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2 Sheets-Sheet 2

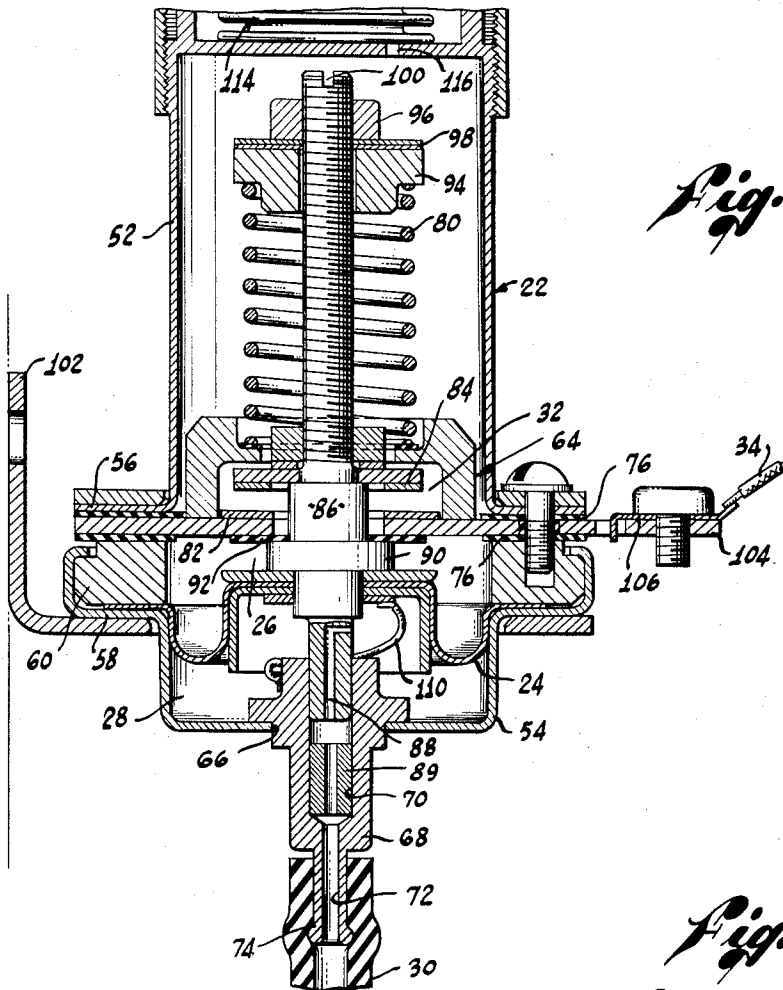


Fig. 3

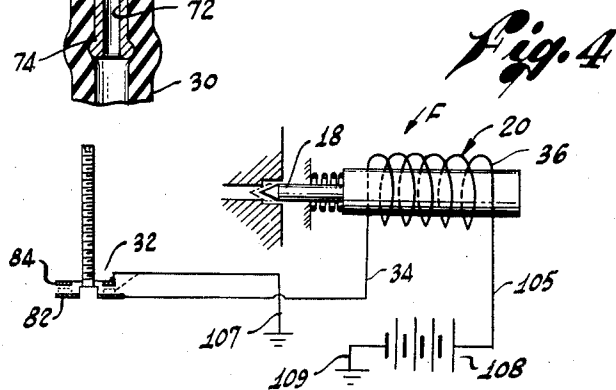


Fig. 4

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ELECTRICALLY ACTUATED FUEL SHUT-OFF APPARATUS

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13 Claims. (Cl. 261—39)

The present invention relates generally to internal combustion engines and more particularly to an electrically actuated fuel shut-off apparatus for use therewith.

It has been heretofore determined that the unburned products of combustion exhausted from the engine of an automotive vehicle constitute a prime source of the so-called "smog" which exists in and around the principal population centers of the country. The harmful effect of this smog upon animate and inanimate objects are very well known. It has been further determined that the largest percentage of these unburned products of combustion are exhausted from automotive vehicle engines during deceleration thereof.

It is a major object of the present invention to provide novel electrically actuated fuel shut-off apparatus for blocking the flow of fuel to the engine of an automotive vehicle during the deceleration thereof so as to reduce to a minimum the unburned products of combustion emitted from said engine.

Another object of the invention is to provide electrically actuated fuel shut-off apparatus employing a fuel shut-off member that is operated by an electric solenoid, together with a switching device for controlling the solenoid responsive to the value of the engine's intake manifold pressure.

A further object is to provide electrically actuated fuel shut-off apparatus of the aforescribed nature which is both positive and fool-proof in operation.

Yet another object is to provide electrically actuated fuel shut-off apparatus of the aforescribed nature which affords a rapid response to the increase in intake manifold vacuum occurring during deceleration so as to be extremely quick-acting.

A more particular object of the invention is to provide electrically actuated fuel shut-off apparatus of the aforescribed nature which is not affected by a change in elevation of the automotive vehicle whereon it is mounted.

A further object of the invention is to provide electrically actuated fuel shut-off apparatus of the aforescribed nature which is not affected by a change in temperature of the space wherein it is installed.

It is a further object to provide electrically actuated fuel shut-off apparatus that is simple in design and rugged of construction whereby it may afford a long and useful service life.

An additional object of the invention is to provide electrically actuated fuel shut-off apparatus which may be employed with any conventional internal combustion engine without requiring other than minor modifications thereof.

These and other objects and advantages of the present invention will become apparent from the following detailed description, when taken in conjunction with the appended drawings, wherein:

Figure 1 is a side elevational view of a preferred form of electrically actuated fuel shut-off apparatus embodying

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the present invention mounted upon the engine of an automotive vehicle;

Figure 2 is an enlarged view of said apparatus taken partly in vertical section;

Figure 3 is a further enlarged view of a component of said apparatus taken in central vertical section; and

Figure 4 is a diagrammatic view of a wiring circuit which may be employed with said apparatus.

Referring to the drawings, the preferred form of electrically actuated fuel shut-off apparatus embodying the present invention is shown mounted upon a conventional internal combustion engine E. This apparatus includes a fuel shut-off member F which is mounted upon a support 10 for the engine's carburetor 12, and a switching member S secured to the engine E below the fuel shut-off member F. Referring to Figure 2, during deceleration of the engine, the fuel shut-off member F is adapted to block the flow of fuel through an idling fuel conduit 14 formed through the carburetor support 10 and interconnecting the carburetor 12 and the interior of the engine's intake manifold 16. Although the exact construction of the fuel shut-off member F may vary without departing from the scope of the present invention, it will preferably include a metering pin 18 movable between its solid and dotted outline positions of Figures 2 and 4 under the influence of a suitable electric solenoid 20. The metering pin 18 is normally disposed in its dotted outline position of Figure 2 (solid outline position of Figure 4) so as to permit idling fuel to flow freely through the conduit 14. Upon deceleration of the engine E, however, the electric solenoid 20 will move the metering pin 18 to the latter's solid outline position of Figure 2 (dotted outline position of Figure 4) so as to positively block the flow of fuel through the conduit 14.

The switching member S includes a case, generally designated 22, wherein is mounted a pressure-responsive wall, such as a flexible metallic diaphragm 24. This diaphragm 24 divides the interior of the case 22 into an upper chamber 26 and a lower chamber 28. The lower chamber 28 is connected to the interior of the intake manifold by means of a flexible conduit 30, while the upper chamber 26 is sealed to the atmosphere. Preferably, the upper chamber 26 will be substantially evacuated. Although the diaphragm 24 is normally disposed in its unflexed position of Figure 3, during deceleration of the engine E it will undergo downward flexure to its position of Figure 2 under the influence of the intake manifold vacuum. An electric switch, generally designated 32, for controlling the electric solenoid 20 is disposed within the case 22. This switch 32 is normally open but is caused to be closed by downward flexure of the diaphragm 24. The solenoid 20 is connected to the switch 32 by suitable electric wiring 34. With this arrangement, the windings 36 of the solenoid 20 will be automatically energized during deceleration of the engine so as to cause the metering pin 18 to temporarily block the flow of fuel through the idling fuel conduit 14.

More particularly, the fuel shut-off member F includes a body 38, the front end of which is formed with an externally threaded nipple 40. This nipple 40 is threadedly secured within a socket 42 formed in the carburetor support 10 and intersecting the idling fuel conduit 14. The longitudinal axis of the metering pin 18 is aligned with an inlet bore 44 defining the lower end of the idling fuel conduit 14. With this arrangement, the pointed inner end of the metering pin 18 is adapted to seat against the outer periphery of the inlet bore 44 so as to positively block the flow of fuel into the vertical bore 46 of the carburetor support 10. The outer portion of the metering pin 18 is rigidly secured to the

core 48 of the electric solenoid 20. The metering pin 18 and solenoid core 48 are constantly biased outwardly, or to the right in the drawings, by a helical compression spring 50.

The switching member S is generally cylindrical in configuration. Its case 22 includes a cup-shaped cap 52 and a cup-shaped cover 54 disposed therebelow. The mounting flanges 56 and 58, respectively, of the cap 52 and the cover 54 are rigidly affixed to a mounting ring 60 by a plurality of bolts 62. The bolts 62 also serve to rigidly secure a spider member 64 to the mounting ring 60. The outer periphery of the flexible diaphragm 24 is sandwiched between the upper surface of the cover flange 58 and the underside of the mounting ring 60. The cover 54 is formed with a coaxial bore 66. A boss element 68 is rigidly affixed within this bore 66. The boss 68 is centrally formed with a guide bore 70, the lower end of which merges into a second bore 72 of smaller diameter which extends through a nipple 74 formed on the lower portion of the boss. This nipple 74 receives the upper end of the flexible conduit 30. The outer portion of the spider 64 is separated from the mounting ring 60 and the mounting flange 56 of the cap 52 by electrical insulating material 76.

The upper portion of the spider 64 coaxially receives the lower end of a coil compression spring 80. The lower portion of the spider 64 supports a bottom contact ring 82 of the electric switch 32. A complementary top contact ring 84 engageable with the lower contact ring 82 is rigidly affixed to the intermediate portion of an upstanding switch post 86 that is affixed to the center of the flexible diaphragm 24. The lower end of the switch post 86 is slidably disposed within the guide bore 70 of the boss 68. A passage 88 is formed through the lower portion of this post for effecting communication between the lower chamber 28 and the flexible conduit 30. Preferably a centrally bored, permanent magnet 89 is fixedly disposed within the lower end of the passage 88 for a purpose to be set forth hereinafter. Above the diaphragm 24 the switch post 86 is formed with a bumper collar 90. A ring 92 of electrical insulating material is positioned upon the upper surface of this bumper collar 90. The upper portion of the switch post 86 is threaded and carries an annular spring retainer 94, such retainer being axially movable relative to the post. The compression spring 80 is interposed between the underside of the spring retainer 94 and the spider 64. It is secured against upward movement by a suitable nut 96 threaded upon the upper portion of the switch post 86. A thermal-responsive bi-metallic washer 98 will preferably be interposed between the upper side of the spring retainer 94 and the underside of the nut 96. The purpose of this bi-metallic washer will be fully set forth hereinafter. The effective force of the spring 80 may be adjusted by rotating the nut 96 relative to the switch post 86. A slot 100 may be formed in the upper end of the post for the reception of a tool which will restrain the post against rotation as the nut 96 is rotated relative thereto. The case 22 may be secured to the engine E by a suitable generally L-shaped bracket 102. The right-hand side of the spider 64 is formed with an extension 104 that receives a suitable electric terminal 106 for connection with the wiring 34.

A generally cylindrical hollow head member 110 is threadably secured to the upper portion of the cap 52. The interior of this head 110 is in communication with the interior of the intake manifold 16 by means of a flexible conduit 112. A metallic bellows 114 is coaxially positioned within the head 110 with its interior in communication with the interior of the cap 52 by means of an aperture 116. A coil compression spring 118 is interposed between the upper end of the bellows 114 and the top of the head 110. The interior of the head 110

is sealed to the atmosphere by a suitable sealing ring 120.

Referring now to Figure 4, there is shown a suitable electrical wiring circuit which may be employed with the aforescribed apparatus. One side of the solenoid windings 36 is connected to the first terminal of a suitable source of electric current 108 by an electric conduit 105. The other side of these windings is connected to the bottom contact ring 82 of the electric switch 32 by conduit 34. The top contact ring 84 and the second terminal of the electric current source 108 are grounded by conduits 107 and 110, respectively.

In the operation of the aforescribed apparatus, the spring 80 will normally retain the switch post 86 in its raised position of Figure 3. At this time, the top contact ring 84 will be spaced from the bottom contact ring 82 and no current will flow through the solenoid windings 36. During deceleration of the engine E, however, the intake manifold vacuum will reach sufficient magnitude as to effect downward flexure of the diaphragm 24 to its position of Figure 2. The top contact ring 84 will then be engaged with the bottom contact ring 82 so as to in effect close the electric switch 32. This will cause electric current from the source 108 to energize the solenoid windings 36 and the solenoid core 48 will be urged to the left with respect to Figures 2 and 4. Such movement of the solenoid core 48 will effect concurrent movement of the metering pin 18 so as to cause its pointed front end to block the flow of fuel through the idling fuel conduit 14. At the conclusion of the deceleration period, the spring 80 will again urge the switch post 86 and hence the top contact ring 84 upwardly to their position of Figure 3. The compression spring 50 will then return the solenoid core 48, and hence the metering pin 18, to the right relative to Figures 2 and 4 so as to withdraw the pointed front end of the metering pin 18 from the inlet bore 44 of the idling fuel of conduit 14. It should be particularly noted that the use of the permanent magnet 89 within the lower end of the passage 88 serves to prevent flutter of the switch post 86 by positively locking the contact rings together. In this manner, damage due to electrical arcing of these contact rings is avoided.

It should be especially noted that the operation of the aforescribed apparatus, for practical purposes, is not affected by a change in elevation of the automotive vehicle wherein it is installed. Thus, it will be apparent that as the automotive vehicle moves to a higher elevation, the magnitude of the downwardly-acting force exerted by the engine's intake manifold pressure upon the flexible diaphragm 24 at a given rotational speed will decrease. Hence, in the absence of a special provision for counteracting such decrease, the diaphragm 24 would be expected to undergo downward flexure at a later time during a deceleration period than would be the case at sea level. Under these circumstances the metering pin 18 would not be moved into position to block the flow of fuel through the idling conduit 14 at the proper time during the deceleration cycle. In order to prevent such occurrence, the present invention contemplates a special provision for supplementing the downwardly-acting force effected by the intake manifold vacuum. Thus, as noted hereinabove, the upper chamber 26 is sealed to the atmosphere. Accordingly, upon an increase in elevation, the resulting decrease in atmospheric pressure acting upon the underside of the flexible diaphragm will tend to supplement the downwardly-acting force created within the lower chamber 28 by the intake manifold vacuum. Such an increase in supplemental downwardly-acting force will be proportional to the increase in elevation. Accordingly, even though the magnitude of the downwardly-acting force effected by the intake manifold vacuum upon the flexible diaphragm 24 will tend to diminish with an increase in elevation, the supplemental downwardly-acting force exerted thereon will increase in substantially the same amount. It is also necessary to compensate for the

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reduced downwardly acting force of the air within the upper chamber 26. In this regard, assuming the upper chamber has been sealed at sea level, the pressure exerted against the upper surface of the diaphragm 24 would be 14.7 pounds per square inch. As the altitude is increased to 10,000 feet, the downwardly-acting pressure against the upper surface of the diaphragm 24 would drop to approximately 10.1 pounds per square inch. In order to compensate for this differential, the bellows 114 will tend to collapse so as to increase the pressure within the upper chamber 26. In this regard, as noted hereinabove, the interior of the head 110 is in communication with the intake manifold 16 by the flexible conduit 112. Thus, although the downwardly acting force exerted by the spring 118 remains constant, the vacuum within the head 110 diminishes proportionately to the elevation. Accordingly, the spring 118 is enabled to compress the bellows 114.

It should likewise be noted that the operation of the aforescribed apparatus will not be affected by a change in the temperature of the space wherein it is mounted. Thus, it will be apparent that an increase of the temperature in the space adjacent the engine E will be transmitted to the case C. Such an increase in temperature will increase the pressure within the upper chamber 26 of the case and thereby tend to effect downward flexure of the flexible diaphragm 24 independently of any downward force created by the intake manifold vacuum. Such downward force will be counteracted, however, by the effect of the aforescribed thermal-responsive bi-metallic washer 98. This washer 98 is so designed that it will tend to assume a cupped configuration with an increase in temperature. As the washer 98 assumes such a cupped configuration it will necessarily effect downward movement of the spring retainer 94 relative to the spring post 86. Such downward movement of the spring retainer 94 will in turn shorten the length of the compression spring 80 and thereby augment its effective upwardly-acting force. Such an increase in the upwardly-acting force of the spring 80 will counteract any increased downwardly-acting pressure applied to the upper surface of the diaphragm 24.

From the foregoing description it will be apparent that the electrically actuated fuel shut-off apparatus of the present invention will be both positive and fool-proof in operation. Additionally, its operation will not be affected by a change in elevation of the automotive vehicle wherein it is mounted nor by a rise in temperature within the space wherein it is installed. The apparatus has but few working parts and will thereby be comparatively inexpensive to manufacture and maintain and will be capable of providing a long and trouble-free service life. Although the switching member S is shown in conjunction with the fuel shut-off member F, it will be apparent that other forms of fuel shut-off members may likewise be employed with this particular switching member.

Various other modifications and changes may be made with respect to the foregoing detailed description without departing from the spirit of the invention or the scope of the following claims.

I claim:

1. Electrically actuated fuel shut-off apparatus for use with an internal combustion engine having an intake manifold, an electric circuit and a source of electric current, comprising: a fuel shut-off member that includes an electric solenoid connected to said circuit; a case; a pressure-responsive wall mounted within said case so as to define first and second chambers, said second chamber being sealed to the atmosphere; a first contact secured to said case and connected to said circuit; a second contact carried by said wall and connected to said circuit; resilient means constantly opposing flexure of said wall whereby said second contact will normally be maintained spaced from said first contact; means for placing said first chamber in communication with the interior of said intake manifold; a third chamber; means for placing said third

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chamber in communication with the interior of said intake manifold; a collapsible pressure member within said third chamber and communicating with said second chamber; and resilient means for exerting a constant force tending to collapse said pressure member.

2. Electrically actuated fuel shut-off apparatus as set forth in claim 1 which includes thermal-responsive means for increasing the force of said resilient means opposing flexure of said wall towards said first chamber in an amount proportional to the increase in temperature within said case.

3. Electrically actuated fuel shut-off apparatus for use with an internal combustion engine having an intake manifold, an electric circuit and a source of electric current, comprising: a fuel shut-off member that includes an electric solenoid connected to said circuit; a case; a pressure-responsive wall mounted within said case so as to define first and second chambers, said second chamber being sealed to the atmosphere; a post carried by said wall; switch means for controlling said solenoid, said switch means including a first contact secured to said case and a second contact formed on said switch post with both contacts connected to said circuit; a spring retainer axially slidably disposed upon said post; connection means for securing said spring retainer to said post, said connection means permitting the axial adjustment of said spring retainer relative to said post; spring means interposed between said case and said spring retainer for constantly opposing flexure of said wall towards said first chamber whereby said second contact will normally be maintained spaced from said first contact; means for placing said first chamber in communication with the interior of said intake manifold; a third chamber; means for placing said third chamber in communication with the interior of said intake manifold; a collapsible pressure member within said third chamber and communicating with said second chamber; and resilient means for exerting a constant force tending to collapse said pressure member.

4. Electrically actuated fuel shut-off apparatus for use with an internal combustion engine having an intake manifold, an electric circuit and a source of electric current, comprising: a fuel shut-off member that includes an electric solenoid connected to said circuit; a case; a pressure-responsive wall mounted within said case so as to define first and second chambers, said second chamber being sealed to the atmosphere; a spider mounted within said case; a switch post carried by said wall and extending through said spider; switch means for controlling said solenoid including a first contact mounted on said spider and a second contact formed on said post, both contacts being in said circuit; a spring retainer axially slidably disposed upon said switch post; connection means for securing said spring retainer to said post, said connection means permitting the axial adjustment of said spring retainer relative to said post; spring means interposed between said case and said spring retainer for constantly opposing flexure of said wall towards said first chamber whereby said second contact will normally be maintained spaced from said first contact; means for placing said first chamber in communication with the interior of said intake manifold; a third chamber; means for placing said third chamber in communication with the interior of said intake manifold; a collapsible pressure member within said third chamber and communicating with said second chamber; and resilient means for exerting a constant force tending to collapse said pressure member.

5. Electrically actuated fuel shut-off apparatus as set forth in claim 4 wherein thermal-responsive means are interposed between said post and said spring means for increasing the force of said spring means opposing flexure of said wall in an amount proportional to the increase in temperature within said case.

6. Electrically actuated fuel shut-off apparatus as set forth in claim 5 wherein said thermal-responsive means

consists of a bi-metallic washer interposed between said spring retainer and said connection means.

7. Electrically actuated fuel shut-off apparatus for use with an internal combustion engine having an intake manifold, carburetor means and a shut-off member operatively connected to said carburetor means for temporarily blocking the flow of idling fuel to said engine during deceleration; an electric circuit and a source of electric current, comprising: a case; a pressure-responsive wall mounted within said case so as to define first and second chambers, said second chamber being sealed to the atmosphere; a post secured to said wall; switch means for controlling said shut-off member including a first contact secured to said case and a second contact carried by said post, said contacts being connected with said circuit; spring means interposed between said case and said post constantly opposing flexure of said wall towards said first chamber whereby said second contact will normally be maintained spaced from said first contact; means for placing said first chamber in communication with the interior of said intake manifold; a third chamber; means for placing said third chamber in communication with the interior of said intake manifold; a collapsible pressure member within said third chamber and communicating with said second chamber; and resilient means for exerting a constant force tending to collapse said pressure chamber.

8. Electrically actuated fuel shut-off apparatus for use with an internal combustion engine having an intake manifold and carburetor means formed with an idling fuel conduit; an electric circuit and a source of electric current, comprising: a fuel shut-off member that includes a metering pin normally permitting fuel to flow through said idling fuel conduit and an electric solenoid that when energized urges said metering pin to a position blocking flow of fuel through said idling fuel conduit, said solenoid being arranged in said circuit; a case; a pressure-responsive wall mounted within said case so as to define first and second chambers, said second chamber being sealed to the atmosphere; electric switch means arranged in said circuit and operatively connected to said wall, said switch means when closed causing said solenoid to be energized; means for placing said first chamber in communication with the interior of said intake manifold; a third chamber; means for placing said third chamber in communication with the interior of said intake manifold; a collapsible pressure member within said third chamber and communicating with said second chamber; and resilient means for exerting a constant force tending to collapse said pressure member.

9. Electrically actuated fuel shut-off apparatus as set forth in claim 8 which includes thermal-responsive means for increasing the force of said resilient means opposing flexure of said wall towards said first chamber in an amount proportional to the increase in temperature within said case.

10. Electrically actuated fuel shut-off apparatus for use with an internal combustion engine having an intake manifold and carburetor means formed with an idling fuel conduit; an electric circuit and a source of electric current, comprising: a fuel shut-off member that includes a metering pin normally permitting fuel to flow through said idling fuel conduit and an electric solenoid that when energized urges said metering pin to a position blocking flow of fuel through said idling fuel conduit, said solenoid being arranged in said circuit; a case; a pressure-responsive wall mounted within said case so as to define first and second chambers; said second chamber being sealed to the

atmosphere; a post secured to said wall; electric switch means which when closed causes said solenoid to be energized; said switch means including a first contact secured to said case and a second contact carried by said post with said contacts being arranged in said circuit; spring means interposed between said case and said post constantly opposing flexure of said wall towards said first chamber whereby said second contact will normally be maintained spaced from said first contact; means for placing said first chamber in communication with the interior of said intake manifold; a third chamber; means for placing said third chamber in communication with the interior of said intake manifold; a collapsible pressure member within said third chamber and communicating with said second chamber; and resilient means for exerting a constant force tending to collapse said pressure member.

11. Electrically actuated fuel shut-off apparatus as set forth in claim 10 which includes thermal-responsive means for increasing the force of said spring means opposing flexure of said wall towards said first chamber in an amount proportional to the increase in temperature within said case.

12. Electrically actuated fuel shut-off apparatus for use with an internal combustion engine having an intake manifold, and carburetor means formed with an idling conduit, an electric circuit and a source of electric current, comprising: a fuel shut-off member that includes a metering pin normally permitting fuel to flow through said idling fuel conduit and an electric solenoid that when energized urges said metering pin to a position blocking flow of fuel through said idling fuel conduit, said electric solenoid being arranged in said electric circuit; a generally cylindrical case; a transverse pressure responsive wall mounted within said case so as to define first and second chambers, said second chamber being sealed to the atmosphere; a spider mounted within said case; an axial switch post coaxially carried by said wall and extending through said spider; switch means for controlling said solenoid including a first contact mounted on said spider and a second contact formed on said post, both contacts being arranged in said circuit; a spring retainer carried by said post; spring means interposed between said spider and said spring retainer for constantly opposing flexure of said wall towards said first chamber whereby said second contact will normally be maintained spaced from said first contact; means for placing said first chamber in communication with the interior of said intake manifold whereby upon deceleration of said engine said wall will undergo flexure towards said first chamber and said second contact will be engaged with said first contact so as to close said switch means; and thermal-responsive means interposed between said post and said spring means for increasing the force of said spring means opposing flexure of said wall in an amount proportional to the increase in temperature within said case.

13. Electrically actuated fuel shut-off apparatus as set forth in claim 12 wherein said thermal-responsive means consists of a bi-metallic washer interposed between said spring retainer and said post.

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