Nov. 9, 1965 G. A. DOTTO 3,217,216

ROTARY CAPACITOR APPARATUS

Filed July 12, 1962

FIG-2

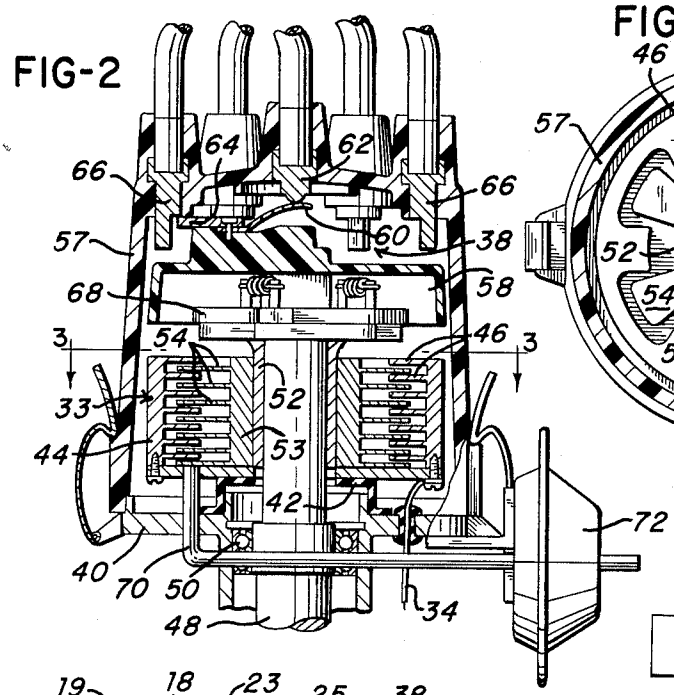
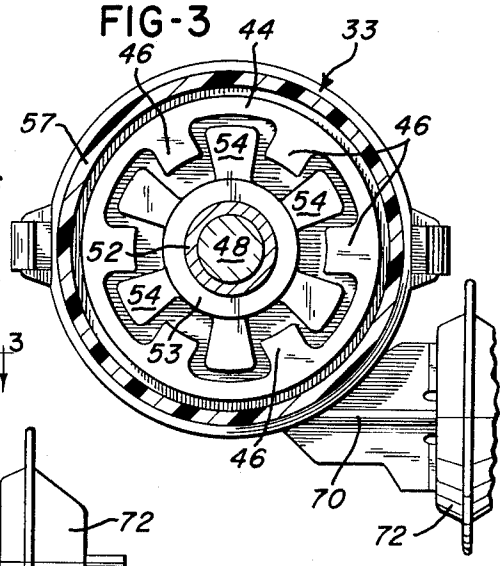


FIG-3



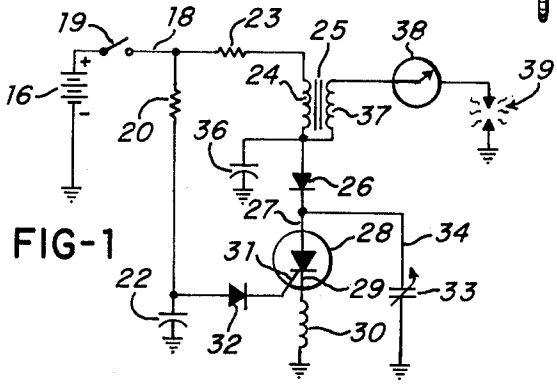


FIG-1

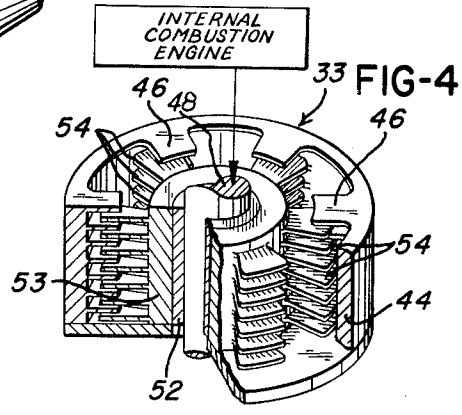


FIG-4

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ROTARY CAPACITOR APPARATUS

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This invention relates to automotive apparatus. The invention relates more particularly to ignition control apparatus for an internal combustion engine. The ignition control apparatus utilizes a novel rotary capacitor apparatus which is the subject of the present invention.

It is an object of this invention to provide ignition control apparatus utilizing the novel rotary capacitor apparatus of the present invention by which higher efficiency operation of an internal combustion engine can be obtained than is possible with any known ignition control system.

Another object of this invention is to provide ignition control apparatus utilizing the novel rotary capacitor apparatus of the present invention which provides consistent operation in the production of a high voltage, high current spark in a combustion chamber of an internal combustion engine during any speed or load in the engine operation.

Another object of this invention is to provide ignition control apparatus utilizing the novel rotary capacitor apparatus of the present invention which thus makes possible a very small amount of waste gases from the exhaust of the engine.

Another object of this invention is to provide ignition apparatus utilizing the novel rotary capacitor apparatus of the present invention which has a minimum number of moving parts and which has a minimum number of parts which are subject to wear or the like.

Another object of this invention is to provide such ignition apparatus utilizing the rotary capacitor apparatus of the present invention which can be produced at relatively low cost.

Other objects and advantages reside in the construction of parts, the combination thereof, the method of manufacture, and the mode of operation, as will become more apparent from the following description.

In the drawings:

FIGURE 1 is a schematic diagram of ignition control apparatus utilizing the rotary capacitor apparatus of this invention.

FIGURE 2 is a sectional view of rotary capacitor apparatus of this invention.

FIGURE 3 is a sectional view taken substantially on line 3—3 of FIGURE 2.

FIGURE 4 is a fragmentary perspective view of a portion of rotary capacitor apparatus of this invention.

Referring to the drawings in detail, the apparatus of FIGURE 1 is illustrated as including a battery **16**, which is ordinarily the conventional power supply battery of an automobile. The negative side of the battery **16** is shown as being grounded. The positive side of the battery **16** is connected by means of a conductor **18** to a resistor **20**. An ignition switch **19** is shown in the conductor **18**. The resistor **20** is connected in series with a capacitor **22** which is connected to ground. Thus, the series of the capacitor **22** and the resistor **20** is connected across the battery **16**.

Also, connected to the conductor **18** is a ballast resistor or impedance member **23** to which is series connected a primary winding **24** of an ignition coil or transformer **25**. The ignition coil **25** may be a conventional ignition coil used in a present day ignition system. A diode **26** is shown as being connected to the primary winding **24**. The diode **26** is also connected to an anode **27** of a controlled rectifier **28**.

The controlled rectifier **28** is preferably of a known type of semiconductor device referred to as a silicon controlled rectifier, ordinarily consisting of a plurality of successive

zones, usually four zones, of alternate P and N material, there being a junction separating adjoining zones.

The controlled rectifier **28** has a cathode **29** at the end thereof opposite the anode **27**. The cathode **29** is connected to ground through an inductance element or impedance member or coil **30**. The controlled rectifier **28** also has an intermediate junction or control electrode or gate **31**. The controlled rectifier **28** is of the type which is ordinarily initiated into a conductive state by passing a given value of current through the gate **31**. However, after conduction of current through the device is begun, the current continues to flow therethrough until the current decreases below a certain holding current value or until the voltage across the controlled rectifier is reversed.

Connected to the juncture between the resistor **20** and the capacitor **22** is a diode **32** which also is connected to the gate **31**.

A rotary capacitor **33**, discussed below, is connected by means of a conductor **34** to the anode **27** of the controlled rectifier **28**. The rotary capacitor **33** is also connected to ground.

A capacitor **36** is shown connecting the primary winding **24** of the ignition coil or transformer **25** to ground. The capacitor **36** may be a capacitor used in a conventional ignition system.

The ignition coil **25** may be of a conventional type and has a secondary winding **37** which is shown as being joined to the primary winding **24** and to the capacitor **36**. The primary winding **24** and the secondary winding **37** of the ignition coil or transformer **25** are wound on a common core. The secondary winding **37** connects through any suitable distributor mechanism **38** to a spark plug **39** or to any other suitable element having a desired spark gap within a combustion chamber of an internal combustion engine. The distributor mechanism **38** is further discussed below. The spark plug **39** is also connected to ground in a conventional manner.

The rotary capacitor

The rotary capacitor, referred to by numeral **33**, is shown structurally in FIGURES 2, 3, and 4. The rotary capacitor **33** is adapted to replace a conventional breaker point switch mechanism in a conventional ignition system. The rotary capacitor **33** has a frame **40** which, by means of an insulating support member **42**, supports an elongate annular member **44** which has a plurality of inwardly extending plates **46**. The plates **46** are preferably arranged in equally spaced-apart stacks around the inner wall of the member **44**, as shown in FIGURE 3. Each stack of plates **46** extends axially within the annular member **44**. The plates **46** in each stack thereof are aligned and spaced-apart, as shown in FIGURE 4.

A rotary shaft **48**, journalled within a bearing **50**, rotatably supports a sleeve **52**. Secured to the sleeve **52** and rotatable therewith is a hub **53** which carries a plurality of stacks of plates **54**, so that there is one plate **54** movable between two plates **46** in each of the stacks thereof. The number of stacks of plates **46** and of plates **54** is shown as being equal. However, the number of stacks of plates **46** may be greater or smaller than the number of stacks of plates **54**. Preferably, the number of stacks of plates **46** and the number of stacks of plates **54** is in a given ratio to the number of combustion chambers of the internal combustion engine with which the apparatus is associated. Ideally, the number of plates **46** is in a given even number ratio to the number of plates **54**.

The shaft **48** is adapted to be attached to suitable mechanism of the engine for rotative movement therewith. Herein, the shaft **48** provides the ground connection of the rotary capacitor **33**. However, connection may be made in any other suitable manner. The con-

ductor 34 is connected to the annular member 44 and, as discussed above, is connected to the anode 27 of the silicon controlled rectifier 28.

A cover member 57 has at the upper portion thereof the distributor mechanism 38, mentioned above. An insulated carrier member 58 is attached to the shaft 48 for rotation therewith adjacent the upper portion of the cover member 57. The carrier member 58 supports a contact member 60 which resiliently engages a center stud 62. The contact member 60 also has a tip 64 which moves to closely spaced relationship with any one of a plurality of studs 66 to provide a circuit therewith. Each of the studs 66 connects to one of the cylinders of the engine for distribution of high voltage thereto from the secondary winding 37 of the ignition coil 25.

Also, attached to the shaft 48 is a conventional type of centrifugally operated mechanical advance mechanism 68 which rotates the hub 53 slightly with respect to the shaft 48 when a given speed of rotation of the shaft 48 is obtained. Connected to the annular member 44 is a rod 70 of a conventional type of vacuum advance mechanism 72. The conventional mechanical advance mechanism 68 and the conventional vacuum advance system 72 are of the type described and shown in U.S. Patent No. 2,131,019, issued to Arthur et al. on September 27, 1938.

When the ignition switch 19 is closed, current passes through the resistor or impedance member 20 and charges the capacitor 22. The time required for charging the capacitor 22 is, of course, determined by the values of the resistor 20 and the capacitor 22. After the capacitor 22 is charged to a predetermined degree, there is a flow of current of a predetermined amount through the diode 32 and through the gate 31 of the controlled rectifier 28. This current flow causes the controlled rectifier to assume a conductive state and to conduct current therethrough. Thus, current flows through the primary winding 24 of the ignition coil 25, through the diode 26, through the controlled rectifier 28, and through the inductance element or coil 30.

This flow of current begins when the rotary capacitor 33 has the rotary plates 54 thereof in the positions shown in FIGURE 3. However, with operation of the engine to which the shaft 48 of the rotary capacitor 33 is connected, the shaft 48 rotates and moves the stacks of plates 54 to positions within the stacks of plates 46, as shown in FIGURE 4. When such position of the plates 54 is obtained, the maximum capacitance of the rotary capacitor is obtained.

Preferably, the coil 30 and the rotary capacitor 33 are constructed so that the inductive reactance of the coil 30 is equal to the capacitive reactance of the rotary capacitor 33. Therefore, as the plates 54 approach the positions thereof as shown in FIGURE 4, an oscillatory current of considerable value is established between the rotary capacitor 33 and the coil 30. As such oscillatory current is established between the coil 30 and the rotary capacitor 33, such oscillatory current flows through the controlled rectifier device 28.

As stated above, one method of stopping conduction of current through a controlled rectifier device, such as the device 28, is that of applying a reverse voltage across the device. Thus, within a cycle after the oscillatory current is established, a half cycle of voltage occurs across the controlled rectifier 28 which is opposite to the normal voltage thereacross. Such voltage in the reverse direction instantaneously causes the controlled rectifier device 28 to become nonconductive.

With the use of the diode 26 which is in series with the controlled rectifier 28 and which is connected to the capacitor 33, a greater voltage charge is created upon the capacitor 33 than would otherwise be possible. This is a result of the choke action of the winding 24 "held" by the diode 26. This causes a very rapid response of the tank circuit action of the capacitor 33 and the coil 30 to make the controlled rectifier 28 nonconductive when the capacitor 33 approaches its maximum capacity position as shown in FIGURE 4.

As the circuit through the controlled rectifier 28 is instantaneously opened, there is a sudden collapse of the magnetic field in the core of the ignition coil 25 and a high voltage is induced in the secondary winding 37. This high voltage in the secondary winding 37 causes a spark across the spark gap of the spark plug 39 which is connected to the secondary winding 37 through the distributor mechanism 38.

It is to be understood that the shaft 48 of the rotary capacitor 33 continuously rotates with operation of the engine to which the apparatus of this invention is associated. The shaft 48 of the rotary capacitor 33 continues to rotate and the plates 46 and 54 again appear as shown in FIGURE 3. The shaft 48 continues to rotate so that the plates 46 and 54 again appear in the manner shown in FIGURE 4 as the distributor mechanism 38 moves to initiate firing in another cylinder of the engine.

Although the preferred embodiment of the device has been described, it will be understood that within the purview of this invention various changes may be made in the form, details, proportion and arrangement of parts, the combination thereof and mode of operation, which generally stated consist in a device capable of carrying out the objects set forth, as disclosed and defined in the appended claims.

Having thus described my invention, I claim:

1. A capacitor comprising: a rotary shaft; a rotary hub means carried by said shaft; a plurality of plates carried by said hub means and extending radially therefrom at equally spaced-apart positions about said hub means; a centrifugally operated mechanical advance means coupled to said shaft, said advance means for rotating said hub means slightly with respect to said shaft when a predetermined speed of rotation of said shaft is obtained; an annular support member encompassing said shaft and said plates; a plurality of plates carried by said annular support member therewithin at equally spaced-apart positions, said plurality of plates carried by said hub means having a given even number ratio to said plurality of plates carried by said annular support member, each of said plates carried by said hub means movable to a position adjacent in alignment with any one of said plurality of blades carried by said annular support member for establishing a capacitive relation therewith.

2. A capacitor comprising: a rotary shaft; a rotary hub means carried by said shaft; a plurality of spaced-apart plates attached to said hub means, said stacks of plates being equally spaced about said hub means and extending axially along said hub means; a centrifugally operated mechanical advance means coupled to said shaft, said advance means for rotating said hub means slightly with respect to said shaft when a predetermined speed of rotation of said shaft is obtained; a housing encompassing said shaft and said hub means; a plurality of stacks of spaced-apart plates carried by said housing therewithin, said stacks of plates equally spaced about said hub means, each stack of plates extending axially along said hub means within said housing, each of said plates carried by said hub means movable to a position intermediate a pair of plates of said housing, each of said stacks of plates carried by said hub means movable to positions within any one of said stacks of plates carried by said housing.

3. A capacitor comprising: a rotary shaft; a rotary hub means carried by said shaft; a plurality of plates attached to said hub means and extending radially therefrom at equally spaced positions about said hub means; a centrifugally operated mechanical advance means coupled to said shaft, said advance means for rotating said hub means slightly with respect to said shaft when a predetermined speed of said shaft is obtained; a plurality of plates fixedly positioned in equally spaced positions about said hub means, said number of fixedly positioned

plates equal in number to said number of plates attached to said hub means, each of said plates attached to said hub means disposed in axial alignment with and adjacent one of said fixedly positioned plates.

4. In an ignition control apparatus for an internal combustion engine provided with a given number of combustion chambers; a rotary shaft, said rotary shaft coupled to and driven by an internal combustion engine, said internal combustion engine having a given number of combustion chambers; a rotary hub means carried by said shaft, said hub means including a plurality of plates extending therefrom at equally spaced-apart positions; a centrifugally operated mechanical advance means coupled to said shaft, said advance means for rotating said hub means slightly with respect to said shaft when a predetermined speed of rotation of said shaft is obtained; an annular support member encompassing said shaft and said hub means; a plurality of plates carried by said annular support member therewithin at equally spaced-apart positions; said number of plate positions of said plates carried by said annular support member being a given even number ratio to said number of combustion chambers of said engine, said number of plate positions of said plates carried by said hub means in a given even number ratio to said number of combustion chambers of said engine.

5. A capacitor comprising: a rotatable shaft; a rotatable hub means provided with a plurality of blades carried thereby and extending radially therefrom and equally spaced thereabout; a centrifugally operated mechanical advance means coupled to said shaft, said advance means for rotating said hub means slightly with respect to said shaft when a predetermined speed of rotation of said shaft is obtained; an annular member encompassing said hub means and said blades thereof, said annular member having an inner wall surface; a plurality of blades fixedly attached to said inner wall surface of said annular member, said number of blades attached to said annular member being in a given ratio to said number of blades carried by said hub means, each of said blades carried by said hub means movable thereby to a position adjacent any one of a plurality of said blades carried by said annular member.

6. A capacitor comprising: a rotary shaft; a rotary hub means carried by said shaft; a plurality of plates carried by said hub means and extending radially therefrom at equally spaced-apart positions about said hub means; a centrifugally operated mechanical advance means coupled to said shaft, said advance means for rotating said hub means slightly with respect to said shaft when a predetermined speed of rotation of said shaft is obtained; an annular support member encompassing said shaft and said plates; a vacuum advance mechanism coupled to said annular support member for slightly rotating said annular support member with respect to said shaft when a predetermined vacuum is attained within said vacuum advance mechanism; a plurality of plates carried by said annular support member therewithin at equally spaced-apart positions, said plurality of plates carried by said hub means having a given even number ratio to said plurality of plates carried by said annular support member, each of said plates carried by said hub means movable to a position adjacent in alignment with any one of said plurality of blades carried by said annular support member for establishing a capacitive relation therewith.

7. A capacitor comprising: a rotary shaft; a rotary hub means carried by said shaft; a plurality of spaced-apart plates attached to said hub means, said stacks of plates being equally spaced about said hub means and extending axially along said hub means; a centrifugally operated mechanical advance means coupled to said shaft, said advance means for rotating said hub means slightly with respect to said shaft when a predetermined speed of rotation of said shaft is obtained; a housing encompassing said shaft and said hub means; a vacuum advance mechanism coupled to said housing for slightly rotating said housing with respect to said shaft when a predetermined vacuum is attained within said vacuum advance mechanism; a plurality of stacks of spaced-apart plates carried by said housing therewithin, said stacks of plates equally spaced about said hub means, each stack of plates extending axially along said hub means within said housing, each of said plates carried by said hub means movable to a position intermediate a pair of plates of said housing, each of said stacks of plates carried by said hub means movable to positions within any one of said stacks of plates carried by said housing.

8. A capacitor comprising: a rotary shaft; a rotary hub means carried by said shaft; a plurality of plates attached to said hub means and extending radially therefrom at equally spaced positions about said hub means; a centrifugally operated mechanical advance means coupled to said shaft, said advance means for rotating said hub means slightly with respect to said shaft when a predetermined speed of said shaft is obtained; a plurality of plates fixedly positioned in equally spaced positions about said hub means; a vacuum advance mechanism coupled to said plates about said hub means for slightly rotating said plates with respect to said shaft when a predetermined vacuum is attained within said vacuum advance mechanism; said number of fixedly positioned plates equal in number to said number of plates attached to said hub means, each of said plates attached to said hub means disposed in axial alignment with and adjacent one of said fixedly positioned plates.

9. In an ignition control apparatus for an internal combustion engine provided with a given number of combustion chambers: a rotary shaft, said rotary shaft coupled to and driven by an internal combustion engine, said internal combustion engine having a given number of combustion chambers; a rotary hub means carried by said shaft, said hub means including a plurality of plates extending therefrom at equally spaced-apart positions; a centrifugally operated mechanical advance means coupled to said shaft, said advance means for rotating said hub means slightly with respect to said shaft when a predetermined speed of rotation of said shaft is obtained; an annular support member encompassing said shaft and said hub means; a vacuum advance mechanism coupled to said housing for slightly rotating said annular support member with respect to said shaft when a predetermined vacuum is attained within said vacuum advance mechanism; a plurality of plates carried by said annular support member therewithin at equally spaced-apart positions, said number of plate positions of said plates carried by said annular support member being a given even number ratio to said number of combustion chambers of said engine, said number of plate positions of said plates carried by said hub means in a given even number ratio to said number of combustion chambers of said engine.

10. A capacitor comprising: a rotatable shaft; a rotatable hub means provided with a plurality of blades carried thereby and extending radially therefrom and equally spaced thereabout; a centrifugally operated mechanical advance means coupled to said shaft, said advance means for rotating said hub means slightly with respect to said shaft when a predetermined speed of rotation of said shaft is obtained; an annular member encompassing said hub means and said blades thereof, said annular member having an inner wall surface; a vacuum advance mechanism coupled to said annular member for slightly rotating said annular member with respect to said shaft when a predetermined vacuum is attained within said vacuum advance mechanism; a plurality of blades fixedly attached to said inner wall surface of said annular member, said number of blades attached to said annular member being in a given ratio to said number of blades carried by said hub means, each of said blades carried by said hub means movable thereby to a position adjacent any one of a plurality of said blades carried by said annular member.

11. A capacitor comprising: a rotary shaft, said shaft coupled to and driven by an internal combustion engine; a rotary hub means carried by said shaft; a plurality of plates carried by said hub means and extending radially therefrom at equally spaced-apart positions about said hub means; a means coupled to said shaft, said means for rotationally advancing said hub means slightly with respect to said shaft when a predetermined speed of rotation of said shaft is obtained; an annular support member encompassing said shaft and said plates; a plurality of plates carried by said annular support member therewithin at equally spaced-apart positions, said plurality of plates carried by said hub means having a given even number ratio to said plurality of plates carried by said annular support member, each of said plates carried by said hub means movable to a position adjacent in alignment with any one of said plurality of blades carried by said annular support member for establishing a capacitive relation therewith.

12. A capacitor comprising: a rotary shaft, said shaft coupled to and driven by an internal combustion engine; a rotary hub means carried by said shaft; a plurality of spaced-apart plates attached to said hub means, said stacks of plates being equally spaced about said hub means and extending axially along said hub means; a means coupled to said shaft, said means for rotationally advancing said hub means slightly with respect to said shaft when a predetermined speed of rotation of said shaft is obtained; a housing encompassing said shaft and said hub means; a plurality of stacks of spaced-apart plates carried by said housing therewithin, said stacks of plates equally spaced about said hub means, each stack of plates extending axially along said hub means within said housing, each of said plates carried by said hub means movable to a position intermediate a pair of plates of said housing, each of said stacks of plates carried by said hub means movable to positions within any one of said stacks of plates carried by said housing.

13. A capacitor comprising: a rotary shaft, said shaft coupled to and driven by an internal combustion engine, said internal combustion engine having a given number of combustion chambers; a rotary hub means carried by said shaft, said hub means including a plurality of plates extending therefrom at equally spaced apart positions; a means coupled to said shaft, said means for rotationally advancing said hub means slightly with respect to said shaft when a predetermined speed of rotation of said shaft is obtained; an annular support member encompassing said shaft and said hub means; and a plurality of plates carried by said annular support member therewithin at equally spaced-apart positions, the number of plate positions of said plates carried by said annular support member being a given even number ratio to said number of combustion chambers of said engine, the number of plate positions of said plates carried by said hub means in a given even number ratio to said number of combustion chambers of said engine.

14. A capacitor comprising: a rotary shaft, said shaft coupled and driven by an internal combustion engine; a rotary hub means carried by said shaft; a plurality of plates carried by said hub means and extending radially therefrom at equally spaced-apart positions about said hub means; a mechanical means coupled to said shaft, said means for rotationally advancing said hub means slightly with respect to said shaft when a predetermined speed of rotation of said shaft is obtained; an annular support member encompassing said shaft and said plates; a vacuum means coupled to said annular support member for slightly rotationally advancing said annular support member with respect to said shaft when a predetermined vacuum is attained within said vacuum means; a plurality of plates carried by said annular support member therewithin at equally spaced-apart positions, said plurality of plates carried by said hub means having a given even number ratio to said plurality of plates carried by said annular support member, each of said plates carried by said hub means movable to a position adjacent in alignment with any one of said plurality of blades carried by said annular support member for establishing a capacitive relation therewith.

15. A capacitor comprising: a rotary shaft, said shaft coupled to and driven by an internal combustion engine; a rotary hub means carried by said shaft; a plurality of spaced-apart plates attached to said hub means, said stacks of plates being equally spaced about said hub means and extending axially along said hub means; a mechanical means coupled to said shaft, said means for rotationally advancing said hub means slightly with respect to said shaft when a predetermined speed of rotation of said shaft is obtained; a housing encompassing said shaft and said hub means; a vacuum means coupled to said housing for slightly rotationally advancing said housing with respect to said shaft when a predetermined vacuum is attained within said vacuum means; a plurality of stacks of spaced-apart plates carried by said housing therewithin, said stacks of plates equally spaced about said hub means, each stack of plates extending axially along said hub means within said housing, each of said plates carried by said hub means movable to a position intermediate a pair of plates of said housing, each of said stacks of plates carried by said hub means movable to positions within any one of said stacks of plates carried by said housing.

16. A capacitor comprising: a rotary shaft, said shaft coupled to and driven by an internal combustion engine, said internal combustion engine having a given number of combustion chambers; a rotary hub means carried by said shaft, said hub means including a plurality of plates extending therefrom at equally spaced apart positions; a mechanical means coupled to said shaft, said means for rotationally advancing said hub means slightly with respect to said shaft when a predetermined speed of rotation of said shaft is obtained, an annular support member encompassing said shaft and said hub means; a vacuum means coupled to said housing for slightly rotationally advancing said annular support member with respect to said shaft when a predetermined vacuum is attained within said vacuum means; a plurality of plates carried by said annular support member therewithin at equally spaced-apart positions, the number of plate positions of said plates carried by said annular support member being a given even number ratio to said number of combustion chambers of said engine, the number of plate positions of said plates carried by said hub means in a given even number ratio to said number of combustion chambers of said engine.

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