

[54] **INTERNAL COMBUSTION ENGINE
IGNITION SPARK VACUUM ADVANCE
SYSTEM**

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[56] **References Cited**

UNITED STATES PATENTS

3,687,120	8/1972	Lenz	123/117
3,685,295	8/1972	Tatsutomi	123/117
3,680,318	8/1972	Nakajima	123/117
3,301,242	1/1967	Candelise	123/117
3,561,410	2/1971	Soeters	123/117

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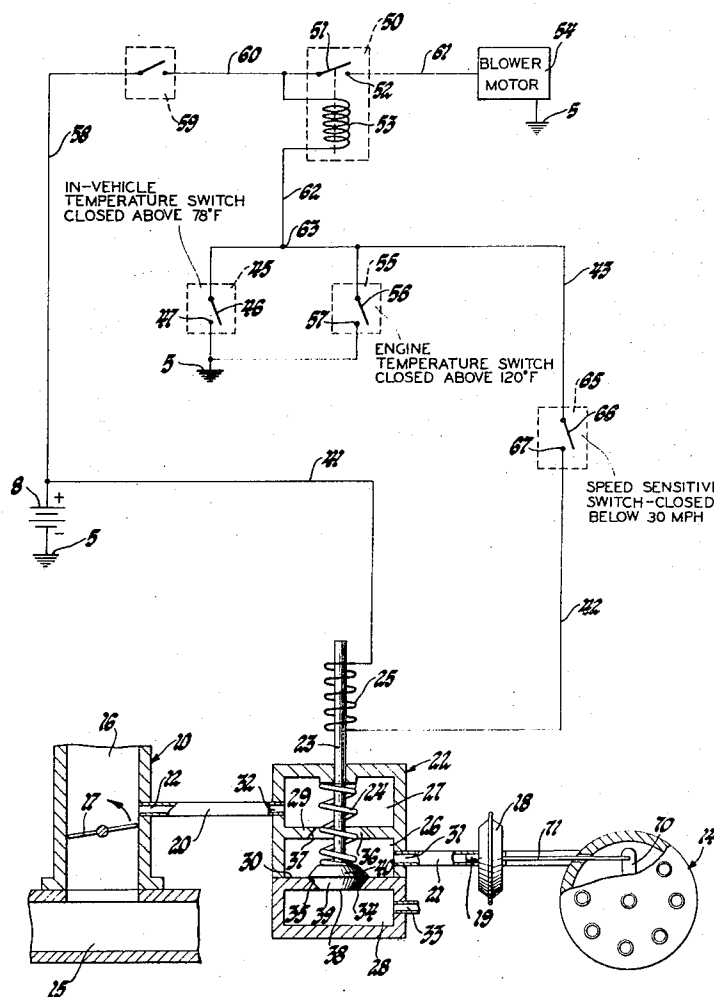
Attorney—Eugene W. Christen et al.

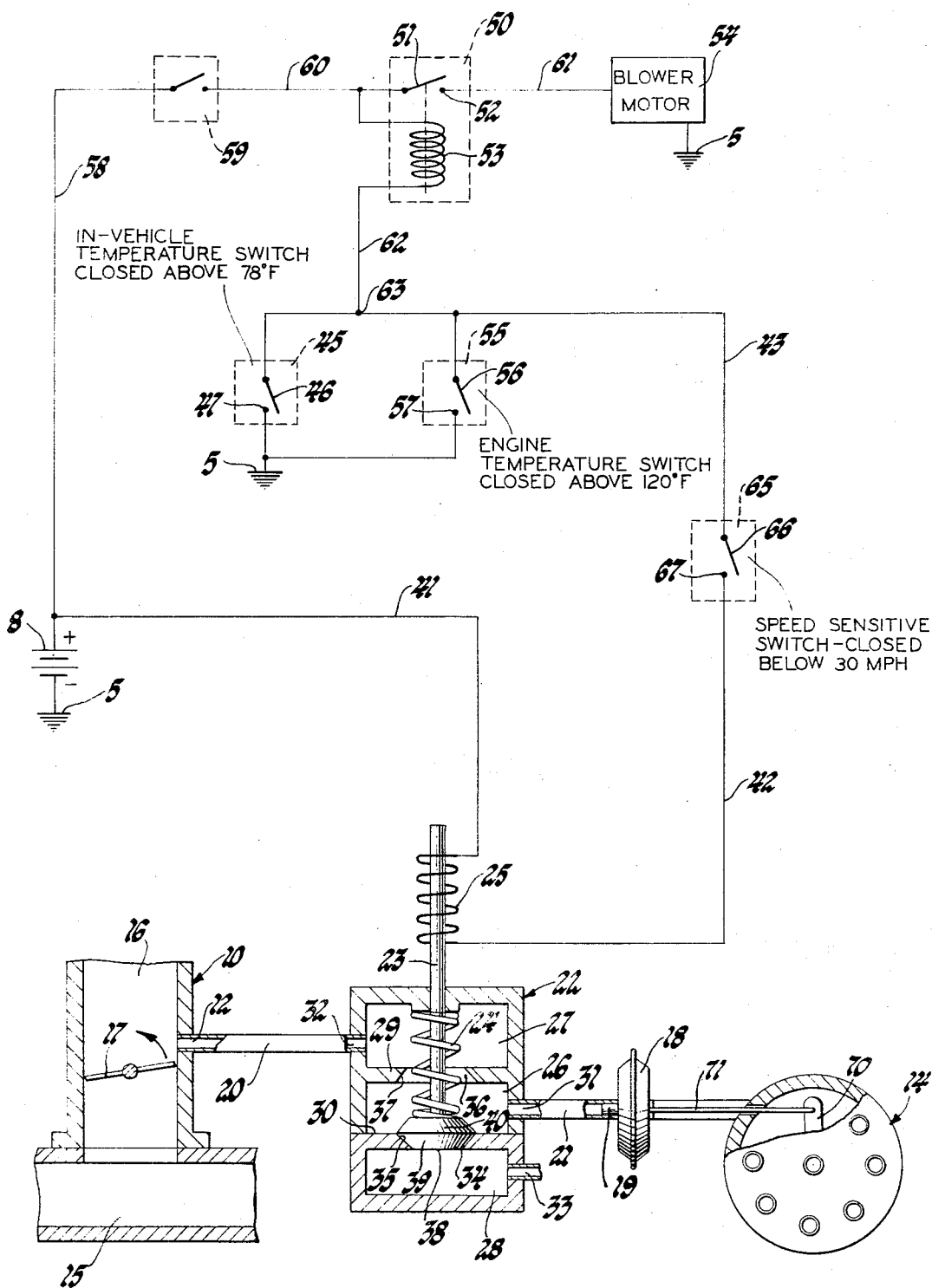
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ABSTRACT

A system for enabling the ignition spark vacuum advance mechanism of an internal combustion engine until the engine has reached operating temperature for use with ignition spark vacuum advance systems which disenable the vacuum spark advance mechanism with vehicle speeds less than a predetermined magnitude of the type having a speed sensitive switch, closed below a selected vehicle speed, connected in series in the energizing circuit of the operating coil of a two-way valve which, when energized, operates the valve to the condition which vents the associated spark advance vacuum unit to atmosphere. The parallel combination of a normally open temperature sensitive in-vehicle temperature switch and a normally open temperature sensitive engine temperature switch is connected in series with the speed sensitive switch to prevent the operation of the valve to the condition which vents the spark advance vacuum unit vacuum port to atmosphere until the engine has reached operating temperature.

1 Claim, 1 Drawing Figure





INTERNAL COMBUSTION ENGINE IGNITION SPARK VACUUM ADVANCE SYSTEM

This invention relates to internal combustion engine ignition spark vacuum advance systems and, more specifically, to a system which, at low vehicle speeds, disables the ignition spark vacuum advance mechanism, which prevents ignition spark advance, while the engine is at operating temperature and enables the ignition spark vacuum advance mechanism while the engine is below operating temperature.

In an effort to reduce the undesirable emissions in the exhaust of internal combustion engines employed to drive motor vehicles, various ignition spark control systems have been developed which prevent ignition spark advance during low vehicle speeds. An undesirable consequence of systems of this type is the inability of a cold engine to start in cold weather and drive the vehicle without stalling. Consequently, a system of this type which permits normal ignition spark vacuum advance until the engine has reached operating temperature is desirable.

It is, therefore, an object of this invention to provide an improved internal combustion engine ignition spark vacuum advance system.

It is another object of this invention to provide an improved internal combustion engine ignition spark vacuum advance system which, at low vehicle speeds, disables the ignition spark vacuum advance mechanism while the engine is at normal operating temperature and enables the ignition spark vacuum advance mechanism while the engine is below operating temperature.

In accordance with this invention, an internal combustion engine ignition spark vacuum advance system which, with vehicle speeds below a selected magnitude, retards the ignition spark while the engine is at normal operating temperature and provides normal ignition spark vacuum advance while the engine is below normal operating temperature is provided wherein the parallel combination of a normally open temperature sensitive in-vehicle temperature switch and a normally open temperature sensitive engine temperature switch is connected in series with a speed sensitive switch, operated to the electrical circuit closed position with vehicle speeds less than a selected magnitude, in the energizing circuit of the operating coil of a two-way valve which, upon the energization of the operating coil, is operated to a condition which vents the vacuum port of the spark advance mechanism vacuum unit to atmosphere.

For a better understanding of the present invention, together with additional objects, advantages and features thereof, reference is made to the following description and accompanying single FIGURE drawing which sets forth the internal combustion engine ignition spark vacuum advance system of this invention.

As point of reference or ground potential is the same point electrically throughout the system, it has been illustrated in the FIGURE by the accepted schematic symbol and referenced by the numeral 5.

The internal combustion engine ignition spark vacuum advance system of this invention operates in combination with a conventional automotive type carburetor 10 having a spark advance port 12, an ignition distributor 14, shown in top plan view in the FIGURE, and a source of direct current potential, which may be a battery 8.

Carburetor 10 may be of conventional design having a spark advance port 12 which opens into the carburetor mixing conduit 16, through which the air-fuel mixture is conducted to the intake manifold 15, just above the throttle plate 17. At idle or conditions of very low engine speeds, throttle plate 17 is closed or nearly closed, consequently, carburetor spark advance port 12 is exposed to substantially atmospheric pressure, as is shown in the FIGURE. As the throttle plate 17 is revolved to open in a counterclockwise direction, as viewing the FIGURE, carburetor advance spark port 12 becomes exposed to the engine intake manifold vacuum.

Ignition distributor 14 may be of conventional design having an ignition spark advance mechanism of conventional design operated by a spark advance vacuum unit 18 having a vacuum port 19. As ignition spark vacuum advance mechanisms of this type are well known in the automotive art and, per se, form no part of this invention, it has not been shown in detail in the FIGURE. The operation will be explained in greater detail later in this specification.

Extending between the carburetor spark advance port 12 and the spark advance vacuum unit vacuum port 19 is a vacuum line which includes vacuum line segments 20 and 21 and a two-way valve 22, having an operating member or rod 23, which is operated to a first position by compression spring 24 to establish a vacuum connection between carburetor spark advance port 12 and spark advance vacuum unit vacuum port 19 and is operable to a second position upon the energization of operating coil 25 to vent the spark advance vacuum unit vacuum port 19 to atmosphere. Two-way valve 22 is illustrated in the FIGURE as having a center chamber 26 and two outside chambers 27 and 28 separated by respective walls 29 and 30. Each of chambers 26, 27 and 28 communicates externally of valve 22 through respective ports 31, 32 and 33. Internally of valve 22, center chamber 26 communicates with outside chamber 28 through an inside port 34 having an angularly disposed valve seat 35 and with the other outside chamber 27 through an inside port 36 having an angularly disposed valve seat 37. Port 31 of two-way valve 22 is interconnected with the spark advance vacuum unit vacuum port 19 through vacuum line segment 21, port 32 is interconnected with the carburetor spark advance port 12 through vacuum line segment 20 and port 33 is vented to atmosphere. Secured to the end of operating member 23 within valve 22 is a piston 38 having two angularly disposed faces 39 and 40 which are arranged to engage respective angularly disposed valve seats 35 and 37 in a tight complementary fit. Valve 22 is operated to the first condition by compression spring 24 and is operated to the second condition by energizing operating coil 25 which moves rod 23 linearly in an upward direction as viewing the FIGURE. In the first condition of valve 22, face 39 of piston 38 is in a tight complementary fit with valve seat 35 to provide an open passage therethrough between only ports 31 and 32 and in the second condition, face 40 of piston 38 is in a tight complementary fit with valve seat 37 to provide an open passage therethrough between only ports 31 and 33. It is to be specifically understood that two-way valve 22 of the FIGURE is only one example of many two-way valves which may be employed for this application.

Also, provided are an in-vehicle temperature sensitive switch 45 having normally open contacts, movable contact 46 and stationary contact 47, which is operated to the electrical circuit closed condition by in-vehicle temperatures greater than a selected magnitude, for example, 78° F.; an engine temperature sensitive switch 55 having normally open contacts, movable contact 56 and stationary contact 57, which is operated to the electrical circuit closed condition by engine temperatures greater than a selected magnitude, for example, 120° F., and a speed sensitive switch 65 having movable contact 66 and stationary contact 67, which is operated to the electrical circuit closed condition in response to vehicle speeds of less than a selected magnitude, for example, 30 miles per hour.

Any one of the many available temperature sensitive switches and speed sensitive switches, well known in the automotive art, may be employed for the in-vehicle temperature switch 45, the engine temperature switch 55, and the speed sensitive switch 65, which have been schematically illustrated in the FIGURE.

Operating coil 25 of valve 22, the normally open contacts 66 and 67 of speed sensitive switch 65 and the parallel combination of the normally open contacts 46 and 47 of the temperature sensitive in-vehicle temperature switch 45 and the normally open contacts 56 and 57 of the temperature sensitive engine temperature switch 55 are connected in series across the source of direct current supply potential, battery 8. This circuit may be traced from the positive polarity terminal of battery 8, through lead 41, operating coil 25 of two-way valve 22, lead 42, stationary contact 67 and movable contact 66 of speed sensitive switch 65, lead 43, and movable contact 56 and stationary contact 57 of engine temperature switch 55 and movable contact 46 and stationary contact 47 of in-vehicle temperature switch 45 in parallel and point of reference or ground potential 5 to the negative polarity terminal of battery 8.

Upon starting an engine of a temperature less than operating temperature and a low in-vehicle temperature, invehicle temperature switch 45 and engine temperature switch 55 are open to interrupt the energizing circuit of operating coil 25 of two-way valve 22. Consequently, compression spring 24 operates piston 38 of two-way valve 22 to the first condition to establish a vacuum connection between the carburetor spark advance port 12 and the spark advance unit vacuum port 19 through vacuum line segment 20, upper chamber 27 of valve 22, port 36, center chamber 26, port 31 and vacuum line segment 21.

With conventional ignition spark vacuum advance mechanisms, the carburetor spark advance port is directly interconnected through a vacuum line with the spark advance vacuum unit vacuum port. The spark advance vacuum unit may be any one of the many vacuum units well known in the automotive art.

Mounted within the distributor 14 is a movable breaker plate, upon which the ignition breaker contact points are mounted, which is rotatable in a plane normal to the axis of the distributor drive shaft to advance and retard the engine ignition spark. This movable breaker plate is revolved by an operating arm, such as that referenced by the numeral 70 in the FIGURE, which is attached to and moved by a diaphragm within the spark advance vacuum unit 18 in a manner well known in the automotive art. At idle or conditions of

low engine speed with the carburetor throttle plate 17 closed or nearly closed, the carburetor spark advance port is exposed to atmospheric pressure, consequently, the diaphragm of the spark advance vacuum unit 18 is exposed to atmosphere on both sides. Under these conditions, the diaphragm and connected operating rod 71 are forced by a spring in a direction which will rotate the movable breaker plate within the distributor in the direction which will retard the ignition spark. With the carburetor throttle plate open during acceleration or cruising speeds, the carburetor spark advance port is exposed to engine intake manifold vacuum, consequently, the diaphragm of the spark advance vacuum unit 18 is exposed to manifold vacuum on the side of the vacuum port 19. Under these conditions, the diaphragm within the spark advance vacuum unit 18 and connected operating rod 71 are forced in the opposite direction by the greater pressure on the side of the diaphragm vented to the atmosphere to rotate the movable breaker plate in the direction which will advance the ignition spark.

As the cold engine is accelerated and the carburetor spark advance port 12 is exposed to intake manifold vacuum, the diaphragm within vacuum advance unit 18 is exposed to manifold vacuum through vacuum line segment 20, two-way valve 22, vacuum line segment 21 and vacuum port 19. Consequently, vacuum advance unit 18 operates arm 70 of the distributor vacuum device mechanism in a counterclockwise direction, as viewing the FIGURE, to advance engine spark in a normal manner, regardless of engine speed.

Should the engine be started while either the invehicle temperature or the engine temperature is greater than the selected magnitude, or both, the normally open contacts of either in-vehicle temperature switch 45 or engine temperature switch 55, or both, are closed and the normally open contacts of speed sensitive switch 65 are closed to complete an energizing circuit, previously described, for operating coil 25 of two-way valve 22. Upon the energization of operating coil 25, rod 23 is moved in a linear vertical direction, as viewing the FIGURE, to place face 40 of piston 38 of valve 22 in a tight complementary fit in valve seat 37. In this second condition of operation, vacuum port 19 of the spark advance vacuum unit 18 is vented to atmosphere through vacuum line segment 21, port 31 of valve 22, chambers 26 and 28 of valve 22 and port 33. Therefore, spark advance vacuum unit 18 maintains the ignition distributor breaker plate in the spark retard position.

At any vehicle speed above the selected magnitude, the energizing circuit of operating coil 25 of two-way valve 22 is interrupted by the open contacts of speed sensitive switch 65. Consequently, compression spring 24 operates piston 38 of valve 22 to the first condition which establishes a vacuum connection, previously described, between the carburetor advance port 12 and the spark advance vacuum unit vacuum port 19. Therefore, the ignition spark vacuum advance mechanism operates normally to adjust the ignition spark advance in response to engine vacuum.

Without intention or interference of a limitation thereto, the ignition spark vacuum advance system of this invention may be combined in an automotive type heater system. The normally open contacts, movable contact 51 and stationary contact 52, of a relay 50, having an operating coil 53, are connected in series

with heater blower motor 54 across the source of direct current potential, battery 8. This circuit may be traced from the positive polarity terminal of battery 8, through lead 58, switch 59, which may be a set of accessory circuit contacts in a conventional automotive type ignition switch, lead 60, movable contact 51 and stationary contact 52 of relay 50, lead 61, heater blower motor 54 and point of reference or ground potential 5 to the negative polarity terminal of battery 8. Relay operating coil 53 is connected in series with the parallel combination of the normally open contacts of the in-vehicle temperature switch 45 and the engine temperature switch 55 across the source of direct current potential, battery 8 through lead 58, switch 59, lead 60, operating coil 53, lead 62, the contacts of temperature sensitive switches 45 and 55, in parallel, and point of reference or ground potential 5. With this arrangement, valve operating coil 25 and speed sensitive switch 65 are connected in series across a selected polarity terminal of the source of direct current potential, the positive polarity terminal of battery 8 in the embodiment of the FIGURE, and the junction 63 between relay operating coil 53 and the parallel combination of the normally open contacts of the in-vehicle and engine temperature switches 45 and 55.

While a preferred embodiment of the present invention has been shown and described, it will be obvious to those skilled in the art that modifications and substitutions may be made without departing from the spirit of the invention which is to be limited only within the scope of the appended claims.

What is claimed is:

1. An internal combustion engine ignition spark vacuum advance system for motor vehicles comprising in

combination with a carburetor having a spark advance port, an ignition distributor having an ignition spark advance mechanism operated by a spark advance vacuum unit having a vacuum port and a source of direct current potential, a vacuum line extending between said carburetor spark advance port and said spark advance vacuum unit vacuum port, a two-way valve having an operating coil included in said vacuum line which is normally in a first condition to establish a vacuum connection between said carburetor spark advance port and said spark advance vacuum unit vacuum port and operable, upon the energization of said operating coil, to a second condition to vent said vacuum advance unit vacuum port to atmosphere, a first temperature sensitive switch having normally open contacts which are operative to the electrical circuit closed condition by in-vehicle temperatures greater than a selected magnitude, a second temperature sensitive switch having normally open contacts which are operated to the electrical circuit closed condition by engine temperatures greater than a selected magnitude, the speed sensitive switch having contacts which are operated to the electrical circuit closed condition in response to vehicle speeds of less than a selected magnitude and, means for connecting said operating coil of said two-way valve, said contacts of said speed sensitive switch and the parallel combination of said normally open contacts of said first and second temperature sensitive switches in series across said source of direct current potential, whereby engine spark advance is provided with in-vehicle and engine temperatures less than respective predetermined normal valves at cranking speed.

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