March 12, 1940. W. C. FURNAS ET AL 2,193,127

SWITCH ASSEMBLY

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Fig. 1.

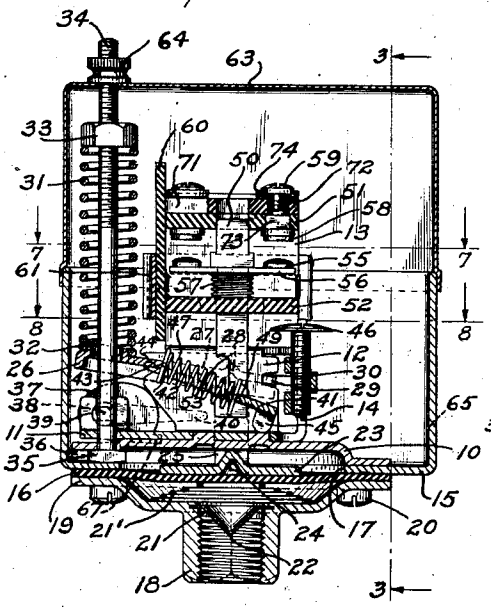
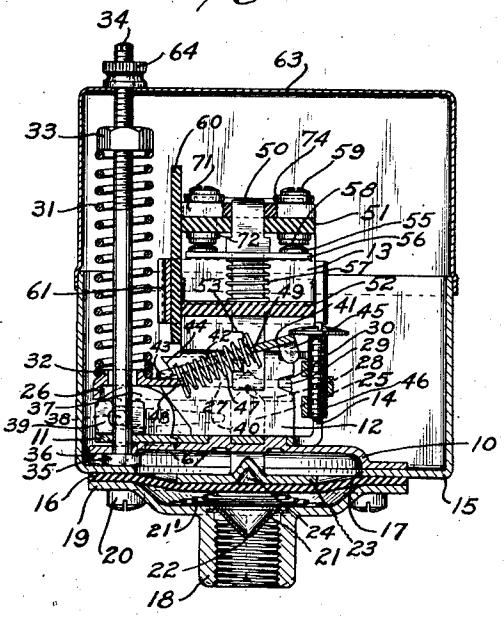


Fig. 2.



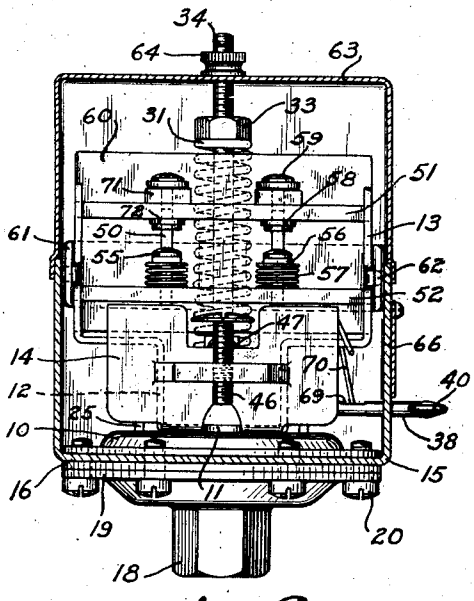


Fig. 3.

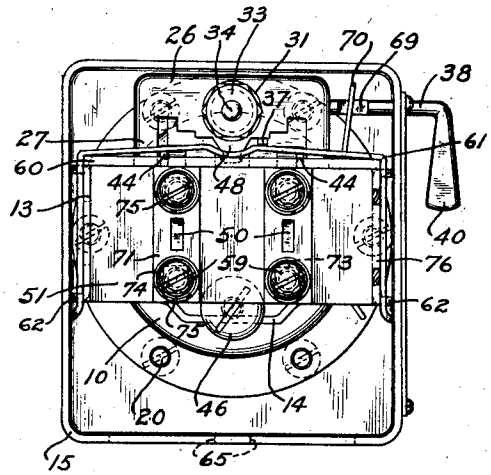


Fig. 4.

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Fig. 5.

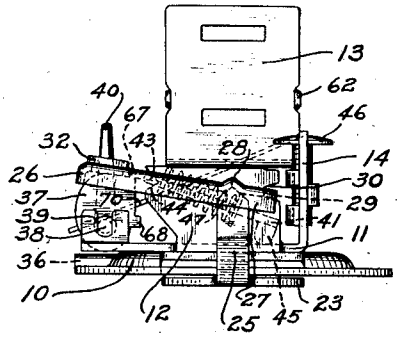
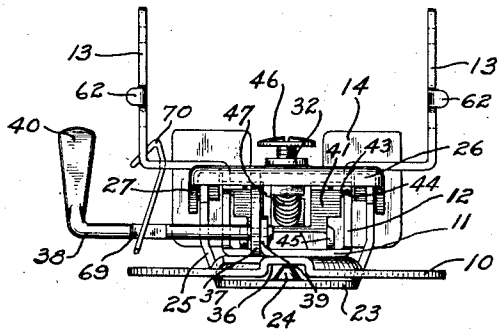


Fig. 6.



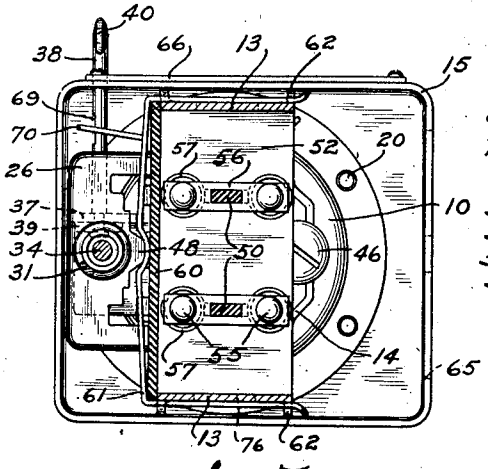


Fig. 7.

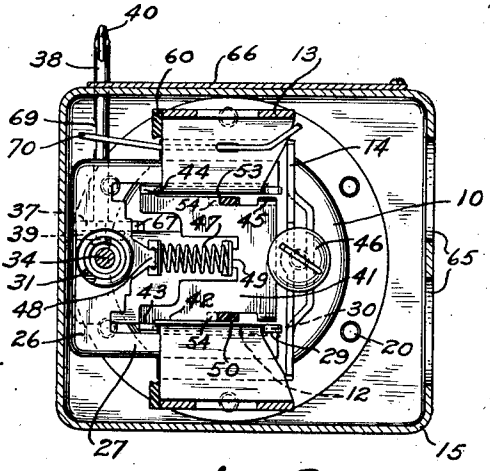


Fig. 8.

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Patented Mar. 12, 1940

2,193,127

UNITED STATES PATENT OFFICE

2,193,127

SWITCH ASSEMBLY

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Application October 6, 1938, Serial No. 233,520

17 Claims. (Cl. 200—83)

Our present invention relates generally to improvements in the art of controlling electrically actuated apparatus, and relates more specifically to improvements in the construction and operation of fluid pressure actuated switches of the general type shown and described in copending application Serial No. 138,296, filed April 22, 1937.

Generally defined, an object of our present invention is to provide an improved automatic pressure switch assembly which is simple in construction and highly efficient in operation.

It is frequently desirable when utilizing fluid pressure actuated switch mechanisms for controlling the operation of electrically operated apparatus such as the motor driving a compressor, to be able to quickly and accurately adjust the pressure range at the ends of which the switch will close and open respectively. In some cases, it may be desirable to adjust this pressure range without varying the magnitude, while in other cases it may be preferable to increase or diminish the magnitude alone in either direction, while in still other instances it may become desirable to vary the position of this range as well as its magnitude. For example, the switch may be initially set for closing operation at twenty pounds pressure and to open at thirty pounds, and it may be desirable to effect closing at fifty pounds and opening at sixty pounds pressure thus preserving the ten pound magnitude of the range. Then again, it may be desirable to change the initial ten pound range of operation to fifteen pounds, whereby the switch might again close at twenty and open at thirty pounds, or close at fifteen and open at thirty pounds pressure. On the other hand, it may be desired to change from the initial twenty and thirty pound limiting positions, to a fifty pound low and sixty-five pound high pressure range. While it has heretofore been proposed and attempted to provide switch adjusting mechanism for effecting some of these desirable variations in operating conditions, the prior proposed mechanisms are not entirely reliable, and are not adapted to meet the various conditions of desirable adjustment.

It is therefore an object of our present improvement to provide new and useful switch mechanism which is extremely flexible in its adjustment so as to meet various operating conditions, and which is also reliable in operation and compact in structure.

Another specific object of the invention is to provide a fluid pressure operated switch assembly which is accurate in operation, and is not undesirably affected by sudden variations or pulsations in the source of fluid pressure which actuates the switch.

A further specific object of the present invention is to provide improved switch mechanism of simplified and compact construction, the essential parts of which may be readily, accurately and economically manufactured from sheet metal with the aid of punches and dies.

Still another specific object of our invention is to provide an electric switch, which is well insulated and protected, and which may be safely operated either automatically or manually.

An additional specific object of the invention is to provide various improvements in the details of construction of switches, especially of the automatic fluid pressure actuated type, whereby such devices may be durably manufactured at minimum cost.

These and other specific objects and advantages of our invention will be apparent from the following detailed description.

A clear conception of embodiments of the several features constituting the present invention, and of the mode of constructing and of operating fluid pressure actuated electric switches built in accordance with our improvement, may be had by referring to the drawings accompanying and forming a part of this specification.

Fig. 1 is a longitudinal central vertical section through one of our improved fluid pressure actuated switches, showing the same released for automatic operation and with the contacts opened by fluid pressure;

Fig. 2 is a similar section through the same switch with the contacts in closed position;

Fig. 3 is a transverse vertical section through the switch taken along the line 3—3 of Fig. 1;

Fig. 4 is a top view of the switch assemblage of Figs. 1, 2 and 3 with the closure cover removed;

Fig. 5 is a side elevation of the main frame and some of the toggle and actuating elements of the switch assemblage, showing the toggle elements locked in contact open position by the manual control means;

Fig. 6 is a rear view of the portion of the switch mechanism shown in Fig. 5, showing the elements in the same position;

Fig. 7 is a transverse horizontal section through the switch assemblage, the section being taken along the line 7—7 of Fig. 1; and

Fig. 8 is another transverse horizontal section through the switch, taken along the line 8—8 of Fig. 1.

Referring to the drawings, our improved fluid pressure actuated switch as shown therein, com-

prises in general a main frame having a circular base 10 riveted or otherwise rigidly attached to an upper portion 11 which is provided with integral side walls 12 and flanges 13, and with an integral front wall 14 contiguous with but extending somewhat above the side walls 12; a lower casing 15 with the bottom of which the frame base 10 coacts, and which is provided with a large central opening 17; a flexible diaphragm 16 coacting with the lowermost face of the casing 15 and spanning the opening 17 therein; a fluid pressure connection or fitting 18 having a flange 19 which is clamped against the diaphragm 16 and to the casing 15 and base 10, by means of screws 20; an inverted conical member 21 secured to the fitting 18 and having a restricted fluid inlet opening 22 at the apex of the cone; a helical spiral spring 21' coacting with the flange 19 and with the center of the diaphragm 16; a motion transfer element or disk 23 coacting with the diaphragm 16 and having a central conical stop 24 adapted to engage the base 10, and integral side projections 25 extending upwardly through the opening 17 and through holes in the base 10 adjacent the side walls 12; a main U-shaped toggle member or bracket 26 having opposite side arms 27 formed with notches 28 which are engageable by the disk projections 25, the bracket 26 being swingable adjacent to the walls 12 upon integral inward extensions 29 coacting with notches 30 formed in the front upper portions of these walls 12; a primary adjusting spring 31 coacting with a retaining flange 32 formed integral with the rear central portion of the bracket 26 and reacting against a nut 33 having screw thread coaction with a bolt 34 the lower head 35 of which is fitted in a recess 36 in the base 10 and the upper threaded end of which extends upwardly a considerable distance; a cam 37 carried by a shaft 38 journalled in a socket 39 formed in the base 10 and in the casing 15, the shaft 38 having an external handle 40 for positioning the cam 37 so as to positively lock the toggle bracket 26 in switch open position; an auxiliary U-shaped toggle member 41 having arms 42 provided with outward extensions 43 coacting with rear notches 44 formed in the rear upper-portions of the side walls 12, the member 41 being swingable between these walls and having lower stop lugs 45 cooperable with the bottom of the frame portion 11 to limit the down-swing, and being cooperable with the head of a differential adjusting screw 46 carried by the front wall 14 to limit the upswing of the member 41; a toggle actuating spring 47 coacting with central projections 48, 49 of the toggle members 26, 41 respectively; a pair of parallel movable switch contact carrying bars 50 slidable in slots formed in upper and lower plates 51, 52 respectively, secured to the frame flanges 13, the bars 50 having notches 53 in their lower rear portions forming vertically spaced abutments with which portions 54 of the toggle member 41 are cooperable; four movable contacts 55 carried by transverse plates 56 secured to the medial portions of the bars 50; compression springs 57 embracing the bars 50 and coacting with the adjacent plates 56 and with the fixed lower plate 52; four fixed contacts 58 secured to the upper plate 51 and each having a conductor attaching screw 59 associated therewith; a flash preventing shield 60 secured to the frame flanges 13 by means of a spring clip 61 provided with side slots coacting with lugs 62 formed integral with the flanges 13; and a removable cover 63 coacting with the casing 15 and being held in normal closing position by means of a clamping nut 64 coacting with the threaded bolt 34.

The frame base 10 and portion 11 as well as the casing 15, fitting 18, disk 23, toggle members 26, 41, plates 56, clip 61 and cover 63 may be formed of sheet metal with the aid of punches and dies; and the casing 15 is provided with front openings 65 for the electrical switch connections, and also has an identification plate 66 at the side thereof for partially closing the slot through which the handle 40 is insertible during assembly of the mechanism, see Figs. 3, 4, 7 and 8. The upper and lower transverse plates 51, 52, the movable bars 50 and the shield plate 60 are all formed of insulating sheet material, and the diaphragm 16 is formed of flexible material such as rubber. The inverted conical member 21 which is rigidly attached within the fitting 18 and is provided with the small hole 22, is provided for the purpose of preventing sudden fluctuations or pulsations in the actuating fluid pressure, from undesirably affecting the movement of the toggle, and the helical spiral spring 21' which constantly presses upwardly against the diaphragm 16 serves to prevent the projections 25 of the disk 23 from leaving the sockets or notches 28 formed in the side arms 27 of the toggle bracket 26.

The cam 37 for locking the switch in open position, is shown in inactive position in Figs. 1 and 2, and in effective position in Figs. 5 and 6. This cam 37 is engageable with the under side of the toggle member or bracket 26 when the manipulating handle 40 is set upright as in Figs. 5 and 6, and has two stop lugs 67, 68 of which the lug 67 engages the bracket 26 when the switch is locked open, while the lug 68 engages the frame portion 11 when the cam 37 is inactive. The shaft 38 which carries the cam 37, is provided with a flattened portion 69 with which a rod spring 70 is engageable to normally retain the cam 37 in inactive position, and the spring 70 may be supported from the main frame portion 11 as shown in Fig. 8.

The two toggle members 26, 41 are independently swingably suspended from the side walls 12 of the stationary main frame, the member 26 being swingable about the extensions 29 and notches 30 from the front portion of the frame, and the member 41 being likewise swingable from the frame about the extensions 43 and notches 44. The compression spring 47 serves to throw the toggle member 41 from one extreme position to the other with a decided snap action, and by virtue of the fact that the member portions 54 are engageable with the opposite ends of the lost-motion cut out or notches 53 of the movable switch bars 50, the movable contact 55 will be simultaneously moved from one extreme position to the other with a similar snap action. The pressure limits of the range of action of the fluid pressure acting upon the diaphragm, are simultaneously but not equally adjustable by varying the tension of the adjusting spring 31 with the aid of the nut 33 coacting with the bolt 34. The high pressure limit of this range is also variable by means of the differential adjusting screw 46 the head of which provides a stop for limiting the upward swinging motion of the toggle member 41, as shown in Fig. 2. For example, if the switch is initially operable with a ten pound differential or range and is set to close at twenty pounds per square inch gage pressure acting on the diaphragm 16, and to close at thirty pounds per inch; the tension of the spring 31 may be increased to cause the switch to close at say fifty

pounds but the opening pressure required will then be approximately sixty seven instead of sixty pounds, thus having increased the ten pound range to seventeen pounds. By manipulating the differential screw **46**, the ten pound differential or range may again be reestablished from fifty to sixty pounds, without materially affecting the lower limit of this range. The adjusting screw **46** may also be utilized to vary the differential or range of action of the toggle without adjusting the spring **31**, as for example, by maintaining the initial twenty pound lower limit and by raising the thirty pound upper limit to thirty five, thereby increasing the original differential from ten to fifteen pounds.

The compression springs **57** which coact with the plates **52**, **56**, function to oppose the toggle action and to constantly urge the movable contacts **55** upwardly. When the mechanism is positioned as shown in Fig. 1 with the switch open, the toggle member **41** is swung downwardly and engages the lower ends of the notches **53** thereby compressing the springs **57**, but when the toggle is swung to the position shown in Fig. 2, the springs **57** quickly become effective to slide the bars **50** upwardly and to thereby close the switch. The movable contacts **55** are rounded as shown, but the fixed contacts **58** are flat faced, thereby insuring perfect contact at all times, and the plates **56** which carry the movable contacts **55** are preferably loosely mounted upon the bars **50** so as to permit the springs **57** to equalize the contact pressures. The upper plate **51** which carries the fixed contacts **58** is reenforced adjacent to these contacts by transverse upper strips **71** which also provide longer guide slots for the movable bars **50**, and the fixed contacts are secured to fasteners **72** having square portions **73** coacting with square holes in the plate **51**, see Fig. 1. The fasteners **72** are rivetted to terminal receptacles **74** which are provided with cut-outs **75** as shown in Fig. 4 so as to separate the lead wires, and the screws **59** coact with internal threads in the fasteners **72**. The flash shield **60** protects the spring **31** from arcing, and also provides an insulated receptacle or housing for the switch contacts **55**, **58**, and the plates **51**, **52** are secured to the flanges **13** by means of end lugs **76** as illustrated in Fig. 4. The cover **63** completes the switch enclosure, but this cover is readily removable for adjustment and inspection purposes, by merely removing the thumb nut **64**.

During normal operation of our improved switch assembly, when the handle **40** is in upright position as shown in Figs. 5 to 8 inclusive, the switch is open and the cam **37** is effective to hold the switch in this position by virtue of the coaction between the cam **37** and the toggle member **26**. During such positioning of the switch, the diaphragm **16** may or may not be subjected to fluid under pressure, and the spring **21'** will function to retain the projections **25** in engagement with the sockets **28** of the bracket member **26**, in case there is insufficient fluid pressure acting on the diaphragm to so retain the projections **28** of the disk **23**. When the cam **37** is positioned as in Figs. 1 and 2, the adjusting nut **33** may be manipulated to predetermine the range of automatic operation of the switch mechanism, and assuming the spring **31** to have been thus adjusted so as to cause the toggle to throw over center in one direction when the pressure falls to a low limit of say twenty pounds and in the opposite direction when the fluid pressure reaches a maximum of thirty pounds, then the switch will be closed during automatic operation when the fluid pressure acting on the diaphragm drops to twenty pounds and the switch will be automatically opened when this pressure reaches thirty pounds. The gradual increase in pressure will obviously cause movement to be transmitted to the main toggle member or bracket **26** through the disk **23** and projections **25** to thereby cause the member **26** to swing about the extensions **29** in an upward direction. When the movement of the member **26** becomes sufficient to permit the compression spring **47** to become effective, this spring acts quickly to swing the auxiliary toggle member **41** about its pivot extensions **43** to the position indicated in Fig. 1, whereby the movable contacts **55** will be snapped into open position. This actual snapping will not occur until the pressure acting upon the diaphragm **16** has increased from twenty pounds initial pressure to thirty pounds maximum. As the pressure acting upon the diaphragm **16** gradually diminishes, the spring **31** becomes effective to push the member **26** downwardly until the spring **47** again becomes effective to swing the auxiliary toggle member **41** in the opposite direction and into the position shown in Fig. 2. It will thus be apparent that the action of the improved switch mechanism when the cam **37** is ineffective, is entirely automatic and that the switch contacts are quickly opened and closed when the toggle mechanism becomes effective.

If it becomes desirable to vary either the range of pressure which will be effective in actuating the switch, or the position of this range, such adjustments may be quickly and accurately effected. In order to vary the range of pressure, it is only necessary to manipulate the differential adjusting screw **46** which limits the throw of the toggle without varying the tension of the toggle spring **47**. For example, if the initial range is ten pounds and it is desired to have an initial range of fifteen pounds, then it is only necessary to manipulate the screw **46** so as to vary the extent of the toggle throw. If, however, it is desired to vary the position of the range, as for instance from an initial position of from twenty to thirty pounds, to a final position of from fifty to sixty-five pounds, then it is necessary to manipulate the nut **33** so as to correspondingly increase the compression of the primary spring **31**. If it becomes desirable to vary the position of the range without increasing or diminishing the pressure range itself, then both adjustments may be utilized. For example, the spring **31** would be adjusted to vary the position of the range and such adjustment would necessarily also vary the magnitude of the range and such variation might be from an initial range of ten pounds to a subsequent range of fifteen pounds. The adjusting screw **46** may then be manipulated so as to return the pressure range to ten pounds or the initial value. An important feature of our present improved adjusting mechanism is the fact that the pressure range position adjustment is effected by varying the tension of a spring; while the adjustment for varying the pressure limits relative to each other, is effected by merely increasing or diminishing the toggle throw and without varying the tension of springs. It will thus be apparent that with the improved adjusting mechanism any desired conditions of operation may be quickly and effectively obtained with minimum effort and without the use of tools other than a screw driver and a wrench. These adjustments may be effected upon removal of the

cover 63, and when proper adjustment has been obtained the cover 63 should again be applied so as to conceal and protect the mechanism.

From the foregoing detailed description it will be apparent that our present invention provides an extremely simple, compact and reliable switch mechanism which is automatically operable and which may be conveniently adjusted to produce any desired operation. By mounting both toggle members 26, 41 on the stationary frame rather than upon each other, a more sturdy and reliable assemblage results, and it has also been found that such mounting permits more accurate adjustment of the pressure limits and pressure ranges. The improved adjusting mechanism is obviously durable in construction and can be conveniently manipulated to produce accurate results, and the cone 21 with its relatively small inlet opening 22 functions to eliminate objectionable operation due to sudden fluctuations in the fluid pressure source. The spring 21' maintains the motion transmitting element 23 in effective operating condition at all times, and the cam 37 provides simple and effective means for permitting manual actuation of the switch in case the automatic operation is not desired. The manual actuating mechanism is extremely simple and compact and can be quickly and conveniently installed. The switch contacts 55, 58 are effectively confined and protected and the mounting of the movable contacts 55 insures efficient closing at all times. The improved construction of the stationary contact supports prevents the contacts 58 from becoming loose due to continued operation, and the lead receptacles 74 are so constructed that they will avoid danger of possible short circuiting of the connections leading to the switch. By virtue of the fact that all of the main elements of the structure are adapted to be formed of sheet metal with the aid of punches and dies, the assemblage can obviously be manufactured and sold at extremely moderate cost, and switches constructed in accordance with this improvement have proven highly satisfactory in actual commercial use.

It should be understood that it is not desired to limit this invention to the exact details of construction and to the precise mode of operation, herein shown and described, for various modifications in the scope of the claims may occur to persons skilled in the art.

We claim:

1. In combination, a frame, spaced insulating plates secured to said frame, stationary contacts secured to one of said plates, movable contact carrier bars slidably coacting with both of said insulating plates, movable contact supports loosely suspended from said bars, springs interposed between the other of said plates and said supports, and toggle means for moving said bars with a snap action.

2. In combination, a frame, spaced insulating plates secured to said frame, a fixed contact carried directly by one of said plates, a movable contact carrier bar slidable in alined slots in said plates, a movable contact support loosely suspended from said bar, a spring coacting with said support to permit said bar to continue its movement after the movable contact has engaged said fixed contact, and means for sliding said bar in said slots to impart a snap closing action to said contact support.

3. In combination, a frame, parallel plates secured to said frame, stationary contacts carried by one of said plates, movable contact carrier bars slidably coacting with both of said plates, movable contact supports loosely suspended from said bars, coil springs interposed between said movable contact supports and the other of said plates, and means for simultaneously moving said bars with a snap action.

4. In combination, a frame having spaced side walls, parallel insulating plates secured to said walls to provide an intervening space, a stationary contact suspended from one of said plates, a movable contact carrier bar slidable through said space, a movable contact slidably suspended from said bar within said space, a spring interposed between said movable contact and the other of said plates, and means for moving said bar with a snap action.

5. In combination, spaced plates, a stationary contact suspended from one of said plates, a bar slidable across the space between said plates, a movable contact slidably suspended from said bar, a spring interposed between said movable contact and the other of said plates, and means for moving said bar longitudinally with a snap action.

6. In combination, a metal frame having laterally spaced side walls, parallel insulating plates secured to said walls to provide an intervening space, fixed contacts secured to one of said plates within said space, movable contact carrier bars slidable through said space, movable contacts slidably suspended from said bars, spring means interposed between said movable contacts and the other of said plates, actuating means disposed outside of said space for imparting movement to said bars, and another insulating plate coacting with said parallel plates to shield said space from said actuating means.

7. In combination, a cup shaped casing having a fluid pressure actuated at the bottom of the cup, a sheet metal frame disposable within said casing and having a base and integral side walls, relatively movable switch contacts carried by said side walls remote from said base, a fluid pressure actuated toggle lever fulcrumed on said side walls between said base and said contacts, a motion transmitting member loosely interposed directly between said diaphragm and said lever, a contact actuating toggle lever fulcrumed on said side walls and cooperating with said fluid pressure actuated lever to impart a snap closing action to said contacts, and a cam journalled in said frame and being manually operable from the exterior of said casing to move said fluid pressure actuated lever to contact closing position.

8. In combination, a cup shaped casing having a fluid pressure actuated at the bottom of the cup, a sheet metal frame disposable within said casing and having a base and integral side walls, relatively movable switch contacts carried by said side walls remote from said base, a fluid pressure actuated toggle lever fulcrumed on said side walls between said base and said contacts, a motion transmitting member having loose surface contact with said diaphragm and being provided with laterally spaced projections engaging said toggle lever to move the same, a contact actuating toggle lever fulcrumed on said side walls remote from the fulcrums of said fluid pressure actuated lever, and a manually operable cam journalled in said frame and coacting directly with said fluid pressure actuated lever to render the fluid pressure inactive.

9. In combination, a sheet metal frame having a base and integral side walls, a fluid pressure

actuated lever having side arms fulcrumed on the front edges of said walls and extending along the outer sides thereof, relatively movable contacts carried by said walls above said lever, and another lever fulcrumed on the rear edges of said walls and extending between the same and disposed between said contacts and fluid pressure actuated lever, said levers cooperating to form a toggle for imparting a closing snap action to said contacts.

10. In combination, a sheet metal frame having a base and integral side walls, a fluid pressure actuated lever having side arms fulcrumed on the front edges of said walls, and extending along the outer sides thereof, relatively movable contacts carried by said walls above said lever, a contact actuating lever having side arms fulcrumed on the rear edges of said walls and located therebetween, and a spring connecting said levers to provide a snap action actuating toggle for said contacts.

11. In combination, a sheet metal frame having a base and integral side walls, a fluid pressure actuated lever having side arms fulcrumed on the front edges of said walls and extending along the outer sides thereof, relatively movable contacts carried by said walls above said lever, a contact actuating lever having side arms fulcrumed on the rear edges of said walls and located therebetween, a spring connecting said levers to provide a snap action actuating toggle for said contacts, and a manually operable cam journalled in said frame and coacting directly with said fluid pressure actuated lever to render the fluid pressure ineffective.

12. In combination, a sheet metal frame having a base provided with integral side walls and an end wall, relatively movable contacts supported by said frame, a fluid pressure actuated lever fulcrumed on said side walls, a contact actuating lever fulcrumed on said side walls, said levers cooperating to provide a contact actuating toggle, and a screw extending parallel to said front wall and coacting with one of said levers to limit the toggle movement.

13. In combination, a sheet metal frame having a base provided with integral side walls and an end wall, said end wall having a laterally off-set integral portion providing a threaded socket extending parallel to said wall, relatively movable contacts supported by said frame, a fluid pressure actuated lever fulcrumed on said side walls near said front wall, a contact actuating lever fulcrumed on said side walls remote from said front wall, said levers forming a contact actuating toggle, and a screw coacting with said socket to limit the movement of said levers.

14. In combination, a frame having relatively movable contacts suspended therefrom, a toggle lever movable to open and close said contacts with a snap action, a fluid pressure actuated toggle lever cooperating with said contact moving lever to provide a toggle, a fluid pressure operable diaphragm for moving said fluid pressure actuated lever, means forming a fluid confining chamber exposed to said diaphragm, and a sheet metal cone having a pin hole at its apex for admitting fluid under pressure to said chamber.

15. In combination, a frame having relatively movable contacts suspended therefrom, a toggle lever movable to open and close said contacts with a snap action, a fluid pressure actuated toggle lever cooperating with said contact moving lever to provide a toggle, a fluid pressure operable diaphragm for moving said fluid pressure actuated lever, means forming a fluid confining chamber exposed to said diaphragm, and a sheet metal cone having a pin hole at its apex for admitting fluid under pressure to said chamber, the apex of said sheet metal cone being directed away from said diaphragm and chamber.

16. In combination, a frame having relatively movable contacts thereon, a toggle for relatively moving said contacts with a snap action, said toggle having a fluid pressure actuated lever, a diaphragm for operating said lever and having a fluid confining chamber at one side thereof, a sheet metal cone having a pin hole at its apex for slowly admitting fluid under pressure to said chamber, and a spring in said chamber for constantly retaining said diaphragm in active position relative to said lever.

17. In combination, a frame having side walls, spaced insulating plates secured to said walls, switch contacts confined within the space between said walls and said plates, means for actuating said contacts, a shield plate coacting with said walls to insulate said contacts from said actuating means, and a spring clip coacting with said shield plate and with said side walls to detachably retain said shield plate in position.

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