Feb. 13, 1923. 1,444,836.

H. HÖRIG.

IGNITION SYSTEM FOR INTERNAL COMBUSTION ENGINES AND THE LIKE PURPOSES.

FILED SEPT. 15, 1921. 3 SHEETS—SHEET 1.

Fig. 1

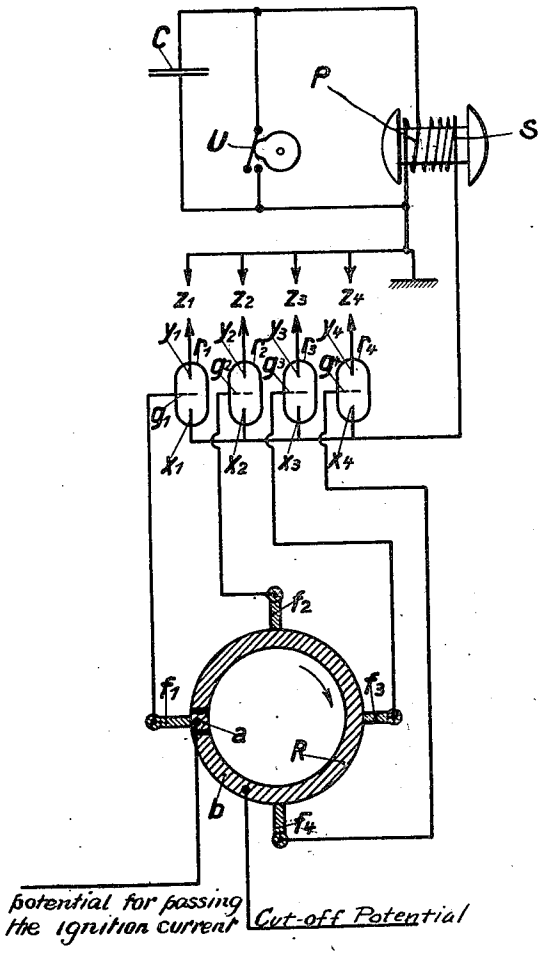
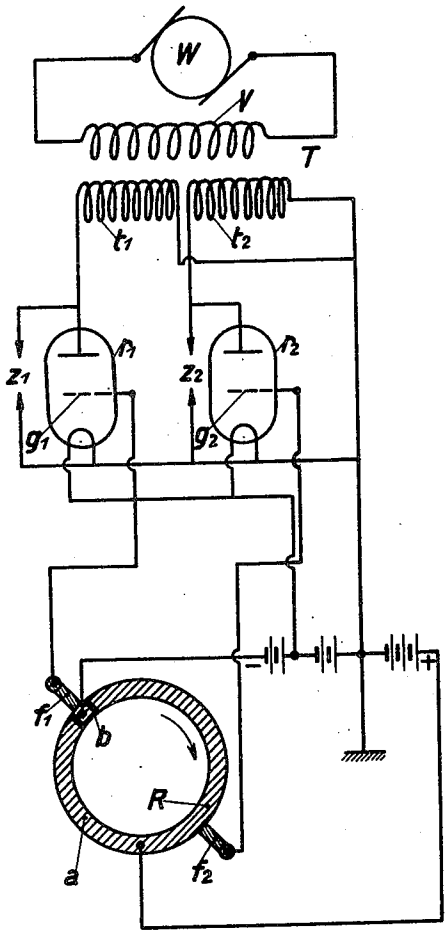


Fig. 3



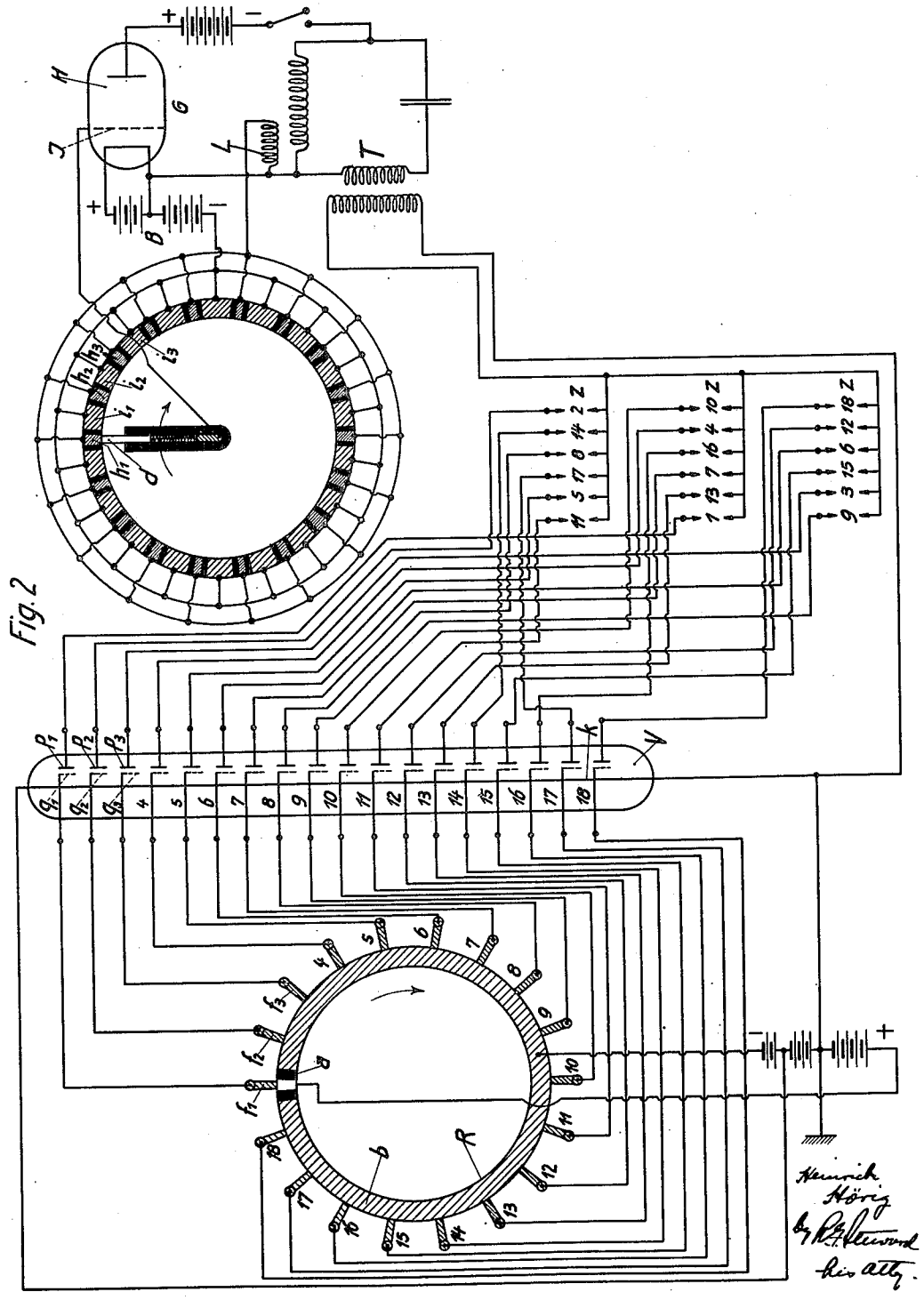
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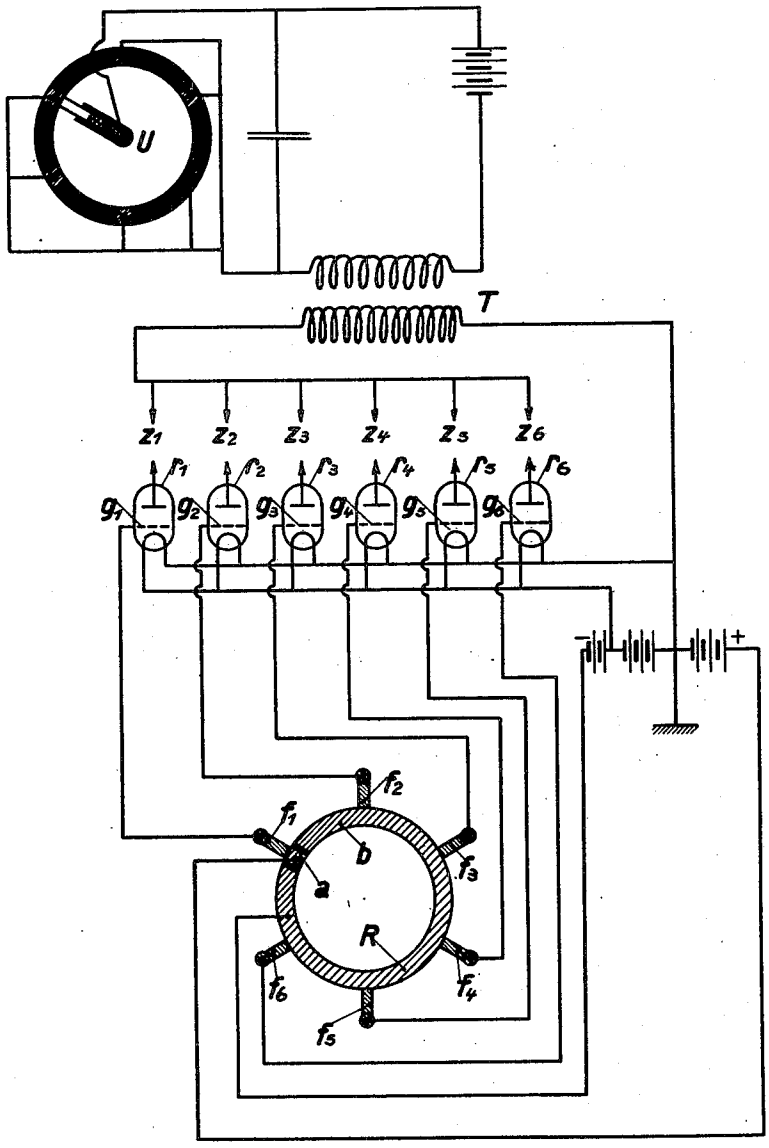
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IGNITION SYSTEM FOR INTERNAL COMBUSTION ENGINES AND THE LIKE PURPOSES.

FILED SEPT. 15, 1921. 3 SHEETS—SHEET 3.

Fig. 4



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Heinrich Hörig
by R. H. Stewart
his attorney

Patented Feb. 13, 1923. 1,444,836

UNITED STATES PATENT OFFICE.

HEINRICH HÖRIG, OF STUTTGART, GERMANY, ASSIGNOR TO ROBERT BOSCH AKTIENGESELLSCHAFT, OF STUTTGART, GERMANY.

IGNITION SYSTEM FOR INTERNAL-COMBUSTION ENGINES AND THE LIKE PURPOSES.

Application filed September 15, 1921. Serial No. 500,947.

To all whom it may concern:

Be it known that I, HEINRICH HÖRIG, German subject, residing at Stuttgart, Germany, have invented certain new and useful Improvements in and Relating to Ignition Systems for Internal-Combustion Engines and the like Purposes, of which the following is a specification, for which the Robert Bosch Aktiengesellschaft of Stuttgart, Germany, has filed application in Germany January 19, 1920.

This invention consists in an improved electric ignition system for internal combustion engines and the like purposes which may be employed as desired in connection with a source of continuous high tension direct current or alternating current of sufficient frequency and particularly to arrangements including thermionic tube generators.

In the improved arrangement each of a number of ignition circuits, each including one or a series of ignition plugs, has at least one thermionic tube circuit associated with it and the transmission of electrical energy between the electrodes of the thermionic tube or tubes of an ignition circuit is controlled for the duration of the ignition interval or somewhat longer so as to establish a flow of ignition current through the respective ignition circuit. By the term "ignition interval" is to be understood the interval of time during which the ignition current is flowing across the plug electrodes.

Ignition distributors including thermionic tubes are indeed already known. These are however, limited to those systems of ignition in which successive ignitions are produced by means of potential differences alternating in direction (magneto electrical ignition apparatus.) Further, in such devices the plugs are arranged in two parallel ignition circuits which contain uncontrolled thermionic tubes connected in opposite directions. An undesirable result of this is, that in the case of four stroke motors, an additional spark occurs at the plug at the end of the exhaust and it is well known that care must be taken that these superfluous sparks are not allowed to occur on any account on the suction stroke of the engine by any accidental undue retarding of the ignition.

In contradistinction to this known arrangement, according to the present invention as already mentioned, there is no restriction to a definite source of potential, and the improved arrangement is adapted for any number and arrangement of cylinders, with any suitable kind of engine cycle, without excess sparks having to be reckoned with. Of course an ignition circuit of a series of several plugs which require to be ignited simultaneously, may be included in any suitable connection.

Generally, each plug circuit has a thermionic valve tube provided for it. The invention comprises however, all those cases in which in place of one tube a system of tubes consisting of a plurality of tubes arranged in series or connected in parallel with one another, is employed or where the thermionic circuits for a plurality of series of plugs are located altogether in a single tube or casing.

An ignition plug or a series of ignition plugs and their respective tube current paths may be connected in series or parallel with one another. In the first case, which is preferable, the tubes must be so controlled that during the ignition interval the current can flow through the tubes. In the second case however, the passage of the current through the tubes must be so regulated that at any time other than during the ignition intervals the potential at the sparking plugs is insufficient for ignition.

In order to make my invention more clear, I refer to the accompanying drawings, in which similar letters denote similar parts throughout the several views, and in which:

Figure 1 is a diagram of one arrangement.

Figure 2 is a modification as applied to an eighteen cylinder engine.

Fig. 3 is a modified ignition system.

Fig. 4 is a further modification.

Fig. 1 shows the improved arrangement used in connection with a magneto electric ignition apparatus for a four cylinder internal combustion engine. The ignition apparatus contains a primary coil p, a secondary coil s, a contact breaker u and a condenser c in parallel with the contact breaker. Thermionic tubes r_1, r_2, r_3, r_4, for example high vacuum tubes or "hard" tubes having a suitable cathode which may for instance, as is known be formed of a radio-active substance. The electrodes x_1, x_2, x_3, x_4 are all

connected with the free end of the secondary coil s whilst the electrodes y_1, y_2, y_3, y_4, are each individually connected with one of the sparking plugs z_1—z_4. The grids g_1 . . . g_4 are connected with fixed brushes f_1—f_4 which contact with a rotating ring R. The ring R has a short contact segment charged to a potential which will allow transmission of electrical energy between the electrodes x and y. The contact segment b on the other hand is charged to a potential such as to prevent free flow of electrons between cathode and anode of the thermionic tubes.

The ignition apparatus and the distributor with the thermionic tubes must cooperate so that at the moment at which the contact breaker u breaks the primary circuit of the ignition apparatus the contact path a of the ring R lies beneath one of the brushes f_1 . . . f_4. Assuming that the brush f_1 is in contact with the contact segment a, the high potential current of the ignition apparatus then passes through the thermionic tube r_1 through the plug z_1 to earth, whilst during the passage of the long contact segment b past the brush f_1, no ignition current passes through the thermionic tube r_1.

Fig. 2 shows an arrangement for an eighteen cylinder aircraft engine using thermionic tubes as a source of ignition potential. The sparking points z_1 . . . z_{18} in Fig. 2 also indicate the order of firing of the engine.

The tube generator G which does not itself form part of this invention, but is particularly well adapted for the present arrangement comprises a single high vacuum incandescent cathode tube H. The generating arrangement G is so controlled that it generates oscillations only when ignition is to be made at one of the sparking plugs z_1—z_{18} of the motor. This control in the example shown is effected by the grid J of the tube H being connected alternately by means of a rotary brush contact d and contact segments h_1 . . . h_{18} and i_1 . . . i_{18} in turn with the grid reactance coil L or with such a potential (negative pole of the battery B) that the production of oscillations is prevented.

The alternating current produced by the generator G is supplied from one end of the secondary coil of the transformer T to the electrodes of the eighteen sparking plugs z_1 . . . z_{18} which are connected with one another. The other end of the secondary coil of the transformer T is connected with the incandescent cathode k of a high vacuum thermionic tube V. The tube V has as many anodes p and grids q as there are plug circuits present, in the present case therefore, eighteen of each. The grids q_1 . . . q_{18} are each separately connected with a fixed brush contact f_1 . . . f_{18} and these brush contacts are arranged round a commutator ring R, as shown in Fig. 2, which ring has a short contact segment a and a long contact segment b similarly as shown in Fig. 1. The anodes p_1 . . . p_{18} of the thermionic tube V are connected in the desired order of firing of the engine with the corresponding electrodes of the ignition plugs. Of course the order of firing may equally be determined by suitably connecting the brushes f_1 . . . f_{18} with the grids q_1 . . . q_{18}.

In the position of the various parts of the ignition apparatus illustrated the sparking plug l is shown at the point of ignition. As of course the brush contact segment h_1 is connected with the grid coil L, current flows from the generator. On the other hand the short contact segment a of the ring R is in contact with the brush f_1 which is connected with the grid q_1 of the thermionic tube V. Consequently the potential of the grid q_1 is reduced to its predetermined lower value so that the ignition current can pass from the common cathode k over the anode p_1 to the plug l.

In spite of the great number of brushes f the controlling arrangement (R, f_1, f_2 and so forth) of the distributing system may be made fairly compact because only very weak currents are to be controlled by them and the differences of potential arising, generally only amount to a few volts.

In the arrangements above described the distributing tube was arranged in series with the sparking plug.

Fig. 3 shows an arrangement in which the thermionic tubes and the sparking points are connected in parallel with one another. As a source of ignition potential, in this case a medium frequency or a high frequency machine w may be adopted. The transformer T in this case has as many secondary coils as there are plug circuits, in the case imagined of a two cylinder motor there are therefore two coils t_1 and t_2. Each of the plug circuits z_1, z_2 has its own thermionic tube r_1 and r_2, the grids g_1 and g_2 of which are connected with brushes f_1 and f_2. The shorter path (b) of the contact segments a and b of the ring R, over which the brushes f_1 and f_2 rub, in contrast to the arrangements hereinbefore described, is connected with the cut off potential and the long segment a with the working potential (predetermined grid potential to allow for sparking). So long as the latter potential is applied to one of the grids, for example g_1, the permanently flowing alternating current passes through the corresponding tube r_1 and is not connected over the spark gap of the plug z_1, in parallel with the tube r_1. If however, the short contact segment b passes beneath the brush f_1 of the tube r_1 the

flow of alternating current through the tube r_1 is prevented and the full voltage therefore passes to the plug z_1 so that the ignition can take place.

For the sake of completeness, in Fig. 4 a battery ignition system is shown for a six cylinder motor. The arrangement for interruption of the battery current is indicated by a device U which always supplies a current impulse when the contact segment a conveying the working potential to the thermionic tube comes in contact with one of the brushes $f_1 \ldots f_6$ which are connected with the grids $g_1 \ldots g_6$ of the tubes $r_1 \ldots r_6$.

Finally it may be mentioned that with thermionic tubes it is to a large extent possible to make the period and duration of the ignition individually adjustable for each separate cylinder, for example, by adjusting the position of the separate connection contacts f on the ring R of the controlling arrangement.

Having now described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. An ignition distributing system for internal combustion engines, comprising, in combination: a plurality of sparking plug circuits forming parts of the ignition circuits; as many thermionic tube circuits as there are sparking plug circuits; and means for controlling the passing of the electrical energy between the electrodes of the thermionic tube of a plug circuit for practically the duration of the ignition interval and connections between each said sparking plug circuit and the associate thermionic tube circuit, whereby the ignition current is caused to flow through the plug circuit, for the purpose set forth.

2. An ignition distributing system for internal combustion engines, comprising, in combination: a plurality of sparking plug circuits forming parts of the ignition circuits; as many thermionic tube circuits as there are sparking plug circuits; connections between each of said sparking plug circuits and the associate therminoic tube circuits whereby these members of the system are connected in series with each other; and means adapted to make the electrical energy flow between the electrodes of the thermionic tube of a plug circuit for practically the duration of the ignition interval, for the purpose set forth.

3. An ignition distributing system for internal combustion engines, comprising, in combination: a plurality of sparking plug circuits forming parts of the ignition circuits; as many thermionic tube circuits as there are sparking plug circuits, connections between each said sparking plug circuit and the associate thermionic tube circuit, and means not included in the ignition circuit for alternately permitting and preventing the passage of the ignition current from the anode to the cathode to control the passing of a spark.

4. An ignition distributing system for internal combustion engines, comprising, in combination: a plurality of sparking plug circuits forming parts of the ignition circuits; as many thermionic tube circuits as there are sparking plug circuits; a connection between each of said sparking plug circuits and the associate thermionic tube circuit whereby these members of the system are connected in series with each other; and means for alternately permitting and preventing the passage of current from the anode to the cathode of said thermionic tubes to control the passing of current across the sparking electrodes.

5. An ignition distributing system for internal combustion engines, comprising, in combination: a plurality of sparking plug circuits forming parts of the ignition circuits; thermionic tubes having control grids between the anode and the cathode; circuits containing said thermionic tubes, connections between said sparking plug circuits and said thermionic tube circuits, and circuits controlling the action of said grids, substantially as described and for the purpose as set forth.

6. An ignition distributing system for internal combustion engines, comprising, in combination: a plurality of sparking plug circuits forming parts of the ignition circuits; thermionic tubes having control grids between the anode and the cathode; circuits containing said thermionic tubes, as well as said sparking plug circuits, and circuits controlling the action of said grids, substantially as described and for the purpose set forth.

7. An ignition system for internal combustion engines, comprising, in combination: a plurality of sparking plug circuits forming part of the ignition circuits, thermionic tubes and circuits containing said tubes, connections between said sparking plug circuits and said thermionic tube circuits, said thermionic tubes having control grids between the anode and the cathode, and circuits controlling the time of ignition by the differing variations of potential applied to said grids.

8. An ignition distributing system for internal combustion engines, comprising, in combination: a plurality of sparking plug circuits forming parts of the ignition circuits; thermionic tubes having control grids between the anode and the cathode; circuits containing said thermionic tubes and said sparking plug circuits; as many brushes as there are thermionic tubes and connected to said grids; and contact segments connected to a source of electric energy at differing potentials and mounted upon an engine

driven member, substantially as described and shown.

9. In an ignition distributing system for internal combustion engines, an ignition circuit, a thermionic tube for controlling said ignition circuit and a control circuit for said thermionic tube independent of said ignition circuit.

10. In an ignition distributing system for internal combustion engines, a plurality of ignition devices, energizing circuits for said ignition devices and distribution control circuits for said energizing circuits exclusive of said energizing circuits.

11. In an ignition distributing system for internal combustion engines, a plurality of ignition devices and circuits therefor, thermionic tube relays for said ignition circuits, control circuits for said thermionic tube relays and distributing means included in said control circuits only.

12. In an ignition distributing system for internal combustion engines, a plurality of ignition circuits, a source of energy therefor, thermionic tube relays for controlling said ignition circuits, a grid for each relay, a source of potential for charging said grids, and means interposed between said source of potential and said grids for distributively reversing the potential of said grids.

In testimony whereof I have affixed my signature in presence of two witnesses.

HEINRICH HÖRIG.

Witnesses:
FRIEDA KLAIBA,
E. SCHLEICHER.