator of said switch and another arm disposed in the path of said plunger, and means mounted on said plunger providing a resilient driving connection between the latter and said other arm of said lever to progressively increase the force applied on said lever as said plunger moves toward its outer extreme position to pivot said lever to operate said switch to said other operating condition, said last mentioned means upon movement of said plunger inwardly of said housing progressively decreasing the force applied to said other arm

of said lever and permitting unrestricted pivotal movement of said lever under the bias exerted through the actuator of said switch.

2. The combination according to claim 1, wherein said last mentioned means comprises a coil compression spring concentrically mounted on said plunger which engages with said other arm of said lever and compresses as said plunger moves toward its outer extreme position.

3. The combination according to claim 2, wherein said last mentioned means also comprises a nut having threaded engagement on said plunger adjacent said coil compression spring to adjust the compressed length of said spring when said plunger is in its outer extreme position.

4. A limit switch unit comprising a housing having a cavity therein, a reciprocably movable operating plunger extending through a wall of said housing into said cavity, means biasing said plunger to an outer extreme position, a plurality of like self-contained electric switches mounted in said cavity, each of said switches having an actuator extending through its casing and a snap action operating mechanism biased to one operating condition when the force applied on its actuator is less than a given amount and operable to another operating condition when such force exceeds said given amount, a bell crank lever pivotally mounted in said cavity and having an arm in engagement with the actuators of said switches and another arm disposed in the path of movement of said plunger, and means mounted on said plunger providing a resilient driving connection between the latter and said other arm of said lever to progressively increase the force applied on said lever as said plunger moves toward its outer extreme position to pivotally move said lever in a direction affording substantially simultaneous operation of said switches to said other operating conditions thereof, and said last mentioned means upon movement of said plunger inwardly of said housing progressively decreasing the force applied to said other arm of said lever and permitting snap action pivotal movement of said lever in the other direction when the forces exerted thereon through the actuators of said switches when their operating mechanism move to said one operating condition.

5. The combination according to claim 4, wherein said last mentioned means comprises a coil compression spring concentrically mounted on said plunger which engages with said other arm of said lever and compresses as said plunger moves toward its outer extreme position.

6. The combination according to claim 5, wherein said last mentioned means also comprises a nut having threaded engagement on said plunger adjacent said coil compression spring to adjust the compressed length of said spring when said plunger is in its outer extreme position.

7. In a limit switch, the combination comprising a housing having a cavity therein, a reciprocably movable operating plunger extending through an opening in a wall of said housing into said cavity, means biasing said plunger to an outward extreme position, a mounting frame secured in spaced relation to an inner wall of said housing and having bearing brackets extending from one side, a plurality of like self-contained electric switches mounted side-by-side on said frame and having actuators extending through openings in said frame beyond the side of said frame adjacent said inner wall of said housing, each of said switches having a snap action operating mechanism biased to one operating position when force applied on its actuator is less than a given amount, a lever pivotally supported on said bearing brackets and having one arm extending between said inner wall of said housing and said frame and engaging with the actuators of all said switches, said lever having another arm extending at a right angle from said one arm and across the path of said plunger, said last mentioned arm having a cut-way portion permitting movement of said plunger therethrough, and means carried on a portion of said plunger that extends beyond said other lever arm providing a resilient driving connection between the latter and said plunger.

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8. The combination according to claim 7, wherein the last mentioned means comprises a coil compression spring concentrically mounted on said portion of said plunger which engages with said other lever arm and compresses as said plunger moves toward its outer extreme position. 5

9. The combination according to claim 8, wherein said plunger is provided with a concentric hollow bearing block secured to the outer side of the wall of said housing, wherein first mentioned means comprises a coil compression spring concentrically mounted on said plunger within 10 said bearing block and wherein a flexible diaphragm has elastic engagement on the periphery of said plunger and

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secured adjacent its peripheral margins between said bearing block and said housing to provide a fluid tight seal for the opening in said housing through which said plunger extends.

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