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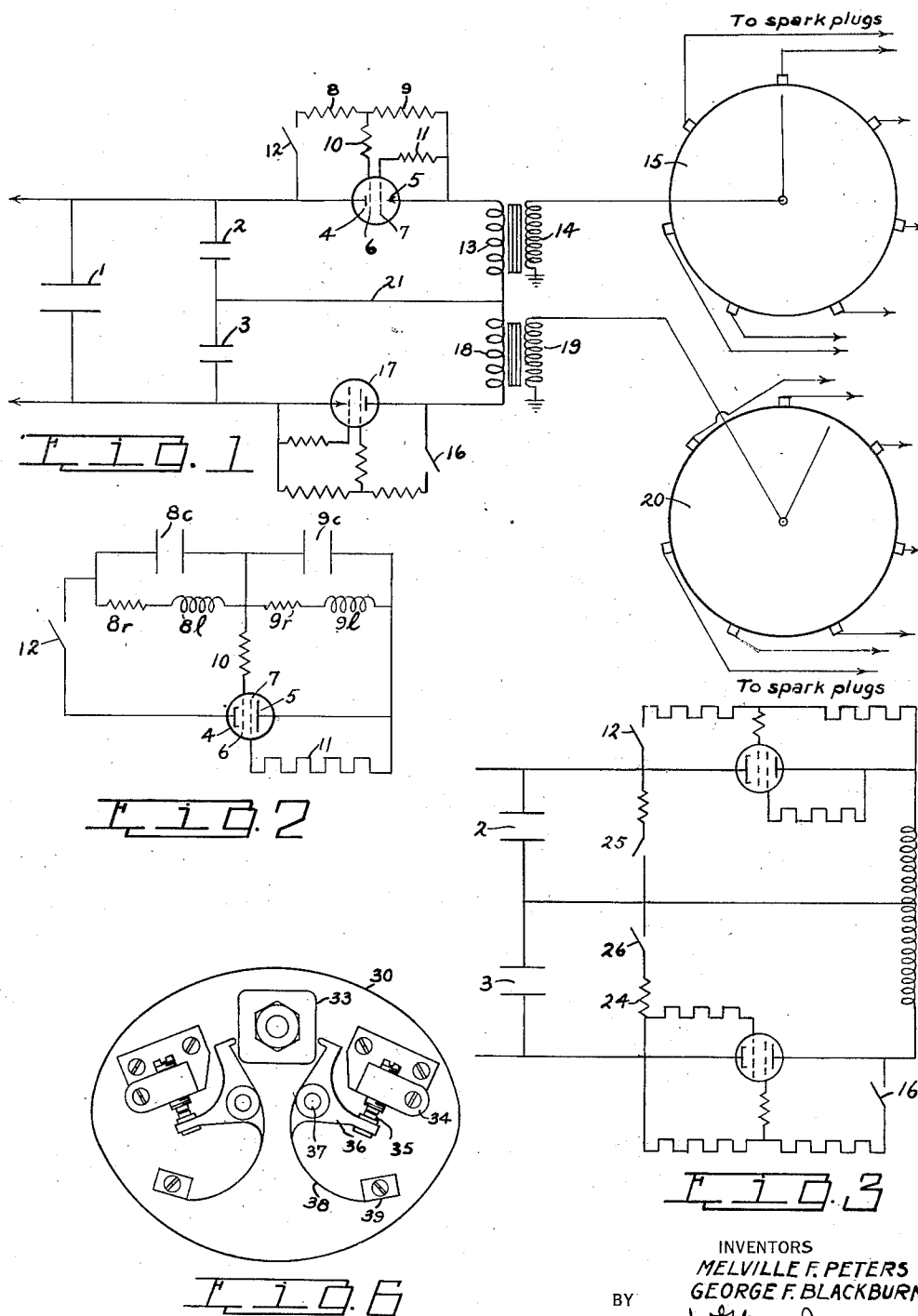
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CONDENSER DISCHARGE IGNITION SYSTEM

Filed July 3, 1940

3 Sheets-Sheet 1



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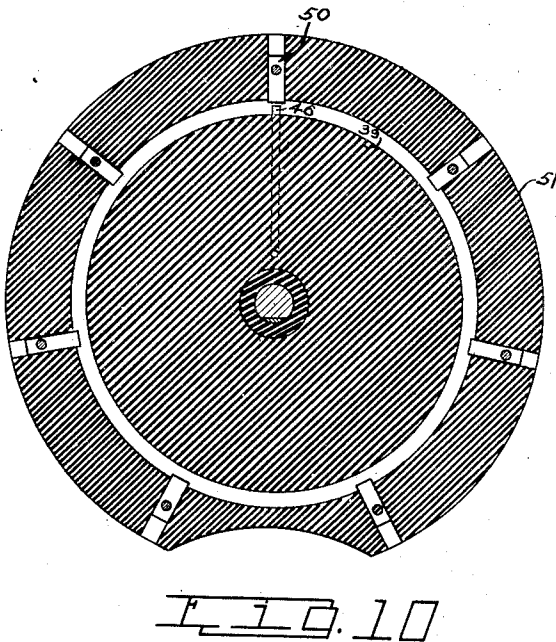
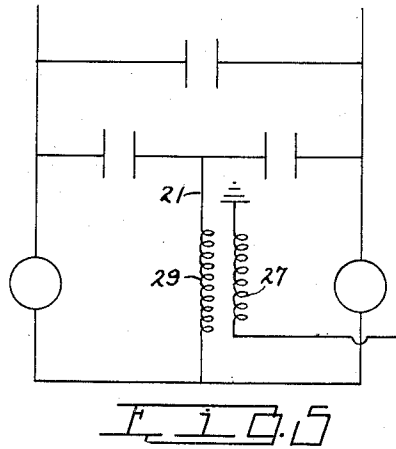
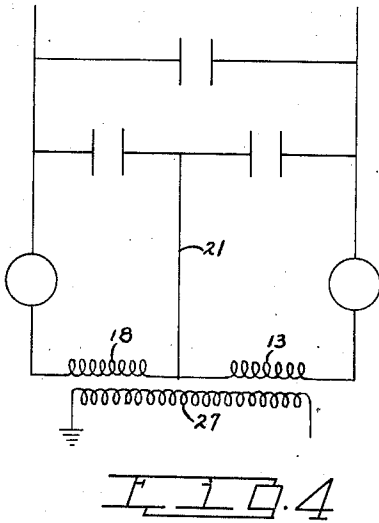
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CONDENSER DISCHARGE IGNITION SYSTEM

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3 Sheets-Sheet 2



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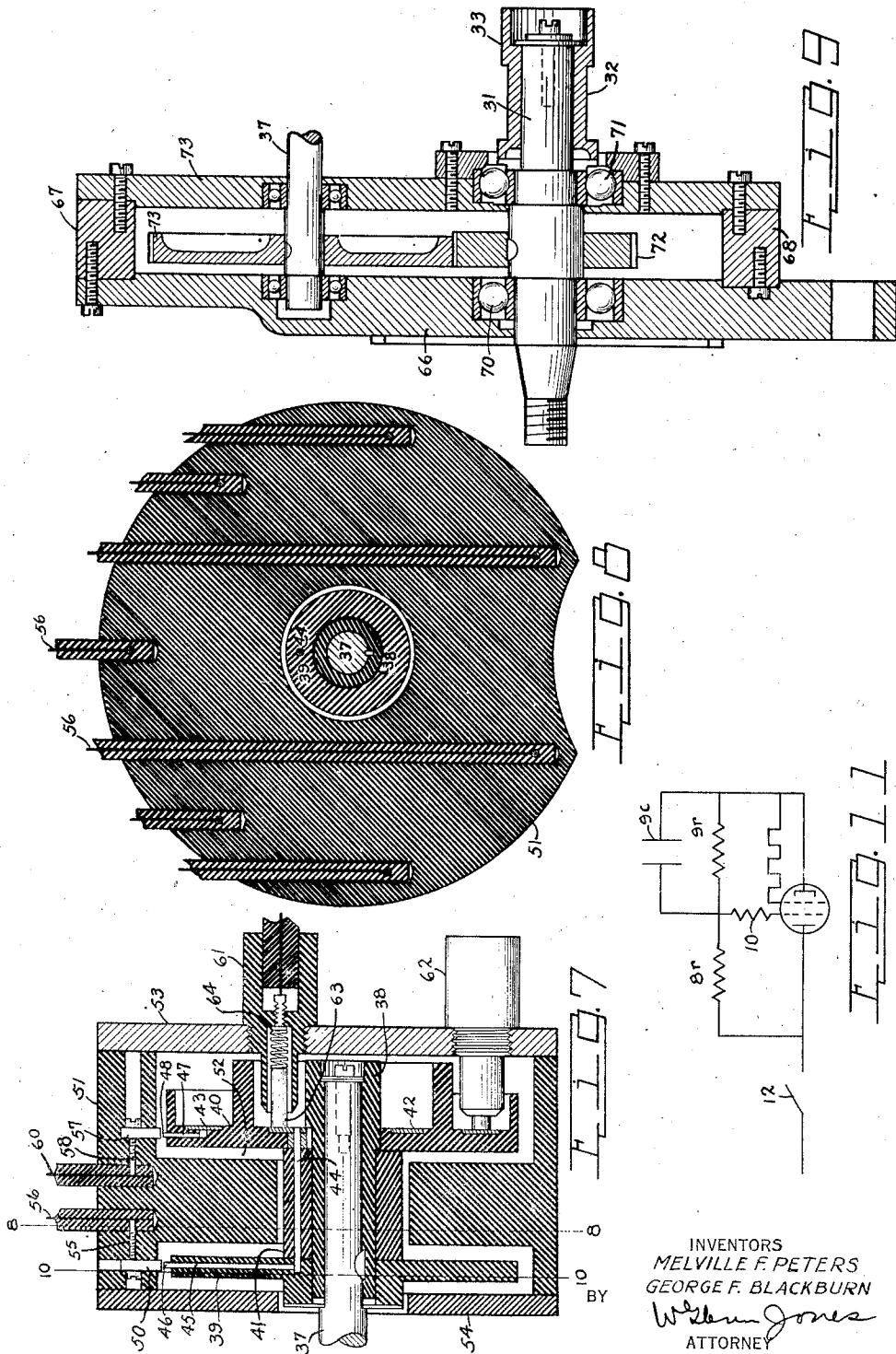
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CONDENSER DISCHARGE IGNITION SYSTEM

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3 Sheets-Sheet 3



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CONDENSER DISCHARGE IGNITION
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15 Claims. (Cl. 123—148)

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amended April 30, 1928; 370 O. G. 757)

This invention relates to an ignition system involving a plurality of distributor circuits.

In engines having a large number of cylinders a single distributor having enough electrodes to serve all the cylinders becomes a large and heavy affair, taking up an inordinate amount of space and adding a considerable amount of weight to the engine, which is particularly objectionable in installations such as aircraft where weight is at a premium.

This is true because of the fact that distributors must of necessity assume a generally cylindrical form and an increase in the number of electrodes will force an increase in the radius of the cylinder. Since the volume of the cylinder will vary as the square of its radius it can be seen that any increase in the number of cylinders in an engine will greatly increase the size and weight of the distributor.

It is an object of this invention to provide an ignition system utilizing more than one distributor for use with engines having a large number of cylinders.

It is another object of this invention to provide an ignition system which, while remaining simple, rugged and compact, will furnish sparks alternately in two distributors.

It is a further object of this invention to provide a dual distributor having two complete sets of electrodes, yet involving only a small increase in weight and size over a distributor having only one set of electrodes.

It is a further object of this invention to provide a dual interrupter or timer, which is simple, compact and rugged and yet will efficiently serve two distributors.

It is a still further object of this invention to provide an ignition system capable of producing a high voltage across a relatively low resistance, as compared with the conventional spark coil or magneto.

With the foregoing objects in mind, a clear understanding of the invention may be had by a careful consideration of the following description, taken together with the accompanying drawings, in which:

Fig. 1 is a diagrammatic view of the electrical circuit supplying sparking voltage to a dual distributor and the contacts of said distributor;

Figs. 2, 3, 4 and 5 are diagrammatic views of fragments of the electrical circuit of Fig. 1, showing various modifications thereof;

Fig. 6 is a plan view of the dual interrupter or timer forming a part of the ignition system;

Fig. 7 is a cross-sectional view of the dual dis-

tributor forming a part of the ignition system of this invention, the section being taken along the longitudinal axis of the distributor;

Fig. 8 is a cross-sectional view of the distributor taken along line 8—8 of Fig. 7;

Fig. 9 is a sectional view in elevation of a mounting unit for the distributor and timer of the ignition system of this invention, showing an arrangement of shafting and gearing for driving these devices;

Fig. 10 is a cross-sectional view of the distributor taken along line 10—10 of Fig. 7; and

Fig. 11 is a diagrammatic view of a portion of the electrical circuit showing an embodiment alternative to those of Figs. 2, 3, 4 and 5.

This ignition system utilizes the discharge current of a condenser through the primary winding of an induction coil to obtain a high voltage induced in the secondary winding.

The operation of the system may be understood by referring to Fig. 1, which is a circuit diagram of the system. In the diagram the source is not shown. It may be any generator or battery capable of supplying the necessary voltage and current. The system to be described operates at 200 to 250 volts, D. C., the current being several milliamperes.

The condenser 1 serves as a storage reservoir for electrical energy; it provides for the rapid charging of the working condensers 2 and 3. The anode of a Strobotron discharge tube is shown at 4, the cathode at 5, and control grids at 6 and 7. The Strobotron is a cold cathode discharge tube marketed by General Radio Co. It is capable of passing large instantaneous current between anode and cathode after the gas has been made conducting by applying a voltage to the grids sufficient to cause a glow discharge. The grids are connected to the circuit through suitable resistances 8, 9, 10 and 11, and voltage is applied by closing the contact 12, at a time when a spark is desired. The condenser 2 having previously been charged to the voltage of the supply, the closing of contact 12 results in the discharge of the condenser through the tube and the primary winding 13. The discharge current changes from zero to its maximum value very rapidly, and this induces a high voltage in the secondary winding 14. This voltage is applied to the proper spark plug by the distributor 15.

The discharge of condenser 2 is accompanied by a simultaneous charging of condenser 3 to the supply voltage. This charging current adds to the discharge current of 2 to induce a higher voltage in winding 14 than would be produced

by the discharge alone. Contact 12 now opens, and when the next spark is required contact 16 closes, resulting in the discharge of condenser 3 through Strobotron 17, in a manner similar to the discharge of condenser 2. The flow of current in primary winding 18 induces a high voltage in secondary winding 19, which is applied to the proper spark plug through distributor 20. The discharge of 3 is accompanied by the charging of 2. The cycle is then repeated.

This system thus provides sparks alternately in two distributor circuits, which makes possible greater clearances between high tension conductors and grounded or other parts at low voltage, when used on engines having a large number of cylinders.

Since only a very small current flows in the control grid circuit, the contacts 12 and 16 are not subjected to any arcing.

The double circuit makes it possible to reduce the resistance in the supply circuit to a very low value since the source is at no time short-circuited by a conducting circuit. The low time constant thus obtained makes it possible to operate at high engine speeds without serious decrease in sparking voltage. Another advantage of this method of producing ignition sparks is its high utility, or ability to produce a high voltage across a relatively low resistance, as compared with the conventional spark coil or magneto.

The resistances designated 8, 9, 10 and 11 in Fig. 1 may in general be impedances, consisting of various combinations of resistance, capacitance and inductance. The same applies to the circuit of discharge tube 17, in the other side of the circuit.

The particular arrangement of resistance, capacitance and inductance to be used in the grid circuit will depend on the supply voltage, speed range, tube characteristics and other factors. In Fig. 2 is shown a general arrangement of resistances, capacitances, and impedances which may be used in various combinations to apply voltage to the grid 6.

The following are typical cases:

When capacitances 8c and 9c and inductances 8l and 9l are zero, the circuit reduces to that shown in Fig. 1 of the disclosure. If an initial surge of voltage applied to grid 6 is desired, resistance 8r is shunted by capacitance 8c, or resistance 8r may be used in series with inductance 9l. The latter arrangement will give a high voltage of self-induction at grid 6 when a current in the grid circuit is interrupted. If a time delay of predetermined magnitude is desired between application of the "trigger" voltage and the occurrence of discharge, one arrangement that will accomplish this is to use resistance 8r, and capacitance 9c in parallel with resistance 9r, as shown in Fig. 11. This is a desirable arrangement when contact 12 is used to close the main discharge circuit, in which case the voltage of condenser 2 is simultaneously applied to the anode and to the grid circuit.

The location of contacts 12 and 16 in the main discharge circuit may be necessary to insure that the tubes will be de-ionized at high speeds. The function of the tubes then becomes the delaying of conduction long enough for the contacts to close fully, thus avoiding arcing at these contacts.

With contacts 12 and 16 located in the grid circuits, de-ionization may be expedited by using an additional set of contacts 25 and 26, Fig. 3, to short-circuit the condensers 2 and 3 at the

proper time. These are connected with resistances 23 and 24 in series. The cycle of operation is then as follows:

Upon closing of contact 12, condenser 2 discharges, and there is a residual voltage left on the system when the discharge tube becomes non-conducting. The contact 26 now closes, allowing the residual voltage to become substantially zero. Contact 16 now closes discharging condenser 3, followed by contact 26, which opens before 12 closes to begin the next cycle.

The secondary windings 14 and 19 may, as shown in Fig. 4, be connected in series and used as one winding 27 with one distributor. In this case, primary windings 13 and 18 may be operated as shown in Fig. 4, in which case the secondary winding will produce voltage of one polarity only; or they may be connected as shown in Fig. 5, as one winding 29 in the branch 21 of the circuit, which is common to both sides, the secondary voltage being then alternating in polarity.

With a primary voltage of 200 to 250 volts, satisfactory operation has been obtained with condenser 1 having a capacitance of 6 to 8 μ f, and condensers 2 and 3, 2 μ f each. The values of resistances 8, 9, 10 and 11 are not critical. The principal requirements concern 8 and 9: (1) their ratio must be such as to give at least the minimum voltage necessary to start the glow discharge; (2) their sum must be large enough to prevent an appreciable loss of charge off condenser 2 before the tube breaks down; and (3) resistance 8 in combination with 10 must be large enough to prevent an excessively large grid current from flowing. The purpose of 11 is also to limit the grid current. For 8, 0.1 megohm has been found satisfactory, with 0.1 to 0.25 megohm for 9. With these values for 8 and 9, 10 has been made zero, while 11 has been varied from 0.1 to 0.25 megohm without noticeably affecting operation over this range.

Fig. 6 illustrates a timer device forming part of the invention. It comprises a base plate 30, through which extends a shaft 31, shown best in Fig. 9. Fixed to said shaft for rotation therewith is an element 32 terminating in a four-lobed cam 33. The cam operates two sets of contacts, each insulated from the other and from ground. These sets of contacts are the ones numbered 12 and 16 in Figs. 1, 2 and 3. Since the two sets of contacts and their associated operating mechanisms are identical, only one will be described.

An adjustable contact 34 is fixed to the base-plate 30. Seating on it is a movable contact 35 held in one arm of a bell crank lever 36 which is pivotally mounted around a stud 37 fixed in base-plate 30. The other arm of the bell crank lever engages cam 33. A spring 38 is secured at one end to lever 36, the other end being anchored at 39 to the base-plate. The spring is so arranged as to continually bias the arms of lever 36 toward contact with cam 33 and contact 34. For the circuit of Fig. 3 a pair of cams would be required. They could be mounted on the same shaft with different angular settings.

The dual distributor forming a part of the invention is shown in Fig. 7. The distributor shaft 37 has keyed to it a bushing 38 of insulating material, which carries for rotation with it a pair of disklike elements 39 and 40 of insulating material, spaced apart by a sleeve-like member 41, also of insulating material. The disk 40 carries on its outer face a pair of concentric pick-up

rings 42 and 43. The ring 42 has leading from it a conductor 44 which passes through sleeve 41 and connects to a conductor 45 extending radially to the periphery of disk 39 and terminating in an electrode 46. The ring 43 connects to a conductor 47 which extends radially through the disk 40 to its periphery where it terminates in an electrode 48.

The shell of the distributor is formed by a cylindrical casing 51 having an intermediate partition wall 52. A face-plate 53 is secured to one end of casing 51, the other end of the casing being formed by a plate 54 of insulating material. A plurality of electrodes 50 are secured in the periphery of casing 51 at equally spaced points in such a manner that the electrode 46 will pass them in succession as the disk 39 rotates. Each of the electrodes 50 is electrically connected by means of a threaded conductor 55 to an insulated cable 56 leading to one of the spark-plugs of the engine.

A series of electrodes 57 similar to those numbered 50 are arranged to be passed in succession by electrode 48 upon the rotation of disk 40. These electrodes are connected by threaded conductors 58 to cables 59 leading to engine spark-plugs. In order that the cables may all leave the distributor casing from its top, they may reach their respective electrodes through holes bored in the central partition 52 of the casing, as shown in Fig. 8.

The voltage from the supply portion of the ignition system described above is impressed upon the dual distributor through a pair of cables which terminate in attachment fittings 61 and 62 of conventional structure. In fitting 61 a brush 63 is biased by a spring 64 into continuous electrical contact with the pick-up ring 42. A similar brush 65 in fitting 62 is maintained in electrical contact with ring 43.

In Fig. 9 is shown a form of mounting and drive means for the timer and distributor. The mounting means comprises a pair of parallel plates 66 and 73 spaced apart by spacer members 67 and 68. The cam shaft 31, driven by the engine, passes through both plates and is supported therein by ball bearings 70 and 71. On the inner end of this shaft is mounted cam 33, which has been previously described. A gear 72 mounted on the shaft 31 between the parallel plates meshes with a gear 73 mounted upon a shaft 37 likewise journaled in ball bearings in plates 66 and 54. Upon the shaft 37 are mounted the rotating parts of the distributor, as previously described. The distributor casing is attached to plate 73.

The timer-distributor arrangement shown is adapted to be used in connection with a 14 cylinder engine.

The invention described herein may be manufactured and/or used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. An ignition system comprising a voltage supply, an induction coil, means normally blocking the flow of current from said supply to said coil, a condenser so arranged in circuit with said supply, said coil, and said blocking means that it will be charged while said blocking means is in operation and will discharge through the primary of said coil when the circuit across said blocking means is completed, means periodically operating to close said circuit across said block-

ing means, and means delaying the passage of electrical energy through said circuit until the operation of said circuit closing means is complete.

2. An ignition system comprising a voltage supply, an induction coil, an electron tube normally blocking the flow of current from said supply to said coil, a condenser so arranged in circuit with said supply, said coil and said tube that it will be charged while said tube is blocking the flow of current to said coil and will discharge through the primary of said coil when said tube is conducting, and means controlling the voltage supply to the grid circuit of said tube and periodically operating to render said tube conducting.

3. An ignition system comprising a voltage supply, a transformer, an electron tube normally blocking the flow of current from said supply to the primary winding of said transformer, said tube having a grid circuit which when interrupted will cause said tube to be non-conducting, and when completed will cause said tube to be conducting, a condenser so arranged in circuit with said supply, said primary winding, and said tube that it will be charged while said tube is non-conducting and will discharge through said primary winding when said tube is conducting, and means periodically completing said grid circuit.

4. An ignition system comprising a voltage supply, a circuit across said voltage supply, a first branch of said circuit, a pair of condensers in series in said branch, a second branch of said circuit in parallel with said first branch and terminating on opposite sides of said pair of condensers, a pair of transformers, the primary windings of which are in series in said second circuit, a circuit interrupting means on each side of said pair of transformers and in said second branch, electrical conducting means joining a point of said first branch between said condensers to a point of said second branch between said transformers, and means periodically closing each of said circuit interrupting means in alternating sequence with the closing of the other.

5. An ignition system comprising a voltage supply, a circuit across said voltage supply, a first branch of said circuit, a pair of condensers in series in said branch, a second branch of said circuit in parallel with said first branch and terminating on opposite sides of said pair of condensers, a pair of transformers, the primary windings of which are in series in said second circuit, an electron tube on each side of said pair of transformers in said second branch, each of said tubes being normally non-conducting, electrical conducting means joining a point of said first branch between said condensers to a point of said second branch between said transformers, and means periodically rendering each of said tubes conducting, in alternating sequence with the other of said tubes.

6. An ignition system comprising a voltage supply, a circuit across said voltage supply, a first branch of said circuit, a pair of condensers in series in said branch, a second branch of said circuit in parallel with said first branch and terminating on opposite sides of said pair of condensers, a pair of transformers, the primary windings of which are in series in said second circuit, an electron tube on each side of said pair of transformers in said second branch, a grid circuit in each of said tubes which, when completed, will render said tube conducting, said

grid circuits normally being broken, electrical conducting means joining a point of said first branch between said condensers to a point of said second branch between said transformers, and means periodically completing each of said grid circuits in alternation with the completion of the other.

7. An ignition system comprising a voltage supply, a circuit across said voltage supply, a first branch of said circuit, a pair of condensers in series in said branch, a second branch of said circuit in parallel with said first branch and terminating on opposite sides of said pair of condensers, a pair of circuit interrupting means in said second branch, an electrical conductor joining a point of said first branch between said condensers to a point of said second branch between said interrupting means, a transformer having its primary winding located in said conductor, and means periodically closing each of said interrupting means in alternating sequence with the closing of the other.

8. An ignition system comprising a voltage supply, a circuit across said voltage supply, a first branch of said circuit, a pair of condensers in series in said branch, a second branch of said circuit in parallel with said first branch and terminating on opposite sides of said pair of condensers, a transformer, a pair of primary windings for said transformers located in series in said second branch, a circuit interrupting means on each side of said pair of transformers and in said second branch, electrical conducting means joining a point of said first branch between said condensers to a point of said second branch between said primary windings, and means periodically closing each of said circuit interrupting means in alternating sequence with the closing of the other.

9. An ignition system comprising a voltage supply, a circuit connected across said voltage supply, a first branch of said circuit, a pair of condensers in series in said branch, a second branch of said circuit in parallel with said first branch and terminating on opposite sides of said pair of condensers, a pair of circuit interrupting means in series in said second branch, electrical conducting means joining a point of said first branch between said pair of condensers to a point of said second branch between said pair of interrupting means, a transformer having its primary winding forming a part of said conductor, and means closing each of said interrupting means in alternation with the closing of the other.

10. In combination, a source of electrical energy, a first capacitor and a second capacitor electrically connected in series across said source, a first step-up transformer, a second step-up transformer, a common circuit for discharging said first capacitor and for charging said second capacitor including the primary winding of said first transformer and a first contact means, a common circuit for charging said first capacitor and discharging said second capacitor and including the primary winding of said second transformer and a second contact means, whereby cyclically said first capacitor is discharged and said second capacitor is substantially simultaneously charged through said primary winding of said first transformer, and alternately said second capacitor is discharged and said first capacitor is substantially simultaneously charged through said primary winding of said second

transformer, both said capacitors being charged from said source.

11. In combination, a source of electrical energy, a first capacitor and a second capacitor electrically connected in series across said source, a first step-up transformer, a second step-up transformer, a common circuit for discharging said first capacitor and for charging said second capacitor including the primary winding of said first transformer and a first contact means, a common circuit for charging said first capacitor and discharging said second capacitor and including the primary winding of said second transformer and a second contact means, means momentarily closing said contact means in sequence, whereby cyclically said first capacitor is discharged and said second capacitor is substantially simultaneously charged through said primary winding of said first transformer, and alternately said second capacitor is discharged and said first capacitor is substantially simultaneously charged through said primary winding of said second transformer, both said capacitors being charged from said source.

12. In combination, a source of electrical energy, a first capacitor and a second capacitor electrically connected in series across said source, a first step-up transformer, a second step-up transformer, a common circuit for discharging said first capacitor and for charging said second capacitor including the primary winding of said first transformer and a first contact means, a common circuit for charging said first capacitor and discharging said second capacitor and including the primary winding of said second transformer and a second contact means, means momentarily closing said contact means in sequence, whereby cyclically said first capacitor is discharged and said capacitor is substantially simultaneously charged through said primary winding of said first transformer, and alternately said second capacitor is discharged and said first capacitor is substantially simultaneously charged through said primary winding of said second transformer, and means delaying the flow of current through each of said circuits upon closing of either of said contact means until said contact means is completely closed, both said capacitors being charged from said source.

13. In combination, a source of electrical energy, a first capacitor and a second capacitor electrically connected in series across said source, a step-up transformer, a common circuit for discharging said first capacitor and for charging said second capacitor, including a first contact means, a common circuit for charging said first capacitor and discharging said second capacitor, including a second contact means, both said circuits including the primary winding of said transformer, whereby cyclically said first capacitor is discharged and said second capacitor is substantially simultaneously charged through said primary winding and alternately said second capacitor is discharged and said first capacitor is substantially simultaneously charged through said primary winding, both said capacitors being charged from said source.

14. In combination, a source of electrical energy, a first capacitor and a second capacitor electrically connected in series across said source, a step-up transformer having a first primary winding, a second primary winding and a secondary winding, a common circuit for discharging said first capacitor and for charging said second capacitor, including a first contact means and

said first primary winding, a common circuit for charging said first capacitor and discharging said second capacitor, including a second contact means and said second primary winding, means momentarily closing said contact means in sequence, whereby cyclically said first capacitor is discharged and said second capacitor is substantially simultaneously charged through said first primary winding, and alternately said second capacitor is discharged and said first capacitor is substantially simultaneously charged through said primary winding, both said capacitors being charged from said source.

15. In combination, a source of electrical energy, two capacitors connected across said source, a first common circuit for charging one of said capacitors and discharging the other, a second common circuit for charging said other of said capacitors and discharging said one of said capacitors, means operable for closing said circuits in sequence and means operable upon the closing of each of said circuits to delay the passage of electrical energy therethrough until the actuation of said closing means is completed.

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