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IGNITION CONTROL APPARATUS

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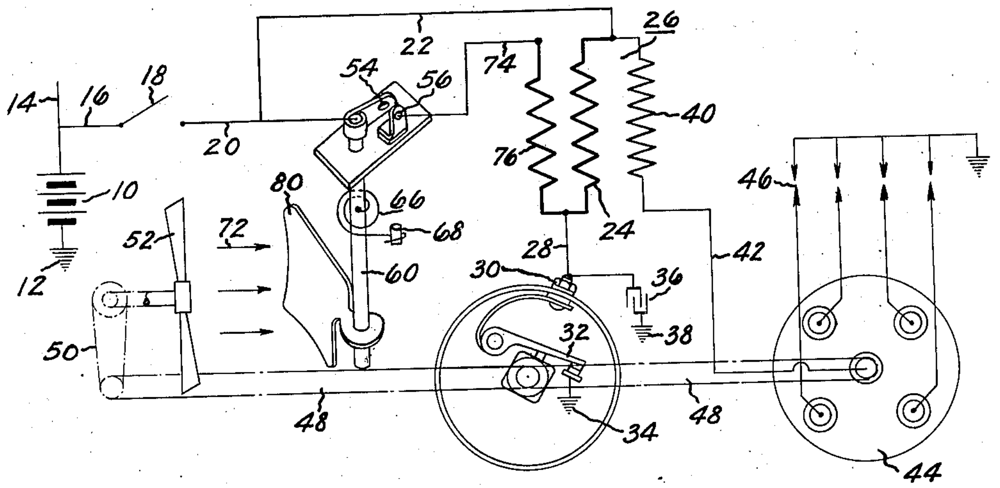

Fig.1

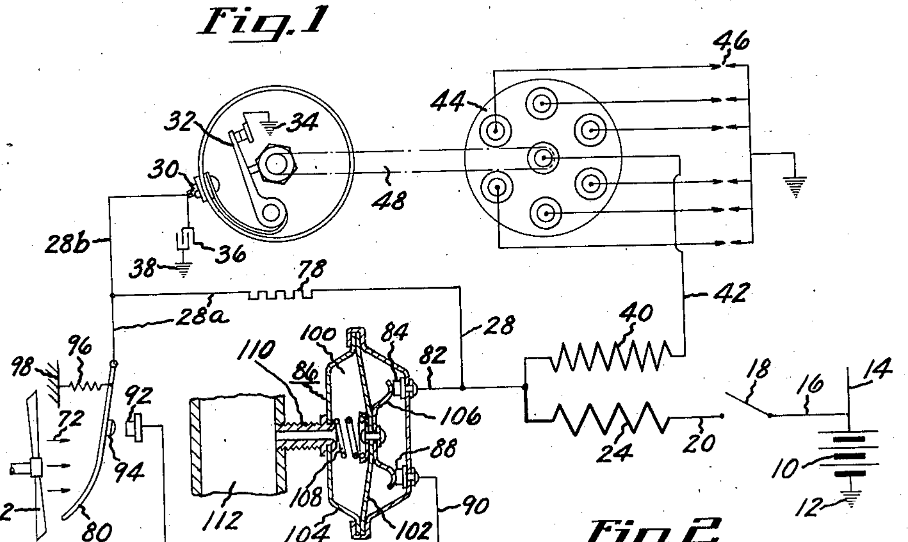

Fig.2

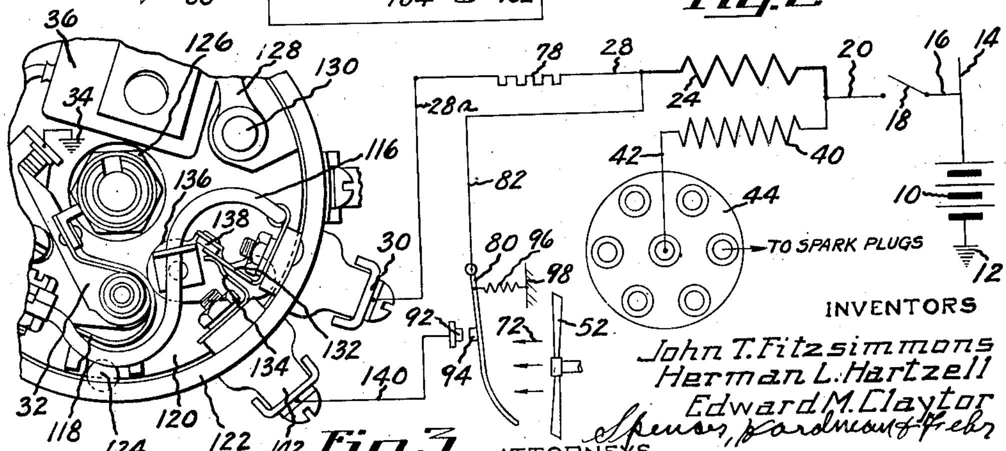

Fig.3

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IGNITION CONTROL APPARATUS

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11 Claims. (Cl. 123—148)

This invention relates to ignition control apparatus, and has for a principal object, to reduce the total resistance of the primary ignition circuit, while an automotive engine is operating under substantially full load and near top speed with wide open throttle.

Another object of the invention, is to provide means for improving the coil characteristics of internal combustion engines while operating under exacting conditions.

Another object of the invention, is to provide means automatically operable in response to engine operating conditions, that will change the ignition coil characteristics for greatest efficiency for the conditions under which the engine is being operated.

A further object of the invention is to provide an ignition system that will maintain a normal excitation circuit for the primary ignition current during ordinary engine operation, and which will automatically substitute an alternative or auxiliary excitation circuit for the primary ignition current during extremes of engine operation, or for other than ordinary engine operation.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein a preferred embodiment of the present invention is clearly shown.

The several objects of the invention are accomplished by providing an auxiliary or an alternative primary excitation circuit with appropriate automatically operable switches therein, which switches are adapted in response to predetermined engine operating conditions to substitute the alternative primary excitation circuit for the normal primary excitation circuit, so that the resistance of the primary circuit of the coil is reduced for certain extremes of engine operation. One convenient change-over device, incorporates a switch responding to the breeze or air blast created by the engine cooling fan at a predetermined engine speed. In another form of the control, a second switch or circuit interrupter is connected in series with that first mentioned, and both switches are so calibrated as to effect the change-over at the prescribed engine operating conditions. This second switch may be a suction operated switch connected into the intake fuel passage, or may amount to a pair of cooperable contacts so disposed as to be actuated by the suction operated timer shifting means, which is usually an expansion chamber having a fluid connection into the fuel induction system. In either instance, the expansion chamber responds to the changes of pressure within the fuel induction pipe, in cooperation with the first mentioned switch, to select the primary excitation circuit under which the engine is to be operated.

In the drawing:

Fig. 1 is a circuit diagram, illustrating the application of the herein described improvement, the changeover or selection being affected by a single air-stream operated switch.

Fig. 2 is a circuit diagram, illustrating the invention as controlled by an air switch in cooperation with a load responsive, or suction actuated switch.

Fig. 3 is a circuit diagram, supplemented by physical structure, illustrating how the invention is practiced through the aid of the convention timer or circuit interrupter shifting mechanism.

In internal combustion engines of the variable speed type, such as those used in automobiles, firing of the fuel charge is effected by means of an ignition coil, one winding of which comprises a primary winding in circuit with a current source and an interrupter, and which effect a sparking circuit through the aid of a secondary winding. The effectiveness of the secondary current to fire the fuel charge, depends upon several characteristics of the primary circuit, one of which is the current that can be passed through the primary circuit, and the length of time that the primary circuit is impressed or energized by the current source. Thus, it is obvious that current conditions in the primary that are satisfactory for normal engine operation, or for a low range of speeds, may not be at all satisfactory during high speed engine operation. During high speed engine operation, the time of engagement of the contacts of the interrupter is so short, as to materially reduce the time of primary energization. A reduced period of primary energization is reflected directly in the current output of the secondary, and this secondary output may be insufficient to properly fire the fuel charge in the engine cylinder. Applicants have devised a method, and means for accomplishing the method, whereby the characteristics of the ignition coil can be improved automatically in response to engine operation, under the contemplated extreme conditions.

With particular reference to the drawing, **10** indicates a battery or current source having a ground connection at **12** and a supply wire **14**, from which a branch **16** connects with an ignition switch **18**. Conductors **20** and **22** make for leading the current source to a primary **24** of an ignition coil **26**, which primary connects by lead 28 to a terminal post 30 of an interrupter mechanism 32, a fixed contact of which is grounded at 34, and a condenser 36 by-passing the interrupter with a ground at 38. Joined to the primary winding there is a secondary 40, provided with a lead 42 communicating with a central contact of a distributor mechanism 44, and by which sparking phenomenon is produced at the points 46, as is usual and well known to those experienced in the art. The interrupter and distributor mechanisms are usually driven by a common shaft 48 from the crank shaft of the engine, which is also appropriately geared through the agency of a belt or similar device 50, for driving an engine cooling fan 52.

The mechanism thus far described, includes what is here termed for the sake of convenience, the normal primary excitation circuit, and which traverses the primary winding 24. The lead 20 is in communication with a movable contact 54, that is adapted to engage a fixed contact 56. The movable contact 54 is actuated to engage fixed contact 56 by means of a rotatable shaft 60 against the effect of a spring 66 anchored at 68. The contact 54 moves to the open position in response to the force of the spring 66, and to the closed position in response to the force of an air blast upon a movable vane 80 emanating from the cooling fan 52, as indicated by the arrows 72. The alternative or auxiliary excitation circuit comprises a conductor 74 joining the contact 56, and communicating with an auxiliary primary winding 76, arranged in inductive relation to the secondary 40 and joined to the lead 28 as indicated.

In Figs. 2 and 3, illustration is made of the normal excitation circuit as including a resistance unit, while the alternative excitation circuit constitutes a by-pass, with a plurality of switches in series, for directing the primary current around the resistance unit under certain engine operating conditions. The elements of construction common to the disclosure of Fig. 1, are indicated by the same reference characters. Referring particularly to Fig. 2, the lead 28 communicating with the primary 24, is joined to a resistance unit 78 from which a conductor 28*a* runs to a vane 80 of an air switch, and from which point a conductor 28*b* communicates with the interrupter device, by joining the terminal 30 as hereinabove described. This connection constitutes the normal excitation circuit, and is that that is ordinarily used during ordinary engine operation. The alternative excitation circuit comprises a conductor 82 attached to the lead 28 and ending in a fixed contact 84 of a suction actuated switch 86. A second fixed contact 88 of this switch communicates by means of a conductor 90 with a fixed contact 92 supported by insulation in cooperable relation with a movable contact 94 of the air switch 80, the contacts 92, 94 being urged to an open relation by means of a spring 96, having an anchorage at 98. The suction actuated switch 86 comprises a substantially sealed chamber 100, bounded by a flexible diaphragm 102, and a rigid case member 104, that insulatingly supports the contacts 84 and 88 in such position as to be bridged by a contact member 106 mounted on the diaphragm 102. A spring 108 disposed between the diaphragm and case member 104 normally closes the contacts 84, 88 and 106, and a nipple 110 establishes communication between the expansion chamber 100 and the fuel induction pipe 112 of the engine.

According to the disclosure of Fig. 3, the normal primary excitation circuit continues from the primary winding 24, through the resistance unit 78 and lead 28*a* to the terminal member 30, from which point the circuit is completed to the interrupter 32 by means of a conducting lead or jumper 116, that communicates with a circuit breaker lever spring 118, as is the usual procedure. Here, the interrupter mechanism is mounted on an oscillatable plate 120, having an anti-friction bearing support from the wall of a housing 122, by means of ball bearings 124, and the plate 120 is oscillatable with respect to the housing 122 and with respect to a rotating cam 126, for altering the time relation of fuel ignition. In the conventional mechanism, the plate 120 is shifted in response to engine operating conditions, by means of a suction unit whose movable member provides a link 128 pivoted to the breaker plate 120 at 130, and is adapted upon rise and fall of fuel induction pressure, to oscillate the plate 120 upon its bearings 124.

Making for adoption of the improvement disclosed herein, a yieldable contact member 132 is secured to the inner end of the terminal member 30 and so disposed as to extend over the breaker plate 120; this contact member always being in communication with the jumper 116 and the terminal 30. A cooperating contact member 134 is secured to the wall of the housing 122 in insulated relation, and is so adjusted as normally to engage the contact member 132, when they are not subject to any biasing force, but are adapted to be separated one from the other. To accomplish the engaging relation, a bracket 136 is mounted on the breaker plate 120 and carries a bumper 138, so disposed as to engage one of the yieldable contact members and press them into electrical conductive relation at some prescribed position of the circuit breaker plate 120. In the illustrated embodiment, the bumper 138 closes the contact members 132 and 134 when the breaker plate 120 has been moved to the full retard position. This switching mechanism mounted in the interrupter housing is disposed within the alternative primary induction path, by means of a conductor 140 joining a terminal 142 supporting the contact 134 and the fixed contact 92 of the air switch 80, from which the lead 82 communicates with the primary 24 where it joins the lead 28.

In practicing the invention according to the disclosure of Fig. 1, the governing function is embodied in the potential of the air blast, created by the engine cooling fan 52 and represented by the arrows 72. Assuming for convenience of illustration, that it is desired to effect the changeover at a road speed of about 55 M. P. H., the air switch is then calibrated, as by adjusting the tension of the spring 66, the size, inclination and pitch of the wind vane 80, or its location with respect to the air stream from the cooling fan, to actuate the movable contact 54 to engage the contact 56 in response to the corresponding wind pressure from the fan 52. When this shift is made, the energy from the battery 10 will be connected with both the primary 24 and the primary 76. Thus, the coil characteristics of the ignition system are automatically changed in response to the air blast from the cooling fan, immediately that the engine speed enters that band of speed above that prescribed for ordinary engine operation. Installation according to Fig. 1, besides operating under the conditions of the car moving at 55 M. P. H., will also operate when the engine is running free at the same relative engine speed, such as when the vehicle is standing at the curb, or when the engine is raced apart from its geared connection to the road wheels.

In the embodiment disclosed in Figs. 2 and 3, the controlling functions are dual, and must co-operate in an additive manner to effect complete control. There it is possible to effect the change over only during engine operation under substantially full load and with wide open throttle. According to those embodiments the air switch is calibrated to close the contacts at engine speeds comparable with 55 M. P. H. vehicle speed, and the suction actuated switches are calibrated so as to be closed at a relatively low depression of the fuel mixture in the induction pipe. One characteristic of variable speed automotive engines is that the depression of the fuel mixture within the induction pipe is low when the engine is operating under substantially full load. In illustration of this, let it be assumed that depression in the fuel induction pipe of about 7 inches of mercury will effect actuation of the diaphragm in the expansion chamber, to opening of the contacts **84** and **88**, or **132** and **134**. With respect to Fig. 3, that will occur when the start of the timing shift is communicated to the breaker plate **120**. The suction operated switch will be closed at low or engine idling speed, and higher engine speeds when operating under full load and with throttle wide open. Therefore, calibration of the suction operated switch for operation at a depression of less than 7 inches of mercury depression, is selected as being a value somewhat below the depression that may exist in the intake passage under ordinary engine operation. Any time that the engine is operated under full load, the depression will be less than 7 inches of mercury. It may therefore be assumed that the suction actuated switch will always be closed during the engine speeds for which it is desired to effect a control. This being the condition, the alternative primary excitation circuit will be substituted for the normal primary excitation circuit only during speeds over 55 M. P. H. with substantially full load, and this will be accomplished by the air switch in response to the air blast from the cooling fan, which is directly proportional to the road speed of the vehicle. On the other hand there will be no change-over during engine cranking conditions, or during engine racing, or during cruising speeds above 55 M. P. H. with part load, because in those instances the depression of the fuel mixture is too great to permit closing of the suction actuated switch. It necessitates the closing of both the air switch and the suction actuated switch in order to complete the alternative primary excitation circuit. In the embodiment of Fig. 3, the load control function is reflected in the retard of the timing for high speed operation, which manifests in the closing of the contacts **132** and **134**. To that effect, the disclosure of Fig. 3 is dependent upon ignition timing retard for high speed engine operation, though that high speed retard is a direct reflection of the fuel induction pipe depression during high speed engine operation under full load.

With respect to either embodiment, a reduction of the engine speed is followed by a reverse movement of the vane of the air switch, and is accompanied by the change-over from the alternative excitation circuit to the normal excitation circuit, which is designed for ordinary engine operation.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. Ignition apparatus comprising in combination, an ignition coil including a primary winding providing a normal excitation circuit, means providing an alternative excitation circuit, a current source, a circuit interrupter for controlling the passage of current from the source through the excitation circuit selected, and fluid operated means for selecting the excitation circuit to be energized during predetermined engine operating conditions, said fluid operated means comprising a switch responding to the air stream of engine operation, and a switch responding to the depression of the fuel mixture during engine operation, both of said switches being connected in series and disposed in the alternative excitation circuit.

2. Ignition apparatus comprising in combination, an ignition coil including a primary winding providing a normal excitation circuit, means providing an alternative excitation circuit, a current source, a circuit interrupter for controlling the passage of current from the source through the excitation circuit selected, and fluid operated means for selecting the excitation circuit to be energized during predetermined engine operating conditions, said fluid operated means including a switch responding to air movement created by engine operation, for selecting the alternative exciting circuit during engine operation at top speed and substantially full load.

3. Ignition apparatus comprising in combination, an ignition coil including a primary winding providing a normal excitation circuit, means providing an alternative excitation circuit, a current source, a circuit interrupter for controlling the passage of current from the source through the excitation circuit selected, and speed responsive means for selecting the excitation circuit to be energized during predetermined engine operating conditions, said speed responsive means including a switch responding to air movement created by engine operation, for selecting the alternative exciting circuit during engine operation at top speed and substantially full load.

4. In ignition apparatus for an internal combustion engine having a cooling fan and an interrupter for control of the fuel firing, the combination comprising, an ignition coil including a primary winding and an external resistance in series providing a path of normal inductance during engine operation, means providing an alternative excitation circuit, including a by-pass around the external resistance, a current source, and means for controlling the passage of current from the source through either excitation circuit, said means operating to select the alternative exciting circuit during engine operation at top speed and full load, said means including a suction actuated switch responding to the depression of fuel mixture, and a switch in series therewith responding to the air stream from the cooling fan.

5. In ignition apparatus for an internal combustion engine having a cooling fan, and an interrupter with spark timing mechanism for controlling the firing of the fuel charge, the combination comprising, an ignition coil including a primary winding and an external resistance in series providing a normal excitation circuit, means providing an alternative excitation circuit including a by-pass around the external resistance, a pair of switches in series for control-

ling the by-pass, one of said switches being actuated by predetermined shift of the spark timing mechanism, the second of said switches being actuated in response to change of air blast from the cooling fan, and a current source for energizing either excitation circuit selected.

6. In ignition apparatus for an internal combustion engine having a cooling fan, and an interrupter with spark timing mechanism for controlling the firing of the fuel charge, the combination comprising, an ignition coil including a primary winding and an external resistance in series providing a normal excitation circuit, means providing an alternative excitation circuit including a by-pass around the external resistance, a switch responding to the air blast from the cooling fan during high speed engine operation for closing an opening in the alternative excitation circuit, a second switch for completing the alternative excitation circuit upon movement of timing mechanism to spark retard position, and a current source for energizing the excitation circuit selected, said switches being in series, and when both closed adapted to alter the coil characteristics for high speed engine operation.

7. The combination set forth in claim 6, wherein the second switch comprises a pair of normally open spring biased contacts mounted in the interrupter and flexed to closing position by a movable abutment on the timing mechanism.

8. In ignition apparatus for an internal combustion engine having a cooling fan and an interrupter for control of the fuel firing, the combination comprising, an ignition coil including a primary winding and an external resistance in series providing a normal excitation circuit during engine operation, means providing an alternative excitation circuit for engine starting, and for engine operation at top speed, and including a by-pass around the external resistance, means for selecting the excitation circuit automatically in response to conditions of engine operation, comprising a switch with normally open contacts adapted to close in response to engine intake suction and a second switch with normally open contacts in series with the first mentioned switch, and adapted to close in response to the air blast from the cooling fan during high speed engine operation, said switches being located in the alternative excitation circuit and when both closed are adapted to improve the coil performance during top speed performance under full load.

9. In an ignition system for internal combustion engines having a cooling fan, in which system an ignition primary coil and interrupter in circuit with a current source effect firing of the fuel charge, the combination with said interrupter and source of means for altering the coil characteristics during top speed engine performance, and means responding automatically to operation of the engine for selecting the coil characteristics under which the engine will be operated, said altering means comprising an additional primary winding connected in parallel with the first mentioned primary, said selecting means comprising an air switch responding to the variations in speed of the cooling fan for substituting one primary for the other in accordance with the speed of engine operation.

10. In an ignition system for internal combustion engines having a cooling fan, in which system an ignition primary coil and interrupter in circuit with a current source effect firing of the fuel charge, the combination with said interrupter and source of means for altering the coil characteristics during top speed engine performance, and means responding automatically to operation of the engine for selecting the coil characteristics under which the engine will be operated, said altering means including an external resistance in series with the primary and electrical connections for by-passing the resistance, and said selecting means responding to an air blast from the cooling fan during high speed engine operation, and also responding to substantially full load engine operating conditions to combine in effecting the by-pass around the external resistance during engine operation at top speed and under substantially full load.

11. Ignition apparatus comprising in combination, an ignition coil including a primary winding providing a normal excitation circuit, means providing an alternative excitation circuit, a current source, a circuit interrupter for controlling the passage of current from the source through the excitation circuit selected, and fluid operated means including a switch responding to the air stream of the engine operation for selecting the excitation circuit, to be energized during high speed engine operating conditions.

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