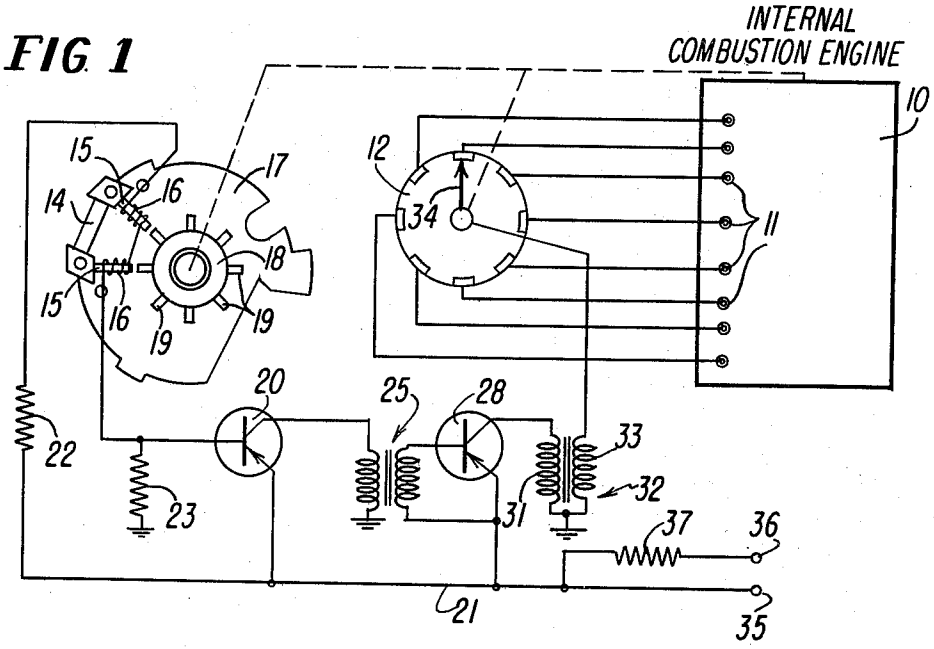
Aug. 31, 1965 O. M. KURITZA ETAL 3,203,412

IGNITION SYSTEM

Filed Jan. 7, 1963 2 Sheets-Sheet 1

FIG. 1



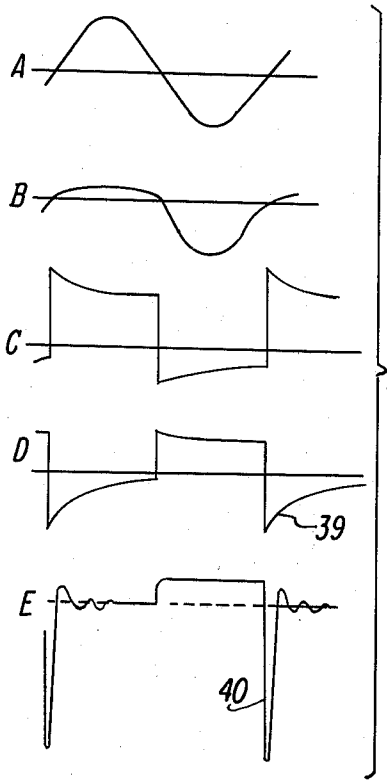
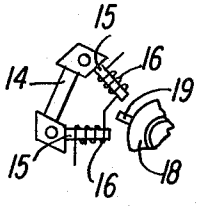


FIG. 3

FIG. 2



INVENTORS
OLEH M. KURITZA
BY EDWARD V. HAVEL
Mueller & Aichele
ATTYS.

Aug. 31, 1965 O. M. KURITZA ETAL 3,203,412

IGNITION SYSTEM

Filed Jan. 7, 1963 2 Sheets-Sheet 2

FIG. 4

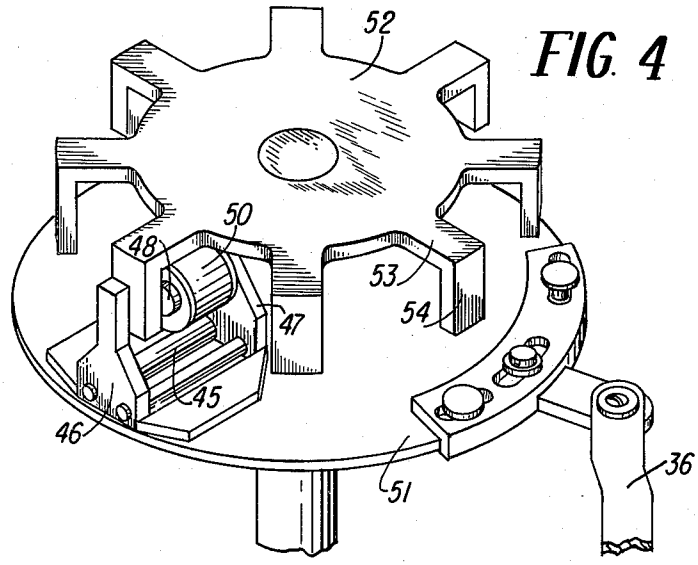


FIG. 5

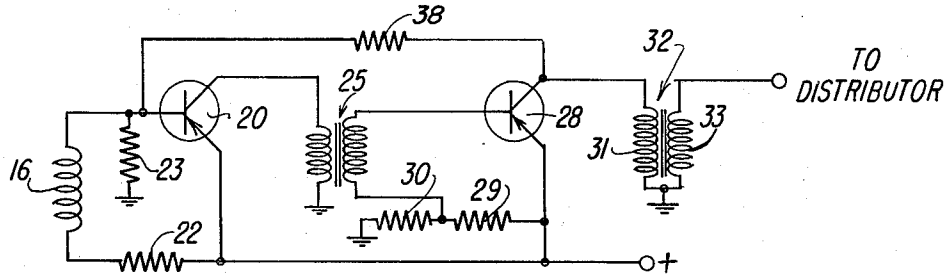
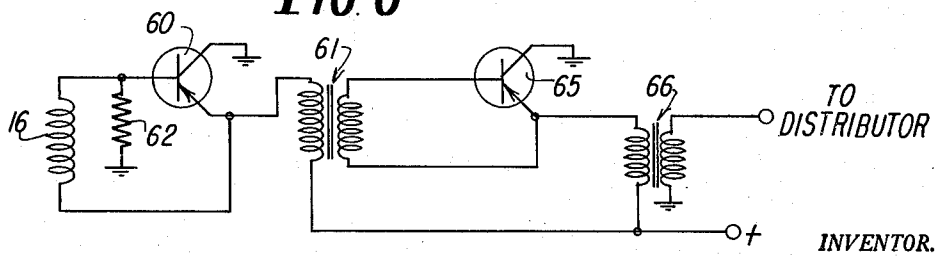


FIG. 6



INVENTOR.
OLEH M. KURITZA
EDWARD V. HAVEL

BY Mueller & Aichele ATTYS.

United States Patent Office 3,203,412 Patented Aug. 31, 1965

3,203,412

IGNITION SYSTEM

Oleh M. Kuritza and Edward V. Havel, Chicago, Ill., assignors to Motorola, Inc., Franklin Park, Ill., a corporation of Illinois

Filed Jan. 7, 1963, Ser. No. 249,952
8 Claims. (Cl. 123—148)

This application is a continuation-in-part of application Serial No. 101,151, filed April 6, 1961, now abandoned.

This invention relates generally to ignition systems for internal combustion engines, and more particularly to an ignition system including transistors for providing high voltage pulses from a low voltage electrical system.

Internal combustion engines as used in automobiles, trucks, etc., include an ignition system controlled by contact points which make and break a circuit so that pulses are developed in a coil or transformer. The pulses from the coil are applied through a distributor to the various spark plugs or ignition means of the cylinders of the engine. The distributor and contact points are controlled by a timing system which operates in synchronism with the engine itself. Such systems have the disadvantage that in order to provide the high voltage required for ignition, it is necessary that a substantial current be supplied to the coil. When this current is interrupted through the contact points arcing takes place and this is effective to pit the contacts. This results in poor operation and requires that the points be replaced. Further, in such systems the condenser used with the coil to provide the high voltage pulse may also have to be frequently replaced.

It has been proposed to use ignition systems including transistors to either replace the contact points or to permit reduced current through the contact points. However, such circuits have not been entirely satisfactory for various reasons, one of which has been that the transistor circuits have been expensive and have not provided reliable operation under all conditions. In many transistor circuits the transistor coupled to the coil is normally conducting and there has been a tendency for the coil to burn out.

It is therefore an object of the present invention to provide an improved ignition system for internal combustion engine.

Another object of the invention is to provide an ignition system for an internal combustion engine which does not require the use of contact points for interrupting a circuit.

A further object of the invention is to provide a transistor ignition system which is excited by a magnetic pulse producing device.

A feature of the invention is the provision of an ignition system for an internal combustion engine including a pulsing unit for intermittently cutting off a normally conducting transistor stage, and which produces pulses to control a second transistor stage which applies pulses to a step-up transformer which provides the high voltage for ignition. The pulsing unit may include a rotating member which moves with respect to pole pieces to produce a voltage wave in a coil on the pole pieces.

Another feature of the invention is the provision of a transistorized ignition system including a first transistor stage which applies voltage pulses to a second non-conducting transistor stage which is rendered conducting and then cut off so that sharp pulses are produced which are stepped up in a transformer to produce high voltage for ignition.

A further feature of the invention is the provision of an ignition system including a transistor for applying voltage pulses to a step-transformer and which is normally non-conducting so that the tendency of the transformer to burn out is reduced, with the transistor being intermittently rendered conducting to produce high voltage pulses in the transformer.

Still another feature of the invention is the provision of a transistorized ignition system having an interstage transformer coupling a driver transistor to the output transistor, wherein the interstage transformer applies reverse bias to the output transistor during the period of high reverse voltage in the high voltage transformer so that the output transistor has improved voltage breakdown characteristics, and can withstand the reverse voltage applied thereto.

The invention is illustrated in the accompanying drawing wherein:

FIG. 1 illustrates one form of the ignition system in accordance with the invention;

FIG. 2 shows the pulsing unit in a different position;

FIG. 3 includes curves showing the operation of the system of FIG. 1 at relatively high speeds;

FIG. 4 is an enlarged view illustrating an alternate construction for the pulsing unit; and

FIGS. 5 and 6 illustrate alternate forms of the circuit.

In practicing the invention there is provided an ignition system for an internal combustion engine including a first stage having a transistor which is biased to be normally conducting. A magnetic pulsing unit is provided including a magnet structure with a permanent magnet and a coil through which flux is passed and which is connected to the base electrode of the transistor. A rotary magnetic disc having projections is mounted so that the projections move adjacent to pole pieces of the magnetic structure so that pulses are produced in the coil. These pulses cause the transistor stage to be intermittently cut off so that a pulse wave is produced in the collector circuit thereof. The collector of the first transistor is coupled to the base of a second transistor, which is biased to be normally cut off. The second transistor is rendered conducting by the pulses from the first transistor and then cut off so that pulses are developed at the collector thereof and applied to the primary of a step-up transformer. The secondary winding of the step-up transformer is connected to the distributor to produce high voltage pulses therein. The coupling between the first and second transistors is provided by a transformer which applies a reverse bias to the second transistor to improve its breakdown characteristics. The magnetic structure may be mounted to be advanced or retarded with respect to the rotating disc to thereby control the timing of the pulses applied to the distributor. The magnetic structure may take various different forms. The circuits of the transistor stages may take other forms and the output may be derived from the emitter electrode rather than the collector electrode as described.

Referring now to the drawings, the ignition system is illustrated in FIG. 1 for use in an internal combustion engine 10 having a plurality of cylinders which are fired by signals applied to terminals 11. The engine is mechanically connected to a distributor 12 which selectively applies high voltage pulses to the terminals 11. The distributor therefore operates at any time that the engine is turning over, either when operating on its own power or when being cranked by a starter or the like.

The pulsing unit of FIG. 1 includes a permanent magnet 14 having pole pieces 15 connected thereto, about which are positioned coils 16. The two coils 16 are connected in series to provide pulses to transistor 20 as will be explained. The permanent magnet and coil assembly are mounted on a plate 17 which may be of the form used to support the contacts in standard automotive distributors. A toothed magnetic disc or wheel 18 is mounted for rotation so that the teeth 19 thereof pass by, and in

close proximity to, the ends of the pole pieces **15**. The disc may be mounted on the shaft which normally carries a cam to operate contact points in standard ignition systems. The disc **18** therefore rotates with the distributor **12**.

As stated above, the coils **16** are connected in a circuit to provide pulses to the input of transistor **20**. The coils **16** are connected in series with resistor **22** between the emitter and base electrodes of transistor **20**. Bias potential is applied to the emitter electrode of transistor **20** from the bias supply line **21**, and through the voltage divider circuit including resistor **22**, coils **16** and resistor **23** to the base electrode to this transistor. This bias potential causes the transistor **20** to be normally conducting.

The resistor **23** may be a positive temperature coefficient thermistor to hold the output of the system substantially constant over a range of temperature. Without this temperature compensation the high voltage produced by the system falls off at both extremely high and extremely low temperatures. The thermistor may have a linear characteristic which provides an increase in resistance of .36% per degree C. increase in temperature.

The collector electrode of transistor **20** is connected to transformer **25** which applies the pulses from the transistor **20** to the transistor **28**. Bias is applied to transistor **28** from line **21** to the emitter electrode thereof and through the secondary winding of transformer **25** to the base electrode. Transistor **28** is normally non-conducting, and is rendered conducting by the pulse applied between the base and emitter electrode thereof. Transistor **28** is cut off at the end of the pulse to develop a sharp pulse in primary winding **31** of transformer **32**. This pulse is stepped up in the secondary winding **33** of transformer **32**, a pulse is applied to the moving contactor **34** of the distributor. The pulse is thereby selectively applied to the terminals **11** of the cylinders of the internal combustion engine.

The potential supply line **21** is connected to the electrical system of the vehicle in which the engine is used through terminals **35** and **36**. Terminal **35** connects the line directly to the vehicle voltage source and is used during starting to provide maximum ignition voltage. Terminal **36** connects line **21** to the electrical system through resistor **37** which causes a drop in the voltage, and the connection may be used after the engine has started.

It will be apparent from FIG. 1 that when the toothed wheel **18** is in the position wherein teeth **19** thereof are directly aligned with the pole pieces **15**, maximum flux will be provided through the coils **16** by the permanent magnet **14**. When the toothed wheel is positioned so that a tooth **19** thereof is between the ends of the pole pieces **15**, as shown in FIG. 2, the flux through the coils will be minimum. This change in flux through the coils **16** as the disc **18** rotates will develop a voltage across the coils **16** as shown by curve A of FIG. 3. Because of the conduction of the transistor base-emitter diode action the voltage applied between the base and emitter will not rise during the first half of the cycle, but the negative portion of the cycle of curve A will cause the transistor **20** to be cut off. Curve B of FIG. 3 shows the voltage at the emitter of transistor **20** with respect to the base thereof.

The voltage between the collector of transistor **20** and ground, which is applied to transformer **25**, is shown by curve C of FIG. 3. This voltage will be positive when the transistor conducts and will swing negative when the transistor is cut off. The negative swing of the voltage across the primary winding of transformer **25** will peak first and then tend to return to zero, an inherent characteristic of transformer action. The resultant change in current through the primary winding with respect to time induces a voltage in the secondary winding. This voltage is applied between the base and emitter electrodes of transistor **28**, and the wave form is shown by curve D of FIG. 3. As previously stated, transistor **28** is normally non-conducting. However, the voltage applied between the base and emitter electrodes thereof during the second half of the cycle will cause the transistor **28** to conduct. The voltage at the collector of transistor **28** is shown by curve E of FIG. 3. The pulse applied to transistor **28** causes the transistor to be driven first to saturation and then back to cut off, to provide a sharp pulse in the primary winding **31** of transformer **32**. This is indicated at **40** on curve E. This pulse is stepped up in the transformer **32** to provide an extremely high voltage at the movable contact **34** of the distributor **12**.

During the period when transistor **20** is turned off, the decaying current in the primary winding of transformer **25** induces a voltage in the secondary winding thereof as shown in curve D. As transistor **20** is turned back on, the collapsing field in the secondary winding of transformer **25** drives transistor **28** to cut off. The voltage in the secondary winding resulting from this collapse, indicated at **39** in curve D, drives transistor **28** beyond cut off. This not only insures a rapid switching action, but enables transistor **28** to withstand higher reverse voltage spikes developed in transformer **32**. Because of the high voltages necessary for satisfactory firing of the spark plugs **11**, transformer **32** must be constructed so that a large voltage spike is induced in secondary winding **33** when transistor **28** is cut off and the field in the transformer collapses. The rapid cut off of transistor **28**, from saturation to reverse bias, aids in attaining such a large voltage spike. This large voltage spike produced in the secondary winding is accompanied by a high voltage spike in the primary winding **31** which is applied across the collector and emitter electrodes of transistor **28**.

By applying reverse bias between the base and emitter electrodes of transistor **28** at the same time that the high voltage spike is present across the collector and emitter electrodes, the breakdown capability of transistor **28** is substantially increased. The interstage transformer **25** supplies such reverse bias to transistor **28** to drive it into the BVcex region. With proper interstage transformer design to insure maximum reverse bias, transistor **28** operating in the BVcex region is driven sufficiently beyond cut off to withstand the maximum breakdown voltage. The transformer **25** applies this reverse bias of proper magnitude at the critical time, enabling the transistor **28** to withstand the voltage applied thereto from winding **31**. This BVcex region, as is known to those skilled in the art, is the region of high transistor collector breakdown capability when reverse bias is applied across the base and emitter electrodes thereof.

The plate **17** of the pulsing unit, on which the coils **16** are mounted, is commonly called the advance plate of the distributor and may be advanced or retarded with respect to the rotating disc **18**. This operation is generally the same as the movement of the contact points so that the spark is advanced or retarded in ignition systems presently used. This controls the time of firing of each cylinder with respect to the movement of the piston therein. The position of the rotating disc **18** may also be varied under different conditions of engine operation.

The structure of the pulsing unit may be modified in various ways as may be desired for a particular application. The coils can be wound directly on a permanent magnet rather than on pole pieces. Alternately, the teeth of the rotating discs can be formed by permanent magnets having alternative polarity, and in such case a magnet is not required in the magnetic structure for the coils. Electromagnets may be used instead of permanent magnets, and if desired a larger number of pickup coils may be provided to increase the voltage produced by the pulsing unit. The use of more economical transistors for a given output voltage is possible because the interstage transformer increases the breakdown capability of the output transistor by applying reverse bias thereto.

One alternate form of pulsing unit is illustrated in FIG.

4. In this unit the magnetic structure includes a permanent magnet 45 supported by pole pieces 46 and 47, with the pole piece 47 having an inturned end 48 about which coil 50 is positioned. The magnetic structure is supported on a plate 51 which may be constructed like the plate which supports the contact points in a standard ignition system. A rotating member 52 is provided having teeth 53 with angle portions 54 which pass between the pole piece 46 and the end 48 of the pole piece 47. When a tooth 54 is positioned between the pole pieces, as shown in FIG. 4, the flux from the permanent magnet 45 through coil 50 will be a maximum, as the air gap between the pole piece 46 and the end 48 of the pole piece 47 is a minimum. However, when the member 52 rotates and the angle tooth portion 54 is clear of the pole pieces, the flux through the coil 50 will be minimum. The change in flux through the coil 50 will develop a voltage therein which will vary in accordance with curve A of FIG. 3. The unit of FIG. 4 may therefore be used in the circuit of FIG. 1 to provide the action as has previously been described. A movable arm 36 is provided to shift the position of the magnetic structure with respect to the rotating member 52 to advance or retard the pulse.

FIG. 5 shows a circuit generally similar to the circuit of FIG. 1, and illustrates variations which may be made in this circuit. In FIG. 5 resistors 29 and 30 form a voltage divider for providing a bias voltage for the base electrode of transistor 28. This may be advantageous when transistors having particular characteristics are used. The circuit of FIG. 5 also has a feedback circuit including resistor 35 connected from the collector electrode of transistor 28 to the base electrode of transistor 20. This may be effective in improving the switching action of the transistors.

FIG. 6 shows a further circuit embodiment which may be utilized. A magnetic pulsing unit as previously described may be used, with the coil 16 producing a voltage having a wave form as shown by curve A in FIG. 3. This voltage is applied between the base and emitter electrodes of transistor 60 of the first stage. The transistor 60 is connected in a grounded collector circuit, with bias being applied to the emitter electrode through the primary winding of transformer 61. Resistor 62 controls the bias to the base electrode and may be a positive temperature coefficient thermistor as previously described. The output signal from transistor 60 is applied by transformer 61 between the base and emitter electrodes of transistor 65. This transistor is also connected as a grounded collector stage with the ouput being derived from the emitter electrode through transformer 66. The secondary winding of transformer 66 provides the high voltage to the distributor.

It will be apparent that various other circuit configurations can also be used. For example, the first stage may include a transistor with the output being derived from the collector electrode thereof as shown in FIGS. 1 and 5, and the second stage may be connected as a grounded collector stage as shown by the stage including transistor 65 in FIG. 6.

The ignition system described has been found to be highly effective to provide the ignition voltage required in modern engines. It has been found that a higher voltage may be provided than in systems now commercially used. The voltage may be maintained at a satisfactory level for high speed operation, and may be held at substantially constant value through a range of temperatures. The interstage transformer isolates the two transistors so that any non-linear characteristics in the first stage are not amplified by the second stage. This improves high temperature operation and prevents runaway. Because the base and emitter electrodes of transistor 28 are coupled directly across the secondary winding of transformer 25, the low resistance therebetween greatly enhances stability of operation. The structure is constructed so that it may be used in present distributor structures to provide advance and retard action, as needed in internal combustion engines which operate at variable speed.

The ignition system has no contact points which must be replaced and no high voltage condenser which is subject to failure. Accordingly, the maintenance of the ignition system will be substantially less than in ignition systems which depend on contact points and a condenser to provide the high voltage. This results in a substantial overall saving in cost during the life of the engine with which the ignition system is used.

We claim:

1. An ignition system for an internal combustion engine having a plurality of ignition means and a distributor coupled to the engine and selectively applying a single high voltage pulse to successive ones of the ignition means, said system including in combination, pulse producing means operating to produce control pulses in synchronism with the internal combustion engine, a transistor stage having a transistor with varying regions of reverse breakdown capability according to the amount of reverse bias applied thereto, said transistor stage having input and output circuits and including bias means for normally holding said transistor cut off, input circuit means including first transform means connected to said input circuit of said transistor stage for applying control pulses thereto from said pulse producing means for rendering said transistor stage conductive, said first transformer means operating at the termination of each pulse from said pulse producing means to apply a potential to said input circuit of said transistor stage to reverse bias said transistor to cut off and beyond cut off into a region of increased breakdown capability so that said transistor can withstand substantial reverse voltage applied thereto, and second transformer means including a primary winding coupled to said output circuit of said transistor stage and a secondary winding coupled to the distributor, said second transformer means providing voltage step-up of said primary winding to said secondary winding, said primary winding being responsive to cut off of said transistor stage to develop a single high voltage pulse which is stepped up in said secondary winding and applied to the distributor.

2. An ignition system for an internal combustion engine having a plurality of ignition means and a distributor coupled to the engine and selectively applying a single high voltage firing a pulse to the ignition means, said system including in combination, pulse producing means operating to produce pulses in synchronism with the internal combustion engine, a first transistor connected to said pulse producing means and being conductive in response to each pulse received therefrom to produce a direct current pulse, a second transistor and input and output circuits therefor, bias means for normally holding said second transistor cut off, first transformer means connecting said input circuit of said second transistor to said first transistor whereby each pulse produced in said first transformer means by said first transistor is applied to said second transistor and causes the same to conduct, said first transformer means applying a potential to said second transistor at the termination of each pulse to drive said second transistor to cut off and beyond cut off, and second transformer means including a primary winding coupled to said output circuit of said second transistor and a secondary winding coupled to the distributor, said primary winding developing a sharp pulse therein in response to cut off of said second transistor, said second transformer means providing voltage step-up from said primary winding to said secondary winding for applying a high voltage pulse to the distributor.

3. An ignition system for an internal combustion engine having a plurality of cylinders with ignition means, and a distributor coupled to the engine and applying high voltage firing pulses in turn to the ignition means of the cylinders thereof, said system including in combination, pulse producing means, a first transistor stage

biased normally conductive, said first transistor stage being connected to said coil means and being cut off in response to each pulse received therefrom, a second transistor stage having input and output circuits and including biasing means for normally holding said second transistor stage cut off, first transformer means connecting said input circuit of said second transistor stage to said first transistor stage and applying a single pulse to said second transistor stage to cause the same to conduct in response to cut off of said first transistor stage, said first transformer applying a potential to said second transistor stage at the termination of each pulse to cut off said second transistor stage, and second transformer means including a primary winding coupled to said output circuit of said second transistor stage to develop a sharp pulse in response to cut off of said second transistor stage, said second transformer means having a secondary winding and providing voltage step-up from said primary winding to said secondary winding for applying a high voltage pulse to the distributor.

4. An ignition system for an internal combustion engine having a plurality of cylinders with ignition means, and a distributor coupled to the engine and applying firing signals in turn to the ignition means of the cylinder thereof, said system including in combination, pulse producing means including coil means and a magnet structure for producing a field in said coil means, and a rotary disc of magnetic material having projections spaced about the outer edge thereof, and positioned for movement adjacent said magnet structure, means coupled to the engine for rotating said disc, a first transistor having base, emitter and collector electrodes, biasing means coupled to said transistor electrodes for normally holding said transistor conducting, means connecting said coil means to said base electrode, a second transistor having base, emitter and collector electrodes, biasing means coupled to said electrodes of said second transistor for normally holding the same cut off, means coupling said base electrode of said second transistor to said collector electrode of said first transistor, transformer means including a primary winding coupled to said collector electrode of said second transistor and a secondary winding coupled to the distributor, and feedback resistor means connecting said collector electrode of said second transistor to said base electrode of said first transistor, said transformer providing voltage step-up from said primary winding to said secondary winding, whereby movement of said projections of said disc with respect to said magnet structure produces pulses in said coil means which are applied to said first transistor to cause the same to be intermittently cut off, and pulses from said first transistor are applied to said second transistor to cause the same to conduct and then be cut off, and cut off of said second transistor produces high voltage pulses in said primary winding which are stepped up in said secondary winding and applied thereby to the distributor.

5. An ignition system for applying high voltage pulses to ignition means for igniting a combustion mixture in a combustion chamber, said system including in combination pulse producing means, a first transistor stage having input and output circuits and including biasing means for normally holding said stage conducting, said biasing means including temperature compensation means, means connecting said pulse producing means to said input circuit to apply pulses to said first stage, a second transistor stage having input and output circuits and including biasing means for normally holding said second transistor stage cut off, means connecting said input circuit of said second transistor stage to said output circuit of said first transistor stage, and transformer means including a primary winding coupled to said output circuit of said second transistor stage and a secondary winding coupled to the ignition means, said transformer providing voltage step-up from said primary winding to said secondary winding, whereby pulses applied to said first transistor stage causes the same to be intermittently cut off, and pulses from said first transistor stage are applied to said second transistor stage to cause the same to conduct and then be cut off, and conduction of said second transistor stage produces high voltage pulses in said primary winding which are stepped up in said secondary winding and applied to the ignition means to ignite the mixture in the combustion chamber.

6. An ignition system for an internal combustion engine having a plurality of cylinders with ignition means, and a distributor coupled to the engine and applying high voltage firing pulses in turn to the ignition means of the cylinders thereof, said system including in combination, pulse producing means including coil means and a magnet structure for producing a field in said coil means, said magnetic structure including a rotary member coupled to the engine for changing the field through said coil means to produce voltage pulses therein, a first transistor having input and output electrodes, means connecting said coil means to said input electrode, a second transistor having input and output electrodes, means coupling said input electrode of said second transistor to said output electrode of said first transistor, transformer means including a primary winding coupled to said output electrode of said second transistor and a secondary winding coupled to the distributor, said transformer providing voltage step-up from said primary winding to said secondary winding, and circuit means connected to said electrodes of said transistors and providing bias to said first transistor for normally holding the same conducting, said circuit means providing bias to said second transistor for normally holding the same cut off, said circuit means including means providing feedback from said second transistor to said first transistor and providing temperature compensation whereby said first transistor is rendered more stable, with movement of said rotary member of said magnet structure producing pulses in said coil means which are applied to said first transistor to cause the same to be intermittently cut off, and said first transistor applying pulses to said second transistor to cause the same to conduct and then be cut off, and with the cut off of said second transistor producing high voltage pulses in said primary winding which are stepped up in said secondary winding and applied to the distributor.

7. An ignition system for an internal combustion engine having a plurality of cylinders with ignition means, and a distributor coupled to the engine and applying high voltage firing pulses in turn to the ignition means of the cylinders thereof, said system including in combination, pulse producing means including a portion coupled to the engine for operating said pulse producing means to produce voltage pulses, a first transformer having primary and secondary windings with said primary winding being connected to said pulse producing means, a transistor having base, emitter and collector electrodes with said base and emitter electrodes being connected directly across said secondary winding, said first transformer operating at the termination of each pulse from said pulse producing means to apply a potential to said transistor to drive said transistor to cut off and beyond cut off, and a second transformer including a primary winding coupled to said collector electrode of said transistor and a secondary winding coupled to the distributor, said second transformer providing voltage step up from said primary winding thereof to said secondary winding thereof, said primary winding of said second transistor developing high voltage pulses when said transistor is cut off which are stepped up in said secondary winding of said second transistor and applied to the distributor.

8. An ignition system for supplying a single high voltage pulses to an ignition device for igniting a combustible mixture in the combustion chamber of an internal combustion engine, said system including in com-

bination, a first transistor stage having input and output circuits and including biasing means for normally holding said stage conducting, means connected to said input circuit to cut off said first stage in timed relation with the internal combustion engine, a second transistor stage having input and output circuits and including biasing means for normally holding said second transistor stage substantially entirely cut off, means connecting said output circuit of said first transistor stage to said input circuit of said second transistor stage to render said second transistor stage substantially fully conductive when said first transistor stage is cut off and to apply a reverse bias to said second transistor stage when said first transistor stage conducts to drive said second transistor stage beyond cut off, and transformer means including a primary winding coupled to said output circuit of said second

transistor stage and a secondary winding coupled to the ignition device, said transformer providing voltage step-up from said primary winding to said secondary winding, whereby cut off of said second transistor stage when substantially fully conducting causes a single high voltage pulse to be produced in said secondary winding for application to the ignition device to ignite the combustible mixture in the combustion chamber.

References Cited by the Examiner

UNITED STATES PATENTS

2,953,719	9/60	Guiot	123—148
2,981,865	4/61	Fernbach	315—209

RICHARD B. WILKINSON, *Primary Examiner.*