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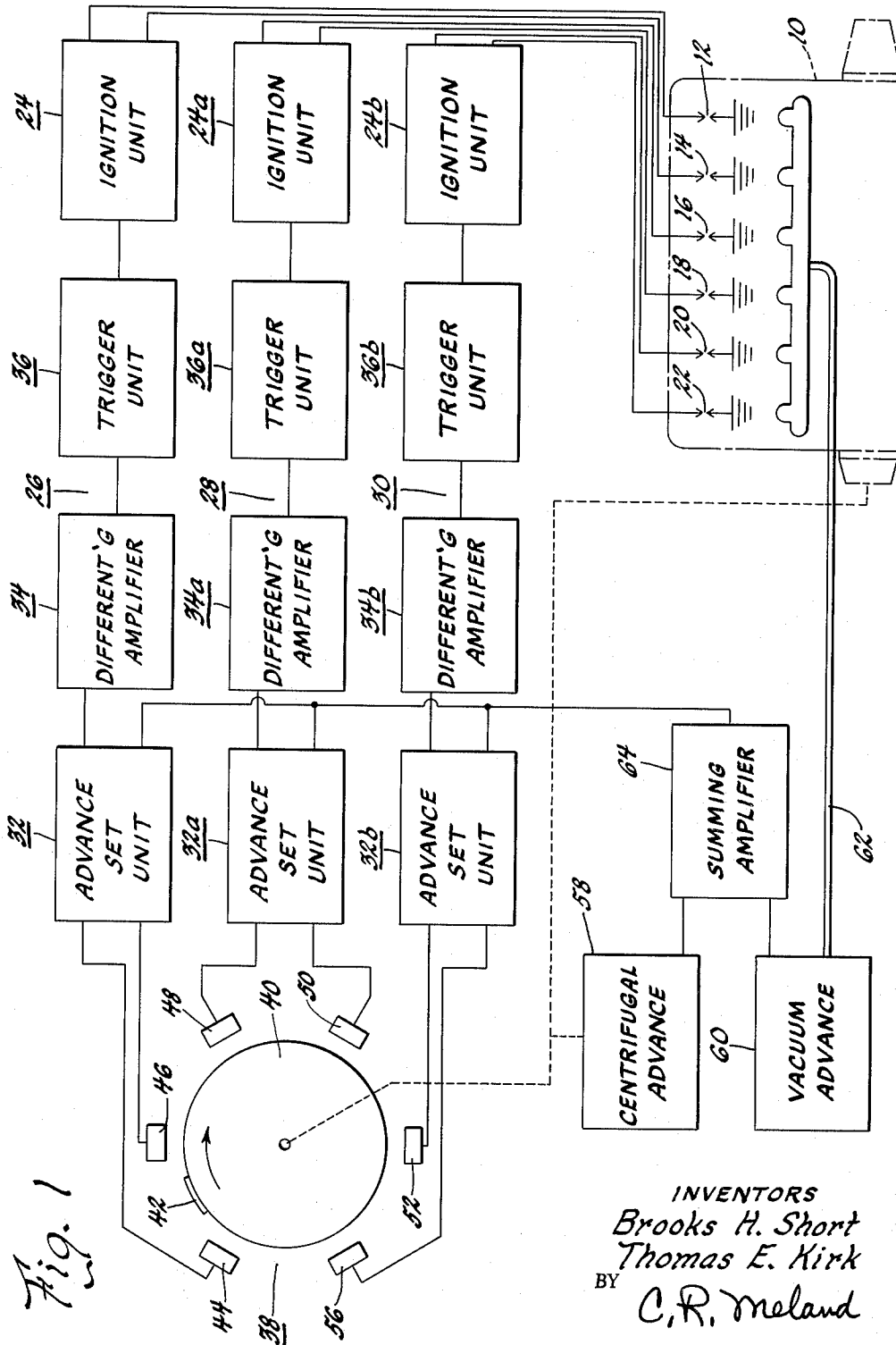
B. H. SHORT ETAL

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STATIC TRANSISTORIZED IGNITION SYSTEM

Filed April 11, 1962

3 Sheets-Sheet 1



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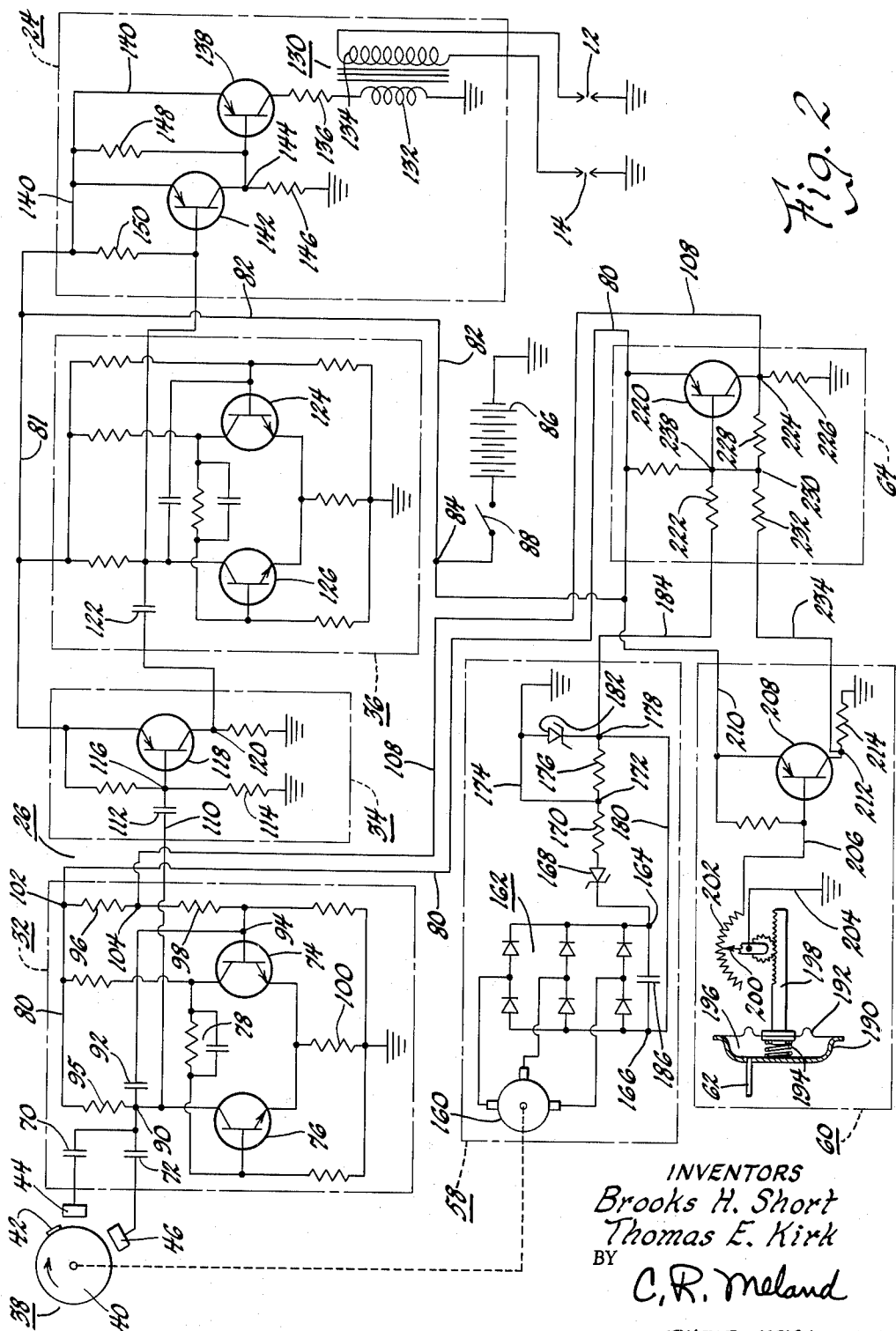
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STATIC TRANSISTORIZED IGNITION SYSTEM

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STATIC TRANSISTORIZED IGNITION SYSTEM

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3 Sheets-Sheet 3

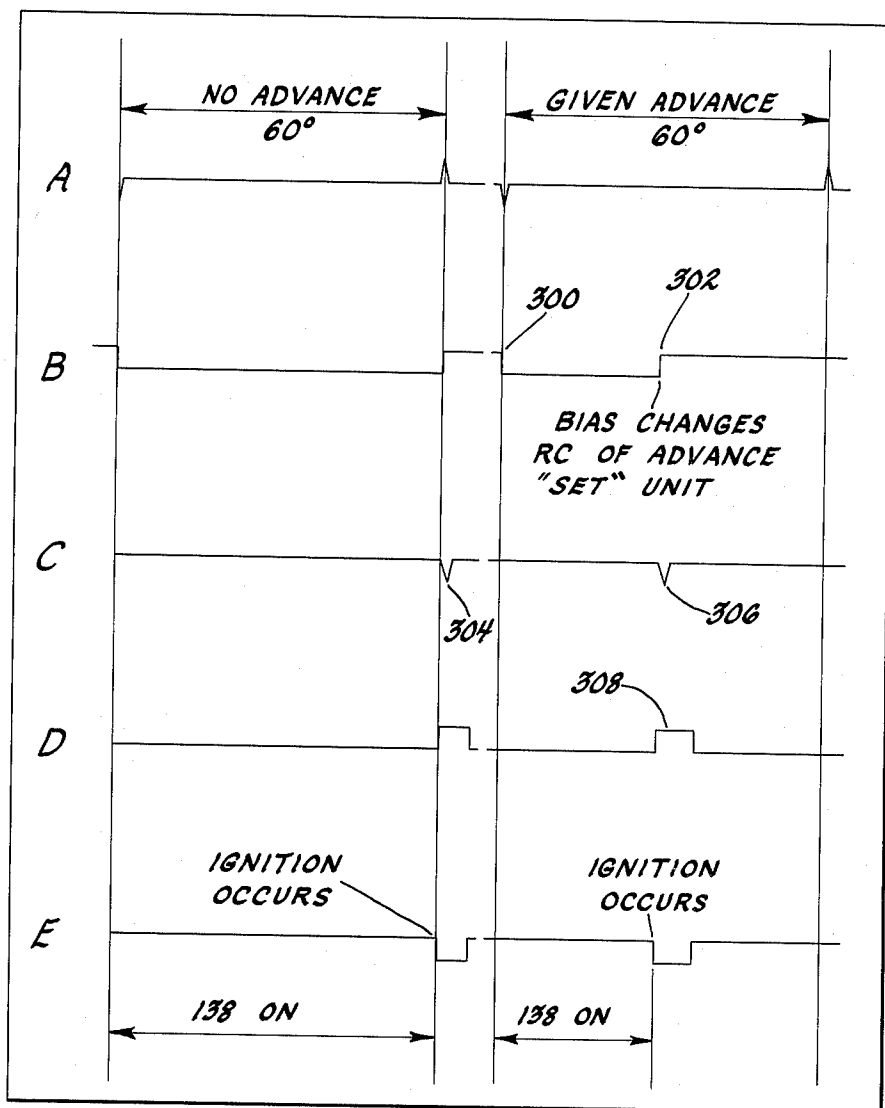


Fig. 3

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STATIC TRANSISTORIZED IGNITION SYSTEM
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This invention relates to an ignition system for an internal combustion engine and more particularly to an ignition system that does not require breaker contacts or distributor contacts for distributing spark impulses to a plurality of spark plugs on the engine.

Ignition systems which are in commercial use on internal combustion engines require a pair of breaker contacts for making and breaking the current to the primary winding of an ignition coil and require a distributor cap and a rotating rotor for distributing the spark impulses from the secondary winding of the ignition coil selectively to the spark plugs of the engine. Although this system has worked reasonably well, it has the disadvantages in that the breaker contacts become burned and pitted and must frequently be replaced. In addition, the distributor cap and rotor must be maintained in good condition to insure proper operation of the ignition system.

In contrast to the above described conventional ignition system, it is an object of this invention to provide an ignition system for an internal combustion engine which requires neither breaker points nor a distributor for distributing the spark impulses to the spark plugs of an engine.

A more specific object of this invention is to provide an ignition system for an internal combustion engine wherein a plurality of ignition coils each supply a pair of spark plugs of the engine and wherein the current flow through the primary winding of each ignition coil is controlled by a semiconductor switch means having its conductivity controlled by a magnetic pick-up means.

A further object of this invention is to provide an ignition system wherein the amount of spark advance is controlled by devices which produce electrical signals in accordance with speed and load conditions of the engine.

Another object of this invention is to provide a timing circuit for an internal combustion ignition system which includes a transistor multivibrator circuit having a voltage output which depends upon electrical signals fed to the multivibrator.

Still another object of this invention is to provide an ignition system for an internal combustion engine wherein an electrical system controls the current flow through the primary winding of an ignition coil and wherein this electrical system is fed with three electrical signals which control the timing of the ignition system in accordance with crank shaft position of the engine, speed of the engine and load conditions of the engine.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein preferred embodiments of the present invention are clearly shown.

In the drawings:

FIGURE 1 is a block diagram illustration of an ignition system made in accordance with this invention.

FIGURE 2 is a schematic circuit diagram of one section of the ignition system illustrated in block diagram form in FIGURE 1.

FIGURE 3 illustrates curves of voltages appearing between different units of the ignition system illustrated in FIGURE 2.

Referring now to the drawings and more particularly to FIGURE 1, the reference numeral 10 designates an internal combustion engine which in this case is illustrated

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as a six cylinder engine having spark plugs 12, 14, 16, 18, 20 and 22 for firing the combustible mixture of the engine. The spark plugs 12 and 14 are connected with an ignition unit 24. In a similar fashion, the spark plugs 16 and 18 and 20 and 22 are respectively connected with ignition units 24a and 24b. The ignition units 24, 24a and 24b are all identical and are illustrated in detail in FIGURE 2. It can be seen from FIGURE 1 that the ignition units 24, 24a and 24b form the output power stage for three separate ignition systems or sections which are respectively designated by reference numerals 26, 28 and 30.

The ignition system of this invention is arranged such that the ignition unit 24 will fire spark plugs 12 and 14 simultaneously. The same is true of ignition units 24a and 24b which respectively cause the simultaneous firing of spark plugs 16 and 18 and 20 and 22. The sequence of firing is such that spark plugs 12 and 14 are fired together, then spark plugs 16 and 18 and then spark plugs 20 and 22. The spark plugs are, of course, associated with different cylinders of the engine and are arranged such that when two spark plugs fire, one of them is in a cylinder that is in its exhaust stroke. This has no harmful effect since the firing voltage is low when the particular cylinder is in its exhaust stroke. Keeping the foregoing in mind, it is apparent that the resultant order of firing will be spark plug 12, then spark plug 16, then spark plug 20, then spark plug 14, then spark plug 18, and then spark plug 22, all of these spark plugs being fired during the compression stroke of the cylinder with which the particular spark plug is associated.

The ignition unit 24 is connected with a spark advance set unit 32 by means of a differentiating amplifier 34 and a trigger unit 36. In a similar fashion, the advance unit 32a is connected with ignition unit 24a via differentiating amplifier 34a and trigger unit 36a. The advance set unit 32b is connected with ignition unit 24b via differentiating amplifier 34b and trigger unit 36b.

The primary ignition timing control for the advance set units is a magnetic voltage pulse generating device which is generally designated by reference numeral 38. This voltage pulse generating unit includes a rotor 40 which is driven by the engine 10 and may be for example the fly wheel of the engine. The rotor 40 carries a permanent magnet 42 which passes by pick-up coils 44, 46, 48, 50, 52 and 56. The pick-up coils 44 through 56 are fixed with respect to the rotatable rotor 40 and as the magnet 42 swings by a respective pick-up coil, a voltage pulse is induced in the pick-up coil.

The rotor 40 is connected with the engine and the pick-up coils 44 and 46 are so positioned that the pick-up coil 44 is approximately 66 degrees ahead of top dead center of the pistons of the cylinders fired by spark plugs 12 and 14 whereas the pick-up coil 46 is mounted to be approximately 6 degrees ahead of top dead center for these same cylinders. The pick-up coils 44 and 46 are spaced approximately 60 degrees apart. The same angular relationship between top dead center is maintained for pick-up coils 48 and 50 and for pick-up coils 52 and 56 with respect to the pistons in the cylinders that they fire. It will, of course, be appreciated that the rotor 40 is driven at engine crankshaft speed. The net result of this arrangement is that two voltage pulses will be developed which are spaced 60 degrees apart in pick-up coils 44 and 46 when the rotor 40 goes through one revolution. This is depicted in curve A of FIGURE 3. Similar voltage pulses will be developed by pick-up coils 48 and 50 and 52 and 56 during one revolution of the fly wheel or rotor 40. It will, of course, be appreciated that the pick-up coils 46 and 48 are spaced 60 degrees from each other as are the pick-up coils 50 and 52 and 56 and 44.

The output voltages of pick-up coils 44 and 46 are applied to the advance set unit 32 whereas the output

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voltages of pick-up coils 48 and 50 are applied to advance unit 32a. In a similar fashion, the output voltages of pick-up coils 56 and 52 are applied to the advance unit 32b.

The ignition system of this invention includes a centrifugal spark advance mechanism 58 which is driven by the engine 10 and which has a voltage output which is proportional to the speed of the engine. A vacuum spark advance mechanism 60 is provided which is connected with the intake manifold of the engine 10 via a pipe 62. The vacuum advance mechanism 60 is a device which converts vacuum signals into a voltage output.

The voltage outputs of the centrifugal advance mechanism 58 and the vacuum advance mechanism 60 are summed in a summing amplifier 64. The output voltage of the summing amplifier 64 is applied to the advance set units 32, 32a and 32b. It can be seen from the foregoing, that each advance set unit is supplied with electrical signals which come from the pick-up coil, and from the centrifugal and vacuum advance mechanisms. The timing of the ignition pulses is thus varied in accordance with engine speed and load conditions with the primary timing control being the magnetic pick-up unit 38.

Referring now more particularly to FIGURE 2, a schematic circuit diagram of one section of the ignition system shown in FIGURE 1 is illustrated. The section to be described is section 26 which feeds the ignition unit 24 and the spark plugs 12 and 14. It will, of course, be realized that sections 28 and 30 are duplicates of the section 26 and therefore will be the same as that shown in FIGURE 2.

In FIGURE 2, the reference numeral 40 once more designates the rotor or fly wheel which is driven by the engine. The pick-up coils are again designated by reference numerals 44 and 46 which control section 26 of the ignition system. The pick-up coils 44 and 46 are coupled to the input of the advance set unit 32 by means of coupling capacitors 70 and 72.

It is seen from FIGURE 2 that the advance set unit 32 is a monostable transistor multivibrator. This multivibrator includes the NPN transistors 74 and 76, each having collector, base and emitter electrodes. It is seen that the collector electrode of transistor 74 is connected with the base electrode of transistor 76 through a parallel resistor-capacitor combination 78. The collector electrodes of transistors 74 and 76 are connected with a power lead 80 through resistors. The power lead 80 is connected with lead wire 82 which in turn is connected with a junction 84. The junction 84 is connected to the positive side of a direct current power source 86 through the ignition switch 88.

The coupling capacitors 70 and 72 are connected with a junction 90 which is connected with the collector electrode of transistor 76. A capacitor 92 couples the junction 90 to the junction 94 which is connected to the base electrode of transistor 74. The capacitor 92 forms part of an RC timing network which includes resistors 95, 96, and 98. It is seen that the base electrodes of transistors 74 and 76 are connected to ground through respective resistors and that the emitter electrodes of transistors 74 and 76 are connected together and to ground through a resistor 100.

The transistor multivibrator 32 has only one stable state and when triggered into an unstable state, will remain in the unstable state for a time determined by the discharge time of the RC network. If this RC discharge time is varied, a variable width square wave voltage pulse can be obtained from the multivibrator 32.

An incoming negative pulse, from the pick-up coil 44, will switch the multivibrator to an unstable state and in this unstable state, transistor 74 is turned off in its collector-emitter circuit. The stable state of operation is where the transistor 74 is turned on in its collector-emitter circuit and transistor 76 is turned off in its collector-emitter circuit.

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It is noted that the opposite ends of resistor 96 are connected with junctions 102 and 104. The junction 102 is connected with a lead wire 80 whereas the junction 104 is connected with lead wire 108. The lead wires 80 and 108 are connected with the summing amplifier 64 and this summing amplifier is operative to vary the effective resistance appearing between junctions 102 and 104 to therefore vary the RC time constant of the RC network. When the RC time constant is varied, it is, of course, possible to vary the width of the square wave pulse that is developed at the output terminals of the multivibrator 32.

The square wave voltage output of the multivibrator 32 is depicted in curves B of FIGURE 3 and is applied to the input of the differentiating amplifier 34. This signal is applied to the differentiating amplifier 34 through the lead wire 110 and the capacitor-resistor combination formed by capacitor 112 and resistor 114. The junction 116 of the differentiating amplifier 34 is connected with the base electrode of a PNP transistor 118. The emitter electrode of transistor 118 is connected with power lead wire 81 while the collector electrode is connected with junction 120. A resistor connects the junction 120 to ground.

The differentiating amplifier 34 receives the square wave signal from the advance set unit 32 and converts this signal to output pulses of voltage which are shown in curves C of FIGURE 3. These pulses of voltage are then supplied to the trigger unit 36 through the coupling capacitor 122.

The trigger unit is another monostable transistor multivibrator whose operation is the same as the advance set unit 32 except that the output wave form of the trigger unit 36 has a fixed pulse width output. This width will determine the period of time that the ignition unit 24 will be triggered. It is seen that the trigger unit 36 includes NPN transistors 124 and 126 which are coupled together and across the power source by resistors and capacitors as shown. The output voltage waveforms of the trigger unit 36 is shown in curves D of FIGURE 3 and it is noted that they have a constant or fixed width. This is because with the multivibrator circuit 36, the RC time constant is not changed.

The constant width square wave output voltage of the trigger unit 36 is supplied to the ignition unit 24. The ignition unit 24 includes an ignition coil 130 having a primary winding 132 and a secondary winding 134. The secondary winding 134 directly feeds the spark plugs 12 and 14 without the use of distributor cap contacts or a rotor.

One side of the primary winding 132 is connected to ground and the other side is connected with a resistor 136. A PNP transistor 138 has its collector electrode connected to one side of resistor 136 and has its emitter electrode connected with lead wire 140. The lead wire 140 is connected with lead wire 81 which is energized from the direct current power source when the ignition switch 88 is closed. A second PNP transistor 142 is provided which has its emitter electrode connected with lead wire 140, and its collector electrode connected with junction 144. The junction 144 is connected with the base electrode of transistor 138 and is connected to ground through the resistor 146. Resistor 148 permanently connects the emitter and base electrodes of transistor 138 and resistor 150 permanently connects the emitter and base electrodes of transistor 142.

It can be seen from FIGURE 2 that the current flow through the primary winding 132 of ignition coil 130 will be controlled by the emitter-collector circuit of transistor 138. When transistor 138 is turned on, there will be a current flow through the primary winding 132. When transistor 138 turns off in its emitter-collector circuit, the current flow through the primary winding 132 will be interrupted and a high voltage will then be induced in the secondary winding 134 to cause a firing of the plugs 12 and 14.

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The centrifugal advance device 58 includes a three phase tachometer generator 160 which has a rotatable part driven by the engine 10. The generator 160 produces an output voltage which is proportional to the speed of the engine 10 and this output voltage is rectified to direct current by a three phase full wave bridge rectifier circuit 162. The D.C. output terminals of the bridge rectifier circuit 162 are at 164 and 165. It will be appreciated that any device which produces an output voltage that is proportional to the speed of the engine 10 can be used as a part of the centrifugal advance unit 58. The output terminal 164 of bridge rectifier 162 is connected to one side of a Zener diode 168. The opposite side of Zener diode 168 is connected with a resistor 170 and this resistor is connected with junction 172. The junction 172 is connected with a lead wire 174 which is grounded. Junction 172 is also connected with a resistor 176 which in turn is connected with junction 178. The junctions 166 and 178 are connected by a level wire 180. A Zener diode 182 connects the lead wire 174 with the junction 178. The output voltage of the centrifugal advance device 58 is taken between lead wire 184 and ground.

The Zener diode 168 determines the cut-in voltage for the centrifugal advance unit 58 whereas the Zener diode 182 limits the D.C. voltage appearing between lead wire 184 and ground for the maximum spark advance required. The D.C. voltage appearing across the output terminals of the bridge rectifier 162 is developed across the capacitor 186. The output voltage is taken across the resistors of the centrifugal advance unit 58 and this network can be set to give a voltage proportional to the degrees advance required versus engine speed.

The vacuum advance unit 60 includes a vacuum unit 190 having a shiftable diaphragm 192 and a spring 194 which urges the diaphragm in one direction. The vacuum chamber 196 which is formed by the casing of the vacuum unit and the diaphragm 192 is connected with the intake manifold of the engine by a pipe 62. The diaphragm 192 is connected with an actuating rod 198 which shifts a tap 200 on a potentiometer resistor 202. The tap 200 is connected to ground via lead wire 204 while one side of the potentiometer resistor 202 is connected with lead wire 206. With this arrangement, the resistance between lead wire 206 and ground is varied in accordance with the vacuum conditions of the engine. The lead wire 206 of the vacuum advance unit 60 is connected with the base electrode of a PNP transistor 208. The emitter electrode of transistor 208 is connected with a lead wire 210 which is in turn connected with junction 84 and therefore energized from the battery 86. The collector electrode of transistor 208 is connected with a junction 212 and a resistor 214 connects this junction with ground.

The summing amplifier 64 includes a PNP transistor 220 having emitter, base and collector electrodes. The emitter electrode of transistor 220 is connected with lead wires 210 and 80. The base electrode of transistor 220 is connected with lead wire 184 through the resistor 222. The collector electrode of transistor 220 is connected with a junction 224. The junction 224 is connected with lead wire 168 and is connected to ground through a resistor 226. A resistor 228 connects the junction 224 with junction 230. Another resistor 232 connects the junction 230 with lead wire 234. It is seen that lead wire 234 is connected with the collector electrode of transistor 208 of the vacuum advance unit 60. The junction 230 of the summing amplifier 64 is connected with junction 238 and this junction is connected with the base electrode of the transistor 220. It can be seen from FIGURE 2 that the summing amplifier 64 receives voltage inputs from the centrifugal advance unit 58 and the vacuum advance unit 60. The summing amplifier 64 mixes the outputs of the centrifugal and vacuum advance units and amplifies them. The output voltage of the summing amplifier 64 is taken across the emitter and collector electrodes of transistor 220 and is applied to the transistor multivibrator 32 across

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resistor 96. Since this output is taken directly across transistor 220, it might be said that a varying resistance has been applied across the junctions 102 and 104 which will vary in accordance with voltage pulses applied to the summing amplifier from the centrifugal advance unit 58 and the vacuum advance unit 60.

When the ignition switch 88 is closed, it is seen that direct current power is supplied to the various elements of the ignition system. If the engine 10 is now being cranked or is running, the rotor or fly wheel 40 will be rotating and pulses of voltage will be induced in the pick-up coils 44 and 46.

The curves of FIGURE 3 depict voltage conditions in the system. The left-hand column is for no spark advance and the right-hand column is for some advance. Referring now to curves A of FIGURE 3, as the fly wheel 40 rotates, two pulses of voltage are developed which are spaced 60 degrees apart when the permanent magnet passes pick-up coils 44 and 46. These two pulses of voltage will be developed regardless of whether the spark is to be advanced as can be seen from the curves of FIGURE 3. As the first pulse of voltage is developed in pick-up coil 44, the transistor multivibrator 32 is triggered to its unstable condition and a square wave voltage then starts to develop as is apparent from curves B of FIGURE 3. The square wave voltage continues for a period of time determined by the RC time constant of the RC network and this time constant is proportioned such that with no signal from the summing amplifier 64, the square wave pulse will terminate only after the second voltage pulse is developed in pick-up coil 46. It thus is seen that where no centrifugal or vacuum advance is called for, the square wave voltage pulse extends over the entire 60 degree range between pick-up coils 44 and 46 and is initiated and terminated respectively by the voltage pulses induced in the pick-up coils 44 and 46.

Assuming now that voltages have been applied to the summing amplifier 64 by either or both the centrifugal advance and vacuum advance units 58 and 60 the transistor multivibrator 32 will be triggered back to its stable operating condition before the rotor has moved 60 degrees. When voltage pulses are received by the summing amplifier 64, the conductivity state of transistor 220 is varied to therefore vary the resistance appearing between junctions 102 and 104 of the multivibrator 32. This changes the RC time constant as is apparent from the right side of curves B in FIGURE 3 so that a square wave voltage wave form is now developed which extends between points 300 and 302 on the right hand curve of curves B in FIGURE 3.

The square wave output voltage which is developed by the multivibrator 32 will have its width varied in accordance with signals produced by the centrifugal advance unit 58 and the vacuum advance unit 60. This square wave pulse which is depicted in curves B of FIGURE 3 is applied to the differentiating amplifier 34 and its output is depicted in curves C of FIGURE 3. It is seen that the leading and trailing edges of the square wave voltage output of multivibrator 32 cause voltage pulses that are applied to the trigger unit 36. These voltage pulses in curves C of FIGURE 3 are designated respectively by reference numerals 304 and 306. The voltage pulses 304 or 306 are applied to the trigger unit 36 and as a result of this, the trigger unit develops square wave output voltages of a constant width which begin at the occurrence of one of the voltage pulses 304 or 306. The output voltage of the trigger unit 36 which is applied to the ignition unit 24 is depicted in curves D of FIGURE 3 and it is seen that a square wave voltage pulse of constant width 308 is generated which begins when a pulse 304 or 306 occurs. As a result, a square wave voltage pulse will be developed by trigger unit 36 each time the fly wheel 40 passes the pick-up coil 44 and the beginning of this square wave pulse 308 will be determined by the occurrence in point of time of the voltage pulse 306.

The output voltage depicted in curves D of FIGURE 3 of the trigger unit is applied to the ignition unit 24. The transistor 138 is normally conductive between its emitter and collector electrodes when there is no voltage developed in any of the pick-up coils. This transistor is normally turned on since there is a path for base current through resistor 146 to ground. When a voltage pulse 308 is applied to the transistor 142, it shifts from a normally nonconductive state to a state where it conducts between its emitter and collector electrodes. This causes the junction 144 to have a potential which is substantially equal to the potential of lead wire 140. When junction 144 has a potential substantially equal to lead wire 140, the potential of the emitter and base electrodes of transistor 138 is substantially equal so that this transistor now turns off in its emitter-collector circuit. When transistor 138 turns off in its emitter-collector circuit, the current flow to the primary winding 132 is interrupted and a high voltage is therefore induced in a secondary winding 134 which causes a firing of the spark plugs 12 and 14. The square wave voltage pulses shown in curves E of FIGURE 3 indicate the time period that the transistor 138 is turned off and this time period is identical to the width or time period of the square wave pulse 308 coming from the trigger unit 36. When no voltage pulses are induced in any of the pick-up coils, the transistor 138 will be conductive and the transistor 142 nonconductive.

In summarizing the operation of the ignition system shown in FIGURE 2, it will be appreciated that the time of firing of the spark plugs 12 and 14 is determined by the electrical signals developed by the pick-up coils 44 and 46, the centrifugal advance unit 58 and the vacuum advance unit 60. Where no centrifugal or vacuum advance is called for, the curves of output voltages are as shown in the left-hand column of FIGURE 3. Where some vacuum or centrifugal advance is called for or where both are called for, the time of firing of the spark plugs is changed due to the change in width of the square wave output voltage coming from multivibrator 32 which is depicted in the right-hand column of the curves B of FIGURE 3. It will, of course, be appreciated that the width of the square wave pulses coming from the multivibrator 32 can vary within wide limits as determined by the centrifugal and vacuum advance units. As pointed out above, the multivibrator circuit 36 is triggered on and off by the voltage pulses developed in pick-up coils 44 and 46. The width of the square wave developed by the multivibrator circuit 36 depends upon the spacing of the pulses from pick-up coils 44 and 46. If the speed of the engine is such as to require a centrifugal advance, the output voltage of bridge rectifier 162 will be sufficient to break down the Zener diode 168 and the width of the square wave will be reduced as explained hereinbefore so that it is less than the spacing provided by the pulses from pick-up coils 44 and 46. The spacing between the pulses provided by pick-up coils 44 and 46 will vary with engine speed but the centrifugal advance is provided by the output voltage of bridge rectifier 162 which is capable of decreasing the square wave output of multivibrator 36 to a value less than is provided by the pickup coils 44 and 46.

The sections 28 and 30 illustrated in FIGURE 1 operate the same as the section 26 which has been illustrated in FIGURE 2 and fully described hereinbefore. It will, of course, be appreciated that only one centrifugal advance unit and one vacuum advance unit are required and one summing amplifier to control all of the sections of the ignition system shown in FIGURE 1.

While the embodiments of the present invention as herein disclosed, constitute a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. An ignition system for an internal combustion engine comprising, an ignition coil having a primary winding, an energizing circuit for said primary winding, first generator means driven by said engine for generating a

first signal voltage which occurs in timed relationship with said engine, second generator means driven by said engine for generating a second signal voltage which is a function of speed of said engine, means for deriving a third signal voltage which is a function of engine load conditions, and means for making and breaking said primary winding energizing circuit in accordance with said first, second and third signal voltages.

2. An ignition system for an internal combustion engine comprising, an engine having a plurality of spark plugs, a plurality of ignition coils each having a primary winding and a secondary winding, a secondary winding of each ignition coil supplying at least two spark plugs of said engine, a plurality of energizing circuits respectively for the primary windings of said ignition coils, means for deriving a first signal voltage in synchronism with said engine, means for deriving a second signal voltage which is a function of the speed of said engine, means for deriving a third signal voltage which is a function of engine load conditions, and means for controlling the conductivity of all of said primary energizing circuits in accordance with said first, second and third signal voltages.

3. A control system for an internal combustion engine ignition system comprising, means for deriving a first signal voltage which is in timed relationship with said engine, means for deriving a second signal voltage which is a function of engine speed, means for deriving a third signal voltage which is a function of engine load conditions, a summing amplifier, means for applying said second and third signal voltages to the input of said summing amplifier, a multivibrator circuit having an output that is capable of controlling an ignition control device, and means for applying the output of said summing amplifier and said first signal voltage to said multivibrator.

4. An ignition system for an internal combustion engine comprising, an ignition coil having a primary winding and a secondary winding, a primary circuit for energizing said primary winding, means for controlling the making and breaking of said primary circuit including a multivibrator circuit having a variable width square wave voltage output, timing means driven in synchronism with said engine for controlling said multivibrator, means separate from said timing means for deriving a first signal voltage which is a function of engine speed, means for deriving a second signal voltage which is a function of engine load conditions, and means for applying said first and second voltages to said multivibrator whereby the width of the output voltage pulses of said multivibrator is controlled as a function of engine speed and load conditions.

5. An ignition system for an internal combustion engine comprising, a source of direct current, an ignition coil having a primary winding and a secondary winding, at least one spark plug connected with said secondary winding, semiconductor switch means, means connecting said semiconductor switch means and said primary winding in series across said source of direct current whereby said semiconductor switch means controls current flow through said primary winding provided by said source of direct current, timing means driven by said engine for generating a first signal voltage in timed relationship with operation of said engine, means separate from said timing means for generating a second signal voltage which is a function of the speed of said engine, means for deriving a third signal voltage which is a function of engine load conditions, and means for controlling the conductivity of said semiconductor switch means in accordance with said first, second and third signal voltages.

6. An ignition system for an internal combustion engine comprising, a source of direct current, an ignition coil having a primary winding and a secondary winding, semiconductor switch means, means connecting said

semiconductor switch means and said primary winding in series across said source of direct current, timing means for generating a first signal voltage in timed relationship with operation of said engine, said first signal voltage being coupled to said semiconductor switch means and initially determining the on-time of said semiconductor switch means, means for deriving a second signal voltage which is a function of the speed of said engine, means for deriving a third signal voltage which is a function of engine load conditions, and circuit means for reducing the on-time provided by said timing means in accordance with said second and third signal voltages when either or both of said second and third signal voltages are present.

7. An ignition system for an internal combustion engine comprising, a source of direct current, an ignition coil having a primary winding and a secondary winding, a semiconductor switch means, means connecting said semiconductor switch means and said primary winding across said source of direct current, a timing circuit connected with said semiconductor switch means having a substantially square wave output coupled to said semiconductor switch means, the conduction of said semiconductor switch means being controlled by the width of the square wave output of said timing circuit, a voltage generating means driven by said engine and coupled with said timing circuit providing a primary control for said timing circuit, a second voltage generating means having an output voltage which is proportional to the speed of said engine, means for providing a signal voltage which is a function of engine load conditions, and means for controlling said timing circuit in response to the output voltage of said second voltage generating means and in response to said signal voltage.

8. An ignition system for an internal combustion engine comprising, a source of direct current, an ignition coil having a primary winding and a secondary winding, semiconductor switch means, means connecting said semiconductor switch means and said primary winding in series across said source of direct current, a multivibrator circuit having a square wave output controlling the conduction of said semiconductor switch means, timing means driven by said engine providing a first signal voltage which provides a primary control for said multivibrator and which is operative to change the state of conduction of said multivibrator in synchronism with operation of said engine, means separate from said timing means for deriving a second signal voltage which is a function of engine speed, means for deriving a third signal voltage which is a function of engine load conditions, and means for coupling said second and third signal voltages with said multivibrator circuit whereby

the square output of said multivibrator circuit as determined by said timing means is modified by said second and third signal voltages.

9. An ignition system for an internal combustion engine comprising, a source of direct current, an ignition coil having a primary winding and a secondary winding, semiconductor switch means, means connecting said semiconductor switch means and said primary winding in series across said source of direct current, a square wave generating means, a timing means driven by said engine and connected with said square wave generating means for providing a primary control for said square wave generating means, means separate from said timing means for deriving a speed signal voltage which is a function of engine speed, means for deriving a voltage which is a function of engine load conditions, and means for modifying the operation of said square wave generating means in accordance with said speed signal voltage and in accordance with said voltage that is a function of engine load conditions.

10. An ignition system for an internal combustion engine comprising, a source of direct current, an ignition coil having a primary winding and a secondary winding, semiconductor switch means, means connecting said semiconductor switch means and said primary winding in series across said source of direct current, a first generator driven by said engine for generating a first signal voltage that is a function of engine piston position, a second generator driven by said engine for developing a second signal voltage that is a function of engine speed, and means for controlling the conduction of said semiconductor switch means in accordance with said first and second signal voltages, said first signal voltage providing an initial on and off timing control for said semiconductor switch means, said second signal voltage modifying the initial on and off timing control provided by said first signal voltage in accordance with engine speed.

11. The ignition system according to claim 10 where the system includes means for providing a third signal voltage in accordance with engine load conditions and wherein said first signal voltage is modified by said second and third signal voltages.

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