

- [54] **BREAKERLESS TRIGGER CIRCUIT WITH VARIABLE DWELL FOR IGNITION SYSTEMS**

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- [63] Continuation-in-part of Ser. No. 44,140, June 8, 1970, abandoned.

- [52] U.S. Cl..... 123/148 E

- [51] Int. Cl. F02p 3/02

- [58] **Field of Search** 123/148 E

- [56]
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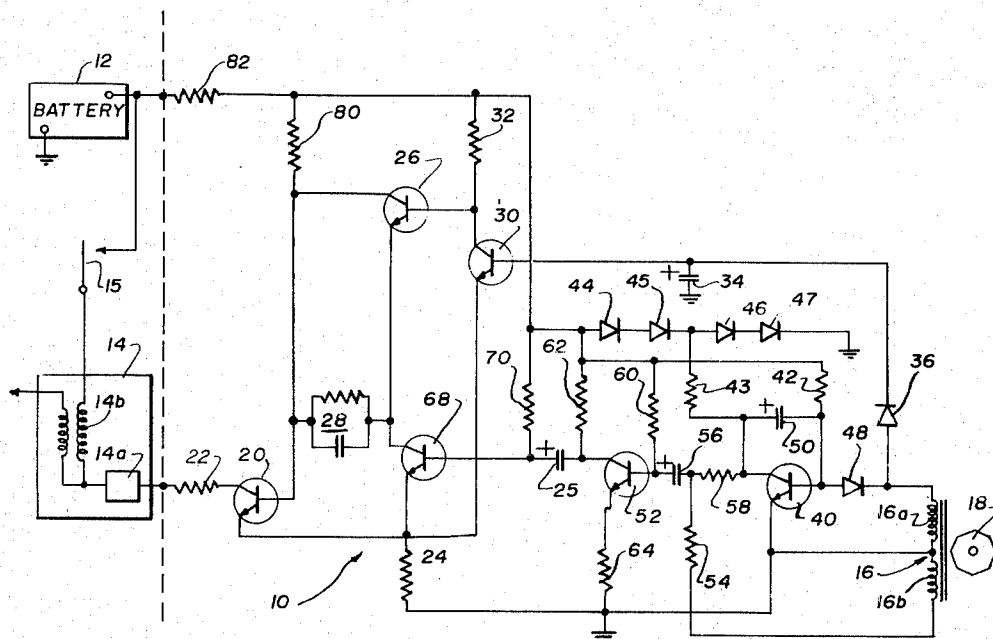
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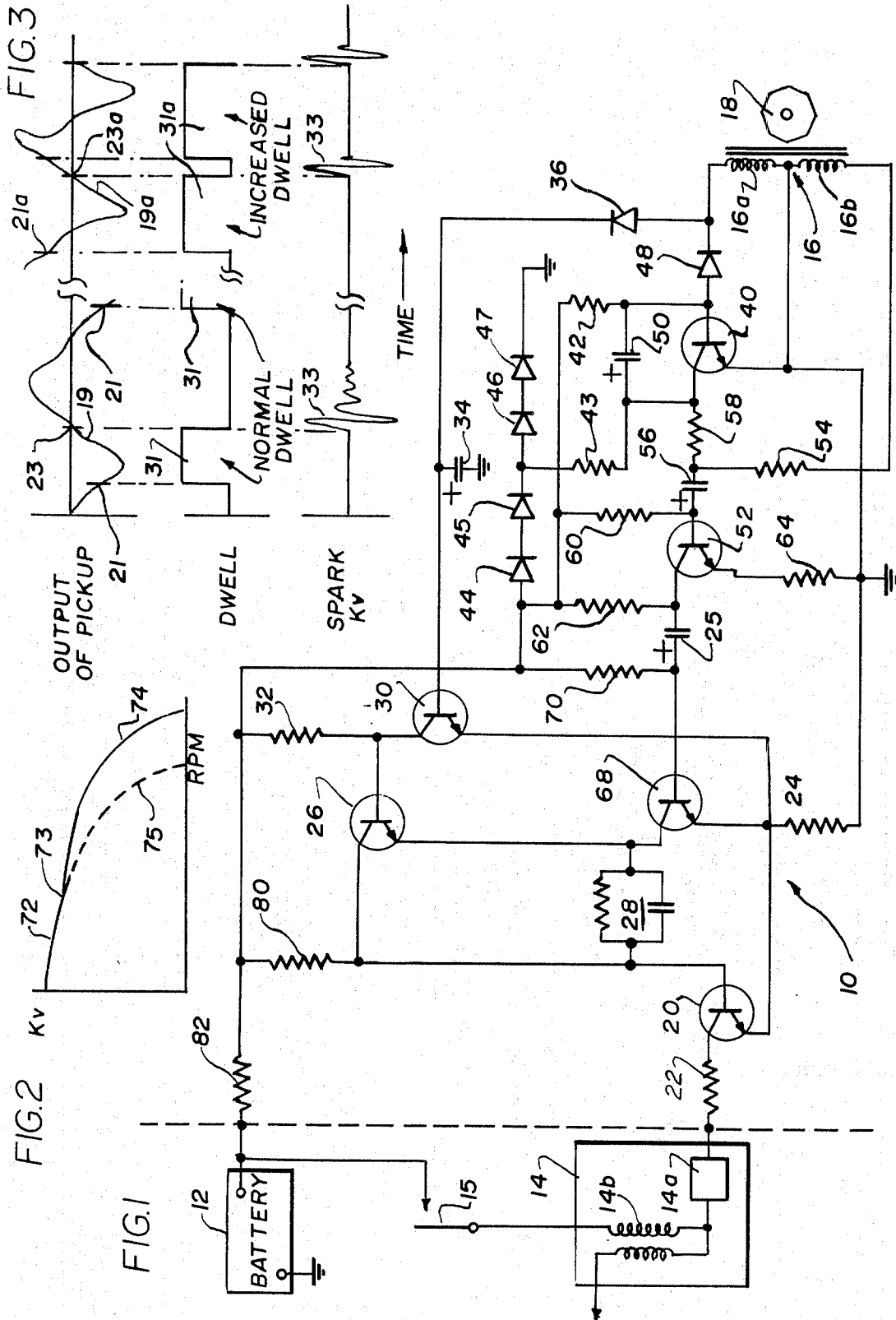
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[57] **ABSTRACT**

A triggering circuit for an ignition system to develop electric signals which correspond to the closing and opening of breaker points. A transistor which controls the current flow through the primary winding of a standard ignition coil is in a quiescent off condition when the engine is not being cranked or turning. Only upon cranking of the engine will the transistor be rendered conductive for a period of time, corresponding to the dwell angle of the system, to apply given-width pulses to the primary winding of the ignition coil. The termination of the pulses produces spark voltage at the secondary winding of the ignition coil. Means are provided to automatically increase the dwell angle of the system at a predetermined engine speed.

2 Claims, 3 Drawing Figures





BREAKERLESS TRIGGER CIRCUIT WITH VARIABLE DWELL FOR IGNITION SYSTEMS

RELATED APPLICATION

This application is a continuation-in-part of my co-pending application Ser. No. 44,140, filed June 8, 1970, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates generally to ignition systems and more particularly to a transistor ignition system. Specifically, the invention is directed to a triggering circuit to control current flow through an ignition system.

Transistor ignition systems are well-known in the art and have gained substantial acceptance in the automotive field as these ignition systems greatly improve breaker point life of the automobile. However, some transistor ignition systems require heavy current flow through the primary winding of a special ignition coil to produce effective results over a wide range of engine speeds. This is an improvement over the conventional Kettering ignition system which inherently decreases the fuel ignition properties of the spark with increased engine speed because of the inductive reactance of the primary winding causing a reduced current flow there-through. That is, because of the relatively short interval which the breaker points are closed at high engine speeds, current flow through the primary winding is not sufficient to build up a suitable magnetic field in the ignition coil. Thus, by using the transistor ignition system with the special coil and high current pulses, the effective result is improved fuel igniting properties of the spark at the higher speeds. However, the disadvantage of this type of ignition system is high cost due to the need of the special ignition coil as well as a more complicated system for installation into a motor vehicle.

Transistor ignition systems are generally thought of as means to provide minimum current flow through the breaker points so that theoretically they last for an indefinite period of time. However, these breaker points suffer from mechanical wear over their period of use and require adjustment from time to time.

SUMMARY OF THE INVENTION

Accordingly, it is an object of this invention to provide a triggering circuit for use with a transistor ignition system which will develop electric signals corresponding to the dwell angle of the system, and to provide means effectively to increase the dwell angle of the ignition system at higher engine speeds to improve the fuel igniting properties of the spark produced thereby.

Briefly, the triggering circuit of this invention includes a first transistor which is in the normal off condition and receives pulse signals at the base electrode thereof either through a normally conductive second transistor or through a resistance capacitive network in parallel with this second transistor when it is not conductive. During low rpm of the engine, the pulse signal to the first transistor will have a given pulse width corresponding to the dwell angle of the system at that slow speed. However, as current flow through the ignition coil of the system becomes more difficult to produce, due to the inductive reactance therein, at increased engine speed, the dwell angle is automatically increased effectively to increase the current flow through the primary winding. This action will enhance the fuel igniting

properties of the spark produced at the output of the ignition coil.

Preferably, an electronic pick-up device is used in the triggering circuit to simulate the opening and closing of breaker points. The pick-up device is positioned within the conventional distributor and has a portion thereof immediately adjacent the rotating cam in the distributor so that each time a lobe portion on the cam passes an area on the pick-up device, a pulse is produced. The pick-up device has two windings, one winding effective upon relatively slow turning or cranking of the engine during start, and slow running thereof, and the other winding effective during running conditions of the engine at higher speeds.

The trigger circuit preferably is used to control current flow through a main transistor within the ignition system. However, the output transistor of the trigger circuit can be of a high current rating type such that current flow through the primary winding of the ignition coil can flow through this transistor.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram of a triggering circuit constructed in accordance with the principles of this invention and used to control the operation of an ignition system;

FIG. 2 is a graphical representation of the spark voltage versus engine speed of the ignition system using the trigger circuit of this invention; and

FIG. 3 illustrates a series of waveforms demonstrating the variable dwell characteristic of the trigger circuit of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, the triggering circuit of this invention is designated generally by reference numeral 10 and is powered by a voltage source, such as a battery 12. Pulses of current of a given width are applied to an ignition system 14 to control the duration of current flow therethrough when an ignition switch 15 is in the closed condition. These pulses of current correspond to the time when the points would be closed and thus form the dwell angle of the ignition system. The dwell angle of an ignition system referred to herein corresponds to the number of degrees of rotation of a cam during which the points of a conventional ignition system are closed and current flows through a primary winding of the ignition coil. This corresponds to a given pulse width for a given speed of rotation. Most advantageously, the triggering circuit of this invention provides a variable dwell which takes effect at a predetermined speed of rotation of an engine, as for example, on an eight cylinder car engine the variable dwell will take effect at approximately 1,400 rpm of the engine.

The ignition system 14 preferably is of a transistor type having a power transistor and other circuitry designated by reference numeral 14a connected in series with the primary winding 14b of the ignition coil to effect current flow therethrough. The current flow, however, will take place only during the given-width pulse applied thereto. The ignition system 14 may take any suitable form as required to operate effectively with the triggering circuit of this invention.

Preferably, a pick-up device 16 is positioned within the distributor of an automobile to have a pair of windings 16a and 16b thereof arranged to be adjacent a cam

18 which is normally within the distributor of the engine. Preferably, the pick-up device 16 is of the type disclosed in U.S. Pat. No. 3,390,668 issued to Arthur G. Hufton and assigned to the same assignee. The cam 18 has a plurality of lobe portions formed thereon, which are traditionally used to open and close the breaker points of the ignition system, and these lobe portions move past the coils 16a and 16b to induce a change in electrical inductance therein to effect a signal output. This signal is represented diagrammatically by the waveform 19 of FIG. 3. This signal is used to produce pulses which are ultimately coupled to the base of an output transistor 20. At a predetermined point 21 of the waveform 19, the output transistor 20 is rendered conductive to apply a control current to the ignition system 14 through a resistor 22. The emitter electrode of transistor 20 is effectively connected to the ground potential through a resistor 24 and produces a square wave pulse 31 corresponding to the dwell angle of the system. The termination of the pulse 31 will occur at point 23 on the negative-to-positive crossing of the waveform 19 and causes a spark at the output of the ignition coil as indicated by reference numeral 33. Transistor 20 is normally in the off condition, and as such, will provide a quiescent off state of the ignition system 14 when the engine is not rotating. That is, the cam 18 must rotate so that the lobe portions thereof move past the windings 16a and 16b before any signal can be induced therein. It will be noted that the transistor 20 may be any suitable current control device.

During starting and slow running rpm of the engine, the pulse from the pick-up device 16 is supplied to the base electrode of transistor 20 via a capacitor 25, a transistor 68, and a normally conductive transistor 26 which provides a shunt current path for a resistance-capacitance network 28. A transistor 30 is connected to the base electrode of transistor 26 and is in the non-conductive state to allow the resistor 32 to forward bias transistor 26 to the conductive state to permit control of the conductivity thereof by the transistor 68 to produce the pulses 31. Output signals from the winding 16a are also applied to a capacitor 34 through a diode 36 which rectifies the same to always apply given polarity pulses to the capacitor 34. Capacitor 34 then charges in accordance with the amplitude and rate of pulses applied thereto and the discharge path effected through the base-emitter junction of transistor 30 and the resistor 24 to ground. At approximately 700 rpm of the cam 18, when it has eight lobe portions, the rectified pulses from the winding 16a will be of sufficient amplitude and rate to charge capacitor 34 to render transistor 30 conductive which, in turn, will render transistor 26 non-conductive in the circuit. It then is non-responsive to pulses on the collector of the transistor 68. Therefore, pulses applied to the base of transistor 20 from capacitor 25 no longer pass through transistor 26, but rather pass through the resistor-capacitor coupling network 28 from the collector of transistor 68. The parameters of the network 28 are selected so that this effectively increases the period of time during which transistor 20 will conduct. Thus, the dwell angle of the pulses applied to the ignition system, as shown by reference numeral 31a (FIG. 3) is increased. This in effect causes more current to flow through the ignition coil for each pulse occurring at the higher speeds than would occur if the dwell angle were not increased. As

illustrated by the curves 33, the sparks are shown being initiated always at the termination of the current pulses 31 or 31a. By increasing the point in time at which transistor 20 starts to conduct, the timing of the ignition system with respect to the engine using the same is maintained unchanged throughout the complete range of operation.

The triggering circuit of this invention produces pulses even when the engine is cranked at very slow speeds. This is accomplished by providing a first pick-up transistor 40 which is biased substantially as a class A amplifier by means of a resistor 42 and a series of diodes 44, 45, 46 and 47, which act as a voltage regulator for low voltage values. A resistor 43 connects the collector of the transistor 40 to the junction of the diodes 45 and 46 and operates to limit the collector current of the transistor 40. A diode 48 connected between the base of transistor 40 and winding 16a causes transistor 40 to conduct for the positive half-cycles of the waveform 19, 19a and to be non-conductive for the negative half-cycles of such waveforms. At low speeds, from substantially zero rpm to approximately 150 rpm of the rotor 18, pulse signals to the base electrode of transistor 20 effectively come from the winding 16a. However, at speeds of rotation of the cam 18 greater than 150 rpm, a capacitor 50 becomes charged to render transistor 40 inoperative and then electric signals are derived from the winding 16b and applied to the base of a transistor 52 through a resistor 54 and a capacitor 56. Thus, during slow speeds, the output of transistor 40 is applied to the base of transistor 52 through a resistor 58 and the capacitor 56 and, at higher speeds, the signal is applied to the base of transistor 52 through the resistor 54 and capacitor 56. Transistor 52 is biased to be in a continuous conductive condition as a result of resistors 60 and 62. The emitter electrode of transistor 52 is connected to ground potential through a resistor 64. The pulse applied through capacitor 56 will render transistor 52 non-conductive for a short period of time to produce a pulse across resistor 62 and apply this pulse through a capacitor 25 to the base electrode of a transistor 68. Transistor 68 likewise is biased to be in the conductive condition during the quiescent state of the triggering circuit. Transistor 68 has the base electrode thereof biased by a resistor 70 which receives power from the battery 12.

FIG. 2 illustrates the improvement voltage of the spark produced in the ignition system 14 when operated by the triggering circuit 10. The curve 72 represents a conventional Kettering ignition system characteristic and shows that the voltage of the spark decreases with increasing rpm. However, at a point 73, on the curve 72, transistor 30 is rendered conductive which, in turn, renders transistor 26 non-conductive to eliminate the bypass around the resistor-capacitor coupling network 28 to cause the electric signal to be applied to the base of transistor 20 at an earlier point in time. This will increase the dwell angle of the system at the particular rpm's involved to maintain a higher spark voltage than would otherwise be the case. This increased spark voltage is illustrated by the portion of the curve 74 extending from the point 73 with the broken line portion 75 illustrating what the result would be if the Kettering system were used.

A biasing resistor 80 causes different bias potential to be applied to the base of transistor 20 when transistor 26 is rendered non-conductive. This different bias po-

tential at the base of transistor 20 will cause it to become conductive at an earlier point in time. The entire triggering circuit 10 may draw a relatively small amount of current as limited by a current limiting resistor 82 connected between the battery supply 12 and the triggering circuit 10. 5

What has been described is a simple triggering circuit which provides means for varying the effective dwell angle of an ignition system during running of a fuel combustion engine so that improved fuel igniting properties of the spark are obtained at the higher rpm's of an engine. 10

Accordingly, it will be understood that variations and modifications of this invention may be effected without departing from the spirit and scope of the novel concepts disclosed and claimed herein. 15

I claim:

1. An ignition triggering circuit for an ignition system of a fuel combustion engine, including in combination:
 - an ignition coil having a primary winding through which pulses of current flow the width of which determine the dwell of the system; 20
 - a first current control device coupled to said primary winding to apply given-width pulses of current thereto at a given engine speed to cause an ignition spark to occur at the termination of each pulse, said first current control device having a control electrode; 25
 - sensor means coupled to the engine for producing an electric signal in response to the rotation of the en- 30

gine;
coupling means connected between said sensor means and the control electrode of said first current control device to render said first current control device conductive at one point of said electric signal and to render said first current control device nonconductive at another subsequent point of said electric signal to produce said given-width pulse; and

said coupling means including a resistor-capacitor coupling network and a second current control device in parallel with said coupling network, said second current control device being operative to bypass said electric signal therethrough at an engine speed below a predetermined value and to cause said electric signal to pass through said coupling network at an engine speed above said predetermined value to increase the dwell of the system, thereby providing improved fuel igniting properties of the spark produced by the ignition system at the higher speeds.

2. The ignition triggering circuit of claim 1 further including a disabling transistor connected in circuit with said second current control device and having a base electrode coupled to said sensor means to receive electric signals therefrom to render said second current control device non-conductive to increase the dwell of the system in response to the number of pulses received at said base electrode of said disabling transistor.

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