Jan. 7, 1947. W. J. SPENGLER 2,414,000

IGNITION SYSTEM

Filed March 3, 1942 2 Sheets-Sheet 1

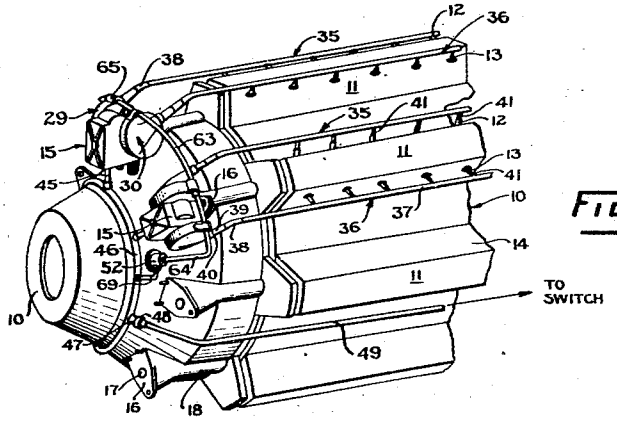


Fig 1

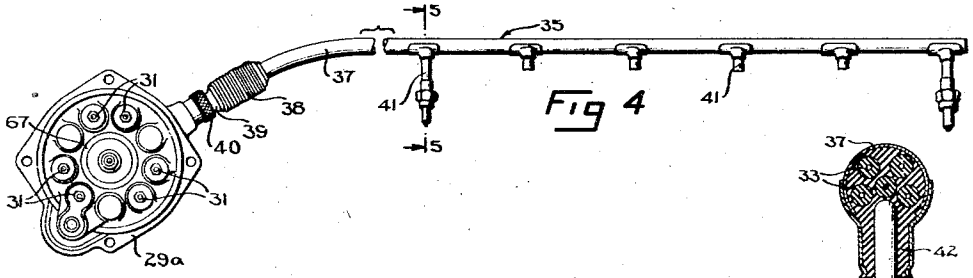


Fig 4

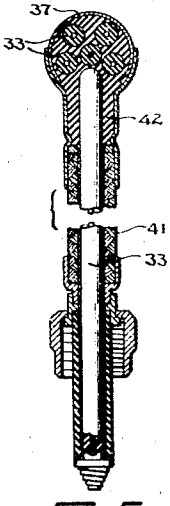


Fig 5

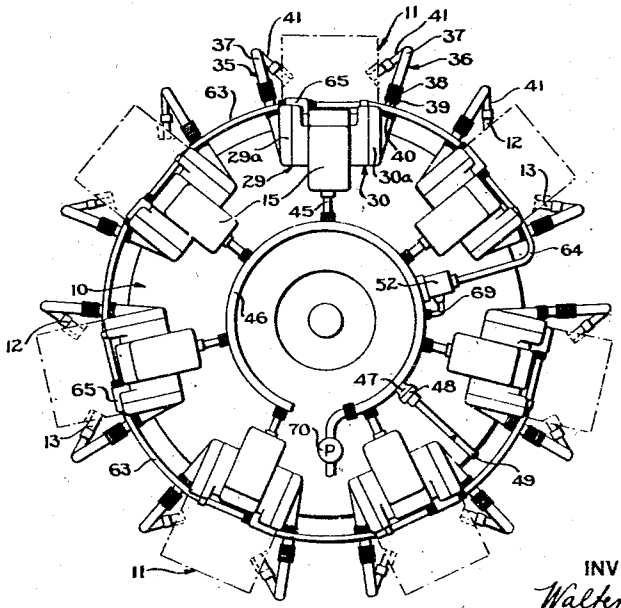


Fig 2

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IGNITION SYSTEM

Filed March 3, 1942 2 Sheets-Sheet 2

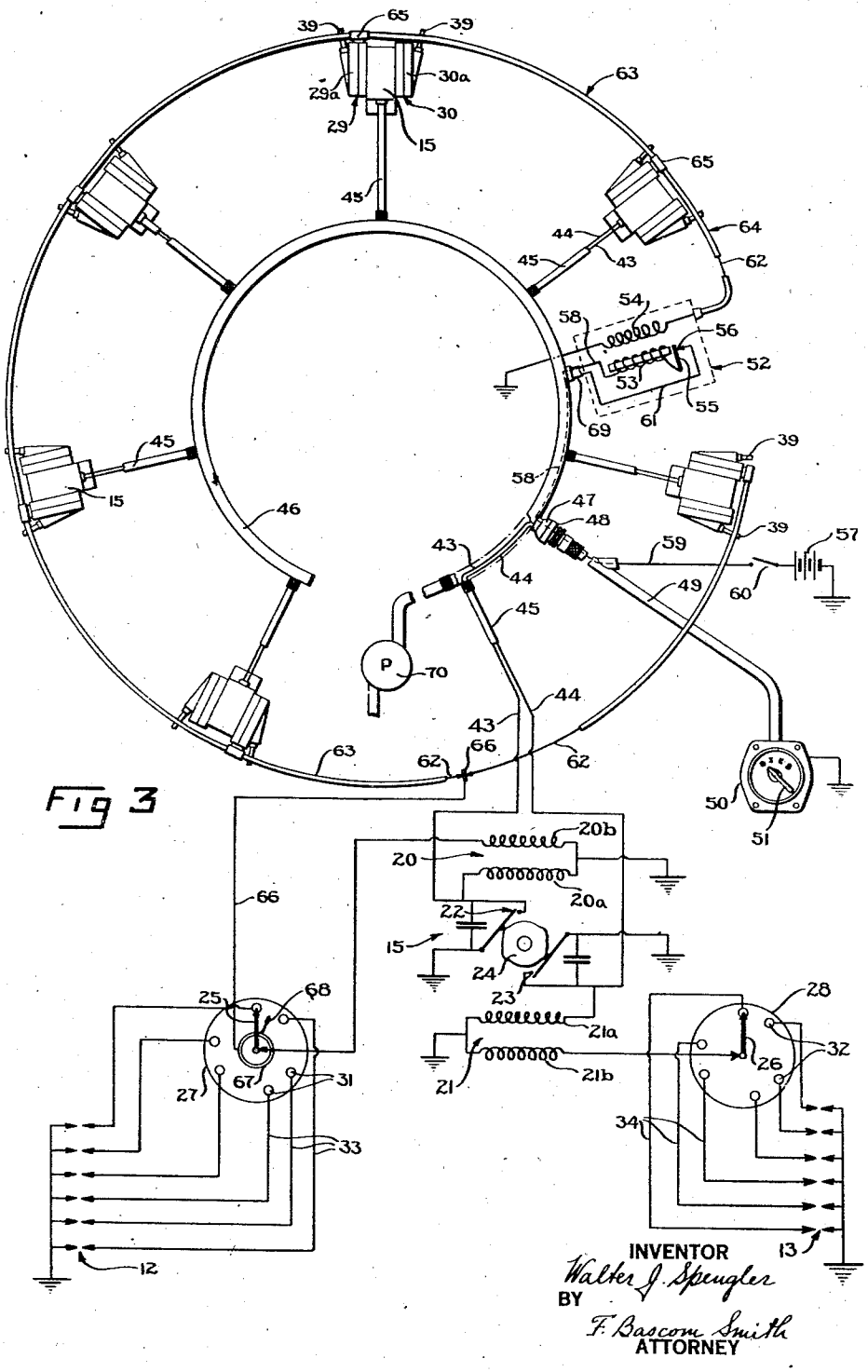


Fig 3

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IGNITION SYSTEM

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Application March 3, 1942, Serial No. 433,174

13 Claims. (Cl. 123—148)

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This invention relates to ignition apparatus and more particularly to an ignition system for multi-cylinder internal combustion engines and radio shielding means therefor.

One of the objects of the present invention is to provide a novel, simple and effective ignition system for engines having a plurality of radially-disposed, axially-extending rows of cylinders.

Another object of the invention is to provide a novel ignition system for engines of the above character whereby maximum safety against complete or even destructive partial ignition failure is attained.

Still another object is to provide a novel ignition system for multi-cylinder engines which is so constituted that the parts thereof may be most advantageously arranged and mounted on the engine from the standpoints of installation, operation, inspection, adjustment and repair.

A further object is to provide a novel system of radio shielding for the ignition wires of an internal combustion engine of the above type.

A still further object is to provide a novel ignition system which is so constituted and arranged as to materially reduce the danger of ignition failures and inefficiency at high altitudes in engines having large numbers of cylinders.

Another object is to provide a novel system of supercharging the distributor chambers of an ignition system to thus enhance the operating characteristics of the engine at high altitudes.

The above and further objects and novel features of the invention will more fully appear from the following detailed description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only and are not intended to define the limits of the invention, reference being primarily had for this latter purpose to the appended claims.

In the drawings, wherein like reference characters refer to like parts throughout the several views,

Fig. 1 is a diagrammatic, isometric view of a portion of an engine embodying one form of the novel ignition system comprehended by the present invention;

Fig. 2 is a diagrammatic illustration of said ignition system as viewed from the front of the engine;

Fig. 3 is a diagrammatic view of said system, with parts broken away, showing samples of the electrical connections for one bank or row of cylinders;

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Fig. 4 is a detail view, with parts broken away, showing a portion of the shielding harness for one bank of cylinders; and,

Fig. 5 is a sectional view, with parts broken away, taken substantially on line 5—5 of Fig. 4.

The single embodiment of the invention illustrated in the drawings, by way of example, is adapted for use on an internal combustion engine 10 of the type wherein several axially extending rows 11 of cylinders are radially disposed about a common crankshaft (not shown), each of said rows comprising a plurality of cylinders in-line. As shown, the engine comprises seven rows 11 of six cylinders each, forty-two cylinders in all. Each cylinder has two diametrically disposed spark plugs 12 and 13 to provide the safety and power afforded by double ignition. Each row of cylinders is preferably surrounded by a cooling jacket 14 for the circulation of a cooling fluid.

A novel and simple system for generating and distributing high tension current to spark plugs 12 and 13 of engine 10 is provided whereby the lengths of the high tension leads or conductors are kept to a minimum, thereby reducing capacity losses, the possibilities of ignition failures, and the radio shielding requirements. Likewise, the necessary parts or units of the present novel ignition system are kept relatively small and are adapted to be relatively evenly distributed on the engine, thereby conserving space and insuring less air resistance and better balance and, hence, a minimum of vibration. Said system, in the form shown, comprises a double magneto 15 for supplying and distributing high tension current to both sets of spark plugs 12 and 13 in each row of cylinders 11. One suitable form of magneto for this purpose is illustrated in U. S. application for patent Serial No. 433,175, filed on March 3, 1942 by Jakob R. Frei for improvements in magneto. It is believed to be unnecessary to show a magneto in detail in the present application, since the magneto, per se, does not constitute a part of the present invention.

Each magneto 15 is preferably removably secured on a so-called mounting pad 16, which may be integrally cast with the cone-like nose of engine 10 and has an opening 17 that receives the driven end of the rotor shaft of the magneto. Said shaft is drivably connected in any suitable manner, preferably through an adjustable coupling to an engine driven shaft (not shown) journaled in a hollow boss 18 on the nose of the engine. The rotor of each magneto 15 may be constructed in accordance with any of several well-known and suitable designs and is rotated in any

suitable manner, such as in the manner pointed out above, in timed relation with the engine crankshaft between two ignition coils 20 and 21 which are diagrammatically illustrated in Fig. 3. The primary windings 20a and 21a of said coils are connected in circuit with circuit breakers 22 and 23 in the usual well-known manner, said circuit breakers being simultaneously and periodically opened and closed by a cam 24 that may be on the rotor shaft of the magneto, or otherwise operatively connected thereto, for rotation in timed relation therewith for the purpose of causing high tension current to be induced in secondary windings of said coils.

Secondary windings 20b and 21b of ignition coils 20 and 21, respectively, of each of the seven magnetos 15 are electrically connected by suitable brushes to the rotating arms 25 and 26 of distributors 27 and 28, respectively, which are housed in oppositely disposed portions 29 and 30 of the metallic casings of said magnetos. Distributor arms 25 and 26 may be operatively connected to and driven synchronously with the magneto rotor, as is common practice in the magneto art, for conducting high tension current in predetermined sequence to circularly arranged, non-uniformly spaced contacts or terminals 31 and 32 in distributor blocks that are preferably mounted in removable sections 29a and 30a of the magneto casing portions 29 and 30.

Separate high tension leads 33 and 34 extend from contacts 31 and 32 to spark plugs 12 and 13, respectively, through tubular metallic shields 35 and 36 (Fig. 1). Each of the latter preferably comprises a rigid tube 37, a short flexible tubular section 38 connected thereto, and a short rigid section 39 provided with an internally threaded nut 40 for detachably connecting the shield to the magneto casing portion 29a ar 30a (Fig. 4). Extending radially from each tube 37 are six flexible metallic conduits 41 provided with means for detachably securing the same to shielded spark plugs 12 and 13 in a manner well understood in the art, one of said conduits being shown in detail in Fig. 5. High tension current conductors 33 and 34 are thus led from conductor housings 29a and 30a where they are connected to terminals 31 and 32 through manifold shielding conduits 38, 37, and individual conductors branch off through flexible conduits 41 for electrical connection to spark plugs 12 and 13.

All free space in the distributor block housings 29a and 30a and in shields 37, 38, 41 is preferably filled with a yieldable insulating compound 42, such as polymerized cashew nutshell oil. The latter may be injected in liquid form into the space to be filled and is then reduced to a unitary yieldable solid by chemical reactions, a solid which has good electrical qualities and is capable of withstanding high temperatures. Shields 37, 38 may be secured by means of suitable brackets (not shown) to a suitable rigid portion of the engine structure.

In order to provide simultaneous and simplified control of the operation of all seven of the magnetos 15 from a centralized and convenient point, means are provided for grounding all of the primary windings 20a and 21a in all of said magnetos through a common control switch that may be located in the cockpit of an airplane or at some other suitable location. From the ungrounded ends of the primary windings of the coils in each magneto, leads 43 and 44 are led from the magneto into a metallic shielding tube 45 which is preferably flexible and, thence, through a metallic manifold ring or tube 46 which is mounted on the nose of engine 10 inside of the circularly arranged magnetos 15. Tubes or conduits 45 may be detachably secured to magnetos 15 as well as to the outer periphery of ring 46, the connection at the magneto being of the plug and socket type for leads 43 and 44 to thus permit quick and easy assembly and disassembly.

For the purpose of convenience and simplicity, all of the so-called ground wires in ring 46 (two for each magneto) are connected to separate terminals in the socket portion 47 of a "Cannon" connector or similar multiple plug and socket connector, the details of which are well-known and, hence, not shown. The plug portion 48 of said connector is secured to a flexible metallic shielding tube 49 housing the necessary extensions of said ground wires 43 and 44 from each magneto. Tube 49 may be similarly provided at its other end with a "Cannon" connector for ready connection to a switch mechanism 50. The latter, which does not, per se, constitute a part of the present invention, is so constructed that when the control lever 51 is in the illustrated or off position, all primary windings 20a and 21a of the magneto coils will be grounded through the switch mechanism and, hence, render the magnetos inoperative for generating high tension current for distribution to spark plugs 12 and 13. When lever 51 points to "I" on the face of switch 50, only the coils for furnishing current to spark plugs 13 on the exhaust side of the cylinders are grounded, thus permitting the engine to run on a single set of spark plugs 12. When lever 51 is at "E" only the coils for furnishing current to spark plugs 12 are grounded, thereby permitting the engine to run on spark plugs 13. With lever 51 pointing toward "B," full operation of all magnetos and, hence, ignition by both sets of spark plugs is permitted.

Conduits 45 and manifold ring 46 may be conveniently referred to as a ground wire harness, said ring being secured to the nose of the engine by suitable brackets or the like in any manner well understood in the art. Manifold conduit 49 may also be considered as a portion or extension of the ground wire harness. This harness serves not only to protect the electrical conductors contained therein and to prevent electrical and magnetic radiations therefrom, but, as hereafter pointed out, may also be employed as a unit in a system for supercharging the magnetos and distributor chambers associated therewith.

For the purpose of increasing the ease with which engine 10 may be started, the above-described ignition system may be supplemented with a novel booster circuit, the current producing ability of which does not depend upon the speed of rotation of the engine crankshaft as does the current supplied by magnetos 15. As shown, the booster circuit comprises a buzzer coil 52 which includes a primary winding 53, a secondary winding 54, and buzzer contacts 55 and 56 (Fig. 3). Movable contact 55 of booster coil 52 is connected to one end of primary winding 53, and the other end of said winding is connected to a battery 57 through a lead 58 which extends through the ground wire harness manifold 46 and is connected by means of plug connector 47, 48 with a lead 59. The latter branches off from shielding tube 49 at any suitable point and has a starter operated switch 60 interposed therein so that the booster circuit

is permitted to function only when the engine starting mechanism (not shown) is in operation. Stationary contact 56 of the booster coil is also connected to a lead 61 which extends through manifold ring 46. Lead 61 is extended through "Cannon" plug 47, 48 and a wire in tube 49 to switch 50, the connection thereof to said switch being such that when the latter is in any of the three "on" positions, the primary winding 53 is grounded through the switch to permit the completion of an electrical circuit containing said primary winding and battery 57 when starter operated switch 60 is moved to closed position. When lever 51 of the switch is in off position, as shown, winding 53 is not grounded and, hence, the booster coil will not function even though switch 60 is closed.

The secondary winding 54 of booster coil 52 is permanently grounded at one end and is connected at its other end to one distributor of each magneto 15 by means of a single although discontinuous lead 62. The latter together with the shielding therefor is divided into a plurality of sections 63 and one section 64. Each of the sections 63 comprises a shielded insulated conductor having a plug connector at each end similar to that shown at the outer end of spark plug lead 33, 41 of Fig. 5. The plug connectors at the adjacent ends of adjacent sections 63 extend into sockets at opposed sides of portions or bosses 65 on distributor housings 29 and yieldably engage a conductor 66 (Fig. 3) which conducts high tension current from secondary winding 54 to a stationary ring 67 in an insulating block mounted in distributor housing 29. From said ring the current jumps across a short gap to a contact 68 that rotates with distributor arm 25 and distributes the booster current to contacts 31 for transmission to spark plugs 12 in the desired sequence (Fig. 3). The distributor contacts for the booster current in the seven magnetos 15 are thus electrically connected in parallel with each other, thereby simplifying both the booster circuit, per se, and the radio shielding required therefor. Section 64 of the booster circuit is similar to sections 63, except that one end thereof plugs into the booster coil 52 for connection with one end of secondary winding 54.

As best illustrated in Figs. 1 and 2, booster coil 52 is mounted on the nose of engine 10 relatively near ground wire harness manifold 46. Leads 58 and 61 from the booster coil may be shielded by a tube or conduit 69 which may be detachably secured to the coil housing and the manifold ring.

For high altitude flying it becomes desirable to maintain a pressure within the magnetos and particularly within the distributor chambers thereof, which pressure is higher than the atmospheric pressure surrounding the aircraft at high altitudes. The magnetos of the novel ignition system comprehended by the present invention may be readily and conveniently supercharged for this purpose by the addition of very little extra equipment. The air or other gas, such as an inert gas, may be supplied to the magnetos through the ground wire harness 45, 46 from a suitable pressure source, such as a tank of compressed gas or a suitable pump 70 (Fig. 3). As shown, the output or pressure side of pump 70 is operatively connected to one end of manifold ring 46.

If desired, the supercharging gas may be passed through a suitable filter and dryer to remove any foreign matter or moisture therefrom.

The gas may be supplied directly into the magneto casings from the ground wire harness, which casings may be rendered relatively gas-tight by suitable sealing means around the shafts which extend therefrom, or the same may be supplied into a gas-tight casing or hood surrounding each magneto. A small amount of leakage is, of course, desirable to permit proper circulation and, hence, prevent any undue ionization of the gaseous medium within the distributor chambers. However, if an inert gas is employed, it is likely that very little, if any, circulation would be required.

There is thus provided a novel ignition system for engines having large numbers of cylinders and particularly for such engines employing double ignition in each cylinder. Having regard for the large number of cylinders, the ignition system provided is very simple from the standpoints of construction and installation and lends itself readily to inspection, repair and overhauling. Additionally, said system includes simply constructed parts and units which are interchangeable and which may be inexpensively repaired or replaced in case of damage without removing the entire system, thus materially reducing the costs of operation and upkeep. The system is also novelly constituted by separable units which may be conveniently arranged on the engine to minimize the lengths of high tension leads and, hence, minimize ignition losses and increase operating efficiency. The novel ignition system comprehended also includes a novel booster circuit for starting purposes. Furthermore, the system provided lends itself to efficient supercharging of the distributor chambers for high altitude flying and is so constructed that it permits of maintaining critical flash-over distances relatively large without unduly increasing the space required by any of the parts or units.

Although only a single embodiment of the invention has been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. For example, various changes in the design and arrangement of parts illustrated will now be apparent to those skilled in the art and may be effected without departing from the spirit and scope of the invention. For a definition of the limits of the invention, reference is had primarily to the appended claims.

What is claimed is:

1. An ignition system for a dual ignition internal combustion engine with a plurality of groups of adjacent cylinders comprising a plurality of magnetos, a pair of ignition distributors operatively associated with each of said magnetos, and means operatively connecting the distributors of each of said pairs to spark plugs in the same group of adjacent cylinders of said engine.

2. An ignition system for a dual ignition internal combustion engine comprising a plurality of magnetos, each of said magnetos being adapted to generate electrical current for firing spark plugs in a separate group of adjacent cylinders of said engine, a pair of ignition distributors operatively associated with each of said magnetos, and means operatively connecting the distributors of each of said pairs to spark plugs in the same group of adjacent cylinders.

3. An ignition system for a dual ignition internal combustion engine comprising a plurality of magnetos, each of said magnetos being

adapted to generate electrical current for spark plugs in a separate group of adjacent cylinders, two ignition distributors operatively associated with each magneto, and means operatively connecting the distributors associated with each magneto to spark plugs in the same group of adjacent cylinders, said magnetos and distributors being so constructed and operated that successive ignitions of charges in the engine cylinders take place in cylinders of different groups.

4. An ignition system for a dual ignition internal combustion engine comprising a plurality of magnetos, a pair of ignition distributors operatively associated with each of said magnetos, and means operatively connecting the distributors of each of said pairs to spark plugs in the same group of adjacently mounted cylinders of said engine, said distributors being so operated that successively firing spark plugs are located in cylinders of different ones of said groups of cylinders.

5. In an ignition system for a dual ignition internal combustion engine comprising a plurality of magnetos, each of said magnetos being adapted to generate electrical current for firing spark plugs in a separate group of adjacent cylinders of said engine, a pair of ignition distributors operatively associated with each of said magnetos, means operatively connecting the distributors of each of said pairs to spark plugs in the same group of adjacent cylinders, a source of booster current, means in at least one distributor of each of said magnetos for distributing booster current to spark plugs connected to said distributor, and means for connecting said last-named means in parallel and to said source of booster current.

6. In an ignition system for internal combustion engines, a plurality of magnetos, a distributor having cooperable stationary and rotary conductors for distributing high tension current from each of said magnetos, a source of high tension current, such as a booster coil, and means for connecting said stationary conductors in parallel with each other and to said source of high tension current whereby current from said source is distributed by said distributors.

7. An ignition system for internal combustion engines comprising a plurality of distributors for distributing high tension current to the spark plugs in the engine cylinders, each distributor comprising a plurality of spaced output terminals and a rotating element adapted to transmit high tension current to said output terminals in predetermined sequence, a common source of high tension current, conducting means in each of said distributors in spark gap relation with said rotating element, and means connecting said conducting means of each distributor in parallel with each other and in a circuit with said common source of high tension current.

8. In an ignition system for an internal combustion engine, a plurality of distributors adapted to distribute high tension current to the spark plugs of the engine, a regular source of high tension current operatively connected to each of said

distributors, a source of booster current, and means including a conductor and a rotary conducting element in each distributor for distributing current from said booster source, said conductors being connected in parallel branches of an electric circuit including said booster source.

9. In an ignition system for an internal combustion engine, a source of high tension current, a plurality of distributors for distributing said current to the spark plugs of said engine, each of said distributors comprising a conducting element, and means connecting said elements to said source, said elements being connected in parallel with each other.

10. In an ignition system for an internal combustion engine having a plurality of radially disposed rows of cylinders, the combination of a magneto mounted on said engine adjacent each of said rows of cylinders, each of said magnetos comprising a distributor, and a radio-shielding harness for the high tension leads to a set of spark plugs in each row of cylinders, each of said shielding harnesses having the manifold thereof connected directly to the casing of the magneto mounted adjacent the corresponding row and extending therefrom along said row of cylinders.

11. In an ignition system for an internal combustion engine having a plurality of radially disposed rows of cylinders, the combination of a magneto mounted on said engine adjacent each of said rows of cylinders, a distributor on each of two opposite sides of each magneto, and a radio-shielding harness on each side of each row of cylinders for shielding the high tension leads to sets of spark plugs on opposite sides of each of said rows of cylinders, the manifold of each harness being directly connected to the casing of the magneto adjacent the corresponding row of cylinders.

12. In an ignition system for a radial type internal combustion engine, the combination of a plurality of magnetos circularly arranged on said engine, each of said magnetos having at least one distributor operatively associated therewith, a single source of booster current, contact means in each of said distributors for distributing current from said source to the spark plugs of said engine, said contact means including a ring-like stationary conductor in each distributor, and means for connecting said conductors in parallel with each other and to said source.

13. In an ignition system for a dual ignition internal combustion engine having a crankshaft and a plurality of rows of cylinders extending radially from said shaft, the combination of two sets of spark plugs in the cylinders of each row, a plurality of magnetos for generating high tension current, and distributor means for distributing high tension current from each of said magnetos to two of said sets of spark plugs in the same row of cylinders, each of said magnetos supplying current to spark plugs in different cylinders than each other magneto.

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