

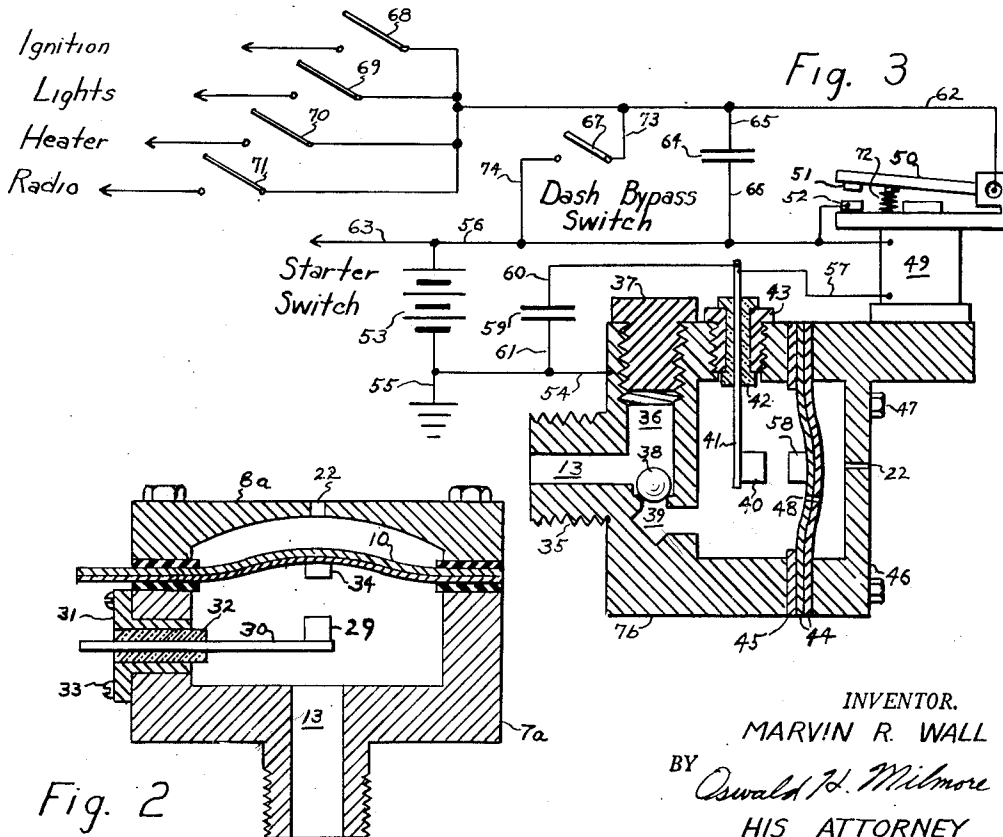
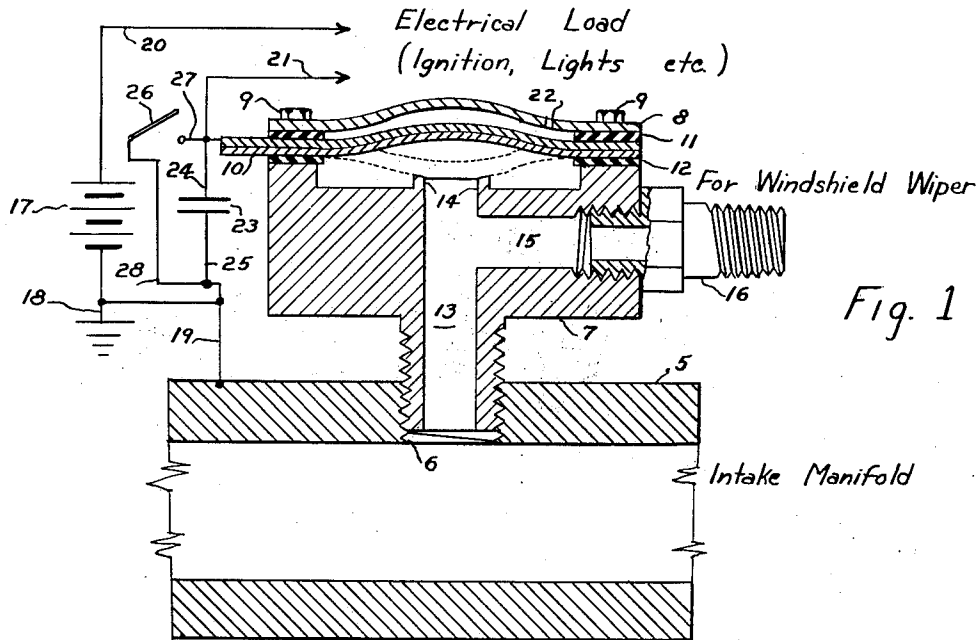
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TEMPERATURE AND PRESSURE RESPONSIVE SWITCH

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1 This invention relates to automatic electrical switches which operate in response to changes in pressure and temperature. While not limited thereto, such switches are particularly intended for use as automatic cutout devices for deenergizing various circuits associated with internal combustion engines, e. g., the ignition circuit or other appliances, after a time delay period following the shutting off of the engine; the engine may be that of an automobile or of a stationary power plant. The invention is, further, concerned with automatic cutout systems for automobiles, power plants, and the like, employing such switches.

Operators of internal combustion engines having storage batteries charged by generators driven by such engines, e. g., automobile gasoline engines, occasionally through inadvertence fail to shut off the electrical power to various electrical appliances powered by the storage battery after the engine has been stopped. Thus, operators at times leave the ignition switch closed after an unsuccessful attempt to start the engine, or after the engine has been accidentally stalled, or operate other appliances, such as lights, radios, heaters, fans, etc., for extended periods of time when the engine is not running and the battery is not being charged, resulting in a severe drain on the storage battery. As a result the battery is often run down to the extent that it is unable to turn the engine over and supply a spark when an attempt is made to start the engine by its starter. This difficulty occurs not only in motor vehicles but also in stationary power plants.

Various vacuum-operated switches have heretofore been proposed for opening the electrical circuit when the vacuum in the intake manifold of the internal combustion engine is dissipated upon stopping the engine. Such devices have met with disfavor because they open the controlled circuits too promptly after the engine is stopped and do not afford the operator the opportunity to operate the lights, etc., for short periods after the engine has been stopped, e. g., to enable passengers to alight from a car after it has been parked, or for closing down a power plant and securing it. Such switches are, therefore, primarily useful only for controlling the ignition circuit or such other circuits as may under all conditions be shut off simultaneously with the engine; manually operated switches must be employed to control other circuits. Proposals to delay the opening of vacuum operated switches by providing a vacuum chamber, 55

2 sealed from the engine intake manifold by a check valve and having an orifice for admitting air slowly into the vacuum chamber, so as to dissipate the vacuum within the chamber slowly after the engine has been stopped, are effective only for very short time periods and are useful only to prevent opening of the controlled circuit in the event of a temporary reduction in the engine vacuum, such as would occur in the event of a misfire or when the engine is accelerating at full throttle.

Switches employing thermal delay elements have, heretofore, been extremely complex and expensive and have not, therefore, met with general acceptance for controlling electrical circuits associated with internal combustion engines.

It is an object of this invention to provide a temperature and pressure responsive switch of extremely simple and rugged construction which 20 comprises a sprung, bi-metallic diaphragm mounted within a housing to move initially from its normal position in response to the pressure within the housing and to return to its normal position in response to the temperature of the housing and to the pressure within the housing, thereby to cause a corresponding movement of an active electrical contact which cooperates with a passive electrical contact (which may be either stationary or spring mounted) for controlling an electrical circuit. The housing is provided with a fitting for connecting its interior to a pressure generator (i. e., a device creating a positive or a negative pressure); the active electrical contact and/or the passive contact may be insulated from the housing or diaphragm, or one of the contacts may be grounded to the housing.

Another object of the invention is to provide a simple and dependable switch suitable for installation in internal combustion engines, e. g., automobile engines or engines of other power plants, for controlling certain electrical circuits associated with the electrical system of the engine, the switch having a sprung, bi-metallic diaphragm mounted within a housing which is connected to a suction point of the engine, such as the intake manifold, by a passageway, the diaphragm being mounted to close the electrical contacts controlling a circuit promptly when a vacuum is created by the engine, regardless of the temperature, and to maintain the contacts in closed position so long as the temperature is above a predetermined level, regardless of the existence or absence of a vacuum, but to open the contacts after the vacuum has been dissipated

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and the temperature has fallen below a predetermined level.

Still another object is to provide a control system for automatically shutting off certain electrical circuits energized by storage batteries charged by internal combustion engine-driven generators after the operation of the engine has been stopped for a time period sufficient to permit the engine to cool to a predetermined temperature, and to close such circuit promptly upon turning over the engine, regardless of the temperature; the switch associated with this system, when in its normally open position, will not move to its closed position by an increase in temperature if the engine is not turned over so as to create a vacuum.

Further objects will become apparent from the following description, taken together with the accompanying drawing forming a part of this specification and illustrating three preferred embodiments of the invention wherein:

Fig. 1 is a vertical sectional view of a switch installed in an internal combustion engine and showing certain circuit elements;

Fig. 2 is a vertical sectional view of a modified form of the switch; and

Fig. 3 is a vertical sectional view of another modified form of the switch, showing a different circuit arrangement.

Briefly, the switch according to the invention comprises a housing, preferably of a metal having fair or excellent heat-conducting properties, fitted with a tube or pipe for connecting the housing to a pressure generator (i. e., a source of vacuum or negative pressure, or a source of positive or superatmospheric pressure, depending upon the service intended), and in heat-transfer relation to a heat generator. The tube itself may serve as the heat conductor, for conducting heat from the heat generator (e. g., an internal combustion engine) to the switch housing. Such tube may be threadedly connected to the intake manifold of the engine. A sprung, bi-metallic diaphragm is sealed within the housing so as to have one face thereof exposed to the pressure created within the housing by the pressure generator, and to assume a temperature approximately equal to that of the housing. The housing contains an active and a passive electrical contact forming switch elements for controlling an electrical circuit; the active contact is moved by the diaphragm, and may be the diaphragm itself or may be carried by the diaphragm, or may be separately supported and actuated by the diaphragm, while the passive contact may be a part of the housing itself or be a separate element rigidly or resiliently mounted within the housing. The diaphragm may be mounted to move the contacts from their normal position, e. g., to close the contacts, either upon a rise or a fall in pressure, and to maintain the contacts in their non-normal position, e. g., in closed position, either at elevated or at low temperature, depending upon the type of service for which the switch is intended. A change in temperature alone will not move the contacts to their non-normal position because the bi-metallic, sprung diaphragm is so arranged that unequal expansion of the two metals will not in itself suffice to move the diaphragm from its normal position. In the specific embodiments herein described the diaphragm is arranged to close the contacts when the pressure falls to below atmospheric pressure, and to maintain the contacts in their closed position at elevated temperatures, while causing the contacts to open upon a rise in pressure and a drop in

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temperature occurring either simultaneously or consecutively in any sequence. Being of sprung metal, the diaphragm tends to flex toward one of its extreme positions with a rapid or snapping action, and does not "float" at an intermediate position.

A check valve may optionally be provided for the housing to isolate its pressure (viz., vacuum) chamber from the pressure generator, to prevent momentary reversals in pressure in the generator from causing fluttering of the switch.

As applied to an internal combustion engine, the engine itself, through its fuel-vapor intake system, constitutes the pressure generator (generating a vacuum or sub-atmospheric pressure in the intake manifold) and the engine also serves as the heat generator; and the diaphragm is mounted to close the contacts when a vacuum prevails, and to maintain the contacts closed when the temperature remains high.

Referring to the drawings, and particularly to Fig. 1, an intake manifold of an automotive engine having a gasoline carburetor (not shown) is indicated at 5. The switch according to the invention is connected thereto at a threaded hole 6, e. g., the hole normally used to attach the suction line of a windshield wiper. The switch comprises a housing 7 and a cap 8 secured by bolts 9. A sprung, bi-metallic diaphragm 10 is clamped between the housing and cap and insulated therefrom by annular insulating and sealing gaskets 11 and 12. The diaphragm has oversized bolt holes to avoid grounding engagement with the bolts 9. The bi-metallic diaphragm is, in actual construction, considerably thinner than indicated on the drawing, e. g., 0.004 inch in thickness, and the metal toward the housing 7 and intake manifold has a higher thermal coefficient of expansion than the other metal. By way of example, a diaphragm having sheet steel toward the cap 8 and a sheet of brass toward the housing 7 and welded to the sheet steel may be used. The housing has a bore 13 forming a passageway between the intake manifold and the interior of the housing. An annular rim 14 at the top of the bore forms a passive contact. The housing may, optionally, be provided with a branch bore 15 to which a threaded fitting 16 may be attached for connecting the windshield wiper suction line which would normally have been connected to the hole 6.

Fig. 1 also illustrates a circuit arrangement and switch suitable for engines and electrical systems wherein one side of the storage battery is grounded and all appliances, including the ignition, have two-wire circuits, i. e., are not separately grounded to complete the circuit. Thus, there is shown a storage battery 17 having one terminal grounded as indicated schematically by the leads 18 and 19, and its other terminal connected by a lead 20 to the electrical load, consisting of various appliances usually having their individual manually operated control switches. The return wire from the electrical load, i. e., the so-called "ground return," is indicated at 21; instead of being directly grounded, it is connected to the bi-metallic element 10.

It is evident that the appliances constituting the electrical load are deenergized when the switch is in the position shown because the lead 21 is not grounded. When the motor is started the suction in the manifold draws the bi-metallic element 10 down against the rim 14, thereby grounding the diaphragm and lead 21 and completing the circuit. This position of the dia-

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phragm is shown in dotted lines. The ignition and other appliances connected to the leads 20 and 21 are thereby energized if their individual switches are closed. When the motor is stopped after having been in operation long enough to warm up the manifold, housing and bi-metallic diaphragm, the heat of the motor holds the diaphragm against the rim 14 even after the vacuum is dissipated. When the motor has cooled down sufficiently, the bi-metallic element returns to its normal position, thereby breaking contact with the rim 14 and deenergizing all appliances. While an elevated temperature causes the diaphragm to remain in its lower position, the application of heat without vacuum will not result in moving the diaphragm from its normal, upper position to the position shown in dotted lines.

The optimum cut-off temperature will depend upon the rate of cooling (as determined by the type of engine, its size and the prevailing ambient temperature) as well as the desired delay period. It was found excellent operation, involving a time delay of from 15 to 30 minutes, is attained in mild climatic conditions with light commercial gasoline-powered motors in automobiles by employing bi-metallic diaphragms which open the contacts when the temperature has fallen to 100° F., but diaphragms which open at other temperatures, such as temperatures up to 140° F. may be used, especially in warmer climates.

The cap 8 is shown to be provided with a port 22 for maintaining atmospheric pressure on the upper face of the diaphragm; this port may, in certain instances, be omitted, or adapted to apply a pressure other than atmospheric. It is evident that the cap 8 is provided primarily to exclude foreign matter and to protect the diaphragm 10, and that it may be omitted, not being a functionally essential element.

To avoid sparking a condenser 23 may optionally be connected in shunt with the switch by leads 24 and 25. Further, a by-pass switch 26 may be connected in shunt with the main switch by leads 27 and 28 and mounted on the automobile dash board to permit the lead 21 to be grounded independently of the position of the diaphragm 10.

In the embodiment described above the diaphragm itself constitutes the active contact and a part of the housing constitutes the passive contact. In the modification according to Fig. 2, the housing 7a carries a separate passive contact 29 at the end of a spring support 30 which is mounted in a plug 31 and insulated therefrom by a ceramic sleeve 32. Plug 31 is secured by screws 33 and the body thereof extends into a hole in the side of the housing large enough to permit insertion of the spring support 30 and contact 29. The bi-metallic element 10 is mounted between the housing 7a and cap 8a and insulated therefrom by annular gaskets as was described for Fig. 1. The diaphragm 10 has an active contact 34 fixed thereto.

The operation of the switch according to Fig. 2 is like that described for Fig. 1. However, because both contacts are insulated from the housing, this switch may be used not only in electrical systems such as that shown in Fig. 1, but also in "single wire" systems, wherein only the ungrounded side of the battery is connected by leads to the various appliances which are individually grounded.

In the embodiment according to Fig. 3 the switch has a grounded, bi-metallic sprung diaphragm and an insulated passive contact. In

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this figure the housing 7b has an externally threaded nipple 35 adapted to be screwed into a horizontal hole in an intake manifold. The main suction bore 13 communicates with a larger branch bore 36, closed by a plug 37 and large enough to permit a ball 38 to be inserted. The ball 38 is of larger diameter than the bore 13 and rests normally on an annular edge of a connecting bore 39. This ball functions as a check valve to prevent inflow of air from bores 13 and 36 into bore 39. The plug 37 may be replaced by a fitting for a windshield wiper suction line, as was described for Fig. 1.

A passive contact 40 is supported within the housing by a spring arm 41 mounted by a ceramic sleeve 42 within a screw plug 43, being thereby insulated from the housing. The bi-metallic sprung diaphragm 44 is in electrical contact with the housing through a washer 45 and retained by a cap 46 and bolts 47. The cap contains a large port 22 to maintain atmospheric pressure on the right face of the diaphragm. The vacuum chamber within the housing on the left face of the diaphragm is vented to the atmosphere in any desired manner to permit a very slow admission of air. Thus, a fine bleeder port or orifice 48 may be provided in the diaphragm.

The cap 46 carries a relay having a winding 49, an armature 50 and relay contacts 51 and 52. Spring 72 normally urges the armature to its raised position, opening the relay contacts.

The switch of Fig. 3 is shown to be connected to a "single wire" circuit comprising a storage battery 53 charged by a generator (not shown) driven by the engine to which the housing 7b is attached, and having one of its terminals grounded, as is indicated diagrammatically by the leads 54 and 55. The other battery terminal is connected by a lead 56 to the stationary relay contact 52 and to one side of the winding 49. The other side of the winding 49 is connected by lead 57 to the passive contact 40, which co-operates with an active contact 58 fixed to and in electrical contact with the diaphragm 44. A condenser 59 may optionally be connected in shunt with the contacts 40 and 58 through leads 60 and 61 to prevent arcing. The movable relay contact 51 is connected to the main power lead 62 which supplies most electrical appliances on the automobile. The starter motor is provided with a separate power lead 63 connecting the battery to the starter switch (not shown). To prevent sparking a condenser 64 may optionally be connected in shunt with the relay contacts by leads 65 and 66. The lead 62 may, further, be energized regardless of the position of the relay armature 50 by a bypass switch 67 which may be located on the dash of the motor vehicle and is connected by leads 73 and 74 to bridge leads 56 and 62. The main power lead 62 is connected to branch switches 68—71 which control various sub-circuits, such as those for the engine ignition, lights, heater, and radio, respectively.

With the switch and relay in the positions shown in Fig. 3 the pressure on both sides of the diaphragm 44 is atmospheric, the engine manifold supporting the housing 7b is cold, and the power lead 62 is deenergized. When the pressure generator, viz., the engine, creates a vacuum in the bore 13 air passes the check valve 38, evacuating the vacuum chamber and causing the sprung diaphragm 44 to move to the left, thereby closing contact 58 against contact 40. This completes the ground return circuit for the relay winding 49, permitting current to flow through 56—57—41—40—58—44—45—7b—54. The ar-

mature 50 is thereby attracted, compressing spring 72 and closing contacts 51 and 52 to energize power lead 62. Should the vacuum be momentarily dissipated before the engine has become warm the contacts 40 and 58 remain closed for short time periods because the check valve 38 and fine orifice 48 prevent rapid dissipation of the vacuum within the vacuum chamber and the return of the diaphragm 44 to its normal position; these contacts may, for example, be held closed for several seconds. Fluttering or chattering of the relay armature is thereby prevented. When the motor is stopped after the housing and diaphragm 44 have become heated the contacts 40 and 58 are kept closed by the heat of the engine even after the vacuum within the housing has been wholly dissipated. After the engine and diaphragm have cooled sufficiently the diaphragm 44 returns to the normal position shown in the drawing; this interrupts the circuit to the relay winding 49, causing the armature 50 to rise under influence of its spring 72, thereby opening relay contacts 51 and 52 and de-energizing the power lead 62.

While three specific embodiments of the invention have been illustrated and described in detail, it should be noted that numerous changes may be made without departing from the spirit and scope of the invention as defined in the appended claims, and without losing the advantages thereof. Thus, the three specific switches shown may be used alternately with any of the circuits described, and are not limited to use with the specific circuits associated therewith in the drawing.

I claim as my invention:

1. A temperature and pressure responsive electrical switch comprising a housing providing a passive contact, a sprung, bi-metallic diaphragm sealed to said housing to form a pressure chamber therein on one side of the diaphragm and providing an active contact cooperating with the passive contact, and a passageway in said housing in communication with said chamber and adapted for connection to a pressure generator whereby the active contact is moved rapidly between extreme positions in response to changes in temperature and pressure.

2. A temperature and pressure responsive electrical switch comprising a housing providing a passive contact, a sprung, bi-metallic diaphragm sealed to said housing to form a pressure chamber therein on one side of the diaphragm and providing an active contact cooperating with the passive contact, said diaphragm having a normal position and being movable away from said normal position only by pressure within said chamber and being maintained away from said normal position only at temperatures beyond a predetermined temperature, and a passageway in said housing in communication with said chamber

and adapted for connection to a pressure generator whereby the active contact is moved rapidly between extreme positions in response to changes in temperature and pressure.

3. The switch according to claim 2 wherein the diaphragm itself forms the active contact.

4. The switch according to claim 2 wherein a part of the housing itself forms the passive contact.

5. The switch according to claim 2 wherein the passive contact is separate from the housing and is supported by the housing.

6. The switch according to claim 1 wherein the passive contact is located within said chamber and the diaphragm is mounted with the metal thereof having the higher thermal coefficient of expansion toward the passive contact, whereby the contacts will be closed when a negative pressure is applied to said passageway and will remain closed while the diaphragm is heated.

7. An automatic cutout switch for controlling an electrical circuit energized by a storage battery receiving a charge from a generator driven by an internal combustion engine comprising a housing providing a passive contact within the housing, duct means communicating with the interior of said housing adapted for connection to a suction line of the fuel-vapor intake system of said engine to apply a vacuum to the interior of the housing when the engine is in operation, and a sprung, bi-metallic diaphragm sealed to said housing and providing an active contact cooperating with said passive contact and mounted with the metal thereof having the higher thermal coefficient of expansion toward the passive contact, whereby said contacts will close only when said engine is in operation and will remain closed only while the diaphragm is heated or the engine is in operation and said active contact is moved rapidly between extreme positions.

8. The switch according to claim 7 wherein both contacts are insulated from the housing.

9. The switch according to claim 7 wherein one of said contacts is grounded to said housing.

10. The switch according to claim 7 wherein said electrical contacts are connected in series with said electrical circuit.

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