Jan. 10, 1967 TOSHIYUKI SASAKI ETAL 3,297,009

CONTACTLESS IGNITION DEVICES

Filed July 8. 1964 3 Sheets-Sheet 1

FIG. 1

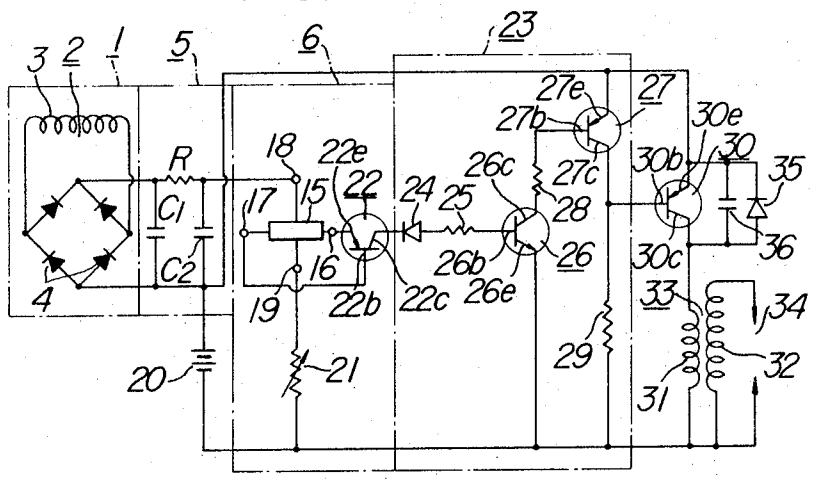
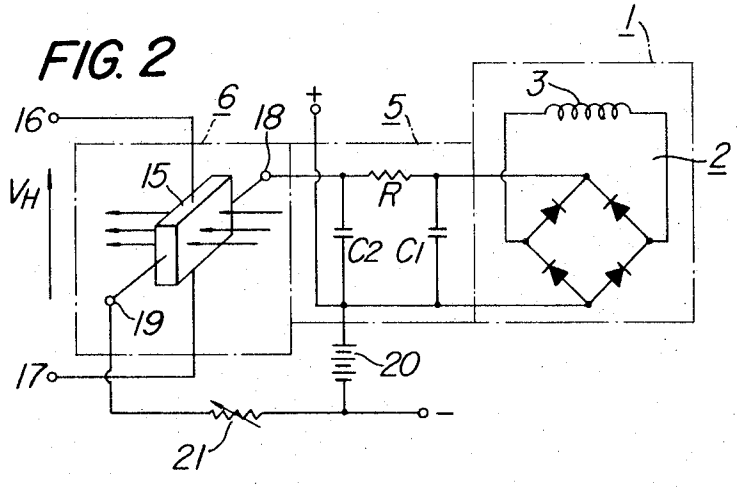


FIG. 2



INVENTORS
Toshiyuki Sasaki
Yoshisada Takakura
By Paul M. Craig, Jr.
ATTORNEY

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FIG. 3

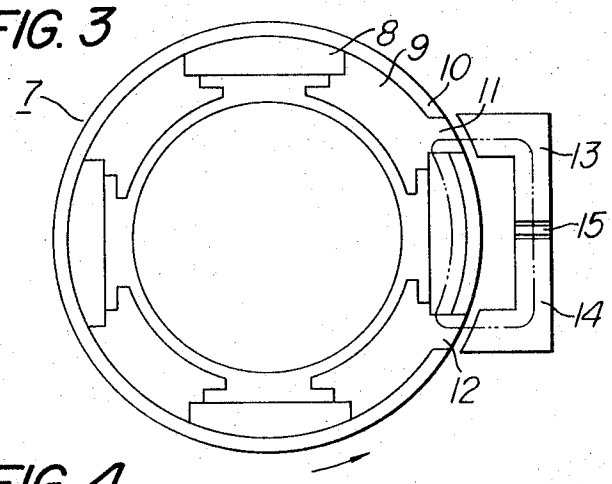


FIG. 4

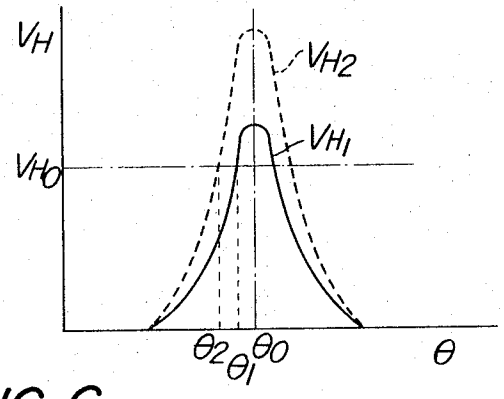
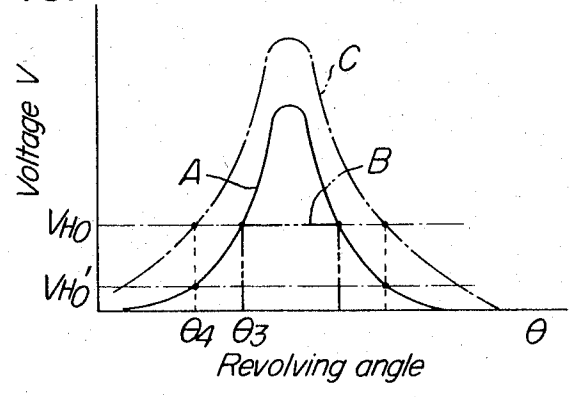


FIG. 6



INVENTORS
Toshiyuki Sasaki
Yoshisada Takakura
By Paul M. Craig, Jr.
ATTORNEY

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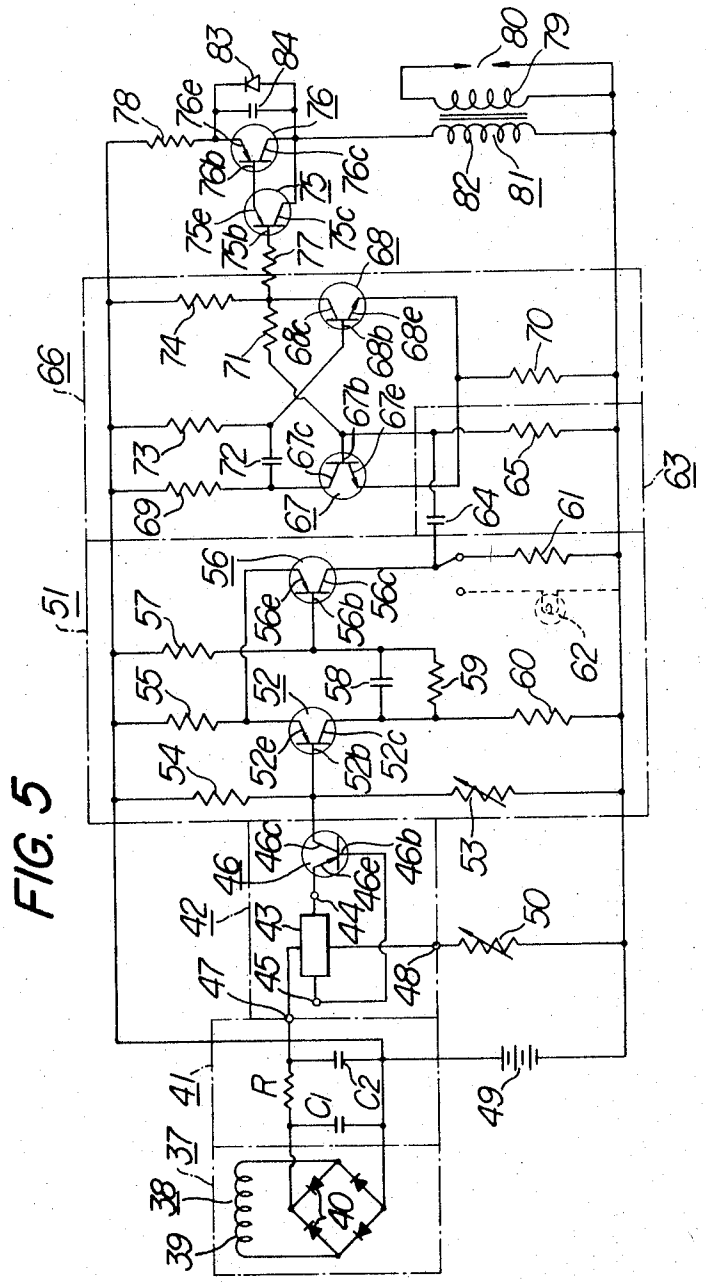


FIG. 5

INVENTORS
Yoshiyuki Sasaki
Yoshisada Takakura
By Paul M. Craig Jr.
ATTORNEY

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CONTACTLESS IGNITION DEVICES

Toshiyuki Sasaki and Yoshisada Takakura, Hitachi-shi, Japan, assignors to Hitachi, Ltd., Tokyo, Japan, a corporation of Japan

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Claims priority, application Japan, July 10, 1963, 38/50,951
6 Claims. (Cl. 123—148)

The present invention relates to new and improved ignition devices of the contactless type which are adapted for ignition of engines of automotive vehicles and the like.

As rotational speeds of the engines of automotive vehicles get higher, the trend is towards the use of a contactless ignition device having transistors therein in lieu of a heretofore generally employed system in which the primary current of an ignition coil is interrupted by the contact of an interrupter. In the transistor-type ignition device, a magneto generator or the like of small size rotating in interengaging relation with the engine revolution is utilized to detect the igniting position of the engine. The operation of a transistor connected with the ignition coil of the engine is controlled by the output of the generator for thereby producing an ignition pulse in the current flowing through the ignition coil. However, such transistor-type ignition device is still defective in that the output of the magneto generator incorporated therein is not stabilized until the number of revolutions of the engine increases up to a certain value. Additionally its output wave forms vary widely at low speed and high speed revolutions of the engine, with the resultant difficulty of detection or regulation of the proper igniting position of the engine.

In an ignition device intended for service as described above, the widely acknowledged requisite is its capability to advance the time of production of the ignition current pulse with the increase in the rotational speed of the engine. A further difficulty encountered with the prior ignition device has been that it is extremely difficult to dispose an automatic time of ignition advancing means at a location adjacent the igniting position detecting means for simultaneous operation therewith. Therefore, ignition lag during the high speed revolution has more or less been inevitable and neglected in practical use, resulting in frequent failures of ignition and loss of fuel.

The present invention intends to obviate the above-described drawbacks of prior contactless ignition devices, and has for its first object to provide a contactless ignition device in which new and improved igniting position detecting means using a Hall element, are provided. The Hall element develops a definite electromotive force irrespective of the rotational speed of the engine. For this purpose, the Hall element is disposed in a magnetic field rotating in association with the revolution of the engine and is arranged such that the magnetic flux, in conjunction with a variable magnitude control current, automatically varies the time of production of the ignition pulse to thereby advance the igniting position of the engine with advancing speed. The Hall element is in effect connected with an ignition coil through ignition control means comprised by an igniting transistor so as to intermittently supply a definite amount of current in the ignition pulse produced in the ignition coil irrespective of the rotational speed of the engine.

Another object of the present invention is to provide a contactless ignition device in which an electric generator whose output is variable in proportion to the engine revolution, is connected across the control current terminals of the Hall element. By this arrangement, the electromotive force of the Hall element is thereby controlled for automatically advancing the igniting position in association with increases in the rotational speed of the engine.

A further object of the invention is to provide a contactless ignition device in which output terminals of the hall element are connected with igniting position regulating means having a pair of transistors whose conducting state abruptly varies at a voltage more than a predetermined value. This insures the positive operation of the ignition control means controlling the igniting transistor by the output voltage of the Hall element, and facilitates the setting or adjustment of an initial igniting position by the igniting position detecting means.

According to the present invention, there is provided a contactless ignition device adapted for automotive vehicles and the like comprising igniting position detecting means having a Hall element disposed in a magnetic field rotating in association with the revolution of the engine. The magnetic flux, in conjunction with a variable magnitude control signal, automatically varies the igniting position of the engine. For this purpose, an igniting transistor, an ignition coil energized by said igniting transistor, and ignition control means are connected with the output terminal of said igniting position detecting means for controlling said igniting transistor therethrough.

According to another feature of the present invention, there is provided a contactless ignition device of above character, further comprising igniting position advancing means having an electric generator whose output is variable in proportion to the revolution of the engine. This electric generator is connected across the control current terminals of said Hall element in said igniting position detecting means for supplying the variable magnitude control current thereto to thereby control the output of said igniting position detecting means.

According to a further feature of the present invention, there is provided a contactless ignition device of above character, in which said Hall element in said igniting position detecting means is held between supporting blocks in a maner such that a closed magnetic circuit is formed therethrough with pole pieces provided in a rotary body rotating in synchronism with the revolution of the engine. The pole pieces are so mounted on the rotary body that they are brought during rotation to a position opposite a set of supporting blocks of low magnetic reluctance material between which the Hall element is supported.

According to a still further feature of the present invention, there is also provided a contactless ignition device of above character, further comprising igniting position regulating means having a pair of transistors whose conducting state is abruptly varied by a voltage appearing at the output terminal of the igniting position detecting means, and pulse generating means for supplying the output of said igniting position regulating means to the ignition control means for thereby controlling the igniting transistor.

There are other objects and particularities of the present invention which will become obvious from the following description when considered with reference to the accompanying drawings, in which:

FIG. 1 is a schematic electrical circuit diagram of an embodiment of a contactless ignition device according to the present invention;

FIG. 2 is a schematic diagram showing the principle of the operation of a Hall element incorporated in an igniting position detecting means of the present invention;

FIG. 3 is a plan view showing the structure of the igniting position detecting means;

FIG. 4 is a graphic representation of a relation between an electromotive force of the Hall element and the revolving angle of a rotating magnetic field;

FIG. 5 is an electrical circuit diagram of another embodiment of the present invention; and

FIG. 6 is a graphic representation of the voltage revolving magnetic field angle characteristic of the Hall electromotive force.

The invention will now be described with reference to the drawings. First referring to FIG. 1, reference numeral **1** denotes automatic igniting position advancing means which includes a small-sized electric generator **2** whose output is variable in proportion to the revolution of the engine. The generator **2** has its power generating coil **3** connected with a rectifier **4** and smoothing filter circuit **5**. Reference numeral **6** designates means for detecting the igniting position. As best shown in FIGURE 3, the igniting position detecting means **6** includes a rotor **7** designed for rotation with the engine, and in which permanent magnets **8** and magnetic poles **9** are alternately annularly arranged and supported by an annular member **10** of nonmagnetic material. On opposite sides of one of the permanent magnets **8** in the rotor **7**, there are provided pole pieces **11** and **12** which extend radially outwardly through the annular member **10**. A Hall element **15** is held between supporting blocks **13** and **14** of low reluctance magnetic material. The blocks **13** and **14** are disposed in a manner such that maximum lines of magnetic flux cut across the Hall element **15** when the pole pieces **11** and **12** of the rotor **7** come to the position just opposite the magnetic supporting blocks **13** and **14** during the rotation of the rotor **7**.

As best seen in FIGURES 1 and 2, the Hall element **15** is provided with output terminals **16** and **17** and control current terminals **18** and **19**. One of the control current terminals **18** is connected to the other terminal by way of a smoothing circuit **5**, a battery **20**, and a rheostat **21**. The output terminal **16** is connected to the emitter **22***e* of a transistor **22**, while the output terminal **17** is connected to the base **22***b* of the transistor **22**.

Reference numeral **23** designates ignition control means which includes therein a Zener diode **24**. The Zener diode **24** has its cathode connected with the collector **22***c* of the transistor **22** and its anode connected with the base **26***b* of a first control transistor **26** by way of a resistor **25**. There is also provided a second control transistor **27**, the base **27***b* of which is connected with the collector **26***e* of the transistor **26** by way of a resistor **28**, while the emitter **27***e* is connected with the collector **27***c* by way of the battery **20**, and a resistor **29**.

The ignition semi-conductor comprised by a device of the present invention has an igniting transistor **30**, the base **30***b*, collector **30***c* and emitter **30***e* of which are connected with the resistor **29**, with the battery **20** and with the battery **20** by way of the primary coil **31** of an ignition coil **33**, respectively. The secondary coil **32** of the ignition coil **33** is connected with an ignition plug **34**. A protective diode **35** for the igniting transistor **30** is connected across the emitter **30***e* and the collector **30***c* and a condenser **36** is connected in parallel therewith.

In the ignition device of the present invention with the arrangement as described above, a Hall electromotive force V_H appearing across the output terminals **16** and **17** of the Hall element **15** in the igniting position detecting means **6** is given by the product of a control current I_C and a magnetic flux density B of the magnetic flux cutting across the Hall element **15**, as shown in FIG. 2. Thus,

$$V_H=\frac{R_H}{d}\cdot I_C\cdot B\cdot f(/b)$$

where:

V_H=Hall electromotive force
B=magnetic flux density
I_C=control current
R_H=Hall constant
d=thickness of Hall element
$f(/b)$=correction factor variable by the shape of Hall element

Therefore, it will be understood that, the output of the igniting position detecting means **6**, which controls the transistors **26** and **27** of the ignition control means **23** and hence the igniting positions of the engine, is set at a predetermined voltage V, by appropriate adjustment of the resistor **21**. The igniting position can be determined by the relation between the control current I_C and the density B of magnetic flux cutting across the Hall element **15** obtained from the above formula of the Hall electromotive force V_H.

The above formula can be expressed as:

$$V_H=\frac{R_H}{d}\cdot I_C\cdot B\cdot f(/b)$$

$$=\frac{R_H}{d}\cdot I_C\cdot\frac{\Phi(\theta)}{S}\cdot f(/b)$$

where,

$\Phi(\theta)$=magnetic flux as a function of angular relation between pole pieces **11**, **12** and supporting blocks **13**, **14**

Current generated in the generating coil **3** of the electric generator **2** is rectified by the rectifiers **4** and is smoothed in the smoothing filter circuit **5**. This current is then applied to the Hall element **15** through the control current terminals **18** and **19** with which the battery **20** is also connected. Therefor, as the amount of charges in the smoothing condenser C_2 of filter **5**, increases or decreases in proportion to the output of the generating coil **3** the control current I_C applied to the Hall element will also increase or decrease proportionally.

It will therefore be understood that, by arranging the control current I_C for the Hall element **15** in a manner that it increases with the increase in the number of revolutions of the engine, the normally required Hall electromotive force can be generated with a fringe magnetic flux density of lower value than that required with revolution at low speed. In other words, the predetermined voltage V_{H0} can easily be developed even when $\Phi(\theta)$ in the above formula involves a greater angular relation between the pole pieces and the supporting blocks, and thus the igniting position can be advanced by an amount of θ which is the angular difference therebetween.

Suppose, for example, that the igniting position is at θ_1 as shown in FIG. 4 at the number of revolutions A (r.p.m.) of the engine. As the engine is revolved at a faster rate, the output of the generating coil **3** is increased to correspondingly increase the control current I_C flowing to the Hall element **15**. As a result, from the relation $B=\Phi(\theta)/S$, the Hall element **15** can develop the normally required Hall electromotive force V_{H0} at a position θ_2 which is advanced ahead of the angle θ_1. Then, by proper arrangement of the breakdown voltage of the Zener diode **24** in the ignition control means **23** so that the voltage V_{H0} has a greater value than the Zener voltage, the Zener diode **24** in the ignition control means **23** is urged to its conducting state by the Hall electromotive force V_{H0} of the Hall element **15**. This occurs upon the pole pieces **11** and **12** of the rotor **7** of the igniting position detecting means **6** being brought to a position just a little ahead of the position opposite the supporting blocks **13** and **14** for the Hall element **15** during the ignition of the engine at angle ϕ_1. Upon Zener diode **24** being rendered conductive, current flows through the circuit of the collector **26***c* and the emitter **26***e* of the first control transistor **26**. As a result of conduction of the first control transistor **26**, base current flows in the second control transistor **27** by way of the resistor **28** and the collector **26***c* and the emitter **26***e* of the first control transistor **26**, resulting in the flow of current through the collector **27***c* of the transistor **27**. Consequently, the potential difference across the resistor **29** becomes greater to abruptly raise the potential at the base **30***b* of the igniting transistor **30** which is thereby cut off. When, therefore, an arrangement is made so that the igniting transistor **30** is normally kept in its con-

ducting state except at the time of ignition, the igniting transistor **30** is cut off at the point where ignition is desired. Upon this occurrence, primary current flowing in the ignition coil **33** connected in series with the igniting transistor **30** is abruptly interrupted to develop a high voltage in the secondary coil **32** of the ignition coil **33**.

A contactless ignition device according to the present invention is quite advantageous in that there is almost no ignition lag since the Hall electromotive force V_H is generated in accordance with the igniting position of the engine by the Hall element **15** of the igniting position detecting means **6** disposed in the rotating magnetic field. A further advantage is that the engine can stably be ignited at both high and low speeds because the Hall electromotive force V_H of a predetermined value can always be developed independently of the rotational speed of the rotor **7**. A still further advantage is that the igniting position can automatically be advanced as the engine speed gets higher. This occurs because the small-sized electric generator **2** whose output is variable in response to the engine revolution is utilized to control the control current I_C for the Hall element **15** to thereby control the Hall electromotive force of the Hall element **15** and to regulate the operating point of the ignition control means **23**. Therefore, the ignition device of the present invention is quite free from the prior difficulty of obtaining a proper igniting position due to friction or the like in a conventional igniting position advancing means of mechanical type, and is effective to simultaneously detect the igniting position of the engine and actuate the automatic igniting position advancing means.

In FIG. 5, there is shown another embodiment of the present invention which can attain an effect substantially similar to that attained by the embodiment shown in FIGS. 1–3. In FIG. 5, reference numeral **37** designates automatic igniting position advancing means which includes therein a small-sized electric generator **38** whose output is variable in response to any change in the revolution of the engine. The generator **38** has its power generating coil **39** connected to a smoothing circuit **41** by way of rectifiers **40**.

Reference numeral **42** designates igniting position detecting means which includes therein a Hall element **43** disposed in a magnetic field rotating in synchronism with the revolution of the engine and a transistor **46**, the emitter **46***e* and the base **46***b* of which are connected with output terminals **44** and **45** of the Hall element **43**, respectively. One of control current terminals **47** of the Hall element **43** is connected with the other control current terminal **48** by way of a battery **49**, the smoothing condenser **41** and a rheostat **50**.

An igniting position regulating means **51** is provided, and is connected to transistor **46**. The collector **46***c* of the transistor **46** is connected with the base **52***b* of a first transistor **52** provided in igniting position regulating means **51**. The first transistor **52** is associated with a rheostat **53**, a resistor **54** and an emitter resistance **55** and is so set that its collector **52***c* is cut off from the emitter **52***e* when a voltage at the rheostat **53** exceeds a predetermined voltage V_{H0}. A second transistor **56** also comprises a part of the igniting position regulating means **51**. The transistor **56** is disposed in a manner that its emitter **56***e* is connected with the emitter resistance **55** in common with the emitter **52***e* of the first transistor **52**. The base **56***b* of the second transistor **56** is connected with the battery **49**, by way of a resistor **57** and at the same time with the collector **52***c* of the first transistor **52** by way of a feedback resistor **59** with which has a condenser **58** connected in parallel therewith. The collector **52***c* of the first transistor **52** is in turn connected with the battery **49** by way of a resistor **60**. The collector **56***c* of the second transistor **56** in the igniting position regulating means **51** is connected with the battery **49** by way of a resistor **61** or a regulating lamp **62**.

Reference numeral **63** designates pulse generating means which is composed of a condenser **64** and a resistor **65** connected in series with the condenser **64**. One terminal of the condenser **64** is connected with the collector **56***c* of the second transistor **56**, while the other terminal is connected with the battery **49** by way of the resistor **65**.

Reference numeral **66** designates ignition control means which includes therein two NPN-type transistors **67** and **68**. The collector **67***c* of the transistor **67** is connected with the battery **49** by way of a resistor **69**, while the emitter **67***e* is connected with the battery **49** by way of a resistor **70** in common with the emitter **68***e* of the transistor **68**. The base **67***b* is connected with the collector **68***c* of the transistor **68** by way of a resistor **71** and at the same time with the junction of the condenser **64** and the resistor **65** in the pulse generating means **63**. The base **68***b* of the transistor **68** is connected with the collector **67***c* of the transistor **67** by way of a condenser **72** and at the same time with the battery **49** by way of a resistor **73**. The collector **68***c* of the transistor **68** is connected with the battery **49** by way of a resistor **74**.

There are two igniting transistors **75** and **76**. The base **75***b* of the igniting transistor **75** is connected with the collector **63***c* of the transistor **68** in the ignition control means **66** by way of a base resistance **77**, while the emitter **75***e* and the collector **75***c* are connected with the base **76***b* and the collector **76***c* of the transistor **76**, respectively. The emitter **76***e* of the transistor **76** is connected with the battery **49** by way of an emitter resistance **78**, and the collector **76***c* is connected with the battery **49** by way of the primary coil **82** of an ignition coil **81**. The secondary coil **79** which is inductively coupled to primary coil **82** is connected with an ignition plug **80**. The emitter **76***e* and the collector **76***c* of the igniting transistor **76** are connected with opposite terminals of a transistor protective diode **83** with which a condenser **84** is connected in parallel.

In the contactless ignition device shown in FIGURE 5, the Hall element **43** in the igniting position detecting means **42** is disposed in the pulsed magnetic field produced in association with the revolution of the engine, and in which the magnetic flux density is subject to variation to thereby vary the igniting position of the engine. The pulsed magnetic field develops the Hall electromotive force V_H which is constant with respect to an angular position θ irrespective of the number of revolutions of the engine, as shown by a curve A in FIG. 6. The output of the Hall element **43** is supplied to the base **52***b* of the first transistor **52** in the igniting position regulating means **51**. As described in the foregoing, the first transistor **52** is so set that conduction betwen its emitter **52***e* and collector **52***c* is interrupted when a voltage across the rheostat **53** exceeds a predetermined value V_{H0}. Therefore, the transistor **52** is driven to its cut-off state whenever the Hall electromotive force V_H of the Hall element **43**, which is amplified by the transistor **46** and applied across the rheostat **53**, exceeds the predetermined voltage V_{H0} in FIG. 6.

Since the second transistor **56** in the igniting position regulating means **51** is preliminarily arranged so that it takes its cut-off state when the first transistor **52** is in its conducting state, tendency of the transistor **52** towards being driven to its cut-off state by the voltage applied across the rheostat **53** is more and more accelerated by the feedback condenser **58** and the resistor **59**, and thus the transistor **52** is abruptly driven to its cut-off state. On the other hand, the second transistor **56** forming a pair with this transistor **52** is quickly driven to its conducting state and is stabilized once it tends to take its conducting state.

When, therefore, the resistor **61** is connected with the collector **56***c* of the transistor **56**, it constitutes the output terminal of the igniting position regulating means **51**, and the voltage appearing across the resistor **61** takes the

form of a square wave as shown by a line B in FIG. 6. The wave form of the output from the igniting position regulating means **51** is differentiated by the condenser **64** and the resistor **65** of the pulse generating means **63** connected with the resistor **61** and is thereby converted into a trigger signal, which is supplied to the ignition control means **66** which acts as a monostable multivibrator by the provision of the transistors **67** and **68**. The transistors **67** and **68** of the ignition control means **66** form a pair and are arranged to be alternately cut off so that one of the transistors **68** is in its conducting state when the other transistor **67** is in its cut-off state. Then when the trigger signal by the pulse generating means **63** is applied to the ignition control means **66**, the operative states of the transistors in the ignition control means **66** are reversed and now the transistor **68** is driven to its cut-off state and the transistor **67** to its conducting state. Duration of the cut-off state of the transistor **68** is $t=0.69$ C.R. second which is determined by the condenser **72** and the resistor **73** connected with the base **68***b* of the transistor **68**. Thus, the transistor **68** can always be maintained in its cut-off state for a definite time. The cut-off of the transistor **68** in the ignition control means **66** results in abrupt cut-off of a pair of igniting semi-conductors comprised by the igniting transistors **75** and **76**. The transistors **75** and **76** normally supply current to the primary coil **82** of the ignition coil **81** by way of the emitter **76***e* and the collector **76***c*, and pulses at high voltage are thereby induced in the secondary coil **79** of the ignition coil **81** upon cut-off of transistors **75** and **76** to generate sparks between a spark gap in the ignition plug **80**.

According to the above arrangement, the engine is ignited at the position when the Hall electromotive force V_H of the Hall element **43** in the igniting position detecting means **42** exceeds the predetermined voltage V_{H0}. Therefore, by replacing the resistor **61** in the igniting position regulating means **51** by the lamp **62**, the igniting position of the engine can be ascertained by the lighting of the lamp **62** because the igniting position of the engine corresponds to a point at which the deenergized lamp **62** is energized, that is, a rising point of the line B in FIG. 6.

In the igniting position detecting means **42** having therein the Hall element **43**, the value of the control current I_C supplied to the Hall element **43** can easily be varied by varying the resistance value of the rheostat **50** and thus the value of the Hall electromotive force V_H of the Hall element **43** can be shifted for example, from the curve A to a curve C in FIG. 6. As a result, the igniting position can be shifted from θ_3 to θ_4 in FIG. 6, with the set voltage V_{H0} of the igniting position regulating means **51** kept fixed. The igniting position can likewise be shifted from θ_3 to θ_4 when the set voltage V_{H0} of the igniting position regulating means **51** is varied to V_{H0}' by varying the resistance of the rheostat **53**, with the control current I_C supplied to the Hall element **42** kept fixed.

Further, the operating point of the igniting position regulating means **51** can easily be detected by employing the lamp **62** in lieu of the resistor **61** disposed at the output end of the igniting position regulating means **51** which is actuated whenever the output of the igniting position detecting means **42** exceeds the predetermined voltage V_{H0}. Therefore, by suitably regulating the control current I_C for the Hall element **43** or the set voltage V_{H0} of the regulating means **51**, the revolving angle θ of the magnetic field rotating in association with the revolution of the engine can be regulated as desired to thereby regulate the igniting position. Thus, the effect similar to that obtained with the first embodiment of this invention can be obtained plus the additional control provided by rheostat **53**.

From the foregoing description, it can be appreciated that the present invention provides new and improved ignition devices of the contactless type which use a Hall element to develop a definite electromotive force irrespective of the rotational speed of the engine. The definite electromotive force is then used to trigger the ignition pulse produced in the ignition coil. Further, the invention provides means including an electric generator whose output is variable in proportion to the engine speed, and which is connected across the control current terminals of the Hall element for automatically advancing the igniting position in association with increases in the rotational speed of the engine. Additionally, the igniting position regulating means are provided having a pair of transistors whose conducting state abruptly varies at a voltage more than a predetermined value. A rheostat is provided for controlling the voltage level at which this conducting state abruptly changes, and hence provides an additional element of control over the operation of the ignition device.

Having described two embodiments of a new and improved contactless ignition device adapted for automotive vehicles and the like, other variations and adaptations of the ignition device will be suggested to those skilled in the art in the light of the above teachings. It is therefor to be understood that any such changes or modifications in the particular embodiments of the invention described are considered to fall within the scope of the invention as defined by the appended claims.

What is claimed is:

1. A contactless ignition device adapted for automotive vehicles and the like comprising igniting position detecting means including a Hall element having input terminals and output terminals and disposed in a magnetic field produced in synchronism with the revolution of the engine, the density of the magnetic flux producing said magnetic field being variable at the fringes thereof for varying the igniting position of the engine, means for applying an adjustable control current to the input terminals of the Hall element an igniting semi-conductor, an ignition coil energized by said igniting semi-conductor, and ignition control means operatively coupled to the output terminals of said Hall element and to the input of the igniting semi-conductor for controlling conduction through said igniting semi-conductor to thereby control the time of production of an ignition spark by said ignition coil.

2. A contactless ignition device according to claim **1**, further including igniting position advancing means comprised by an electric generator whose output is variable in proportion to the revolution of the engine, said means being connected with across the control current input terminals of said Hall element in said igniting position detecting means for thereby controlling the output of said igniting position detecting means in accordance with the speed of the engine.

3. A contactless ignition device according to claim **2** in which said Hall element in said igniting position detecting means is held between supporting blocks of low magnetic reluctance material, and pole pieces are provided in a rotary body rotating in synchronism with the revolution of the engine, said pole pieces being brought during rotation to a position opposite the supporting blocks to form a closed magnetic path through said Hall element.

4. A contactless ignition device according to claim **3**, further comprising igniting position regulating means having a pair of transistors whose conducting state is abruptly varied by a voltage appearing at the output terminal of said igniting position detecting means, and pulse generating means for supplying the output of said igniting position regulating means to said ignition control means for thereby controlling said igniting semi-conductor.

5. A contactless ignition device according to claim **4**, further comprising a variable impedance element coupled to the input of said pair of transistors for controlling the voltage level at which their conducting state is abruptly varied.

6. A contactless ignition device according to claim 1, further comprising igniting position regulating means having a pair of transistors whose conducting state is abruptly varied by a voltage appearing at the output terminal of said igniting position detecting means, pulse-generating means for supplying the output of said igniting position regulating means to said ignition control means for thereby controlling said igniting semi-conductor, and a variable impedance element coupled to the input of said pair of transistors for controlling the voltage level at which their conducting state is abruptly varied.

References Cited by the Examiner

UNITED STATES PATENTS

2,785,215	3/1957	Yetter	123—148
2,924,633	2/1960	Sichling et al.	123—148
3,020,897	2/1962	Sekine et al.	
3,195,043	7/1965	Burig et al.	
3,202,146	8/1965	Short et al.	123—148

MARK NEWMAN, *Primary Examiner.*

LAWRENCE M. GOODRIDGE, *Examiner.*