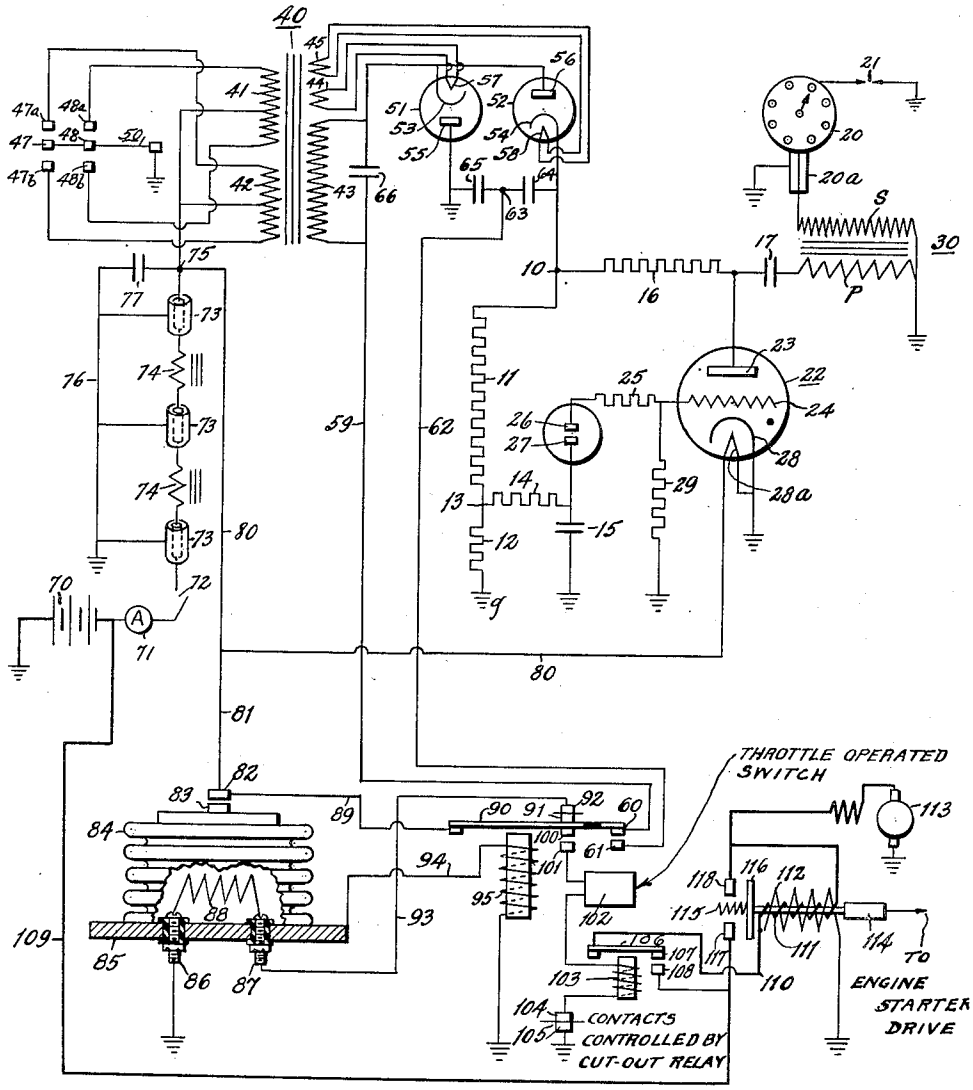
April 24, 1951 B. H. SHORT 2,550,026

STARTING AND IGNITION SYSTEM

Filed May 14, 1946



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Patented Apr. 24, 1951

2,550,026

UNITED STATES PATENT OFFICE

2,550,026

STARTING AND IGNITION SYSTEM

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Application May 14, 1946, Serial No. 669,498

2 Claims. (Cl. 123—179)

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This invention relates to ignition apparatus for internal combustion engine and more particularly the type of apparatus shown in the copending application of B. H. Short and A. G. Tynan, Serial No. 611,402, filed August 18, 1945, now Patent No. 2,463,123. The apparatus disclosed in said application comprises a source of direct current, a main condenser and an auxiliary condenser charged thereby, a thyratron tube which, upon being rendered conducting, provides a discharge path from the main condenser through the primary of a high frequency ignition coil, and a circuit including the auxiliary condenser, the grid of the thyratron and an ignition timer which at the proper instant causes the auxiliary condenser to discharge through the thyratron grid to render it conducting.

One object of the invention is to provide in connection with ignition apparatus, such as the type referred to, means for withholding the application of voltage from the D. C. source to the thyratron tube for a predetermined time following the closing of a main control switch which renders the D. C. source operative to supply voltage to the tube. This time is sufficient for the heating of the cathode of the thyratron. In this connection it is a further object to prevent the use of the engine starter during the interval required to heat the thyratron cathode. If the D. C. source is a vibrator power pack operated by the storage battery and having rectifier tubes, the time interval required for heating the thyratron cathode would include the time required for heating the cathodes of the rectifier tubes.

A further object of the invention is to suppress the emanation of high frequency disturbances so that the operation of adjacent radio apparatus is not interfered with.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing, wherein a preferred embodiment of the present invention is clearly shown.

The figure of the drawing is a wiring diagram disclosing an embodiment of the invention.

As disclosed in the copending application referred to, the ignition apparatus comprises a terminal 10 connectible with a D. C. source and connected with a voltage divider comprising resistance elements 11 and 12 connected by a tap 13 and grounded at *g*. A resistance 14 connects tap 13 with condenser 15 which is grounded. Terminal 10 is connected by resistance 16 with a main condenser 17 connected with primary P of

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a high frequency ignition coil 30 whose secondary S is connected with an ignition distributor 20 for distributing sparking impulses to a plurality of spark plugs, one of which is indicated at 21. The charging of the main condenser is from the high voltage terminal 10, resistance 16 and through primary P to ground. The discharge of the main condenser 16 is controlled by a hydrogen filled thyratron tube 22 whose plate 23 is connected between resistance 16 and condenser 17 and whose grid 24 is connected by resistance 25 with ignition timer contact 26 cooperating with timer contact 27 connected with resistance 14 and auxiliary condenser 15. Tube 22 has a grounded cathode 28 heated by a filament 28*a*. A resistance 29 connects grid 24 and resistance 25 with ground.

Suitable electrical dimensions of the condensers and resistances are as follows:

Resistance 11	megohms	5
Resistance 12	do	.75
Resistance 14	do	.75
Resistance 16	do	.1
Resistance 25	ohms	2500
Resistance 29	do	25,000
Condenser 15	mf	.001
Condenser 17	mf	.02

While the dimensions given have proven satisfactory for certain types of service it may be understood that other dimensions may be selected depending upon the type of service. A satisfactory thyratron tube is type 4C35. The high frequency ignition coil may be constructed in the manner disclosed in the copending application referred to. The operation of the ignition system is disclosed in detail in said application.

Briefly stated, the operation is as follows: Condensers 15 and 17 are charged by applying a suitable voltage from a D. C. source to the terminal 10. When the timer contacts 26 and 27 are closed, condenser 15 discharges thereby rendering the tube 22 conductive whereby the condenser 17 is discharged through the primary P of ignition coil 30 and a sparking impulse is distributed to the required spark plug 21 by the distributor 20. When condenser 17 is discharged the thyratron 24 becomes nonconducting and cannot be rendered conducting again until condenser 15 is discharged by another closing of the timer contacts.

The ignition apparatus is operable by any suitable source of direct current of sufficient voltage. One suitable source is what is known as a vibrator power pack comprising a power

transformer 40 having center tapped primaries 41 and 42 and a main secondary 43 and auxiliary secondary windings 44 and 45. The lower ends of the primary windings 41 and 42 are connected respectively with the fixed contacts 48b and 47b of a vibrator having fixed contacts 48a and 47a connected respectively with the upper ends of primary windings 42 and 41. A vibrator reed 50 carries contacts 48 and 47 which respectively make contact concurrently with contacts 48a and 47a or with contacts 48b and 47b concurrently. The reed 50 is caused to vibrate by an electromagnet (not shown) having a coil which is intermittently energized and then de-energized by a short circuit controlled by the reed in the well known manner. For full wave rectification the power pack includes rectifier tubes 51 and 52 having cathodes 53 and 54 respectively and plates 55 and 56, respectively. The respective cathode heater filaments 57 and 58 of the tubes are connected respectively with the transformer secondaries 44 and 45. Plate 56 and cathode 53 are connected with the upper end of secondary winding 43, the lower end of which is connected by wire 59 with a switch contact 60 which at the proper time makes engagement with a contact 61 connected by a wire 62 with a terminal 63. A condenser 64 is connected between terminal 63 and cathode 54. A condenser 65 is connected between terminal 63 and plate 55 which is grounded. Cathode 54 is connected with the terminal 10. A condenser 66 is connected across the terminals of secondary winding 43.

The low voltage current for operating the power pack is obtained from the storage battery 70 which is grounded and which is connected through ammeter 71 and ignition switch 72 with a chain of concentric condensers 73 alternating with choke coils 74 connected in series with the switch 72 and a terminal 75 which is connected with the center taps of primary windings 41 and 42. The outer terminals of the condensers 73 are connected with a grounded wire 76. A condenser 77 is located between wire 76 and terminal 75. The elements 73, 74 and 77 connected as shown provide for the suppression of emanations from the ignition apparatus which would interfere with adjacent radio apparatus. The lead from the secondary S of coil 30 to the distributor 20 may be provided with a grounded shield 20a. Satisfactory suppression of radio interference has been obtained when the condenser capacities are as follows: Condenser 77, 4 mf.; uppermost condenser 73, .1 mf.; and the two lower condensers 73, .7 mf.

The reasons why the condensers 77 and 73 and the choke 74 are effective to suppress interference with radio operation are as follows. When the vibrator contacts close and open, the form of the electrical wave in the parts of the transformer primaries is substantially rectangular. These rectangular waves are the resultants of component fundamental waves of relatively low frequency and harmonies of different relatively high frequencies. Therefore, if no suppressors were placed in the relatively long line between the battery and the power pack, this line would serve as an antenna which would broadcast waves resulting from the transient currents which would occur in the line by reason of the components of the rectangular waves in the transformer primary. The function of the condensers is to supply the transient currents as needed thus avoiding as much as possible their

supply from the battery through the line. The 4 mf. condenser 77 supplies the demand for low frequency current at point 75 and the .1 mf. condenser 73 for certain higher frequency currents. Demand for currents of other frequencies which the upper choke 74 does not entirely minimize will be supplied by upper condenser 73. If there is still an unsatisfied demand for transient current not minimized by the lower choke 74, the lower condenser 73 will supply it. In this way the long line from the battery to the power pack is not required to transmit transient currents which would interfere with operation of the car radio. Obviously, the power pack, its suppressors, the ignition apparatus, the thermal switch and the relay switch connected with the power pack would be closely grouped and shielded.

The apparatus for withholding the application of voltage to the terminal 10 of the ignition apparatus until after the cathode 28 has been sufficiently heated will now be described. The cathode heater filament 28a is connected by wire 80 with terminal 75. A wire 81 connects wire 80 with a contact 82 engageable with a contact 83 mounted on the upper wall of a flexible metal bellows 84 whose lower wall is provided by a metal plate 85 which insulatingly supports terminals 86 and 87 connected with a heater coil 88 located within the bellows 84. Contact 82 is connected by wire 89 with a relay armature 90 carrying a contact 91 normally engaging a contact 92 connected by wire 93 with terminal 87. Terminal 86 is grounded. Plate 85 is connected by wire 94, with a magnet coil 95 which is grounded. When ignition switch 72 is closed, heater filament 28a is connected with the battery 70. While the cathode 28 is being heated to the temperature required for proper operation of the tube 22, the power pack cannot supply a voltage to the terminal 10 because a circuit of the transformer secondary winding 43 is interrupted by the separated contacts 60 and 61. While cathode 28 is being heated, the heater 88 within the Sylphon is connected with the battery through a circuit which includes the terminal 75, wire 80, wire 81, contact 82, wire 89, armature 90, contact 91, contact 92, wire 93, terminal 87, heater 88 and terminal 86. By the time the cathodes 28 have been heated sufficiently for proper operation of the tube 22, the air within the bellows 84 will have expanded to such extent that contact 83 will engage contact 82 and the magnet coil 95 will be connected with the battery through a circuit which includes: Terminal 75, wire 80, wire 81, contact 82, contact 83, bellows 84, plate 85, wire 94 and coil 95. Armature 90 will be actuated downwardly to separate contact 91 from contact 92 thus open circuiting the heater coil 88 and causing the contact 60 to engage contact 61 whereupon the power pack 40 will be effective to supply the proper voltage to the terminal 10.

In order that the car driver will not inadvertently attempt to operate the engine starter while there is no ignition available, means are provided for preventing the connection of the storage battery with the starting motor until after ignition is available. For this purpose, a control of the connection of the starting motor with the battery includes a contact 100 carried by the armature 90 and normally separated from a stationary contact 101. Various means can be provided for utilizing contacts 100 and 101 for controlling the connection between the storage battery and the

starting motor. For example, in a starter system using the accelerator or throttle pedal for causing the battery to become connected with the engine starting motor the contacts 100 and 101 would be connected into a series circuit which includes the following elements: Battery 70, ignition switch 72, terminal 75, wire 80, wire 81, contact 82, wire 89, armature 90, contact 100, contact 101, a switch 102 which can be closed by the accelerator pedal only when the engine is not self-operative, a relay coil 103 and a pair of normally closed contacts 104 and 105 which are opened automatically by the cut-out or reverse current relay (not shown) used to control the connection between the generator (not shown) and the storage battery. Therefore, before the cathode 28 has been heated sufficiently for proper operation of the tube 22 no current can flow from the battery through the relay magnet coil 103. When armature 90 is attracted downwardly after the lapse of time sufficient for the proper heating of cathode 28, then the battery becomes connected with the magnet coil 103 through the series circuit which has been described. When this occurs, the armature 106 of the relay moves a contact 107 into engagement with a contact 108 thereby connecting the battery through wire 109, contact 108, contact 107, armature 106 and wire 110 with a solenoid magnet coil 111 of relatively coarse wire and a solenoid magnet coil 112 of relatively fine wire. The circuit of winding 111 is completed through the starting motor 113 to ground. The circuit of the fine winding 112 is completed directly to ground. The energization of both windings 111 and 112 is sufficient to effect left movement of a solenoid armature 114 against the action of a spring 115 to cause a contact 116 to bridge contacts 117 and 118 thereby connecting the battery 70 with the starting motor 113 through the wire 109, contact 117, contact 116 and contact 118. When this occurs, the coil 111 is short-circuited, but coil 111 is able to maintain the contacts in engagement since the air gap between the armature 114 and the core, not shown, is relatively small. The left movement of the solenoid armature 114 may be used to shift the starting motor drive which is not shown. When coil 112 is deenergized, the spring 115 is permitted to separate the contact 116 from the contacts 117 and 118 and to disengage the engine starter drive from the flywheel of the engine. Coil 112 is deenergized when relay coil 103 is disconnected from the battery. This is accomplished by the separation of contacts 104 and 105 when the cut-out relay closes to connect the generator with the battery after the engine becomes self-operative, as disclosed in Dyer Patent 2,167,646, and also by the opening of throttle-pedal-operated switch 102 in the manner disclosed in said Dyer patent which shows in detail one form of such switch or in the manner disclosed in Dermond Patent 2,324,125 which shows another form of such switch.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted all coming within the scope of the claims which follow.

What is claimed is as follows:

1. Ignition apparatus for internal combustion engines, comprising an ignition coil, a condenser, a power pack for charging the condenser, a thyratron for withholding the discharge of the condenser to the thyratron until the required instant of firing, a timer driven by the engine for effecting the thyratron, a low voltage current source for operating the power pack and for supplying current to the filament of the thyratron, an electric motor for cranking the engine, and means for withholding the application of a voltage by the power pack to the plate of the thyratron and for withholding the connection of the current source with the electric motor, for a time during which the thyratron is heated to operating temperature.

2. Ignition apparatus for internal combustion engines, comprising an ignition coil, a condenser, a thyratron for controlling condenser discharge to the coil, a power pack for applying a charging voltage to the condenser and a suitable voltage to the plate of the thyratron, means including a timer driven by the engine for rendering the thyratron conducting, a low voltage current source for operating the power pack and for supplying current to the filament of the thyratron, an electric motor for cranking the engine, and means for withholding the application of voltage by the power pack to the condenser and to the plate of the thyratron and for withholding the connection of the current source with the electric motor for a time sufficient for the proper heating of the thyratron to operating temperature.

BROOKS H. SHORT.

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