

H. H. GORDON.
ELECTRICAL SYSTEM.
APPLICATION FILED DEC. 4, 1916.

1,328,374.

Patented Jan. 20, 1920.
2 SHEETS—SHEET 1.

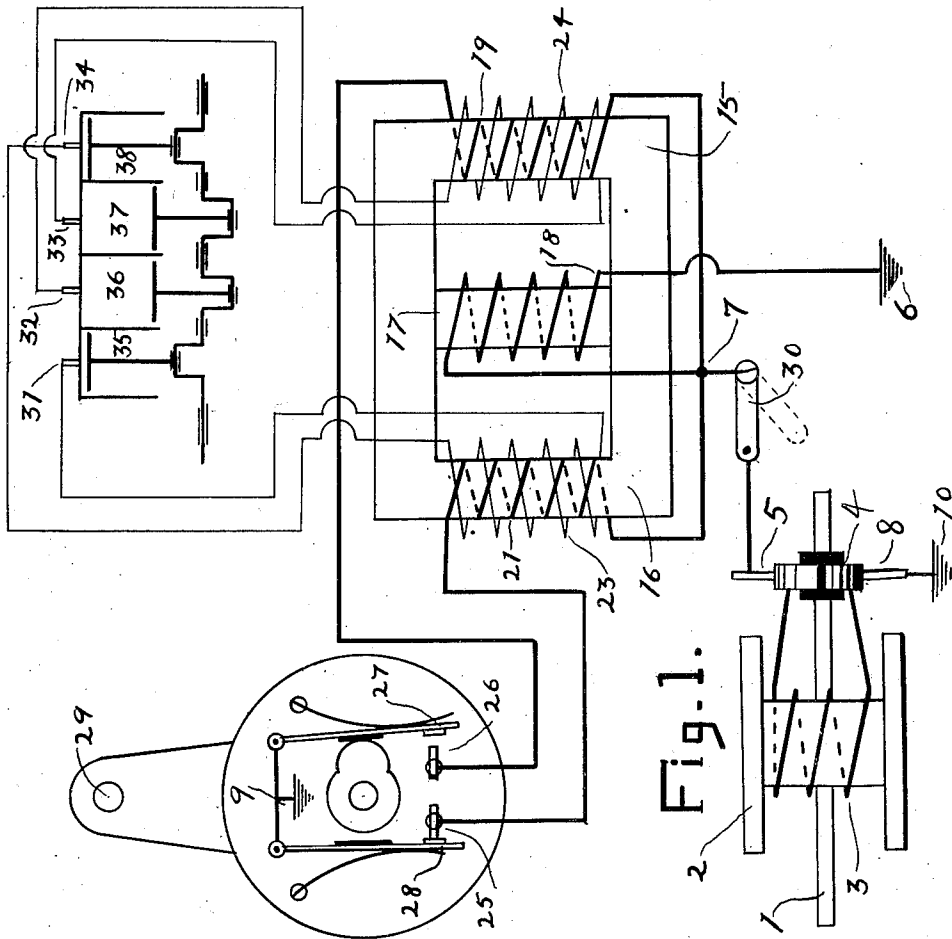


Fig. 1.

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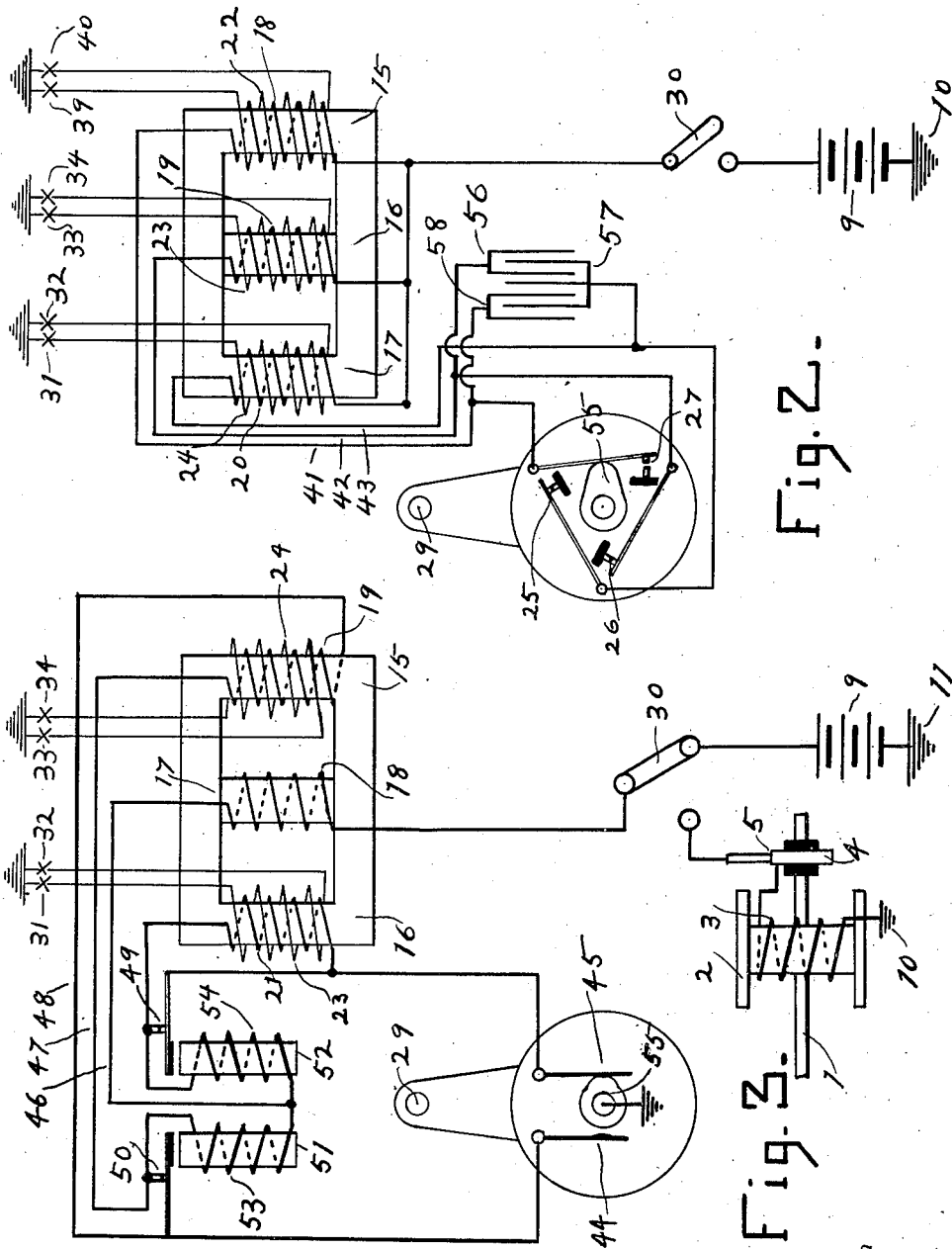


Fig. 2.

Fig. 3.

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ELECTRICAL SYSTEM.

1,328,374.

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To all whom it may concern:

Be it known that I, HAYNER H. GORDON, a citizen of the United States of America, residing at Washington, in the District of Columbia, have invented new and useful Improvements in Electrical Systems, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, which form part of this specification.

This invention relates to electrical systems. It may find embodiment in many systems in which it is desired to control an intermittent flow of current in a plurality of circuits energized from a common source. In the particular instance I have selected as an embodiment of my invention, an ignition system for a multiple cylinder internal combustion engine, in which the flow of the high tension current to the spark plugs of the engine is controlled.

The usual ignition system for an internal combustion engine of the multiple cylinder type must comprise either a plurality of induction coils or transformers, there being as many coils required as there are spark plugs in the engine, or else one coil or transformer is used, and a high tension current thus generated is led to a distributor which mechanism is employed to selectively distribute the high tension current to the spark plugs in the necessary firing sequence. In the first case there is never absolute synchronism present in the spark timing owing to the fact that it is almost impossible to construct a plurality of coils which will have the same electrical lag. This is due to that fact that the quality or quantity of iron in the core will vary as well as the electrical constants of the various coils. In the second case the objection due to unequal electrical lags is overcome, but this is only accomplished by the addition of a distributor, a device whose delicate and expensive construction is well known and the use of which adds greatly to the complication of the ignition system.

The general object of my invention is to provide an electrical system in which a plurality of high tension circuits are energized from a common transformer with a single primary winding. The high tension circuits are controlled by means of low tension circuits associated with the transformer.

A further object is to provide an ignition

system for a multiple cylinder internal combustion engine in which but one transformer or coil is used and which does not necessitate the use of a high tension distributor.

A further object of my invention is to provide a transformer for ignition purposes, which utilizes the change of magnetic flux from a positive maximum to a negative maximum instead of the usual utilization of flux in an ignition transformer from a maximum to zero value.

My invention is herein set forth for the sake of illustration, comprises broadly a source of current, a single transformer energized therefrom, a plurality of high tension leads or conductors connecting the transformer to the spark plugs of the internal combustion engine, and a plurality of low tension circuits associated with the transformer for controlling the alternative energization of the high tension conductor as will be hereinafter fully set forth.

Figure 1 is a diagrammatic view of circuits and apparatus embodying my invention, said diagram showing a particular electrical system, such as may be used in connection with an internal combustion engine and to be hereinafter more fully referred to.

Fig. 2 illustrates my invention as arranged for the ignition of a six cylinder internal combustion engine.

Fig. 3 illustrates a modification of my invention in which electro-magnetic control relays are used.

In these figures like numerals are used to designate corresponding parts.

Referring to Fig. 1 the numeral 2 represents the armature of a direct current generator mounted upon a shaft 1 and carrying a winding 3 connected to the commutator 4 and brushes 5 and 8, the brush 8 being grounded at 10 and the brush 5 being connected to a switch 30. It is to be understood that I do not limit myself to any specific source of current, as I may employ any other type of generator than that shown or in fact a battery may be used. The switch 30 connects this source of current with the windings upon the transformer 18, 19 and 21. This transformer consists of three legs or cores 15, 16 and 17 connected by the two end pieces as shown such cores and end pieces being of the well known laminated structure such as is used in transformer construction. The 3 windings 18, 19 and 21

are connected in parallel with the source of current, the winding 18 being grounded at 6 and windings 19 and 21 being respectively connected with the fixed timer contacts 26 and 27 which contacts are normally grounded at 9 by the movable contacts 27 and 28, which are alternately operated by the interrupter cam as it rotates. The usual condensers may be placed across the interrupter contacts 26—27 and 25—28 if necessary. The windings 18, 19 and 21 are all wound in the same direction so that upon the excitation of any or all of the coils, the magnetic flux will take place in the same direction in the cores 17, 16 or 15. Wound upon the cores 15 and 16 and superimposed upon the primary windings 19 and 21 are secondary windings 24 and 23. The ends of the secondary 23 lead to the spark plugs 31 and 34 in the cylinders 35 and 38 of the internal combustion engine, while the ends of the secondary 24 lead to the plugs 32 and 33 in the cylinders 36 and 37.

It will be understood that the interrupter cam is driven synchronously with the crank shaft of the engine by any of the interrupter driving mechanisms such as are well known in the art. The hole 29 in the interrupter controlling arm is for the connection of the spark control lever. It will be noted that the circuits of the three primary windings 18, 19 and 21 are normally closed, current flowing in the same direction as previously set forth and a flow of magnetic lines of force being set up in the same direction in each of the cores 15, 17 and 16. As the interrupter cam rotates it alternately opens the circuits of the coils 19 and 21; as shown in Fig. 1, the cam has just caused the contacts 26—27 to be suddenly opened. Such action causes the current to cease flowing in the primary winding 19, thereby causing the flux set up by this current to die away suddenly. Such collapse of the lines of force build up a voltage in the secondary winding 24 sufficient to break down the air gaps at the plugs 32 and 33. The spark thus formed, however, is not a mere instantaneous flash or of brief duration but it continues to burn in the form of a flaming arc as a magnetic flux has now been set up in the core 15 by the current which continues to flow in the windings 18 and 21, which flux is in the opposite direction from that originally existing in the core 15. The breaking down of the spark gaps at the plugs by the initial collapse of the flux in the core 15 in effect causes a closing of the circuit containing the coil 24 with the result that there is established a mutual or reciprocal regulative relationship between the arc and the coil 24 or the flux change which tends to prevent immediate assumption of the maximum value of the flux in the core 15 set up by the windings 18 and

21. Thus as the arc is established at the gaps 32 and 33, current flows in the secondary circuit and coil 24 which current flow in the turns of coil 24 tends to restrain the inflow of flux and thus prevents the instantaneous discharge of energy in the secondary system. It will thus be seen that my construction combines the advantages of such systems as operate to induce a spark by the interruption of the primary circuit and of systems in which the spark is produced by the closing of the primary circuit. In addition my system operates to instantaneously break down the resistance of the spark gap with a current of high voltage and to follow the initial formation of the spark with a current of sustained high heat value.

It will be noted that the pistons move together in cylinders 36 and 37 of the engine, one ascending on the compression stroke and the other on the exhaust stroke. As the plugs 32 and 33 both function simultaneously, one spark will be produced in the compressed mixture igniting the same while the other takes place in the inert burnt gas. In the manner just set forth the plugs 31 and 34 function when the interrupter contacts 25—28 are opened and the secondary winding 23 excited.

A modification of my invention is illustrated in Fig. 2 in which like numerals are used to designate the corresponding parts.

In this modification which is an adaptation of my system to a six cylinder internal combustion engine, the three cores of the transformer 15, 16 and 17 carry the primary 18, 19 and 20, which primary windings are grounded through the leads 41, 42 and 43 and the interrupter contacts 25, 26 and 27. The cores 15, 16 and 17 are also provided with secondary windings 22, 23 and 24, the ends of the secondary 22 being connected to the spark plugs 39 and 40, those of the secondary 23 being connected to the spark plugs 33 and 34 and those of secondary 24 being connected to spark plugs 31 and 32. It is to be understood that the plugs 39 and 40 are placed in those cylinders in which the pistons move together as is also the case with plugs 33 and 34 and plugs 31 and 32.

Such an arrangement of circuits which obviate the use of a high tension distributor has already been explained in connection with the ignition system shown in Fig. 1. A battery 9 grounded at 10 and connected to a switch 30 together with a triplex condenser across the interrupter contacts completes the system shown in Fig. 2. The triplex condenser consists of three sets of tin foil sheets 56, 57 and 58 interleaved with the usual insulating medium, each set being connected to one of the conductors 41, 42 and 43 leading to the stationary inter-

rupter contacts. This type of condenser will have the same result as three separate condensers connected across each set of interrupter contacts owing to the fact that only one of the contacts is opened at any one time, and that portion of the condenser connected to the remaining contacts is grounded through the closed contacts.

The operation of this system is the same as that disclosed in Fig. 1 and a full repeated explanation is unnecessary, it being clear that as each of the interrupter contacts is selectively opened by the cam 55 the current flow through the primary winding connected thereto ceases and the flux dies away in the core upon which the selected primary is wound, such action being followed by a flow of flux in the reverse direction from the two primary windings that remain closed. Such action produces the sparks or arcs at the plugs connected to the proper secondary winding.

Fig. 3 shows a modification of my system involving electro-magnetic control relays which system may be used with either alternating or direct current as a source. The sources of current shown in Fig. 3 consist of a battery 9 grounded at 11 and an alternating current generator represented by the armature 2 mounted on the shaft 1 and carrying a winding 3 connected to a slip ring 4 and collector brush 5, the switch 30 being used to select either source of current. The transformer consists of the three cores 15, 17 and 16 each carrying a primary winding 19, 18 and 21 respectively. In this modification however the winding 18 is connected to the switch lever 30 while the two windings 19 and 21 are normally short circuited through the contacts of the electro-magnetic interrupter 49 and 50, the winding 19 being connected to the contacts 50 by the leads 47 and 48 and the winding 21 being connected to the interrupter contacts 49. Windings 19 and 21 have superimposed upon them, secondary windings 24 and 23 respectively connected to spark plugs 33—34 and 31—32 in the manner already explained in connection with Figs. 1 and 2. The coil 18 is connected to the electro-magnetically controlled relays by the lead 46. These relays consist of cores 51 and 52 surrounded by windings 53 and 54 one end of each of these windings being connected to the upper or stationary contact of the interrupter contacts 49 and 50 and the other ends being connected to the lead 46. The contacts carried by the springs of the interrupters are connected by leads to the timer contacts 44 and 45, the timer in this case being of the circuit closing type the cam 55 rotating and making selective contact with the springs 44 and 45.

Assuming the switch 30 to be in a position connecting one of the sources of current

to the winding 18 and the interrupter cam to be revolving the circuit will be closed through the coil 18 through lead 46 and alternately through the windings 53 and 54, interrupter contacts 50 and 49 and timer contacts 44 and 45. Assuming the timer contacts to be in the position shown in Fig. 3 the current will flow through winding 18 lead 46 coil 54, interrupter contacts 49 and through the timer contact 45, to the cam 55 and thence to ground. As soon as this current flow reaches a high enough value, the spring of the interrupter will be influenced by the core 52 and the interrupter contacts 49 will be opened. Previous to this opening of the interrupter contacts the windings 19 and 21 being short circuited, act as choke windings, preventing any flux from passing through the cores 15 or 16 and tendency for flux change setting up a current in the short circuited windings 19 and 21 which in turn sets up a counter magnetic flux, but as soon as the interrupter contacts 49 are opened the coil 21 is introduced in the circuit and a current flow takes place in coil 21 in a direction opposite to that in coil 18. Therefore the opening of the contacts 49 not only permits the flux set up by the winding 18 to pass through the core 16 but reinforces this flow of flux by a passage of current in the winding 21 in a direction proper for such flux reinforcement. This sudden increase of flux in the core 16 will build up the voltage in the secondary winding 23 with a consequent breaking down of the spark gaps 31 and 32 and a production of a flaming arc will then take place at the gaps 31 and 32 in the manner already set forth in connection with the system disclosed in connection with Fig. 1. When the timer cam makes contact with the spring 44 the same action will take place in core 15 in the manner just described, and sparks will be produced at the gaps 33 and 34.

What I claim is:

1. In an ignition system the method of producing an ignition current which consists of controlling the direction of flow of magnetic flux in a multiple magnetic circuit transformer.

2. In an ignition system a transformer comprising a plurality of complete magnetic circuits, each circuit being surrounded by one or more energizing coils, a source of current, and circuit controlling means connected with the source of current and the energizing coils, whereby the direction of magnetic flux in the transformer may be controlled.

3. In an ignition system, a transformer comprising two end pieces, a plurality of cores connecting said end pieces, an energizing coil associated with each of said cores, a source of current connected to said energiz-

tion connecting one of the sources of current

ing coils, and a circuit controller adapted to selectively interrupt the flow of current in the energizing coils, thereby producing a change of direction of flux flow in certain portions of the core of the transformer.

4. In an ignition system a transformer comprising a plurality of closed magnetic circuits, an energizing coil associated with each magnetic circuit, a source of current connected to said energizing coils, secondary windings associated with each of said closed magnetic circuits, a circuit controller adapted to selectively interrupt the flow of current in the energizing coils thereby producing a change of flux in said magnetic circuits and causing the successive energization of said secondary coils.

5. In an ignition system an electrical transformer comprising a plurality of closed magnetic circuits, an energizing coil surrounding each magnetic circuit, a secondary winding surrounding each closed magnetic circuit, spark plugs connected to said secondary windings, a source of current normally connected with said energizing coils, and a timer adapted to successively interrupt the flow of current in the energizing coils, thereby causing the successive energization of the secondary windings and spark plugs.

6. In an ignition system, the combination with a plurality of magnetic paths having portions thereof in common, of means comprising windings for setting up a magnetic flux in said paths, and circuit controlling means for first producing the cessation of magnetic flux in one of said paths immediately followed by a reversal of magnetic flux in said path.

7. In an ignition system, the combination with a plurality of magnetic paths having portions thereof in common, of means comprising windings and a source of direct current for setting up a magnetic flux in said paths, and selective circuit controlling means for first producing the cessation of magnetic flux in a selected path immediately followed by a reversal of magnetic flux in said path.

8. In an ignition system, the combination with a plurality of magnetic paths having portions thereof in common, of means comprising windings and a source of direct current for setting up a magnetic flux in said paths, selective circuit controlling means for first producing the cessation of magnetic flux in a selected path immediately followed by a reversal of magnetic flux in said path, and means exterior to said magnetic paths for determining the rate of reversal of magnetic flux in said selected path.

9. In an ignition system for an internal combustion engine, the combination with a plurality of magnetic paths having portions thereof in common, of means comprising windings and a source of direct current for

setting up magnetic flux in said paths, and a selective circuit controlling device driven in synchronism with said engine for first producing the cessation of magnetic flux in a selected path immediately followed by a reversal of magnetic flux in said path.

10. In an ignition system for an internal combustion engine, the combination with a plurality of magnetic paths having portions thereof in common, of means comprising windings and a source of direct current for setting up magnetic flux in said paths, a selective circuit controlling device driven in synchronism with said engine for first producing the cessation of magnetic flux in a selected path immediately followed by a reversal of magnetic flux in said path, and means exterior to said magnetic paths for determining the rate of reversal of magnetic flux in said selected path.

11. In an ignition system for an internal combustion engine, the combination with a plurality of magnetic paths having portions thereof in common, of means comprising windings and a source of direct current for setting up magnetic flux in said paths, a selective circuit controlling device driven in synchronism with said engine for first producing the cessation of magnetic flux in a selected path immediately followed by a reversal of magnetic flux in said path, and means exterior to said magnetic paths, and depending upon the compression pressure in said engine for determining the rate of reversal of magnetic flux in said selected path.

12. In a high tension electric system, the combination with a plurality of magnetic cores having primary windings thereon, of means comprising a source of direct current connected to normally energize said primary windings and to cause a magnetic flux to be set up in said cores, secondary windings arranged to coact with certain of said primary windings, a load circuit associated with said secondary windings, and selective circuit controlling means adapted to selectively interrupt the current flow to certain of said primary windings, said cores being so correlated that when the flow of current in one of said primary windings is interrupted the magnetic flux in the remaining cores may act to increase the electrical energy in the secondary winding and associated load circuit co-acting with the primary winding in which said current flows interrupted.

13. In an electric system, a source of energy, a transformer core, a primary winding about a portion of the core and in circuit with said energy source, means to energize other portions of said core, means to selectively deenergize said other portions, and energy producing coils in operative relationship to said core portions.

14. In an electric system, a source of en-

ergy, a transformer core, a plurality of primary windings on separate sections of said core and in circuit with said energy source, means to energize the sections of said core, means to selectively deenergize said core sections to create a reversal of magnetic flux, and an energy producing coil on each core section in series with a spark gap.

15. In an ignition system for an internal combustion engine, the combination of sparking devices in circuit with secondary windings of a transformer, a core for said transformer, a plurality of primary windings on said core, a source of energy for said windings and means for selectively deenergizing said primary windings.

16. In an ignition system for internal combustion engines, the combination with a source of energy, of a unitary transformer structure including a plurality of secondary windings, a plurality of spark plugs continuously connected to said secondary windings, and means for controlling the selective sparking of said spark plugs in the operation of the engine comprising a low

tension circuit breaker driven in synchronism therewith and connected to said transformer to produce a reversal of flux in certain portions of the secondary windings at given periods.

17. In an electric system, the combination with a core having primary windings thereon, of means comprising a source of electrical energy connected to energize said primary windings, secondary windings arranged to co-act with said primary windings, load circuits associated with said secondary windings, and selective circuit controlling means adapted to interrupt the current flow in certain of said primary windings, said core being so constructed that when the current flow in certain portions of said primary windings is interrupted, the magnetic flux produced by the remainder of the primary windings acts to produce electrical energy in certain portions of the secondary windings.

In testimony whereof I have hereunto set my hand.

HAYNER H. GORDON.