Jan. 11, 1966 C. O. FINNEGAN ET AL 3,229,054

TIME DELAY SWITCH

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FIG. 1.

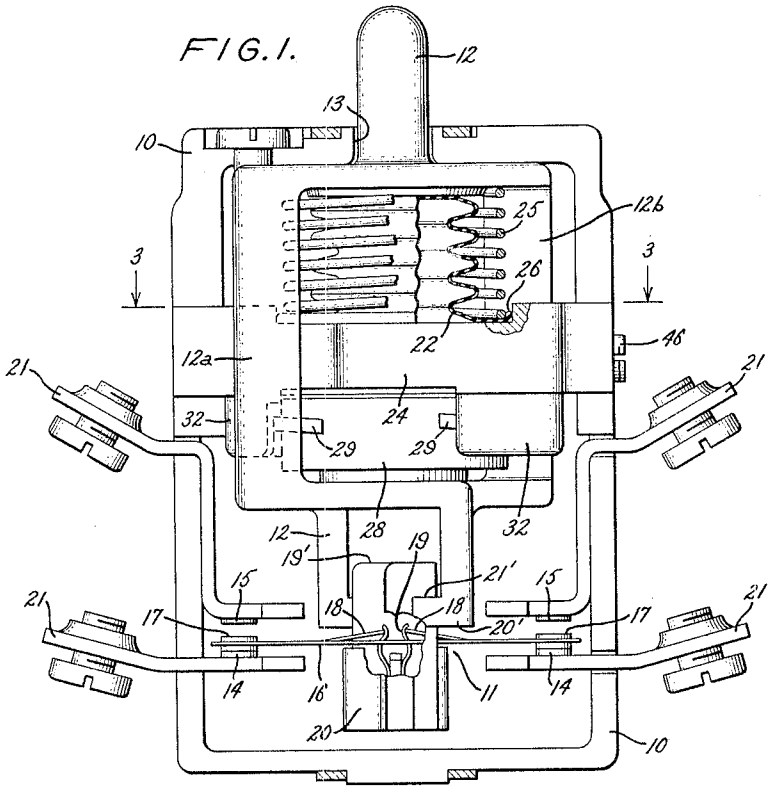
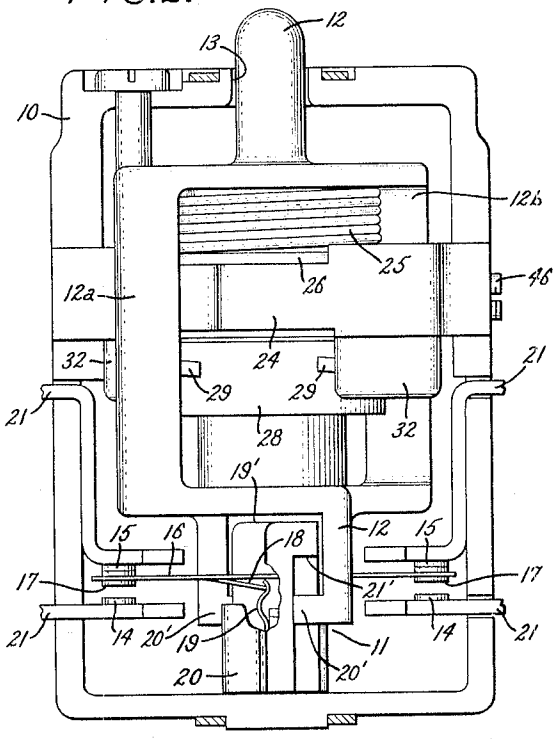


FIG. 2.



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FIG. 3.

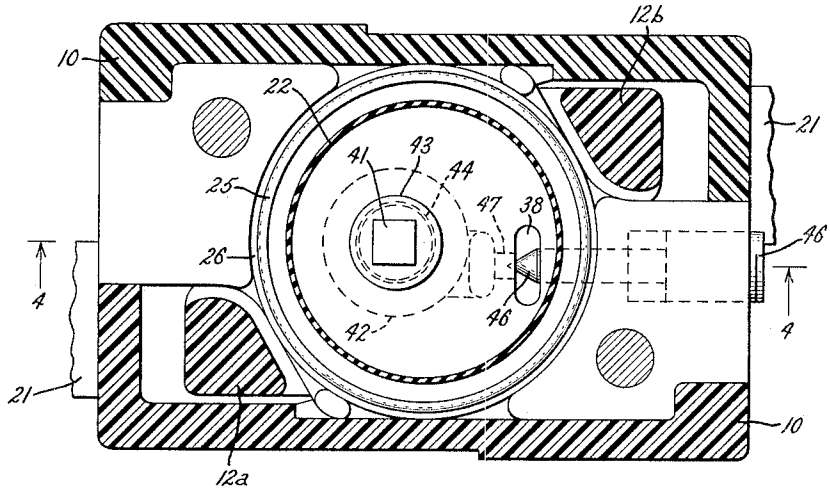
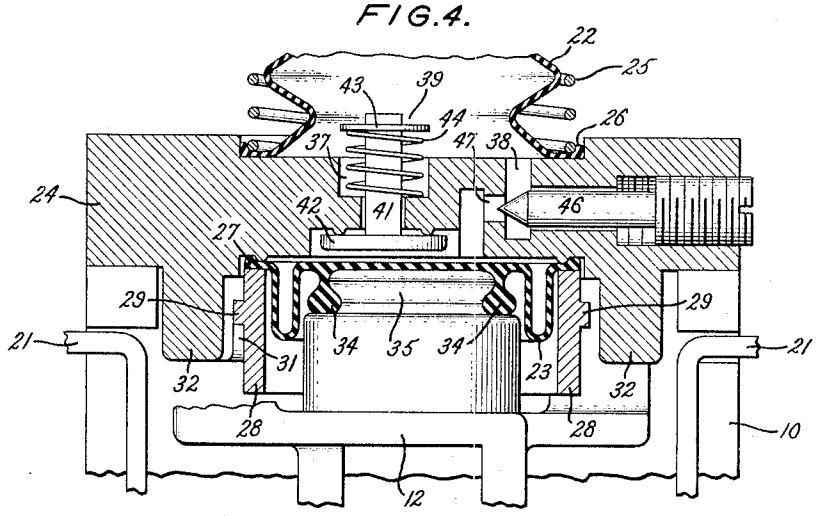


FIG. 4.



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3,229,054

TIME DELAY SWITCH

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8 Claims. (Cl. 200—33)

This invention relates to time delay switch mechanisms and more particularly to switch mechanisms in which a time delay feature is provided by the escape of a fluid through a restricted orifice.

In industrial control panels and on industrial machinery it is often desired that there be a means for timing certain functions initiated under the control of an operator. One form of such timing means is a time delay pushbutton switch which, upon actuation, initiates a timing sequence at the conclusion of which a selected operation is performed. For example, it may be desirable in starting up an industrial machine to supply energization to an electrically powered lubrication system therein before the machine itself is powered. There are, of course, many types of examples which could be cited wherein it is desirable to initiate one electrical circuit operation and, a predetermined time interval thereafter, to initiate a second or to terminate the first.

For such purposes pushbutton switches are sometimes provided with a dashpot arrangement to control the timing function of the switch. The construction and use of such time delay switches has, however, heretofore involved certain difficulties. For example, in any surroundings, but especially in an industrial environment, the internal mechanism which controls the time delay period may become dirty and clogged due to the movement of air in and out of the dashpot, thereby creating a condition which affects the length of the time delay period and which often brings about complete loss of function.

Accordingly, it is an object of this invention to provide a time delay switch mechanism subject to operator control which is capable of functioning accurately and repeatedly in many types of environment.

More specifically, it is an object of this invention to provide a time delay pushbutton switch having a time delay mechanism inherently protected against the entry of foreign matter capable of affecting the timing performance.

Briefly, in accordance with a preferred embodiment of the invention, a time delay switch is provided wherein the making and breaking of switch contacts is controlled by the rate of the flow of air between two sealed communicating bellows. The switch mechanism incorporates a movable plunger having a longitudinal opening therein, which plunger is mounted for reciprocation within the switch housing. The plunger surrounds the pair of bellows which bear against opposite ends of the longitudinal opening in the plunger and against a stationary structural member extending into the plunger opening. The two bellows, which are otherwise sealed with respect to their surrounding environment, communicate with each other through an adjustable restricted orifice in the stationary structural member. A return spring biases the plunger toward one extreme position so that one of the aforesaid bellows is normally expanded and the other normally collapsed. To operate the time delay switch, the plunger is depressed into the switch casing thereby to compress the normally expanded bellows against the bias of the spring and to force air from that bellows into the normally collapsed bellows. Simultaneously, depression of the plunger also operates a switch mechanism included within the casing. After actuation of the switch, the biasing spring tends to force the actuating plunger back to its original position, a tendency which is partially impeded and therefore delayed by the escape of air from the now expanded bellows through the restricted orifice and into the compressed bellows. The return movement of the switch actuating plunger to its original position eventually actuates the switch mechanism and restores it to its original condition. The timing operation, thus started instantaneously with initial actuation of the switch, is performed without any outside air being drawn into the bellows as in prior art devices.

The novel features believed characteristic of the invention are set forth in the appended claims. Further details of the invention, however, together with additional objects and advantages thereof may be more readily understood with reference to the following more complete description taken together with the accompanying drawings in which:

FIGURE 1 is a side view, partially cut away, of a preferred form of time delay switch constructed in accordance with this invention and showing the switch in its normal position but with part of the switch cover removed;

FIGURE 2 is a view similar to that of FIGURE 1 showing the switch mechanism with its actuating plunger depressed;

FIGURE 3 is an enlarged cross-sectional view taken on line 3—3 of FIGURE 1 but showing the switch cover in place; and

FIGURE 4 is a cross-sectional view taken on line 4—4 of FIGURE 3.

In FIGURES 1 and 2 may be seen the general construction of a preferred form of time delay switch mechanism in which a switch housing or cover **10** encloses an electrical switching assembly **11**. A reciprocating switch actuating plunger **12** extends through an aperture **13** in an upper surface of the housing. By depressing the extended end of the plunger **12**, it may be moved from the normal position shown in FIGURE 1 to the depressed position shown in FIGURE 2. Switching assembly **11** incorporates a first pair of stationary switch contacts **14** and a second pair of stationary contacts **15**. To control the electrical currents between the respective pairs of stationary contacts, a movable current-carrying bridging member **16** bearing contact elements **17** at opposite ends cooperates with the stationary contacts. Bridging member **16** incorporates a pair of inwardly directed stressed arms **18** which bear against depressions in a bearing member **19** carried by an assembly **20** at the lower end of the switch actuating plunger **12**. Movement of the switch actuating plunger downward from the position shown in FIGURE 1 to the depressed position of FIGURE 2 causes the plunger to engage the top surface **19'** of the assembly **20** to displace the assembly **20** and the bearing member **19** downward through the center of the bridging member **16** until the bearing points cross the center line of the bridging member. When this occurs, the stressed arms **18** are driven over center and thereby force the bridging member **16** to snap upwardly from the lower position in which stationary contacts **14** are bridged to the upper position shown in FIGURE 2 wherein the stationary contacts **15** are bridged.

As the switch actuating plunger **12** returns to its upper position shown in FIGURE 1, spaced inwardly directed projections **20'** at the lower end of the plunger **12** engage upper shoulders **21'** of the assembly **20** to lift the assembly whereby the contact-carrying bridging member **16** is forced to move suddenly downward with a snap-acting movement to restore the condition of the switch to that shown in FIGURE 1. The movements of bridging member **16** thus control the electrical connections between the upper and lower pairs respectively of terminal assemblies **21** which extend to the outside of the switch housing **10**. It will be seen that the initial actuation of the switch

in response to the depression of plunger **12** is almost instantaneous whereas the return or reverse operation of the switch occurs only after a predetermined and fully adjustable time delay period. This time delay is a consequence of the unique flexible bellows arrangement incorporating an upper bellows **22**, best seen in FIGURE 1, and a lower bellows **23**, best seen in FIGURE 4.

These two bellows preferably formed of a rubber like material are mounted in opposed or back-to-back arrangement on opposite sides of a central stationary support structure **24** fixed rigidly with respect to the housing **10**. The opposite ends of both bellows, however, are engaged directly by and movable with the switch actuating plunger **12**. It is to be noted that the elongated switch actuating plunger **12** contains or rather, defines an aperture therein through which the stationary support structure **24** extends and within which bellows **22** and **23** are retained. The manner in which the switch actuating plunger extends around and on both sides of the bellows arrangement is especially discernible in FIGURE 3 wherein arms **12***a* and **12***b* of the plunger are visible on opposite sides of bellows **22**. Surrounding the upper bellows **22** is a bias spring **25** which exerts a bias force upward on plunger **12**. It is to be noted that bias spring **25** traps an extending lip **26** at the lower end of bellows **22** and effectively seals the upper bellows **22** against the stationary support structure **24**. Bias spring **25** therefore fulfills the functions not only of urging the plunger **12** toward its normal position shown in FIGURE 1, but also of sealing bellows **22** against the surrounding atmosphere.

The lower bellows **23** is also sealed against the stationary support structure **24**, but in a different manner. As best seen in FIGURE 4 an outwardly extending ridge or flange **27** of the lower bellows is sealed between the stationary support structure **24** and a retainer ring **28**. The latter has on its outer surface inclined interrupted locking threads **29** which interfit with ridges **31** on downwardly extending projections **32** of the stationary support structure. The interfitting relationships between the retainer ring **28** and the stationary support structure **24** are very much in the nature of a breech plug. Bellows **23** is shown in FIGURE 4 in its normally collapsed condition to which it is urged by the action of bias spring **25** on the plunger **12**. It can been seen that the movable end of the bellows **23** incorporates an integrally molded O-ring **34** which fits tightly as a collar around a plug-like extension **35** at the lowermost extremity of the aperture in plunger **12**. Thus, a downward movement of plunger **12** not only forces bellows **22** to collapse by compressing it between the stationary structure **24** and the upper portion of plunger **12**, but also extends and expands the lower bellows **23** by pulling the integral O-ring downward and away from the stationary support structure **24**.

Neither bellows **22** nor bellows **23** communicates with the outside atmosphere. There are, however, between these two bellows connecting passageways **37** and **38** which are best seen in FIGURES 3 and 4. In passageway **37** is positioned a one-way valve **39** comprising a valve stem **41** having at one end a sealing lip **42** which seats against the periphery of aperture **37** and, at the other end, a C-ring **43** against which a biasing force is exerted by the valve spring **44** seated in a depression on the stationary support structure. An increase in pressure above the one-way valve opens the valve **39** against the bias of its light valve spring and permits the easy escape of air from the upper bellows **22** through passageway **37** into the lower bellows **23**. When the pressure differential across the valve is in an opposite direction, however, with the higher pressure below in bellows **23**, the sealing lip **42** of the one-way valve seats and effectively closes the passageway **37**. Under such conditions the sole available passageway for air to escape from lower bellows **23** into the upper is through passageway **38** To control the flow of air through passageway **38** an adjustable needle valve **46** is threaded into the stationary support structure from the side and extends into a central orifice **47** in passageway **38** thereby to vary the diameter of the orifice and its resistance to the passage of air therethrough.

It can thus be seen that manual depression of the plunger **12** effects an immediate actuation of the switching mechanism **11** since the air flows easily from the upper bellows **22** to the lower bellows **23** through the one-way valve to permit the plunger **12** to be unimpeded. The plunger **12** when released, however, does not spring back to its normal position but returns slowly under the urging of bias spring **25**. Because of the air which has been forced into the lower bellows **23** and trapped therein in the expansion of its internal volume, the lower bellows inhibits the return of the plunger **12** to its original position. Hence, plunger **12** returns slowly to the position shown in FIGURE 1 under the urging of bias spring **25** as the air escapes through the controlled orifice **47** from the lower bellows **23** into the upper bellows **22**.

The time delay switch illustrated therefore provides an instant initial actuation in response to manual control and an adjustable, time-delayed, secondary response. It provides these functions, furthermore, by means of a fully sealed time delay operating mechanism whose operation is not affected by the contaminants and particles typically found in an industrial environment.

Although but one preferred embodiment of the invention has been presented, certain variations in the details of carrying out the invention are obviously permissible. For example, the fluid contained in the bellows arrangement shown need not be air but could consist of other gases or liquids. The switch assembly illustrated, in addition is adaptable to actuation by a variety of means of which pushbuttons are but one example. As a basic switching module, this switch assembly may also be operated by a rotary cam-type control member or electrically, such as by a solenoid. Other details of construction including the arrangement of parts may also be varied. We therefore intend to cover by the following claims all such variations as fall within the true spirit and scope of the invention in its broader aspects.

What is claimed as new and is desired to be secured by Letters Patent of the United States is:

1. A mechanical time delay assembly comprising:

a hollow casing,

an actuating plunger having an aperture therein movable within said casing between first and second discrete positions,

resilient biasing means urging said plunger toward said first position,

a control mechanism actuated by movement of said plunger,

a stationary member fixed with respect to said casing and extending into said aperture,

a first flexible fluid-filled member mounted on said stationary member within said aperture in a normally expanded condition and bearing against said plunger,

a second flexible fluid-filled member mounted on said stationary member within said aperture in a normally compressed condition and bearing against said plunger,

passage-defining means communicating with the interior of both of said first and second members and providing the sole means of ingress and egress for the fluid in said first and second members,

said passage-defining means including a restricted orifice providing the sole path of escape for fluid flowing from said second member to said first member,

and means for effecting movement of said plunger relative to the casing and to the stationary member from the first to the second of said positions against the urging of said biasing means, thereby to force fluid from said first member into said second member,

whereby return actuating movement of said plunger to its first position is delayed a predetermined time

interval by the escape of fluid through said restricted orifice.

2. A time delay switch assembly comprising:
a switch casing,
a switch actuating plunger having an aperture therein and movable within said casing between first and second discrete positions,
resilient biasing means urging said plunger toward said first position,
an electrical switch mechanism actuated by movement of said plunger,
a stationary member fixed with respect to said casing extending into said aperture,
a first flexible fluid-filled member mounted on one side of said stationary member within said aperture in a normally expanded condition and bearing against said plunger,
a second flexible fluid-filled member mounted on the other side of said stationary member within said aperture in a normally compressed condition and bearing against said plunger,
said stationary member containing passage means communicating with the interior of both of said first and second members and providing the sole means of ingress and egress for the fluid in said first and second members, said passage means including a restricted orifice providing the sole path of escape for fluid flowing from said second member to said first member, and
means for effecting movement of said plunger from the first to the second of said positions against the urging of said biasing means, thereby to force fluid from said first member into said second member,
whereby return switch actuating movement of said plunger to its first position is delayed a predetermined time interval by the escape of fluid through said restricted orifice.

3. A time delay switch assembly comprising:
a switch casing,
a switch actuating plunger having an aperture therein and movable within said casing between first and second positions,
a switch mechanism actuated in response to movement of said plunger,
a stationary member fixed with respect to said casing and extending into said aperture,
a first flexible fluid-filled member mounted on one side of said stationary member within said aperture in a normally expanded condition and bearing against said plunger,
spring means surrounding said first member and urging said plunger toward said first position,
a second flexible fluid-filled member mounted on the other side of said stationary member within said aperture in a normally compressed condition and bearing against said plunger,
a one-way valve providing a low resistance path of escape for fluid flowing from said first member into said second member but blocking reverse flow of fluid therethrough,
means defining a reduced orifice providing a high resistance path of escape for fluid flowing from said second member into said first member,
said valve and said orifice providing the sole means of ingress and egress for the fluid in either of said first and second members,
and means for effecting the movement of said plunger relative to the casing and to the stationary member from the first to the second of said positions against the urging of said spring means and in a direction to force fluid to flow from said first member into said second member through said one-way valve,
whereby return switch actuating movement of said plunger to its said first position is delayed a predetermined time interval by the escape of the fluid through said restricted orifice.

4. A time delay switch assembly comprising:
a switch casing,
a switch actuating plunger having an aperture therein and movable within said casing between first and second actuating positions,
a switch mechanism actuated to different states in response to the movement of said plunger between said positions,
a stationary member fixed with respect to said casing extending into said aperture,
a first hollow expansible and contractible fluid-filled element mounted on one side of said stationary member within said aperture in a normally expanded condition and having an end bearing against said plunger,
spring means surrounding said first hollow element and urging said plunger toward said first position,
a second hollow expansible and contractible flexible fluid-filled element mounted on the other side of said stationary member within said aperture in a normally compressed condition and having an end connected to said plunger,
said stationary member having a passage connecting said hollow elements,
a one-way valve in said passage providing a low resistance path of escape for fluid flowing from said first hollow element into said second hollow element but blocking reverse flow of fluid therethrough,
said stationary member also having a reduced orifice providing a high resistance path of escape for fluid flowing from said second hollow element into said first hollow element,
said valve and said orifice providing the sole means of ingress and egress for the fluid in either of said elements,
and means for effecting movement of said plunger relative to the casing and to the stationary member from the first to the second of said positions against the urging of said spring means and in a direction to force fluid to flow from said first element into said second element through said one-way valve,
whereby return switch actuating movement of said plunger to its said first position is delayed a predetermined time interval by the escape of the fluid through said restricted orifice.

5. A time delay switch assembly comprising:
a switch casing,
a switch actuating member having an aperture therethrough and movable within said casing between first and second positions,
a switch mechanism actuated in response to movement of said switch actuating member,
a stationary support member fixed with respect to said casing extending through said aperture,
a first flexible fluid-filled member mounted on one side of said stationary support member within said aperture in a normally expanded condition and having an end bearing against said actuating member,
spring means surrounding said first member and extending between said support member and said actuating member to urge the actuating member toward said first position,
a second flexible fluid-filled member mounted on the other side of said stationary support member within said aperture in a normally compressed condition and having an end connected to said actuating member,
said support member having a passage connecting said first and second members,
a one-way valve in said passage providing a low resistance path of escape for fluid flowing from said first member into said second member but blocking reverse flow of fluid therethrough,

said stationary member also having a reduced orifice providing a high resistance path of escape for fluid flowing from said second member into said first member,

a needle valve mounted by said support member for adjustment from outside said casing to permit variable restriction of said orifice,

said valve and said orifice-defining means providing the sole means of ingress and egress for the fluid in either of said first and second members,

and means for effecting movement of said actuating member relative to the casing and to the support member from the first to the second of said positions against the urging of said spring means and in a direction to force fluid to flow from said first member into said second member through said one-way valve,

whereby return movement of said actuating member to its said first position is delayed a predetermined time interval by the escape of the fluid through said restricted orifice.

6. A time delay switch assembly comprising:

a switch casing,

a switch actuating plunger having an aperture and movable within said casing between first and second positions,

a support secured to said casing and extending through said aperture,

a first flexible element having a closed end and having an open end with a laterally extending lip adjacent the closed end,

said first element being mounted on one side of said support within said aperture with its open end adjacent the support and with its closed end bearing against the plunger,

a spring surrounding said first element engaging said lip and said plunger to seal the first element against the support and to urge the plunger toward said first position,

a second flexible element mounted on the other side of said support within said aperture and having an open end adjacent the support, said second element having its other end connected to said plunger,

said support having a passage communicating with the interior of said first and second elements,

a one-way valve in said passage providing a low resistance path of escape for fluid flowing from said first element into said second element but blocking reverse flow of fluid therethrough,

said support also having a reduced orifice providing a high resistance path of escape for fluid flowing from said second element into said first element,

said valve and said orifice providing the sole means of ingress and egress for the fluid in either of said elements,

and means for effecting movement of said plunger relative to said casing and to said support from the first to the second of said positions against the urging of said spring and in a direction to force fluid to flow from said first element into said second element through said one-way valve,

whereby return switch actuating movement of said plunger to its first position is delayed a predetermined time interval by the escape of the fluid through said restricted orifice.

7. A time delay switch assembly comprising:

a switch casing,

a switch actuating plunger having an aperture and movable within said casing between first and second positions,

a support secured to said casing and extending through said aperture,

a first flexible element having a closed end and having an open end with a laterally extending lip adjacent the closed end,

said first element being mounted on one side of said support within said aperture with its open end adjacent the support and with its closed end bearing against the plunger,

a spring surrounding said first element engaging said lip and said plunger to seal the first element against the support and to urge the plunger toward said first position,

a second flexible element having an open end and having an O-ring integrally formed thereon at its other end, said second element being mounted on the other side of said support within said aperture with its open end adjacent the support,

an extension on said plunger within said aperture surrounded by said O-ring to connect said other end of the second element to said plunger,

said support having a passage communicating with the interior of said first and second elements,

a one-way valve in said passage providing a low resistance path of escape for fluid flowing from said first element into said second element but blocking reverse flow of fluid therethrough,

said support also having a reduced orifice providing a high resistance path of escape for fluid flowing from said second element into said first element,

said valve and said orifice providing the sole means of ingress and egress for the fluid in either of said elements,

and means for effecting movement of said plunger relative to said casing and to said support from the first to the second of said positions against the urging of said spring and in a direction to force fluid to flow from said first element into said second element through said one-way valve,

whereby return switch actuating movement of said plunger to its first position is delayed a predetermined time interval by the escape of the fluid through said restricted orifice.

8. A time delay switch assembly comprising:

a switch casing,

a switch actuating plunger having an aperture and movable within said casing between first and second positions,

a support secured to said casing and extending through said aperture,

a first flexible element having a closed end and having an open end with a laterally extending lip adjacent the closed end,

said first element being mounted on one side of said support within said aperture with its open end adjacent the support and with its closed end bearing against the plunger,

a spring surrounding said first element engaging said lip and said plunger to seal the first element against the support and to urge the plunger toward said first position,

a second flexible element having an open end and having an O-ring integrally formed thereon at its other end, said second element being mounted on the other side of said support within said aperture with its open end adjacent the support,

an extension on said plunger within said aperture surrounded by said O-ring to connect said other end of the second element to said plunger,

said support having a passage communicating with the interior of said first and second elements,

a one-way valve in said passage providing a low resistance path of escape for fluid flowing from said first element into said second element but blocking reverse flow of fluid therethrough,

said support also having a reduced orifice providing a high resistance path of escape for fluid flowing from said second element into said first element,

said valve and said orifice providing the sole means

of ingress and egress for the fluid in either of said elements,

means for effecting movement of said plunger relative to said casing and to said support from the first to the second of said positions against the urging of said spring and in a direction to force fluid to flow from said first element into said second element through said one-way valve,

whereby return switch actuating movement of said plunger to its first position is delayed a predetermined time interval by the escape of the fluid through said restricted orifice,

a needle valve mounted by said support for adjustment from outside said casing to permit variable restriction of said orifice,

a movable bridging contact member carried by said plunger,

and a pair of spaced fixed contacts on each side of said casing cooperating with said bridging contact.

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