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DISTRIBUTOR MECHANISM HAVING MAGNETICALLY RESPONSIVE BALL

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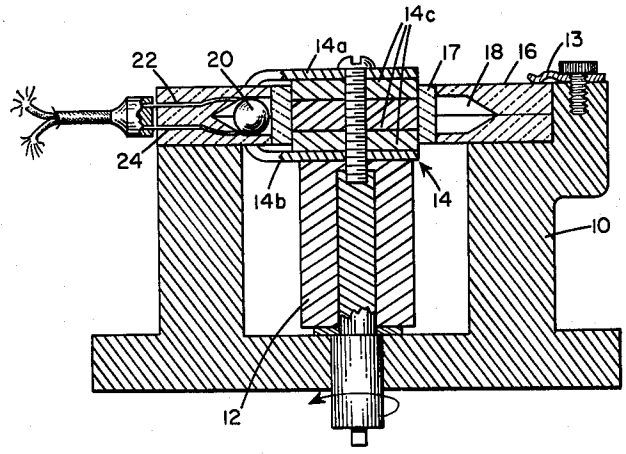


FIG. 1

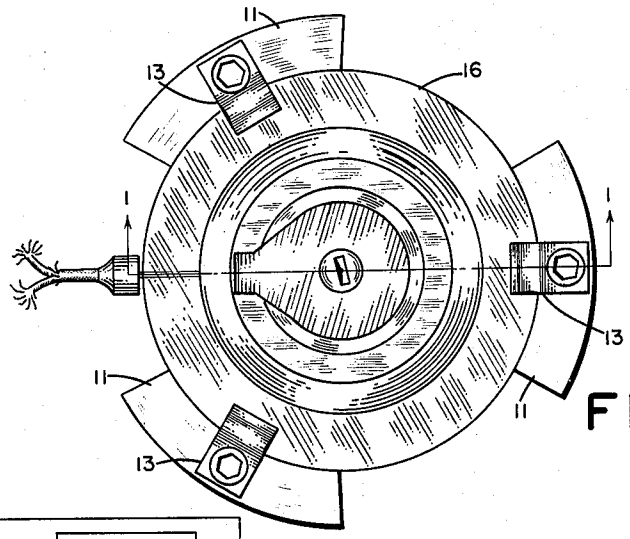


FIG. 2

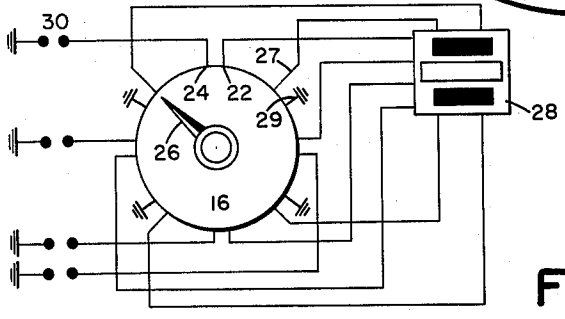


FIG. 3

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DISTRIBUTOR MECHANISM HAVING MAGNETICALLY RESPONSIVE BALL

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This invention relates generally to a high voltage vacuum switch and more particularly to a switch which is magnetically actuated.

The device of this invention is uniquely adapted to be employed in conjunction with a piezoelectric ignition system for internal combustion engines. However, the vacuum switch can be used with equal facility in other applications were exacting standards for switching high voltage are required.

In the prior art it has been customary to use a reed type switch in which the reeds are disposed in an evacuated housing. The reeds in this conventional arrangement are arranged in partly overlapping relationship. It is well known that the reed type vacuum switch has numerous disadvantages. For instance, the reeds must exhibit metallurgical characteristics for establishing a sufficient degree of resiliency to cause the reeds to be deflected in response to magnetic actuation to bring the reeds together. On the other hand, the reeds must be constructed of sufficiently stiff material to attain a reasonably fast reaction upon actuation. The balancing of these requirements is difficult. The time element is of critical importance inasmuch as the reeds must move rapidly apart upon removal of the magnetic actuating force to collapse the field of flux so that the electric charge is not dissipated and for the switching to occur at a rate useful for devices under consideration. Timing difficulties are frequently experienced when the reeds are too resilient, or become resilient during operation, and do not part sufficiently fast enough to avoid dissipation of electrical energy.

This problem of constructing the reeds so as to obtain a fast switching device is made more difficult by the erosion of the reed tips after substantial use. Thus, it is customary to coat the tips with a very high melting point material, such as tungsten. This material is relatively heavy and adds to the mass which must be moved by the magnet. In the prior art the space between the reeds and the area of overlap is a decisive load factor which must be taken into consideration in determining the flux of the magnetic circuit and the force required to close the reeds.

The present invention avoids many of the shortcomings hereinbefore discussed. Instead of two reeds, the instant invention utilizes a rotating ball which periodically closes the circuit between the input and output conductor. The advantages are obvious. The critical metallurgical requirements of the reeds are completely eliminated. The dissipation of electric energy as normally experienced in reed type devices is substantially absent. A greater accuracy in switching is obtained since the arc gap of the device in accordance with this invention is about one-half of the reed type switch, as the instant device uses two gaps instead of a single gap, and no area of overlap exists so that the likelihood of dissipating electric energy is substantially reduced.

It is therefore the primary object of this invention to eliminate and/or avoid the shortcomings of the devices of the prior art by providing a device generally as aforesaid.

It is another object of this invention to provide a ball type, magnetically actuated, high voltage vaccum switch in which the timing for switching the electric energy is substantially improved and in which electrical and mechanical juxtaposition of the switching device relative to the input and output conductors occurs simultaneously.

It is a further object of this invention to provide a ball type high voltage vacuum switch adapted to be employed as a switching device for a multi-cylinder internal combustion engine ignition system.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

In the drawings:

FIGURE 1 is a cross sectional view taken along line 1—1 of FIGURE 2 of this invention illustrating a high voltage vacuum switch;

FIGURE 2 is a plan view of the device of this invention; and

FIGURE 3 is a schematic representation of a high voltage vacuum switch in a multi-cylinder internal combustion engine piezoelectric ignition system.

One aspect of this invention resides in the provision of a high voltage vacuum switch, which includes a housing member of electrically insulating material in which the housing has an air evacuated circular cavity defining a passageway for containing a magnetically responsive member movable within the passageway. An input and an output conductor are suitably secured to the housing and insulated from each other and extraneous leakage, and project part-way into the air evacuated circular cavity for electric circuit closing position with the magnetic member. A rotatably disposed magnetic actuator is arranged in close proximity to the magnetic member for rotating the member within and along the passageway, periodically, between the input and output conductors.

Turning now to the drawing, see FIGURES 1 and 2, there is shown a support member **10** which may be suitably mounted to an internal combustion engine (not shown). Protruding centrally through the support member **10** is a rotatively disposed distributor shaft **12** connectible to the cam shaft or crankshaft of the engine for rotation in unison therewith. The distributor shaft **12**, composed of magnetically non-responsive material, carries a permanent magnet **14** hereinafter further described.

A partly hollow housing member **16** is formed of a material having suitable electrically insulating qualities and low permeability to gas. The housing member **16** has the configuration of a circular disc and includes a central aperture in which is disposed an annular sleeve **17** through which the permanent magnet **14** is extended. The housing **16** is provided with an air evacuated circular cavity **18** which defines a passageway. To facilitate the construction, the member **16** is fabricated in two parts, suitably hot sealed together and fused with sleeve **17**, and a small opening in one part is used to evacuate the cavity. The opening (not visible) is hot sealed by the application of heat to the area of the opening with the result that the vacuum within the cavity **18** collapses the opening. The support **10** includes a plurality of flanges **11** including a clamp **13** on each flange bearing on the housing to retain and carry the housing member **16** and to make it possible to turn the member **16** to change the relative location between the shaft **12** and housing **16**.

A ball **20** having magnetically responsive qualities is rotatably disposed within the passageway **18** and in rolling contact with the walls thereof. An input **22** and an output conductor **24** are disposed within the housing **16** and both conductors extend through the housing and slightly into the passageway **18**. The conductors are located in the housing in axially spaced relationship, i.e., one

underneath the other with the housing **16** serving as insulator, see FIG. 1, and are in substantially circumferential juxtaposition with respect to each other, see FIG. 2.

The permanent magnet **14** constitutes a magnetic actuator for moving the ball **20**. The magnet or actuator **14** includes magnetic core portions **14***c* and two pole pieces **14***a* and **14***b* which are spacedly located on opposite sides of the housing with the ball **20** being attracted by the magnet and therefore normally interposed between the pole pieces **14***a* and **14***b*. The actuator rotates in unison with shaft **12** and continuously moves the ball **20** along with it.

In operation the rotatable magnetic actuator is effective to establish, periodically, simultaneous mechanical and electrical juxtaposition between the ball **20** and the input and output conductors **22** and **24**, respectively, by moving the ball **20**, within the passageway **18** along the circular path thereof. Each time such juxtaposition takes effect the electric circuit between the input and output conductors **22**, **24**, respectively, is closed.

FIGURES 1 and 2 also illustrate the means for advancing or retarding the circuit closing position of the conductors relative to the rotatable shaft **12**. This may be accomplished by manually shifting the relative location of the housing member with respect to the shaft **12**. It is also possible with the use of conventional equipment to automatically change the relative location of the two components to advance or retard the timing for closing the electric circuit.

Referring now to FIGURE 3, the housing member **16** is provided with four sets of conductors, each set consisting of an input and an output conductor **22** and **24**, respectively, suitably spaced around the outer periphery of the housing **16** in the same manner as previously discussed, the input conductor **22** being electrically connected to a voltage source **28** and the output conductor to a load or spark gap **30**. Upon rotation of the shaft **12** and the magnetic actuator **14** electrical juxtaposition with each set of conductors is established in a continuously repeating sequence. Inasmuch as the electric circuit is closed upon electrical juxtaposition of the ball relative to said conductors, only a very small arc is established and, moreover, since the electrical circuit is completed within a vacuum, it is possible to space each set of conductors rather closely together.

While the instant invention can be used as a switching device per se as well as in a transistorized ignition system for internal combustion engines, the device is particularly suited for use in conjunction with piezoelectric ignition systems in which the main voltage is generated by a piezoelectric voltage source, not shown. When so used, it is at times desirable to include in the circuit a grounding arrangement to bleed off any residual charge that may still remain in the piezoelectric generator upon discharge of the energy through the conductor cables. When present, this residual charge is preferably eliminated since it will have the effect of cancelling out any subsequent electric potential generated by the piezoelectric device. Therefore, there is shown in FIGURE 3, schematically, a grounding means **26**, the magnetic actuator **14** may be utilized for this purpose, to rotate in unison with the shaft **12**. For each set of conductors there is provided one conductor **27** circumferentially spaced between the sets of conductors and connected to the piezoelectric source of potential **28** and underneath the conductor **27** there is disposed a ground conductor **29** connected to ground. Upon rotation of the grounding means **26** the circuit between conductors **27** and **29** is closed and any residual charge is bled off. Alternatively, the ground conductor **29** may be arranged in very close proximity to conductors **22** and **24**. One of the pole pieces **14***a* and **14***b* is constructed with a circumferential width to bridge the circuit between conductors **29** and **22** after the circuit between conductors **22** and **24** has been broken. The conductor **27** is then not required. Conversely, the grounding means **26** itself can be suitably connected to ground and periodically close the circuit between itself and conductor **27**.

While there have been described what are at present considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is aimed, therefore, in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What we claim is:

1. A high voltage vacuum switch comprising, in combination: a substantially circular housing member of electrically insulating material having an air evacuated circular cavity defining a passageway; an input conductor and an output conductor each projecting into said housing member and each terminating proximate to said passageway substantially flush with the surface thereof: magnetically responsive means movably disposed within said passageway; and a rotatably disposed magnetic actuator arranged proximate to said magnetically responsive means for rotating said means along said passageway to establish, periodically, a closed electric circuit between said conductors.

2. A high voltage vacuum switch according to claim 1, wherein said conductors are located in said housing axially spaced and radially in parallel and in operable proximity to said passageway to establish, periodically, a simultaneous mechanical and electrical juxtaposition with said magnetically responsive means when said means is rotated.

3. A high voltage vacuum switch according to claim 1, wherein said means is a magnetically responsive ball.

4. A high voltage vacuum switch comprising, in combination: a substantially circular housing member of electrically insulating material having an air evacuated circular cavity defining a passageway; an input conductor and an output conductor each projecting into said housing member, the conductors being located therein axially spaced, radially in parallel, and terminating in operable proximity to said passageway substantially flush with the surface thereof; a magnetically responsive ball movably disposed within said passageway; and a rotatable magnetic actuator projecting through said housing concentric with said circular cavity, said actuator including two pole pieces spacedly located on opposite sides of the housing with the said ball interposed therebetween, said actuator being effective to establish, periodically, by its action on the ball, a closed electric circuit between said conductors.

5. A high voltage vacuum switch comprising, in combination: a housing member of electrically insulating material having an air evacuated circular cavity defining a passageway; a plurality of input and a corresponding number of output conductors projecting into said housing member, said conductors being disposed in sets composed of a single input and a single output conductor, the conductors of a single set being located in the housing axially spaced and radially in parallel, and each set being circumferentially spaced relative to any other set of conductors; magnetically responsive means movably disposed within said passageway; and a rotatably disposed magnetic actuator arranged proximate to said magnetically responsive means for rotating said means along said passageway to establish, periodically, electrical juxtaposition with each set in a continuously repeating sequence so long as said means rotates, to effect a closed electric circuit between conductors of a single set.

6. A high voltage vacuum switch according to claim 5 connectible to a piezoelectric source of potential, including grounding means rotatably arranged in operative relation to said housing; and a plurality of conductors circumferentially spaced on said housing relative to said sets of conductors and connectible to said piezoelectric source of potential to establish, periodically, electrical

juxtaposition with said grounding means when said means is rotated.

7. A high voltage vacuum switch according to claim 1 connectible to a piezoelectric source of potential, including grounding means rotatably arranged in operative relation to said housing; and a third conductor circumferentially spaced on said housing relative to said input and output conductors and connectible to said piezoelectric source of potential to establish, periodically, electrical juxtaposition with said ground conductor when said conductor rotates.

8. A high voltage vacuum switch according to claim 7, and a fourth conductor connectible to ground, said grounding means being constructed and arranged to establish, periodically, a closed circuit between said third and fourth conductors.

9. A high voltage vacuum switch according to claim

1 connectible to a piezoelectric source of potential, a third conductor connected to ground and spaced in operative proximity to said input conductor, said actuator being constructed and arranged to establish, periodically, a closed circuit between said input and third conductors.

References Cited by the Examiner

UNITED STATES PATENTS

1,402,696	1/1922	Wallis	200—11
1,514,596	11/1924	Adams	200—26
2,492,727	12/1949	Ballard	200—87 X
2,786,654	3/1957	Green	200—61.52 X
2,929,896	3/1960	Ronning	200—19 X

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