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CONTROL CIRCUIT FOR ENGINE STARTING AND IGNITION SYSTEM

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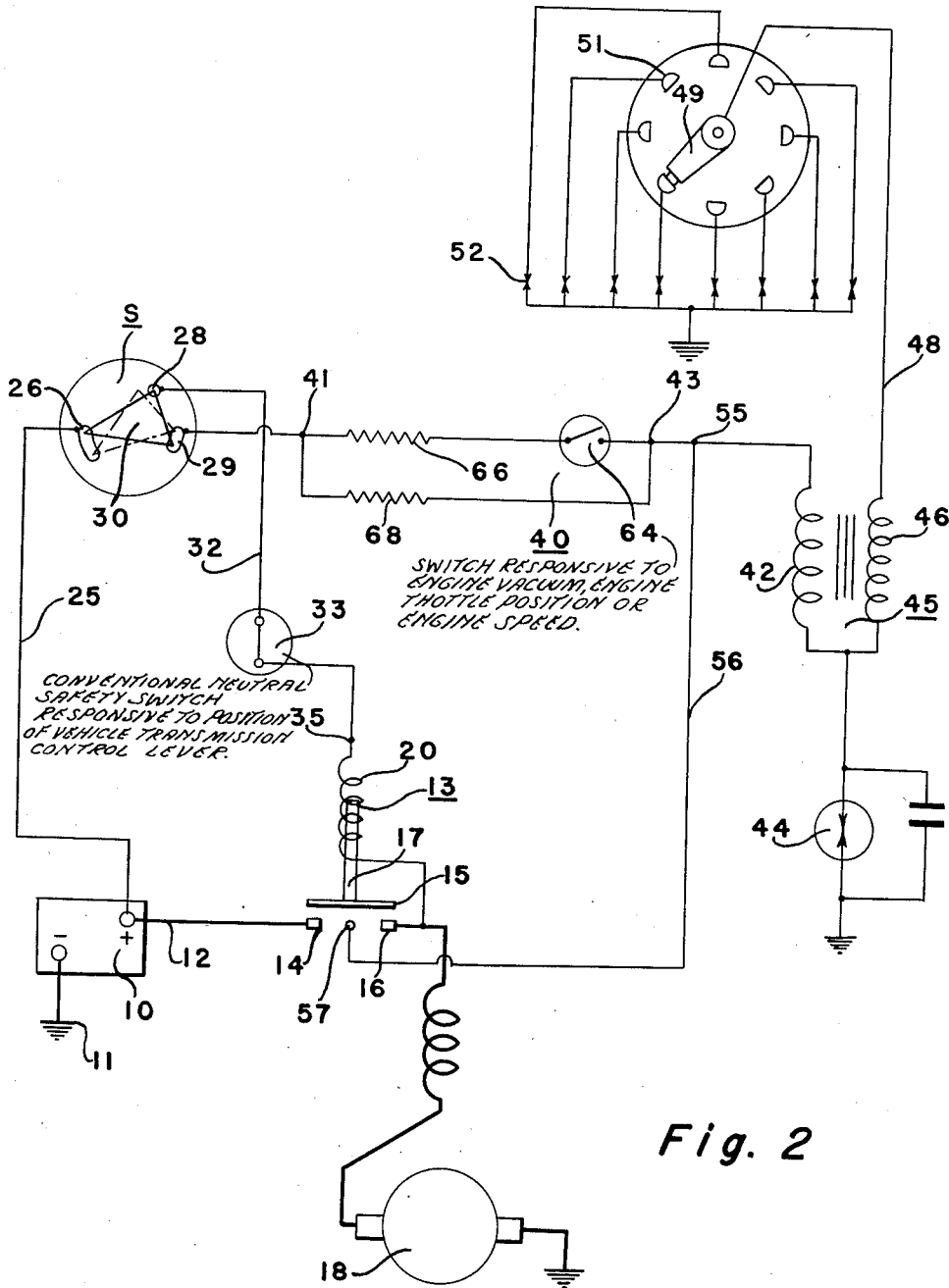


Fig. 2

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CONTROL CIRCUIT FOR ENGINE STARTING AND IGNITION SYSTEM

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The invention relates to electric circuits for internal combustion engines and is particularly concerned with the control of current in an ignition circuit therefor.

It is well known that the current requirements in ignition circuits for internal combustion engines vary over the entire range of operation of the engine. For example, the requirements during periods when the engine is operating under load at a high r. p. m. or during starting periods are greater than the current requirements during normal operational periods.

It is an object therefore of the present invention to increase the current in an ignition system during cranking periods and when the engine operation exceeds a predetermined condition of load and speed.

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

In the drawings:

Figure 1 illustrates a wire diagram of the circuit connections of one embodiment of an ignition circuit according to the present invention.

Figure 2 illustrates a wire diagram of another modification of an ignition circuit according to the present invention.

It is well known that a very heavy current is required to operate the starting motor for cranking an internal combustion engine during starting periods. This causes a considerable drop in voltage across the battery terminals which exists as long as the starting motor is energized. It is further known that the adjustments of the timing and the gaps of the spark plugs and distributor points, etc., to produce desired ignition characteristics in the present day high compression engines, are of a critical nature and if the normal current is of an excess value, the points will quickly burn or otherwise deteriorate. On the other hand, any reduction of the system voltage and current will reduce the voltage and current to the primary ignition coil winding and make for more difficult starting. It is further known that under various conditions of operation, more particularly when the engine is operating at close to the full open throttle position at a high speed, the ignition current requirements are increased. The present invention is directed to the elimination of the above difficulties and will provide an ignition system wherein a higher current will be available to the ignition spark plugs only during the starting periods and when the engine is operating under heavy loads and at a high rate of speed.

Referring now to the drawings, the numeral 10 designates a current source such as a storage battery which is grounded at 11. The battery 10 is connected by a lead 12 with an electromagnetic switch 13 which includes stationary contacts 14 and 16 and a movable contact 15 attached to a solenoid armature 17. Contact 16 is electrically connected to a starter motor 18 which is grounded.

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The electro-magnetic switch 13 includes a winding 20 which attracts the armature 17 to move contact 15 into a circuit closing position in which the motor 18 is connected with the battery 10.

The battery 10 is also connected by a lead 25 to the stationary contact 26 of a manually operated key switch S which may be of the type disclosed in U. S. Patent 2,655,570; and which has been assigned to the assignee of the present invention. This switch S provides at least three positions; namely, Off, Run, and Start. In the present instance the switch is shown diagrammatically and includes a movable contact 30 of triangular form having three contact bosses, not shown. The movable contact bosses cooperate with the stationary contacts 26, 28 and 29, which are connected as follows: contact 26 is connected to the battery 10 by lead 25; contact 28 is connected by a lead 32 through a neutral safety switch 33, which may be of any suitable type, to a terminal 35 which is connected with coil 20 and the contact 29 is connected by a lead 36 to a terminal 41 of resistance unit 40 which will be hereinafter described. The other terminal 43 of the resistance unit 40 is connected through a junction 55 to one end of the primary winding 42 of ignition coil 45. The other end of the primary winding 42 is connected with a timer mechanism 44, of conventional form, which includes a fixed contact and a movable contact with the movable contact grounded at 11. A secondary winding 46 of coil 45 is inductably associated with the primary winding 42 and is electrically connected by a conductor 48 with a rotor 49 of a distributor which includes a plurality of spaced terminals 51 which are connected through spark plugs 52, diagrammatically shown; to ground 11.

From the juncture 55, to which terminal 43 of the resistance unit 40 is connected, a conductor 56 leads to a terminal 57 which is arranged to be engaged by the movable contact 15 whenever the latter bridges contacts 14 and 16. The lead 56 provides a shunt circuit that is adapted to cut out resistance unit 40 when the switch S is closed in the start position.

The operation of the circuit during starting when the neutral safety switch 33 is in the closed position is as follows: when the switch S is moved manually to the position shown in full lines, the movable contact 30 will bridge contacts 26, 28 and 29. In this position the battery will be connected to the ignition terminal contact 29 and the terminal 28 so that current will flow from the battery to winding 20 to attract the armature 17 and cause the movable contact to bridge contacts 14, 57 and 16. When this occurs, the resistance unit 40 will be shunted or short circuited so that as the engine is being cranked, current will pass through the shunt circuit including wire 56 and thus provide a greater flow of current through the primary winding 42 than would be accomplished if the circuit included the resistance unit 40. When the engine becomes self-operative and the operator permits the movable contact 30 to move automatically to the position shown in dashed lines the shunt circuit is broken and the resistance unit 40 will be included in the ignition circuit. The insertion of resistance 40 will reduce the flow of current to winding 42 to a value sufficient to maintain good ignition of the combustion mixture when the engine is operating under a normal range of conditions.

It is well known that if the engine speed and load is increased, the ignition requirements also are increased and that the manifold vacuum of the engine is decreased. The present invention is primarily directed to a method whereby an increased current is provided to the ignition system during the periods when the engine is operating under a load at high speed or under a heavy load at low speeds. The resistance unit 40, as shown in Figure 1, is provided with a pair of resistances 60 and 62 which are

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in series in the circuit between terminals 41 and 43. Both of these resistances 60 and 62 are shunted out by conductor wire 56 during the cranking periods as heretofore described. When the engine is in normal operation, both of these resistances 60 and 62 are in circuit so as to limit the current to the primary winding 42 of coil 45. When the engine throttle opening exceeds a predetermined amount and the manifold vacuum is decreased to a predetermined value as, for example, in the order of 8 or 10 inches of mercury, a switch 64 which is normally open and connected with the intake manifold of the engine is caused to close. The switch 64 is of any well known pressure responsive type calibrated for the application involved and connected to close a circuit whenever the engine vacuum decreases below a predetermined value. The closing of switch 64 will shunt the resistance 60 from the ignition circuit so that more current will be available to the primary winding 42 and thereby increase the strength of the sparking impulses to spark plugs 52. In Figure 2 a resistance 66 and 68 which comprises the resistance unit 40 are in parallel. Resistance 66 is of a higher ohmic value, i. e., 6.25 ohms, than the resistance 68 which may have a value of 1.8 ohms. As heretofore described, switch 64 is responsive to the manifold vacuum and is normally open so that during normal engine operations all of the ignition current will pass through resistance 68 except when the resistance unit 40 is shunted during the starting periods. When, however, the manifold vacuum is sufficiently decreased switch 64 will close and, resistance 66 will be placed in parallel with resistance 68 so as to reduce the overall ohmic resistance value of resistance 40 and, thereby provide an increased current to the primary winding 42 for the purposes heretofore set forth.

From the above it is apparent that the ignition circuit according to the present invention will not only provide for a greater ignition current to the engine during the starting periods but will also provide a higher current when the engine is operating under load at approximately the full throttle position or when the engine is under a heavy load at low speeds. This increased ignition when the engine is operating at full throttle will result in an increased economy of operation and an improved engine performance.

While the embodiments of the present invention as herein disclosed constitute preferred forms, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. In a starting and ignition apparatus for an internal combustion engine that is subjected to variable operating conditions, the combination comprising: a dynamo electric machine for starting said engine, a storage battery for supplying current through a circuit to said dynamo, an ignition coil having a primary winding connected to the battery, a current limiting resistance in circuit between said battery and the primary of said coil, means connected with the circuit to the dynamo for shunting out said resistance when the dynamo is supplied with current from said battery, and a second means responsive for shunting at least a portion of said resistance when a predetermined intake vacuum condition of said engine is achieved.

2. In a starting and ignition apparatus for a variable speed internal combustion engine, the combination comprising: a dynamo electric machine for starting said engine, a storage battery for supplying current through a circuit to said dynamo, an ignition coil having a primary winding connected to said battery, a current limiting resistance in circuit between said battery and the primary of

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said coil, means connected with the circuit to the dynamo for shunting said resistance when the dynamo is supplied with current from said battery, and a second means responsive to intake vacuum of said engine for shunting at least a portion of said resistance when the vacuum of said engine describes below a predetermined value.

3. In a starting and ignition apparatus for an internal combustion engine that is subjected to a variable operation of speed and load, the combination comprising: a dynamo electric machine for starting said engine, a storage battery for supplying current through a circuit to said dynamo, an ignition coil having a primary winding connected in a circuit with said battery, a pair of current limiting resistances in said coil and battery circuit, means connected with the dynamo circuit for shunting both of said resistances when the dynamo is supplied with current from said battery, and a second means responsive for decreasing the effect of said pair of said resistances when the engine vacuum is decreased below a predetermined value.

4. The combination as set forth in claim 3 wherein the pair of resistances are connected in series in the circuit between said coil and battery and said second means shunts one of said resistances.

5. The combination as set forth in claim 3 wherein said pair of resistances are connected in parallel with each other and wherein the second means mentioned closes a circuit to one of said pair of resistances.

6. In an ignition system for an internal combustion engine that is subjected to variable operating speeds and loads, the combination comprising: a storage battery, an ignition coil having a primary winding connected in circuit with said battery, a resistance in said circuit, and a means responsive to a predetermined condition of operation for varying the effective value of said resistance in said circuit, wherein said resistance in said circuit includes a pair of resistances which are in series in the circuit between said coil and said battery, and said means shunts one of said resistances.

7. In an ignition system for an internal combustion engine that is subjected to variable operating conditions of load and speed, the combination comprising: a storage battery, an ignition coil having a primary winding connected in circuit with said battery, a pair of resistances in said circuit, and a means for decreasing the effective resistance values of said pair of resistances in response to a predetermined condition of operation of said engine, wherein one of said pair of resistances is connected in parallel with the other of said pair of resistances by said means closing a circuit to said first mentioned resistance.

8. In a method for increasing the actuation of a primary winding of a coil for an ignition system for an internal combustion engine during predetermined operating conditions, the steps comprising: providing a resistance in the circuit between the primary winding and a storage battery; shunting out the resistance when said battery is supplying current to a dynamo electric machine that is used to start the engine, and reducing the effective ohmic value of the resistance when the engine intake vacuum is decreased to a predetermined value.

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