

[54] **TEMPERATURE RESPONSIVE IDLING SPEED CONTROL DEVICE FOR INTERNAL COMBUSTION ENGINE**

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[51] Int. Cl. **F02p 5/04, F01p 5/14, F02m 23/04**

[58] Field of Search **123/117 R, 117 A, 124 A, 124 B, 123/41.13, 41.15**

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[57] **ABSTRACT**

Temperature responsive idling speed control device for internal combustion engine arranged to reduce the noxious gases when the engine runs at idle, and to prevent overheating of the engine during idling conditions. The speed control device is in the form of a vacuum control valve controlling the advancing and retarding of the spark of the engine, a normally closed switch and a solenoid energized through the switch, controlling the position of the butterfly valve of the carburetor for the engine during idling conditions. The switch is a part of the vacuum control valve and is operated by a thermally responsive element in direct association with the water jacket of the engine. When the switch is closed during normal idling conditions with the spark retarded, the solenoid is energized to hold the butterfly valve open a slight amount. As the temperature of the engine rises sufficiently to cause overheating of the engine during idling, the vacuum control valve is moved to connect the automatic spark advance to manifold vacuum, and advance the spark to increase engine speed. The temperature rise operating the vacuum control valve also opens the switch to deenergize the solenoid and accommodate the butterfly valve to close and prevent excessive engine speed when the engine is running hot with the spark advanced.

12 Claims, 3 Drawing Figures

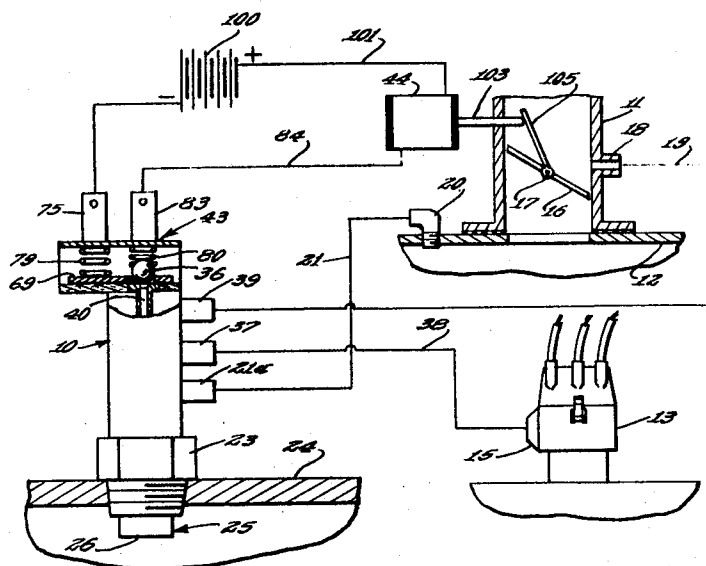


Fig. 2

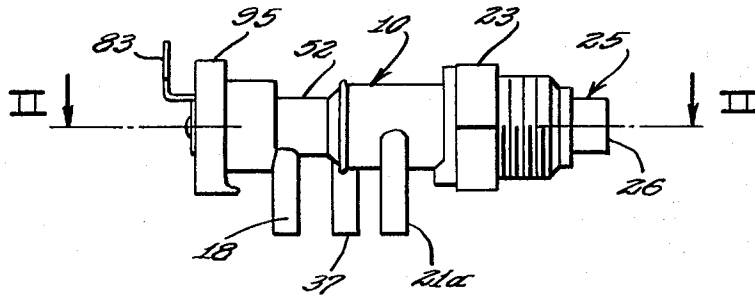
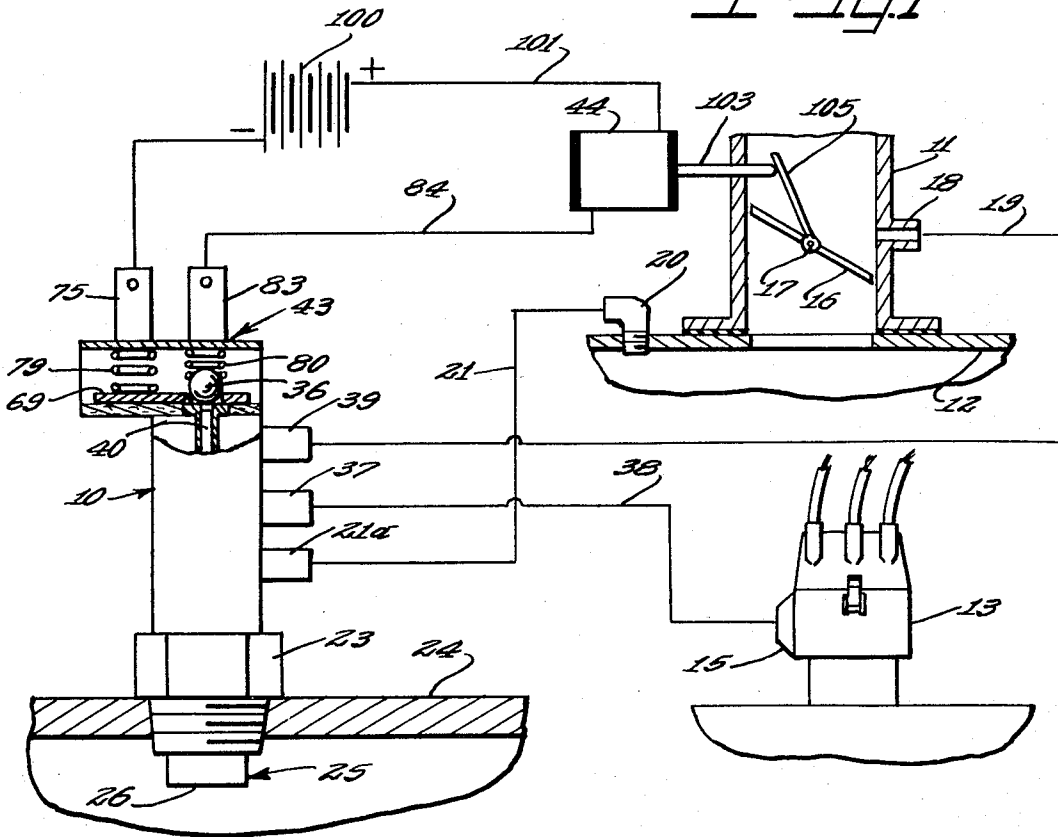


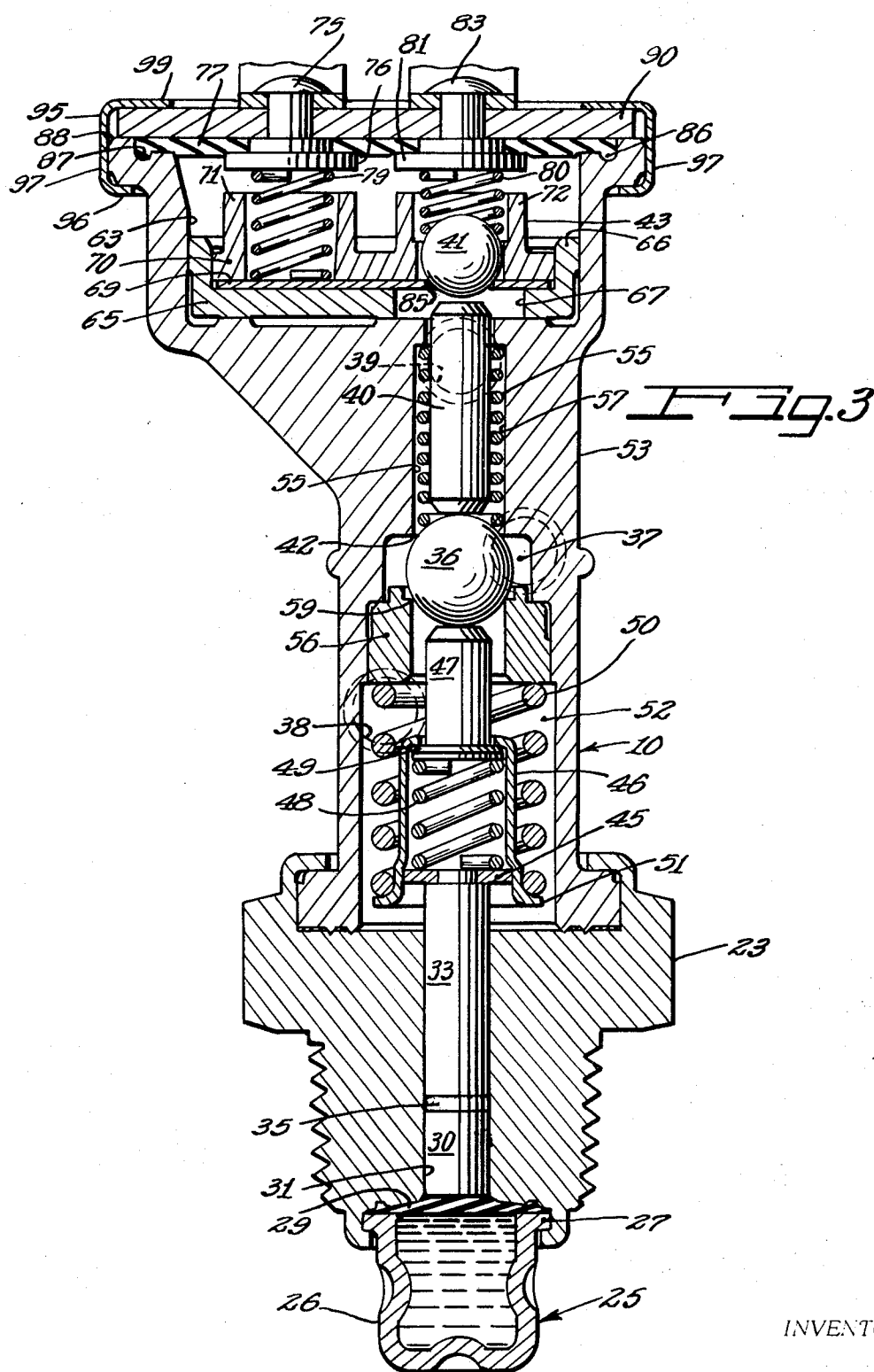
Fig. 1



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TEMPERATURE RESPONSIVE IDLING SPEED CONTROL DEVICE FOR INTERNAL COMBUSTION ENGINE

BACKGROUND, SUMMARY AND OBJECTS OF INVENTION

Heretofore, thermally responsive vacuum control valves have been used as a part of emissions controls systems for internal combustion engines, and operate to connect the automatic spark advance to carburetor vacuum, during idling, resulting in a retarded spark and relatively "clean" operation of the engine at idle, and a reduced emission of noxious gases during idling. As the engine temperatures have increased to an overheated condition due to the retarded spark, the automatic spark advance has been connected to manifold vacuum advancing the spark and the resultant speed of the engine with a reduction in the operating temperature of the engine.

While such vacuum control valves have been satisfactory, it has been difficult to control the speed at idle conditions both when the spark is retarded and advanced with the result that when the carburetor is adjusted to operate at the proper speed during idling with the spark retarded the engine speed increases an excessive amount for idling as the spark is advanced.

By the vacuum control valve and switch of the present invention, the automatic spark advance is connected to carburetor vacuum under low temperature idling conditions of the engine and a solenoid is engageable with the butterfly valve of the carburetor to open the valve an amount sufficient to increase engine speed to the extent that it will reduce overheating of the engine when idling with a retarded spark, and as the engine approaches overheating conditions, will connect the automatic spark advance to manifold vacuum and advance the spark and close the butterfly valve of the carburetor, to prevent excessive speed of the engine at idle with the spark advanced.

It is, therefore, an object of the present invention to reduce air pollution by reducing the amount of noxious gases discharged to the atmosphere from internal combustion engines during idling, and to prevent excessive speed of the engine during idling as the spark is advanced, due to temperature rises of the engine.

Another object of the invention is to provide a means for controlling the speed of an internal combustion engine during idling which acts as a function of the operating temperature of the engine.

Another object of the invention is to provide a normally closed switch operated by a vacuum control valve for automatically advancing and retarding the spark of an internal combustion engine, arranged to control the position of the butterfly valve of the carburetor dependent upon engine operating conditions.

Still another object of the invention is to provide a temperature responsive normally closed switch and vacuum control valve, which is simple in construction, inexpensive to manufacture, reliable in operation and capable of serving a long and useful life.

Other objects, features and advantages of the invention will be readily apparent from the following description of a preferred embodiment thereof, taken in conjunction with the accompanying drawings, although variations and modifications may be effected without departing from the spirit and scope of the novel concepts of the disclosure.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view diagrammatically illustrating the valve and switch and the control system for controlling engine speed at both cool and overheated conditions.

FIG. 2 is a view in side elevation of a vacuum control valve and switch constructed in accordance with the principles of the present invention; and

FIG. 3 is a sectional view taken substantially along line III—III of FIG. 2.

DESCRIPTION OF PREFERRED EMBODIMENT OF INVENTION

In FIG. 1 of the drawings, a vacuum control valve and thermally responsive switch 10 is shown as connected in the fuel supply and ignition system for an internal combustion engine, for controlling the idling speed of the engine both during normal idling and overheated conditions of the engine. The fuel supply and ignition system includes a conventional carburetor having an air intake passageway 11 supplying a mixture of air and fuel to an intake manifold 12 of the internal combustion engine, directing the mixture of air and fuel to the various cylinders of the engine. The system also includes a distributor 13 directing current to the spark plugs of the engine in a preselected timed relation and having an automatic spark advance, generally indicated by reference numeral 15 governing the time of firing of the spark plugs with respect to the positions of the respective pistons of the engine, during the compression and power strokes of the engine. The air intake 11 has a butterfly valve 16 pivotally mounted therein, on a pivot pin 17, and controlling the supply of air and fuel to the intake manifold 12. Upstream of the butterfly valve 16 is a vacuum fitting 18 connecting the automatic spark advance 15 to carburetor vacuum through a vacuum line 19 and a fitting 39 leading from the valve 10 and through a fitting 37 leading into the valve and a vacuum line 38 leading from the spark advance 15, under low temperature idling conditions of the engine, and effecting idling of the engine under retarded spark conditions. A fitting 20 in the intake manifold is connected with the valve 10 through a vacuum line 21 and connects the valve 10 to manifold vacuum through a fitting 21a leading from the valve and connects the automatic spark advance to manifold vacuum through the fitting 37 and vacuum line 38, to advance the spark as the temperature of the engine rises to temperatures approaching overheating of the engine.

The thermally response vacuum control valve and normally closed switch 10 is mounted on a threaded coupling member 23 threaded in a cylinder head 24 of the engine, and positioning a thermally responsive element 25 in the water jacket of the engine.

The thermally responsive element 25 is shown as including a casing 26 containing a fusible thermally expandable material, such as a wax or a mixture of wax with a powdered metal heat conducting material, with or without a binder, to attain a material which will expand in its fusion range, at a temperature range selected for operation of the valve and switch.

As shown in FIG. 3, the casing 26 has a flange 27 abutting a resilient diaphragm 29. The flange and diaphragm are sealed to the coupling member 23 by

crimping an axially flanged portion of the coupling member over the flange 27. A piston 30 is slidably guided in a bore 31 of the coupling member 23 and is spaced from an extensible power member 33 as by a spacer 35.

The power member 33 as moved in an extensible direction by the temperature sensing element 25 unseats a ball-type valve 36 from a seat 59 and seats said valve on a vertically spaced seat 42 to block communication between the fitting 18 and carburetor vacuum line 19 and the output vacuum fitting 37, and afford communication between the outlet vacuum fitting 21a and the distributor fitting 37 and vacuum line 38 and the automatic spark advance 15. Extensible movement of the power member 33 will also effect the extensible movement of a plunger 40 engaging the opposite side of the valve 36 from the power member 33, and unseating a contact ball 41 forming a contact for a normally closed switch 43, energizing the coil of a solenoid 44 when the switch is closed.

The power member 33 has a disk 45 seated on its upper end engageable within a shouldered portion of a downwardly opening bell-like cage 46. The cage 46 slidably extends along a plunger 47 and is retained to said plunger by an overtravel spring 48, seated on the disk 45 at one end and on a flanged portion 49 of the plunger 47 at its opposite end. The spring 48 accommodates continued travel of the power member 33 as the ball valve is seated on the valve seat 42 and thereby prevents damage to the thermally responsive element upon overtravel conditions. A return spring 50 encircles the cage 46 and plunger 47 and is seated at its lower end on a flanged portion 51 of the cage 46 and at its upper end on an insert 56 seated in a valve chamber 52 of a housing 53 for the valve.

A return spring 57 in a cylindrical passageway 55, forming an upward continuation of a valve chamber 52, encircles the plunger 40 and abuts the ball valve 36 at its lower end to bias the valve 36 into engagement with a seat 59 in the insert 56, and out of engagement with the seat 42, to thereby block the flow of manifold vacuum out of the valve housing through the port 21a, but accommodate carburetor vacuum to draw vacuum through the fitting 37 and vacuum line 38.

The switch 43 is carried in an enlarged cavity 63 in the upper end of the valve housing 53 and opening toward the top of the valve body. An insulator 65 is seated in the cavity 63 and generally conforms to the form thereof.

Said insulator 65 has an upright wall 66 extending thereabout and an opening 67 in the bottom thereof registering with the plunger 40, accommodating the plunger 40 to engage the ball contact 41 and open the circuit through the switch. A contact plate 69 is seated in the bottom of the insulator 65 within the flanged portion thereof and forms the stationary contact of the switch and has an open portion 85 in axial alignment with the plunger 40 and forming a seat for the contact 41. As shown in FIG. 3, an insulator 70 is seated in the insulator 65 and abuts the top surface of the contact 69. The insulator 70 has two laterally spaced annular wall portions 71 and 72 extending upwardly of its base. The wall portion 71 is in alignment with a contact 75, which may have connection with the negative side of a source of power, such as a storage battery 100. The

contact 75 has a flanged head 76 at its inner end, abutting the underside of a gasket 77, and forming a seat for a spring 79 forming a current conductor from the contact 75 to the contact plate 69.

The annular wall portion 72 forms a guide for the contact ball 41 and for a compression spring 80 seated against a flanged head portion 81 of a contact 83, which may be connected with the solenoid 44 through a conductor 84, to energize said solenoid as the ball contact 41 is seated in the open portion 85 extending through the contact plate 69, in axial alignment with the axial center of the plunger 40.

The gasket 77 forms an insulator for the contacts 75 and 83 and has a depending bead 86 extending thereabout engageable within an upwardly opening recess 87 extending about a flange 88 extending laterally from the upper margins of the portion of the valve housing 53 defining the receptacle 63. The gasket 77 is abutted at its upper side by an insulator plate 90, forming a mounting for the contacts 75 and 83. A clamping ring 95 has an inwardly curled bottom flange 96 engaging the underside of the flange 88 and has a wall 97 extending vertically therefrom about the periphery of the flange 88 and also has an inwardly curled top flange 99 curled about the top side of the insulator 90 and maintaining the insulator in engagement with the top surface of the flange 88 and sealing the gasket to the annular recess 87, to form a seal for the valve and switch.

The coil of the solenoid 44 is connected with a source of power shown as being a battery 100, through a conductor 101 and is connected with the contact 83 of the switch 43 through the conductor 84. The solenoid 44 has an armature 103 extensible from the solenoid coil upon energization of said coil, as the switch 43 is closed. The armature 103 is slidably guided in the air intake 11 in a suitable manner and is shown for illustrative purposes as having engagement at its inner end with an arm 105 extending upwardly of the pivot pin 17 for the butterfly valve 16 and connected with said valve, it being understood that the armature 103 in practice would actuate a throttle plate linkage outside the carburetor. As the solenoid coil is energized, the armature 103 engaging the arm 105 will move the butterfly valve 16 to slightly open the throttle for increased speed of the engine at the idle position of the throttle, when the spark is retarded. As the coil for the solenoid is deenergized the butterfly valve 16 will be returned to its normal idle position and prevent an engine dieseling condition as the engine is shut off.

In operation of the engine during normal car operation, the electrical switch 43 is in its normally closed position and provides an energizing circuit to the solenoid coil 44. When, however, an overheated condition occurs during idling of the engine, the thermally responsive element 25 moves the ball valve 36 off of the seat 59 and into engagement with the seat 42 to afford communication between the manifold vacuum line 21 and fitting 21a and the vacuum output fitting 37, connecting the automatic spark advance to a source of manifold vacuum to effect advance of the spark to increase the speed of the engine and reduce the temperature of the engine.

As the spark is advanced the ball 36 will also move the plunger 40 to engage the ball contact 41 and lift

said contact off the contact plate 69 and deenergize the coil for the solenoid 44. This will accommodate retractable movement of the armature 103, to release the arm 105 and allow the butterfly valve 16 to move toward a predetermined normal idle position and prevent excessive rpm of the engine when idling.

Thus, during operation of the engine when the engine is started the extensible power member 33 will be retracted and the spring 80 will engage the ball contact 41 with the contact seat 85 in the contact plate 69 and complete a circuit through the contacts 75 and 83 and connect the solenoid coil 44 to a source of electrical power such as the battery 100. The armature 103 will thus be extended to open the butterfly valve 16 a preselected amount, and the automatic spark advance will retard the spark. The engine will then idle, and since the spark is retarded, combustion will be substantially complete and the exhaust gases will be clean.

As, however, the engine temperature increases, due to operation of the engine with a retarded spark, even with the engine running at a fast idling speed due to the partial opening of the butterfly valve 16, and the engine approaches a hot condition, the thermally responsive material of the thermal element 25 will expand and effect movement of the plunger 47 to seat the ball valve 36 on the seat 42 and move the plunger 40 to raise the ball contact 41 off of the contact plate 69.

This will connect the automatic spark advance to manifold vacuum and will also break the circuit between the contacts 75 and 83 of the switch 43 and deenergize the coil of the solenoid 44. The valve 16 may then return to its normal idling position and continue operation at idle speed under an advanced spark until the engine again cools down sufficiently to accommodate retraction of the piston 30 and power element 33, and thereby accommodate the spring 50 to close the contacts of the switch 43, and will also effect movement of the valve 36 to block the passage of manifold vacuum to the distributor and connect the distributor with a source of carburetor vacuum. The engine will again idle with a retarded spark and substantially complete combustion until the engine temperature approaches an overheated condition.

I claim as my invention:

1. An idler speed control device for an internal combustion engine ignition and carburetion system including, a distributor having a vacuum operated automatic spark advance, a carburetor including an air intake passageway and a butterfly valve positioned in the passageway and an intake manifold downstream of the valve, the improvement comprising,

electrical energizable means, an operative connection between said electrically energizable means and the butterfly valve maintaining said butterfly valve in a predetermined open position during idling of the engine with the spark retarded, and accommodating the butterfly valve to move to a normal idle position and prevent excessive engine speed at idle upon increases in engine temperature above a normal engine temperature and the advance of the spark.

2. The idle speed control device of claim 1, wherein the electrical energizable means includes, a normally closed switch, a solenoid energized by said switch when closed,

an operative connection between said solenoid and the butterfly valve, holding said butterfly valve in a predetermined open position during energization of said solenoid and idling of the said engine with a retarded spark, and a thermally responsive element effective upon predetermined increases in engine temperature above normal engine temperatures, to open said switch and deenergize said solenoid to accommodate said butterfly valve to move to a normal idling position and to effect the advance of said spark.

3. The idler speed control of claim 2,

wherein the thermally responsive element senses the temperature of water in the water jacket of the engine, and

wherein a vacuum control valve is provided to connect the automatic spark advance to manifold vacuum upon predetermined increases in engine temperature with the spark retarded, as said normally closed switch opens to deenergize said solenoid and to accommodate the return of said butterfly valve to a normal idle position as the spark is advanced.

4. The idler speed control device of claim 3,

wherein the butterfly valve has an arm extending therefrom, and

wherein the solenoid includes an armature engageable with said arm and providing a connection between said solenoid and said butterfly valve, holding said butterfly valve in a predetermined open position upon energization of said solenoid as the spark is retarded.

5. The idle speed control device of claim 2,

wherein the thermally responsive element is positioned in the water jacket of the internal combustion engine,

wherein valve means are operated by said thermally responsive element to connect the distributor to carburetor vacuum and effect retarding of the spark for idling when the engine temperature is at a predetermined low temperature and to connect the distributor to manifold vacuum to advance the spark when the engine is running hot, due to idling with the spark retarded, and an operative connection from said valve means to said switch to effect opening of said switch and deenergization of said solenoid to effect the return of said butterfly valve to a normal idle position upon engine temperatures approaching overheating.

6. The idle speed control of claim 5,

wherein the butterfly valve has an arm extending therefrom, and

wherein the solenoid includes a coil and an armature extensible relative to said coil upon energization of said coil, and engageable with said arm to provide a direct connection between said solenoid and said butterfly valve to move said butterfly valve to a predetermined open position upon energization of said solenoid and idling of the engine with the spark retarded.

7. In a vacuum control valve and switch assembly particularly adapted to control the position of the carburetor butterfly valve during engine idling conditions as a function of internal combustion engine temperature and in combination with a carburetor, distributor,

automatic spark advance for the distributor and butterfly valve in the carburetor manifold, supplying a mixture of fuel and air to the intake manifold of the engine, a valve housing having a valve chamber therein having a vacuum outlet port for carburetor vacuum upstream of the butterfly valve,

- a vertically spaced vacuum output port for connection with the automatic spark advance and distributor of the engine and
- a manifold vacuum outlet port for connection with the automatic spark advance for supplying the vacuum to advance the spark upon certain predetermined engine temperature conditions,
- a valve member in said housing biased into a first position to afford communication between said carburetor vacuum outlet port and said vacuum output port for connection with the distributor,
- a thermally responsive element, responsive to the operating temperature of the engine for moving said valve member against its bias to afford communication between said manifold vacuum outlet port and said distributor output port upon predetermined increases in engine temperature,
- an electrical switch contained within said housing and including a contact normally biased into a closed position,
- electrical energizable means operated by said switch for moving said butterfly valve to a predetermined open position during idling of the engine with a retarded spark, and
- an operative connection between said valve member and said switch, opening said switch upon movement of said valve into position to connect said manifold vacuum outlet to said distributor output port, to effect advance of the spark and movement of said butterfly valve to a normal idling position upon predetermined overheated conditions of the engine.

8. The vacuum control valve and switch assembly of claim 7, in which the thermally responsive element is positioned in the water jacket of the internal combustion engine and has a power member extensible along said valve housing to effect operation of said valve member to connect the automatic spark advance to manifold vacuum to effect advance of the spark and to open said normally closed switch to allow said butterfly valve to return to a normal idling position.

9. The vacuum control valve and switch assembly of claim 7,

- wherein a switch chamber opens to the end of said housing,
- wherein a closure is provided for said chamber and contains spaced contacts, one of which is in direct axial alignment with said valve,
- wherein a contact plate is mounted in said switch chamber and insulated therefrom,
- wherein means are provided to electrically connect

one terminal with said contact plate, wherein a movable contact member is in alignment with said other terminal and has electrical connection therewith, and is biased into engagement with said contact plate in axial alignment with said valve, and

wherein an operating member operated by movement of said valve from a position to connect the distributor output port to manifold vacuum, is effective to break the electrical connection between said contacts and accommodate the carburetor butterfly valve to move to a normal operating position upon advance of the spark and idling of the engine.

10. The vacuum control valve and switch assembly of claim 9,

- wherein the closure for said switch chamber is an insulator plate,
- wherein a gasket member is provided between said insulator plate and end of said switch chamber, and

- wherein a clamping ring is curled about said housing and insulator plate to sealingly engage said gasket with said switch chamber.

11. The vacuum control valve and switch assembly of claim 9,

- wherein the vacuum control valve is a ball-type valve,

- wherein a plunger engages such valve and extends from said valve into said switch chamber,

- wherein said electrical contact member is a ball-type contact member in axial alignment with said plunger, and

- wherein said contact plate has a passageway leading therethrough forming a seat for said ball-type contact, and accommodating said contact to move off its seat upon increases in engine temperature sufficient to disconnect said vacuum output from carburetor vacuum and connect said vacuum output with distributor vacuum to effect opening of said switch.

12. The vacuum control valve and switch assembly of claim 11, wherein a solenoid coil is provided and energized through said switch upon closing of the contacts of said switch,

- wherein an armature is extensible from said solenoid coil upon energization of said coil, and

- wherein an operative connection is provided between said armature and said butterfly valve to effect opening of said butterfly valve a predetermined amount upon idling of the engine when the spark is retarded, and to accommodate movement of said butterfly valve to a normal idling position upon heating of the engine sufficient to move said valve into position to connect the distributor output with manifold vacuum and advance the spark.

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