

May 6, 1941.

R. H. STONE

2,240,632

IGNITION MEANS

Filed June 11, 1938

2 Sheets-Sheet 1

FIG. 2

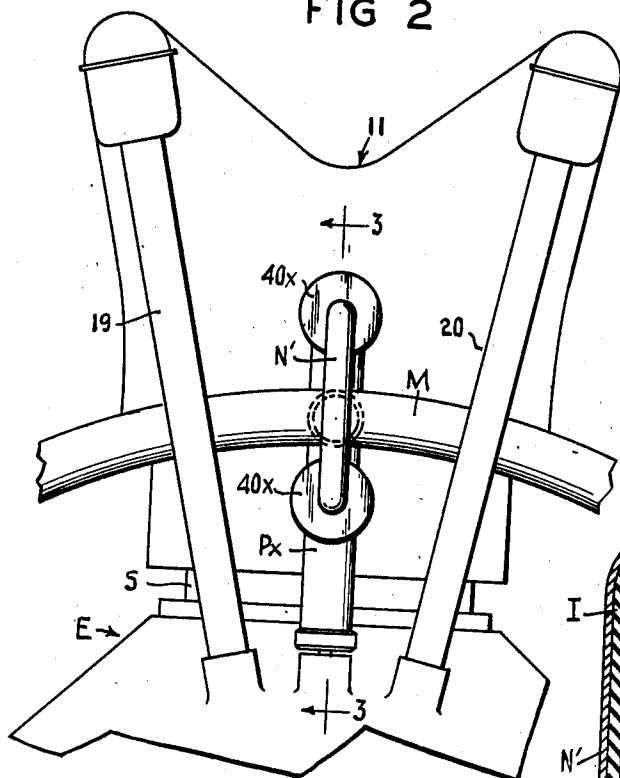


FIG. 1

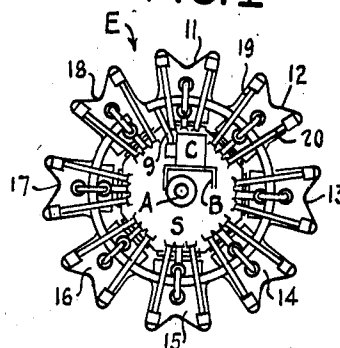


FIG. 4

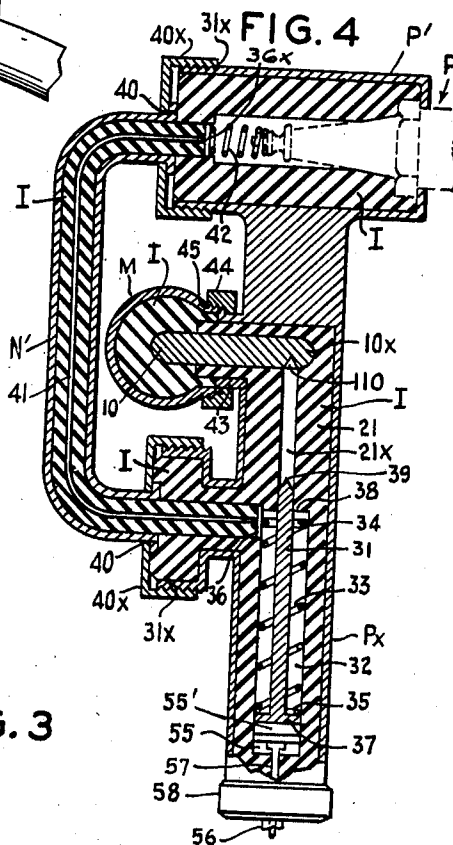
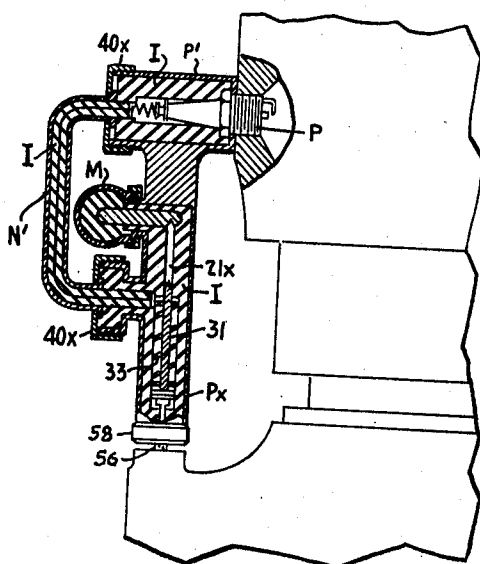


FIG. 3



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2 Sheets-Sheet 2

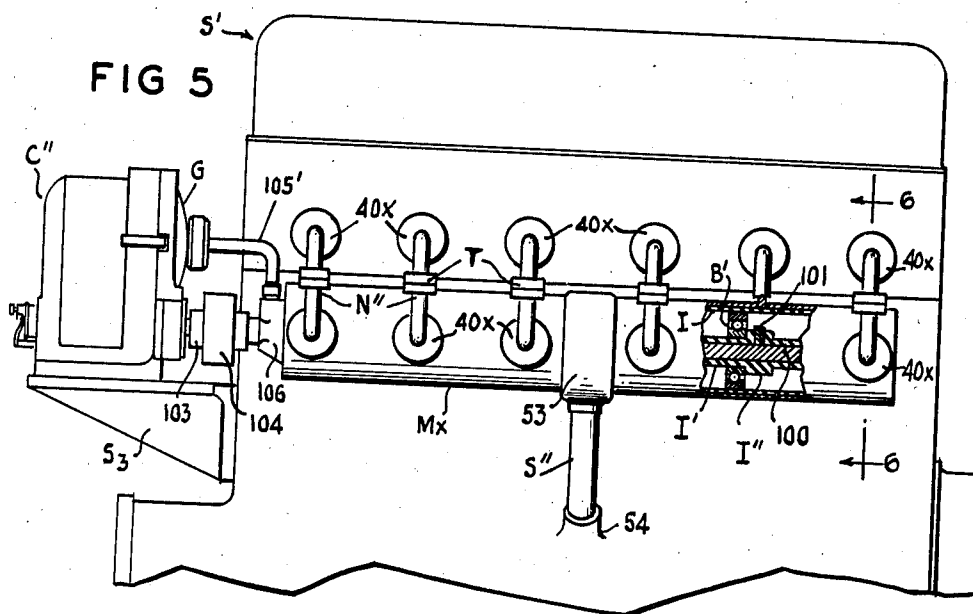
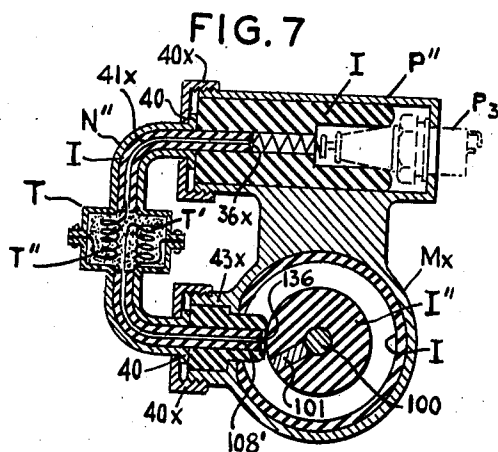
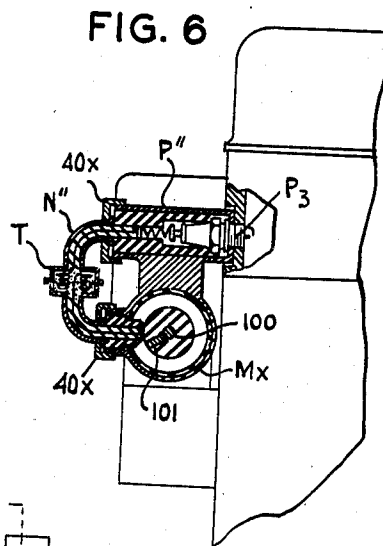
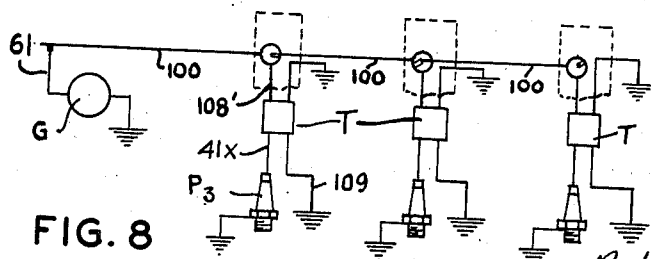


FIG. 8

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UNITED STATES PATENT OFFICE

2,240,632

IGNITION MEANS

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Application June 11, 1938, Serial No. 213,230

16 Claims. (Cl. 123—148)

This invention relates to an internal combustion engine, especially to an ignition system for such an engine, and more particularly to an ignition system in which each cylinder of the engine is provided with one or a plurality of spark plugs.

In conventional ignition systems of this general character, where a magneto energizes a distributor common to several individual spark plug circuits each of which comprises a separate insulated conductor running to its plug from its individual terminal in said distributor, and a common rotating member in the distributor is connected in series with the output terminal of the magneto being grounded to the engine block; and the plugs being usually grounded to the engine block likewise; there is a complexity of loosely extending conductors which interferes with ready access to the engine and constitutes at least an inefficient, unreliable and unsatisfactory expedient for the intended purpose.

Among other inconveniences, the loose conductors are subjected to frequent unintended displacement and to destruction of their insulation by heat, abrasion, or forcible contact with tools; and they are always likely to be connected up improperly by persons unfamiliar with the characteristics of an ignition system. Such an exposed arrangement of the spark plug leads lends itself also to intentional disablement of a car, since the distributor can be readily displaced or dismembered, and the ignition system incapacitated, thus putting the engine out of commission.

With the addition of each set of spark plugs, as for example in the use of a dual ignition system, the complex of conductors becomes an intolerable tangle, particularly in the case of a multi-cylinder radial type of engines used in aviation, where the disadvantages of loose conductors aggravates the problem of radio shielding.

Under such conditions an object of the present invention is to provide an improved ignition system free from loose conductors and from the disadvantages attendant thereupon, as above briefly summarized.

Another object is to provide a multi-cylinder internal combustion engine with an ignition system mechanism comprising a source of electric current; a main conductor extended therefrom within a part of the supporting structure on which the cylinders are supported, and extended past the cylinders and their spark plugs; also to provide an individual conductor extended from each plug within a part of the supporting

structure, through a short path to an individual contact terminal in the vicinity of the main conductor; and a movable means adapted to connect each of said individual conductor contact terminals in periodic succession with a complementary individual contact terminal or portion of said main conductor.

Stated in different terms, the general object of the invention is to effect a shortening of the branch spark plug connections by localizing them in the vicinity of their respective plugs, and a cognate object of the invention is to provide for localizing the high-tension portions of an ignition system in the vicinity of each spark plug, instead of transmitting current of suitably high sparking voltage over a large number of conductors of considerable length, and exposed to disturbance in the manner already mentioned, according to existing practice.

To carry the last-mentioned object of the invention into effect, the invention provides for including in each of the individual spark plug circuits a transformer, to the primary of which a low voltage current is supplied from a central generator preferably through a main conductor common to all of the individual sparking circuits; in each of which sparking circuits is included a transformer secondary adapted to deliver to each relatively short spark plug circuit a sparking current of adequate voltage.

Other and ancillary objects and features of the invention will appear as the description of the particular physical embodiment selected to illustrate the invention progresses.

In the accompanying drawings, like characters of reference have been applied to corresponding parts throughout the several views which make up the drawings, in which:

Fig. 1 is a view in front elevation of a radial type internal combustion engine provided with an ignition system in the construction of which the present invention has been embodied;

Fig. 2 is a fragmentary detail view, on an enlarged scale, of one of the cylinder heads shown in Fig. 1, with its associated valve stem guides;

Fig. 3 is a fragmentary detail view, in vertical section, taken on the line 3—3 of Fig. 2;

Fig. 4 is a view similar to Fig. 3, on an enlarged scale;

Fig. 5 is a view in side elevation, partly in section, of an internal combustion engine of the straight row type provided with an ignition system in the construction of which the present invention has been embodied;

Fig. 6 is a view in vertical section, taken on the line 6—6 of Fig. 5;

Fig. 7 is a view similar to Fig. 6 on a larger scale;

Fig. 8 is a schematic view of the working circuit of an ignition system, according to the invention, of the apparatus of Figs. 5, 6 and 7.

In a now-preferred embodiment of the invention selected for illustration and description, and referring to Figs. 1, 2 and 3, the radial cylinder 10 of the last-mentioned plunger being disposed suitable to be operated by a motor-actuated means, such as a cam (not shown) which rotates when so actuated by working parts of the engine to which it is connected.

The central supporting structure S on which the cylinders and their associated conventional valve-stem-guide pipes 19 and 20 are mounted radially with respect to the common main shaft A, may be of any suitable construction and is illustrated as of known form.

A source of current C is indicated diagrammatically as a magneto, mounted on a bracket B and may be driven by a conventional or other suitable connection (not shown) with a moving part of the engine, such as the main shaft.

In pursuance of the present invention, a main conductor 10 leads from the current source, as at 9 in Fig. 1, through a metal conduit which connects with an arcuate metal sheath or conduit M that constitutes a substantially circular manifold running past all of the cylinders in the vicinity of the spark plugs P therein.

The main conductor 10 is embedded in a suitable mass of insulation I within the manifold M and the same reference character I is applied to insulation wherever utilized within the system.

Referring to Figs. 3 and 4, it will be seen that a branch 10X of the main conductor 10 is led into a counter tube 21 of metal and filled with insulation except for an axial bore 21x in which is movable longitudinally a stem 31 adapted to complete the connection periodically between the main conductor 10 at a position 110 thereof which may be considered as a local contact terminal or portion of the main conductor 10.

The stem 31 is constantly in electro-conductive relation with the spark plug P which it serves by a branch conductor 41 extended through a short U-shaped metal sheath or conduit N' having end flanges 40 engaged by coupling caps 40x which secure the branch N' to threaded nipples 31x of which one is formed integrally with a substantially conventional radio-shielding "cam" P' surrounding the spark plug P; while the other nipple 31x is formed integrally with a hollow post Px in which the spindle 31 works, and which is made a part of the supporting structure of the engine as a whole.

The bore 21x within this post has an enlargement 32 adapted to accommodate a spring 33 coiled around the shank of the spindle and having a flat terminal coil 34 at its upper end and a like coil 35 at its lower end.

The coil 34 is in constant electrical contact with a disk 36 connected electrically to the conductor 41, while the coil 35 is similarly maintained by the spring 33 in electrical contact with the foot 37 of the stem 31, and as the coil 33 is confined between the shoulder 38 of the insulation and the foot 37 of the stem, it tends to bias constantly the stem 31 away from the conductor contact terminal 110.

Each spark plug circuit being thus normally

held open in the yielding action of its spring 33, the periodic completion of any particular plug circuit will be accomplished by the action of suitable means associated with the working parts within the engine casing S.

As an example of such provision, a device 55 is provided movable with a plunger 56, which traverses hole 57 in a cap 58 screwed upon and closing the lower end of hollow post Px, the lower end of the last-mentioned plunger being disposed suitable to be operated by a motor-actuated means, such as a cam (not shown) which rotates when so actuated by working parts of the engine to which it is connected.

When the stem 31 is moved upwardly, its pointed end 39 makes good electrical contact with the corresponding contact surface 110 in the branch 10x of the main conductor 10, from which sparking current is conducted to the spark plug P along a path which is traced through the stem 31, its foot 37, the spring 33, coil 34, contact terminal disk 36, spark plug lead 41 contact terminal 36x, and spring 42 to the spark plug P and thence ground (the cylinder block) to the magneto C which also has a ground connection as hereinbefore pointed out. The foot 7 is insulated from its operating means by a washer or block 55' of insulation.

From the foregoing disclosure it will be readily understood that no conductor is exposed to deleterious influences throughout the novel ignition system provided in pursuance of the present invention, all parts being thoroughly protected both against extraneous causes of impairment and against emission of an electrical field likely to interfere with radio communication with or from the plane.

The branch 10x of the main conductor 10 is likewise shielded, as shown by the short nipple 43 and coupling 44, screwed thereon and upon a threaded outlet nozzle 45 provided around an orifice in the wall of the manifold M.

In Figs. 5 to 7 inclusive I have shown the invention as applied in a modified embodiment to an internal explosion engine in which the cylinders are formed in a straight row within a supporting structure S' which is indicated as an engine block of conventional form, containing six cylinders, not illustrated, in detail, their number and particular physical structure not being important.

The reference characters P₃ designate the spark plugs for these cylinders, and Mx designates a tubular metal manifold lined with insulation and connected physically with and forming a unitary fixed structure with the engine block S'. Such connection may be provided in any suitable fashion, and is shown as so provided by a stout pillar S'' screwed into a boss 54 of the engine block, and into a collar 53 encircling the manifold Mx.

Further support and stability is provided for the said manifold by the six branch conduits N'' which are identical with the structure illustrated and described already with reference to parts similarly identified by the same reference characters in Figs. 2 and 3, so that the description of such parts will not be repeated.

Instead of the fixed main conductor 10 provided and described with reference to the structure of Figs. 1 and 3, provision is made, in the instance of the modification shown in Figs. 5 and 6, of a main conductor 100, covered by a sleeve of insulation I', through which extend radially branches 101 of the main conductor, there being one of these for each of the spark plug circuits.

Enlargements I'' of the insulating sleeve I' are provided, each forming a collar to receive its branch or contact terminal 101, and anti-friction bearings B' (see Fig. 5), are provided at suitable intervals within which the insulated conductor 100 rotates as a slender shaft. It may be rotated by an electrical motor C'' mounted on a bracket S₃ and mechanically connected with the shaft conductor 100 by a flexible insulating coupling 103. The motor may serve also to enclose a generator G which is driven by the electric motor. The generator serves to furnish current to activate the spark plugs P₃ respectively and in periodic succession. Any other suitable means, driven from the moving parts of the engine if desired, may be provided for driving the ignition generator G and the shaft conductor 100.

The current supplied by the generator may be of any suitable voltage, but in pursuance of an important feature of the invention, provision is made preferably of the novel arrangements illustrated in Fig. 7 and diagrammatically in Fig. 8, these arrangements being devised to carry out the localization of the relatively high-voltage sparking current at the region of each spark plug.

For this purpose a transformer, designated generally by the reference character T is interposed in each electrical sparking circuit, and the primary coil T' of such transformer may be impressed with a current of low voltage by means of a conductor 61 leading from one terminal of the generator G as indicated in Fig. 8 (the other terminal being grounded), this conductor passing through the metal elbow 105', shown in Fig. 5, to a contact brush in the box 106, such contact brush being in sliding electrical contact with the conductor shaft 100 which thus receives its supply of current of low voltage through the commutator brush. The conductor 100 passes through the manifold M₂, as indicated, with branches at the region of the respective spark plugs as indicated at 101 in Fig. 7. A conductor 108' leads from a contact terminal 136 (engaged by contact stud 101) to one terminal of the primary coil T' and whenever the rotation of shaft 100 swings the outer end of stud 101 around into registry with the contact terminal 136, the energizing low voltage current from generator C'' flows through the path traced by 62, 100, 101, 136, 108', primary T' to ground on the transformer casing.

The secondary coil T'' of the transformer may be designed desirably to furnish a high voltage sparking current, and one of its terminals is connected to a lead 41x to the spark plug P₃, the other terminal being connected to ground on the transformer casing, as shown in Fig. 7, and also indicated clearly in Fig. 8, the grounding being preferably to the engine block, to which the spark plugs also are grounded, preferably in known fashion.

From the foregoing it will be seen that the high tension sparking current is localized at each spark plug, within a working circuit of very short length, and is so confined that it has no opportunity to wander, nor does it exercise any unfavorable static action on the radio of a plane for example, being completely radio shielded.

The arrangements of Fig. 7 may be readily provided in connection with the modification of Fig. 4, so far as the interposition of a transformer into the sparking circuit is concerned, and it will be clear that any desired number of spark plug circuits may be provided corresponding to the plugs used in any number of cylinders, and that

these may be one, two, three or more plugs used in each cylinder.

What I claim is:

1. In an internal combustion engine having a plurality of cylinders each provided with at least one spark plug and a common supporting structure therefor: an ignition system mechanism comprising a source of electric current; a main conductor extended therefrom within a part of said supporting structure, past a plurality of said cylinders and spark plugs; an individual conductor extended within a part of said supporting structure from each plug to a contact terminal in the vicinity of said main conductor; and movable means, corresponding to each cylinder and distributed along said main conductor, adapted to connect each of said individual conductor contact terminals in periodic succession with a complementary individual contact portion of said main conductor, a housing encasing said main conductor and said contact terminals, a housing for each of said spark plugs and a conduit for each of said individual conductors, each of said conduits being separate from said housings but removably secured thereto.

2. In an internal combustion engine having a plurality of cylinders each provided with at least one spark plug and a common supporting structure therefor: an ignition system mechanism comprising a source of electric current; a main conductor extended therefrom within a part of said supporting structure, past a plurality of said cylinders and spark plugs; an individual conductor extended within a part of said supporting structure from each plug to a contact terminal in the vicinity of said main conductor; and movable means, corresponding to each cylinder and distributed along said main conductor, adapted to connect each of said individual conductor contact terminals in periodic succession with a complementary individual contact portion of said main conductor, said movable means being constituted by a rotatable conductor shaft having contact terminals spaced serially along its length and each adapted to serve a spark plug contact, a housing encasing said main conductor and said contact terminals, a housing for each of said spark plugs and a conduit for each of said individual conductors, each of said conduits being separate from said housings but removably secured thereto.

3. In an internal combustion engine having a plurality of cylinders each provided with at least one spark plug and a common supporting structure therefor: an ignition system mechanism comprising a source of electric current; a main conductor extended therefrom within a part of said supporting structure, past a plurality of said cylinders and spark plugs; an individual conductor extended within a part of said supporting structure from each plug to a contact terminal in the vicinity of said main conductor; and movable means, corresponding to each cylinder and distributed along said main conductor, adapted to connect each of said individual conductor contact terminals in periodic succession with a complementary individual contact portion of said main conductor, said movable means being constituted by a rotatable conductor shaft having contact terminals spaced serially along its length and each adapted to serve a spark plug contact and means to rotate said shaft, a housing encasing said main conductor and said contact terminals, a housing for each of said spark plugs and a conduit for each of said individual con-

ductors, each of said conduits being separate from said housings but removably secured thereto.

4. In an internal combustion engine having a plurality of cylinders each provided with at least one spark plug and a common supporting structure therefor; an ignition system mechanism comprising a source of electric current; a main conductor extended therefrom within a part of said supporting structure, past a plurality of said cylinders and spark plugs; an individual conductor extended within a part of said supporting structure from each plug to a contact terminal in the vicinity of said main conductor; and movable means, corresponding to each cylinder and distributed along said main conductor, adapted to connect each of said individual conductor contact terminals in periodic succession with a complemental individual contact portion of said main conductor, said movable means being constituted by a rotatable conductor shaft having contact terminals spaced serially along its length and each adapted to serve a spark plug contact; and a motor to drive said shaft separately, a housing encasing said main conductor and said contact terminals, a housing for each of said spark plugs and a conduit for each of said individual conductors, each of said conduits being separate from said housings but removably secured thereto.

5. In an internal combustion engine having a plurality of cylinders each provided with at least one spark plug, and a common supporting structure therefor: an ignition system mechanism comprising a source of electric current; a main conductor extended therefrom within a part of said supporting structure, past a plurality of said cylinders and spark plugs; an individual conductor extended within a part of said supporting structure from each plug to a contact terminal in the vicinity of said conductor; and movable means, corresponding to each cylinder and distributed along said main conductor, adapted to connect each of said individual conductor contact terminals in periodic succession with a complemental individual contact terminal of said main conductor; said movable means being constituted by a conductor shaft having an insulating sleeve and radial contact studs adapted to be engaged serially with said individual conductor contact terminals as the shaft rotates, a housing encasing said main conductor and said contact terminals, a housing for each of said spark plugs and a conduit for each of said individual conductors, each of said conduits being separate from said housings but removably secured thereto.

6. In an internal combustion engine having a plurality of cylinders each provided with at least one spark plug, and a common supporting structure therefor: an ignition system mechanism comprising a source of electric current, including a magneto; a main conductor extended therefrom within a part of said supporting structure, past a plurality of said cylinders and spark plugs; an individual conductor extended within a part of said supporting structure from each plug to a contact terminal in the vicinity of said main conductor; and movable means, corresponding to each cylinder and distributed along said main conductor, adapted to connect each of said individual conductor contact terminals in periodic succession with a complemental individual contact terminal of said main conductor; said movable means being constituted by a conductor shaft

having an insulating sleeve and radial contact studs adapted to be engaged serially with said individual conductor contact terminals as the shaft rotates and a motor to rotate said shaft a housing encasing said main conductor and said contact terminals, a housing for each of said spark plugs and a conduit for each of said individual conductors, each of said conduits being separate from said housings but removably secured thereto.

7. In an internal combustion engine having a plurality of cylinders each provided with at least one spark plug, and a common supporting structure therefor: an ignition system mechanism comprising a source of electric current; a main conductor extended therefrom within a part of said supporting structure, past a plurality of said cylinders and spark plugs; an individual conductor extended within a part of said supporting structure from each plug to a contact terminal in the vicinity of said main conductor; and a reciprocating cam-controlled means adapted to connect each of said individual conductor contact terminals in periodic succession with a complemental individual contact portion of said main conductor.

8. An ignition system for an internal combustion engine having the features claimed in claim 7, in which each of said cam-controlled devices includes a stem reciprocable in a socket formed in the supporting structure and having one end adapted to make and break contact with a part of said main conductor and a spring coiled around said stem within the socket and adapted to bias said stem to circuit-breaking position.

9. An ignition system of an internal combustion engine having the features claimed in claim 7, in which each of said cam-controlled devices includes a stem reciprocable in a socket formed in the supporting structure and having one end adapted to make and break contact with a part of said main conductor and a spring coiled around said stem within the socket and adapted to bias said stem to circuit-breaking position, said spring adapted to serve in part at least to maintain said stem and one of said individual contact terminals in constant electro-conductive relation.

10. In an internal combustion engine having a plurality of cylinders each provided with at least one spark plug, and a common supporting structure therefor: an ignition system mechanism comprising a source of alternating electric current; a main conductor extended therefrom within a part of said supporting structure, past a plurality of said cylinders and spark plugs; an individual working circuit for each plug including a transformer having a primary and secondary within a part of said supporting structure including an individual contact terminal in the vicinity of said main conductor; and also including a transformer having a primary and secondary for each plug, and movable means, corresponding to each cylinder and distributed along said main conductor, adapted to connect each of said transformer primaries in periodic succession with a complemental individual contact terminal of said main conductor to activate said primaries serially.

11. In an internal combustion engine having a plurality of cylinders each provided with at least one spark plug, and a common supporting structure therefor: an ignition system mechanism comprising a source of alternating electric

current; a main conductor extended therefrom within a part of said supporting structure, past a plurality of said cylinders and spark plugs; an individual working circuit for each plug including a transformer having a primary and secondary within a part of said supporting structure including an individual contact terminal in the vicinity of said main conductor; and also including a transformer having a primary and secondary for each plug, and movable means, corresponding to each cylinder and distributed along said main conductor, adapted to connect each of said transformer primaries in periodic succession with a complementary individual contact terminal of said main conductor to activate said primaries serially, each secondary being included in an individual sparking circuit with its spark plug.

12. In an internal combustion engine having a plurality of cylinders each provided with at least one spark plug, and a common supporting structure therefor: an ignition system mechanism comprising a source of electric current; a main conductor extended therefrom within and insulated from, a metal conduit or sheath constituting a part of said supporting structure, past a plurality of said cylinders and spark plugs; an individual conductor extended within and insulated from a metal conduit or sheath constituting a part of said supporting structure, from each plug to a contact terminal in the vicinity of said main conductor and movable means corresponding to each of said cylinders and distributed along said main conductor for connecting the said contact terminals with said main conductor in periodic succession, a housing for each of said spark plugs, each of said conduits for said individual conductors being separate from the first mentioned metal conduit or sheath and said spark plug housing, but removably secured to the last mentioned conduit and to said housing.

13. The combination with the spark plug of an internal combustion engine, of a radio shield-

ing casing therefor, an ignition conductor detachably contacting said spark plug and a radio shielding conduit for said conductor comprising an elbow separate from but detachably secured to said spark plug casing and a second elbow at the other end of said conduit.

14. The combination with the spark plug of an internal combustion engine, of a radio shielding casing therefor, an ignition conductor detachably contacting said spark plug and a radio shielding conduit for said conductor comprising an elbow separate from but detachably secured to said spark plug casing and a second elbow at the other end of said conduit, said elbows being integral with said conduit.

15. The combination with a plurality of spark plugs, of radio shielding housing common to conducting means for said spark plugs, conducting means in said housing, a radio shielding casing for each of said spark plugs, individual radio shielding conduits each detachably secured to said housing and also detachably secured to said casing, each of said conduits comprising an elbow adjacent the spark plug casing and a second elbow at the other end of the conduit, said elbows being integral with the conduit, and an ignition conductor extending through each of said conduits and detachably connected with a spark plug and also with said conducting means.

16. The combination with a plurality of spark plugs, of radio shielding housing common to conducting means for said spark plugs, conducting means in said housing, a radio shielding casing for each of said spark plugs, individual radio shielding conduits each detachably secured to said housing and also detachably secured to said casing, each of said conduits comprising elbows one adjacent the spark plug casing and another adjacent said housing and an ignition conductor extending through each of said conduits and detachably connected with a spark plug and also with said conducting means.

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