

[54] IGNITION SYSTEM

[72] Inventor: **Thomas P. Spalding**, 245 Grand Ave.,
Monrovia, Calif. 91016

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[52] U.S. Cl. 123/117 A, 123/146.5 A, 200/19

[51] Int. Cl. F02p 5/06

[58] Field of Search 123/117.1, 146.5 A, 148 E;
200/19

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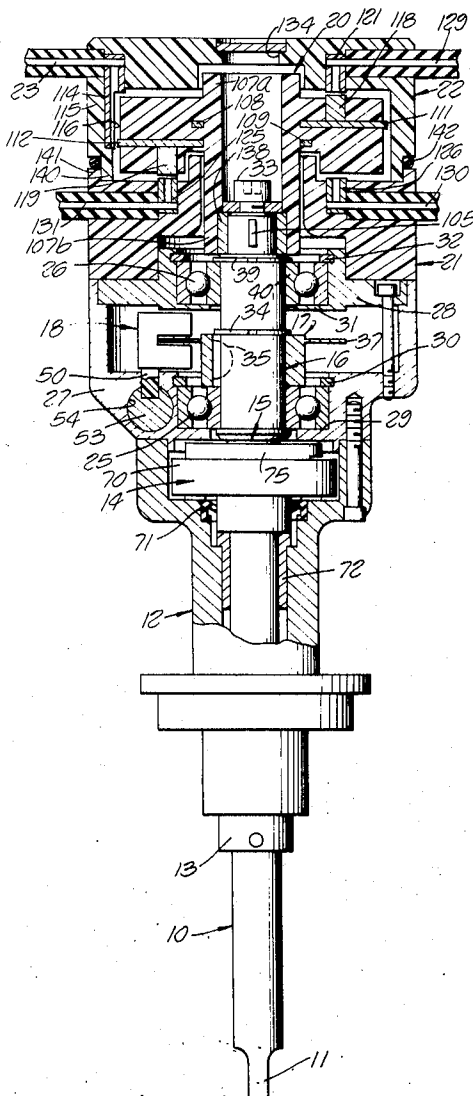
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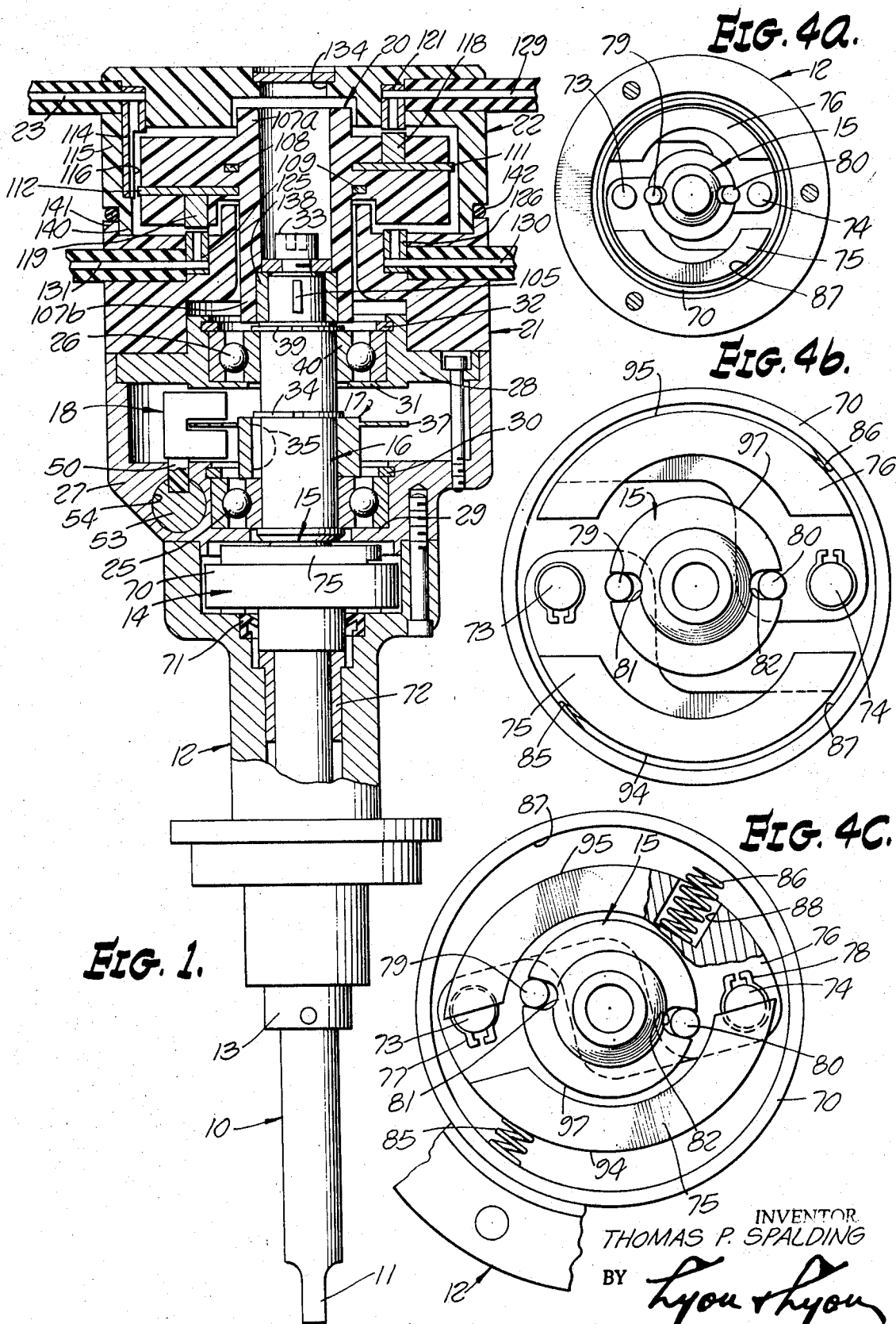
Primary Examiner—Laurence M. Goodridge
Attorney—Lyon & Lyon

[57] ABSTRACT

There is disclosed herein an ignition system of the capacitor discharge-type. The ignition system includes a source and cell, and a shutter therebetween driven from a suitable member of an internal combustion engine. The source and cell are included in a circuit arrangement for properly triggering an ignition coil. A new cap and rotor structure is disclosed for distributing voltage from the secondary of the ignition coil to the plugs of the engine. Additionally, a new centrifugal advance and a vacuum advance mechanism are disclosed.

15 Claims, 33 Drawing Figures





INVENTOR
THOMAS P. SPALDING

BY *Hyon & Hyon*

ATTORNEYS

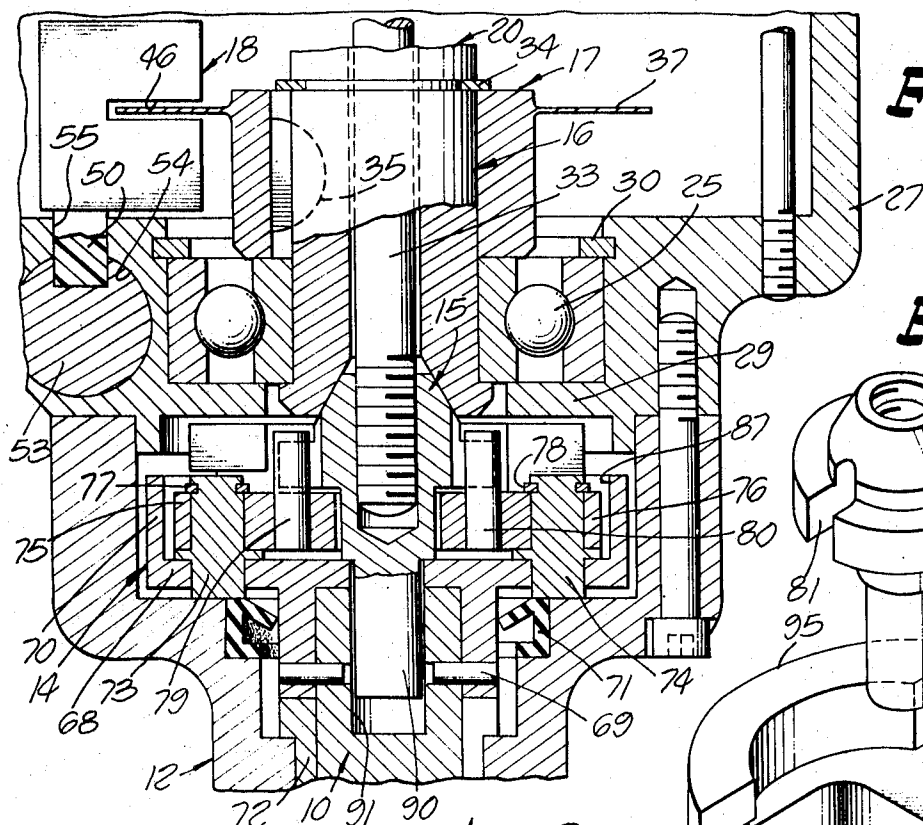


FIG. 2A.

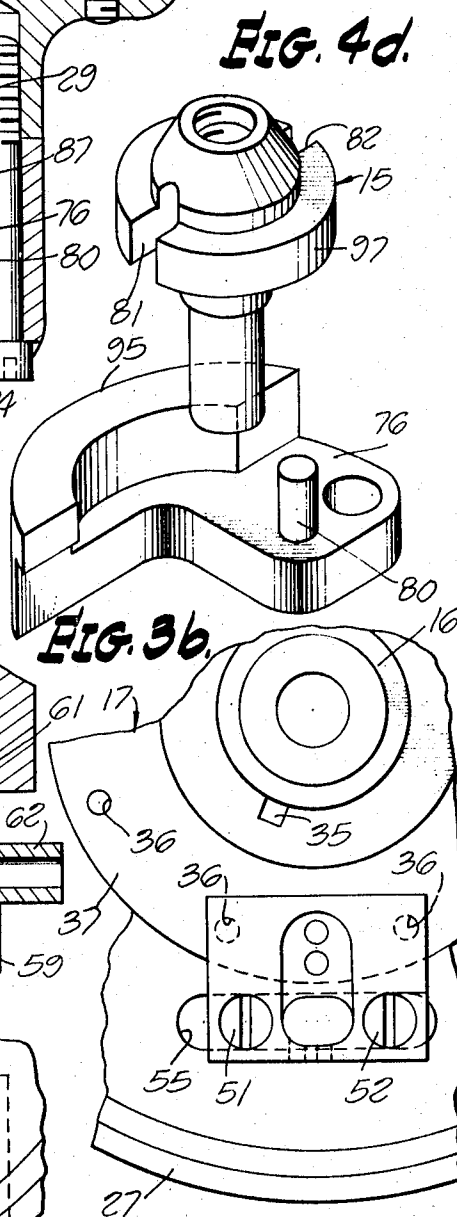


FIG. 4d.

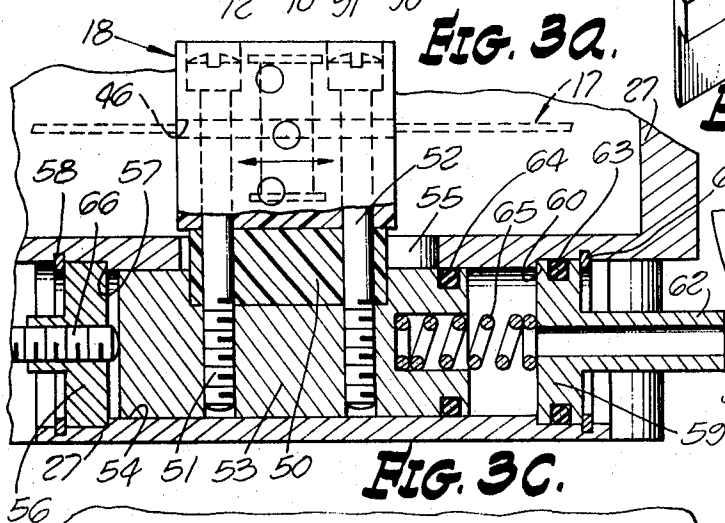


FIG. 3A.

FIG. 3B.

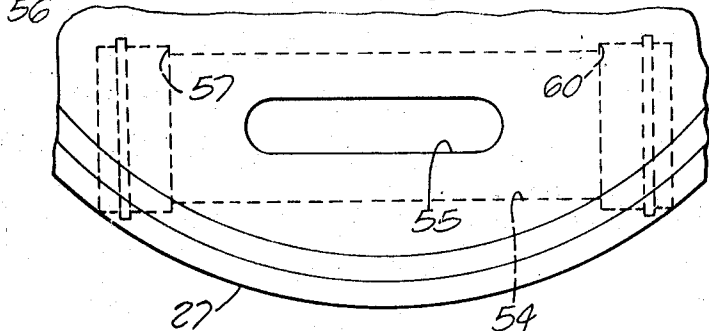


FIG. 3C.

INVENTOR.
THOMAS P. SPALDING

BY

Lyon & Lyon
ATTORNEYS

FIG. 3d.

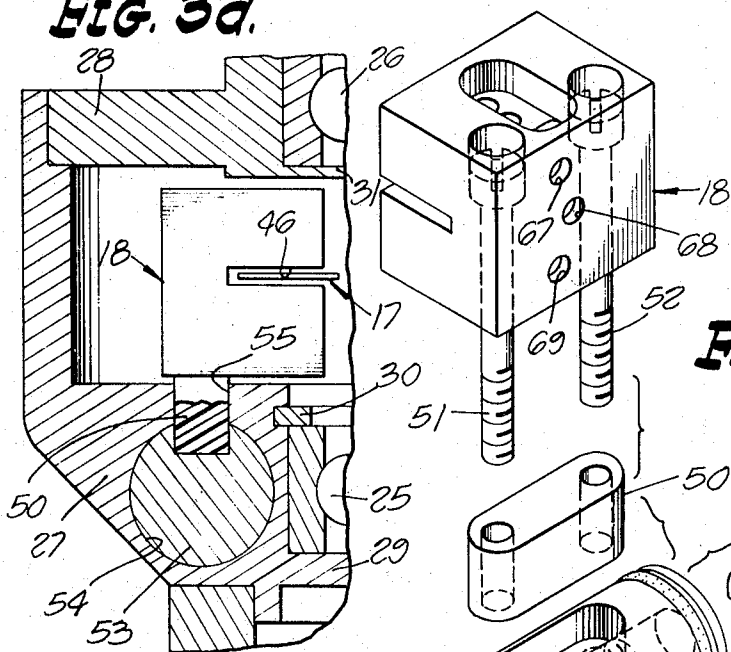


FIG. 3f.

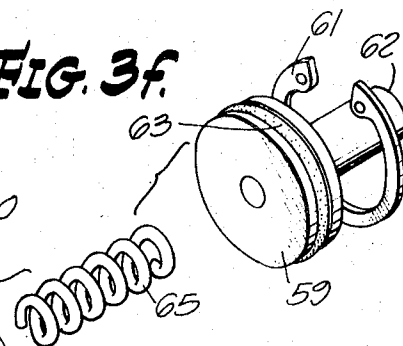


FIG. 3e.

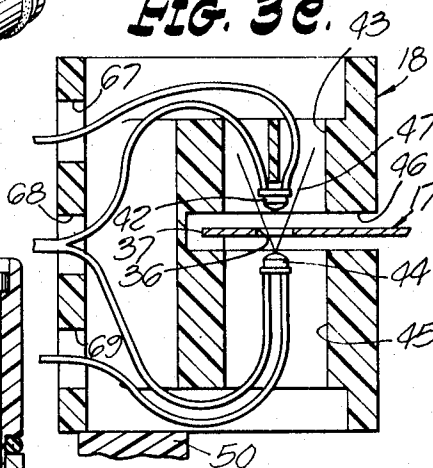
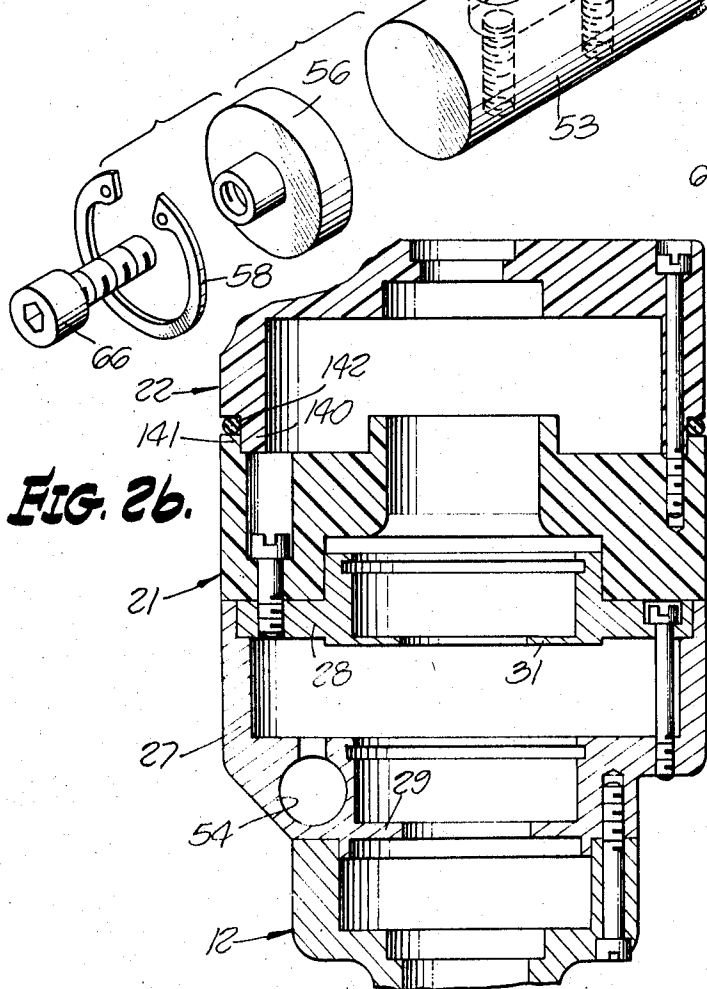


FIG. 2b.



INVENTOR
THOMAS P. SPALDING
BY *Lyon & Lyon*
ATTORNEYS

FIG. 5a.

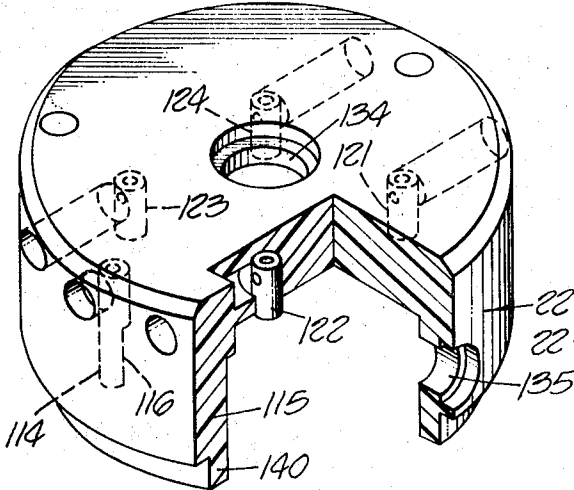


FIG. 5b.

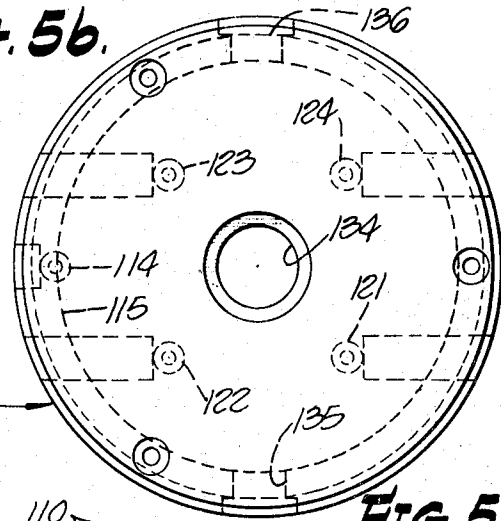


FIG. 5d.

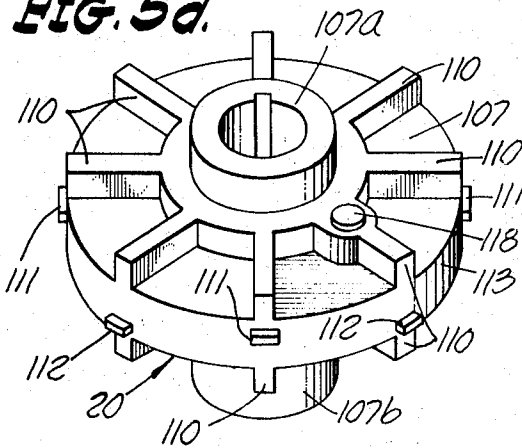


FIG. 5e.

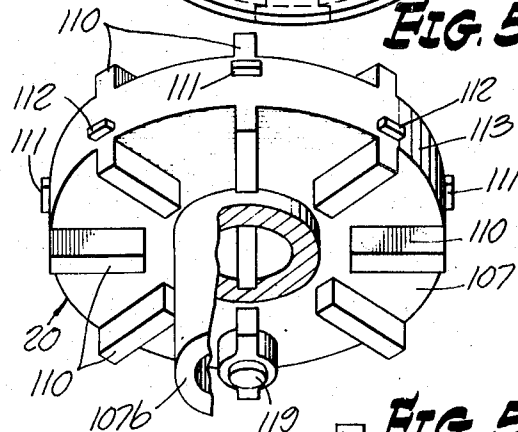


FIG. 5f.

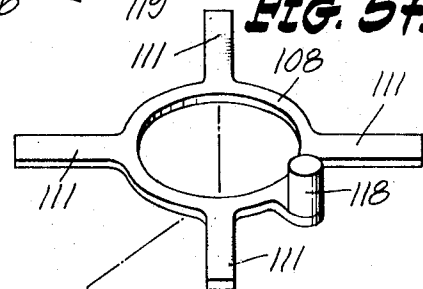


FIG. 5c.

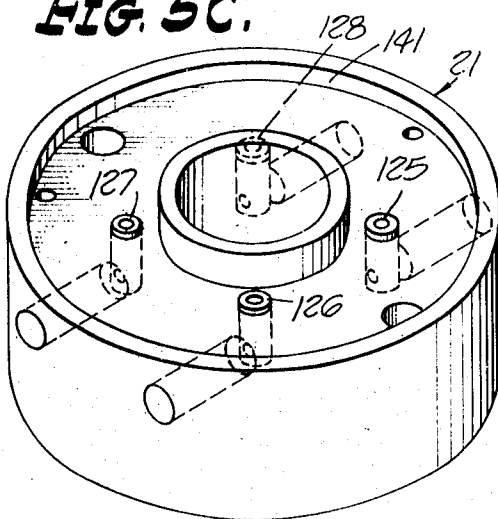
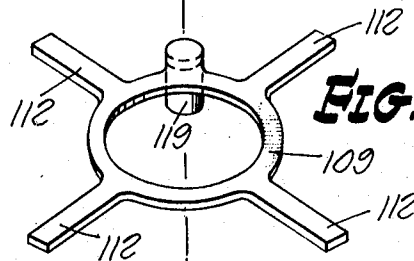


FIG. 5g.



INVENTOR
THOMAS P. SPALDING
BY *Lyon & Lyon*
ATTORNEYS

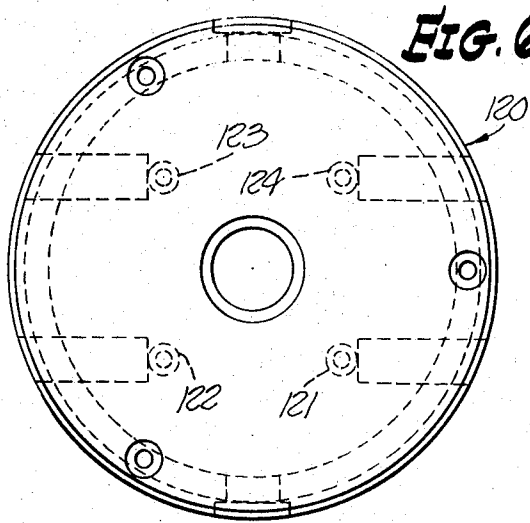


FIG. 6a.

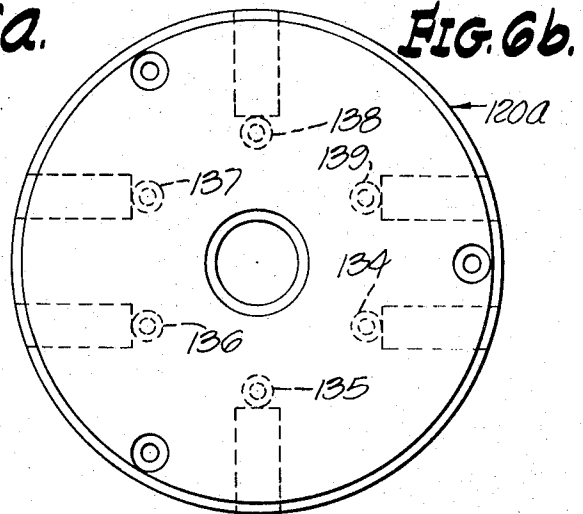


FIG. 6b.

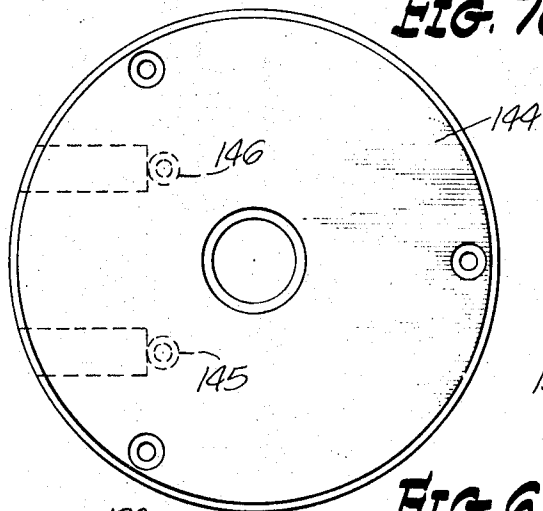


FIG. 7a.

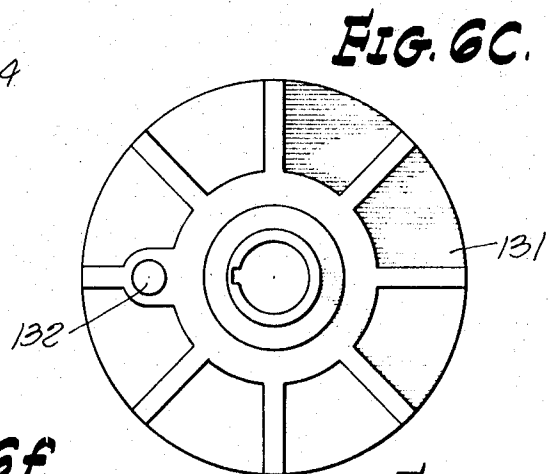


FIG. 6c.

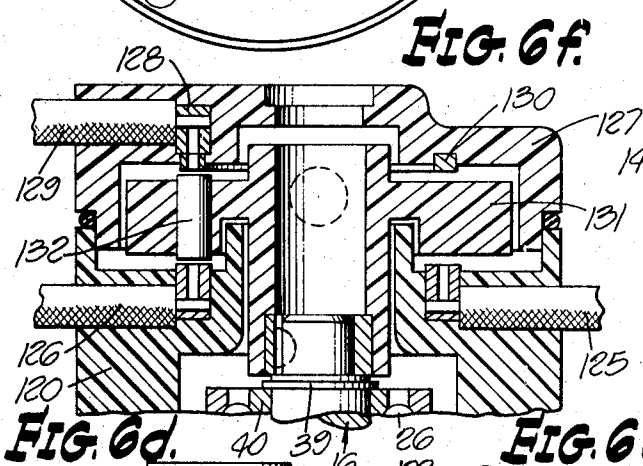


FIG. 6d.

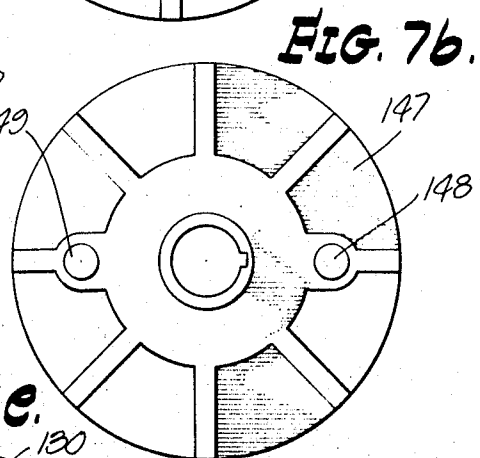


FIG. 7b.

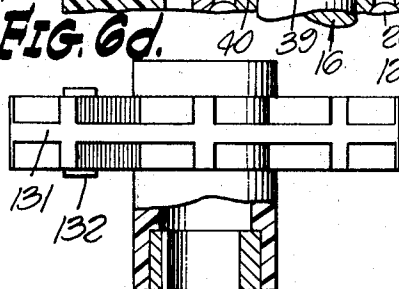
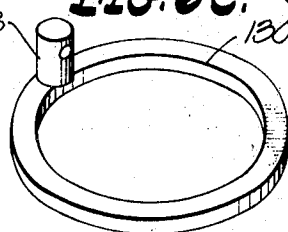


FIG. 6e.



INVENTOR
THOMAS P. SPALDING

BY

Lyon Lyon
ATTORNEYS

FIG. 8a.

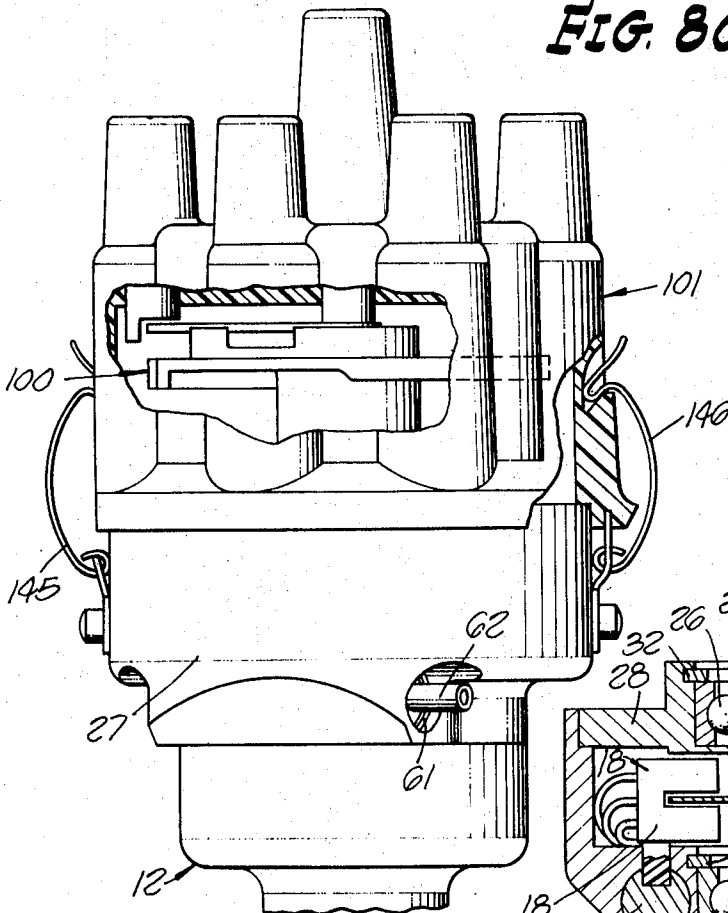


FIG. 8b.

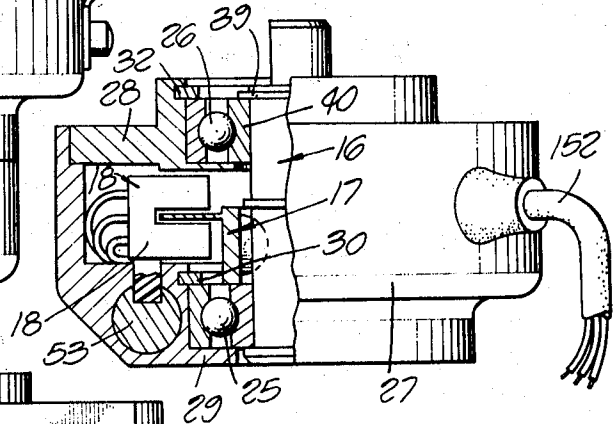


FIG. 8c.

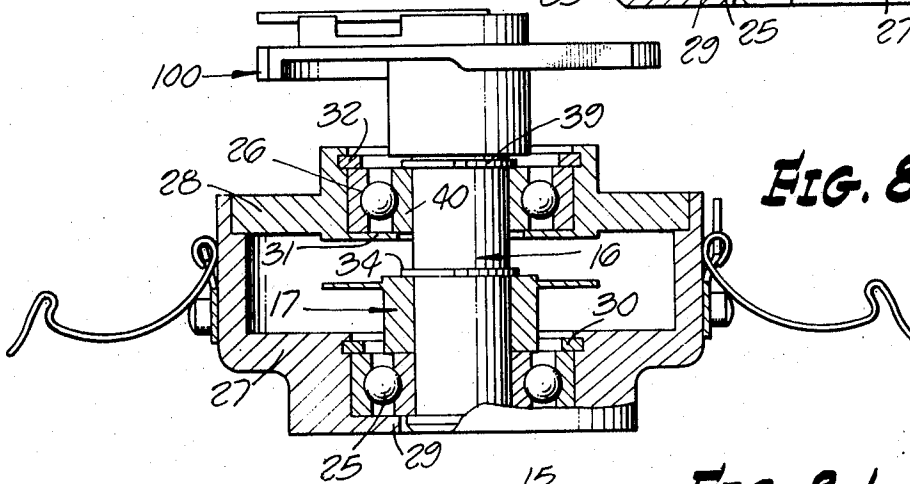
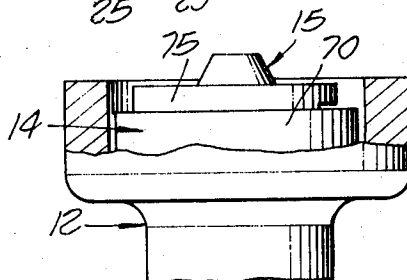
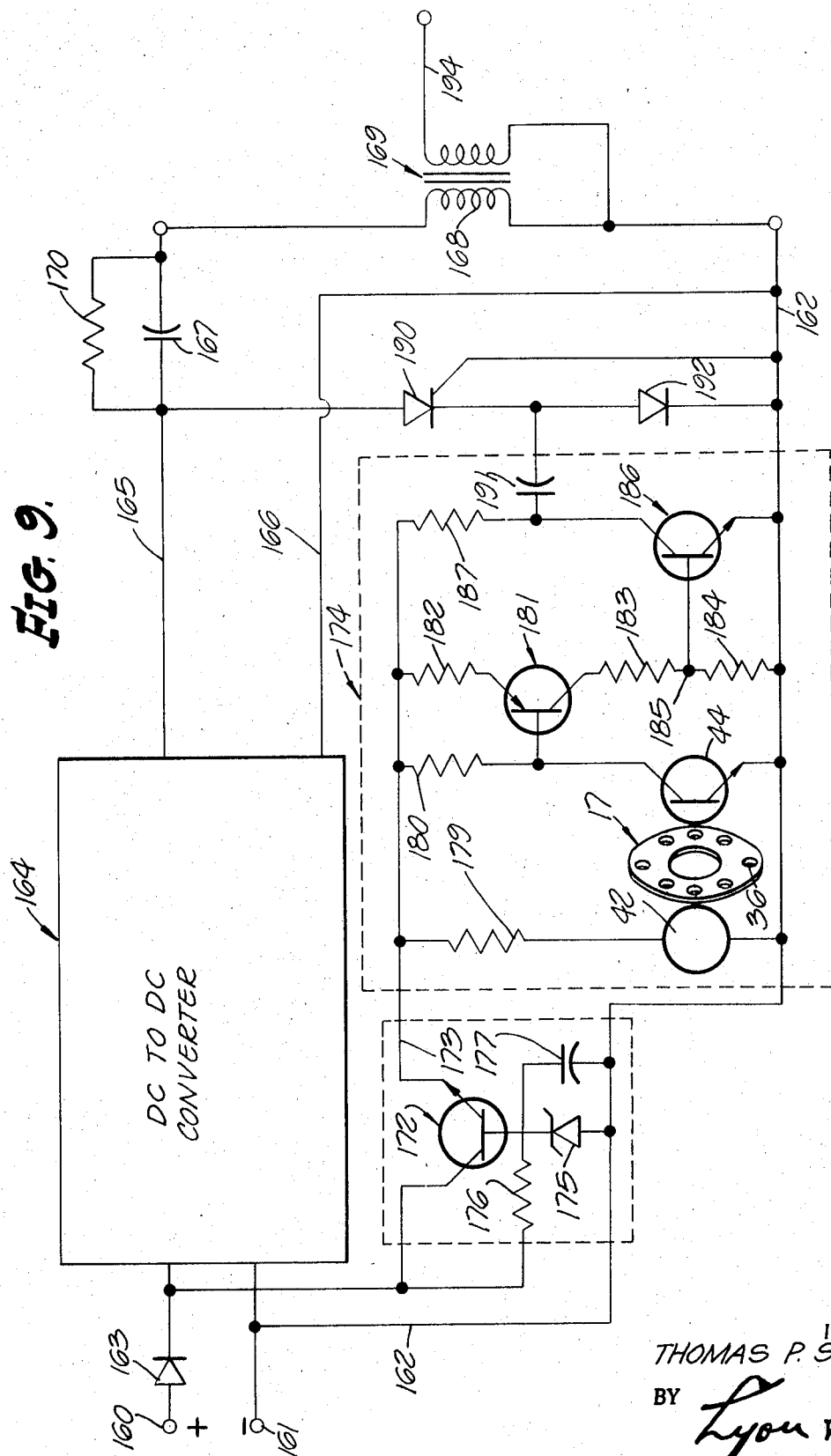


FIG. 8d.



INVENTOR
THOMAS P. SPALDING
BY *Lyon Lyon*
ATTORNEYS

FIG. 9.



INVENTOR.
THOMAS P. SPALDING
BY *Lyon & Lyon*
ATTORNEYS

IGNITION SYSTEM

This invention relates to ignition systems and more particularly to capacitor discharge-type ignition systems for use with internal combustion engines.

Various types of ignition systems have been devised and used over the years. The typical and most familiar type employs breaker points for pulsing an ignition coil used along with the familiar cap and rotor for distributing voltage pulses to the spark plugs of the engine. More recently, there have been developed capacitor discharge ignition systems employing either the conventional breaker points or some other arrangements for triggering the ignition coil. Such prior systems and devices have suffered from a number of drawbacks and disadvantages, such as, the requirement of maintenance and adjustments, improper plug firing over the usual range of engine revolutions, poor spark plug life, high current drain, unsatisfactory voltage rise time, and so forth.

Accordingly, it is a principal object of this invention to provide a new ignition system or apparatus.

An additional object of this invention is to provide an ignition system having improved operational characteristics.

An additional object of this invention is to provide a novel breakerless capacitor-discharge ignition system.

Another object of this invention is to provide a novel vacuum advance mechanism for a breakerless ignition system.

A further object of this invention is to provide a new rotor and cap assembly for an ignition system.

Another object of this invention is to provide an improved centrifugal advance mechanism for an ignition system.

These and other objects and features of the present invention will become better understood through a consideration of the following description taken in conjunction with the drawings in which:

FIG. 1 is a cross-sectional elevational view of ignition apparatus in accordance with the present invention;

FIG. 2a is an enlarged cross-sectional view of a portion of the apparatus shown in FIG. 1 better illustrating the shutter and centrifugal advance arrangements thereof;

FIG. 2b is a partial view showing the manner in which the housing components of the present apparatus are secured together;

FIGS. 2a through 3f are fragmentary views illustrating the source and cell, shutter, and vacuum advance mechanisms;

FIGS. 4a through 4d illustrate the improved centrifugal advance mechanism of the present invention;

FIGS. 5a through 5g illustrate in detail the new cap and rotor of the present invention for use with an eight cylinder four cycle internal combustion engine;

FIGS. 6a through 6f illustrate new caps and a rotor for four and six cylinder four cycle engines;

FIGS. 7a and 7b illustrate a new cap and rotor for a two cylinder two cycle engine;

FIGS. 8a through 8d illustrate the source, cell, shutter, vacuum advance and centrifugal advance arrangements of the present invention employed with a conventional rotor and distributor cap; and

FIG. 9 is a circuit diagram of a circuit for triggering the ignition coil.

The present ignition system provides a number of features and benefits not found in conventional ignition systems. Many such systems still employ breaker points which have many well-known disadvantages. Even the magnetic trigger types of capacitor discharge systems suffer from the disadvantage that it is difficult to obtain properly shaped trigger pulses at low speeds. On the other hand, extremely accurate and consistent trigger pulses are obtained with the present ignition system. Ample spark energy to fire spark plugs even in a fouled condition, and over an extremely wide speed range is available. Longevity is ensured because much of the present mechanism can be sealed from outside dust, oil and other contaminants, and the only contact between moving members is provided by two ball bearings. The capability of providing a sealed unit reduces the effects of heat, vibration and contamination.

Other advantages will become apparent through a consideration of the following description.

Turning now to the drawings, and particularly FIGS. 1 and 2, a suitable adapter drive member 10 is coupled with the internal combustion engine for driving the components of the ignition system or apparatus. The drive member 10 may include a tongue 11, or a suitable gear member as will be apparent to those skilled in the art. The shaft 10 is mounted within a lower housing 12 and is retained for rotation therein by means of a retaining collar 13. The upper end of the shaft 10 is affixed to a centrifugal advance mechanism 14 in a manner to be described subsequently. An advance coupling 15 is coupled between the mechanism 14 and an upper drive shaft 16 as best seen in FIG. 2.

A shutter 17 is mounted on the shaft 16 and serves to shutter a light source with respect to a light pickup or cell mounted in a fixture 18 for properly triggering the ignition coil as will be described subsequently. The upper end of the shaft 16 is coupled with a rotor 20 which is mounted within bottom and top caps 21 and 22. The rotor 20 serves to distribute the voltage from the secondary of the ignition coil through a plurality of ignition wires to the spark plugs of the engine. In the embodiment illustrated in FIGS. 1 and 2, a wire 23 from the secondary of the ignition coil supplies voltage which in turn is distributed by the rotor 20 through four lower and four upper wires to the plugs. As can be seen in FIG. 1, the shaft 16 is mounted in two ball bearings 25 and 26 which are respectively mounted in an intermediate housing 27 and cap 28. These bearings constitute the only contacting surfaces of the shutter and distributor assembly.

Turning first to a detailed discussion of the shutter assembly, the same is best seen in FIGS. 1, 2 and 3, and is diagrammatically illustrated in the electrical circuit of FIG. 9.

The shaft 16 is mounted in the bearings 25 and 26 as noted above, and the bearing 25 is positioned against a flange 29 in the lower end of the housing 27 and is retained in position by a snapping 30. The upper bearing 26 rests on a flange 31 in the cover 28 for the housing 27, and is retained in position by a snapping 32. The shaft 16 is secured to the advance coupling 15 by a bolt 33 as best seen in FIG. 2. The shutter 17 is mounted on the shaft 16 and is retained in place by a snapping 34 and key 35. The shutter has a plurality of holes 36 as best seen in FIG. 3b in the flange portion 37 thereof. The flange portion 37 is relatively thin to enable the holes 36 to be punched rather than requiring the same to be machined. The holes are preferably approximately one-sixteenth inch in diameter, and holes occasion less refraction and diffusion than do radial slots although such slots can be used. An upper snapping 39 couples the upper end of the shaft 16 with the inner portion 40 of the bearing 26. Neglecting the action of the centrifugal advance mechanism 14 for the moment, it will be apparent that the shutter 17 is driven by the shaft 16 which is driven from the shaft 10 through the advance mechanism 14.

The source and cell fixture 18 houses a radiation source 42 within a hole 43 and a pickup cell 44 within a hole 45 as best seen in FIG. 3e. The flange portion 37 of the shutter 17 extends into an opening 46 between the source 42 and cell 44. The openings 36 periodically allow light from the source to reach the cell 44. The source 42 preferably is a gallium arsenide source such as a Fairchild FLD-100. Alternatively, an incandescent bulb operated at low voltage so as to operate in the near infrared region may be employed as a source. The cell 44 preferably is a silicon phototransistor such as a Fairchild FPD-100 or Motorola MRD-310. The lens of the source 42 is mounted just above the plane defined by the upper limit of the groove 46, and the cell 44 is mounted in a similar manner below the lower limit of the groove 46. The source and cell may be retained in position by a suitable potting compound.

If desired, two sources can be used, such as two incandescent bulbs at low voltage, for reliability. In this instance, the bulbs preferably are mounted within the hole 43 so as to provide an angle of approximately 20° apart with respect to

the active surface of the cell 44 as illustrated by lines 47. This arrangement is to ensure that the cone of light from each source properly intersects the cell.

The fixture 18 is movable to provide vacuum advance. The fixture is coupled to a spacer 50, by capscrews 51 and 52, with a solid cylindrical vacuum plunger or piston 53 as best seen in FIGS. 3a and 3f. This piston 53 is mounted in a cylindrical hole 54 in the housing 27, and a slot 55 is provided through which the spacer 50 extends to enable the fixture 18 to move back and forth as viewed in FIG. 3a. A vacuum cylinder cap 56 rests against a shoulder 57 in the housing 27, and is retained by a clip 58. Similarly, a vacuum connector 59 rests against a shoulder 60 and is retained by a clip 61. The connector 59 includes a tube 62 which is connected to the vacuum hose (not shown) of the engine. An O-ring 63 provides a seal for the connector 59, and an O-ring 64 provides a seal for the plunger 53. A spring 65 is provided between the plunger 53 and connector 59 and normally biases the plunger 53 to the left as seen in FIG. 3a to the retard position. As will be apparent, an increase in vacuum, as at engine idle, causes the plunger 53 to move to the right as seen in FIG. 3a thus also shifting the fixture 18 to the right. This action causes the slots 36 in the shutter 17 to allow light from the source 42 to reach the cell 44 at a different point in time. A screw 66 is threaded through the cap 56 to allow the amount of advance to be adjusted. Holes 67 through 69 are provided in the fixture 18 for the wires from the source 42 and cell 44 so that the same may be coupled with the external circuit shown in FIG. 9 in any suitable manner.

Turning now to a detailed discussion of the centrifugal advance mechanism 14, the same is best seen in FIGS. 2 and 4a through 4d. The advance mechanism 14 includes an advance plate or housing 68, the lower end of which is firmly affixed to the upper end of the adapter shaft 10 by a roll pin 69. The upper portion of the advance plate 68 is in the form of a cylindrical cup 70. A resilient lip seal 71 is mounted in the lower housing 12 to prevent oil from passing from the engine into the components of the present ignition apparatus. A sleeve bearing 72 is provided between the housing 12 and the shaft 10.

A pair of pivot pins 73 and 74 are secured in the bottom of the advance plate 14 and serve as pivots for respective weights 75 and 76. The weights are pivotally mounted on the pins 73 and 74 by respective clips 77 and 78. The weights 75 and 76 have respective pins 79 and 80 affixed thereto which extend upwardly and couple with respective slots 81 and 82 in the advance coupling 15. A pair of compression springs 85 and 86 extend between the respective weights 75 and 76 and the inner wall 87 of the cup portion 70 of the advance plate. These springs are retained in position by seating the same within holes in the weights, such as a hole 88 in the weight 76 as seen in FIG. 4c. The spring 85, termed a primary spring, is lighter than the spring 86, termed a secondary spring. The secondary spring 86 is slightly shorter than the spring 85 and thus there is a slight amount of clearance between the spring 86 and wall 87. Accordingly, the weights 75 and 76 can at first move outwardly faster since the only restraining force is the lighter primary spring 85, and then the weight movement is more restricted because of the action of both the light spring 85 and heavy spring 86. The lower end 90 of the advance coupling 15 loosely fits within a hole 91 in the upper end of the adapter shaft 10. As noted earlier, the advance coupling 15 is secured to the drive shaft 16 by means of the bolt 34. The centrifugal advance mechanism can be relatively small and compact because then there is no usual breaker-point load thereon.

From the foregoing, it will be apparent that the weights 75 and 76 are driven by the adapter plate 68 which is driven by the shaft 10. The upper components of the ignition apparatus, that is the shaft 16, shutter 17 and rotor 20, are coupled to the advance coupling 15 which is in turn only coupled with the weights by means of the pins 79 and 80 mating with the respective slots 81 and 82. It can be seen from FIG. 4c that the coupling 15 assumes one angular position when the weights 75

and 76 remain in their inward position as biased by the springs 85 and 86, but that the coupling 15 assumes another angular position as seen in FIG. 4b as the weights move outwardly as a result of centrifugal force. Thus, the coupling 15 is shifted angularly as the weights 75 and 76 move outwardly, thereby effecting an angular shift in the shutter 17 and hence a change in the time of plug firing. The weights 75 and 76 preferably are made of die-cast zinc, bronze or sintered bronze, or other suitable heavy material, and the advance coupling 15 is made of metal with all contacting surfaces such as the coupling 15 and the pins 79 and 90 being hardened for wear resistance.

It should be noted that the inner wall 87 of the advance plate 14 not only serves as a seat for the springs 85 and 86, but also forms an end stop for the weights 75 and 76. The diameter of the wall 87, and the outside diameter of the peripheral arcuate portions 94 and 95 of the respective weights 75 and 76 determine the maximum advance and form a positive stop to the centrifugal advance operation. The outside diameter of the enlarged portion 97 of the advance coupling 15 also may be varied to provide further selection of the advance range. Thus, a full range of advance is determined by the outside diameter of the advance coupling 15, the outside diameter of the arcuate portions of the weights, and the inside diameter of the wall 87. Additionally, the force provided by the springs 85 and 86 affect the advance operation curve.

It further should be noted that typical centrifugal advance mechanisms employ tension springs, but high speed and high temperature detrimentally affect the characteristics thereof, and they frequently disintegrate under these conditions. Such springs typically have eyes formed on the ends thereof which, when formed, are inherently fractured giving rise to failures under adverse conditions. The compression springs 85 and 86 are relatively simple and easy to manufacture accurately so as to obtain the best and most reliable performance from the centrifugal advance mechanism.

Both the shutter and centrifugal advance mechanisms as described above may be incorporated into a distributor mechanism of the manner illustrated in FIGS. 8a through 8d and employed with a conventional distributor rotor 100 and distributor cap 101. In these figures, similar parts have been numbered with like reference numerals described previously. It will be apparent that the rotor 100 distributes the voltage to the various ignition leads (not shown) coupled with the cap 101 in a conventional manner, but triggering is provided by the shutter arrangement and circuit of FIG. 9, and vacuum and centrifugal advance are provided by the mechanisms described previously. However, as is known, the conventional rotor and distributor cap have certain drawbacks not the least of which is wear on the contacts thereof and loading caused by a number of contacting surfaces. According to another aspect of the present invention, a new rotor and cap assembly is provided.

Turning now to a detailed discussion of the rotor 20 and bottom and top caps 21 and 22, the same are illustrated in detail in FIGS. 5a through 5g. The assembly shown is for an eight cylinder four cycle internal combustion engine. The rotor 20 is keyed to the shaft 16 by a key 105 as seen in FIG. 1 and is secured thereto by the bolt 34 as noted previously. The rotor includes a disk or flange section 107 intermediate upper and lower collars 107a and 107b. The disk section 107 has molded therein an upper spider 108 and a lower spider 109, each of which may be formed of copper, bronze or other suitable electrically conductive material. A plurality of vanes 110 may be formed on the rotor to provide forced ventilation of the rotor-cap assembly so as to expell ozone, acid and any other contaminants to prevent corrosion of the metal components thereof. The rotor and caps may be molded of alkyl material or of a silicon ceramic material.

The spiders 108 and 109 include a plurality of respective fingers 111 and 112 which extend radially outwardly from the periphery 113 of the disk portion 107 of the rotor 20 and serve as pickups for the voltage from the secondary of the ignition coil. For this purpose, an input coil terminal 114 is secured in

the outer wall 115 of the top cap 22. The wire from the secondary of the ignition coil is coupled with this terminal 114, and the terminal 114 has a substantially flat face 116 as seen in FIG. 1 which is slightly spaced from the outer ends of the fingers 111 and 112. The spacing from the tips of the fingers 111 and 112 is preferably about twenty to thirty thousandths of an inch. The spiders 108 and 109 also each include rotor terminals or conductors 118 and 119 which serve to distribute the voltage to plug terminals in the top and bottom caps. The top cap 22 includes four plug terminals 121 through 124 to which are connected ignition wires (not shown), and the bottom cap 21 includes four plug terminals 125 through 128 to which are connected four additional ignition wires (not shown). One of the upper ignition wires 129, and two of the lower ignition wires 130 and 131 are seen in the elevational view of FIG. 1. The ignition wires run to the spark plugs of the associated engine.

The terminals 121 through 128 are molded into the top and bottom caps and also are positioned to be spaced by twenty to thirty thousandths of an inch from the surfaces of the conductors 118 and 119. With this cap and rotor arrangement, there are not contacting surfaces between the rotor 20 and cap sections 21 and 22. Several ventholes 134 through 136 are provided in the top cap 22 to allow the release of ozone and acids other contaminants, and preferably these ventholes are covered by sintered bronze filters which are snapped into the holes or secured therein by a suitable adhesive. Ionized air, which reduces the internal electrical impedance of the distributor assembly, can thus be purged. The bottom cap 21 includes a solid body within which are molded or otherwise secured the plug terminals 125 through 128.

The lower portion of the bottom cap 21 rests upon and is bolted to the cover cap 28 as seen in FIGS. 1 and 2b. The rotor 20 is interposed between the bottom and top caps 21 and 22 and maintained out of contact with the lower cap in any suitable manner, as by means of an internal sleeve 138 as seen in FIG. 1 which abuts the top of the shaft 16. The lower end of the top cap 22 has a cylindrical skirt 140 which mates with the inner surface of a shoulder 141 at the top surface of the bottom cap 21. An O-ring 142 may be used between the bottom and top caps as seen in FIG. 1 to provide a seal therebetween. These cap sections are secured together, as well as the other housing components of the ignition apparatus by suitable screws or bolts as seen in FIGS. 1, 2a and 2b. In the case of the conventional rotor and distributor illustrated in FIGS. 8a through 8d, the distributor cap 101 may be secured onto the housing 27 by clips 145 and 146 in a conventional manner.

Other rotor and cap configurations may be provided for other types of engines. FIGS. 6a through 6d illustrate cap and rotor constructions for four and six cylinder, four cycle engines. In this case, only an upper or a lower cap plug contacts is necessary, the remaining lower or upper cap serving merely to supply the secondary voltage from the ignition coil. FIG. 6a illustrates a lower or bottom cap 120 for use with a four cylinder engine. This cap includes four plug terminals 121 through 124 angularly spaced 90 degrees to which are connected suitable ignition wires, such as wires 125 and 126 as seen in FIG. 6. Considering the cap 120 to be a bottom cap, the top cap 127 as seen in FIG. 6f includes a coil terminal 128 to which is connected the wire 129 from the secondary of the ignition coil. The coil terminal 128 is affixed to a coil terminal ring 130 which is best seen in FIGS. 6e and 6f. The rotor 131 is shown in FIG. 6c and is the same as the earlier described rotor 20 but does not include either of the spiders 108 and 109. Only a single rotor terminal or conductor 132 is required. It will be apparent that as the rotor terminal 132 becomes aligned with one of the plug terminals 121 through 124, voltage is supplied to the associated spark plug.

In the case of a six cylinder engine, the lower cap 120a is in the form illustrated in FIG. 6b. This cap is identical with the cap 120 in FIG. 6a, but includes six plug terminals 134 through 139 angularly spaced apart 60 degrees. The rotor for the six cylinder engine is the same as the rotor 131 shown in

FIG. 6c for the four cylinder engine. Thus, the rotor terminal 132 serves to transfer the voltage from the terminal ring 130 successively to each of the plug terminals 134 through 139 as is the case with the plug terminals 121 through 124.

FIGS. 7a through 7b respectively illustrate a cap and rotor for a two cylinder two stroke engine. The cap 144, which likewise may form the lower or bottom cap used in conjunction with the upper cap 127 of FIG. 6f, includes two plug terminals 145 and 146. The rotor 147 is like the rotor 131 shown in FIG. 6c, but includes two rotor terminals 148 and 149. The rotor 147 is driven at one-half the normal speed, and provides proper firing for a two cylinder two stroke engine. As is the case with the caps shown in FIGS. 5a and 5c, the caps 120, 120a, 127 and 144 may be molded and include vent openings. Likewise, the rotors 131 and 147 may be molded and include a plurality of vanes.

Turning now to the electrical circuit which triggers the ignition coil, a suitable circuit is illustrated in FIG. 9. Although not specifically discussed earlier, it will be apparent that suitable wires are provided from the source 42 and cell 44 to the circuit of FIG. 9. Preferably a coaxial cable having three conductors, such as a cable 152 as seen in FIG. 8b, is used. The circuit illustrated in FIG. 9, which may be termed a power pack, serves to periodically charge and discharge a capacitor and apply or dump, the charge to the primary of the ignition coil as determined by the speed of rotation of the shutter 17. Considering the circuit in more detail, the same includes a pair of input terminals 160 and 161 coupled to the conventional twelve-volt storage battery used with the engine. The terminal 161 is connected to a line 162 which serves as a common line for the circuit. The terminal 160 is connected through a diode 163 to a DC-to-DC converter which converts the input 12 volts DC to an output 375 volts DC at output lines 165 and 166. The converter 164 raises the voltage to a higher value for charging a capacitor 167, the charge on which is periodically dumped into the primary 168 of an ignition coil 169. The coil may be a conventional one hundred-to-one ignition coil. A resistor 170 is connected in parallel with the capacitor 167 and serves as a bleeder resistor to bleed off the charge on the capacitor 167 when the unit is turned off.

The diode 163 is connected to the collector of a transistor 172 which serves as a series regulator and supplies on a line 173 a suitable operating voltage for a source-cell-amplifier circuit 174. A diode 175 is coupled between the base of the transistor 172 and the common line 162 and serves as a voltage regulating diode which determines the operating voltage output of the transistor 172. A resistor 176 is coupled between the collector and base of the transistor 172 and serves as a current limiting resistor for the diode 175. A filter capacitor 177 is connected across the diode 175. The source 42 is connected in series with a resistor 179 across the lines 173 and 162. The value of the resistor 179 determines the current through the source 42. The cell 44 is similarly connected in series with a resistor 180 across the lines 173 and 162, the resistor 180 serving as the collector load for the transistor cell 44. The collector of the transistor 44 is connected to the base of a transistor 181, the emitter of which is connected through a resistance 182 to the line 173, and the collector of which is connected through resistors 183 and 184 to the line 162. The junction 185 between the resistors 183 and 184 is connected to the base of a transistor 186, the emitter of which is connected to the line 162 and the collector of which is connected through a resistor 187 to the line 173. The resistor 182 is used for emitter degeneration, and the resistors 183 and 184 form a voltage divider so that the voltage at the base of the transistor 186 is not too high so as to cause damage to the base of the transistor 186. The resistor 187 serves as a collector load for the transistor 186.

The transistors 181 and 186, and associated circuit components, form an amplifier for sufficiently increasing the output of the cell 44 to drive a silicon controlled rectifier 190. The collector of the transistor 186 is connected through a capacitor 191 to the cathode of the SCR 190 which in turn is

connected through a diode 192 to the line 162. The anode of the SCR 190 is connected to the line 165, and the gate thereof is connected to the line 162. The secondary of the ignition coil 169 is connected to an output line 194 which in turn is connected through an ignition wire, such as the wire 23 in FIG. 1, to the distributor assembly. The entire circuit illustrated in FIG. 9 may be suitably mounted on a heat sink and covered or otherwise enclosed to provide protection from moisture and other contaminants.

During operation of the circuit of FIG. 9, the storage capacitor 167 is charged to approximately 375 volts by the DC-to-DC converter 164. As the shutter 17 rotates, the holes 36 therein allow light from the source 42 to impinge upon the cell 44, and the surfaces of the shutter between the holes interrupt the light. The number of holes 36 is determined by the number of cylinders of the engine. When light from the source 42 reaches the cell 44, the cell 44 turns on thereby causing current through the resistor 180 to increase. This causes the base of the transistor 181 to go more negative thereby turning on the transistor 181. When the transistor 181 is turned on, the voltage at the base of the transistor 186 goes positive which in turn causes the transistor 186 to turn on. This causes the voltage at the collector of the transistor 186 to go negative thereby applying a pulse through the capacitor 191 to the cathode of the SCR 190. The cathode of the SCR goes negative thereby turning on the SCR. The diode 192 normally holds the cathode of the SCR 190 at plus 0.6 volt above the gate thereof which is tied directly to the line 162. Thus, when the negative pulse is applied to the cathode, the cathode becomes more negative than the gate thereby turning on the SCR. When the SCR 190 turns on, the 375 volts stored on the capacitor 167 is applied across the primary 168 of the ignition coil 169. The converter 164 is a current limited converter, and when the SCR 190 becomes nonconductive the load is removed from the converter and the converter turns on. When the SCR is turned on, the converter turns off until the current through the SCR is low enough such that the SCR can return to a nonconductive state.

It will be apparent to those skilled in the art that the continued rotation of the shutter 17 causes the charge on the capacitor 167 to be periodically applied to the primary 168 of the coil 169, which in turn steps up this voltage and supplies high voltage pulses on the output line 194. These high voltage pulses on the line 194 are distributed by either the new or the conventional distributor mechanisms discussed previously. The maximum engine r.p.m. obtainable is determined by how fast the capacitor 167 can be recharged. The converter 164 preferably recharges the storage capacitor in less than 0.5 millisecond which gives a maximum speed range well above the requirements of conventional multicylinder engines. The cell 44 generates an extremely fast pulse which is amplified to a sufficient level to fire the SCR 190. The maximum limits of the trigger source are governed by the rise time and fall time of the cell 44, and this amounts to only several microseconds. The series regulator 172 ensures a constant voltage for the source, cell and amplifier regardless of the input voltage at the input terminals 160 and 161, even down as low as approximately eight volts. With the circuit arrangement illustrated in FIG. 9, the same can operate for approximately eight to 16 volts which in turn facilitates cold weather starting of an engine.

The present embodiments of this invention are to be considered in all respects as illustrative and not restrictive.

What is claimed is:

1. Ignition apparatus for engines and the like for supplying triggering pulses to an electrical ignition circuit and for distributing voltage pulses comprising

rotatable shutter means,

radiant source and cell means disposed adjacent said shutter means, said shutter means serving to periodically pass radiation from said source means to said cell means, said source means comprising a near infrared source and said cell means comprising a semiconductor responsive to

near infrared radiation, and said near infrared source comprising a pair of incandescent lamps mounted in a predetermined apart relationship to provide a cone of light for impingement upon said cell means,

vacuum advance means coupled with said source and cell means for relatively shifting said source and cell means and said shutter means as a function of pressure, said vacuum advance means comprising a fixture supporting said source and cell means, said fixture having an opening therein for receiving a peripheral portion of said shutter means to enable radiation from said source means directed toward said cell to be periodically interrupted, driving means providing a source of rotary motion, centrifugal advance means coupled between said driving means and said shutter means for rotating said shutter means, the angular phase relationship of said shutter means with respect to said driving means being a function of the operation of said centrifugal advance means, said centrifugal advance means including pivoted weight means normally biased in one direction by compression spring means, and

distributor means comprising a cap means having a plurality of output voltage terminals and rotor means driven with said shutter means, said rotor means having conductor means for receiving an input voltage and transferring said input voltage to said output terminals.

2. Ignition apparatus for engines and the like for supplying triggering pulses to an electrical ignition circuit and for distributing voltage pulses comprising

rotatable shutter means,

radiant source and cell means disposed adjacent said shutter means, said shutter means serving to periodically pass radiation from said source means to said cell means,

vacuum advance means coupled with said source and cell means for relatively shifting said source and cell means and said shutter means as a function of pressure,

driving means providing a source of rotary motion,

centrifugal advance means coupled between said driving means and said shutter means for rotating said shutter means, the angular phase relationship of said shutter means with respect to said driving means being a function of the operation of said centrifugal advance means, said centrifugal advance means including pivoted weight means normally biased in one direction by compression spring means, and said centrifugal advance means comprising a cup member coupled with said driving means and said weight means comprises a pair of weights pivotally coupled with said cup member, compression spring means disposed between said cup member and said weights for normally biasing said weights in said first direction, and adapter means coupled with said shutter means, said adapter means and weights having mating coupling means for enabling said adapter means to be rotated by said weights, and

distributor means comprising a cap means having a plurality of output voltage terminals and rotor means driven with said shutter means, said rotor means having conductor means for receiving an input voltage and transferring said input voltage to said output terminals.

3. Ignition apparatus as in claim 2 wherein

said vacuum advance means comprises a fixture supporting said source and cell means, said fixture having an opening therein for receiving a peripheral portion of said shutter means to enable radiation from said source means directed toward said cell to be periodically interrupted, housing means within which said fixture and said source and cell means are mounted, said housing means including a chamber having a piston therein responsive to pressure, said piston being coupled with said fixture for moving said fixture as a function of pressure.

4. Ignition apparatus for engines and the like for supplying triggering pulses to an electrical ignition circuit and for distributing voltage pulses comprising

rotatable shutter means,

radiant source and cell means disposed adjacent said shutter means, said shutter means serving to periodically pass radiation from said source means to said cell means, vacuum advance means coupled with said source and cell means for relatively shifting said source and cell means and said shutter means as a function of pressure, driving means providing a source of rotary motion, centrifugal advance means coupled between said driving means and said shutter means for rotating said shutter means, the angular phase relationship of said shutter means with respect to said driving means being a function of the operation of said centrifugal advance means, said centrifugal advance means including pivoted weight means normally biased in one direction by compression spring means, and

distributor means comprising a cap means having a plurality of output voltage terminals and rotor means driven with said shutter means, said rotor means having conductor means for receiving an input voltage and transferring said input voltage to said output terminals, and said cap means of said distributor means comprising first and second caps with said rotor means disposed within said caps, one of said caps having an input voltage terminal and the other of said caps having a plurality of output voltage terminals, said conductor means of said rotor means being disposed to periodically align with respective output terminals for transferring voltage from said input terminal to said output terminals.

5. Ignition apparatus as in claim 4 wherein said second cap has four output terminals for use with a four cylinder internal combustion engine.

6. Ignition apparatus as in claim 4 wherein said second cap has six output terminals for use with a six cylinder internal combustion engine.

7. Ignition apparatus as in claim 4 wherein said second cap includes two output terminals, and said conductor means of said rotor means comprises a pair of conductors for periodically transferring voltage from said input terminal to said output terminals.

8. Ignition apparatus as in claim 4 wherein said first cap includes said inlet terminal and further includes four outlet terminals, said second cap includes four outlet terminals, and said conductor means comprises a pair of conductors, one of which transfers voltage from said input terminal to the output terminals of said first cap and the second of which transfers voltage from said input terminal to said output terminals of said second cap.

9. Ignition apparatus as in claim 8 wherein said output terminals of each of said caps are substantially equally angularly spaced, and the first of said pair of conductors has a plurality of voltage pickup members disposed to periodically align with said input terminal and an outlet terminal disposed to periodically align with said output terminals of said first cap, and

the second of said pair of conductors has a plurality of voltage pickup members disposed to periodically align with said input terminal and an output terminal disposed to periodically align with said output terminals of said second cap.

10. Distributor apparatus for engines and the like for receiving an input voltage and providing a plurality of output voltage pulses comprising

cap means including first and second caps, one of said caps having an input voltage terminal and the other of said caps having a plurality of output voltage terminals, and rotor means disposed within said cap means, said rotor means having conductor means spaced from but alignable with said input and output terminals for receiving an input voltage and being disposed to periodically align with respective output terminals for transferring voltage from said input terminal to said output terminals.

11. Distributor apparatus as in claim 10 wherein, said second cap has four output terminals for use with a four cylinder internal combustion engine.

12. Distributor apparatus as in claim 10 wherein, said second cap has six output terminals for use with a six cylinder internal combustion engine.

13. Distributor apparatus as in claim 10 wherein said first cap includes said inlet terminal and four outlet terminals, said second cap includes four outlet terminals, and said conductor means comprises a pair of conductors, one of said conductors serving to transfer voltage from said input terminal to the output terminals of said first cap and the second of said conductors serving to transfer voltage from said input terminal to said output terminals of said second cap.

14. Distributor apparatus as in claim 10 wherein said first cap includes said inlet terminal and four outlet terminals, said second cap includes four outlet terminals, the outlet terminals of each cap respectively being substantially equally angularly spaced, and said inlet terminal projecting into the interior of said first cap, and said rotor means is mounted for rotation within said cap and includes a central member of insulating material having first and second surfaces and a peripheral surface, said conductor means comprises a pair of conductors in said central member with each of said pair of conductors having a plurality of voltage pickup members extending through said peripheral surface and disposed to periodically align with said input terminal, each of said pair of conductors having a respective output conductor extending through the respective first and second surfaces of said central member and disposed to periodically align with the output terminals of said respective caps, said pair of conductors being insulated from one another by said central member.

15. Apparatus as in claim 14 wherein one of said caps has at least an opening therein through which contaminants within said caps may be exhausted.

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