

[72] Inventors **Rudolph Bergsma;**
Harry I. Baker, both of Ann Arbor, Mich.
 [21] Appl. No. **863,108**
 [22] Filed **Oct. 2, 1969**
 [45] Patented **Aug. 17, 1971**
 [73] Assignee **Chrysler Corporation**
Highland Park, Mich.

[56]

References Cited

UNITED STATES PATENTS

1,782,458	11/1930	Brennen	200/153 (.22) UX
1,981,934	11/1934	Werner	337/366 X
1,992,765	2/1935	Petersen	337/366 X
2,096,502	10/1937	Wetzel	200/153 (.22) X
3,370,459	2/1968	Cescati	200/83 (.8) X

Primary Examiner—Robert K. Schaefer

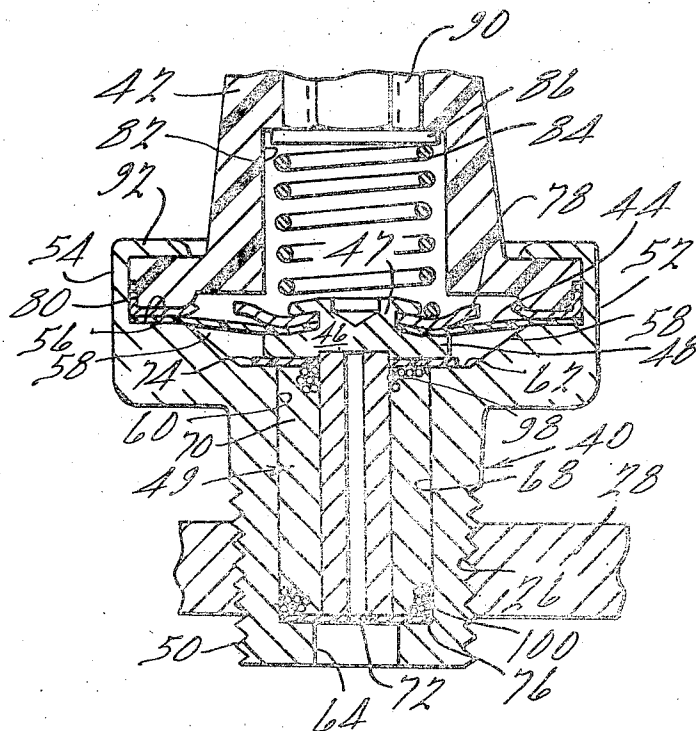
Assistant Examiner—Robert A. Vanderhye

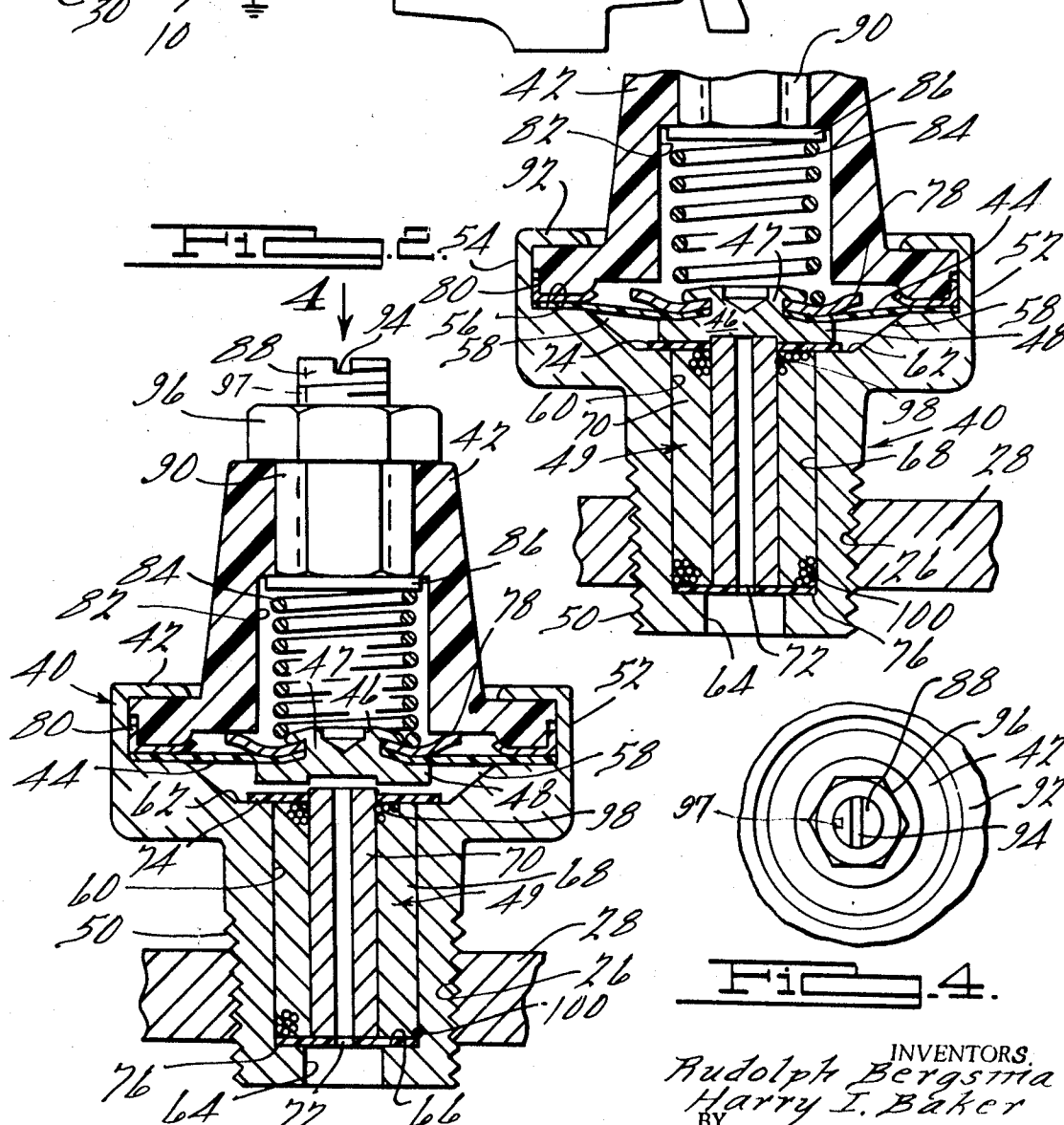
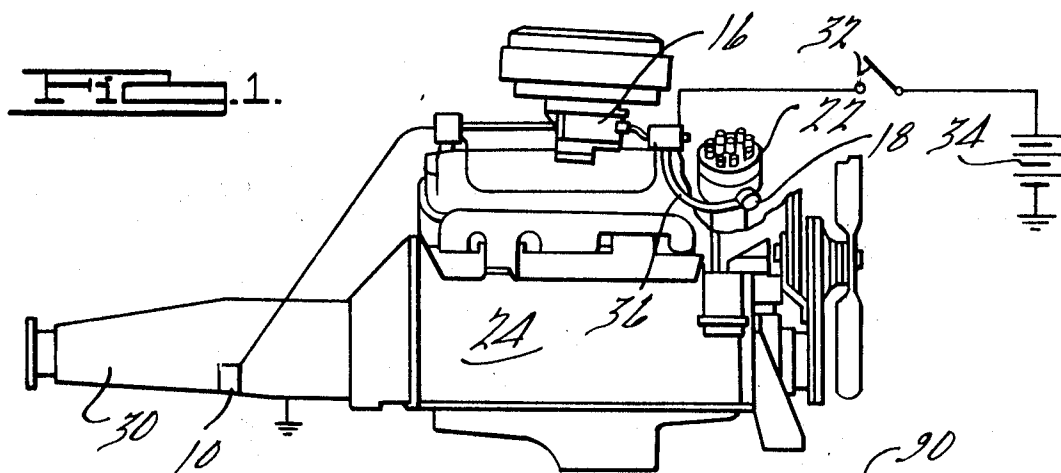
Attorney—Harness, Talburt and Baldwin

[54] **FLUID PRESSURE ACTUATED ELECTRICAL SWITCH WITH ELECTROMAGNETIC BIASING MEANS FOR ESTABLISHING DIFFERENT PRESSURE LEVELS FOR ACTUATION AND DEACTUATION**
 4 Claims, 4 Drawing Figs.

[52] U.S. Cl. 200/83 R
 [51] Int. Cl. H01h 35/34
 [50] Field of Search 200/83.8,
 83, 153.22; 337/90, 134, 366, 344

ABSTRACT: An electrical switch operable from a source of variable fluid pressure and settable from a first electrical condition to a second electrical condition when the applied pressure attains a first predetermined level and resettable from the second back to its first electrical condition when the applied pressure decreases to a second predetermined level. The operating levels of the switch are determined by a compound biasing means establishing the first pressure level to set the switch and by a portion of the biasing means establishing the second pressure level to reset the switch.





INVENTORS
Rudolph Bergstria
Harry I. Baker
 BY
Harness, Talbot & Baldwin
 ATTORNEYS.

FLUID PRESSURE ACTUATED ELECTRICAL SWITCH WITH ELECTROMAGNETIC BIASING MEANS FOR ESTABLISHING DIFFERENT PRESSURE LEVELS FOR ACTUATION AND DEACTUATION

BACKGROUND OF THE INVENTION

This invention relates to fluid pressure actuated electrical switches and, more particularly, to such switches operable in a variable fluid pressure environment between an electrical circuit making and circuit breaking condition.

The invention has among its objects to provide an electrical switch of the above character that is specially, although not exclusively, suited for use in an automobile engine emission control environment in which the switch is exposed to a source of variable fluid pressure and is operable with a positive and reliable action, devoid of bouncing or chattering of the electrical contacts thereof.

SUMMARY

Toward the accomplishment of the above and other objects, the invention provides a fluid pressure actuated electrical switch which is adapted to be mounted in a portion of an automatic transmission that is exposed to fluid pressure varying with vehicle speed. The switch is operated from a first to a second electrical condition when the applied fluid pressure attains a first predetermined level and from its second back to its first electrical condition when the applied pressure decreases to a second predetermined level. The snap action characteristic of the switch is established by a compound electromechanical biasing means, which utilizes the combined effects of a coil spring and an electrical solenoid to oppose and establish the higher fluid pressure actuating level. The application of the engine fluid pressure results in opening of the switch and deenergization of the solenoid, thereby decreasing the initial biasing force and leaving only the coil spring to return the switch at a lower fluid pressure level. Resetting of the switch at the lower fluid pressure level results in restoration of the switch to its original condition and in the reenergization of the solenoid which locks the switch in its reset condition.

The operation and structural organization of the fluid pressure actuated switch device will be understood from consideration of the detailed description of a preferred embodiment of the invention made with reference to and following the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates an environment and electrical utilization circuit in which the fluid pressure actuated switch of the present invention may be employed;

FIG. 2 is an enlarged longitudinal sectional view of a fluid pressure operated electrical switch device in accordance with the present invention;

FIG. 3 is a longitudinal section view taken in the direction 3-3 of FIG. 2; and

FIG. 4 is a top plan view of the pluglike switch device taken in the direction 4-4 of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to the drawings, FIG. 1 illustrates an environment in which the fluid pressure actuated switch 10 may be employed. The switch 10 is employed in conjunction with a manifold vacuum-actuated switch 12 to control the energization of an electrical solenoid-operated valve 14, which controls the application of ported spark advance vacuum from a carburetor 16 to the vacuum-operated actuator 18 associated with the ignition distributor 22 of an automobile engine 24. The system disables the normal vacuum modulation of the distributor spark advance during acceleration above a specified rate, as sensed by the vacuum switch 12, at vehicle speeds up to a predetermined speed, as sensed by the switch 10 used as a speed sensor in the illustration application.

The switch device 10 is supported from and is threadably received in an opening 26 in a portion of the housing 28 of the vehicle automatic transmission 30, where it is exposed to fluid pressure therein that varies directly with vehicle speed. Switch 10 is included with the vacuum switch 12 in the electrical energization circuit for the solenoid valve 14, which is shown connected through the vehicle ignition switch 32 to the positive side of the negatively grounded vehicle storage battery 34. When both switches 10 and 12 are closed, the solenoid valve 14 is energized to disable the vacuum line 36 to the distributor spark advance chamber of the vacuum actuator 18 and vent the chamber to atmosphere. When the vehicle attains a predetermined vehicle speed of say 30 m.p.h., the correspondingly increased fluid pressure sensed by the switch 10 in the transmission housing operates the switch to affect the deenergization of the solenoid valve 14 and reestablishes the normal vacuum modulation of the distributor spark advance mechanism.

With reference to FIGS. 2 and 3, the switch is a pluglike device comprising a tubular electrically conducting metallic housing 40, an insulating cap and spring retaining member 42, a flexible diaphragm member 44 carrying an electrical contact element 46 thereon, and an electrical solenoid 49 within the housing 40.

The housing 40 is of one-piece unitary construction having an externally threaded cylindrical body portion 50, an enlarged hexagonally shaped intermediate portion 52, and a thin wall cylindrical collar portion 54. Collar portion 54 bounds an annular land 56 surrounding a shallow frustoconical chamber 58 formed in the hexagonally shaped portion 52 of the housing. Interiorly, the housing has a smooth cylindrically bored wall 60 which opens at one end into the chamber 58 and is of lesser diameter than the annular shoulder or land 62 formed at the juncture of the cylindrical bore 60 and chamber 58. At its other end, bore 60 communicates with a restricted bore 64 at the other end of the housing forming another annular land 66 at the juncture of the restricted bore 64 and the cylindrical bore 60.

The solenoid 49 is shown received in the cylindrical bore portion 60 of the housing and seats against the annular land portion 66 therein. The solenoid comprises an annular coil 68 composed of a number of turns of insulated magnet wire wound about a cylindrical core 70 of cold-rolled steel. Extending longitudinally axially of the solenoid core 68 is a narrow restricted bore 72 for admitting fluid from the bore 64 therethrough into the chamber 58 at the other end of the housing.

The diaphragm 44 is an impermeable annular member of thin flexible material such as "H-film" sold under the Dupont Corporation trade name "Kapton," which is a polyamide possessed of excellent electrical and thermal insulating properties. Similar insulating material in the form of annular washers is employed at 74 and 76 to insulate the opposite ends of the solenoid coil from the housing 50. The diaphragm carries the electrical contact element 46, which comprises a reduced stem portion 47 passing centrally through the diaphragm and an enlarged disc-shaped contacting element 48 at one end thereof adapted to seat against the solenoid coil and/or core as shown. The upper end or stem portion 47 of the contact 46 is assembled to the diaphragm by peening or curling the apertured outer end thereof over a reinforcing, springlike metallic washer element 78 as shown. The diaphragm and contact assembly is received within the cylindrical collar portion 54 of the housing to seat on the annular land 56 against which it is sealingly retained by a spring washer 80 and cap member 42.

The cap member 42 is formed of electrical insulating material with an enlarged central bore 82 therein in which is received a biasing spring 84. At one end spring 84 seats against the washer 78 on the diaphragm, and at its other end it contacts one surface of an electrically conducting disc 86. The other or outwardly facing side of the disc is contacted by the inner end of an externally threaded electrical terminal stud 88 threadably received in an internally threaded sleeve or nut 90 integrally molded in the plastic-retaining cap. The cap, spring

and stud assembly is then assembled to the housing by inwardly turning the marginal peripheral portion of the cylindrical collar portion 54 of the housing as shown at 92. The outer end of the stud 88 is slotted as shown at 94 for receiving the nib of an adjustment tool for adjusting the position of the stud and affecting the calibration of the switch after which a jam nut 96 received on the stud is tightened against the exposed outer end of the cap to lock the stud against further relative displacement thereto. In order to vent the interior of the cap, the stud 88 may be slotted longitudinally as shown at 97.

The coil spring 84 has a spring rate equivalent or sufficient to balance a fluid pressure of, say, 17 p.s.i., for example, admitted through the restricted bore 72 of the solenoid core. One end of the solenoid coil winding 68 is electrically connected as shown at 98 to the core 70, and its other end 100 is electrically connected to the housing 50, which is electrically grounded through the grounded transmission housing. Hence, in the initial or normal position of the switch shown in FIG. 2, the diaphragm is displaced toward the core, and the contact 48 carried by the diaphragm makes firm and direct electrical contact with the inner or upper end of the solenoid core 70 constituting the other contact of the switch. Thus, the solenoid coil 68 is energized over an electrical circuit through the terminal stud end 88 of the switch 10 and through the spring 84, washer 78, contact 48, core 70 and coil 68 to ground, and exerts a magnetic attractive force equivalent to, say 3 p.s.i., on the opposite side of the diaphragm. It will be noted that the magnetic force of the solenoid is in the same direction as the biasing force of the coil spring 84 and adds its cumulative effect to the spring to retain the diaphragm with the electrical contacts of the switch in the position shown.

When the fluid pressure admitted through the bore 72 attains a predetermined level, say 20 p.s.i., to balance or exceed the combined effect of the biasing force of the coil spring on one side of the diaphragm and the magnetic attractive force of the solenoid on the other side of the diaphragm, the diaphragm is displaced from the position shown in FIG. 2 to its limit position shown in FIG. 3, opening the switch contacts 48, 70 and deenergizing the solenoid coil 68. The magnetic biasing force of the solenoid 49 will thus be disabled or discontinued, leaving only the 17 p.s.i. rate of the coil spring 84 to oppose the higher applied fluid pressure of 20 p.s.i., whereby the switch contacts 48 and 70 will open with a positive and rapid snap action devoid of any contact bounce or chattering. The switch contacts will remain in this open or actuated position until the fluid pressure decreases or drops to a value equivalent to or slightly less than the biasing force of the coil spring acting alone, i.e., 17 p.s.i. At this point the diaphragm will then be returned to its original position with the contact 48 against the solenoid core 70, as shown in FIG. 2. It will be noted that this action is accompanied by the reenergization of the solenoid 49, which then exerts its magnetic attractive force to positively seal and lock the switch in its normally closed position of FIG. 2.

It will be seen that adjustment of or changing either of the biasing forces relative to the other will change the upper operating pressure level for actuation of the switch. As the coil spring 84 determines the lower of the two operating levels of the switch, changing the biasing force of the spring changes both the upper and lower operating levels of the switch, the difference between which levels is established by the magnitude of the biasing force effect of the electromagnetic biasing means 49.

Through the design of the electromagnet and/or by affecting the current therethrough, the differential range of operation of the switch can be selected so as to be greater than the range of variations or any modulation of the applied fluid pressure due to the character of the fluid pressure source and/or the means for driving the source. Thus, the operation of the

switch is rendered insensitive to such variations at the selected operating level or levels of the switch and enables the selection of distinct operating levels that are independent of any manufacturing variations and asymmetrical operating or hysteresis characteristics of the components of the switch structure.

We claim:

1. A fluid pressure actuated electrical switch operated from a first electrical condition to a second electrical condition at a first predetermined fluid pressure attained by a source of variable fluid pressure to be sensed by the switch and operated from its second electrical condition back to its said first electrical condition at a second and lower predetermined fluid pressure, said switch comprising the combination of

a first housing member of electrical insulating material, a second housing member of electrically conductive material,

a flexible impervious diaphragm member peripherally secured between said housing members and defining a fluid pressurizable chamber with said second housing member,

a centrally located bore formed in and extending through said second housing member to communicate at one end with said chamber therein and at its other end with said source of fluid pressure,

an electrical solenoid oriented in the direction of and fixedly mounted within said bore of said second housing member, said solenoid including

a central core having a passage extending therethrough in the direction of said bore to admit fluid to said pressurizable chamber and

a coil of insulated wire wound about said core and electrically connected at one end to said second housing member and at its other end to said core,

movable electrical contact means mounted centrally of and extending through said diaphragm member and cooperating with one end of said solenoid core constituting a fixed electrical contact of said switch, said movable electrical contact means covering the passage in said solenoid core when said switch is in its first electrical condition,

electrical terminal means located externally of and extending into said first housing member, and

a compression coil spring extending between and in electrical contact with said movable electrical contact means and said electrical terminal means, said spring opposing displacement of said diaphragm member by said source of fluid pressure and urging said movable contact means into engagement with said solenoid core and completing an electrical circuit path for said solenoid coil from said electrical terminal means, said spring, said movable contact means, said solenoid core and said second housing member.

2. A fluid pressure actuated switch in accordance with claim 1 wherein said movable contact means also covers the bore in said second housing member when said switch is in its first electrical conditions.

3. A fluid pressure actuated switch in accordance with claim 1 wherein said electrical terminal means is positionally adjustable in said first housing member to change both said first and second predetermined operating levels of said switch.

4. A fluid pressure actuated switch in accordance with claim 1 above wherein the difference between said first and said second predetermined operating level of said switch is established by the magnitude of the magnetic force effect of the electrical solenoid and wherein the first predetermined operating level is established by the combined biasing effect of said biasing means and the magnetic force effect of said electrical solenoid.