United States Patent

[11] **3,551,615**

[72] Inventor **John J. Dennison**
Southington, Conn.

[21] Appl. No. **827,323**
[22] Filed **May 23, 1969**
[45] Patented **Dec. 29, 1970**
[73] Assignee **Arrow-Hart, Inc.**
Hartford, Conn.
a corporation of Connecticut

[54] **PNEUMATIC TIME DELAY SWITCH WITH IMPROVED DASHPOT STRUCTURE**
4 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **200/34, 188/95**
[51] **Int. Cl.** **H01h 7/03**
[50] **Field of Search** 200/34; 188/95; 318/485; 335/61, 240; 337/127; 251/48, 50, 52, 54, 55; 137/514, 515, 516

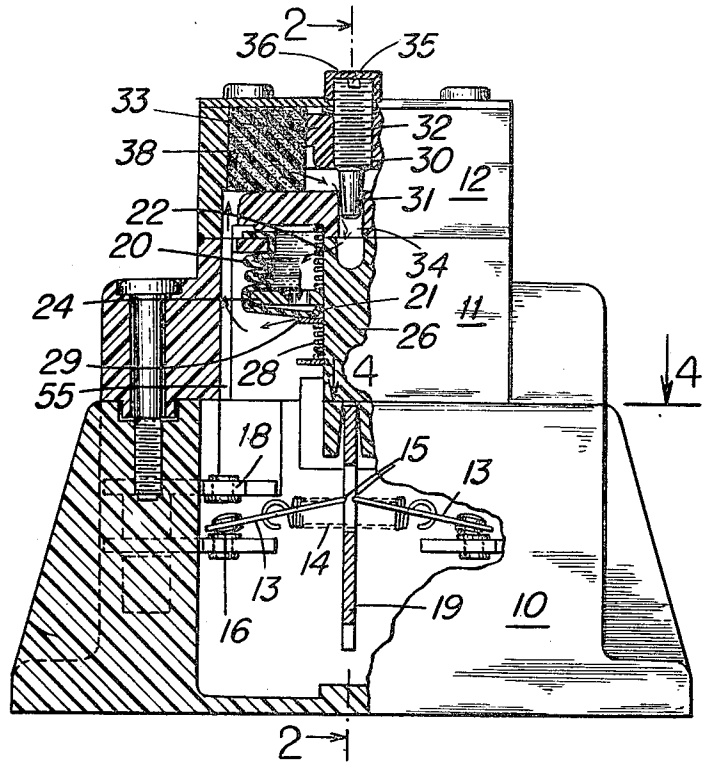
[56] **References Cited**

UNITED STATES PATENTS

2,543,090	2/1951	Ballou	200/34
2,866,862	12/1958	Bachi	200/34
2,996,155	8/1961	Priesemuth	200/34X
3,178,524	4/1965	Frisk	200/34
3,268,675	8/1966	Willcox	200/34

Primary Examiner—Robert K. Schaefer
Assistant Examiner—J. R. Scott
Attorney—Davis, Hoxie, Faithfull & Hapgood

ABSTRACT: An electrical switch includes a pneumatic time delay mechanism to provide a delay between movement of the actuator and transfer of the contacts. The pneumatic mechanism is vented to ambient air pressure until movement of the actuator to insure repeatability of the delay time irrespective of the frequency of actuation.



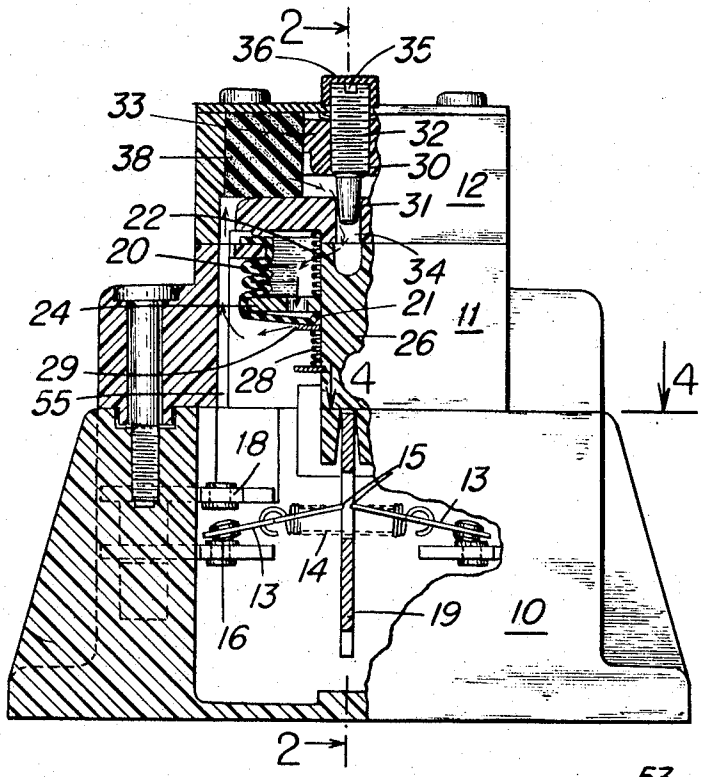


FIG. 1

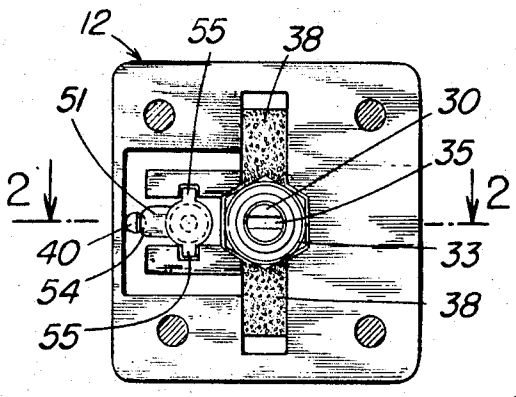


FIG. 3

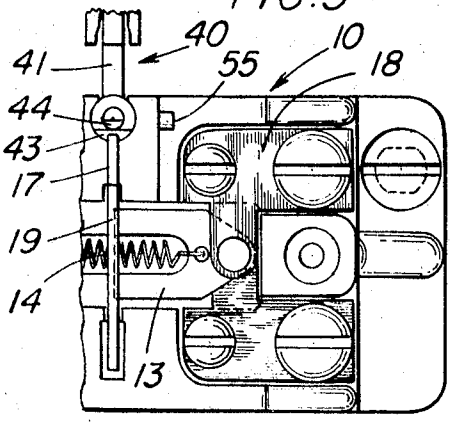
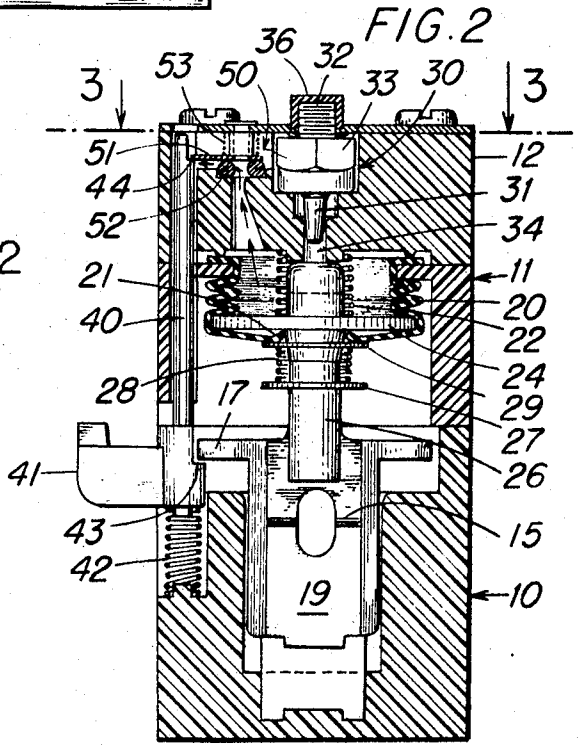


FIG. 4

FIG. 2



INVENTOR.
John J. Dennison
By Davis, Hoxie, Faithfull & Hapgood
Attorneys

PNEUMATIC TIME DELAY SWITCH WITH IMPROVED DASHPOT STRUCTURE

The present invention is concerned with a switch which pneumatically provides an adjustable delay between movement of the actuator and movement of the contacts. The switch contacts can be arranged to make contact, break contact, or change to a second contact after the delay. The switch assembly is useful for motor starting where windings are connected in a time sequence. It also can be used to establish a minimum recycle time for such applications as refrigeration compressors.

According to the present invention, movement of an actuator frees a spring loaded bellows to expand at a rate determined by an adjustable air inlet flow control. The expanding bellows cause the switch contacts to change their position to accomplish the switching function.

Since the time delay is determined by the rate at which air is permitted to enter the bellows, air remaining in the bellows in their initial or collapsed state will cause a variation in the time of delay dependent upon the completeness of the previous air exhaustion from the bellows. The degree of exhaustion of bellows air depends, in part, upon the frequency of actuation. Long intervals permit the escape of residual air whereas short intervals may not. Thus, the time delay may be irregular.

The present invention provides a solution to the problem of delay irregularity due to residual air by providing a valve structure which opens after completion of the delay function to exhaust the bellows thereby insuring that the device is reset to the same initial bellows condition every time the delay function is completed.

In the drawings:

FIG. 1 is an elevational view partially in section of a switch according to the present invention;

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

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

FIG. 4 is a sectional view taken along line 4–4 of FIG. 1.

Referring now to the drawings, particularly FIG. 1, the switch mechanism of the present invention is housed in a three part case comprising a lower portion 10, an intermediate portion 11, and an upper portion 12. The housing portions are assembled with screws. Lower portion 10 includes a pair of moving contact blade members 13 associated with a spring 14 which provides toggle action to bias the moving contact blade members 13 upwardly or downwardly against fixed contacts in a conventional manner. Fixed contact members 16 and 18 are affixed to the lower portion 10 such that the moving contact blade members can establish spring-biased contact with the fixed contacts. In the switch assembly illustrated in FIG. 1, the normal condition completes the circuit with fixed contacts 16. A vertically reciprocable blade carrier 19 having blade receiving grooves 15 is located between the pair of contact blade members 13 such that downward motion of the blade carrier 19 from the position illustrated in FIG. 1 will cause the contact blade members 13 to snap over to establish contact with fixed contacts 18.

Intermediate housing portion 11 includes a bellows member 20 which is formed of elastomeric material. Within bellows 20 is an actuator spring 22 which acts downwardly against a disc member 24 affixed to or integral with a plunger 26. Spring 22 tends to urge the plunger downwardly to cause actuation of the switch contacts. Another spring 28 bears against an annular washer member 27 associated with the plunger 26. Spring 28 is arranged to bias a movable annular washer member 29 upwardly of the plunger 26 against the lower edge portion 21 of the bellows member 20 to urge the bellows edge 21 against the disc 24 to form therewith a check valve.

The upper housing portion 12 includes an air inlet plug valve member 30 having a tapered plug portion 31 and having a portion 32 in threaded association with an insert member 33 affixed in upper housing portion 12 to permit vertical position adjustment of the tapered portion 31. The vertical adjustability of plug valve member 30 permits a variable clearance between the tapered portion 31 and the bore 34 into which it fits. This clearance provides an air inlet orifice of variable dimension leading to the interior of the bellows member 20. A pad of filter material 38 such as polyurethane foam is included in the upper housing portion 12 and serves to clean the air before it enters the clearance space about the tapered portion 31 of valve member 30. Adjustment of plug valve 30 is accomplished by a screwdriver slot 35 in the protruding threaded portion 32. A cover 36 may be provided to discourage tampering with the adjustment and for protection.

As is best illustrated in FIG. 2, the switch mechanism is actuated by an actuator member 40 having a portion 41 which protrudes from an appropriate opening in the lower housing portion 10 to be engageable by an external device. Actuator member 40 is a rod vertically reciprocable within a vertical bore in the housing and is biased upwardly by a spring 42. Blade carrier 19 has a projection 17 which engages a ledge 43 on the actuator 40 such that spring 42 exerts upward force on the blade carrier when the mechanism is returning to its normal position after the actuator is released.

Upper housing member 12 includes a reset valve unit 50 which comprises a valve plate 51 which seats against an elastomeric O-ring 52 and is biased into sealing relationship therewith by means of a spring 53 which exerts a downward force against the valve plate 51. Reset valve 50 is in communication with the interior of the bellows via a passage 15 formed in the upper housing member 12. The valve plate 51 includes a portion 54, best illustrated in FIG. 3, which portion extends horizontally to be engaged by a ledge 44 near the top of the actuator rod 40 such that valve plate 51 may be canted to unseat the plate 51 from the O-ring 52 to open the valve 50 when the actuator 40 has returned to its uppermost or rest position. Small projecting ears or lugs 55 fit within grooves in housing member 12 to retain valve plate 51 in position with respect to O-ring 52 while permitting tilting or canting motion of the plate.

Operation of the device will now be described. The switch mechanism is illustrated in its normal or initial position. Downward movement of actuator 40 initiates the time delay sequence which results in transfer of the moving contact blades 13 from fixed contact 16 to fixed contacts 18. Contact with fixed contacts 18 prevails until the actuator 40 is released. When actuator 40 has been moved downwardly against the spring 42, ledge 43 is moved out of engagement with projection 17 of blade carrier 19 thereby freeing blade carrier 19 for downward movement. Spring 22 within the bellows 20 exerts a downward force on disc 24 and plunger 26 to move the plunger and blade carrier 19 downwardly. This motion is resisted by the extension of the bellows 20 creating therein a subatmospheric pressure. Air is permitted to enter the bellows through the adjustable orifice whose dimensions are determined by the adjustment of inlet air valve 30. Air traversing the clearance between tapered plug portion 31 and bore 34 enters bellows 20 relieving the subatmospheric pressure at a rate determined by the setting of air inlet valve 30. As bellows 20 is permitted to extend under the urging of spring 22, blade carrier 19 proceeds downwardly causing contact blades 13 to rise to a horizontal position. In so doing, blade spring 14 is stretched. Spring 14 provides an overcentering toggle action which causes the blades 13 to snap upwardly against fixed contacts 18 accomplishing the desired contact change. The time between depression of the actuator and snapping of the moving contact blades is the delay time. It is apparent that this time can be set to that desired by adjustment of the valve 30. Switch devices made in accordance with the present invention have delay capabilities of up to about five minutes.

The switch mechanism is returned to its initial condition by release of downward force on actuator 40. Spring 42 urges the actuator upwardly such that ledge 43 engages projection 17 of blade carrier 19. Spring 42 has a spring rate adequate to overcome spring 22 and the downward component derived from spring 14 with the result that blade carrier 19 moves upwardly

and plunger **26** collapses bellows **20**. The moving contact blades **13** snap back to their initial position in contact with fixed contacts **16**. The return to the initial condition is rapid.

Air within bellows **20** is compressed as the bellows is collapsed. The resulting superatmospheric pressure deflects bellows edge **21** downwardly against spring biased washer **29**. Deflection of edge **21** creates a passage for the compressed air to escape between plunger **26** and the surrounding bellows edge **21**. Edge **21**, washer **29**, spring **28**, and the surface of plunger **26** cooperate to form a check valve which relieves superatmospheric pressure within the bellows but seals against ingress of air when the bellows interior is subatmospheric during the delay function.

Because of the elasticity of edge **21** and the bias of spring **28**, this check valve will close before the pressure within the bellows has completely returned to atmospheric pressure. This remaining air pressure must be vented to reestablish the initial condition with certainty. Without venting provision for this residual air pressure, the residual pressure in the bellows will only slowly approach atmospheric pressure, thereby creating a condition of an initial bellows pressure which is a variable dependent upon the time between actuations of the device. A variation in initial conditions causes an undesirable irregularity in the delay time.

Applicant provides a reset valve structure **50** to prevent the above residual pressure condition. Near the end of the upward travel of actuator rod **40**, ledge **44** engages horizontally extending portion **54** of valve plate **51**. Continued upward motion of the actuator **40** causes a canting or tilting of the valve plate to unseat it from the elastomeric ring **52**. A venting passage **15** for residual air pressure in the bellows is thereby opened to reset the bellows to atmospheric pressure. The passage remains open until the actuator **40** is depressed to initiate a new cycle. A small spring **53** recloses reset valve **50** immediately upon actuation.

Because switch devices are frequently employed in unclean environments, applicant provides filter means **38** which may be polyurethane foam pads to clean the air prior to its passage through the adjustable inlet valve orifice. To further promote cleanliness, the air used in the pneumatic system recirculates within the system. This permits hermetic enclosure of the moving parts of the switch if desired. Where hermetic sealing is not necessary, recirculation of air obviates the need to introduce unclear external air to the interior of the device. The path of air circulation is illustrated in FIG. 1 by arrows. Air travels past adjustable plug valve **50** into the bellows interior. Upon release of the actuator, air exits from the bellows by passing through an aperture in disc **24** and then passing between edge **21** and plunger **26**. At the completion of a cycle, residual air in the bellows is exhausted to the interior of the housing through reset valve **50**. The air is drawn from the interior of the housing through passage **55** and through filter **38** when the bellows are being extended.

The above-described device provides a pneumatic time delay switch having a repeatable time delay of great accuracy. The delay is adjustable over a wide range of times. By recirculating and filtering the air used by the pneumatic system, the device is insensitive to the cleanliness of its environment. The arrangement of the moving contact blades provides rapid and positive contact establishment and maintains adequate contact pressure with the resulting benefits of reduced arcing, contact sticking, and insensitivity to shock and vibration.

I claim:

1. An adjustable delay time electrical switch having first and second positions, at least one of said positions having fixed electrical contacts, electrical contacts movable between the first position and the second position, a movable actuator member for initiating transfer of the movable contacts, and a pneumatic time delay device for effecting a delay of contact transfer subsequent to actuator movement, said time delay device comprising a bellows spring biased to extend subsequent to actuator movement, said bellows being collapsible upon actuator release, said bellows being associated with the movable contacts to effect their movement to the second position upon extension, an inlet orifice to admit air at a selected rate to the interior of the bellows during their extension, the rate of air admission being determinative of the delay time, a pressure responsive check valve for exhausting air under pressure from the interior of the bellows during the collapse, and a reset valve which vents the interior of the bellows to maintain ambient pressure when they are collapsed, said check valve and said reset valve being arranged to close upon extension of the bellows.

2. A switch according to claim **1** wherein the reset valve includes a valve plate spring biased toward sealing engagement with a resilient ring surrounding the terminal end of a vent passage in communication with the interior of the bellows, and wherein the actuator member has a portion adapted to displace said valve plate when the actuator is in its released position to interrupt said sealing engagement.

3. A switch according to claim **2** wherein filtering means are provided on the intake side of said adjustable inlet orifice.

4. A switch according to claim **3** wherein air exhausted through the bellows check valve and the reset valve is recirculated to the adjustable inlet orifice through the filtering means.