United States Patent

[11] **3,548,800**

[72] Inventors **Arnaldo Lombardini;**
Giorgio Ferretti, Reggio Emilia, Italy

[21] Appl. No. **873,145**
[22] Filed **Nov. 3, 1969**
[45] Patented **Dec. 22, 1970**
[73] Assignee **Lombardini-Fabrica Italiana Motori S.p.A.**
Reggio Emilia, Italy
[32] Priority **Aug. 31, 1967**
[33] **Italy**
[31] **No. 33588/67**
Continuation-in-part of application Ser. No. 699,728, Jan. 22, 1968, now abandoned.

---

[54] **IGNITION SYSTEM FOR GASOLINE ENGINES**
3 Claims, 1 Drawing Fig.

[52] **U.S. Cl.** **123/149,**
123/148; 322/91; 315/209

[51] **Int. Cl.** **F02p 1/02**
[50] **Field of Search** 123/148E,
148AC, 149, 149D; 322/17, 91; 315/209

[56] **References Cited**

UNITED STATES PATENTS

3,367,314	2/1968	Hirosawa et al.	123/148
3,484,677	12/1969	Piteo	322/91

Primary Examiner—Laurence M. Goodridge
Attorney—Holcombe, Wetherill and Brisebois

ABSTRACT: A transistorized ignition system of the magneto-type which comprises a breaking transistor, a pilot transistor connected to control the timing of the breaking transistor, and a silicon transistor connected to prevent temperature changes from adversely affecting the timing.

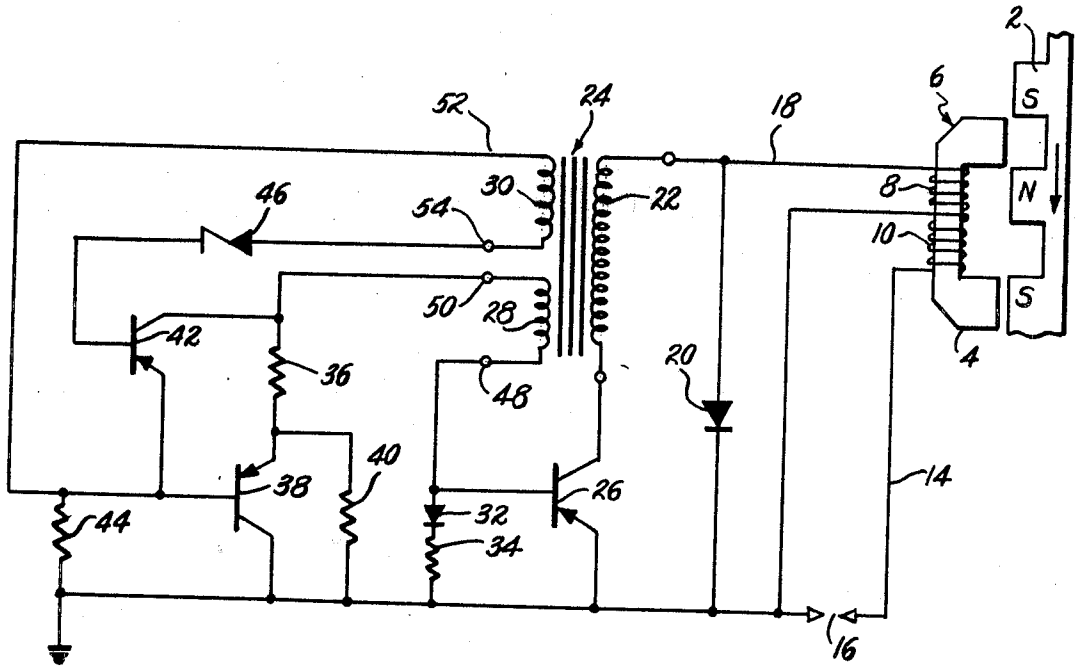


Fig. 1.

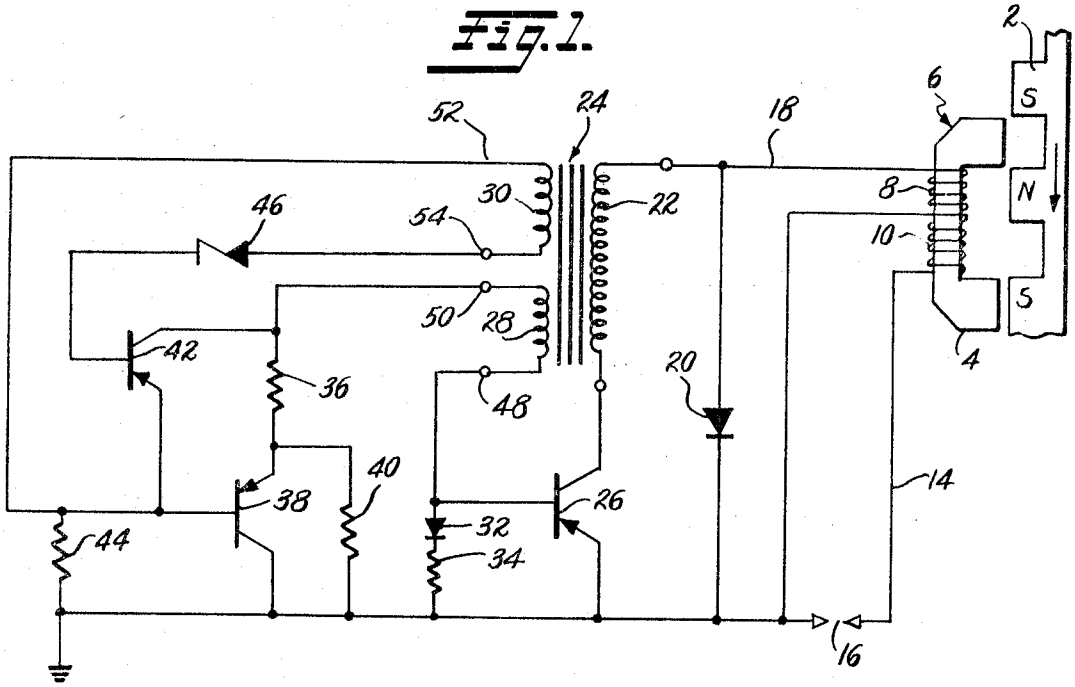


Fig. 2.

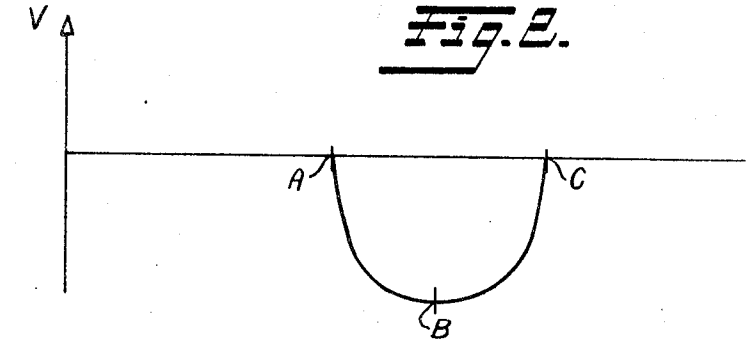
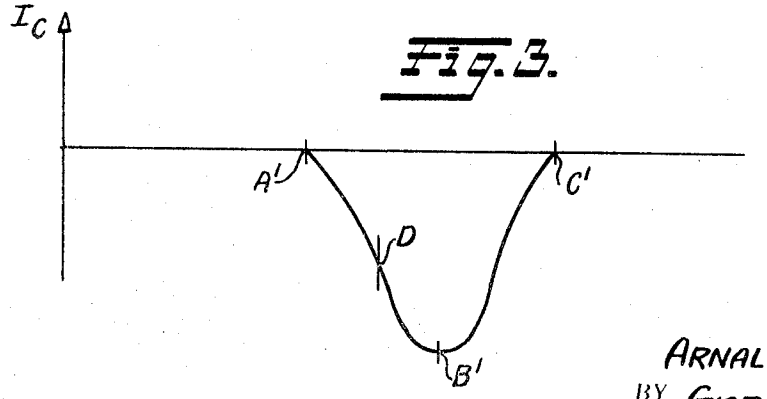


Fig. 3.



INVENTORS
ARNALDO LOMBARDINI
BY GIORGIO FERRETTI
Holcombe, Wetherill & Brisebois
ATTORNEYS

IGNITION SYSTEM FOR GASOLINE ENGINES

CROSS-REFERENCES TO RELATED APPLICATIONS

This application is a continuation-in-part of our copending application Ser. No. 699,728, filed Jan. 22, 1968, now abandoned and relates to an improvement of the device disclosed in our application Ser. No. 639,827, now U.S. Pat. No. 3,439,663, granted Apr. 22, 1969.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a transistorized ignition system for internal combustion gasoline engines in which the contact breaker in the primary circuit is replaced by a transistor, and more particularly to an improved system whereby the ignition timing can be made nearly independent of the temperature of the circuit.

2. Description of the Prior Art

A transistorized ignition system of the type disclosed in our U.S. Pat. No. 3,439,663 uses a magnetized flywheel attached to move with the motor in order to generate a substantially sinusoidal voltage in the primary of an ignition coil. When a transistor circuit breaks the ignition primary circuit at the peak of the sinusoidal voltage, a voltage surge is generated in the secondary winding of the ignition coil, thereby causing a spark across the spark gap of a spark plug in the circuit of this secondary winding.

In our previous device, the primary of ignition coil was connected in series with the primary of a reaction transformer and the emitter-collector circuit of a breaking transistor. Two secondary windings of the reaction transformer were connected to a zener diode and pilot transistor circuit to trigger the breaking transistor at or near the peak of the sinusoidal ignition coil voltage.

This system, while being a very useful system, has the disadvantage that, when the temperature rises too far or the engine operates too fast, the firing circuit acts late, causing the breaking transistor to break the ignition primary circuit when it is too far from its maximum.

SUMMARY OF THE INVENTION

In the present invention an additional transistor, the control transistor, has been added to aid in synchronizing the pilot transistor for timed firing of the breaking transistor. The control transistor can be made of silicon to thereby be very insensitive to temperature changes. Because it operates on low power, it can be very small in size. It also reduces the current through the pilot transistor, thereby preventing the pilot transistor from getting too hot.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic circuit diagram of an embodiment of the invention.

FIG. 2 and 3 are timing diagrams illustrating waveforms associated with the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1, a magnetic flywheel 2 is attached to the motor (not illustrated) to rotate therewith and apply alternating magnetic flux to the core 4 of an ignition coil unit 6. The ignition coil unit 6 includes an ignition primary coil 8 and an ignition secondary coil 10. The primary and secondary coils are connected together at one side of each to a grounded line 12. The other side of secondary coil is connected via a line 14 to one side of a spark-plug gap 16. The other side of the gap 16 is grounded.

At this point it should be pointed out that only one spark gap is illustrated, for ease of illustration and description, and that, therefore, the invention as described will operate only for a one-cylinder internal combustion engine. However, it will require a mere duplication of parts for a skilled mechanic to adapt the present invention to an engine having any number of cylinders.

The other side of the ignition primary coil 8 is connected to a line 18. In this embodiment, positive voltages appearing on line 18 are shorted across coil 8 to ground through a diode 20. It has been necessary to eliminate this positive voltage since, under some operating conditions, it can cause improperly timed sparks.

Line 18 is connected to one side of a primary winding 22 of a reaction transformer 24. The other side of winding 22 is connected to the collection of a breaking transistor 26. The emitter of transistor 26 is connected directly to ground.

Reaction transformer 24 also includes two isolated secondary windings 28 and 30. One side 48 of winding 28 is connected through a diode 32 and resistor 34 to ground, and is also connected directly to the base of the breaking transistor 26. The second side 50 of winding 28 is connected through a gain-stabilization resistor 36 to the emitter of a pilot transistor 38 and to one end of a high-value bypass resistor 40. The collector of transistor 38 and the other end of resistor 40 are connected to ground.

The second side 50 of winding 28 is also connected directly to the collector of a control transistor 42. The emitter of transistor 42 is connected directly to the base of transistor 38. The base of transistor 38 is connected through a resistor 44 to ground and is also connected directly to one side 52 of reaction transformer secondary winding 30. The second side 54 of winding 30 is connected through a zener diode 46 to the base of control transistor 42.

In operation, flywheel 2 moves past core 4, inducing an alternating current in the ignition primary coil 8. Diode 20 shorts out the positive half-wave from coil 20 and the negative half-wave is applied to the series combination of breaking transistor 26 and the primary winding 22 of reaction transformer 24.

When transistor 26 is conducting, the negative half-wave induces current in the secondary windings 28 and 30 of transformer 24. The current in winding 28 produces a voltage between terminals 48 and 50, thereby causing a current to flow from terminal 50 through resistor 36, across transistor 38 emitter to collector to ground, through transistor 26 emitter to base and back to terminal 48. By thus increasing the emitter to base current of transistor 26, transistor 26 is caused to conduct more heavily, causing a greater current to flow from line 18 through winding 8 to ground then through transistor 26 emitter to collector and through winding 22 back to line 18. The increase in current through transistor 26 and winding 22 causes an increase in current in winding 28, resulting in a current from winding 22 of such magnitude that transistors 26 and 38 become saturated.

Since the current from coil 8 would be approximately sinusoidal if the breaking did not occur, the half-wave current from winding 8, which is substantially proportional to the half-wave voltage as illustrated in FIG. 2, periodically reaches a peak B and begins to decrease, thereby causing a periodic reversal in the direction of the current from winding 28. For low frequencies of flywheel rotation (e.g., below 400 r.p.m.) and consequently low voltages, when the current direction reverses, the base current of transistor 26 is reversed, thereby rapidly shutting off current through transistor 26. This induces a sudden great potential in coil 10, thereby firing sparking device 16.

When the number of revolutions per minute of the flywheel increases, the half-wave current through transistor 26 increases, and, if it were not switched, would assume a waveform similar to that shown in FIG. 3. The voltage in secondary winding 30 is also increased, thereby exceeding the threshold voltage of zener diode 46 and causing the zener diode to conduct a base current to control transistor 42. This base current causes transistor 42 to conduct, thereby blocking pilot transistor 38. When transistor 38 is blocked, base current can no longer flow in breaking transistor 26 and sparking results at sparking device 16.

The impedance presented to current flowing in the emitter-collection circuit of transistor 26 is largely resistive when the flywheel is travelling at a low revolution rate. But when the

rate and the resulting electrical frequency increases, the impedance becomes more inductive, resulting in a phase shift of the electrical wave that would cause improperly timed sparking if sparking continued to occur at the wave form peak B' as it does at lower frequencies. But in the present invention the ratio of turns of windings **30** to **22** is adjusted with respect to the threshold voltage of the zener diode so that the threshold is reached at the proper phase angle for the frequency and resulting frequency-related wave form amplitude. Thus if the voltage amplitude at point D is reached before the wave form peak is reached, breaking occurs at point D. Point D, having a fixed amplitude, remains at a substantially constant phase angle even as the overall wave form and wave amplitude vary.

Thus, at low rotation rates, firing occurs at the peak current from winding **8**, but at high rotation rates, firing occurs when the zener threshold is reached.

Diodes **20** and **32** are used to avoid the highest reverse voltages in the base of transistor **26** and to maintain this voltage positive for a certain period of time in which the voltage in range B to C might cause transistor **26** to switch over. This voltage maintenance is a function of the time constant L/R of the resistance **34** and the inductance of winding **28**. The resistance **44** serves to render transistors **26** and **38** conductive. The high value of resistance **40** has been introduced to secure the breaking of transistor **26** at the right moment.

In one preferred embodiment of the device in FIG. **1**, the components have the following parameters:

Resistor 34=390 ohms.
Resistor 36=3.3 ohms.
Resistor 44=1500 ohms.
Resistor 40=15000 ohms.
Transistor 26=ASZ 15.
Transistor 38=ASY 80.
Transistor 42=BCY 10.
Zener diode 46=BXY 61.
Diode 32=OA 200.
Diode 20=21/100.
Winding 22=19 turns of 0.8 mm. diameter wire.
Winding 28=380 turns of 0.3 mm. diameter wire.
Winding 30=190 turns of 0.3 mm. diameter wire.
Coil 8=100 turns of 0.8 mm. diameter wire.
Coil 10=15,000 turns of 0.06 mm. diameter wire.

We claim:

1. An ignition system for an engine comprising:

a. a coil;

b. means for generating an alternating current in said coil in response to the turning over of said engine;

c. a transformer having a primary winding and first and second secondary windings;

d. a breaking transistor connected in a series circuit with said primary winding and said coil;

e. a pilot transistor connected to said first secondary winding to control the base current in said breaking transistor;

f. a threshold element connected in series with said second secondary winding and arranged to conduct current when said engine reaches a predetermined revolution rate; and

g. a control transistor of small temperature sensitivity connected to be controlled by current from said threshold element to thereby control the conduction of said pilot transistor.

2. A system according to claim **1** wherein said threshold element is a zener diode.

3. A system according to claim **2** wherein the collector of said control transistor is connected to said first secondary winding, its base is connected to said second secondary winding through said zener diode, and its emitter is connected to the base of said pilot transistor.