

[54] **VACUUM ACTUATED IGNITION
SPARK ENERGY LEVEL CONTROL
CIRCUIT**

[75] Inventor: **Harvey A. Burley**, Warren, Mich.
[73] Assignee: **General Motors Corporation**,
Detroit, Mich.
[22] Filed: **Oct. 4, 1971**
[21] Appl. No.: **186,033**

[52] U.S. Cl. 123/148 DC, 123/148 E
[51] Int. Cl. F02p 3/02
[58] Field of Search 123/148 E, 148 DC, 97 B

[56] **References Cited**

UNITED STATES PATENTS

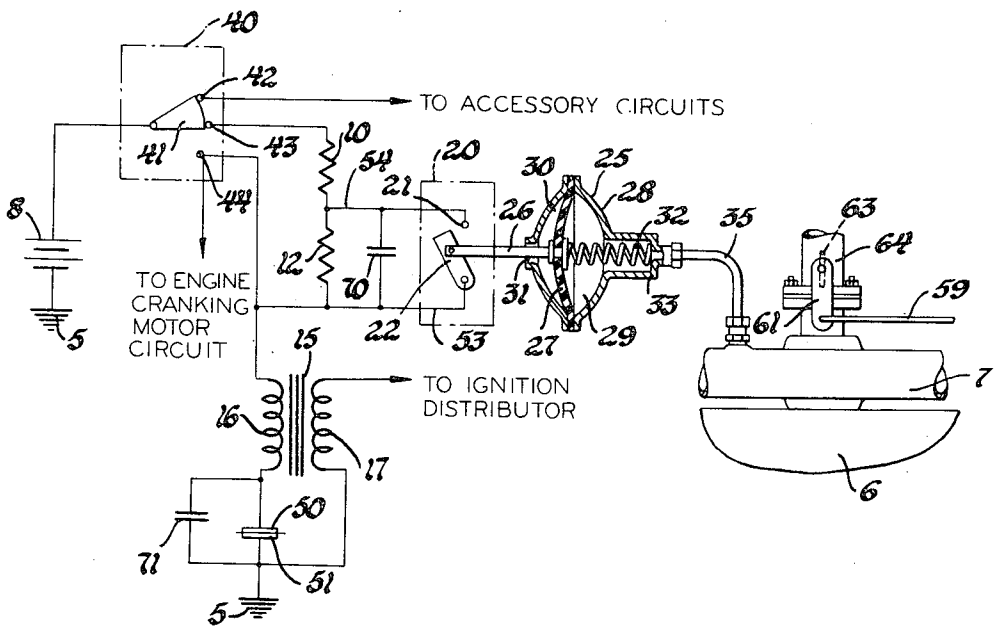
1,549,732	8/1925	Boughton.....	123/148 DC
1,716,895	6/1929	Mallory.....	123/148 DC
2,075,431	3/1937	Du Laney	123/148 DC
3,075,029	1/1963	Michaud	123/148 DC

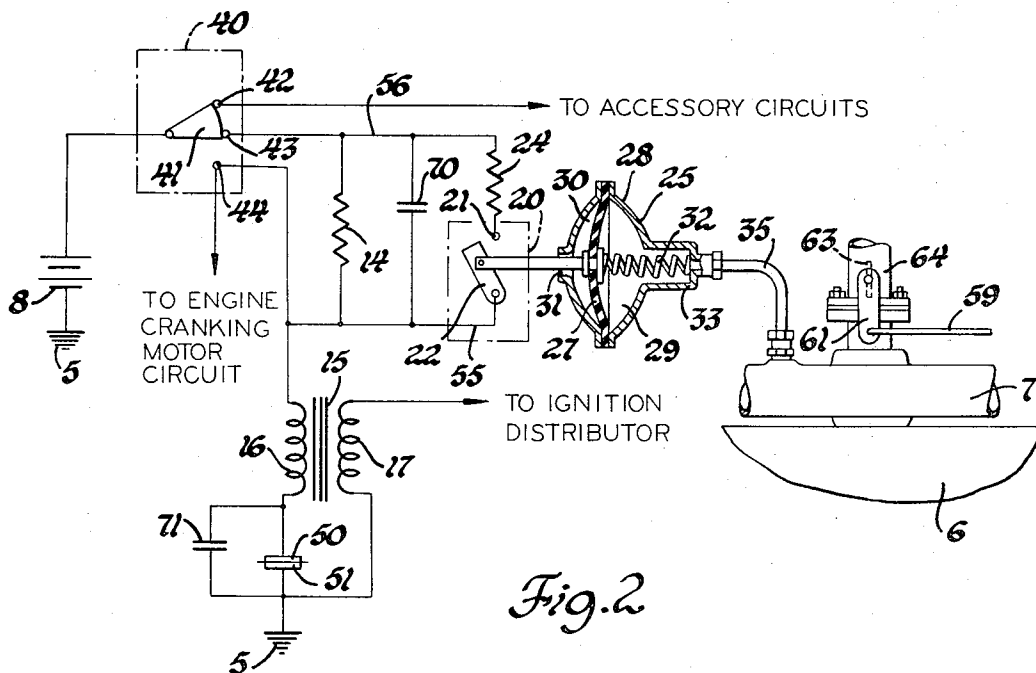
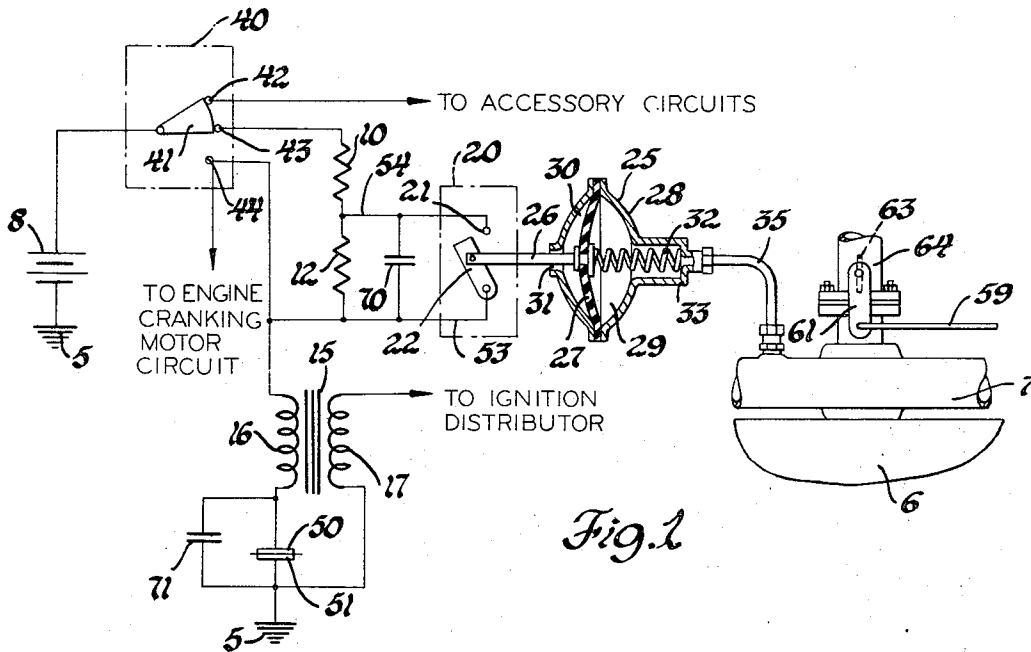
Primary Examiner—Laurence M. Goodridge
Assistant Examiner—Cort R. Flint
Attorney—Eugene W. Christen et al.

[57] **ABSTRACT**

A vacuum actuated ignition spark energy level control circuit for increasing the ignition spark energy level upon engine deceleration. The stationary contact and a normally open movable contact, operable to an electrical circuit closed condition, of an electrical switch are connected across at least a portion of the ballast resistance connected in series with the ignition coil primary winding while the engine is in the running mode. A pressure responsive electrical switch operating device, in communication with the intake manifold of the associated internal combustion engine, is operatively connected to the movable contact of the electrical switch for operating the movable contact to the electrical circuit closed condition upon engine deceleration to reduce the value of ballast resistance connected in series with the ignition coil primary winding.

3 Claims, 2 Drawing Figures





INVENTOR.
Harvey A. Burley
 BY
Richard G. Stake
 ATTORNEY

VACUUM ACTUATED IGNITION SPARK ENERGY LEVEL CONTROL CIRCUIT

This invention is directed to a vacuum actuated ignition spark energy level control circuit, and, more specifically, to a circuit of this type which is responsive to the engine intake manifold vacuum for decreasing the magnitude of ballast resistance connected in series with the ignition coil primary winding during engine deceleration.

For the purpose of increasing ignition distributor breaker point life, most inductive internal combustion engine ignition systems include a ballast resistance connected in series with the ignition coil primary winding while the engine is in the running mode of a resistance value which will limit the ignition coil primary winding current to approximately 3.75 amperes. To provide for a more complete conduction of the rich fuel-air mixture during engine deceleration, the ignition spark energy level may be increased during engine deceleration by reducing the magnitude of ballast resistance connected in series with the primary winding of the ignition coil.

It is well known in the art that the magnitude of ballast resistance connected in series with ignition coil primary winding may be reduced at high engine speeds for the purpose of increasing ignition coil primary winding energizing current which is reduced at high engine speeds due to circuit time constants. Examples of systems of this type are shown and described in U.S. Pat. Nos. 2,037,059, Beltz, Apr. 14, 1936 and 3,075,029, Michaud, Jan. 22, 1963.

It is the purpose of the circuit of this invention, however, to reduce the magnitude of ignition coil primary winding ballast resistance during periods of engine deceleration.

It is, therefore, an object of this invention to provide an improved vacuum actuated ignition spark energy level control circuit for increasing the ignition spark energy level upon engine deceleration.

It is another object of this invention to provide an improved vacuum actuated ignition spark energy level control circuit responsive to the reduction of pressure of the engine intake manifold upon engine deceleration for increasing the ignition spark energy level upon engine deceleration by reducing the magnitude of ignition coil primary winding ballast resistance.

In accordance with this invention, a vacuum actuated ignition spark energy level control circuit for increasing the ignition spark energy level upon engine deceleration is provided wherein the stationary contact and a normally open movable contact, operable to an electrical circuit closed condition under the influence of a pressure responsive electrical switch operating device in communication with the engine intake manifold, are connected across at least a portion of the ballast resistance connected in series with the ignition coil primary winding while the engine is in the running mode.

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 drawing in which:

FIG. 1 sets forth one embodiment of the vacuum actuated ignition spark energy level control circuit of this invention, and

FIG. 2 sets forth an alternate embodiment of the vacuum actuated ignition spark energy level control circuit of this invention.

Referring to FIG. 1 of the drawing, the vacuum actuated ignition spark energy level control circuit of this invention for increasing the ignition spark energy level upon engine deceleration is set forth in schematic form in combination with an internal combustion engine 6 having an intake manifold 7 in which the pressure decreases upon engine deceleration and an ignition system of the type having a ballast resistance, shown as two series connected resistors 10 and 12, connected in series with the primary winding 16 of the ignition coil 15 across a direct current potential source, which may be a conventional storage battery 8, while the engine is in the running mode and includes an electrical switch 20 having a stationary contact 21 and a normally open movable contact 22, operable to an electrical circuit closed condition, connected across at least a portion of the ballast resistance and a pressure responsive electrical switch operating device, which may be a conventional vacuum actuator 25, in communication with the intake manifold 7, through vacuum line 35, and operatively connected to the movable contact 22 of electrical switch 20 through a rod 26 for operating the movable contact 22 of electrical switch 20 to the electrical circuit closed condition upon engine deceleration.

Switch member 40, connected between battery 8 and the ignition system, may be a conventional automotive type ignition switch well known in the art having a movable contact 41 and three stationary contacts 42, 43 and 44. Ignition switches of this type are manually operable, generally with an ignition key, to an engine "crank" position, at which movable contact 41 is in electrical contact with stationary contacts 43 and 44, and is spring biased to return to the "run" position upon the release of the torque upon the ignition key, at which movable contact 41 is in electrical contact with stationary contacts 42 and 43.

While ignition switch 40 is in the "crank" position, the engine cranking motor circuit, not shown, is connected across battery 8 through movable contact 41 and stationary contact 44 and the ignition coil primary winding 16 is connected across battery 8 through movable contact 41, stationary contact 44, the engine ignition distributor breaker contacts 50 and 51 which are operated to an electrical circuit closed and open position in timed relationship with the associated engine in a manner well known in the automotive art and point of reference or ground potential 5. While ignition switch 40 is in the "run" position in which it is shown in the FIGURES, the associated automotive accessory circuits are connected across battery 8 through movable contact 41 and stationary contact 42 and ballast resistance resistors 10 and 12 are connected in series with ignition coil primary winding 16 across battery 8 through movable contact 41 and stationary contact 43 and the ignition distributor breaker contacts 50 and 51 and point of reference or ground potential 5.

While ignition distributor breaker contacts 50 and 51 are closed and the engine is in the running mode, ignition coil primary winding energizing current flows from the positive polarity terminal of battery 8, through movable contact 41 and stationary contact 43 of ignition switch 40, ballast resistance resistors 10 and 12 in

series, ignition coil primary winding 16 in series, ignition distributor breaker contacts 50 and 51 and point of reference of ground potential 5 to the negative polarity terminal of battery 8. Upon the operation of ignition distributor breaker contacts 50 and 51 to the electrical circuit open condition by the ignition distributor cam which is rotated in timed relationship with the engine by the engine in a manner well known in the automotive art, the ignition coil primary winding energizing circuit is opened. The resulting collapsing magnetic field induces a high potential ignition spark in secondary winding 17 of ignition coil 15 which is directed to the proper engine spark plug through the rotor of the ignition distributor, not shown, in a manner well known in the automotive art. It may be noted that, while ignition switch 40 is in the "crank" position, the ignition coil primary winding 16 is connected directly across battery 8 through movable contact 41 and stationary contact 44 of ignition switch 40, ignition distributor breaker points 50 and 51 and point of reference or ground potential 5. With this arrangement, the ignition coil primary winding energizing current is increased during engine cranking operations, a desirable condition, to provide a sufficient ignition spark energy to start the engine.

The stationary contact 21 and movable contact 22 of electrical switch 20 are connected across a portion of the ballast resistance, resistor 12, through respective leads 53 and 54.

The pressure responsive electrical switch operating device may be any conventional vacuum actuator of the type well known in the art having a diaphragm 27 drivingly connected at one end with push rod 26 which is pivotally secured to movable contact 22 of electrical switch 20 at the opposite end. Diaphragm 27 is peripherally sealed within a casing 28 to form an airtight chamber 29 and a chamber 30 which is open to the atmosphere through an opening 31 formed in the casing. A compression spring 32 is disposed in a cylindrical portion 33 of the casing to urge the diaphragm 27 and the push rod 26 in a direction toward the left as viewed in FIG. 1. A vacuum line 35 communicates with intake manifold 7, consequently, intake manifold pressure is thus applied to diaphragm 27 in opposition to the atmospheric pressure in chamber 30. The manifold pressure, which is normally less than atmospheric, permits the atmospheric pressure to urge diaphragm 27 and push rod 26 toward the right, as viewed in FIG. 1, against the bias of compression spring 32.

A throttle lever 59 is secured, by means of a link 61, to the throttle valve 63 of carburetor 64 which is mounted upon intake manifold 7 in a conventional manner.

Upon engine deceleration, link member 61 rotates in a counterclockwise direction, as viewed in FIG. 1, to close throttle valve 63. Upon the closure of throttle valve 63, the pressure within intake manifold 7 falls well below atmospheric, consequently, atmospheric pressure forces diaphragm 27 of vacuum actuator 25 in a direction toward the right, as viewed in FIG. 1, against compression spring 32. Push rod 26, which is secured to diaphragm 27, is moved thereby toward the right, as viewed in FIG. 1, to operate movable contact 22 of electrical switch 20 to the electrical circuit closed condition in electrical contact with stationary contact

21. With movable contact 22 of electrical switch 20 in electrical contact with stationary contact 21, ballast resistance resistor 12 is shorted out, consequently, only ballast resistance resistor 10 remains in series with ignition coil primary winding 16 during periods of engine deceleration. Ballast resistance resistor 10 may be so proportioned to provide an ignition coil primary winding energizing current of approximately 4.5 amperes. With an increase of ignition coil primary winding energizing current during periods of engine deceleration with electrical switch 20 operated by the engine vacuum through vacuum actuator unit 25 to the electrical circuit closed condition to provide a short circuit around ballast resistance resistor 12, the ignition spark energy level induced in ignition coil secondary winding 17 upon the operation of ignition distributor breaker contacts 50 and 51 to the electrical circuit open condition is increased to provide for improved combustion of the fuel-air mixture.

In FIG. 2, wherein the elements identical to corresponding elements of FIG. 1 has been assigned like characters of reference, an alternative embodiment of this invention is set forth in schematic form. In FIG. 2, the ballast resistance is illustrated as a single resistor 14 which is connected in series with the ignition coil primary winding 16 across battery 8 with movable contact 41 of ignition switch 40 closed to stationary contact 43 through ignition distributor breaker contacts 50 and 51 and point of reference or ground potential 5.

In this embodiment, another resistor 24 and the stationary contact 21 and movable contact 22 of electrical switch 20 are connected in series across ballast resistance resistor 14 through respective leads 55 and 56.

Upon engine deceleration with throttle valve 63 closed, atmospheric pressure again forces diaphragm 27 and, consequently, push rod 26, attached thereto, to the right, as viewed in FIG. 2, against compression spring 32 to operate movable contact 22 of electrical switch 20 to the electrical circuit closed condition in electrical contact with stationary contact 21.

With movable contact 22 of electrical switch 20 operated to the electrical circuit closed condition by vacuum actuator 25, resistor 24 is connected in parallel with ballast resistance resistor 14. Consequently, the resistance of this parallel combination, connected in series with ignition coil primary winding 16, is less than the resistance value of ballast resistance resistor 14. With electrical switch 20 operated to the electrical circuit closed condition, the ignition coil primary winding energizing current is increased, a condition which increases the ignition spark energy level induced in ignition coil secondary winding 17 upon each operation of ignition distributor breaker contacts 50 and 51 to the electrical circuit open condition in a manner previously explained. In this embodiment, resistance 24 and ballast resistance resistor 14 are so proportioned to produce a primary winding energizing current of approximately 4.5 amperes while they are connected in parallel through electrical switch 20.

Capacitor 70 in both FIGS. 1 and 2 is a spark inhibiting capacitor and capacitor 71 is the conventional ignition distributor capacitor.

In both of the embodiments of FIGS. 1 and 2, movable contact 22 of electrical switch 20 is shown to be operated directly by a vacuum actuator unit 25 in com-

munication with intake manifold 7 of engine 6. It is to be specifically understood that movable contact 22 of electrical switch 20 may be operated by the conventional vacuum advance mechanism of a conventional automotive type distributor without departing from the spirit of the invention.

While two preferred embodiments of the present invention have 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. A vacuum actuated ignition spark energy level control circuit for increasing the ignition spark energy level upon engine deceleration comprising in combination with an internal combustion engine having an intake manifold in which the pressure decreases upon engine deceleration and an ignition system of the type having a ballast resistance connected in series with the primary winding of the ignition coil across a direct current potential source while the engine is in the running mode, an electrical switch having a stationary contact and a normally open movable contact, operable to an electrical circuit closed condition, connected across at least a portion of said ballast resistance, and a pressure responsive electrical switch operating means in communication with said intake manifold and operatively connected to said movable contact of said electrical switch for operating said movable contact to the electrical circuit closed condition upon engine deceleration.

2. A vacuum actuated ignition spark energy level control circuit for increasing the ignition spark energy level upon engine deceleration comprising in combination with an internal combustion engine having an in-

take manifold in which the pressure decreases upon engine deceleration and an ignition system of the type having a ballast resistance connected in series with the primary winding of the ignition coil across a direct current potential source while the engine is in the running mode, a resistor, an electrical switch having a stationary contact and a normally open movable contact, operable to an electrical circuit closed condition, means for connecting said resistor and said stationary contact and said movable contact of said electrical switch in series across said ballast resistance, and a pressure responsive electrical switch operating means in communication with said intake manifold and operatively connected to said movable contact of said electrical switch for operating said movable contact to the electrical circuit closed condition upon engine deceleration.

3. A vacuum actuated ignition spark energy level control circuit for increasing the ignition spark energy level upon engine deceleration comprising in combination with an internal combustion engine having an intake manifold in which the pressure decreases upon engine deceleration and an ignition system of the type having two ballast resistors connected in series with the primary winding of the ignition coil across a direct current potential source while the engine is in the running mode, an electrical switch having a stationary contact and a normally open movable contact, operable to an electrical circuit closed condition, connected across one of said ballast resistors, and a pressure responsive electrical switch operating means in communication with said intake manifold and operatively connected to said movable contact of said electrical switch for operating said movable contact to the electrical circuit closed condition upon engine deceleration.

* * * * *

40

45

50

55

60

65