

Nov. 15, 1966

R. C. McLAUGHLIN

3,285,234

IGNITION SYSTEM WITH INDUCTOR CONNECTED BETWEEN
BREAKER POINTS AND SEMICONDUCTOR DEVICE
Filed Nov. 12, 1963

FIG 1

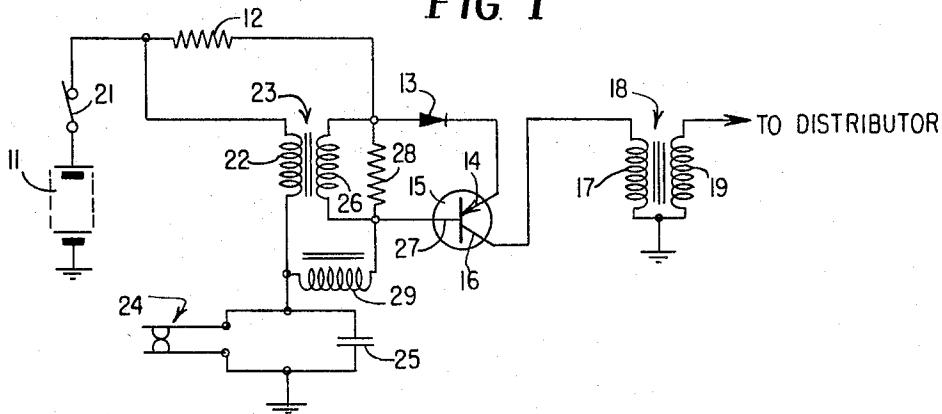
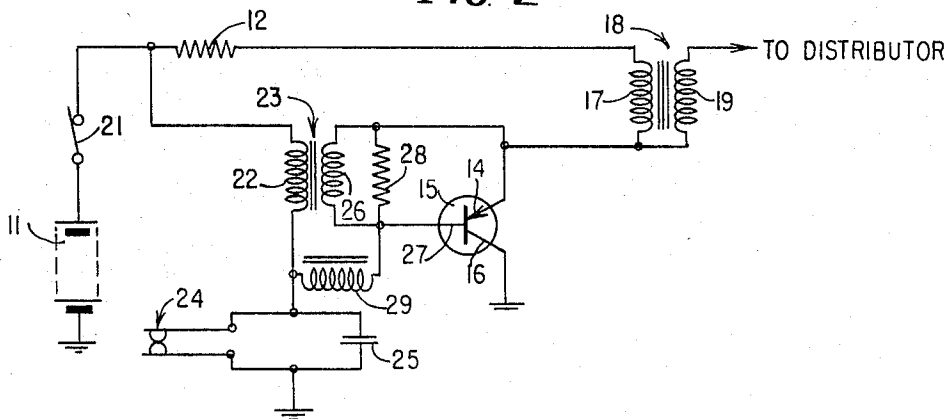


FIG 2



INVENTOR.

Robert C. McLaughlin

BY

Muller & Rickels

ATTYS.

1

2

3,285,234

IGNITION SYSTEM WITH INDUCTOR CONNECTED BETWEEN BREAKER POINTS AND SEMICONDUCTOR DEVICE**Robert C. McLaughlin, Bloomington, Ill., assignor to Motorola, Inc., Franklin Park, Ill., a corporation of Illinois****Filed Nov. 12, 1963, Ser. No. 322,786****5 Claims. (Cl. 123—148)**

This invention relates to ignition systems for internal combustion engines, and more particularly to an improved transformer coupled ignition system utilizing conventional breaker points.

With the increasing commercial availability of transistors, a large number of various types of transistorized ignition systems have been proposed. Among these is a general category wherein a transistor is used to break the current through the ignition coil in place of the conventional breaker points, and the breaker points are used to actuate a circuit to trigger the transistor. Some advantages of such systems are that the breaker points do not switch large currents and therefore have longer life, and that the system may be readily incorporated into existing ignition systems without extensive modification thereof.

A difficulty with such systems is that although transistors have been improved in their voltage capacities, transistors capable of withstanding the high voltage transients generally produced by ignition coils may be difficult or expensive to obtain. One way of obviating this difficulty is to utilize a transformer coupling the breaker points to the transistor. In this type of ignition system, the reverse transient spike produced by the collapsing field in the coupling transformer places a reverse bias on the transistor for rapid switching and to drive the transistor into a region of high voltage breakdown capability. In a transformer coupled ignition system, a difficulty presents itself at low engine speeds as the breaker points are opening more slowly and pulses in the transformer get very long. As a result, the current induced in the secondary may deteriorate, causing poor switching operation.

Accordingly, it is an object of this invention, to provide a transformer coupled ignition system wherein sure control of the switching transistor is maintained at low engine speeds.

Another object of the invention is to provide an improved transformer coupled transistor ignition system which may be produced at a minimum cost.

Still another object of the invention is to provide a transformer coupled ignition system which is effectively directly coupled at low engine speeds.

A feature of the invention is the provision, in a transformer coupled transistor ignition system, of an inductance coil coupled in series between the transistor and the breaker points to provide an additional control circuit at low speeds.

Another feature of the invention is the provision of a transistor ignition system having a coupling transformer with a primary winding in series with the breaker points across the source of voltage and with the secondary winding connected across base and emitter of the transistor. A further connection is made of an inductance coil between the base of the transistor and the juncture between the primary winding and the breaker points.

Referring now to the drawing:

FIG. 1 is a schematic diagram of an ignition system constructed in accordance with the invention; and

FIG. 2 is a schematic diagram of a further embodiment of the invention.

In accordance with the invention, an ignition system

for an internal combustion engine includes a switching transistor having its emitter to collector path connected in series with an ignition coil across a voltage source. A coupling transformer is provided for coupling a pair of breaker points to the transistor for controlling the latter. The coupling transformer has a primary winding which is connected in series with the breaker points across the voltage source, and a secondary winding which is connected across the base and emitter portions of the transistor. A second control circuit for low speed operation is provided by connecting an inductance coil from the base portion of the transistor to the juncture between the primary winding of the coupling transformer and the breaker points. In one embodiment of the invention, the ignition coil may be connected in the collector circuit of the transistor, while in another embodiment the ignition coil may be connected in the emitter circuit.

Referring now to FIG. 1, there is shown a circuit extending from storage battery 11 through switch 21 through a ballast resistor 12 and a diode 13 to the emitter electrode 14 of a switching transistor 15. The collector electrode 16 of transistor 15 is connected in series with the primary winding 17 of ignition coil 18. The secondary winding 19 of ignition coil 18 may be connected to the distributor for supplying firing pulses to the ignition means of an internal combustion engine.

Firing pulses are produced by the switching action of transistor 15, as will be more fully explained subsequently. When transistor 15 is on, current builds up in primary winding 17 of ignition coil 18. When transistor 15 is cut off, the collapsing current in ignition coil 18 results in a high voltage transient spike appearing in the secondary winding 19. This spike is used for firing the spark plugs of an internal combustion engine, as is well known in the art.

Switching control of transistor 15 is provided as follows. A connection is made from battery 11 through ignition switch 21 to the primary winding 22 of a coupling transformer 23. The opposite end of primary winding 22 is connected through a pair of intermittently opened breaker points 24 to ground. A capacitor 25 may be connected in parallel across breaker points 24 to reduce arcing across the contacts of breaker points 24, and to discharge the transformer 23 more rapidly for optimum switching. Breaker points 24 may be operable in timed relation with the internal combustion engine, as is well known in the art. The secondary winding 26 of transformer 23 is connected through diode 13 across base 27 and emitter 14 of transistor 15. A resistor 28 is connected across base 27 and emitter 14, in parallel with the secondary winding 26 of transformer 23.

As breaker points 24 open, the collapsing current in transformer 23 induces a reverse voltage across base 27 and emitter 14 of transistor 15, suddenly biasing transistor 15 to cut off. Such a reverse voltage will also bias transistor 15 into the BV_{cex} breakdown region wherein transistor 15 is capable of withstanding very high breakdown voltages between the emitter and collector thereof. Accordingly, transistor 15 will be able to withstand the high voltage transient spike induced by the collapsing field in high voltage coil 18. Resistor 28 helps spread out this reverse bias over the duration of the spike from high voltage coil 18, but may not be necessary in all cases, or may be designed into the transformer 23 itself. Diode 13 is optional and merely serves as a safety valve to provide additional breakdown protection.

At low engine speeds, such as for example 20 r.p.m., the breaker points 24 open more slowly. Accordingly, the relatively longer pulses produced reduce the effectiveness of the A.C. coupling, and the current in secondary winding 26 deteriorates. This causes the conduction of

3

transistor 15 to be impaired and since there is less current in the ignition coil to cut off, the voltage pulse output is reduced. This problem could also arise in a system which incorporated some other type of current interrupting device, such as another transistor. Such a control transistor could be switched by mechanical means or by some other type of pulses. Thus the problem is present in any system wherein the control portions of the semiconductor switching device are transformer coupled to a current interruptor which opens more slowly as engine speeds decrease. This may be prevented by connecting an inductance coil 29 from base 27 of transistor 15 to the juncture between primary winding 22 of transformer 23 and breaker points 24.

In effect, coil 29 provides a second control circuit for transistor 14, from voltage source 11 through ignition switch 21, resistor 12, diode 13 and the base emitter circuit of transistor 15, through coil 29 and breaker points 24 to ground. The first control circuit is that provided by the transformer itself, that is, from battery 11 through ignition switch 21, primary winding 22 of transformer 23, and breaker points 24 to ground. Thus at low speeds, base 27 of transistor 15 is direct coupled to ground through points 24 and induction coil 29. Reverse bias is provided by transients as the field in secondary winding 26 collapses due to the opening of points 24.

As engine speeds increase, the effect of transformer 23 similarly increases as the pulse duration shortens. Coil 29 acts as a low pass filter which presents an impedance which increases with frequency. As the speed of the engine increases, the frequency of pulses provided by breaker points 24 increases commensurately. Accordingly, more and more control over the switching of transistor 15 will be provided from transformer 23, and less and less by coil 29 until, at high speeds, coil 29 will effectively be an open circuit. This maintains optimum performance because at high speeds, direct coupling is undesirable.

Referring now to FIG. 2 a further embodiment of the invention is shown. The circuit of FIGURE 2 is substantially identical to that of FIG. 1 save for the fact that the primary winding 17 of ignition coil 18 is connected in series between ballast resistor 12 and the emitter 14 of transistor 15. Accordingly, the collector electrode 16 of transistor 15 may be grounded for improved heat dissipation.

It may therefore be seen that the invention provides an improved transformer coupled transistor ignition system wherein low speed operation is optimized by the simple addition of an extra inductance coil for direct coupling. On the other hand high speed operation of the system utilizes transformer coupling, and the effect of the added coil is negligible.

I claim:

1. A transformer coupled ignition system for use with a vehicular electrical system for an internal combustion engine, which electrical system incorporates a D.C. voltage source and intermittently operable breaker means, said ignition system including in combination, an ignition coil for supplying high voltage pulses to the internal combustion engine, semiconductor switching means adapted for connection in series with said ignition coil across the volt-

4

age source to interrupt the current in said ignition coil and cause the same to produce high voltage pulses, transformer means having a primary winding connected between the voltage source and the breaker means and a secondary winding connected to said semiconductor switching means and supplying control pulses thereto in response to the operation of the breaker means, and inductance means connecting said semiconductor switching means to the breaker means in shunt with the coupling therebetween through said transformer means, said inductance means providing direct coupling of said semiconductor switching means across the voltage source through the breaker points at relatively low speeds of operation of the breaker means.

2. A transformer coupled ignition system for use with a vehicular electrical system for an internal combustion engine, which electrical system incorporates a voltage source and a pair of intermittently operable breaker points, said ignition system including in combination, an ignition coil for supplying high voltage pulses to the internal combustion engine, transistor switching means having base, emitter and collector portions with said emitter and collector portions adapted for connection in series with said ignition coil across the voltage source to interrupt the current in said ignition coil and cause the same to produce high voltage pulses, a control circuit for said transistor switching means including transformer means having secondary winding means connected between said base and emitter portions of said transistor switching means and having primary winding means connected in series with the breaker points across the voltage source, and inductance means connected between said base portion of said transistor switching means and the juncture between said primary winding means and the breaker points, whereby said inductance means provides direct coupling of said transistor switching means to the breaker points in shunt with the coupling through said transformer means and applies switching pulses to said transistor switching means at relatively low frequency operation of said breaker points.

3. An ignition system in accordance with claim 2 including resistance means connected in parallel with said secondary winding means.

4. An ignition system in accordance with claim 2 wherein said ignition coil is connected between said collector portion and a reference potential.

5. An ignition system in accordance with claim 2 wherein said ignition coil is connected between the voltage source and said emitter portion.

References Cited by the Examiner

UNITED STATES PATENTS

2,497,307	2/1950	Lang	123—148 X
2,878,298	3/1959	Giacoletto	123—148
3,018,413	1/1962	Neapolitakis	123—148 X
3,150,286	9/1964	Quinn	123—148 X
3,178,608	4/1965	McKendry	307—10.90

CARLTON R. CROYLE, *Primary Examiner*.

LAURENCE M. GOODRIDGE, *Examiner*.