

March 12, 1940.

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2,193,126

SWITCH MECHANISM

Filed April 22, 1937

2 Sheets-Sheet 1

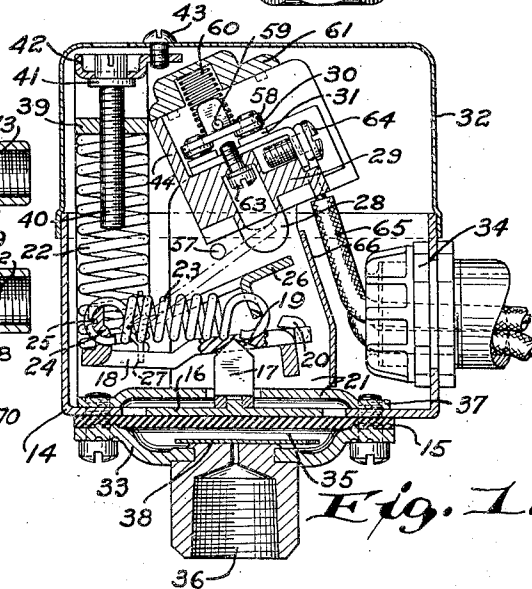
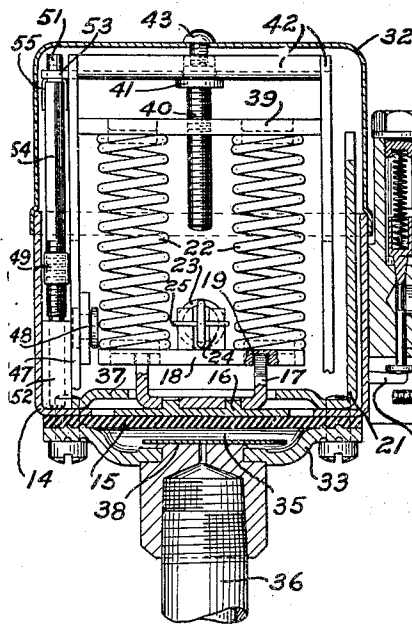
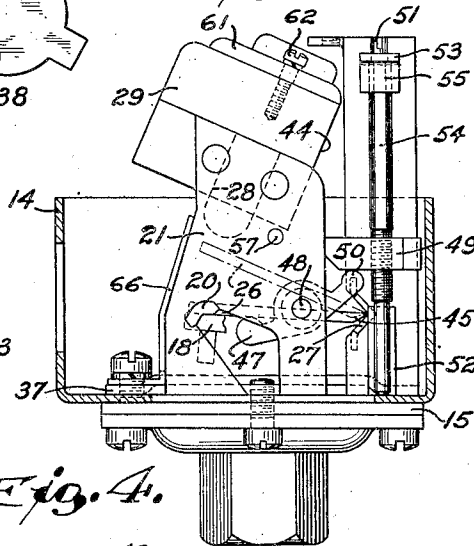
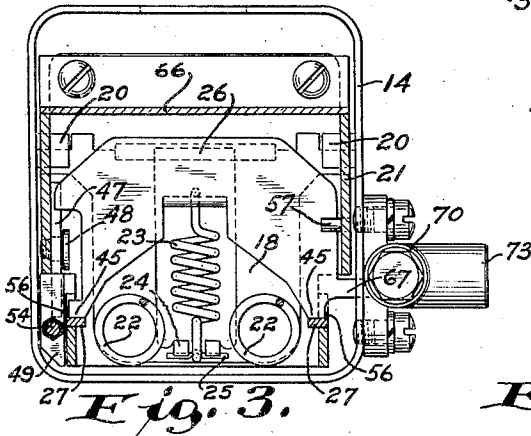
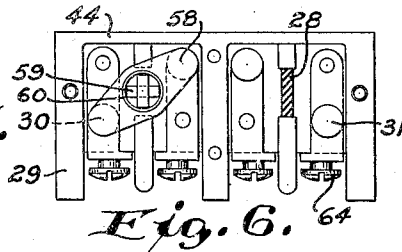
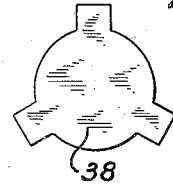
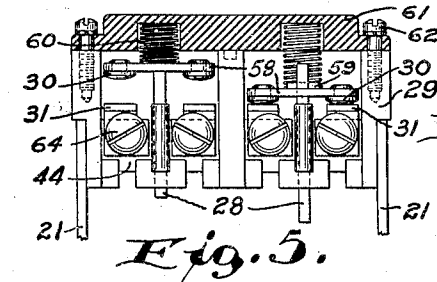


Fig. 2.

Fig. 1.

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SWITCH MECHANISM

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2 Sheets-Sheet 2

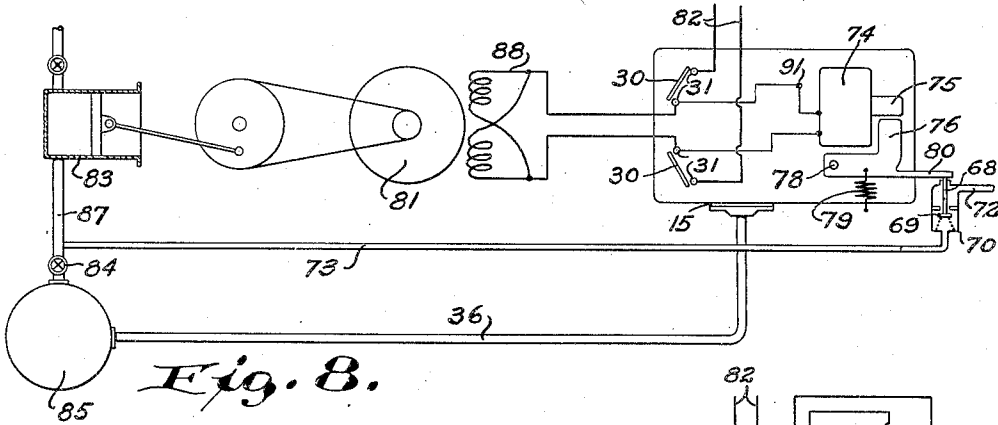


Fig. 8.

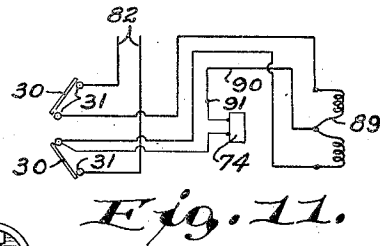


Fig. 10.

Fig. 11.

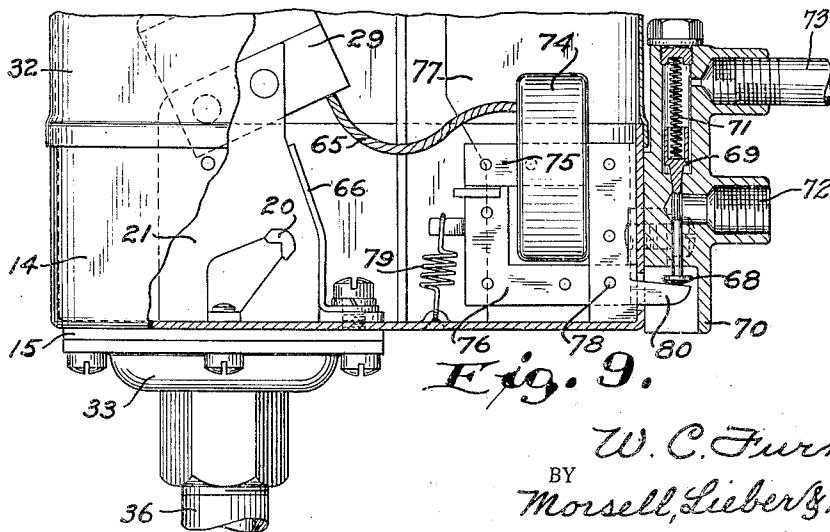
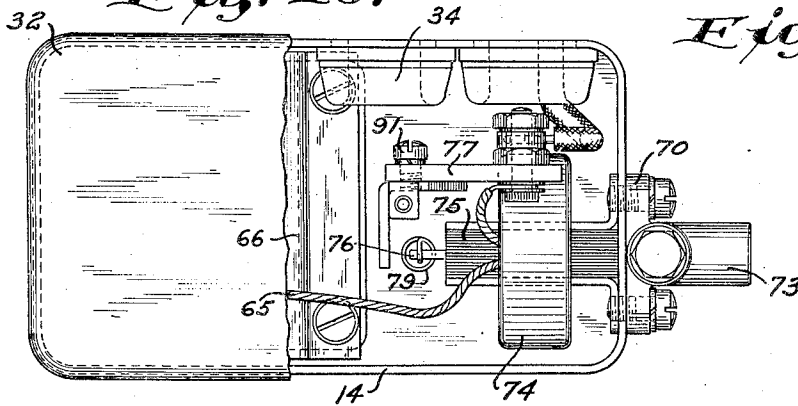


Fig. 9.

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2,193,126

SWITCH MECHANISM

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3 Claims. (Cl. 200—83)

My present invention relates in general to improvements in the art of utilizing fluid under pressure to actuate the control mechanism for a pressure generating system, and relates more specifically to improvements in the construction and operation of pressure actuated switch mechanisms and unloading devices operable in conjunction therewith.

Generally defined, an object of the present invention is to provide improved electric switch mechanism which is simple and compact in construction, and which is also highly efficient in operation.

Some of the more specific objects of my invention are as follows:

To provide an improved pressure actuated switch assemblage which is extremely compact and durable in construction, and which is moreover sensitive and precise in operation.

To provide a new and useful fluid pressure operated switch of the multiple contact type, wherein the closing pressure on the several contacts is effectively equalized and distributed.

To provide a switch assembly in which the various movable elements are most effectively relieved of excessive friction, and wherein relatively small plural springs are utilized to insure most efficient functioning of the switch.

To provide a switch especially adapted to control the operation of a pressure producing pump or compressor, and which is adapted to control the range of fluid pressure variation with the utmost precision.

To provide an improved pump unloading assemblage cooperable with a switch for controlling the operation of the motor for driving the pump.

To provide an improved unloading device which is effectively cooperable with electrical systems operable with different voltages, as for instance, either with 110 or 220 volts.

To provide a compact and highly efficient electromagnetically actuated unloader for a motor driven compressor or the like, which will automatically unload the compressor upon interruption for any reason of the motor energizing current.

To provide an improved combined switch and unloader unit which is extremely compact and all portions of which are conveniently accessible but thoroughly protected and concealed during normal operation and use.

To provide improved diaphragm structure for transmitting variations in fluid pressure to switch actuating mechanism.

To provide improved pressure actuated control

mechanism, the main parts of which may be manufactured with the aid of punches and dies and thereafter readily assembled to produce final durable assemblages which may be sold at moderate prices.

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

A clear conception of embodiments of the various features constituting the present invention, and of the mode of constructing and of operating switch and unloading mechanisms built in accordance with the improvement, may be had by referring to the drawings accompanying and forming a part of this specification wherein like reference characters designate the same or similar parts in the several views.

Fig. 1 is a transverse central vertical section through a fluid pressure actuated multiple contact electric switch, showing the actuating mechanism in neutral position and the contacts closed;

Fig. 2 is a longitudinal vertical section through the switch actuating mechanism of Fig. 1, a part of the section being taken centrally through the housing and fluid pressure mechanisms, and the switch mechanism being shown in elevation;

Fig. 3 is a transverse horizontal section through the switch actuating mechanism, the main closure cover having been omitted;

Fig. 4 is a side view of the switch and switch actuating mechanism, looking toward the pressure range adjusting structure;

Fig. 5 is a part sectional front elevation of the switch contact assembly, showing one of the contact members closed and the other open;

Fig. 6 is a full top view of the improved switch contact assemblage, with the cover plate removed;

Fig. 7 is a plan view of the diaphragm protecting plate;

Fig. 8 is a diagram showing one of the improved switches and a magnetically actuated unloader, applied to a fluid pressure supply system;

Fig. 9 is a transverse vertical section through a combined switch and unloader unit, the latter being of the magnetically actuated type;

Fig. 10 is a top view of the unit of Fig. 9 with the cover removed from the magnetic unloader; and

Fig. 11 is a wiring diagram for the switch and magnetic unloader, showing the same cooperating with a 220 volt motor, instead of a 110 volt motor as in Fig. 8.

While the invention has been shown and de-

scribed herein as being embodied in an air pressure operated switch and compressor unloader of the multiple contact type, it is not the intent to thereby unnecessarily restrict the scope, since some of the novel features may obviously be applied to other types of switch mechanisms operable with other fluids.

Referring specifically to Figs. 1 to 7 inclusive of the drawings, the improved pressure actuated switch shown therein comprises in general a main cup-shaped lower casing 14 having a substantially central opening in the bottom thereof normally sealed by a flexible rubber diaphragm 15 provided at its top with a reenforcing plate 16 and with a central U-shaped motion transmitting pointed member 17; a main horizontal lever 18 having medial recesses 19 coacting with the points of the member 17 and being fulcrumed at one end on hardened bearing blocks 20 secured to the opposite side walls of the frame 21; a pair of similar laterally spaced vertical compression springs 22 coacting with the other swinging end of the lever 18 so as to constantly urge the recesses 19 against the points of the member 17 in opposition to the action of the diaphragm 15; a substantially horizontal tension spring 23 having one end detachably connected to upstanding ears 24 at the swinging end of the lever 18 by means of a pin 25 and having its opposite end attached to the swinging end of a toggle striker plate 26 which is fulcrumed in other bearing blocks 27; a pair of contact carriers 28 slidably supported in a contact carried block 29 and having lower ends engageable by the toggle striker plate 26, these carriers 28 also having movable upper contacts 30 adapted to engage fixed contacts 31 secured to the block 29; mechanism for adjusting the tension of the springs 22 and the range of travel of the striker plate 26; and suitable closures including a top cover 32 and a lower plate 33, the latter having a central threaded pipe connection cooperating therewith to provide a diaphragm chamber 35.

The main lower casing 14 may be formed of a single sheet of relatively heavy sheet metal, and has several side openings adapted for the reception of conventional bushings 34; and the diaphragm 15 which is formed of flexible material such as rubber, is clamped between the casing 14 and the lower plate 33 so as to provide the hermetically sealed diaphragm chamber 35 which is in constant open communication through the threaded connection with a fluid pressure supply pipe 36, see Figs. 1 and 2. The diaphragm plate 16 may also be constructed of sheet metal and the upstanding pointed portions of the member 17 extend vertically through a central hole in the base plate 37 of the frame 21. In order to prevent the rubber diaphragm 15 from sticking in contact with fluid pressure supply port in the lower plate 33, I provide a thin metal plate 38 such as shown in Figs. 1, 2 and 7 which may be readily lifted by the fluid pressure, but which also prevents the diaphragm 15 from directly engaging the threaded pipe connection of the plate 33. The main lever 18 which is preferably formed of sheet metal has a relatively wide central fulcrum portion which engages the bearing blocks 20 on the upstanding side walls of the frame 21, and the central portion of the plate or lever 18 is open so as to prevent interfering with the movement of the spring 23.

The upper ends of the vertical compression springs 22 react against a transverse horizontal flat bar 39 which is vertically adjustable to vary

the spring tension, by means of an adjusting screw 40, the lower portion of which has screw thread coaction with a central threaded hole in the bar 39, and the upper end of which is provided with a journal collar 41 rotatably engaging the central portion of a fixed inverted U-shaped sheet metal bracket 42 formed integral with or attached to the frame 21, as shown in Figs. 1 and 2. This screw 40 is adapted to predetermine the maximum pressure at which the switch mechanism will operate, and the top cover 32 may be provided with a hole in line with the screw 40 so as to permit external adjustment, and is detachably secured to the medial upper portion of the stationary bracket 42 by means of a screw 43. The space within which the springs 22 are confined, may also be segregated from the space in which the electrical contacts 30, 31 are located, by means of a guard plate 44 formed of insulating material and integral with the block 29 which is also formed of insulating material.

As previously indicated, one end of the tension spring 23 is attached to the ears 24, midway between the compression springs 22, by means of a retainer pin 25, and the opposite end of this tension spring coacts with a knife edged opening at the medial portion of the swinging end of the toggle or striker plate 26, as clearly shown in Figs. 1 and 3, so that the tension spring 23 is capable of throwing the plate 26 either above or below the central plane of the toggle. The fulcrumed end of the plate 26 is provided with two spaced knife edges 45 which coact with V-grooves formed in the bearing blocks 27, these blocks being fixedly secured to the fixed bracket 42 as indicated in Figs. 1, 3 and 4; and at least one side of the toggle plate 26 is provided with an integral outwardly extending projection 46 which is engageable with an adjustable side lever 47. The lever 47 is swingable for adjustment about a pivot 48 by means of a vertically adjustable block 49 coacting with the rounded end 50 of the lever 47, and the block 49 also coacts with the screw threaded medial portion of an upright spindle 51 shown in Figs. 2, 3 and 4. The spindle 51 is journaled in an upper bearing 53 at one side of the fixed bracket 42, and has its lower cylindrical portion fitted in a spring clip 52 which forms a stop for limiting the downward travel of the block 49 along the screw threads so as to insure proper functioning of the toggle plate 26. The block 49 is guided between and is prevented from rotating by the casing 21 and bracket 42, and the portion 54 directly beneath the bearing 53 is preferably polygonal. An inverted U-shaped spring member 55 is cooperable with the flat faces of the portion 54 to lock the spindle 51 in adjusted positions, while permitting rotation thereof for purposes of adjustment, and the spindle is accessible for rotation upon removal of the cover 32. Adjustment of the lever 47 about its pivot pin 48 with the aid of the spindle 51 and block 49 obviously serves to vary the limit of swing of the plate 26.

The bearing blocks 27 which are secured to the frame bracket 42 have small abutments 56 as shown in Fig. 3 for preventing sidewise shifting of the plate 26, and as heretofore indicated, the swinging portion of the striker plate 26 is adapted to impinge against the contact carriers 28 to open the switch, see Figs. 1 and 4. The plate 26 is adapted to strike both of the contact carriers simultaneously, so as to insure simultaneous making and breaking of all contacts, and the contacts 30, 31 are formed of suitable material such

as silver. The upward swinging motion of the plate 26 is arrested by a stop 57 secured to or formed integral with one side wall of the frame 22, and the movable contacts 30 of each set are mounted upon a diagonal plate 58 detachably secured to the upper end of the adjacent contact carrier 28 by means of a retaining pin 59. Each of the diagonal contact supporting plates 58, is constantly urged toward closed position by means of a compression spring 60 coacting therewith in line with its carrier 28, and reacting against a socketed top plate 61 formed of insulating material and detachably secured to the carrier block 29 by screws 62. The block 29 is firmly attached to the side walls of the main frame 21 in any suitable manner, and this block with its guard wall 44 cooperates with the top plate 61 to house, protect and segregate the contacts 30, 31. The fixed contacts 31 are firmly attached to the insulating mounting block 29 by means of screws 63 and are provided with terminal posts 64 to which the terminals 65 may be attached as depicted in Fig. 1; and the terminal space is preferably segregated from the space within which the switch mechanism is confined, by means of a removable protecting shield 66.

It is also desirable to provide some kind of compressor unloading means when switch mechanism of the improved type is used to control the operation of electric motor driven compressors, and such unloading may be accomplished either mechanically or electrically, but the unloader should preferably constitute an integral part of the switch unit. In Figs. 2 and 3, I have illustrated an improved mechanical unloader comprising a lever projection 67 formed integral with the impact plate 26 and having its outer end cooperable with the stem 68 and adapted to actuate an unloading valve 69 which is confined within a fitting 70 secured to a side of the main casing 14. The projection 67 is obviously adapted to lift the unloading valve 69 against fluid pressure and the action of the compression spring 71, when the impact plate 26 moves the contacts 30, 31 to open position so as to stop the motor which drives the compressor or pump. The fitting 70 may be provided with a connection 73 communicating with the compressor, and with another connection 72 ordinarily leading to the atmosphere, so that when the unloading valve is opened by elevation of the lever 67, the compressor will be automatically unloaded preparatory to restarting of its driving motor.

In Figs. 8 to 11 inclusive, I have disclosed another type of unloader which is operable electrically and which may also constitute an integral part of the switch unit. In this embodiment of my invention, the switch mechanism is essentially the same as previously described, with the exception that the lever 67 is omitted, and casing 14 and cover 32 are somewhat enlarged to provide an auxiliary unloader chamber between the main switch and the fitting 70. Located within this auxiliary chamber is an electro-magnet comprising a coil 74, the opposite terminals of which are adapted to be connected to the two medial fixed contacts 31 of the main switch, and having a laminated fixed core 75 cooperable with a laminated pivotally suspended armature bar 76. The armature bar 76 is swingably suspended from the magnet supporting frame 77 by means of a pivot pin 78 and is urged out of engagement with the core 75 by a tension spring 79. The swinging end of the bar 76 also has a projection 80 which is engageable with the stem 68 of an

unloading valve housed within the concealing fitting 70 in the manner previously described.

By referring to the diagram of Fig. 8, which shows my improved pressure switch and magnetically actuated unloading unit applied to a typical air pressure system, it will be apparent that the compressor driving motor 81 is connected through the fixed switch contacts 31 to the main line 82, and is adapted to propel a compressor 83 which normally delivers air past a non-return valve 84 to a storage reservoir 85. The storage reservoir communicates with the diaphragm 15 at all times through the pipe 36, and the unloading valve 69 is spring pressed and communicates through the connection 73 with the compressor 16 discharge pipe 87 in advance of the non-return valve 84 so as to adapt the valve 69 for compressor unloading purposes.

In the 110-volt circuit of Fig. 8, the motor winding 88 has two leads connected directly to the adjacent fixed contacts 31 as shown; but in the 220 volt system of Fig. 11, the motor winding 89 has an extra lead 90 which is connected to the terminal post 91 of the electro-magnet. The same switch and unloading mechanisms may thus be utilized for either 110 or 220 volt circuits.

During normal operation of the improved switch mechanism, and assuming the switch to be applied to a typical fluid pressure system such as shown in Fig. 8 in conjunction with either type of unloader, the set screw 40 must first be adjusted to cause the contacts 30, 31 to separate or open when a predetermined maximum pressure of, say, one hundred pounds per square inch is attained in the storage reservoir 85, and the spindle 51 should be set to cause the contacts 29 to close when the pressure in the reservoir has dropped to a predetermined minimum of, say, eighty pounds per square inch. The pressure range will then be twenty pounds, and the high and low limits may obviously be fixed at any predetermined value by proper adjustment of the screw 40 and spindle 51. When the maximum pressure has been reached in the system, and the switch is open, the toggle plate 26 will be in the position indicated in dot-and-dash lines in Fig. 1, that is, in engagement with the extreme lower ends of the contact carriers 28, the spring 23 serving to retain the plate 26 and the movable contacts 30 in open position. The unloading valve 69 will then be open so as to unload the compressor 83 and to permit easy starting thereof by the motor 81.

As the pressure in the reservoir 85 and in the pipe 36 and chamber 35 is reduced, the diaphragm 15 will move downwardly thereby causing the main springs 22 to force the main lever 18 in a downward direction. As this reduction in fluid pressure continues, the main lever 18 will eventually carry the end of the spring 23 across the center of the toggle of which the plate 26 constitutes one element, and the spring 23 will then become quickly effective to swing the toggle plate 26 downwardly against the adjusting lever 47. When this action takes place, the compression spring 60 quickly becomes effective to move the diagonal plates 58 and the movable contacts 30 and carriers 28 which are associated with these plates toward closed position, thereby quickly moving the contacts 30 into engagement with the fixed contacts 31 thus completing the electrical circuit. This completion of the electrical circuit will again start the motor 81 and the compressor 83 and will eventually cause restoration of the pressure in the reservoir 85.

As the pressure within the reservoir 85 and in the pipe 36 and chamber 35 again reaches the maximum predetermined pressure, the diaphragm 15 will have moved the lever 18 upwardly so as to carry the swinging end of the spring 23 upwardly across the central plane of the toggle. The spring 23 will then become effective to quickly snap the toggle plate 26 into its upper extreme position, and the plate 26 will strike against the lower ends of both of the contact carriers 28, thereby opening the switch and restoring the parts to contact open position. While Fig. 5 illustrates one set of contacts 30 as being open while the other is closed, this condition never actually exists, since the striker plate 26 always cooperates with both carriers 28.

The insulating block 29 with its walls 44, and the formation of the carriers 28 and plate 61 of insulating material, serve to prevent short circuiting and possible damage by flashing, and the contacts 30 are formed of suitable material which when engaging the fixed contacts 31, will insure most effective electrical connections without melting or burning. The protecting plate 66 disposed in advance of the terminal bushing 34 prevents the terminals 65 from engaging the switch mechanism, and the top cover 32 is readily removable to permit inspection of the mechanism and easy adjustment of the pressure ranges. The diaphragm protecting disk 38 also prevents the diaphragm 15 from sticking to and sealing the air admission and exhaust opening in the plate 33, thus insuring effective operation at all times. By utilizing two relatively light main springs 22 disposed on opposite sides of the toggle actuating spring 23, a simple and more compact and flexible mechanism results, and the tension of the springs 22 may obviously be quickly changed from the exterior of the housings by manipulating the adjusting screw 40. The adjustable spindle 51 provides simple and readily manipulable means for varying the pressure range under which the switch mechanism will operate, and by virtue of the fact that practically all of the essential portions of the mechanism are formed of sheet metal, the assemblage can be readily produced with punches and dies at minimum cost.

When a mechanical unloader such as shown in Figs. 2 and 5 is employed, the unloading projection 67 will cooperate with the impact plate 26 so that when the desired maximum pressure is attained and the switch is open, the projection 67 will lift the unloading valve 69 through the stem 68, and will thereby permit escape of the fluid pressure from the pipe line 72 to the atmosphere. Since the plate 26 and projection 67 are entirely enclosed within the switch casing, and the operating end of the projection 67 is entirely concealed within the fitting 70, the unloading mechanism constitutes an integral part of the switch unit and cannot be tampered with. The spring 71 aids the fluid pressure in seating the valve 69, and when the projection 67 of the plate 26 engages the pin 68, the valve 69 is forced open against the spring and fluid pressure so that unloading will be quickly effected when the switch is open.

The magnetically actuated unloading mechanism of Figs. 8 to 11 inclusive, is adapted to function when the circuit is broken by operation of the switch, or when the electrical line is interrupted in any manner so as to stop the operation of the motor 81. In this magnetically actuated unloading device, the valve 69 is adapt-

ed to open against spring and fluid pressure when the projection 80 of the armature bar 76 engages the stem 68, and the armature bar 76 will be pulled away from the core 75 of the magnet, by the spring 79, whenever the electrical circuit is broken and the coil 74 is de-energized. As soon as the switch is closed, the armature bar 76 will be drawn into contact with the core 66 against the action of the spring 79, and will thereby permit closing of the unloading valve 69. This magnetic unloader likewise constitutes an integral part of the switch mechanism, and all portions of the switch and of the unloading device are again thoroughly concealed and protected.

From the foregoing specific description of the construction and operation of my improved switch and unloading mechanism, it will be apparent that the present invention provides a switch assembly of simple construction which is highly efficient in actual operation. The improved pressure actuated switch functions positively and with extreme accuracy, and may be conveniently adjusted to operate within any desired pressure ranges. The improved unloading mechanisms constituting an integral part of the switch unit, provide an extremely compact assemblage, all elements of which are effectively protected against tampering. While the improved switch is especially adapted to control the operation of a motor driven compressor, the switch itself may be utilized for other purposes and in any system wherein it is desirable to control the range of fluid pressure operations with utmost precision. The fulcrum blocks 20, 27 and the knife edges coacting therewith eliminate friction losses and avoid necessity of lubrication, and the same is true of the knife edges of the member 17 coacting with the recesses 19. The improved switch assembly may obviously be manufactured at moderate cost and has proven highly successful in actual commercial use, and the unit is also adapted for use in circuits having different voltages.

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

I claim:

1. In combination, a diaphragm movable by fluid pressure, a main toggle lever movable by said diaphragm, a plate having surface contact with said diaphragm, and being provided with rigid laterally spaced knife edge projections engaging said lever, a spring coacting with each side of said lever approximately in the plane of the corresponding knife edge projection, a pressure equalizing cross bar coacting with both of said springs, adjusting means coacting with said bar midway between said springs for causing the latter to exert equal pressures against said lever in the planes of said knife edge projections, relatively movable switch contacts, and another toggle lever operable by said main lever to actuate said contacts.

2. In combination, a diaphragm movable by fluid pressure, a frame having a base adjacent said diaphragm and side wall formed integral with the base, a main toggle lever fulcrumed on the front portions of said walls and being movable by said diaphragm, a rigid plate having surface contact with said diaphragm and being provided with integral laterally spaced knife edge

projections engaging the bottom of said lever, a compression spring coacting with the top of each side of said lever approximately in the plane of the corresponding knife edge projection, a pressure equalizing bar coacting with both of said springs, an adjusting screw coacting with said bar so as to equalize the pressures on said springs, and on said projections, relatively movable switch contacts carried by said frame, and another toggle lever fulcrumed on the rear portions of said walls and cooperating with said main lever to actuate said contacts.

3. In combination, a diaphragm movable by fluid pressure, a frame having a base adjacent said diaphragm and side wall formed integral with the base, a main toggle lever fulcrumed on the front portions of said walls and being movable by said diaphragm, a rigid plate hav-

ing surface contact with said diaphragm and being provided with integral laterally spaced knife edge projections engaging the bottom of said lever, a compression spring coacting with the top of each side of said lever approximately in the plane of the corresponding knife edge projection, a pressure equalizing bar coacting with both of said springs, an adjusting screw coacting with said bar so as to equalize the pressures on said springs, and on said projections, relatively movable switch contacts carried by said frame, another toggle lever fulcrumed on the rear portions of said walls and cooperating with said main lever to actuate said contacts, and a tension spring coacting with the swinging ends of said levers midway between said compression springs.

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