

May 9, 1967

T. A. BYLES

3,318,295

IGNITION SYSTEM

Filed Jan. 5, 1965

FIG. 1

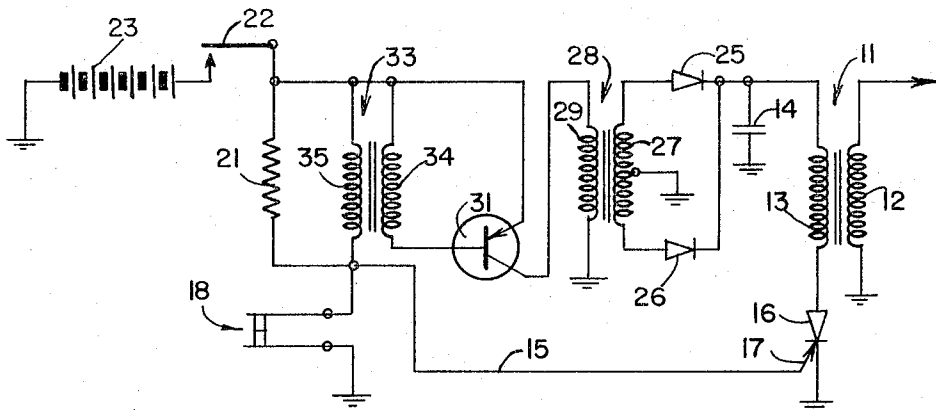
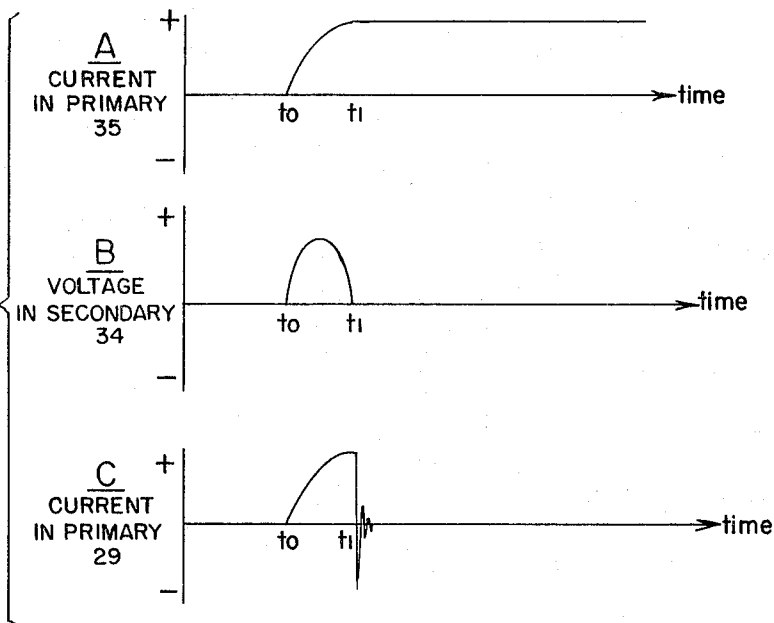


FIG. 2



Inventor
Theodore A. Byles
By *Mueller and Aichele*

Attys.

1

3,318,295

IGNITION SYSTEM

Theodore A. Byles, Villa Park, Ill., assignor to Motorola, Inc., Franklin Park Ill., a corporation of Illinois

Filed Jan. 5, 1965, Ser. No. 423,487

2 Claims. (Cl. 123-148)

This invention relates to ignition systems for internal combustion engines, and more particularly to an improved ignition system utilizing the capacitor discharge principle.

Capacitor discharge ignition systems, that is, those systems which utilize an ignition capacitor for intermittently discharging and causing current flow through an ignition coil, have been proposed over a long period of time. Such systems have been recognized as theoretically superior to other types of ignition systems. Such systems may utilize a charging transformer with a rectifier connecting the secondary winding of the transformer to the ignition capacitor. It has been proposed to utilize a transistor rather than mechanical breaker points for switching the current in the primary winding of the charging transformer so that the breaker points do not carry the full primary current. The transistor is controlled by the switching of the breaker points and since the switching current is considerably less than the primary current, the point life is prolonged.

Normal operation of mechanical breaker points necessitates that the points remain closed for a substantial duration of time. Conventional transistor biasing techniques would therefore cause the transistor to conduct throughout the entire period of point closure. This, under some circumstances, can result in excessive current drain and overheating of the transistor.

Accordingly, it is an object of this invention to provide a capacitor discharge ignition system with low current drain and long component life.

Another object of the invention is to provide a capacitor discharge ignition system utilizing a switching transistor for the charging transformer wherein the switching transistor will not heat up excessively and wherein current drain is minimized.

A feature of the invention is the provision, in a capacitor discharge ignition system utilizing a transistor for switching the primary current in the charging transformer, of a further transformer coupling the transistor to the breaker points to control the conduction of the transistor.

Another feature of the invention is the provision, in a capacitor discharge ignition system utilizing a charging transformer, of a transistor having an output electrode connected in series with the primary winding of the transformer and having control and input electrodes connected across the secondary winding of a further transformer, the primary winding of which is connected in series with breaker points across a source of potential.

In the drawings:

FIG. 1 is a schematic diagram illustrating an ignition system incorporating the invention; and

FIG. 2 is a graph showing various characteristics of the ignition system with respect to time in degrees of crankshaft rotation.

In a particular form of the invention, an ignition system for an internal combustion engine includes an ignition coil for supplying high voltage firing pulses to the internal combustion engine, and further includes mechanical breaker points operable in synchronism with the internal combustion engine. A firing circuit provides intermittent current flow in the ignition coil to produce firing pulses therein and includes an ignition capacitor and a switch device connected in series with the primary winding of the ignition coil. The switch device is responsive to pulses provided thereto to close and discharge

2

the ignition capacitor through the coil. The capacitor is charged through a rectifying diode or diodes from a charging transformer. Primary current for the charging transformer is controlled by a switching transistor, the conduction of which is in turn controlled by a further transformer. The primary winding of this latter transformer is connected in series with the breaker points across a source of potential such that the switching transistor is controlled by the breaker points through the transformer.

Referring now to FIG. 1, the ignition transformer 11 has a secondary winding 12 with one end coupled to the center post of a distributor, not shown, as is well known in the art. Secondary winding 12 is grounded at its other end. An auto transformer might be used instead of the transformer 11 in the circuit of FIG. 1. One end of the primary winding 13 of transformer 11 is coupled to one side of an ignition capacitor 14. The other side of the ignition capacitor 14 is grounded. The end of primary winding 13 opposite the ignition capacitor 14 is connected to the anode of a semiconductor controlled rectifier 16. Controlled rectifier 16 has a control gate or region 17 for controlling the conduction thereof, and when controlled rectifier 16 is conductive, a circuit path is completed through the series combination of capacitor 14, primary winding 13 of transformer 11 and the controlled rectifier 16.

Pulses are applied to the gate 17 of controlled rectifier 16 by means of conductor 15. Conductor 15 connects the gate 17 to the ungrounded side of a pair of mechanical breaker points 18 which are connected through a resistor 21 and ignition switch 22 to a source of direct current potential, storage battery 23. Breaker points 18 open and close in synchronism with the internal combustion engine as is well known in the art.

Assuming for the present that a charge is placed on ignition capacitor 14 at the proper time, the operation of the ignition system is as follows. With breaker points 18 closed, the gate 17 will be at ground potential and the controlled rectifier 16 will remain non-conductive. When the points 18 open, however, gate 17 will rise to a positive potential, turning the controlled rectifier 16 on. Capacitor 14 is thereby short circuited through the primary winding 13 of transformer 11 such that the full voltage across ignition capacitor 14 appears across primary winding 13 of the ignition coil in a very short time. This causes a rapid build-up of current, thereby inducing a high voltage in the secondary winding 12 of the ignition coil 11 according to the turns ratio of the ignition coil. The high voltage pulse thus induced is then applied to the center post of the distributor for firing the fuel mixture in the respective cylinders of the internal combustion engine.

The charging circuit for the ignition capacitor 14 includes a pair of diodes 25 and 26 which connect opposite ends of the secondary winding 27 of charging transformer 28 to the capacitor 14. The center of secondary winding 27 is grounded. The primary winding 29 of transformer 28 is connected to the collector electrode of the switching transistor 31. Conduction of transistor 31 results in current flow through the primary winding 29 and induces a pulse in the secondary winding 27 which is sufficient to charge ignition capacitor 14 and supply the losses in the balance of the circuit.

Conduction of transistor 31 is controlled by a transformer 33. Transformer 33 has a secondary winding 34, across which the base and emitter portions of transistor 31 are connected. A primary winding 35 of transformer 33 is connected in series between ignition switch 22 and breaker points 18, and in parallel with resistor 21. Closure of breaker points 18 causes a build-up of current

flow through primary winding 35 (see curve A of FIG. 2) thereby inducing a potential difference across secondary winding 34 (see curve B of FIG. 2) sufficient to drive transistor 31 into conduction. Conduction of transistor 31 will cause a current pulse in primary winding 29 (see curve C of FIG. 2) which induces a pulse in secondary winding 27 to charge capacitor 14. Charging is also accomplished by the backswing voltage in secondary 29. By proper design of transformer 33, the current through points 18 may be limited to result in long point life. Furthermore, since transistor 31 is on only for a brief period during which current through primary winding 35 is increasing, the transistor will not overheat and current drain is minimized. It is possible to achieve full charge of approximately 300 volts on the capacitor 14 less than two milliseconds after point closure (the time between t_0 and t_1 in FIG. 2).

It may therefore be seen that the invention provides an improved capacitor discharge system wherein losses are minimized and wherein long component life is assured.

I claim:

1. In an ignition system for an internal combustion engine, which system has an ignition coil for supplying high voltage firing pulses to the internal combustion engine and mechanical breaker points operable in synchronism with the internal combustion engine, a firing circuit for providing intermittent current flow in the ignition coil to produce firing pulses therein, including a combination, capacitor means and switch means connected in series with the ignition coil, said switch means being responsive to pulses applied thereto to complete a circuit to discharge said capacitor means through the ignition coil, a first transformer having a primary winding and a secondary winding, full wave rectifier means connecting said secondary winding to said capacitor means for charging the same from the voltage induced in said secondary winding and from the voltage backswing induced in said secondary winding, transistor means connecting said primary winding of said first transformer to potential supply means for controlling the supply of energy thereto, and a second transformer isolated from said first transformer and having a secondary winding connected to said transistor means for controlling the conduction thereof and having a primary winding adapted for connection in series with the breaker points across the potential supply means, said second transformer thereby controlling the conduction of said transistor means in accordance with the operation of said breaker points.

2. An ignition system for an internal combustion engine which system has an ignition coil for supplying high voltage firing pulses to the internal combustion engine and has a pair of mechanical breaker points operable in synchronism with the internal combustion engine, a firing circuit for providing intermittent current flow in the igni-

tion coil to produce firing pulses therein, including in combination, capacitor means and switch means connected in series with the ignition coil, said switch means being responsive to pulses applied thereto in synchronism with the internal combustion engine to close and discharge said capacitor means through the ignition coil, a first transformer having primary and secondary windings, a transistor having base, emitter and collector regions, said collector region being connected to said primary winding of said first transformer for supplying energy thereto in accordance with the conduction of said transistor, and thereby inducing a voltage in said secondary winding of said first transformer, said secondary winding of said first transformer further having a center tap connected to one side of said capacitor means, full wave rectifying means having a first rectifier connected between one side of said secondary winding of said first transformer and the other side of said capacitor means for charging the same in response to the voltage induced in said secondary winding of said first transformer, said full wave rectifying means further having a second rectifier connected between the other side of said secondary winding of said first transformer and the other side of said capacitor means for further charging said capacitor means in response to the backswing of the induced voltage in said secondary winding of said first transformer, and a second transformer isolated from said first transformer and having primary and secondary windings, said secondary winding of said second transformer being connected across said base and emitter regions of said transistor for controlling the conduction thereof, said primary winding of said second transformer being adapted for connection in series with the breaker points across a source of potential to induce a biasing voltage in said secondary winding in response to rising current through said primary winding upon closure of the breaker points, said second transformer thereby controlling the conduction of said transistor in accordance with the operation of said breaker points.

References Cited by the Examiner

UNITED STATES PATENTS

3,032,685	5/1962	Loomis.
3,263,124	7/1966	Stuermer.

References Cited by the Applicant

UNITED STATES PATENTS

2,980,822	4/1961	Short.
3,127,540	3/1964	Collins.
3,131,327	4/1964	Quinn.
3,150,286	9/1964	Quinn.

MARK NEWMAN, *Primary Examiner.*

LAURENCE M. GOODRIDGE, *Examiner.*