Nov. 8, 1966 N. T. NEAPOLITAKIS 3,284,740

ELECTRONIC IGNITION SYSTEM WITH ENCAPSULATED REED DEVICE AND CONDUCTING SLEEVE THEREABOUT FORMING A FLUX FILTER

Filed July 15, 1965

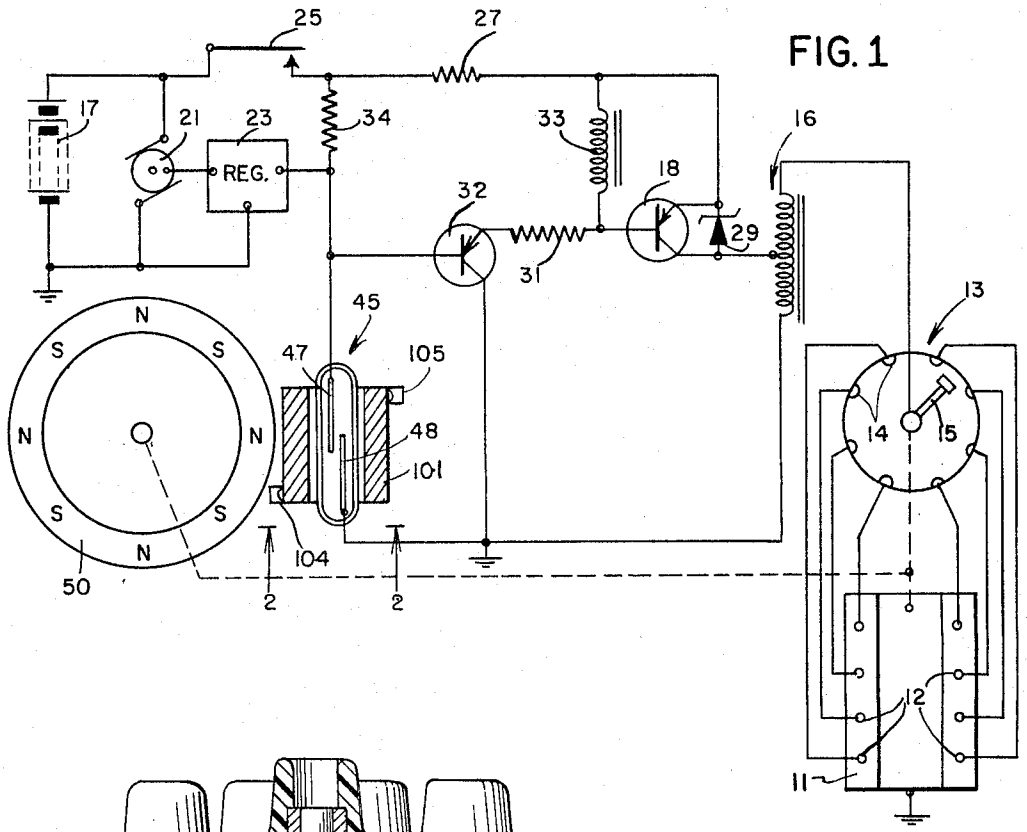


FIG. 1

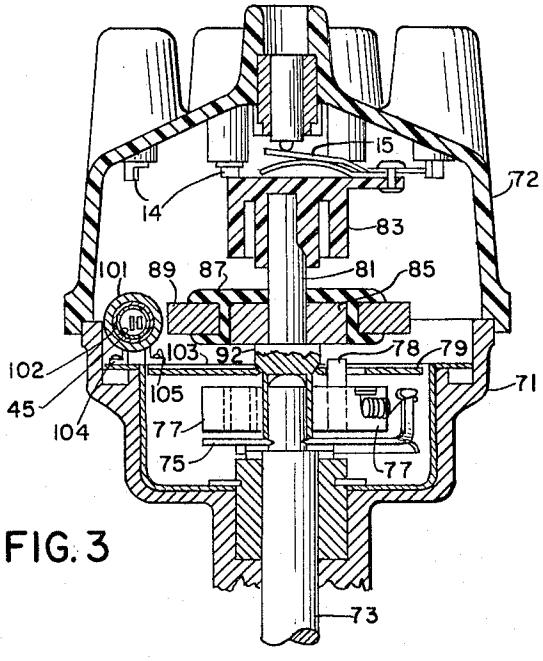


FIG. 3

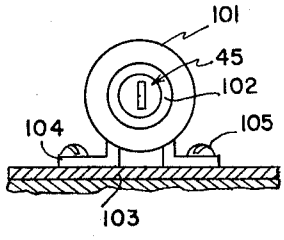


FIG. 2

INVENTOR
NICHOLAS T. NEAPOLITAKIS

BY
Mueller, Aichele & Rauner

ATTYS.

United States Patent Office

3,284,740

Patented Nov. 8, 1966

3,284,740

ELECTRONIC IGNITION SYSTEM WITH ENCAPSULATED REED DEVICE AND CONDUCTING SLEEVE THEREABOUT FORMING A FLUX FILTER

Nicholas T. Neapolitakis, Chicago, Ill., assignor to Motorola, Inc., Franklin Park, Ill., a corporation of Illinois

Filed July 15, 1965, Ser. No. 472,138
4 Claims. (Cl. 335—153)

This invention relates to magnetically actuated reed switches, and more particularly to improvements in systems utilize a magnetically actuated reed switch.

Magnetically actuated reed switches have numerous applications in which they are opened and closed at a certain frequency. For example, ignition systems for internal combustion engines may utilize a magnetically actuated reed switch to synchronize operation of the system with the operation of the internal combustion engine in order to produce the firing pulses at the proper time. Such a system is described in the co-pending application of Robert C. McLaughlin, Serial No. 343,652 (assigned to the assignee of the present invention). This involves utilizing a rotating magnet proximate the reed switch to produce flux variations at the desired frequency.

Under certain conditions, reed switches may tend to bounce in the presence of spurious flux variations at the natural resonance frequency of the reed switch. Spurious flux variations at the resonance frequency of the reed switch may result from vibrations at such frequency or at frequencies to which the resonance frequency is harmonically related. These vibrations may be produced due to play or variation in dimensions in the mechanical structure of the switch actuating mechanism, to variations in power supply current which produce spurious fields, or by other causes.

Accordingly, it is an object of this invention to improve the operation of systems utilizing magnetically actuated reed switches.

Another object of the invention is to reduce the tendency for reed bouncing in a system which utilizies a magnetically actuated reed switch.

A feature of the invention is the provision of a magnetic shield surrounding the reed switch of a system, which magnetic shield has an inductance sufficiently low to have a negligible affect in flux variations below a given frequency and which operates to filter out flux variations at frequencies of the order of the natural resonance frequency of the reeds.

Another feature of the invention is the provision of a copper sleeve surrounding an encapsulated reed switch, which sleeve filters out spurious flux variations which can cause vibration of the reed due to the natural resonance thereof.

In the drawings:

FIG. 1 is a schematic diagram of an ignition system incorporating the invention, and showing the reed switch and shielding structure in full section;

FIG. 2 is an end view of the reed switch and shielding structure of FIG. 1 taken along the line 2—2; and

FIG. 3 is a full section view of a distributor in which the invention is incorporated.

In accordance with the invention, an electrical system includes a magnetically actuated reed switch operable to control a function of the system. Magnetic means are provided adjacent the reed switch and produce flux variations to open and close the switch. The reed switch has a natural resonance frequency which is substantially higher than the operating frequency. A magnetic shield surrounds the reed switch. The magnetic shield has an inductance sufficiently low to have a negligible affect on flux variations at the operating frequency and operates to filter out flux variations at frequencies of the order of the natural resonance frequency of the reed switch.

Referring now more particularly to the drawing, FIG. 1 shows the invention incorporated in an ignition system for an internal combustion engine 11. Engine 11 has a plurality of spark plugs 12 for igniting the fuel mixture in the cylinders of the engine. High voltage firing pulses are supplied to spark plugs 12 by a distributor 13 which has a plurality of fixed contacts 14 connected to a respective ones of spark pulgs 12, and a moving contact 15 connected across the secondary winding of a high voltage ignition coil 16. As shown in FIG. 1, ignition coil 16 is of the auto transformer type, however, the double winding type of transformer might also be used. When current flowing through the primary of ignition coil 16 is suddenly interrupted, a high voltage spike will be introduced in the second thereof. It is this spike that is applied to moving contact 15 of distributor 13 and from there to one of the spark plugs 12 of internal combustion engine 11.

The primary ignition coil 16 is connected to the source of current, namely storage battery 17, by a transistor 18. Battery 17 may be charged by an alternator or generator 21, the output of which may be regulated by regulator 23 in a well known manner. Also connected in series with the primary of coil 16 and transistor 18 are the ignition switch 25 and ballast resistor 27. A protective zener diode 29 is connected across the emitter and collector portions of transistor 18. The base portion of transistor 18 is connected through resistor 31 to the emitter portion of the control transistor 32. Transistor 32, when conductive, will therefore cause resistor 31 to forward bias transistor 18 into conduction. When transistor 32 is cut off, the resistive choke 33 which is connected across the emitter and base portions of transistor 18 will produce a transient pulse to reverse bias transistor 18 cutting it off. This interrupts current through coil 16 and produces a firing pulse.

Conduction of transistor 32 is controlled by a resistor 34 connecting the base portion of transistor 32 to ignition switch 25, and by a magnetically actuable reed switch 45. Reed switch 45 comprises a pair of reeds 47 and 48 which are normally open. Reed switch 45 is glass encapsulated and placed adjacent a rotating magnet 50 which, during the course of its rotation, will align pole pieces of opposite polarity adjacent respective ones of reeds 47 and 48. This causes the reeds to attract one another and therefore to close. The alternate poles marked N, S, N, etc. around the periphery of the annular magnet are uniformly spaced to operate the reed switch at regular angular positions of the magnet. As the magnet 50 continues rotation, the alternate poles produce fields which are in opposite direction to open the reeds at the half way point and then close them again once the field is completely reversed. It should be noted that the poles at the half way point may actually force the reed apart in the event that they tend to stick together due to magnetic retentivity or moisture.

With reed switch 45 closed, the base portion of transistor 32 will be grounded and hence transistor 32 will be driven into conduction to turn on transistor 18. When reed switch 45 opens, the base portion of transistor 32, which is connected to battery 17 through resistor 34, will rise to battery potential, actually reverse biasing the transistor 32 to insure rapid cut off.

Magnetically actuable reed switches of the general nature of switch 45 are commercially available from numerous sources. One such source is Hamlin, Inc. of Lake Mills, Wisconsin, under the designation MRG-1.

The glass encapsulating tube may be approximately one eighth inch in diameter and less than one inch long. The reed may be a nickel iron alloy and rhodium plated at the contacting portions. As an alternative, the reeds may be gold diffused and/or nickel plated. Numerous other types of reed switches are available and reed switches which are normally closed rather than open may also be obtained commercially. Because insulated connection is easily made to both ends of the reed switch, it may be readily incorporated in positive or negative ground systems.

Physical placement of the magnetically actuated reed switch **45** in relation to the rotating magnet **50** and other elements of the system may affect the operation of the system. In FIG. 3, a particular way of mounting the reed switch in a conventional distributor is shown. The distributor includes a housing **71** and a cap **72**. A distributor shaft **73** extends upwardly into the housing and drives a drive plate **75**. Drive plate **75** is connected through the usual spring biased flyweights **77** and drive pins **78** to a centrifugal advance plate **79**.

Advance plate **79** drives the distributor bushing **92** and the rotor shaft **81** upon which rotor **83** is mounted. Rotor **83** carries the moving contact **15** of the distributor, and fixed contacts **14** of the distributor extend downwardly in the interior of cap **72**. Rotor shaft **81** carries a cam **85** which may be the conventional type used to operate mechanical breaker points. A grommet **87** of rubber, plastic or other suitable material, is fitted over cam **85** to be driven thereby and carries an annular magnet **89**. Magnet **89** may be of powdered barium ferrite and is magnetized about the periphery thereof in alternate evenly spaced poles. The magnet need not be annular, however, and may be constructed without alternate poles. Instead of a rotating magnet, a fixed magnet with a rotating piece of soft iron might suffice.

It has been found under certain circumstances that the reeds **47**, **48** of the reed switch tend to bounce at their resonant frequency. Naturally this can cause faulty operation of the ignition system. Such bouncing may be the result of flux variations of the resonance frequency produced by vibrations. Such vibrations may be due to minute changes of gap between to periphery of magnet **50** and the reeds **47** and **48**. This can occur as the result of play in the distributor bushing **92** within the tolerance requirements of the structure, for example, 2 to 10 thousands of an inch. The magnet **50** may have a peripheral eccentricity which varies within several thousands of an inch. Finally, vibration of the distributor housing causing the distributor shaft and reed switch housing to flex slightly may also set up vibrations to produce variations in flux. As the distance between the magnet and the reed changes with vibration, the flux changes produced, or some harmonic frequencies of these flux changes, approach the resonance frequency of the reed itself. It takes very little driving force to cause the reeds to vibrate or bounce at the resonance frequency.

This problem is eliminated by utilizing a high frequency flux filter **101**. Filter **101** may be comprised of a copper bushing or sleeve or may be a multi-turn winding surrounding the reed switch **45**. The space between the glass capsule of reed switch **45** and the sleeve may be filled with epoxy **102** (see FIG. 2) to provide a secure mechanical mounting. The sleeve is secured by brackets **104** and **105** to the vacuum advance plate **103** of the distributor and may be advanced in a known manner. The bushing or winding acts as a shorted turn to filter out flux variations. The inductance of the magnetic shield must be low such that it will affect only the higher frequencies, those frequencies of the order of the nautral resonance frequency of the reed switch **45**. The resonance frequency of the reed switch may, for example, be of the order of 2200 cycles per second while the maximum frequency of the firing pulses may approximate 330 cycles per second. The resistance and turns of the shielding must be such

that the back magnetomotive force produced thereby should block the high frequency components of the main pulse flux. By utilizing such shielding, the likelihood of bouncing in the reeds of the reed switch is substantially reduced. With a reed switch resonance frequency of the order of 2200 cycles per second and a maximum operating frequency of the reed switch of the order of 330 cycles per second, a satisfactory sleeve thickness has been found to be of the order of one eighth inch.

It may therefore be seen that the invention provides an improved electrical system utilizing a magnetically actuated reed switch. The vibrations of the reed switch which may be caused by spurious flux variation are minimized for superior performance of the system. The invention has been shown in connection with an ignition system. However, any system wherein a reed switch is to be operated at a frequecy substantially lower than the resonance frequency of the reed switch and wherein stray fields may cause spurious flux variation at the resonance frequency of the reed switch, may effectively utilize the invention.

I claim:

1. A switching structure for use in an electrical system which may be subject to the influence of magnetic fields exhibiting variations in flux, said switching structure including in combination, a reed switch comprising a pair of magnetic reeds encapuslated within a glass tube and operable to control a function of the electrical system, a copper sleeve directly surrounding said glass tube, movable magnetic means operable to provide a magnetic flux through said reeds varying in a given frequency range to open and close said reed switch, said reed switch having a natural resonance frequency which is substantially higher than the given frequency range, said copper sleeve forming a shorted turn about said reeds and being of a thickness to provide a sufficiently low inductance to have a negligible effect of magnetic flux variations within the given frequency range, and acting to filter out magnetic flux variations at frequencies of the order of said natural resonance frequency.

2. An ignition system for an internal combustion engine, including in combination, a switching circuit and means responsive thereto to produce firing pulses for the engine, said switching circuit including a reed switch operable to control the frequency at which firing pulses are produced, a permanent magnet annular disc having alternate north and south poles located about its periphery, said magnetic disc being positioned proximate said reed switch and having eccentricity variations, a rotatable shaft fixed to said disc for rotating the same in synchronism with the engine for producing a varying magnetic flux through said reed switch, to open and close said reed switch to produce firing pulses within a range of frequencies, said reed switch having a natural resonance frequency which is substantially higher than the maximum frequency of the firing pulses, said magnetic disc and said shaft producing variations in flux having a frequency of the order of said natural resonance frequency due to vibration and the eccentricity of said disc and a magnetic shield surrounding said reed switch, said magnetic shield forming a shorted turn about said reed switch and having an inductance sufficiently low to have a negligible effect on magnetic flux variation below the maximum frequency of firing pulses and operating to filter out magnetic flux variations at frequencies of the order of said natural resonance frequency.

3. The combination of claim **2** wherein the natural resonant frequency of said reed switch is of the order of 2200 cycles per second, and said magnetic shield comprises a copper sleeve of the order of one eighth inch thick.

4. A switching structure for use in an electrical system which may be subject to the influence of magnetic fields exhibiting variations in magnetic flux, said switch struc-

ture including in combination, a magnetic reed switch operable to control a function of the electrical system, a magnetic shield surrounding said reed switch and forming at least one shorted turn about said reed switch, permanent magnet means outside said shield and movable to provide a magnetic flux through said reed switch which varies at frequencies up to a given frequency to operate said reed switch, said reed switch having a natural resonant frequency which is substantially higher than the given frequency of operation resulting from said magnet means, said magnetic shield having an inductance sufficiently low to have a negligible effect on magnetic flux variations at the operating frequencies and acting to filter out flux

variations at frequencies of the order of said natural resonant frequency.

References Cited by the Examiner

UNITED STATES PATENTS

2,614,188	10/1952	Williams et al.	200—93 X
2,781,412	2/1957	Mike	200—19 X
2,938,982	5/1960	Brown et al.	200—87 X
3,005,069	10/1961	Sippach et al.	200—138 X
3,187,244	6/1965	Summerer	200—19 X

BERNARD A. GILHEANY, *Primary Examiner.*

J. J. BAKER, *Assistant Examiner.*