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CIRCUIT BREAKER FOR IGNITION SYSTEMS

Filed May 12, 1966

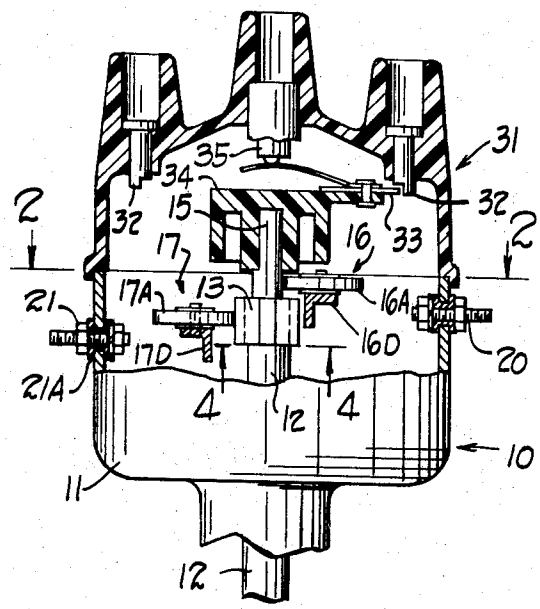


Fig. 1

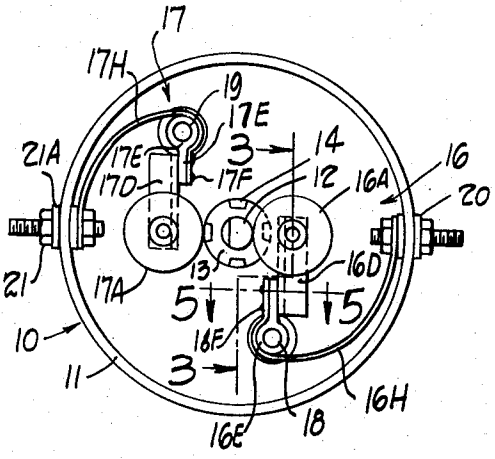


Fig. 2

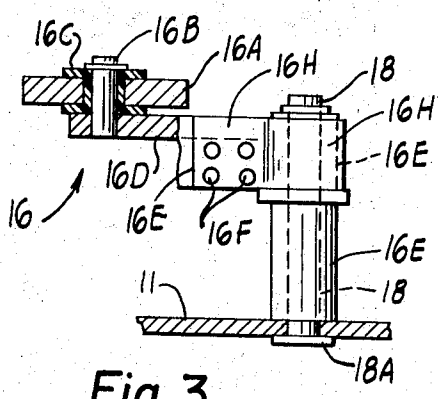


Fig. 3

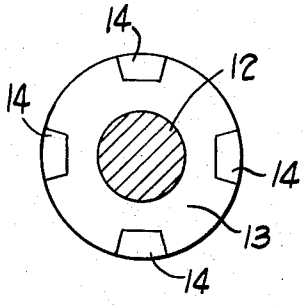


Fig. 4

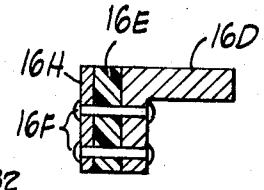


Fig. 5

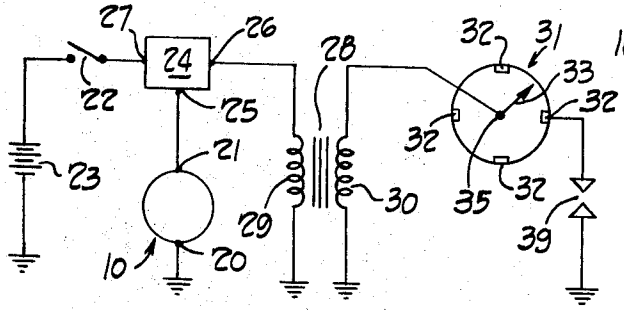


Fig. 6

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CIRCUIT BREAKER FOR IGNITION SYSTEMS

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ABSTRACT OF THE DISCLOSURE

A circuit breaker arrangement for an ignition system in which there are two cylindrical surfaces non-rotatably mounted on an engine-driven rotatable shaft of an internal combustion engine, the surfaces being spatially disposed relative to each other along the axis of the shaft, a first of the surfaces being of electrical conducting material around its circumference and a second of said surfaces being of electrical conducting material interrupted by electrical insulating material about its circumference, the electrical conducting material of the two cylindrical surfaces being in continuous electrical connection through the shaft, a pair of rollers of electrically conducting material, a first of the rollers being maintained in continuous engagement with the first of said surfaces during its rotation with the shaft, a second of said rollers being in continuous engagement with the second of said surfaces during its rotation with the shaft, one of said rollers being electrically connected with one side of the ignition system and the other of said rollers being electrically connected with the other side of the ignition system, the second roller on engaging the insulating material of the second surface breaking the circuit of the ignition system, the said surfaces and rollers all being enclosed in a unitary housing which carries the rollers in position and which protects the rollers and surfaces from foreign material which might interfere with good electrical contact between rollers and the respective surfaces.

My invention relates to circuit breakers for distributors utilized in ignition systems of internal combustion engines.

This invention is directed to a novel structure and arrangement in a circuit breaker of a distributor for an ignition system wherein the maintenance and efficiency difficulties and deficiencies of the prior circuit breakers are minimized or eliminated. In the prior circuit breakers utilized in the distributors of ignition systems, wherein there are embodied make and break contacts open and closed by a rubbing block which recurrently moves a contact bearing arm outwardly away and which resiliently moves back after each movement imparted by the rubbing block, there are several deficiencies. One of these deficiencies is the rapid deterioration of the contacts through arcing between them and the physical striking of the contacts together. Another of these deficiencies is the change in the spacing between contacts and the upsetting of the timing occurring through the progressive wearing away of the rubbing block through frictional abrasion during the operation of the circuit breaker. My invention by avoiding the structure of such prior circuit breakers obviates such difficulties and shortcomings of the prior art. In my circuit breaker, there is a structure for intermittently breaking a circuit without intermittent radially outward movement of a contact arm provided by a rubbing block, and in which results of wear on parts rubbing during rotation of one relative to the other are inconsequential of minimal. Efficiency is readily maintained, and repair and replacement of parts is greatly reduced, through the use of my new circuit breaker.

While deterioration of the contacts was reduced through the greater use of electronic ignition systems for internal combustion engines, the problems and difficulties arising from the wearing away of the rubbing blocks were not eliminated in the prior circuit breakers used in such electronic ignition systems. Examples of such electronic ignition systems are shown in U.S. Patents No. 3,072,823 and No. 3,072,824.

An object of my invention is to provide a circuit breaker of unique and advantageous structure for a distributor to be embodied in some available electronic ignition system, the circuit breaker having an economical and reliable construction whereby relatively maintenance-free electronic ignition systems may be more readily afforded by the purchasing public.

Another object is the provision of a novel circuit breaker for a distributor to be embodied in some available electronic ignition system, in which circuit breaker mechanical wear is radically reduced and its effect minimized or eliminated as compared with the mechanical wear on the rubbing block and deterioration of contacts in the usual and prior common mechanical types of circuit breaker with their inherent disadvantageous effects.

Another object is the provision of a unique circuit breaker for distributors to be used in some available electronic ignition system whereby the dwell time of the said ignition system is not changed notwithstanding any mechanical wear that may occur in the circuit breaker.

Another object is the provision of a new circuit breaker for a distributor to be embodied in an available ignition system which new circuit breaker assures that the electrical timing of the ignition system related to the rotation of the internal combustion engine is not substantially changed by any mechanical wear of the circuit breaker.

Other objects and a fuller understanding of the invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawing, in which:

FIGURE 1 is a side elevational view, partially in section, of a combined circuit breaker and distributing mechanism in a housing, the whole unit being usually referred to as a distributor for an ignition system of an internal combustion engine having multiple cylinders and spark-plugs, in the example given here the engine having four cylinders and four spark plugs;

FIGURE 2 is a plan view of the lower portion of the unit shown in FIGURE 1, and looking in the direction of the arrows **2—2** of FIGURE 1;

FIGURE 3 is an enlarged view, partially in section, of a portion of the unit shown in FIGURE 2 and taken along the line **3—3** of FIGURE 2;

FIGURE 4 is an enlarged view, partially in section, taken through the line **4—4** of FIGURE 1;

FIGURE 5 is an enlarged cross-sectional view taken through the line **5—5** of FIGURE 2; and

FIGURE 6 is a diagrammatic view of the components and circuit of an electronic ignition system for a four cylinder internal combustion engine, only one of the four spark plugs being depicted, and in which my novel circuit breaker is embodied.

My distributor unit of my novel circuit breaker together with an appropriate distributing mechanism is indicated generally by the reference character **10**. This unit **10** includes a metal housing **11**, of electrical conducting properties, bolted to the engine structure, and a cap or cover **31**, of electrical insulating material such as molded insulating plastic material. The cap **31** fits over the open top of the metal housing **11** as shown in FIGURE 1 so as to be in axial alignment therewith and to enclose the chamber formed between housing **11** and cap **31**.

Extending through an opening in the bottom wall of housing **11**, and in axial alignment with the cylindrically

shaped housing 11, is a distributor shaft 12 which is rotatable on its axis by the internal combustion engine in the conventional manner so as to rotate in synchrony with the engine speed. The upper end of shaft 12 within the unit 10 terminates in a flattened or noncircular end portion 15. This end portion 15 non-rotatably interfits with a head 34 of electrically insulating material forming a distributor arm which carries thereon to revolve therewith a revolving electrical contact element 33. The contact element 33 is electrically interconnected through a usual spring arm with a centrally located electrical contact 35 in the well-known manner so that the contact element 33 is at the same electrical potential as central contact element 35.

The distributor cap 31 of electrical insulating material carries thereon a plurality (in the example given, four) electrical contact elements 32, each electrically connected to one pole or electrical terminal of a usual spark plug, of a set, such as four spark plugs, installed in the internal combustion engine. These contact elements 32, electrically insulated from each other, are equidistantly spaced apart around a reference circle and are electrically insulated from each other so that there is a flow of electrical current between central contact 35 and one only at a time of the plurality (four) of contacts 32.

Secured to one side of the metal housing 11 by a nut and bolt assembly 20 is a metal arcuate spring member 16H. The assembly 20 constitutes a terminal that is electrically connected with ground, that is, one side of the circuit of the ignition system. The spring 16H being of electrically conducting material is thus electrically connected through the terminal 20 with ground.

Secured to the bottom wall of housing 11 spaced inwardly from the cylindrical wall of housing 11 is a pin 18, by means of the upset portion 18A on the lower end of the pin. The axis of pin 18 is parallel to the axis of the housing 11. Carried on this pin 18 is an assembly denoted generally by the reference character 16. This assembly 16 includes a nylon supporting member 16E having a cylindrical portion fitting over and revolvable about pin 18, and an arm portion extending outwardly therefrom so as to pivotally swing about the axis of pin 18.

The outer or free end of metal spring 16H is secured by four metal rivets 16F to the nylon arm of electrically non-conducting member 16E. A steel arm 16D is also secured to the nylon arm of member 16E by the metal rivets 16F. The end portion of spring 16H is on one side of the nylon arm and the steel arm 16D is on the other side of the nylon arm, and the spring 16H and arm 16D are electrically connected by the metal rivets 16F.

A metal pin 16B is carried on the free end of arm 16D so as to project upwardly therefrom and having its axis parallel to the axis of pin 18 and parallel to the axis of housing 11. Rotatably mounted on pin 16B by means of metal washers and bushing assembly 16C is a metal roller or wheel 16A. This wheel 16A is held in rolling engagement and electrical interengagement with shaft 12. The bias and conformation of spring 16H are such that the arm of nylon member 16E and steel arm 16D are resiliently urged to swing in a direction and with such force as to hold the roller 16A against the steel shaft 12 as the shaft 12 rotates on its axis. Thus, the shaft 12 is maintained in good electrical connection with ground, that is, one side of the ignition circuit, through roller 16A, assembly 16C, pin 16B, arm 16D, rivets 16F, spring 16H, and terminal or assembly 20 with its lead to ground.

As the shaft 12 within the chamber of the housing 11 is relatively clean and free of grease and the like, an improved electrical connection is maintained between the shaft 12 and ground. Were the electrical connection attempted to be made between shaft 12 and ground at a location outside of housing 11, such as where the shaft 12 is exposed below the housing 11, it would be difficult to effect and maintain a good electrical connection. Even a thin film of lubricant or other foreign material on the shaft 12 interferes with a good electrical contact made with a roller held against the shaft at the location of such a film.

Another assembly denoted generally by the reference character 17 is carried by the housing 11 diametrically opposite the assembly 16. The construction of assembly 17 is the same as the construction of assembly 16, except that pin 19 is shorter than pin 18 and the axial length of the cylindrical portion of member 17E rotatable on pin 19 is shorter than the corresponding part of nylon member 16E. The terminal 21, made up of nut and bolt assembly on the side wall of housing 11, similarly carries metal spring 17H (similar to metal spring 16H) which biases the member 17E and steel arm 17D, interconnected with spring 17H through metal rivets 17F, to swing the rotatable roller 17A, carried by the free end of arm 17D, radially inward toward the axis of shaft 12.

Non-rotatively mounted on shaft 12 so as to rotate therewith is a disc or roller 13 disposed in the plane of roller 17A so as to be in engagement therewith. The disc or roller 13 is of metal except for a plurality of segments 14 of electrically non-conducting material such as nylon, hard rubber or other non-conducting plastic material. These segments, in the illustration given of an ignition system for a four-cylinder internal combustion engine, are four in number. The four non-conducting segments 14 are equidistantly spaced apart around the cylindrical periphery of the disc or roller 13. The remainder of disc or roller 13 is of electrically conducting material and is in electrical connection with shaft 12 so that shaft 12 and disc 13 are substantially at the same electrical potential.

The terminal 21 is electrically insulated from the housing 11 and hence electrically insulated from ground by the electrically insulating sleeve 21A permitting the bolt of terminal 21 to pass through the wall of housing 11 without electrically contacting the same. The arm 17D of assembly 17 is electrically connected to roller 17A which is resiliently biased by spring 17H against the disc 13, that is, toward the axis thereof. As the shaft 12 and disc 13 rotate on their common axis, the roller 17A sequentially engages the outer metal wall of disc 13 and the segments 14.

Upon the roller 17A being in engagement with the metal wall of disc 13, current may flow between terminals 20 and 21 through the assemblies 16 and 17, shaft 12 and disc 13. However, upon the roller 17A being in engagement with one of the segments 14, then that flow of current is interrupted or broken. Upon the shaft 12 and disc 13 rotating to where the roller 17A again is in engagement with the metal portion of the disc 13, the said flow of current between terminals 20 and 21 is re-established.

Thus, the mechanism provides for a circuit breaker which sequentially breaks the current as the shaft 12 is rotated. The action remains the same regardless of any wear on the parts. There is no snap action or quick swinging movement in or out of a contact arm. There is no rubbing block to wear and thus cause maladjustment of the circuit breaker.

In FIGURE 6 there is illustrated diagrammatically and with parts being shown in block form, my improved circuit breaker 10 embodied in an electronic ignition system of an internal combustion engine, assumed for purposes of example to have four cylinders and four spark plugs 39, one for each cylinder.

The circuit breaker 10 is connected with ground through terminal 20. The terminal 21 of the circuit breaker 10 is connected to terminal 25 of a usual and well-known electronic control unit 24. Another terminal 27 of the control unit 24 is connected through switch 22 with one pole or terminal of battery 23, the other pole or terminal of the battery being connected to ground. A third terminal 26 of the control unit 24 is connected through winding 29 of ignition coil 28 to ground. The other winding 30 of ignition coil 28 is connected at one end to ground and at the

other end to electrical contact **35** carried by distributor cap **31**. This contact **35** is electrically connected to revolvable contact member **33** which sequentially engages and electrically contacts equidistantly spaced and electrically insulated contact elements **32**. Each of the four contact elements in turn is connected with one pole or terminal of a spark plug **39**, the other pole or terminal of which is electrically connected with ground. As the control unit **24** in itself is not part of my invention, it is shown in block form.

It is thus seen that my improved circuit breaker, of which an example is given as circuit breaker **10**, provides to terminal **25** of the control unit **24** in an electronic ignition system, a supply of electrical current broken or interrupted in accordance with the speed of rotation of shaft **12**, rotated in synchrony with the engine. The interruption or breaking of the electrical current is thus synchronized with the requirements of the spark plugs. The circuit breaker having the advantages here described is peculiarly fitted for incorporation in such an ignition system.

It is to be understood that segments **14** need not be of electrically insulating material but may be of electrical conducting material such as metal but which is electrically insulated from the main metal body portion of disc member **13**, whereby each segment is electrically insulated from shaft **12**, and roller **17A** when in engagement with a segment **14** is electrically insulated from shaft **12**.

It is also to be understood that while it has been stated that the electric current supplied for energizing the spark plugs is intermittently broken by my circuit breaker, this has been described in a brief manner as in fact the intermittently broken current is supplied to electronic control unit **24** which in turn energizes a winding **29** of coil **28**, which is the usual and well-known manner provides pulses of electrical energy to the spark plugs.

The present disclosure includes that contained in the appended claims, as well as that of the foregoing description.

Although this invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and the numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and scope of the invention as hereinafter claimed.

What is claimed is:

1. In an electronic ignition system of an internal combustion engine having a plurality of spark plugs and having a distributor shaft of electrically conducting material rotated by the engine in synchrony with the rotation thereof, said system including a housing concentrically mounted about said shaft, a circuit breaker comprising in combination a first roller of electrically conducting material mounted within said housing and resiliently biased radially inward and against and in electrical contact with the said shaft within said housing to maintain continuous electrical interconnection therebetween during full rotation of the shaft, first electrical connecting means connecting said first roller with a first terminal carried by the housing adapted to be electrically connected to one portion of the ignition system circuit whereby said shaft is maintained continuously in electrical connection with said one portion of the said circuit, a disc member non-rotatively mounted on said shaft within said housing, said disc member having a cylindrical outer surface concentric with said shaft, said disc member having a body portion of electrically conducting material in electrical connection with said shaft, said disc member including a plurality of segments electrically insulated from said body portion of electrically conducting material substantially equidistantly spaced around said cylindrical surface and alternating therearound with the electrically conducting material of the body of said disc member, a second roller of electrically conducting material mounted within said housing and resiliently biased radially inward against the

cylindrical surface of said disc member, said second roller being in electrical contact with said shaft through the said body portion of the disc member upon the interengagement of the second roller and the electrically conducting material of the body of said disc member and being electrically insulated from said shaft upon the interengagement of the second roller and one of said plurality of segments and not with said electrically conducting material of said body, second electrical connection means connecting said second roller with a second terminal carried by the housing adapted to be electrically connected to another portion of the ignition system circuit whereby said shaft is intermittently electrically connected with said another portion of said circuit upon the second roller engaging the electrically conducting material of the body of the disc member at said cylindrical surface and electrically disconnected from said another portion of said circuit upon the second roller engaging only one of said plurality of segments, the rotation of said shaft and disc member therewith causing a making and a breaking of the current flow between said terminals in synchrony with the rotation of said shaft and disc member as the second roller sequentially engages said segments and the portion of body of the disc member separating said segments during rotation of the disc member.

2. A circuit breaker as claimed in claim **1** and in which said first roller is carried by a first arcuate metal leaf spring that is carried by the wall of the housing, said first leaf spring being directed and biased to urge the roller toward the axis of said shaft, in which said first electrical connecting means includes said first arcuate metal leaf spring, in which said second roller is carried by a second arcuate metal leaf spring that is carried by the wall of the housing on a side opposite of said shaft, said second leaf spring being directed and biased to urge the roller toward the axis of said disc member, and in which said second electrical connecting means includes said second arcuate metal leaf spring, the axes of said first and second rollers and of said shaft being parallel.

3. A circuit breaker as claimed in claim **1**, and in which said first roller is disposed in said housing in a first plane normal to the axis of said shaft axially spaced from a second plane normal to the axis of said shaft through both said disc member and the said second roller.

4. A circuit breaker as claimed in claim **1** and in which said housing is of electrical conducting material connected to ground, and one of said terminals is electrically connected to said housing and the other of said terminals is electrically insulated from said housing.

5. A circuit breaker as claimed in claim **1** and including a distributor contact element connected to said shaft to be revolved thereby in synchrony with the rotation of said disc member, a plurality of spaced contact elements insulated from each other and from said shaft and each adapted to be connected to a separate spark plug of said engine, and in which said revolvable distributor contact element is supplied with electrical potential for sequential supply to said spaced contact elements in accordance with electrical energy effected by the making and breaking of electrical current in accordance with the rotation of said disc member relative to said second roller sequentially engaging said segments and said body of electrically conducting material.

6. A circuit breaker mechanism for incorporation in the circuit of an electronic ignition system for an internal combustion engine, in which said ignition system requires an intermittent breaking of a circuit in synchrony with the rotation of the engine, the engine having a distributor shaft rotatable in synchrony with the rotation of the engine, said circuit breaker mechanism comprising in combination a first cylindrical surface portion and a second cylindrical surface portion both carried by and concentrically disposed about said shaft and rotatable therewith, said first and second surface portions being spatially disposed relative to each other axially of said shaft, a first roller having its axis parallel to the axis of said

shaft and disposed adjacent said first cylindrical surface to maintain constant engagement with the same during rotation of the shaft, a second roller having its axis parallel to the axis of said shaft and disposed adjacent said second cylindrical surface to maintain constant engagement with the same during rotation of the shaft, a housing enclosing both said surface portions and said rollers, said first and second rollers being of electrically conducting material, first electrical connecting means continuously connecting said first roller and a first portion of the said circuit to conduct electrical current between said first portion of the circuit and said first roller and the said first cylindrical surface of said shaft engaged thereby, second electrical connecting means connecting said second roller and another portion of said circuit to conduct electrical current between said another portion of the said circuit and the said second cylindrical surface of said shaft engaged thereby, said first cylindrical surface being of electrical conducting material and in continuous electrical contact during rotation of the first cylindrical surface with the first roller engaged thereby, said second cylindrical surface having a plurality of first contact portions and a plurality of second contact portions alternately disposed around the circumference thereof, said first contact portions being substantially equidistantly spaced from each other around the circumference of said second cylindrical portion and said second contact portions being substantially equidistantly spaced from each other around the circumference of said second cylindrical surface, said first contact portions being of electrical conducting material and being electrically connected with said first cylindrical surface and the first roller engaged thereby, said second contact portions being electrically insulated from said first contact portions and from first cylindrical surface, the said second roller sequentially engaging said first and second contact portions as said second cylindrical surface rotates with said shaft to alternately electrically engage with said first contact portions to electrically connect through each said first contact portion engaged with said first cylindrical portion and the first roller engaged thereby, said second roller

upon alternate engagement with each said second contact portion being electrically insulated from said first cylindrical surface and the first roller engaged thereby, the rotation of said cyindrical surfaces with said shaft intermittently breaking the circuit therethrough between said rollers.

7. A circuit breaker as claimed in claim 6 and including first resilient means carried by said housing resiliently urging the first roller in engagement with said first cylindrical surface portion and second resilient means carried by said housing resiliently urging the second roller in engagement with said second cylindrical surface portion, said first resilient means being included in said first electrical connecting means and said second resilient means being included in said second electrical connecting means.

8. A circuit breaker as claimed in claim 6 and in which said first cylindrical surface is the peripheral circumferential surface of said shaft, and said second cylindrical surface is provided by a cylindrical body provided on said shaft and rotatable therewith and having a greater diameter than the diameter of said first cylindrical surface, said cylindrical surfaces being disposed relative to each other axially of said shaft.

9. A circuit breaker as claimed in claim 6 and in which said first and second rollers are carried by said housing, in which said housing is of electrical conducting material, and in which one of said electric connecting means includes therein said housing and in which the other of said electrical connecting means is electrically insulated from said housing.

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