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TRANSISTORIZED IGNITION SYSTEM

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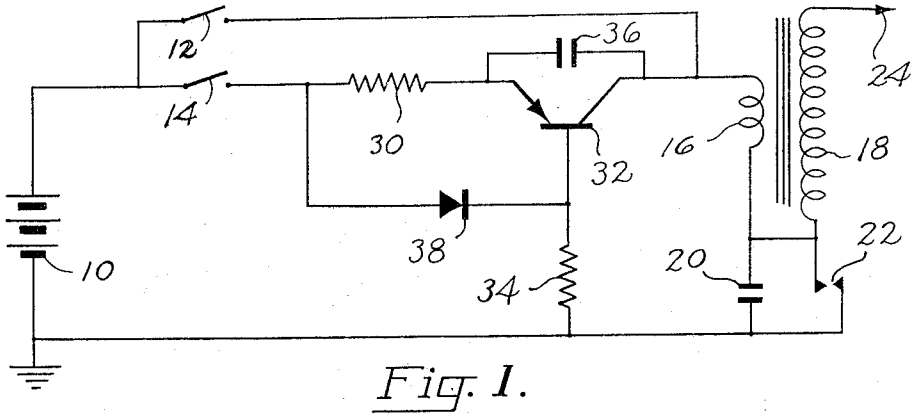


Fig. 1.

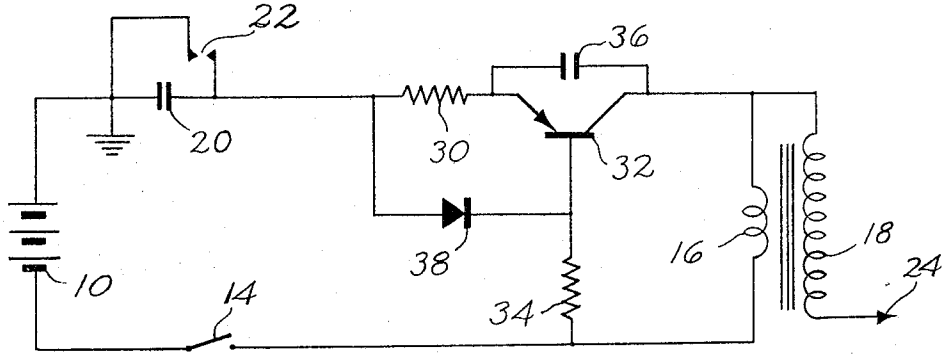


Fig. 2.

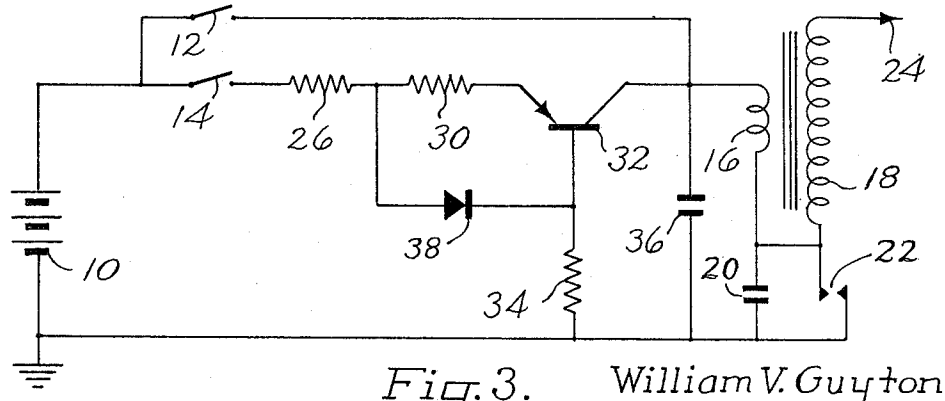


Fig. 3.

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TRANSISTORIZED IGNITION SYSTEM

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This invention relates to ignition systems for internal combustion engines, and more particularly to an improved ignition system by which the following objectives are achieved:

The system minimizes wear, and therefore extends the service life, of the breaker points, spark plugs and all other components thereof.

The system improves uniformity of ignition at all engine speeds and under varying conditions of battery voltage and ignition components.

The system permits the engine to operate efficiently at speeds greater than those attainable with conventional ignition systems.

The system improves the economy of operation of the engine.

The system affords the elimination of the ballast resistor required in conventional ignition systems.

The system is of simplified construction for economical manufacture and is characterized by long service life with minimum maintenance and repair.

The foregoing and other objects and advantages of this invention will appear from the following detailed description, taken in connection with the accompanying drawing, in which:

FIGS. 1, 2 and 3 are schematic diagrams of electric circuits illustrating different forms of the ignition system of the present invention.

Conventional internal combustion engines have ignition systems in which a source of electric potential, such as the battery 10, is releasably connected sequentially through an ignition key start switch 12 and running switch 14 to the primary winding 16 of an ignition coil. The stepped up voltage at the secondary winding 18 of the coil, controlled by the points condenser 20 and the cam-operated breaker points 22, is fed through the common rotor contact 24 of a distributor (not shown) sequentially to the several spark plugs of the engine.

Although conventional systems of this type include a current limiting resistance 26 (FIG. 3), commonly called a ballast resistor, between the potential source 10 and primary winding 16, sufficient variations in current are developed during engine operation to adversely affect the performance of the latter and the service life of the system components.

In accordance with the present invention, a transistorized circuit assembly is incorporated in the circuit of such conventional ignition system, to stabilize the coil current and thereby achieve the objectives set forth hereinbefore.

Referring first to FIGURE 1 of the drawing, wherein a negative ground ignition system is illustrated, there is interposed between the ignition key running switch 14 and the positive end of the primary winding 16 of the ignition coil the series arrangement of the emitter current limiting resistance 30 and the emitter-collector circuit of the transistor 32. The base of the transistor is connected through the biasing resistance 34 to the negative side of the potential source, herein shown as ground.

The emitter-collector circuit is shunted by the protective capacitance 36 to prevent inductive kick of the ignition coil from damaging the transistor. The value of this capacitance is chosen sufficiently large as to store at least the same amount of energy at its rated voltage as

the points condenser 20 can store at its rated voltage. The capacitance 36 permits the discharge current of the ignition coil to be increased, because the reactance of the capacitor is very low at the frequency of oscillation. Thus, the provision of this capacitance effectively increases the Q of the system.

Shunting the series arrangement of the emitter current limiting resistance 30 and the emitter-base junction of the transistor is the diode rectifier 38. This diode provides a regulated source of bias voltage at the transistor base, the magnitude of which is defined over narrow limits by the value of the biasing resistance 34. Thus, assuming a substantially constant voltage in shunt with the series arrangement of resistor 30 and the emitter base junction, any change in current through the emitter will cause a corresponding change in voltage drop across the resistor 30. This, in turn, produces a corresponding but inverse change in available voltage across the emitter-base junction and a corresponding compensating change in current through the emitter-collector circuit, thereby maintaining said current substantially constant.

Accordingly, the diode functions to provide a substantially constant voltage which, in conjunction with resistance 30 and the emitter-base junction, provides a substantially constant current through the transistor collector, ignition coil, breaker points 22 and spark plugs, regardless of changes in battery voltage, faulty regulator, or faulty coil. Moreover, this substantially constant current is provided over the operating range of the engine, thus providing lower point current at low speeds and higher output voltage at higher speeds as compared with conventional systems. The lower point current at lower speeds effectively decreases ignition noise, with consequent reduction in radio interference, and extends the life of the breaker points, spark plugs and all other ignition components. The higher output voltage at higher engine speeds affords efficient operation of the engine at speeds higher than those attainable with conventional ignition systems.

The use of the diode also provides automatic temperature compensation for the system. For example, as the components of the system increase in temperature the required voltage across the transistor emitter-base circuit for a given current drops, and simultaneously the voltage across the diode also drops.

The circuit illustrated in FIG. 2 is adapted for positive ground ignition systems. In this instance the parallel arrangement of the points condenser 20 and breaker points 22 is inserted in the ignition circuit between common ground and the emitter current limiting resistance 30, and the interconnected ends of the primary and secondary windings of the ignition coil are connected to the transistor collector. The junction of the primary winding 16 and base bias resistance 34 is connected through the ignition key running switch 14 to the negative side of the battery 10. The operation of this circuit is the same as that of FIG. 1.

It is to be noted in FIGS. 1 and 2 that the series arrangement of the emitter current limiting resistance 30 and emitter-collector circuit of the transistor replaces the conventional ballast resistance employed in conventional ignition systems.

The embodiment illustrated in FIG. 3 is similar to that of FIG. 1, with the exception that the conventional ballast resistance 26 is retained. In this instance the series arrangement of the emitter current limiting resistance 30 and the transistor emitter-collector circuit is connected between the ballast resistance and the positive side of the primary winding 16 of the ignition coil. The protective capacitance 36 is connected between the transistor collector and the negative side of the circuit, herein designated common ground, and functions in the same man-

ner as the protective capacitance of FIGS. 1 and 2 by shunting the collector circuit of the transistor.

Although the circuit of FIG. 3 operates effectively to achieve certain of the objectives of the present invention, the circuit of FIG. 1 is preferred since it eliminates the use, and hence the expense, of the ballast resistance, and is more effective in improving high speed performance of the engine.

Although the values of components in the circuit arrangements disclosed herein may be varied, as desired, typical values are as follows: The emitter current limiting resistance is approximately 0.1 ohm, the biasing resistance 150 ohms, and the protective capacitance 25 microfarads. The diode is a conventional silicon type rectifier, connected for forward bias.

In FIGS. 1 and 2 the small resistance **30** and the battery **10** have very low impedance to transient currents of the type generated in the coil as the result of normal ignition. Accordingly, capacitance **36** effectively shunts the series arrangement of coil **16** and ignition condenser **20** to provide a low reactance discharge path for the discharge oscillations of said series arrangement. In FIG. 3 the capacitance **36** directly shunts this series arrangement to provide the same function. In every case this assures higher discharge currents than with conventional ignition systems, as explained hereinbefore.

In the operation of the ignition system of the present invention, the ignition key is manipulated first to close both the starting switch **12** and running switch **14**. Closure of the starting switch bypasses the transistorized circuit arrangement of FIG. 1 as well as the ballast resistance in FIG. 3, to provide higher initial starting voltage, in conventional manner. Upon starting of the engine, the ignition key is moved to the position at which the starting switch **12** opens and the running switch **14** remains closed. The substantially constant current provided by the transistorized circuit arrangement is maintained regardless of variations in ignition components, battery voltage and engine speed. Thus, more uniform ignition is achieved at all speeds throughout the extended range of engine operation, and the service life of the breaker points, spark plugs and other ignition components is substantially increased. These factors reduce materially the incidence of necessary tune-ups and component replacements and also contributes to improved economy of operation.

It will be apparent to those skilled in the art that various changes may be made in the values and arrangements of components described hereinbefore without departing from the spirit of this invention and the scope of the appended claims.

Having now described our invention and the manner in which it may be used, what we claim as new and desire to secure by Letters Patent is:

1. A kit for use in stabilizing the coil current in an ignition system for an engine having the series circuit arrangement of an ignition primary coil and the parallel combination of breaker points and ignition capacitor normally connected across a source of electric potential, the kit comprising

(a) a transistor,

(b) means for connecting the transistor collector to the ignition primary coil,

(c) base bias voltage resistance means connected to the transistor base,

(d) means for connecting the base bias voltage resistance means to one terminal of the source of electric potential,

(e) emitter current limiting resistance means connected to the transistor emitter,

(f) means for connecting the emitter current limiting resistance means to the other terminal of the source of electric potential,

(g) bias voltage source means connected across the series arrangement of the emitter current limiting resistance means and the emitter-base junction of the transistor for providing substantially constant bias voltage across said series arrangement and substantially constant current through the emitter-collector circuit, and

(h) capacitance means connected in the transistor circuit operatively to shunt the series arrangement of the ignition primary coil and ignition capacitor for providing a low reactance discharge path for the discharge oscillations of said series arrangement.

2. The kit of claim **1** wherein the ignition system of the engine normally includes a ballast resistance connected between the ignition primary coil and the source of electric potential, and wherein the means for connecting the transistor collector to the ignition primary coil and the means for connecting the emitter current limiting resistance means to the other terminal of the source of electric potential serve to connect the series arrangement of the emitter current limiting resistance means and the emitter-collector of the transistor into the ignition system in place of said ballast resistance.

3. The kit of claim **1** wherein the ignition system of the engine includes a ballast resistance, and the means for connecting the emitter current limiting resistance means to the other terminal of the source of electric potential serves to make said connection through said ballast resistance.

4. The kit of claim **1** wherein the capacitance means comprises a capacitor connected across the emitter-collector circuit of the transistor.

5. The kit of claim **1** wherein the capacitance means comprises a capacitor connected at one side to the transistor collector, and means is included for connecting the opposite side of the capacitor to said one terminal of the source of electric potential.

6. The kit of claim **1** wherein the bias voltage source means comprises a diode rectifier.

7. An ignition circuit for an engine comprising, in combination,

(a) the series circuit arrangement of an ignition primary coil and the parallel combination of breaker points and ignition capacitor,

(b) a source of electric potential,

(c) a transistor,

(d) means connecting the transistor collector to the ignition primary coil,

(e) base bias voltage resistance means connecting the transistor base to one terminal of the source of electric potential,

(f) emitter-current limiting resistance means connecting the transistor emitter to the other terminal of the source of electric potential,

(g) bias voltage source means connected across the series arrangement of the emitter current limiting resistance means and the emitter-base junction of the transistor for providing substantially constant bias voltage across said series arrangement and substantially constant current through the emitter-collector circuit, and

(h) capacitance means connected in the transistor circuit operatively to shunt the series arrangement of the ignition primary coil and ignition capacitor for providing a low reactance discharge path for the discharge oscillations of said series arrangement.

8. The combination of claim **7** wherein the series arrangement of the emitter current limiting resistance means and the emitter-collector circuit of the transistor is interposed between the ignition primary coil and the ignition capacitor.

9. The combination of claim **7** including ballast resistance means connected electrically between the emitter

current limiting resistance means and said other terminal of the source of electric potential.

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