

Nov. 20, 1962

C. D. AINSWORTH

3,065,321

VACUUM SWITCH ACTUATED BY FLUID PRESSURE IMPULSE MEANS

Filed Nov. 6, 1959

Fig. 2

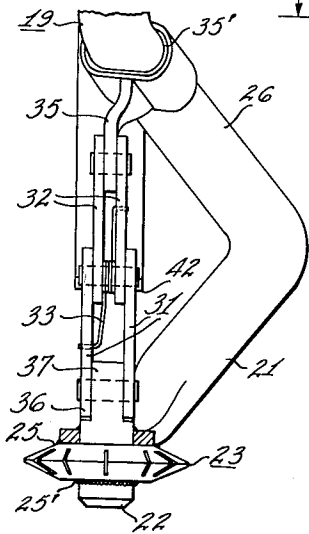
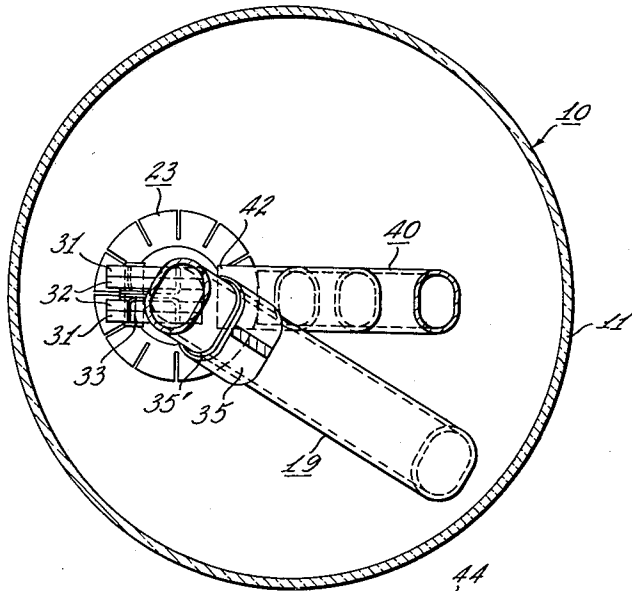


Fig. 3

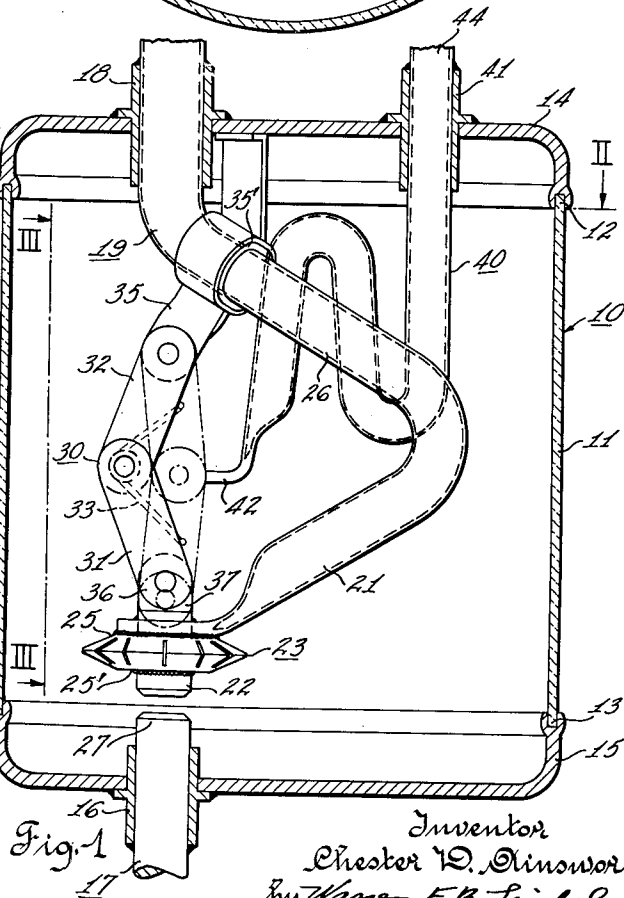


Fig. 1

Inventor
Chester D. Ainsworth
By Wm. F. B. Fidelity
Attorneys

1

2

3,065,321

VACUUM SWITCH ACTUATED BY FLUID PRESSURE IMPULSE MEANS

Chester D. Ainsworth, Milton, Mass., assignor to Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
 Filed Nov. 6, 1959, Ser. No. 851,390
 11 Claims. (Cl. 200-144)

This invention relates to electric devices employing a movable element therein and more particularly to a new and improved vacuum switch employing relatively movable cooperating contacts which are actuated by fluid under pressure.

Heretofore electric devices such as vacuum switches employed a plurality of sliding members for controlling the axial and lateral movement of the movable contacts. These sliding members not only are costly to manufacture but require bearings and make the vacuum switch highly susceptible to shock and vibration. Further, the axial movement of a movable contact extending through a bellows attached in fluid tight engagement to the walls of a vacuumized envelope makes the envelope susceptible to air leakage and increases the possibility of a short life for the switch.

In accordance with the invention claimed there is provided a new and improved electrical device such as an electric switch, a vacuum condenser or an electron discharge device comprising in combination an envelope and a hollow member extending within the envelope. The hollow member employs a deformable portion arranged within the envelope for movement from a first position to a second position upon application of fluid under pressure to the interior of the member. The deformable portion returns to its first position upon predetermined reduction of fluid pressure therewithin. As set forth in some of the claims the deformable portion of the hollow member may comprise one of a pair of cooperating contacts arranged within the vacuumized envelope. An overcenter toggle is arranged within the envelope and connected at one end to the movable end of the hollow member and at the other end to a fixed member of the electrical device within the envelope. The toggle is biased to its overcenter position when the hollow member is deformed to contact closed position. Means are arranged to extend into the envelope through an opening therein for engaging the toggle when in its overcenter position and biasing it back to its collapsed position.

It is, therefore, one object of this invention to provide a new and improved electric device embodying an enclosing envelope in which a hollow member extending therein is caused to deform to perform a useful function.

Another object of this invention is to provide a new and improved device of the character described in which a hollow, deformable contact member mounted for movement within a vacuumized envelope and actuated by internal pressure is retained in contact closed position when moved thereto and released at will for movement to contact open position upon predetermined reduction of said internal pressure.

A further object of this invention is to provide a new and improved vacuumized electric switch in which an overcenter toggle is utilized to retain a hollow, deformable contact member in contact closed position when said contact member is actuated thereto by a fluid impulse applied to the hollow interior thereof.

A still further object of this invention is to provide a new and improved vacuumized electric switch in which an overcenter toggle is utilized to retain a hollow, deformable contact member in contact closed position and a second hollow, deformable member within the envelope is arranged to deform and engage the toggle to collapse it.

A still further object of this invention is to provide a

new and improved vacuumized electric switch in which an overcenter toggle is utilized to retain a hollow, deformable contact member in contact closed position and a second hollow, deformable member within the envelope is arranged to form a stop for the toggle in its overcenter position and to engage and collapse the toggle when the second member is deformed by internal pressure.

Objects and advantages other than those set forth will be apparent from the following description when read in connection with the accompanying drawing, in which:

FIG. 1 is an elevational view partly in axial section of a vacuum switch embodying the invention;

FIG. 2 is a top cross sectional view of FIG. 1 taken along the line II—II; and

FIG. 3 is a partial cross sectional end view of FIG. 1 taken along the line III—III.

Referring more particularly to the drawing by characters of reference FIG. 1 illustrates an electric switch 10 comprising a cylindrical envelope 11 which may be formed, for example, of a suitable vitreous material. The ends of envelope 11 are provided with annular rims 12 and 13 to which are fixedly secured in gas tight connection thereto metallic caps 14 and 15, respectively. The caps 14 and 15 may be relatively flat and protruding, as shown or reentrant if so desired.

Cap 15 supports in gas tight connection therewith a contact mounting or bushing 16 to which is secured in gas tight connection one end of a fixed contact member 17. Contact member 17 is arranged to extend longitudinally of envelope 11 and is substantially rigidly supported so as to restrict longitudinal or lateral movement thereof. Cap 14 supports in gas tight connection therewith a contact mounting or bushing 18 to which is fixedly secured in gas tight connection a hollow fluid conducting contact member 19. Contact member 19 is arranged to extend into envelope 11 longitudinally thereof and is substantially rigidly supported so as to restrict longitudinal or lateral movement thereof at the point at which it enters envelope 11. Either of caps 14 or 15 supports a tubular venting passage (not shown) through which envelope 11 may be evacuated and sealed off in the usual way.

The hollow, tubular, deformable curved member 19 comprises a relatively fixed first hollow portion 26 and a relatively movable hollow, tubular, deformable second portion 21 both together called a hollow deformable arm portion, an arcing tip portion 22 and a resilient unitary diaphragm spring washer or portion 23. Although curved member 19 may be of any geometrical cross sectional area an oval cross sectional area is preferable. The upper portion 25 of the unitary diaphragm type spring washer 23 is conductively secured to the end of the second portion 21 of the curved member 19. To the lower portion 25' of washer 23 the arcing tip 22 is conductively secured. The arm portion is connected in vacuum tight seal to the envelope and particularly cap 14 through bushing 18 and is normally curved and biased to contact open position and deformable to contact closed position. When suitable fluid under pressure, such as air, is applied to the open end of hollow, tubular contact member 19 outside of the confines of envelope 11, the deformable arm portion is flexed or actuated for movement through an arcuate path from a first curved location in contact open position to a second less curved contact engaging position in contact with the arcing tip 27 of relatively stationary contact 17.

Upon movement to contact closed position the arcing tip portion 22 engages the arcing tip 27 of stationary contact 17 whereupon the diaphragm spring portion 23 is compressed until a contact retaining means is actuated for keeping or locking the contact elements 17 and 19 in contact closed position.

The contact retaining means may comprise, as shown by way of example in the drawing, a latching toggle 30

comprising a pair of pivotally connected toggle arms 31 and 32 and a spring 33. Toggle arm 32 is pivotally connected at its free end to a bracket 35. Bracket 35 is fixedly attached to the inside of envelope 11 and more particularly to the inside of cap 14. In order to support contact member 19 bracket 35 and a resilient insert pad 35' arranged within the contact surrounding portion of bracket 35 are arranged to surround and hold contact element 19 firmly adjacent bearing 18. The free end 36 of toggle arm 31 is pivotally connected to the bifurcated end 37 of the relatively movable end of contact element 19. Spring 33 is connected in the usual manner to bias toggle 30 to its overcenter position. When the contact element 19 is biased to contact closed position by fluid under pressure the toggle 30 is biased to its overcenter position by spring 33 (shown in dot dash lines in FIG. 1) thereby locking contact elements 17 and 19 in contact closed position and permitting immediate cessation of the fluid pressure.

In order to collapse toggle 30 a hollow, tubular, deformable disengaging member 40 is provided to extend into envelope 11 through cap 14. Member 40 may have any suitable cross sectional area configuration although an oval cross sectional shape is preferable. Cap 14 supports a bushing 41 to which is secured in vacuum tight engagement one end of member 40. The other end of member 40 is closed and comprises a prong 42 arranged in the path of movement of toggle 30 to function as a stop for toggle 30 when in its overcenter position. When suitable fluid under pressure, such as air which may be, for example, in the form of a pulse or of a longer duration, is applied to the open end 44 of member 40 inside of the confines of envelope 11 the deformable portion of the hollow, tubular, member 40 flexes and moves the end or prong 42 thereof against toggle 30 forcing it backwards through its center position thereby releasing tubular member 19 and permitting the retracting bias of tubular member 19 to return it and its arcing tip portion 22 to contact open position, against the bias of spring 33.

The use of the Bourdon tube principle of straightening out a curved section of a hollow tube closed at one end by the application of fluid under pressure thereto makes it possible to interrupt high voltage circuits in a vacuumized envelope with the usual contact gap of about 1 kv. per mil without requiring axial movement of the movable contact member through the vacuumized envelope. As noted from FIGS. 1-3 of the drawing cooperating contact members 17 and 19 perform their opening and closing switching function without the use of a flexible seal such as bellows or diaphragms. No sliding movable contacts are required. Thus, the prior art bearings, guiding means and the associated shunt current conducting braids are eliminated.

In accordance with the invention claimed the vacuum switch 10 is closed by forcing fluid under pressure, for example, an impulse of a relatively short duration into hollow, tubular, deformable contact member 19. The hollow arm portion thereof deforms by tending to straighten out causing the arcing tip portion 22 to engage the arcing tip portion 27 of the stationary contact element 17. When arcing tip portion 22 engages the arcing tip portion 27 the resilient diaphragm spring 23 compresses. This action makes possible some overtravel of the movable arm portion of contact element 19 and insures a strong, firm contact tip engagement of the two contact elements in contact closed position. Upon such overtravel of the movable arm portion the latching toggle is actuated by the toggle closing bias of spring 33 to its overcenter position thereby firmly holding contact elements 17 and 19 in contact closed position. When it is desired to actuate the contact elements to contact open position fluid under pressure is applied to the tubular, deformable member 40 which tends to straighten out and moves transversely to the longitudinal length of the toggle 30 thereby engaging toggle 30 and forcing it back-

wards through its center position from which position it will be biased back to its initial contact open position by the retractive force within its arcuate structure, against the bias of spring 33.

Although but one embodiment of the present invention has been illustrated and described it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

Having now particularly described and ascertained the nature of my said invention and the manner in which it is to be performed, I declare that what I claim is:

1. An electric device comprising a vacuumized envelope, a pair of relatively movable cooperating contacts mounted within said envelope, at least one of said contacts comprising a hollow member extending into said envelope through an opening therein, said member being connected in vacuum tight seal to said envelope and comprising a contact engaging portion within said envelope which is biased to contact open position and deformable to contact closed position, means for applying fluid under pressure to the interior of said member outside of said envelope for deforming said portion to contact closed position, passive retaining means arranged within said envelope for keeping said member in contact closed position when actuated thereto by said pressure means, and disengaging means arranged adjacent said retaining means within said envelope for releasing said retaining means causing said member to move to its contact open position.

2. An electric device comprising a vacuumized envelope, a pair of relatively movable cooperating contacts mounted within said envelope, at least one of said contacts comprising a hollow member extending into said envelope through an opening therein, said member being connected in vacuum tight seal to said envelope and comprising a contact engaging portion within said envelope which is biased to contact open position and deformable to contact closed position, means for applying an impulse of fluid under pressure to the interior of said member outside of said envelope for deforming said portion to contact closed position, passive means arranged within said envelope for only retaining said portion in contact closed position when actuated thereto by said pressure means, and disengaging means arranged adjacent said passive means within said envelope for releasing said passive means causing said member to move to its contact open position.

3. An electric device comprising a vacuumized envelope, a pair of relatively movable cooperating contacts mounted within said envelope, at least one of said contacts comprising a hollow member extending into said envelope through an opening therein, said member being connected in vacuum tight seal to said envelope and comprising a contact engaging first portion within said envelope which is biased to contact open position and deformable to contact closed position, means for applying gas under pressure to the interior of said member outside of said envelope for deforming said first portion to contact closed position, an overcenter passive toggle arranged within said envelope and connected at one end to the movable end of said member, said toggle being biased to its overcenter position when said member is deformed to contact closed position to retain said member in contact closed position, and means extending into said envelope through an opening therein for engaging said toggle when in its overcenter position and biasing it back to its collapsed position.

4. An electric device comprising a vacuumized envelope, a pair of relatively movable cooperating contacts mounted within said envelope, at least one of said contacts comprising a hollow member extending into said envelope through an opening therein, said member being connected in vacuum tight seal to said envelope and comprising a contact engaging portion within said envelope

5

which is biased to contact open position and deformable to contact closed position, means for applying an impulse of gas to the interior of said member outside of said envelope for deforming said portion, an overcenter passive toggle arranged within said envelope and connected at one end to the inside of said envelope and at the other end to the movable end of said member, said toggle being biased to its overcenter position when said member is deformed to contact closed position to retain said member in contact closed position, and means extending into said envelope through an opening therein for engaging said toggle when in its overcenter position and biasing it back to its collapsed position.

5. An electric device comprising a vacuumized envelope, a pair of relatively movable cooperating contacts mounted within said envelope, at least one of said contacts comprising a first hollow member extending into said envelope through an opening therein, said first member being connected in vacuum tight seal to said envelope and comprising a contact engaging portion within said envelope which is biased to contact open position and deformable to contact closed position, means for applying gas under pressure to the interior of said first member outside of said envelope for deforming said contact engaging portion, an overcenter toggle fixedly arranged at one end within said envelope and connected at the other end to the movable end of said first member, said toggle being biased to its overcenter position for holding said contacts in engagement when said first member is deformed to its contact closed position, and a second hollow member extending into said envelope through an opening therein, said second member being connected in vacuum tight seal to said envelope and comprising a toggle engaging portion deformable to engage said toggle when said toggle is in its overcenter position for biasing said toggle back to its collapsed position, said toggle engaging portion being deformed upon reduction of pressure in said contact engaging portion.

6. An electric device comprising a vacuumized envelope, a pair of relatively movable cooperating contacts mounted within said envelope, at least one of said contacts comprising a first hollow member extending into said envelope through an opening therein, said first member being connected in vacuum tight seal to said envelope and comprising a contact engaging portion within said envelope which is biased to contact open position and deformable to contact closed position, means for applying gas under pressure to the interior of said first member outside of said envelope for deforming said contact engaging portion to actuate it from contact open to contact closed position, an overcenter toggle arranged within said envelope and connected at one end to the inside of said envelope and at the other end to the movable end of said first member, said toggle being biased to its overcenter position when said first member is deformed to contact closed position, and a second hollow member extending into said envelope through an opening therein, said second member being connected in vacuum tight seal to said envelope and comprising a toggle engaging portion deformable to engage said toggle when in its overcenter position and biasing it back to its collapsed position, said toggle engaging portion forming a stop for said toggle when biased to its overcenter position.

7. An electric device comprising a vacuumized envelope, a pair of relatively movable cooperating contacts mounted within said envelope, at least one of said contacts comprising a first hollow member extending into said envelope through an opening therein, said first member being connected in vacuum tight seal to said envelope and comprising a contact engaging portion within said envelope which is biased to contact open position and deformable to contact closed position, means for applying gas under pressure to the interior of said first member outside of said envelope for deforming said contact en-

6

gaging portion to actuate it from contact open to contact closed position, an overcenter toggle arranged within said envelope and connected at one end to the inside of said envelope and at the other end to the movable end of said first member, said toggle being biased to its overcenter position when said first member is deformed to its contact closed position and locking said contacts in contact closed position, and a second hollow member extending into said envelope through an opening therein, said second member being connected in vacuum tight seal to said envelope and comprising a toggle engaging portion which is deformable to engage said toggle when in its overcenter position and biasing it back to its collapsed position, said toggle engaging portion forming a stop for said toggle when moved to its overcenter position, said toggle engaging portion being deformed upon reduction of pressure in said contact engaging portion to cause said contacts to return to their contact open position.

8. An electric device comprising a vacuumized envelope, a pair of relatively movable cooperating contacts mounted within said envelope, one of said contacts comprising a hollow deformable arm portion extending into said envelope through an opening therein and a resilient diaphragm spring portion mounted at one end of said arm portion within said envelope and an arcing tip portion mounted on one side of said spring portion, said arm portion being connected in vacuum tight seal to said envelope and being biased to contact open position and deformable to contact closed position, means for applying gas under pressure to the interior of said arm portion outside of said envelope for deforming said arm portion, an overcenter toggle arranged within said envelope and connected at one end to the movable end of said one of said contacts and at the other end to said envelope, said toggle being biased to its overcenter position when said one of said contacts is deformed to its contact closed position, and a hollow member extending into said envelope through an opening therein, said member being connected in vacuum tight seal to said envelope and comprising a portion deformable to engage said toggle when said toggle is in its overcenter position for biasing said toggle back to its collapsed position, said toggle engaging portion being deformed upon reduction of pressure in said one of said contacts.

9. An electric device comprising a vacuumized envelope, a pair of relatively movable cooperating contacts mounted within said envelope, one of said contacts comprising a hollow deformable arm portion extending into said envelope through an opening therein and a resilient diaphragm spring portion mounted at one end of said arm portion within said envelope and an arcing tip portion mounted on one side of said spring portion, said arm portion being connected in vacuum tight seal to said envelope and being biased to contact open position and deformable to contact closed position, means for applying gas under pressure to the interior of said arm portion outside of said envelope for deforming said arm portion, an overcenter toggle arranged within said envelope and connected at one end to the movable end of said one of said contacts and at the other end to said envelope, said toggle being biased to its overcenter position when said one of said contacts is deformed to its contact closed position, and a hollow member extending into said envelope through an opening therein, said member being connected in vacuum tight seal to said envelope and comprising a toggle engaging portion deformable to engage said toggle when said toggle is in its overcenter position for biasing said toggle back to its collapsed position, said toggle engaging portion being deformed upon reduction of pressure in said one of said contacts.

10. An electric device comprising a vacuumized envelope, a pair of relatively movable cooperating contacts mounted within said envelope, one of said contacts comprising a hollow deformable arm portion extending into

7

said envelope through an opening therein and a resilient diaphragm spring portion mounted at one end of said arm portion within said envelope and an arcing tip portion mounted on one side of said spring portion, said arm portion being connected in vacuum tight seal to said envelope and being biased to contact open position and deformable to contact closed position, means for applying gas under pressure to the interior of said arm portion outside of said envelope for deforming said arm portion, an overcenter toggle arranged within said envelope and connected at one end to the movable end of said one of said contacts and at the other end to said envelope, said toggle being biased to its overcenter position when said one of said contacts is deformed to its contact closed position, and a hollow member extending into said envelope through an opening therein, said hollow member being connected in vacuum tight seal to said envelope and comprising a toggle engaging portion deformable to engage said toggle when said toggle is in its overcenter position for biasing said toggle back to its collapsed position, said toggle engaging portion forming a stop for said toggle when said toggle is moved to its overcenter position.

11. An electric device employing a vacuumized en-

8

velope for enclosing a pair of cooperating arcing contacts wherein one of said contacts comprises a hollow member extending through said envelope, said member being biased to contact open position and deformable to contact closed position, means for applying fluid under pressure to the interior of said member for deforming said member to contact closed position, and passive means within the envelope for only retaining said member in contact closed position and actuable for releasing said member for movement to contact open position.

References Cited in the file of this patent

UNITED STATES PATENTS

1,784,302	Millikan et al. -----	Dec. 9, 1930
2,356,174	Olken -----	Aug. 22, 1944
2,441,192	Graves -----	May 11, 1948
2,993,971	Pfianz -----	July 25, 1961

FOREIGN PATENTS

125,461	Austria -----	Nov. 25, 1931
532,639	Germany -----	Sept. 3, 1931
554,101	Italy -----	Jan. 7, 1957
638,489	France -----	Feb. 21, 1928