

[54] IGNITION SPARK VACUUM ADVANCE SYSTEM

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[58] Field of Search 123/117 R, 117 A, 102

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Primary Examiner—Laurence M. Goodridge

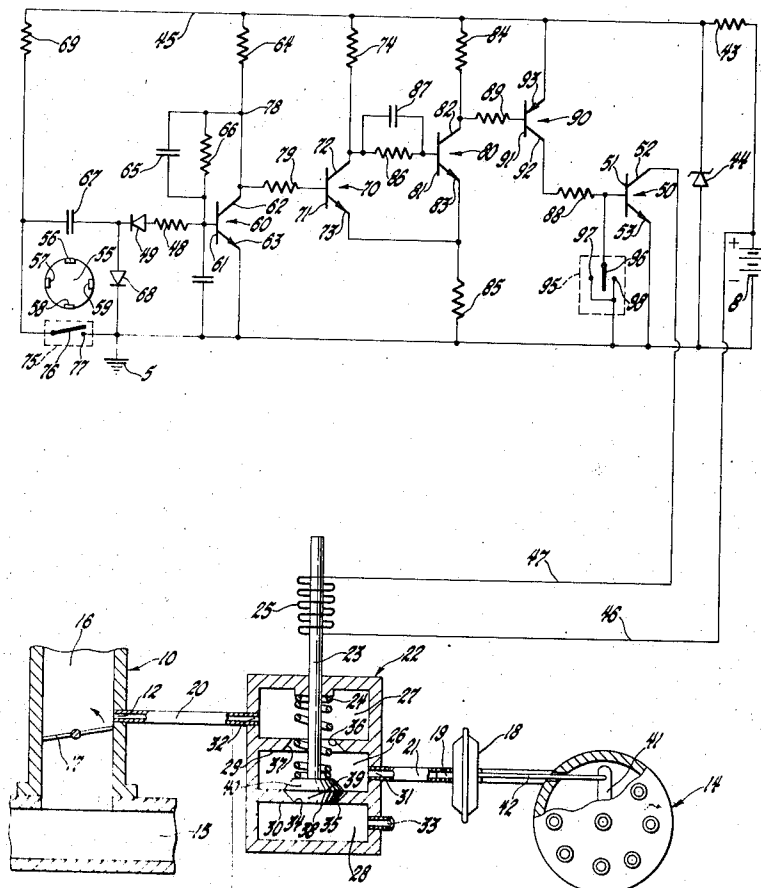
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[57]

ABSTRACT

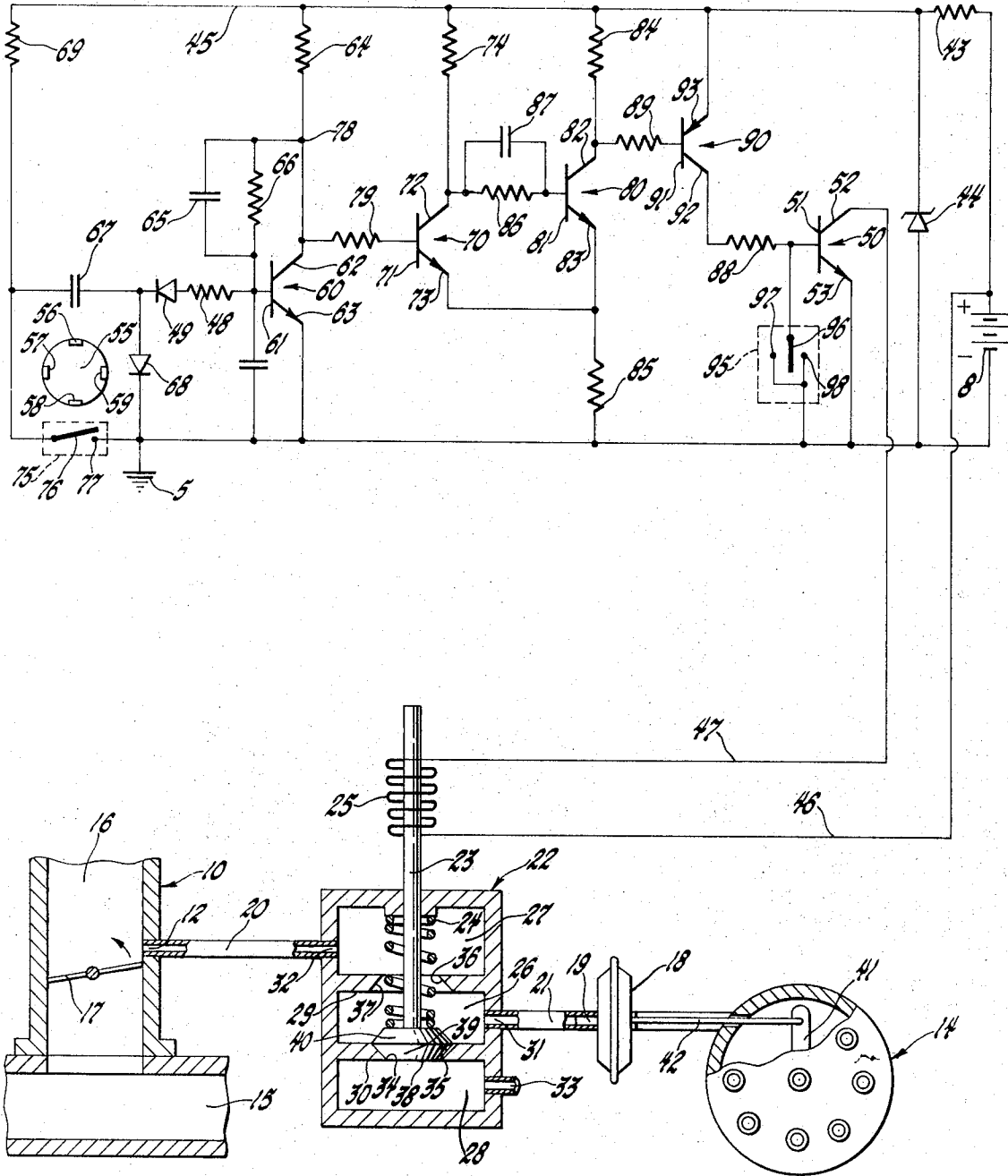
An ignition spark vacuum advance system for use with motor vehicle internal combustion engines. The collector-emitter electrodes of a switching transistor are connected in series in the energizing circuit of the operating coil of a two-way valve which normally establishes a vacuum connection between the carburetor vacuum spark advance port and the associated spark advance vacuum unit vacuum port and, upon the energization of the operating coil, vents the spark advance vacuum unit vacuum port to atmosphere. A trigger circuit responsive to a reference potential signal of a magnitude proportional to vehicle or engine speed produces a control signal during vehicle acceleration until the vehicle has accelerated to a speed of a selected magnitude and during vehicle deceleration after the vehicle has decelerated to a speed less than the selected magnitude which triggers the switching transistor conductive to complete the energizing circuit for the valve operating coil. The current carrying elements of a temperature sensitive switch which are operated to the circuit closed condition with engine temperatures less and greater than a selected engine temperature range are connected across the base-emitter electrodes of the switching transistor to provide for a normal ignition spark vacuum advance at any engine speed with a cold engine or an engine approaching over-heating.

5 Claims, 1 Drawing Figure



PATENTED MAY 14 1974

3,810,451



IGNITION SPARK VACUUM ADVANCE SYSTEM

This invention is directed to an ignition spark vacuum advance system and, more specifically, to an ignition spark vacuum advance system for use with motor vehicle internal combustion engines which provides ignition spark retard at vehicle or engine speeds less than a preselected magnitude with normal engine temperatures and normal ignition spark vacuum advance at any vehicle or engine speed with a cold or over-heated engine.

In an effort to reduce the undesirable emissions of the exhaust of internal combustion engines employed to drive motor vehicles, various ignition spark control systems have been developed which prevent ignition spark vacuum advance during low vehicle speeds. One undesirable consequence of systems of this type is the difficulty of a cold engine to start properly in cold weather and drive the vehicle without stalling. Furthermore, since internal combustion engines heat more rapidly with a retarded spark, there is a tendency for the engine to overheat at low vehicle speeds, such as encountered in slow traffic or standing, with the spark retarded.

It is, therefore, an object of this invention to provide an improved ignition spark vacuum advance system for use with motor vehicle internal combustion engines.

It is another object of this invention to provide an improved ignition spark vacuum advance system for use with motor vehicle internal combustion engines which, at low vehicle or engine speeds, disengages the ignition spark vacuum advance mechanism while the engine is at normal operating temperature and enables the ignition spark vacuum advance mechanism at any vehicle or engine speed while the engine is operating at temperatures less than and greater than a selected engine temperature range.

In accordance with this invention, an ignition spark vacuum advance system for use with motor vehicle internal combustion engines which retards the ignition spark at low vehicle or engine speeds while the engine is operating within a selected engine temperature range and provides normal ignition spark vacuum advance at any vehicle or engine speed while the engine operating temperature is less than and greater than a selected engine temperature range is provided wherein a switching transistor having the collector-emitter electrodes connected in series in the energizing circuit of the operating coil of a two-way valve, the energization of which operates the valve to a condition which vents the vacuum port of an associated spark advance mechanism vacuum unit to atmosphere, is triggered conductive through the collector-emitter electrodes in response to a control signal produced during vehicle acceleration until the vehicle has accelerated to a speed of a selected magnitude and during vehicle deceleration after the vehicle has decelerated to a speed less than the selected magnitude and the current carrying elements of a temperature sensitive switch, operated to the electrical circuit closed condition in response to engine temperatures less than and greater than a selected engine temperature range, are connected across the base-emitter electrodes of the switching transistor.

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 ignition spark vacuum advance system of this invention in schematic form.

The ignition spark vacuum advance system for use with motor vehicle internal combustion engines of this invention operates in combination with a conventional automotive type carburetor 10 having a vacuum 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 conventional automotive type battery 8.

Carburetor 10 may be of conventional design having a vacuum 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 vacuum spark advance port 12 is exposed to substantially atmospheric pressure as shown in the FIGURE. As the throttle plate 17 is revolved to open in a counterclockwise direction, as viewing the FIGURE, carburetor vacuum spark advance 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 illustrated in detail in the FIGURE. The operation will be explained in greater detail later in this specification.

Extending between the carburetor vacuum 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 the carburetor vacuum 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 vacuum 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.

With conventional ignition spark vacuum advance mechanisms, the carburetor vacuum spark advance port is directly interconnected through a vacuum line with the spark advance vacuum unit vacuum port. The spark advance vacuum unit 18 may be 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 41 in the FIGURE, which is attached to and moved by a diaphragm within the spark advance vacuum unit 18 through push rod 42 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 vacuum spark advance port 12 is exposed to atmospheric pressure, consequently, the diaphragm within the spark advance vacuum unit 18 is exposed to atmosphere on both sides. Under these conditions, the diaphragm and connected operating rod 42 are forced by a spring, also within the spark advance vacuum unit 18, in a direction which will rotate the movable breaker plate within the distributor 14 in the direction which will retard the ignition spark. With the carburetor throttle plate 17 open during acceleration or cruising speeds, the carburetor vacuum spark advance port 12 is exposed to engine intake manifold vacuum, consequently, the diaphragm within 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 42 are forced in the opposite direction by the greater pressure on the side of the diaphragm vented to atmosphere to rotate the movable breaker plate in the direction which will advance the ignition spark. From this description, it is apparent that with two-way valve in the first condition of operation with face 39 of piston 38 in tight complementary fit with valve seat 35, the ignition spark vacuum advance mechanism illustrated in the FIGURE will operate in a normal manner.

Also, provided is circuitry for producing a direct current reference potential signal of a magnitude proportional to engine or vehicle speed, circuitry responsive to the reference potential signal for producing a control signal during vehicle acceleration until the vehicle has accelerated to a speed of a selected magnitude and during vehicle deceleration after the vehicle has decelerated to a speed less than the selected magnitude, an electrical switching device having normally open current carrying elements, which may be a type NPN transistor 50 having a base electrode 51, a collector electrode 52, and an emitter electrode 53, operable to an electrical circuit closed condition in response to an electrical signal, circuitry responsive to the control sig-

nal for operating the electrical switching device to the electrical circuit closed condition and a device responsive to engine temperatures less than and greater than a selected engine temperature range for diverting the control signal from the electrical switching device.

In the FIGURE, the output potential of battery 8 is shown to be regulated by series resistor 43 and Zener diode 44. It is to be specifically understood that this potential regulating arrangement is not absolutely necessary for the practice of this invention.

One method, and without intention or inference of a limitation thereto, for producing a direct current reference signal of a magnitude proportional to vehicle or engine speed may be a type NPN transistor 60 operating as a Class A amplifier having the collector electrode 62 and emitter electrode 63 thereof connected across the positive and negative polarity terminals, respectively, of battery 8 through collector resistor 64 and positive polarity potential lead 45 and point of reference or ground potential 5, respectively; the parallel combination of capacitor 65 and resistor 66 connected across the collector electrode 62 and the base electrode 61 and the parallel combination of capacitor 67 and diode 68 in series and the normally open contacts 76 and 77 of a magnetically operated reed switch 75 connected across battery 8 through current limiting resistor 69. Member 55 may be any member which may be conveniently rotated at a speed equal to or proportional to engine speed which is arranged to carry a plurality of permanent magnets, four of which are illustrated in the FIGURE and referenced by the numerals 56, 57, 58, and 59. For example, member 55 may be a drum mounted upon the engine crankshaft, it may be a member mounted upon the engine flywheel or a member mounted upon any other vehicle part which is rotated at a speed equal to or proportional to vehicle or engine speed. It is only necessary that the permanent magnets rotated thereby are in operative relationship with the normally open contacts 76 and 77 of reed switch 75 to operate these contacts to the electrical circuit closed condition at a frequency proportional to vehicle speed by passing in close proximity thereto in a manner well known in the art. While the contacts 76 and 77 of reed switch 75 are open during any of the spaces between the permanent magnets carried by member 55, capacitor 67 charges through resistor 69 and diode 68. Upon the passing of one of the magnets 56 through 59 in close proximity to reed switch 75, movable contact 76 is magnetically operated to the electrical circuit closed condition to stationary contact 77 to establish a discharge circuit for capacitor 67.

Discharging capacitor 67 reduces the positive polarity potential upon the base electrode 61 of type NPN transistor 60 thereby decreasing the collector-emitter conduction therethrough as a Class A amplifier. Capacitor 65 charges through the relatively low value resistance 64 and discharges through high resistance 66 or much more rapidly through type NPN transistor 60, depending upon the degree of its conductivity. Consequently, the more frequently the normally open contacts 76 and 77 of reed switch 75 are operated to the electrical circuit closed condition by the magnets carried upon rotating member 55 with increases of engine and vehicle speed, the lower the degree of conduction through type NPN transistor 60. As capacitor 65 discharges more slowly with a decrease of conduction through transistor 60, the potential appearing across

junction 78 and point of references or ground potential 5 increases in magnitude. Consequently, this reference potential is of a magnitude proportional to vehicle or engine speed. This reference potential, across junction 78 and point of reference or ground potential 5, is of a positive polarity upon junction 78 with respect to point of reference or ground potential 5.

The circuitry responsive to the reference potential appearing across junction 78 and point of reference or ground potential 5 for producing a control signal during vehicle acceleration until the vehicle has accelerated to a speed of a selected magnitude and during vehicle deceleration after the vehicle has decelerated to a speed less than the selected magnitude may be a trigger type circuit comprised of type NPN transistors 70 and 80 and the associated circuitry. The respective collector electrodes 72 and 82 of type NPN transistors 70 and 80 are connected to the positive polarity terminal of battery 8 through respective collector resistors 74 and 84 and the emitter electrodes 73 and 83 of respective transistors 70 and 80 are connected to the negative polarity terminal of battery 8 through a common emitter resistor 85 and point of reference or ground potential 5. Consequently, the collector-emitter electrodes of both type NPN transistors 70 and 80 are connected across battery 8 in the proper polarity relationship for forward collector-emitter conduction through type NPN transistors. The base electrode 71 of transistor 70 is connected to junction 78 through a current limiting resistor 79 and the base electrode 81 of transistor 80 is connected to the collector electrode 72 of transistor 70 through the parallel combination of resistor 86 and capacitor 87. A capacitor 87 is included in this coupling circuit for the purpose of absorbing any transient voltages and for filtering any input ripple, thereby providing consistent operation of the trigger circuit.

The circuitry responsive to the control signal for operating the electrical switching device to the electrical circuit closed condition may be a type PNP driver transistor 90 having the emitter electrode 93 connected to the positive polarity terminal of battery 8 through positive polarity potential lead 45 and the collector electrode 92 connected to the negative polarity terminal of battery 8 through current limiting resistor 88, the base-emitter electrodes of switching transistor 50 and point of reference or ground potential 5. Consequently, the emitter-collector electrodes of type PNP driver transistor 90 are connected across battery 8 in the proper polarity relationship for forward emitter-collector conduction through a type PNP transistor. The base electrode 91 of type PNP driver transistor 90 is connected to the collector electrode 82 of transistor 80 through current limiting resistor 89.

The device responsive to engine temperatures less than and greater than a selected engine temperature range, for example 140° to 160° F., for diverting the control signal from the electrical switching device may be a temperature sensitive switch 95 having a movable contact 96 and two stationary contacts 97 and 98 connected across the base-emitter electrodes of switching transistor 50. Switch 95 may be any one of the many temperature sensitive switches having a movable contact which is operated to an electrical circuit closed condition to an associated stationary contact with engine temperatures below a selected minimum and to an electrical circuit closed condition to another associated

stationary contact with engine temperatures greater than a selected maximum.

The current carrying elements, the collector-emitter electrodes of type NPN switching transistor 50, of the electrical switching device and the operating coil 25 of two-way valve 22 are connected in series across the source of direct current potential, battery 8, through a circuit which may be traced from the positive polarity terminal of battery 8, through lead 46, operating coil 25 of two-way valve 22, lead 47, the collector-emitter electrodes of type NPN switching transistor 50 and point of reference or ground potential 5 to the negative polarity terminal of battery 8.

Assuming that the associated internal combustion engine, not shown, is operating at idle or low engine speed within the selected engine temperature range, transistor 60 is operating as a Class A amplifier and the contacts 76 and 77 of reed switch 75 are being slowly operated by the magnets upon rotating member 55 and capacitor 65 is charged through resistor 64, resistor 48, diode 49 and diode 68. With these conditions, the direct current reference potential appearing across junction 78 and point of reference or ground potential 5 is of an insufficient magnitude to provide base-emitter drive current for transistor 70 of the trigger circuit, consequently, transistor 70 is not conducting. With transistor 70 not conducting, base drive current is supplied to the base-emitter electrodes of type NPN transistor 80 of the trigger circuit through resistors 74 and 86, through which the base electrode 81 is connected to the positive polarity terminal of battery 8, and through common emitter resistor 85, through which the emitter electrode 83 is connected to the negative polarity terminal of battery 8, consequently, transistor 80 is conducting through the collector-emitter electrodes. Conducting transistor 80 establishes a circuit through which emitter-base drive current is supplied to type PNP driver transistor 90 from positive polarity potential line 45, through the emitter-base electrodes of type PNP transistor 90, resistor 89, the collector-emitter electrodes of transistor 80, common emitter resistor 85 and point of reference or ground potential 5 to the negative polarity terminal of battery 8. The flow of current through conducting transistor 80 also produces a potential drop across common emitter resistor 85 which is applied to the emitter electrode 73 of transistor 70, thereby establishing the base electrode 71 and emitter electrode 73 at substantially the same potential, a condition which maintains transistor 70 not conductive. With emitter-base drive current supplied to type PNP driver transistor 90, this device conducts through the emitter-collector electrodes thereof to supply base-emitter drive current to type NPN switching transistor 50 from positive polarity potential line 45, through the emitter-collector electrodes of driver transistor 90, base resistor 88, the base-emitter electrodes of transistor 50 and point of reference or ground potential 5 to the negative polarity terminal of battery 8. Consequently, switching transistor 50 conducts through the collector-emitter electrodes thereof to complete an energizing circuit for operating coil 25 of two-way valve 22 through a circuit previously described. Upon the energization of operating coil 25, two-way valve 22 is operated to the second condition in which the vacuum port 19 of spark advance vacuum unit 18 is vented to atmosphere through port 31 of valve 22, center chamber 26, internal port 34, outside

chamber 28 and port 33. With vacuum port 19 of spark advance vacuum unit 18 vented to atmosphere, the ignition spark vacuum advance mechanism is disabled and the ignition spark is retarded at these low engine and, consequently, vehicle speeds.

As the speed of the engine is increased to accelerate the vehicle, the magnets carried by rotating member 55 operate the contacts 76 and 77 of reed switch 75 more rapidly to the electrical circuit closed condition to reduce the degree of conduction through transistor 60 for the reason previously set forth. A decreased degree of conduction through transistor 60 results in the retention of a charge of increased magnitude upon capacitor 65 as it is not as rapidly discharged through conducting transistor 60. Consequently, as the engine continues to accelerate the vehicle, the reference potential appearing across junction 78 and point of reference or ground potential 5 continues to increase in magnitude with increase of vehicle speed until the vehicle has been accelerated to a speed of selected magnitude, for example, 30 m.p.h., at which the magnitude of the reference potential appearing across junction 78 and point of reference or ground potential 5 is of a sufficient magnitude to produce base-emitter drive current through transistor 70 of the trigger circuit. With transistor 70 conducting through the collector-emitter electrodes, base drive current is drained from the base electrode of transistor 80 to extinguish this device. With transistor 80 extinguished, the circuit through which emitter-base drive current is supplied to type PNP driver transistor 90 is interrupted, consequently, driver transistor 90 extinguishes. With driver transistor 90 extinguished, the circuit through which base drive current is supplied to type NPN switching transistor 50 is interrupted, consequently, switching transistor 50 extinguishes to interrupt the energizing circuit of operating coil 25 of two-way valve 22. Upon the deenergization of operating coil 25, compression spring 24 operates piston 38 of two-way valve 22 into a tight complementary fit with valve seat 35 to place valve 22 in the first condition. With two-way valve 22 in the first condition, a vacuum connection is established between the carburetor spark advance port 12 and the spark advance vacuum unit 18 vacuum port 19 through vacuum line segment 20, port 32 of valve 22, outside chamber 27, internal port 36, center chamber 26, port 31 and vacuum line segment 21. With the establishment of this vacuum connection, the internal combustion engine ignition spark vacuum advance mechanism operates in a normal manner to provide ignition spark advance in accordance with engine vacuum.

While the vehicle and engine is being operated at a speed greater than the selected magnitude, transistor 70 of the trigger circuit is maintained conductive. Conducting transistor 70 supplies less current to common emitter resistor 85, a condition which results in a lower potential drop thereacross. With a lower potential drop across common emitter resistor 85, the emitter potential of transistor 70 is reduced, therefore, a substantial drop in base voltage upon transistor 70 will be required before transistor 70 is extinguished. During deceleration, the contacts 76 and 77 are operated at a proportionally lower rate, consequently, the degree of conduction through transistor 60 begins to increase proportionately resulting in a proportionate decrease of the magnitude of the reference potential appearing across junction 78 and point of reference or ground po-

tential 5. However, since the emitter potential of transistor 70 is of a lower value while transistor 70 is conducting, to extinguish transistor 70, the magnitude of the reference potential applied across the base-emitter electrodes thereof must reduce below the magnitude of the reference potential corresponding to the speed of a selected magnitude. Consequently, upon deceleration, transistor 70 is not extinguished until the magnitude of the reference potential has reduced to a value lower than that corresponding to a speed of a selected magnitude, for example, 20 m.p.h. With this arrangement, a hysteresis is introduced into the system to provide increased stability and smoothness of vehicle operation. As the engine and vehicle continue to decelerate until a speed is reached at which the reference potential is no longer of a sufficient magnitude to maintain transistor 70 conductive through the collector-emitter electrodes, the transistor 70 extinguishes and transistor 80 again conducts through the collector-emitter electrodes. With transistor 80 conducting through the collector-emitter electrodes, the emitter-base drive circuit for type PNP driver transistor 90, previously described, is again established to trigger drive transistor 90 conductive through the emitter-collector electrodes to supply base-emitter drive current to switching transistor 50. Upon the conduction of switching transistor 50 through the collector-emitter electrodes, the energizing circuit for operating coil 25 of two-way valve 22 is again established to operate two-way valve 22 to the second condition which vents the vacuum port 19 a spark advance vacuum unit 18 to atmosphere. With vacuum 19 vented to atmosphere, the ignition spark remains retarded at these low engine speeds.

Should the vehicle or engine be operating at any speed at a temperature less than the selected engine temperature range, movable contact 96 of temperature sensitive switch 95 is operated to the circuit closed condition to one of stationary contacts 97 or 98. With movable contact 96 electrical contact with one of the movable contacts 97 or 98, base drive current for switching transistor 50 is diverted therethrough, consequently, switching transistor 50 remains not conductive to interrupt the energizing circuit for operating coil 25 of two-way valve 22. With operating coil 25 de-energized, compression spring 24 operates piston 38 to the first condition to establish a vacuum connection, previously described, between the carburetor spark advance port 12 and the vacuum port 19 of spark advance vacuum unit 18, consequently, the ignition spark vacuum advance mechanism operates in a normal manner to advance the ignition spark in accordance with engine vacuum.

Should the vehicle or engine be operating at any speed at a temperature greater than the selected engine temperature range, movable contact 96 of temperature sensitive switch 95 is operated to the electrical circuit closed condition to the other one of stationary contacts 97 or 98 to divert base drive current from switching transistor 50. Consequently, at any engine speed while the engine is operating at a temperature greater than the selected engine temperature range, the ignition vacuum spark advance mechanism operates in a normal manner to advance the ignition spark in accordance with engine vacuum.

From this description it is apparent that the ignition spark vacuum advance system of this invention provides:

1. With the engine operating at a temperature less than a selected engine temperature range, the ignition spark vacuum advance mechanism operates in a normal manner to advance the ignition spark as a function of manifold vacuum at all vehicle speeds.
2. With the engine operating at normal temperature, the ignition spark is retarded below a vehicle speed of a selected magnitude.
3. With the engine operating at normal temperature, the ignition spark vacuum advance mechanism operates in a normal manner to advance the ignition spark as a function of manifold vacuum with vehicle speeds greater than the selected magnitude.
4. With the engine operating at a temperature greater than a selected engine temperature range, the ignition spark vacuum advance mechanism operates in a normal manner to advance the ignition spark as a function of manifold vacuum at all vehicle speeds, including standstill.
5. A hysteresis feature is introduced to provide for ignition spark retard at normal engine temperature until the vehicle has reached a speed of a selected magnitude upon acceleration and to introduce ignition spark retard when the vehicle has decelerated to a speed less than the selected magnitude upon deceleration.

While a preferred embodiment of the present invention has been shown and described, it will be obvious to those skilled in the art that various 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 ignition spark vacuum advance system for use with motor vehicle internal combustion engines 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,
 - means for producing a direct current reference potential signal of a magnitude proportional to vehicle speed,
 - means responsive to said reference potential signal for producing a control signal during vehicle acceleration until said vehicle has accelerated to a speed of a selected magnitude and during vehicle deceleration after said vehicle has decelerated to a speed less than the selected magnitude,
 - an electrical switching device having normally open current carrying elements operable to an electrical circuit closed condition in response to an electrical signal,
 - means for connecting said current carrying elements of said electrical switching device and said operat-

- ing coil of said two-way valve in series across said source of direct current potential,
- means responsive to said control signal for operating said electrical switching device to the electrical circuit closed condition, and
- means responsive to engine temperatures less than and greater than a selected engine temperature range for diverting said control signal from said electrical switching device.
2. An ignition spark vacuum advance system for use with motor vehicle internal combustion engines 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,
 - means for producing a direct current reference potential signal of a magnitude proportional to vehicle speed,
 - means responsive to said reference potential signal for producing a control signal during vehicle acceleration until said vehicle has accelerated to a speed of a selected magnitude and during vehicle deceleration after said vehicle has decelerated to a speed less than the selected magnitude,
 - a normally not conducting transistor having a base electrode and two currents carrying electrodes,
 - means for connecting said current carrying electrodes of said transistor and said operating coil of said two-way valve in series across said source of direct current potential,
 - means responsive to said control signal for supplying base drive current to said base electrode of said transistor, and
 - means responsive to engine temperatures less than and greater than a selected engine atmosphere range for diverting said base drive current from said transistor.
3. An ignition spark vacuum advance system for use with motor vehicle internal combustion engines 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,

means for producing a direct current reference potential signal of a magnitude proportional to vehicle speed,

means responsive to said reference potential signal for producing a control signal during vehicle acceleration until said vehicle has accelerated to a speed of a selected magnitude and during vehicle deceleration after said vehicle has decelerated to a speed less than the selected magnitude,

a normally not conducting transistor having a base electrode and two current carrying electrodes, means for connecting said current carrying electrodes of said transistor and said operating coil of said two-way valve in series across said source of direct current potential,

means responsive to said control signal for supplying base drive current to said base electrode of said transistor,

a temperature sensitive switch having current carrying elements operable to an electrical circuit closed condition in response to engine temperatures less than and greater than a selected engine temperature range, and

means for connecting said current carrying elements of said temperature sensitive switch across said base electrode of said transistor and a point of reference potential for diverting said base drive current from said base electrode of said transistor.

4. An ignition spark vacuum advance system for use with motor vehicle internal combustion engines 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,

means for producing a direct current reference potential signal of a magnitude proportional to vehicle speed,

a trigger circuit responsive to said reference potential signal for producing a control signal during vehicle acceleration until said vehicle has accelerated to a speed of a selected magnitude and during vehicle deceleration after said vehicle has decelerated to a speed less than the selected magnitude,

a normally not conducting switching transistor having a base electrode and two current carrying electrodes,

means for connecting said current carrying electrodes of said transistor and said operating coil of said two-way valve in series across said source of direct current potential,

a driver transistor having two current carrying electrodes connected across a selected polarity terminal of said source of direct current potential and said base electrode of said switching transistor responsive to said control signal for completing a circuit through which base drive current is supplied to said base electrode of said switching transistor, and

means responsive to engine temperatures less than and greater than a selected engine temperature range for diverting said base drive current from said switching transistor.

5. An ignition spark vacuum advance system for use with motor vehicle internal combustion engines 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 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,

means for producing a direct current reference potential signal of a magnitude proportional to vehicle speed,

a trigger circuit responsive to said reference potential signal for producing a control signal during vehicle acceleration until said vehicle has accelerated to a speed of a selected magnitude and during vehicle deceleration after said vehicle has decelerated to a speed less than the selected magnitude,

a normally not conducting switching transistor having base, emitter and collector electrodes,

means for connecting said collector-emitter electrodes of said switching transistor and said operating coil of said two-way valve in series across said source of direct current potential, a driver transistor having base, collector and emitter electrodes,

means for applying said control signal to said base electrode of said driver transistor,

means for connecting said emitter-collector electrodes of said driver transistor and said base-emitter of said switching transistor across said source of direct current potential,

a temperature sensitive switch having current carrying elements operable to an electrical circuit closed condition in response to engine temperature less than and greater than a selected engine temperature range, and

means for connecting said current carrying elements of said temperature sensitive switch across said base-emitter electrodes of said switching transistor.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,810,451 Dated May 14, 1974

Inventor(s) Douglas I. Fales

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 10, line 47, "atmosphere" should read
-- temperature --.

Signed and sealed this 10th day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents