Nov. 14, 1950 J. H. BOOTH 2,529,480

TIMER

Original Filed Jan. 31, 1944 3 Sheets-Sheet 1

Fig. 1.

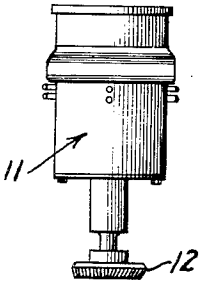


Fig. 2.

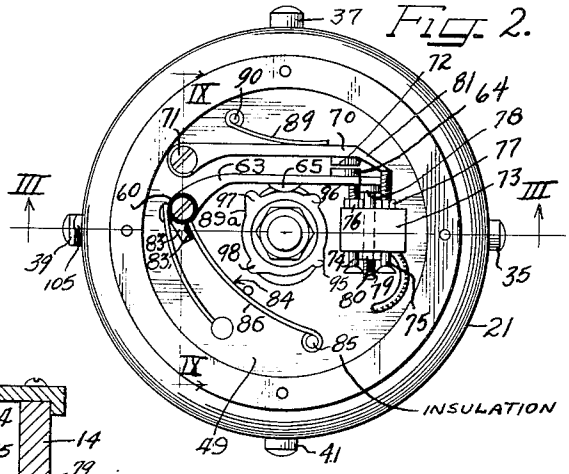


Fig. 3.

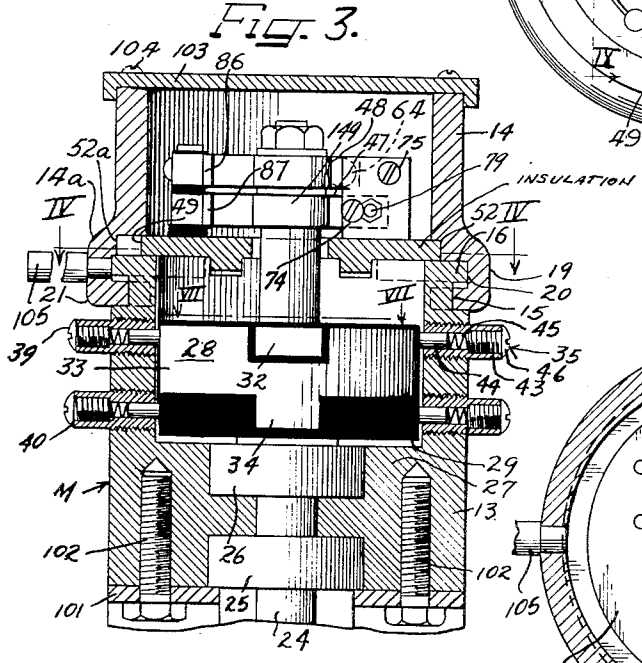


Fig. 4.

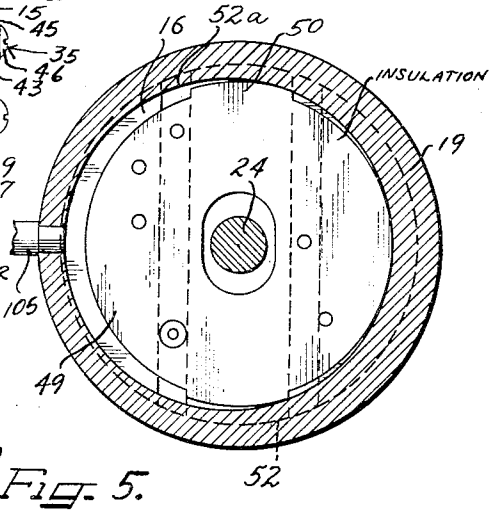
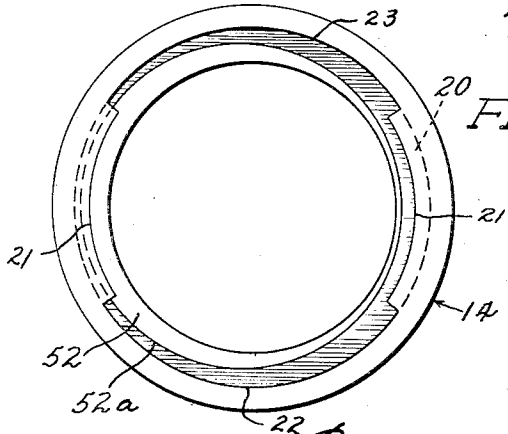


Fig. 5.



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Fig. 6.

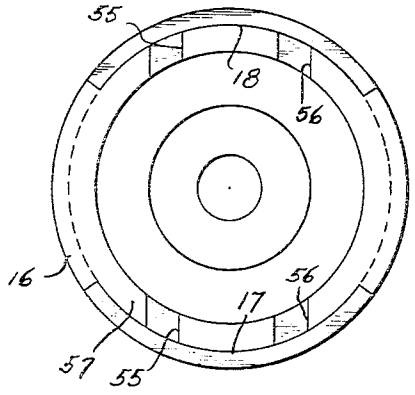


Fig. 7.

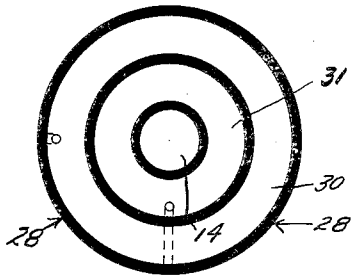


Fig. 8.

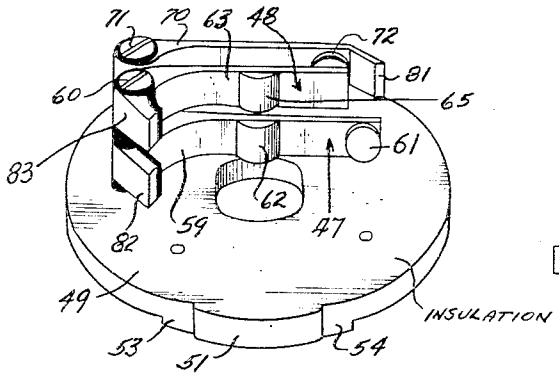


Fig. 9.

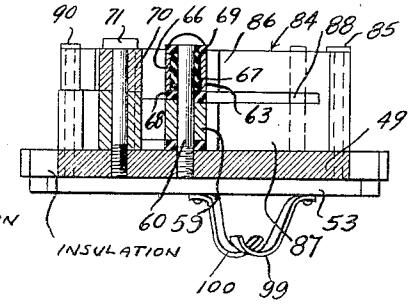
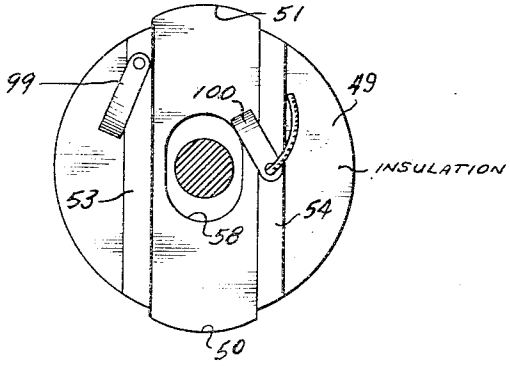


Fig. 10.



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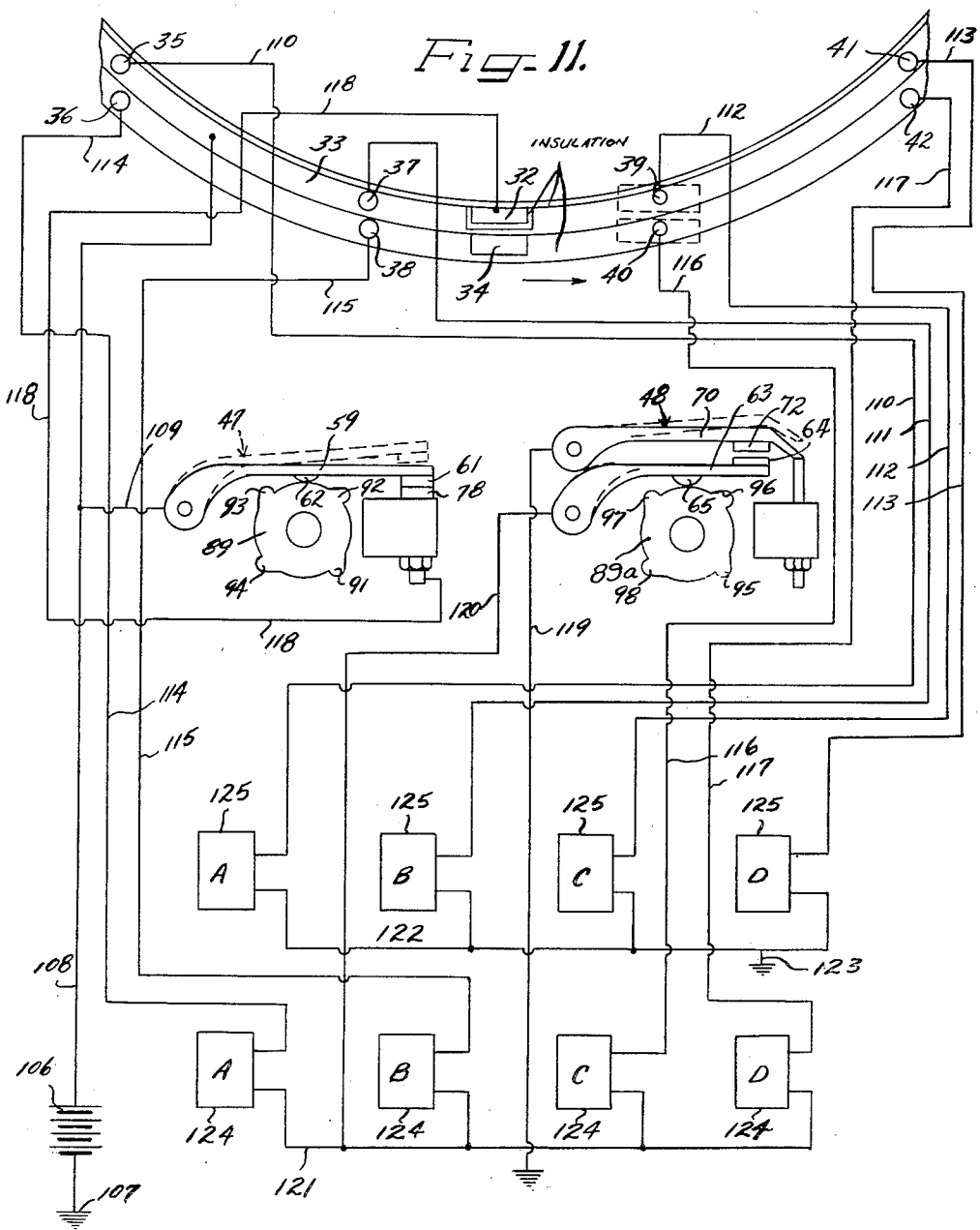
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TIMER

Original Filed Jan. 31, 1944 3 Sheets-Sheet 3

Fig. 11.



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Patented Nov. 14, 1950

2,529,480

UNITED STATES PATENT OFFICE

2,529,480

TIMER

James H. Booth, Detroit, Mich., assignor to Thompson Products, Inc., Cleveland, Ohio, a corporation of Ohio

Original application January 31, 1944, Serial No. 520,563. Divided and this application June 8, 1946, Serial No. 675,454

15 Claims. (Cl. 200—30)

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This invention relates to a timer, and more particularly to a timer for a fuel injection system.

Many arrangements have been devised for metering and feeding fuel into the cylinders of an internal combustion engine. The most widely used form of combustion engine at the present time is one employing a carburetor for vaporizing and mixing the fuel with air to obtain a combustible mixture which in turn is fed to the engine cylinders. A type of system was devised some time ago which eliminated the need for a carburetor and is known as a fuel injection system.

In such a system, a metered quantity of liquid fuel under pressure is fed directly or through an intake manifold to each cylinder of the engine. Air is mixed with this metered quantity of fuel in the cylinder itself. This type of system would have many advantages over the carburetor type of system if reliable and efficient means is provided for metering and feeding the fuel into the cylinders.

One particular novel form of fuel injection system is described and claimed in my copending application entitled "Fuel Injection System," U. S. Serial No. 520,563, filed January 31, 1944, and assigned to the same assignee as the present invention. The present application is a division of this aforesaid application, and is directed to the novel timer which is illustrated therein and which may be used efficiently in other types of fuel injection systems or the like.

One of the principal features and objects of the present invention is to provide a novel timer which is particularly suited for use in fuel injection systems.

Another object of the present invention is to provide a novel structure for opening and closing electrical circuits in timed sequence.

Still another object of the present invention is to provide a novel timer for internal combustion engines.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims. My invention itself, however, both as to its manner of construction and method of control together with further objects and advantages, may best be understood by reference to the following description, taken in connection with the accompanying drawings, in which:

Figure 1 is an elevational view of a timer embodying the novel teachings and principles of the present invention;

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Figure 2 is a top enlarged view of the timer with the cover removed;

Figure 3 is an elevational view partly in section of the interior of the timer as taken along the line III—III of Figure 2;

Figure 4 is a sectional view of the timer as taken along the line IV—IV of Figure 3;

Figure 5 is a bottom view of the top cylindrical housing member;

Figure 6 is a top plan view of the bottom cylindrical housing member;

Figure 7 is a top plan view of the slip ring and commutator block as viewed along the section line VII—VII of Figure 3;

Figure 8 is an isometric view of the switch block with certain portions thereof removed to show more clearly the movable arms mounted on the block;

Figure 9 is a sectional view of the switch block as taken along the line IX—IX of Figure 2;

Figure 10 is a bottom plan view of the switch block showing the distributor contact fingers; and

Figure 11 is a circuit diagram illustrating a control circuit for a fuel injection system in which my timer may be used.

The timer mechanism 11 illustrated in the various figures of the drawings is arranged to be driven through a bevel gear 12 in a manner hereinafter to be described. The timer is mounted in a pair of interlocking cylindrical housing members 13 and 14. The upper end of the lower housing member 13 is provided with a radially outwardly opening channel 15, the upper lip 16 of which is cut away on diametrically opposite sides over a substantially arcuate portion as at 17 and 18 (Figure 6).

The somewhat enlarged lower end 14a of the upper housing member 14 is provided with a radially inwardly opening channel 20, the lower wall or lip 21 of which is cut away on diametrically opposite sides over a substantially arcuate portion as at 22 and 23, Fig. 5. The cut-away portions 17 and 18, Fig. 6, and 22 and 23, Fig. 5, are substantially coextensive to permit the lip 21 to be moved axially into the channel 15 and then the upper housing member 14 turned until the lip 21 is interlocked under the lip 16. The arcuate length of the lips 16 and 21 is sufficiently extensive that limited relative angular movement may be had between the housing members 13 and 14 without the lips becoming disengaged.

A timer shaft 24 extends up through the bottom of the housing 13 and is journaled in two bearing members 25 and 26, which are mounted

in the base wall 27 of the housing 13. The shaft 24 is driven through the bevel gear 12 from the main timer shaft (not shown) of the internal combustion engine with which the timer is to operate.

A commutator 28 is mounted on the shaft 24 for rotation therewith immediately above the base wall 27 of the housing 13. The commutator 28 includes a cylindrical block of insulating material 29; in the upper surface of which are embedded two concentric conducting rings 30 and 31, and in the cylindrical surface of which are embedded a short arcuate conducting segment 32 and a complete conducting ring 33. Conducting ring 33 includes an offset portion 34 directly opposite segment 32.

Symmetrically mounted in the lower housing 13 around the commutator 28 are eight brush assemblies 35, 36, 37, 38, 39, 40, 41 and 42 (Figs. 3 and 10) arranged in pairs (the number of pairs being the same as the number of engine cylinders). By way of illustration and not by way of limitation, a sufficient number of brush assemblies are illustrated in the drawings for operation with a four-cylinder engine.

Each brush assembly includes a brass sleeve 43, a carbon brush 44, a spring 45 and a bolt 46, as is shown in Figure 3. The inner end of the sleeve 43 is threaded into an opening in the wall of the housing 13, while the outer end acts as a terminal post and is internally threaded near its outer end to receive bolt 46.

The upper brush assemblies 35, 37, 39 and 41 of the respective pairs are located opposite the upper end of the cylindrical surface of the commutator 28, and hence are disposed in the path of movement of the conducting segment 32 and the main body portion of conducting ring 33. The gaps between the ends of the conducting segment 32 and the confronting portion of the ring 33 are sufficiently small that the brush 44 of each upper brush assembly will bridge the gap as the ring 33 moves out of engagement therewith, and as the conducting segment 32 moves into engagement therewith.

The lower brush assemblies 36, 38, 40 and 42 are located in the path of movement of the offset portion 34 of the conducting ring 33. This offset portion 34 is arranged to be engaged successively and at spaced intervals by first one lower brush assembly and then another, and this period of engagement will coincide with the engagement of the conducting segment 32 by the upper brush assembly of the same pair.

The timer 11 is also provided with a pair of cam-operated switches 47 and 48, the former being a normally closed switch and the latter being a normally opened switch. These two switches are mounted on a plate 49 which is generally circular in shape but which is provided with two portions 50, 51 which project slightly as shown in Figures 4, 8 and 10. Plate 49 is seated on the upper end of the housing 13. The lower interior portion of the housing 14 is recessed to provide an annular shoulder 52 which is eccentrically disposed with respect to the central axis of the housings 13 and 14. The inner diameter of the annular shoulder 52 is substantially the same or slightly greater than the distance across the disk 49 where the lips 50 and 51 are located. The inner wall defined by the shoulder 52 is indicated at 52a, Figs. 3 and 4.

The disk 49 is prevented from rotating by providing a pair of ribs 53 and 54 on the undersurface thereof which fit into channels 55 and 56 formed in the upper edge 57 of the lower housing 13. The disk 49 is also provided with an oblong center opening 58 through which the shaft 24 extends. The major axis of the oblong center opening 58 is parallel to the ribs 53 and 54.

Due to the eccentricity of the shoulder 52 and due to the fact that the lips 50 and 51 of the disk 49 lie against this shoulder 52, it will be apparent that limited movement of the disk 49 may be had with respect to the shaft 24, it being remembered that the ribs 53 and 54 in conjunction with the channels 55 and 56 confine the movement of the disk 49 to a single path.

The two cam-operated switches 47 and 48 which are mounted on the disk 49 will now be described. As previously mentioned, the switch 47 is a normally closed switch and includes a movable contact arm 59 which is mounted for limited movement on a pin 60. The outer free end of the movable contact arm 59 includes a contact button 61 and the intermediate portion of the arm 59 includes contact button 62 substantially opposite the opening 58 in the disk 49. Substantially opposite the opening 58 in the disk 49 is secured a raised portion or button 62 of fiber or other insulating material which provides a cam follower. A second movable contact arm 63 is mounted on the same pin 60 above the movable contact arm 59. This second movable contact arm 63 is somewhat shorter than the movable contact arm 59 and is provided with a contact button 64 on the side of the arm away from the hole 58 on the disk 49. This movable arm 63 does, however, have a raised portion or button 65 which is similar to the raised portion 62 on the arm 59.

Since the movable contact arm 63 must be electrically insulated from the movable contact arm 59, an insulating bushing 66 is provided around the shank of the pin 60 of the opening 67 through which the pin 60 passes (see Figure 9). Insulating washers 68 and 69 are also provided on opposite ends of the bushing 66 to complete the insulation of the arm 63 from the pin 60.

A third movable contact arm 70 is mounted on a second pin or post 71 behind the movable contact arm 63. It is to be understood that this movable contact arm 70 lies in the same plane of movement as the plane of movement of the contact arm 63, and is provided with a contact button 72 (Fig. 2) which is arranged to be engaged by the contact button 64 on the arm 63.

A stationary block 73 (Fig. 2) is mounted on the disk 49 on the opposite side of the hole 58 from the pin or post 60. The block 73 carries two adjustable stop members 74 and 75 which are provided, respectively, with lock nuts 76 and 77. It is also provided with an adjustable stationary contact 78 having a threaded shank 79 which extends through the block 73 and which is provided on the underside of the block 73 with a lock nut 80. Stationary contact 78 is arranged to be engaged by the contact button 61 (Fig. 8) on the movable contact arm 59. The adjustable stop 74 limits the clockwise movement of the movable contact arm 63 about the pin or post 60. The adjustable stop 75 is arranged to be engaged by the projecting or bent tip portion 81 of the movable contact arm 70, and is thus arranged to limit the clockwise movement of the movable contact arm 70 about the post 71.

Each of the arms 59 and 63 is provided with a tail portion 82 and 83 (Fig. 8), respectively, which are engaged by a leaf spring 84 (Fig. 2)

mounted on a post 85 and have a pair of fingers 86 and 87 (Fig. 9) which extend around a fixed post 88 and engage the tail portions 82 and 83, respectively, of the movable arms 59 and 63. These leaf spring portions 86 and 87 tend to move the arms 59 and 63 in a clockwise direction about their posts 60, and it will thus be understood that these arms are normally biased against the stationary contact 78 and the adjustable stop 74, respectively.

A leaf spring 89 (Fig. 2) is rigidly mounted on the post 90 and is sprung in such a manner as to normally urge the movable contact arm 70 against the adjustable stop 75.

The adjustable stops 74 and 75 are so adjusted with respect to each other that the contact button 64 and the movable contact arm 63 is out of engagement with the contact button 72 on the movable contact arm 70. A relatively slight movement of the contact arm 63 in a counter-clockwise direction, however, will cause it to engage the movable contact arm 70 and this engagement will continue even though further movement of the movable contact arm 63 follows.

It will thus be understood that the contact arm 70 is in effect merely a yieldable stationary contact.

Two cam disks 89 and 89*a* (Fig. 11) are rigidly secured to the shaft 24 in any suitable manner. Cam disk 89 has four raised portions 91, 92, 93 and 94 (see Figure 11). Cam disk 89*a* has four raised portions similar to those of cam disk 89 and which are identified as 95, 96, 97 and 98 (see Figures 2 and 11). The projecting portions 91 to 94 on cam disk 89 are arranged to engage the cam follower 62 on the movable contact arm 59 and lift the latter off stationary contact 78 each time one of the projections 91 to 94 engages the cam follower. The raised portions 95 to 98 on the cam disk 90 are arranged to engage the cam follower 65 on the movable contact arm 63. Each time that one of the raised portions 95 to 98 engages the cam follower 65, the movable contact arm 63 is moved to cause engagement of the same with the contact arm 70.

It will, of course, be understood that the number of raised portions on the cam disk 89 as well as the number of raised portions on the cam disk 89*a* is such as to correspond to the number of cylinders of the internal combustion engine with which the timer is associated.

It will be apparent from the above description that the length of time that the normally closed switch 47 remains open and the length of time that the normally open switch 48 remains closed depends upon the shape of the projecting portions on the respective cam disks 89 and 90 and on the speed of rotation of the timer shaft 24.

It will further be apparent that this length of time may be adjusted slightly by varying the relative position of the switch block 49 with respect to the shaft 24, since this varies the effectiveness of the projecting portions on the cam disks 89 and 90, and in effect, varies the angular extent on the cam disks over which one of the movable contact arms has been lifted away from its normal position.

As will be evident from Figure 4, rotation of the upper housing member 14 by means of the arm 105, causes the portion of the wall formed by the shoulder 52 to shift relative to the extended portions 50 and 51 of the member 49. One or the other of these portions then engages the wall 52*a* and causes the member 49 to shift along the axis determined by the ribs 53 and 54, thereby shifting the switches 47 and 48, Figure 8, relative to the shaft 24 and the cams 89 and 89*a*. This movement varies the dwell of the cam followers 62 and 65 on the cams 89 and 89*a* and thus controls the duration of the period during which the solenoid 124 is energized to inject fuel to each cylinder of the engine. The measured quantity of fuel admitted on each cycle is thereby controlled and the speed of the engine adjusted.

A pair of contactor brushes 99 and 100 (Figs. 9 and 10) for continuous sliding engagement with the conducting rings 30 and 31 (Fig. 7), respectively, on the upper surface of the commutator block 28 are conveniently mounted on the ribs 53 and 54, respectively, of the switch block 49.

The upper end of the housing 14 is preferably closed off by a cover plate 103 which is screwed to the upper end of the housing 14 by a suitable bolt 104.

Any mechanical means may be provided for varying the angular position of the upper housing member 14 with respect to the lower housing member 13 to thereby vary the eccentricity of the switch plate 49 with respect to the shaft 24. For purposes of illustration, a lever arm 105 has been shown in Figure 3 as the means by which the upper housing member 14 is angularly moved about its vertical axis with respect to the lower housing member 13.

In the foregoing paragraphs, I have described one embodiment of my novel timer. In order that the distinctive features and characteristics of this invention may be more readily appreciated and in order that the operation of this timer may be more clearly described, I have illustrated in Figure 11 a fuel injection system control circuit in which the timer may be used, and which control circuit is described and claimed in my aforementioned copending application, Serial No. 520,563.

As shown in Figure 11 of the drawings, the commutator ring 33 has been developed so as to show all of the brush assemblies 35 to 42. For the purposes of this application, it is sufficient to say that each cylinder of the internal combustion engine with which the present timer 11 is associated is provided with two valve operating solenoids 124 and 125 and the pairs of solenoids 124 and 125 for each cylinder have been identified diagrammatically with the letters A, B, C, and D, each letter designating a different cylinder. It is desired that the timer 11 effect the energization and deenergization of each solenoid 124 and 125 of each cylinder A, B, C, and D in a certain desired sequence as will hereinafter be pointed out.

Energy for operating the various solenoids 124 and 125 is obtained from any suitable source of electro-motive force, such, for example, as a six-volt battery 106. The negative side of the battery 106 is grounded as at 107, while the positive side of the battery is connected through a conductor 108 to the commutator ring 33. The particular manner in which the conductor 108 is connected to the commutator ring 33 is to connect the conductor 180 to brush 99 (Figs. 9 and 10) which, in turn, engages the conducting ring 30 (Fig. 7). This ring 30 is connected to the interior of the block 29 to the commutator ring 33. The positive side of the battery 106 is also connected through the conductor 108 and a branch conductor 109 to the movable contact arm 59 of the switch 47.

The upper brush assemblies 35, 37, 39 and 41 are connected through conductors 110, 111, 112, and 113 to the upper valve assembly coils 125 of

cylinders A, B, C, and D, respectively. Similarly, the lower brush assemblies 36, 38, 40 and 42 are connected through conductors 114, 115, 116 and 117, respectively, to the lower valve assembly coils 124 of the cylinders A, B, C, and D, respectively. The stationary contact 78 of the switch 47 is connected to the conducting segment 32 through the conductor 118. The contact arm 70 of the switch 48 is grounded through a conductor 119. The movable contact arm 63 of the switch 48 is connected through a conductor 120 and a common bus 121 to the other end of each of the lower valve assembly coils 124 of the cylinders A, B, C, and D, respectively. The ends of the upper valve assembly coils 125 which are not connected to the brush assemblies 35, 37, 39 and 41 are connected together by a common bus 122, which, in turn, is grounded as at 123.

Without describing the details of the valve mechanism of the fuel injection system, it will be sufficient to say that the coils 124 are energized to cause the fuel injection valve to open and admit fuel, and the coils 125 are energized to cause the valve to close. With this understanding, it will be apparent that the fuel injection valves of each cylinder are opened and closed during the time that the off-set portion 34 of the commutator ring 33 and the conducting segment 32 are in engagement with one of the pairs of brush assemblies 35 to 42. Which cylinder is having its fuel injection valve opening solenoid 124 energized will depend upon which pair of brush assemblies 35 to 42 is in engagement with the off-set portion 34 and the conducting segment 32 at the time.

Let it be assumed, for example, that the conducting ring 33 is being moved in the direction indicated by the arrow in Figure 11. As shown by the full line in Figure 11, all of the upper contacting brushes 35, 37, 39 and 41 are in engagement with the main body portion of the commutator ring 33. Under such a circumstance, all of the upper valve assembly coils 125 of the cylinders A, B, C, and D are energized.

Furthermore, since none of the lower contacting brushes 36, 38, 40 and 42 are in engagement with the offset portion 34 of the commutator ring 33, it is apparent that the lower valve assembly coils 124 of the cylinders A, B, C, and D are all deenergized. Hence, in the position shown by the full line in Figure 11, all of the fuel injection valves with which the operating coils 124 and 125 are associated are closed.

As the rotation of the disk 29 continues, it carries the commutator ring 33 in the direction indicated by the arrow, the brushes 40 and 39 will ride onto the off-set portion 34 and the conducting segment 32, respectively. This now places the engine cylinder with which the brush assemblies 39 and 40 are associated under control of the cam-operated switches 47 and 48. The valve actuating solenoids 124 of the remaining cylinders A, B, and D are still deenergized, however, and hence their associated valves remain closed.

Due to the fact that the brush 40 is now in engagement with the off-set portion 34, it will be apparent that the lower coil 124 of the cylinder C will be energized through the cam-operated switch 48 as soon as the movable contact arm 63 thereof is moved into engagement with the yieldable contact arm 70. The electrical circuit for this energization circuit extends from the battery 106 through the conductor 108, commutator ring 33, brush 40, conductor 116, coil 124 of cylinder C, conductor 121, conductor 120, movable contact arm 63, yieldable contact arm 70 and conductor 119 to ground.

The energization of the upper valve assembly coil 125 of cylinder C is under control of the cam-operated switch 47. This coil 125 of cylinder C remains energized only so long as the movable contact arm 59 of the switch 47 remains in engagement with the stationary contact 78. The reason for this is that the energization of the upper valve assembly coil 125 of the cylinder C is transferred from the commutator ring 33 and is now made through the switch 47 and the conducting segment 32.

More particularly, the coil 125 of cylinder C remains energized while the switch 47 is closed through conductors 108 and 109, switch 47, conductor 118, conducting segment 32, brush 39, conductor 112, coil 125 of cylinder C, and conductor 122 to ground 123. As soon as the movable contact arm 59 is lifted off of the stationary contact 78, however, this energization circuit is broken and the upper valve assembly coil 125 of cylinder C becomes deenergized.

In the embodiment of the invention above described, the movable contact arm 63 is arranged to close simultaneously with the opening of the movable contact arm 59. Likewise, the movable contact arm 59 is arranged to open simultaneously with the closing of the movable contact arm 59. The length of time which the movable contact arm 63 remains closed and the movable contact arm 59 remains open determines the length of time which the fuel injection valve of the cylinder remains open.

As the disk 29 continues to rotate, the off-set portion 34 and the conducting segment 32 will successively engage the brushes 42 and 41, then the brushes 36 and 35, and finally the brushes 38 and 37, which completes one revolution of the disk 29. The length of time that each intake valve remains open will, of course, be determined by the relative position of the upper housing member 14 of the timer 11 with respect to the lower housing member 13 as determined by the actuating lever 105.

While not shown, it will be readily apparent to all those familiar with a fuel injection system that a variable air intake opening is provided for the intake manifold of the engine, and this opening may be varied in size by any conventional mechanism operated in conjunction with the operating lever 105 of the timer.

While I have shown a particular embodiment of my invention, it will, of course, be understood that I do not wish to be limited thereto, since many modifications may be made, and I, therefore, contemplate by the appended claims, to cover all such modifications that fall within the true spirit and scope of my invention.

I claim as my invention:

1. A timer comprising a pair of contiguous interlocking cylindrical members forming a housing, a timer shaft extending through and journaled in an end wall of one of said housing members, a plate member in said housing transversely of said shaft, said plate member having an opening substantially larger than said shaft through which said shaft extends, said plate member being adjustably mounted for limited movement over a single path lying in a plane substantially perpendicular to said shaft, a plurality of switches mounted on said plate member including a normally closed switch and a normally opened switch, and a plurality of cams

on said shaft for cyclically operating said switches.

2. A timer comprising a pair of contiguous interlocking members forming a housing, a timer shaft extending through and journaled in an end wall of one of said housing members, a plate member in said housing transversely of said shaft, said plate member having an opening substantially larger than said shaft through which said shaft extends, said plate member being adjustably mounted for limited movement over a single path lying in a plane substantially perpendicular to said shaft, a normally closed switch and a normally opened switch mounted on said plate member, a cam disk for each of said switches secured to said shaft, one of said disks having means for periodically opening said normally closed switch, and the other of said disks having means for periodically closing said normally opened switch.

3. A timer comprising a pair of contiguous interlocking cylindrical members forming a housing, a timer shaft extending through and journaled in an end wall of one of said housing members, a plate member in said housing transversely of said shaft, said plate member having an opening substantially larger than said shaft through which said shaft extends, said plate member being adjustably mounted for limited movement over a single path lying in a plane substantially perpendicular to said shaft, a pair of movable switch arms mounted above the other for movement in spaced parallel planes, a stationary contact on said plate arranged to be engaged by one of said movable arms, a yieldable contact arm arranged to be engaged by the other of said movable arms, means for urging said movable arms and said yieldable arm toward said timer shaft, said stationary contact acting as a stop member for its associated movable contact arm, additional stop means for said other movable arm and said yieldable arm, said stop means for said yieldable arm being arranged to normally maintain said yieldable arm and said second movable arm separated, radially projecting means on said shaft in the plane of said first movable arm, radially projecting means on said shaft in the plane of said second movable arm, said radially projecting means being arranged to periodically separate said first movable contact from its associated stationary contact and for closing said second movable contact against said yieldable contact.

4. A timer comprising a pair of contiguous interlocking cylindrical members forming a housing, a timer shaft extending through and journaled in an end wall of one of said housing members, a plate member in said housing transversely of said shaft, said plate member having an opening substantially larger than said shaft through which said shaft extends, said plate member being adjustably mounted for limited movement over a single path lying in a plane substantially perpendicular to said shaft, a pair of movable switch arms mounted above the other for movement in spaced parallel planes, a stationary contact on said plate arranged to be engaged by one of said movable arms, a yieldable contact arm arranged to be engaged by the other of said movable arms, means for urging said movable arms and said yieldable arm toward said timer shaft, said stationary contact acting as a stop member for its associated movable contact arm, additional stop means for said other movable arm and said yieldable arm, said stop means

for said yieldable arm being arranged to normally maintain said yieldable arm and said second movable arm separated, radially projecting means on said shaft in the plane of said first movable arm, radially projecting means on said shaft in the plane of said second movable arm, said radially projecting means being arranged to periodically separate said first movable contact from its associated stationary contact and for closing said second movable contact against said yieldable contact, and means responsive to a relative rotational movement between said cylindrical members for shifting the position of said plate member with respect to said shaft.

5. A timer comprising a pair of contiguous interlocking cylindrical members forming a housing, a timer shaft extending into said housing through one end thereof, a switch mounting plate seated against the inner end of one of said members, said plate having projecting arcuate lips, the other of said members having an eccentrically formed inwardly facing annular shoulder against which said lips are seated, and means for preventing relative rotation of said plate whereby rotational movement of one cylindrical member with respect to the other causes movement of said plate member toward and away from said shaft.

6. A timer comprising a housing, a timer shaft extending into said housing, a plate member in said housing disposed transversely of said shaft, said plate member having an opening substantially larger than said shaft through which said shaft extends, said plate member being adjustably mounted for limited movement crosswise of said shaft, a plurality of switches mounted on said plate member including a normally closed switch and a normally opened switch, and a plurality of cams on said shaft in proximity to said switches for cyclically operating said switches.

7. A timer comprising a housing, a timer shaft extending into said housing, a plate member in said housing disposed transversely of said shaft, said plate member having an opening substantially larger than said shaft through which said shaft extends, said plate member being adjustably mounted for limited movement crosswise of said shaft, a normally closed switch and a normally open switch mounted on said plate member, and at least one cam for each switch on said shaft for cyclically moving its associated switch away from its normal position.

8. A timer comprising a housing, a timer shaft extending into said housing, a plate member in said housing disposed transversely of said shaft, said plate member having an opening substantially larger than said shaft through which said shaft extends, said plate member being adjustably mounted for limited movement crosswise of said shaft, a plurality of switches mounted on said plate member including a normally closed switch and a normally opened switch, a plurality of cams on said shaft in proximity to said switches for cyclically operating said switches, and means for moving said plate member to vary the position of said switches with respect to said cams.

9. A timer comprising a housing, a timer shaft extending into said housing, a plate member in said housing disposed transversely of said shaft, said plate member having an opening substantially larger than said shaft through which said shaft extends, said plate member being adjustably mounted for limited movement crosswise of

said shaft, a normally closed switch and a normally open switch mounted on said plate member, at least one cam for each switch on said shaft for cyclically moving its associated switch away from its normal position, and means for adjustably moving said plate member thereby to vary the relative spacing between said cams and their associated switches.

10. A timer comprising a housing, a timer shaft extending into said housing, a switch supporting member mounted in said housing for limited back and forth movement in the transverse plane of said shaft and diametrically of said shaft, a plurality of switches on said member including a normally closed switch and a normally opened switch, and a plurality of cams on said shaft in proximity to said switches for cyclically operating said switches.

11. A timer comprising a housing, a timer shaft extending into said housing, a switch supporting member mounted in said housing for limited movement crosswise of said shaft, a normally open switch mounted on said member, a normally closed switch mounted on said member, said switches being spaced axially of each other with respect to said shaft, and a plurality of cams on said shaft in proximity to said switches for cyclically operating said switches.

12. A timer comprising a housing, a timer shaft extending into said housing, a switch supporting member mounted in said housing for limited movement crosswise of said shaft, a normally open switch and a normally closed switch mounted on said member, said switches being spaced from each other in an axial direction with respect to said shaft, and a pair of cam rings on said shaft lying respectively in the planes of said switches and in engagement with said switches, said cam rings including a plurality of radially outwardly projecting humps for cyclically moving said switches away from their respective normal positions.

13. A timer comprising a housing, a timer shaft extending into said housing, a switch supporting member mounted in said housing for limited movement crosswise of said shaft, a normally open switch and a normally closed switch mounted on said member, said switches being spaced from each other in an axial direction with respect to said shaft, a pair of cam rings on said shaft lying respectively in the planes of said switches and in engagement with said switches, said cam rings including a plurality of radially outwardly projecting humps for cyclically moving said switches away from their respective normal positions, and means for moving said member to vary the spacing between said cam rings and said switches, thereby to vary the time said switches are held away from their respective normal positions by said cam ring humps.

14. A timer comprising a housing, a rotatable timer shaft extending into said housing, a switch supporting member mounted in said housing, a pair of switches mounted for movement toward and away from said shaft in spaced parallel transverse planes of said shaft and each having an inner and an outer position, means normally biasing said switches to their respective inner positions, and a pair of cam rings on said shaft in the planes of said switches respectively, said cam rings having projecting cam portions thereon for moving said switches from their inner to their outer positions each time said cam portions strike said switches.

15. A timer comprising a housing, a rotatable timer shaft extending into said housing, a switch supporting member mounted in said housing for movement crosswise of said shaft along a single path, a pair of switches mounted for movement at substantially right angles to the path of movement of said spporting member toward and away from said shaft, said switches lying in spaced parallel transverse planes of said shaft, and each having an inner and an outer position, means normally biasing said switches to their respective inner positions, one of said switches being normally closed in its inner position and the other of said switches being normally open in its inner position, a pair of cam rings on said shaft in the planes of said switches respectively, said cam rings having projecting cam portions thereon for moving said switches from their inner to their outer positions each time said cam portions strike said switches, and means for adjustably moving said switch supporting member, thereby to vary the length of time said switches are held in their outer positions by said cam portions.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
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