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IGNITION SYSTEMS FOR INTERNAL COMBUSTION ENGINES

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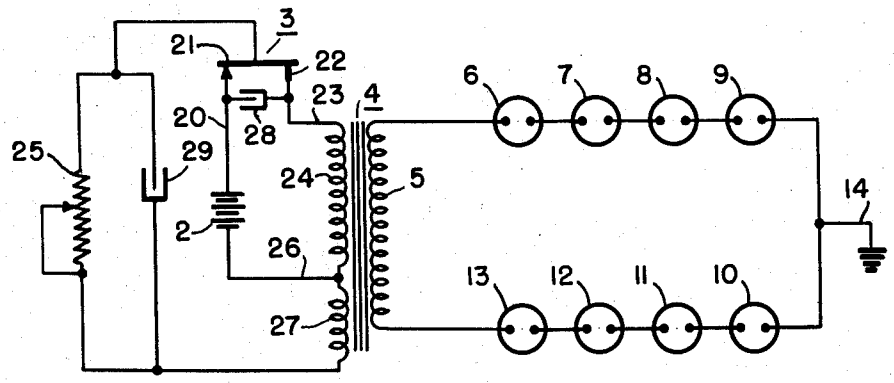


Fig. 1

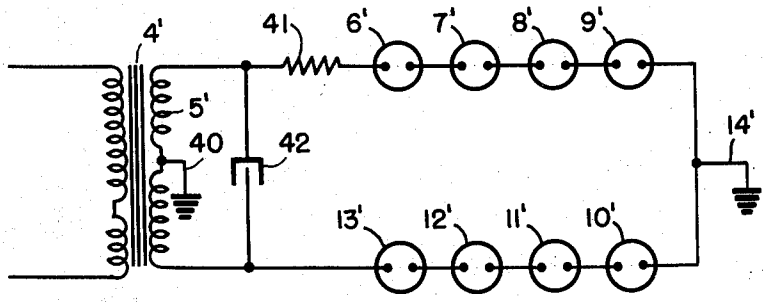


Fig. 2

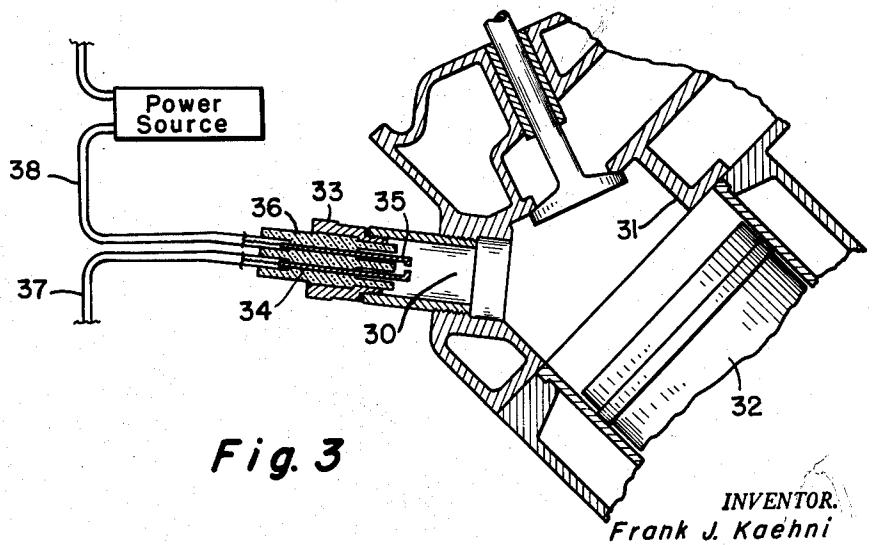


Fig. 3

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IGNITION SYSTEMS FOR INTERNAL COMBUSTION ENGINES

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The present invention relates generally to internal combustion engines and, more particularly, to ignition systems for such engines. It provides a materially simplified ignition system and, at the same time, overcomes many of the known objectionable operating characteristics of such engines and eliminates some of the mechanical requirements therefor.

In my Patents Nos. 2,866,447 and 2,866,839, granted December 30, 1958, I have described ignition systems for internal combustion engines employing a continuous spark for ignition purposes instead of the usual single timed spark as employed in the conventional system. In the systems shown therein, a compact series of sparks is formed and maintained at all times during operations in all cylinders and the sparking electrodes of the spark plugs are located so that the sparks are formed in recesses which are in communication with the cylinders or combustion chambers. The systems which are shown and described in said patents are of such character as to permit the elimination of the usual timing mechanism and the distributor.

The term "continuous spark" is employed in said patents and also herein to designate a series of individual sparks for each explosion of the engine. The continuous spark, in reality, may be continuous in the sense that a spark is maintained at the electrodes of each spark plug at all times during the operation of the engine, i.e., throughout the four cycles of a four cycle engine. However, it is not necessary that the continuous spark function throughout each complete cycle. It is merely necessary that a compact series of individual sparks be supplied for each explosion and, in order to accomplish this, the power source and the electrical connections should be such as to provide continuous sparking at the electrodes during a substantial portion of the combined compression and power strokes of any specific cylinder. In my preferred system, I maintain sparking at the electrodes of each of the spark plugs at all times and maintain a sparking condition of such character that, when peak pressure is achieved in any given cylinder, a hot spark of sufficient intensity to ignite the compressed gases is present.

In the system disclosed in Patent 2,866,839, the individual spark plugs are arranged in parallel circuit relationship and a resistance, capacitance or reactance is present in each of the individual spark plug circuits. These act as current limiters to maintain the required current at each plug; and the voltage at each plug varies with the pressure and temperature conditions so that, when the pressure in each cylinder increases, the power at each plug increases because of the increase in voltage.

In the parallel arrangement as disclosed in Patent No. 2,866,839, if the engine is an eight cylinder engine and a current of approximately 2 milliamps per cylinder is required, the high voltage power supply must supply 16 milliamps at a voltage slightly higher than the highest voltage necessary for peak compression sparking through the current limiters in series with each plug. I have found that a series arrangement of all of the plugs can be employed in this system and that, when employed, it is only necessary that the power supply a total of 2 milliamps at a voltage slightly higher than is required for the parallel circuit of Patent No. 2,866,839. I have also found

that, by employing this series circuit arrangement, the current limiters for each plug circuit may be eliminated.

In carrying out my present invention, special spark plugs are required since it is necessary that each has two insulated electrodes. The electrodes of adjacent plugs are, of course, connected in series relationship with respect to the high voltage ignition circuit. By this arrangement, the current remains substantially equal throughout the entire circuit, but the voltage varies in individual parts according to the resistance of each part of the circuit. The resistance in the circuit for that plug which is about to fire is, of course, increased as the pressure at such plug increases.

In the accompanying drawings, I have shown, for purposes of illustration only, a preferred embodiment of my invention and several modifications thereof.

In the drawings:

FIGURE 1 shows a system in accordance with my invention and in which a transistor is employed in the primary circuit and in which the spark plugs for the eight cylinders are arranged in series circuit relationship in the secondary circuit;

FIGURE 2 is a partial view somewhat similar to FIGURE 1 except that it embodies several modified features;

FIGURE 3 is a view illustrating the relationship between the plug, ignition chamber and main combustion chamber and illustrating somewhat diagrammatically the type of spark plug required for the circuit of my invention.

In the embodiment shown in FIGURE 1, the power source comprises a battery **2**, a transistor indicated generally by the reference character **3**, and a transformer indicated generally by the reference character **4**. The high voltage current for ignition purposes is supplied by the secondary **5** of the transformer **4** to the spark plugs **6**, **7**, **8**, **9**, **10**, **11**, **12** and **13**, these plugs being arranged in series relationship. One side of the secondary coil **5** is connected to one electrode of the spark plug **6** and the other electrode of said spark plug is connected to an electrode of the adjacent spark plug **7**. This same arrangement is continued through the circuit and one electrode of the plug **13** is connected to the other side of the secondary. The circuit may be grounded, as indicated at **14** to serve as a regulator for the voltages supplied. The shell of each spark plug likewise may be grounded if desired. The shell of each plug, however, is not connected electrically to either of the two electrodes, as will be pointed out more fully hereinafter.

Referring to the power supply illustrated, the positive terminal of the battery is connected by a lead **20** to the emitter **21** of the transistor. The current flows through the emitter to the collector **22** and thence, by means of the connecting lead **23**, to one side of the primary winding **24** of the transformer. The current rapidly reaches its maximum value depending upon the base bias current setting of the resistor **25** in the transistor circuit and upon the fact that the voltage on the base terminal of the transistor is negative in respect of the emitter. The other side of the primary coil **24** is connected by a lead **26** to the negative terminal of the battery and it is also connected to one end of a control winding **27** in the primary circuit. The other side of this control winding is connected to the resistor **25**. When the magnetic flux in the core has reached its maximum value, the flux change becomes zero and the induced voltages in the windings are zero. This causes the base bias current from the control winding **27** to begin to reverse and start the negative or cut-off portion of the current cycle. With a decreasing flux in the core of the transformer, reverse voltages are induced and this rapid collapse of flux in the core produces the high peak voltages in the

secondary 5 and, in turn, produces the rapid recurring sparks at the spark plugs. A capacitor 28 is included in the transistor circuit to protect it against excessive voltage. Another capacitance 29 is included in the circuit also as a protective measure.

Referring now to FIGURE 3, I have illustrated the relationship between a cylinder, its communicating recess or ignition chamber, and its spark plug. I have also shown in FIGURE 3, somewhat diagrammatically, the type of spark plugs required for this invention. As shown in this view, the recess or ignition chamber 30 is in communication with the main combustion chamber 31 of the cylinder. An individual piston 32 is slidably mounted in each cylinder and has associated therewith conventional inertia means external of the cylinders for continuing movement of the pistons in rotation according to a regular firing order. The spark plug 33 has its lower end threaded so that it can be mounted in the threaded upper end of the ignition chamber 30. The spark plug has two electrodes 34 and 35 which extend downwardly into the ignition chamber 30 and sparking takes place between the inner ends of these electrodes. The other ends thereof extend through an insulator 36 and one electrode is connected to the power source and the other to the adjacent plug by leads 37 and 38. These electrodes must be insulated from each other to a point adjacent the inner ends thereof and must be insulated from the side walls of the ignition chamber in order to preclude spark-over from the electrodes to the adjacent wall. As shown in FIGURE 3, there is an insulator 36 between the electrodes and between the electrodes and the adjacent wall and the insulator extends downwardly into the ignition chamber to a slight extent in order to prevent sparking to take place only between the electrodes and the chamber side walls.

Referring now to FIG. 2, I have shown here a partial view illustrating a modification of the circuit shown in FIGURE 1. In FIGURE 2, the transformer 4' is similar to the transformer 4 of FIGURE 1 and the battery and transistor circuits are the same as shown in FIGURE 1. Therefore, they have not been illustrated in FIGURE 2. The secondary 5' is divided into two coils and one end of each coil is connected to ground, as illustrated at 40. The plugs 6' to 13', inclusive, and the ground 14' are the same as the parts carrying corresponding numbers in FIGURE 1. In this circuit, however, I have shown a resistance 41 in the secondary circuit which may be used for the purpose of limiting the current in the secondary to any desired value.

In the circuit of FIGURE 2, I have also shown a capacitance 42 which, if desired, can be embodied within the transformer case. This capacitance is for the purpose of providing resonance in the circuit. A greater voltage per turn can be obtained from the transformer when its inductive and capacity reactance are equal; that is, when the circuit is properly tuned. Resonance can be obtained in various ways in addition to the manner illustrated in FIGURE 2.

It will be readily apparent from what has been stated above that the present invention provides a simple, inexpensive ignition system for internal combustion engines and that, due to the pressure conditions prevailing in the various cylinders, the plugs of which are arranged in series, suitable and accurate timing can be obtained without the necessity of a usual distributor and timing mechanism and that a hot spark will be formed in any cylinder under pressure at the right time to deliver the greatest amount of power for the amount of fuel consumed.

The present invention is not limited to the embodiments disclosed herein as it may be otherwise embodied within the scope of the appended claims.

I claim:

1. An ignition system for an internal combustion engine having a plurality of cylinders providing a plurality of combustion chambers and pistons reciprocating in said cylinders, comprising an ignition chamber for each cylinder, each ignition chamber communicating with the combustion chamber of a cylinder, a pair of permanently spaced electrodes within each ignition chamber and spaced from the communicating combustion chamber, a source of high potential current, and electrical conductors directly connecting all of said pairs of electrodes in series with each other to said source of high potential current.

2. An ignition system according to claim 1 in which said source produces an oscillating high potential current and in which a capacitor is connected across said source to tune the electrical circuit to oscillate in resonance.

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