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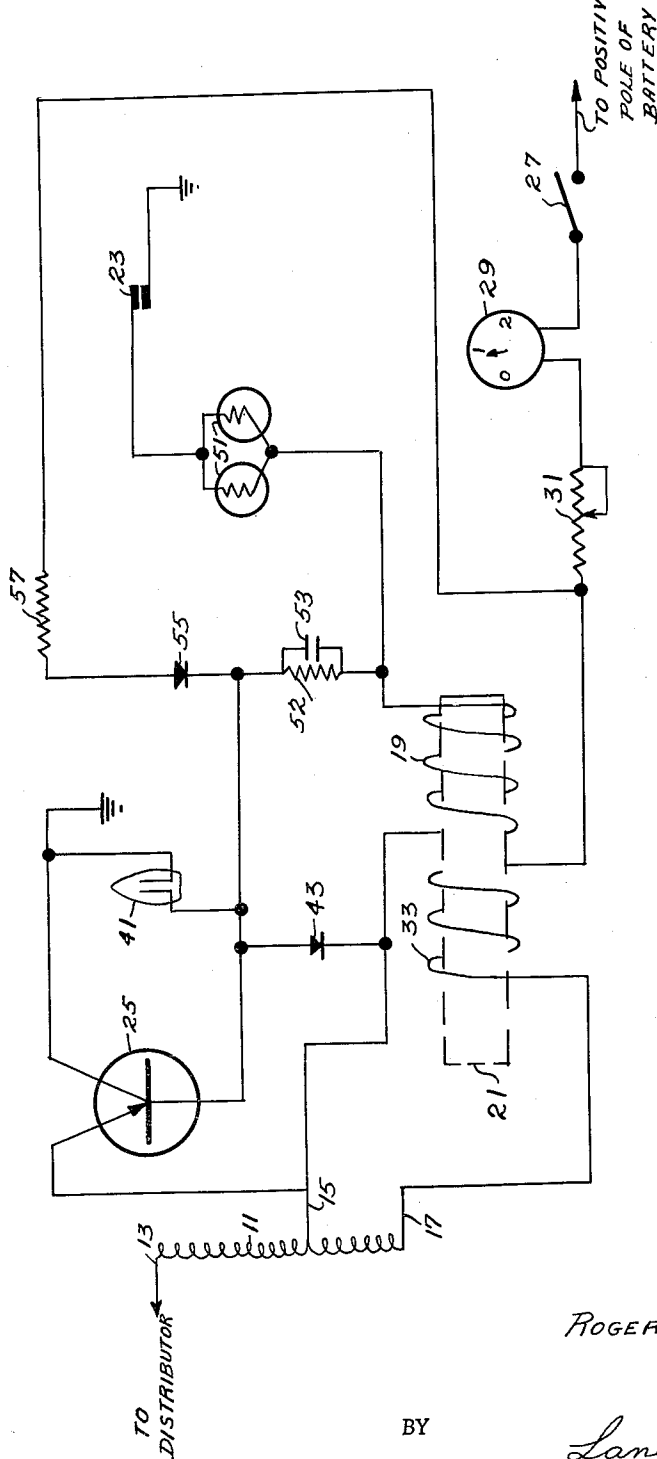
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TRANSISTORIZED IGNITION SYSTEM

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Fig. 3.



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TRANSISTORIZED IGNITION SYSTEM

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This invention relates to an improved ignition system and more particularly to a transistorized ignition system which can be easily installed in a modern day automobile.

In the conventional ignition system used in spark ignited internal combustion engines, a high voltage for producing the spark is generated in a transformer coil having a large number of turns by interrupting the current flow in a coil of the transformer having a relatively small number of turns. The current is interrupted by means of breaker points connected in series with the coil having a small number of turns. Each time the breaker points open to interrupt the current, the inductance of the coil tends to cause an arc across the breaker points. This arc, if permitted to occur with full force, would burn out the breaker points very quickly, thus necessitating replacement of the breaker points so frequently as to be impractical. Moreover, the arcing across the breaker points would generate strong radio interference and reduce the quality of the radio reception in the area near the engine such as in the automobile radio. To reduce this arcing across the breaker points a condenser is added to the circuit in parallel with the breaker points. However, the nature of the condenser reduces the high voltage and hot spark required for efficient engine operation at higher engine speeds. To compensate for this reduction, the conventional ignition circuit is therefore designed so that an excessively high voltage and an excessively high current is produced at low engine speeds so that a sufficiently high voltage spark will be produced at higher engine speeds. This high voltage and high current at low engine speeds decreases the life of the spark plugs, distributor, breaker points, and can cause the insulation of the ignition wires to break down especially in damp or wet weather. Consequently, when starting the engine, high current, which accompanies high voltage is present in the ignition system and less current is therefore available to the starter motor.

Furthermore, the condenser, while it reduces the arcing across the breaker points sufficiently to make the conventional ignition system practical, does not eliminate the arcing entirely. This results in the expense and inconvenience of periodically replacing the breaker points, condenser, spark plugs, rotor, and distributor.

The system of this invention, instead of using the breaker points themselves for interrupting the current in the coil, uses a transistor as a switch under the control of the breaker points. With the system of this invention relatively little current flows through the breaker points and so substantially no arcing across the breaker points occurs. As no arcing occurs, no condenser is needed. Thus with the system of this invention the high voltage for producing the spark is uniform for all engine speeds, therefore, at low engine speeds the voltage need not be exceedingly high. As a result spark plugs, distributor, breaker points and ignition wires life are increased. In fact, good spark plugs may last the life of the engine when used with the ignition system of this invention. Furthermore, since the current producing the spark does not have to be as high in this system, greater current is made available to drive the starter motor.

When an internal combustion engine using a conventional spark ignition system floods with fuel or becomes

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damp or wet, it is difficult if not impossible to start. When the system of this invention is used there is a greater possibility of starting when flooded, damp, or wet. In the system of this invention the current through the transistor is cut off by means of regenerative feedback action, and the timing of the spark produced is controlled by the breaker points opening. This regenerative feedback action not only effects quick cut off of the current flowing in the transistor when the breaker points are opened, but also causes the transistor circuit to oscillate. At low engine speeds such as when the engine is being started, the interval between opening and closing of the breaker points is rather long in respect to the frequency of the oscillations of the transistor. This oscillation will cause a repetitive spark to be generated during each ignition phase of the cycle of an engine. This repetitive spark will enable the engine to start much quicker under adverse conditions as previously mentioned. The reason is that it will dry the spark plug quicker and have a greater probability of igniting the fuel.

After the engine is started with this ignition system, and running at 200 to 250 r.p.m. or as the phrase "Idling" is used, this system produces a much smoother engine operation over a long period of time. To qualify this statement, we must remember that the conventional system has a high current flow through the breaker points along with arcing. This condition becomes a problem, as the breaker points wear with age. Carbon, oxide, etc. cause high resistance at the breaker points, and the result is poor ignition, or skipping. Hence a rough idling engine. With this system of repetitive spark each ignition phase of the cycle is ideal because if it does not ignite the first spark it will the second or third. We are mainly concerned with igniting each cylinder each ignition phase of the cycle. It is more harmful to have a cylinder misfire, as it dilutes the oil in the lubrication system, loss of power, and poor fuel economy. Second, this system does not depend on low contact resistance of the breaker points, as illustrated in the diagram, ballast lamps are used to compensate for this condition.

At higher engine speeds this oscillation does not affect the operation of the system as at low speeds. The bias of the circuit changes so that the breaker points become the predominant factor as to the spark igniting the fuel. We no longer have a repetitive spark for each ignition phase of the cycle to the spark plug, but rather a single spark.

In addition to these advantages the system of this invention, because there is no arcing across the breaker points, greatly reduces the radio interference.

Transistorized ignition systems are not new but the transistorized systems of the prior art are much more complicated and expensive than the system of this invention. They require a complete revamping of the ignition system in use in the modern day automobile, and they do not have the features and advantages of this ignition system for flooded or damp conditions in starting the engine.

Further advantages and objects of the invention will become readily apparent as the following detailed description of the invention unfolds and when taken in conjunction with the drawings wherein:

FIGURE 1 illustrates one embodiment of the invention;

FIGURE 2 illustrates another embodiment of the invention incorporating all of the structure of the embodiment of FIGURE 1; and

FIGURE 3 illustrates another embodiment of the invention incorporating all of the structure of the embodiment of FIGURE 2.

The conventional ignition system of the modern auto-

mobile can easily be replaced with the ignition system of this invention simply by replacing the connection in the conventional automobile ignition system between the battery, breaker points, and the ignition coil with the transistorized circuit connection of this invention. The ignition system of this invention makes use of the same distributor, ignition coil, and breaker points used in the conventional automobile ignition systems so that the conversion of a conventional ignition system to the system of this invention does not involve the expense of replacing these parts. In FIGURE 1, the ignition coil is designated by the reference number 11. The ignition coil of the conventional ignition system as illustrated by the coil 11 is an autotransformer having a high voltage output taken from one terminal 13 of the coil 11. A tap 15 is connected near the terminal 17 at the opposite end of the coil 11 so that the ratio of the turns between terminals 13 and 17 to the turns between the tap 15 and the terminal 17 is high. In the conventional automobile ignition system the high voltage output taken from the terminal 13 is connected to the spark plugs through the distributor, the terminal 17 is connected to one side of the battery, and the terminal 15 is connected to the other side of the battery through the breaker points. When the breaker points are closed current flows from the battery through the breaker points and that part of the coil between the tap 15 and the terminal 17. When the breaker points are opened the current flowing through the part of the coil 11 between the tap 15 and the terminal 17 drops off very quickly. This action induces a high positive voltage pulse at the output 13 taken from the terminal 17 and this high voltage pulse generates a spark in one of the spark plugs.

In the system of this invention the tap 15, instead of being connected directly to the other side of the battery, is connected to the emitter of a PNP transistor 25, the collector of which is connected to the other side of the battery. In the preferred embodiment of the invention, as in the case of a conventional automobile ignition system, this other side of the battery is the negative pole and it is grounded. The breaker points, designated by the reference number 23 in FIGURE 1, are connected between the base of the transistor 25 and the grounded negative pole of the battery. A winding 19 of an iron core transformer is connected between the tap 15 and the junction between the base of the transistor 25 and the breaker points 23. The positive pole of the battery is connected as in a conventional ignition system to the terminal 17 of the coil 11 through an ignition switch and an ammeter, which are designated 27 and 29 in FIGURE 1, but included in series circuit in this connection between the ammeter 29 and the terminal 17, is a variable resistor 31, serving to control the amount of current flowing in the ignition system, and a winding 33 of the transformer 21. The ratio of the turns of the winding 19 of the transformer 21 to the turns of the winding 33 is high. The condenser normally found in the conventional automobile ignition system across the breaker points is not necessary.

When the ignition switch 27 is closed (FIGURE 1) and the breaker points 23 are closed, current flows from the positive pole of the battery through the ignition switch 27, the ammeter 29, the variable resistor 31, the winding 33, the part of the coil between the terminal 17 and the tap 15, and from the emitter to the collector of the transistor 25 to ground. The base of the transistor 25 will be at ground potential and the transistor 25 will be saturated. Because the transistor 25 is saturated, the impedance of the transistor 25 will be very low relative to the impedance of the winding 19 so very little current will flow through the winding 19. When the breaker points 23 open, the current flowing in the base of the transistor 25 is reduced thus reducing the conduction through the transistor 25 and through the winding 33. This action causes a voltage to be induced in the winding 19, the

polarity of which is such that the voltage applied by the winding 19 to the base of the transistor 25 further reduces the conduction through the transistor 25. The effect is thus regenerative and the current flowing through the emitter and collector of the transistor 25 is quickly cut off causing a quick reduction in the current flowing in the part of the coil 11 between the tap 15 and the terminal 17. This action causes a high voltage to be produced at the terminal 13 and this high voltage is applied through the distributor to one of the spark plugs and generates a spark. The regenerative action effected by the coils 33 and 19 of the transformer 21 together with the transistor 25 will cause the circuit to oscillate when the breaker points 23 are open but the oscillation frequency of the circuit is low enough that at high engine speeds, before the circuit has a chance to go through one cycle of oscillation the breaker points 23 are closed again, thus preventing oscillation of the circuit. At low speeds however, for example, when the engine is being started, the regenerative circuit will have a chance to go through several oscillations during each period that the breaker points 23 are open. This oscillation of the circuit will cause high voltage pulses to be repetitively produced at the terminal 13 and thus will cause repetitive generation of a spark in one of the spark plugs. Thus, at low starting speeds there will be a repetitive spark generated in each cylinder during the ignition phase of the cycle in such cylinder. The starting of the engine is effected because of two reasons. The repetitive spark (1) tends to dry out the spark plugs, and (2) provides a better chance of igniting the fuel in each cylinder since at the time of ignition there are a plurality of repetitive sparks instead of just one spark.

The embodiment shown in FIGURE 2 is just like that in FIGURE 1 except that it has in addition a neon lamp 41 connected between the collector and the base of the transistor 25, a diode 43 connected across the winding 19 with its anode connected to the base of the transistor 25 and its cathode connected to the tap 15, and a variable resistor 45 connected in series with the breaker points 23.

The diode 43 limits the voltage output of the winding 19 and thus prevents the voltage applied to the base of the transistor 25 by the winding 19 from becoming so high as to cause a breakdown of the transistor 25. The diode 43 also aids a negative pulse generated at the output terminal 13 immediately following the spark producing positive pulse generated when the breaker points 23 are opened. This action hastens the return of the system to readiness to generate the next spark when the breaker points 23 are next opened and therefore enables the system to operate efficiently at a higher opening and closing frequency of the breaker points 23. The diode 43 thus makes the ignition system efficient at high engine speeds as well as limit base voltage.

The neon lamp 41 serves as a built-in check point to determine whether the ignition system is in satisfactory operating condition. To make the check with the neon lamp 41, the terminal 13 is disconnected from the distributor and the ignition switch 27 is closed. If the neon lamp glows the system will operate properly. The neon lamp 41 also limits the voltage which may be applied to the base of the transistor 25 and therefore serves to provide further protection for the transistor 25.

The variable resistor 45 provides an adjustment to vary the current flowing in the transistor 25 when the breaker points are closed and thus provides an adjustment of the output voltage generated by the coil 11.

The embodiment shown in FIGURE 3 is just like that shown in FIGURE 2 except that the variable resistor 45 is replaced by two incandescent ballast lamps 51, a parallel circuit of a resistor 52 and a capacitor 53 is connected in the circuit leading from the base of the transistor 25 to the breaker points 23 and to the winding 19, and a series circuit of a diode 55 and a resistor 57 is connected be-

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tween the base of the transistor 25 and the junction between the winding 33 and the variable resistor 31.

The parallel circuit of the resistor 52 and the capacitor 53 serves to stabilize the oscillation frequency of the regenerative circuit and the series circuit of the diode 55 and the resistor 57 also has this function and in addition reduces any radio interference generated by the circuit by shunting out high frequencies.

The ballast lamps serve to provide an increase in the output voltage of the system with an increase in engine speed, which is desirable for the most efficient operation. As the engine speed increases less average current will flow through the breaker points 23. With less average current flowing through the breaker points the incandescent lamps 51 will have a lower resistance and the voltage drop across the incandescent lamps will be less when the breaker points 23 are closed. More will flow in the emitter collector circuit of the transistor 25 because the base of the transistor will be closer to ground potential. Therefore, a greater voltage will be produced when this current is interrupted by the opening of the breaker points 23.

The ballast lamps 51 also serve the function of compensating for changes in the resistance of the breaker points 23. The increase in resistance of the breaker points as they get dirty has been a problem in transistorized ignition systems. In conventional ignition systems the arcing that occurs across the breaker points tends to keep them clean. Of course in conventional ignition systems the arcing itself eventually builds up carbon deposits on the breaker points but until this effect becomes appreciable the arcing does tend to keep the breaker points clean. In transistorized ignition systems the arcing across the breaker points is eliminated and the breaker points can become dirty. When the breaker points become dirty their resistance increases and changes the operating characteristics of the system. The ballast lamps 51 compensate for the increase in resistance in the breaker points 23 because as the resistance of the breaker points increases the current flowing through the breaker points 23 will tend to decrease. But any decrease in current

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will cause a decrease in the resistance of the lamps 51 and thus the effect of the increase of the resistance of the breaker points 23 is greatly mitigated. The brightness of the lamps 51 provide an indication of the resistance of the breaker points and can be mounted on the dashboard to serve this purpose. The ballast lamps also serve as fuses which will burn out if excessive current starts flowing through the breaker points such as might result from a short in the system.

The above described circuits shown in FIGURES 1, 2 and 3 are specific embodiments of the invention and many modifications may be made thereto without departing from the spirit and scope of the invention which is limited only as defined in the appended claims.

15 What is claimed is:

1. An ignition system comprising an ignition transformer having a high voltage output and an input winding, a battery, a transistor having an emitter electrode, a base electrode, and a collector electrode, a second transformer having a first winding and a second winding, a circuit connecting said first winding of said second transformer, said input winding of said ignition transformer, and the emitter and collector electrodes of said transistor in series across said battery, a circuit connecting said second winding of said transformer between the emitter and base electrode of said transistor, and a set of breaker points connected between the base electrode of said transistor and one side of said battery.

2. An ignition system as recited in claim 1 wherein a diode is connected across the second winding of said second transformer.

3. An ignition system as recited in claim 1 wherein a neon lamp is connected between the base electrode and the collector electrode of said transistor and an ignition switch is connected in said series circuit.

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