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CHARLES H. DAVIS, JR., DECEASED, LATE OF ANDERSON, INDIANA, BY JOHN T. FITZSIMMONS, ADMINISTRATOR, OF ANDERSON, INDIANA, ASSIGNOR TO DELCORREMY CORPORATION, OF ANDERSON, INDIANA, A CORPORATION OF DELAWARE

IGNITION APPARATUS

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This invention relates to ignition apparatus for internal combustion engines and more particularly to engines which operate at relatively high speed and which require a plurality of sparking impulses be provided simultaneously during each instant or period of power impulse.

It is one of the objects of the present invention to provide ignition apparatus for engines of the type referred to and this object is accomplished in the disclosed embodiment of the invention by novel distributing means operating in conjunction with sparking impulse generating means comprising a plurality of alternately operated generators each providing simultaneously a plurality of sparking impulses. The ignition distributor comprises a head carrying a circular row of posts to which the various spark gaps of the engine are connected and a rotor carrying a plurality of distributing conductors each of which is provided with an arm which moves past the row of spark plug posts of the distributor and each of which is provided with a plurality of branches so constructed and arranged as to cooperate alternately with other terminal posts connected with the sparking impulse generators.

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

In the drawings:

Figs. 1 and 2 together constitute a wiring diagram illustrating the present invention applied to an 8-cylinder double spark engine.

Figs. 3 and 4 together constitute a wiring diagram illustrating the present invention applied to a 12-cylinder double spark engine.

Referring to Fig. 1 the circles numbered 1 to 8 respectively, represent the cylinder of an 8 cylinder engine. Each cylinder is provided with a plurality of spark gaps A and B. The manner of connecting these spark gaps with the ignition apparatus is indicated by symbols rather than lines in order to avoid confusion of the diagram as shown in Fig. 2 which will now be described.

The battery 20 is grounded at 21 and is connected by a switch 22 with a wire 23 which leads to sparking impulse generators 24 and 34. The generator 24 comprises primaries P3 and P4 cooperating with secondaries S3 and S4, respectively. The generator 34 comprises ignition coils having primaries P1 and P2 cooperating respectively with secondaries S1 and S2.

The primaries P3 and P4 are connected in series with battery 20 and with a terminal 25 of an ignition timer. Terminal 25 is connected by leaf spring conductor 26 with a lever 27 pivoted at 28 and carrying a rubbing block 29 which cooperates with an ignition timer cam 30. Lever 27 carries contact 31 cooperating with grounded contact 32. Terminal 25 is connected with condenser 33.

Primaries P1 and P2 are connected with terminal 35 of an ignition timer. Terminal 35 is connected by leaf spring conductor 36 with lever 37 pivoted at 38 and carrying a rubbing block 39 which cooperates with the cam 30. Lever 37 carries a contact 41 cooperating with a grounded contact 42. Terminal 35 is connected with a condenser 43.

The cam 30 is driven by a shaft 45 which rotates at one-half engine speed for a four cycle engine or at engine speed for a two cycle engine. The shaft 45 rotates a distributor rotor carrying segments 51 and 52 having arms 53 and 54, respectively, which move in proximity to a row of posts 55 each of which is connected with an engine spark gap or spark plug in a manner to be described later. Rotor 51 serves the A spark gaps and rotor 52 serves the B spark gaps.

The rotor 52 has branches R2 and R4 which are located in the same plane and which move in proximity to distributor posts 56#S1 and 56#S2 which are located diametrically opposite each other and which are connected by wires 61 and 62 respectively, with terminals of the secondary coils S1 and S2, respectively. The rotor 52 is provided with branches R6 and R8 which alternate with the branches R2 and R4 and which terminate in projections extending into a plane other than and preferably above the plane of the branches R2 and R4. These rotor branches R6 and R8 move

in proximity to distributor posts 57#S3 and 57#S4 which terminate in the same plane, said plane being other than the plane containing the ends of posts 56#S1 and 56#S2 and being preferably above the plane of the ends of posts 56#S1 and 56#S2. The posts 57#S3 and 57#S4 are connected respectively, by wires 63 and 64 with the terminals of secondary coils S3 and S4.

Likewise the rotor 51 is provided with branches R1 and R3 cooperating with distributor posts 56#S1 and 56#S2. The branches R1 and R3 alternate with branches R5 and R7 which are located in the same plane as the branches R6 and R8 and which cooperate with the posts 57#S3 and 57#S4.

It will be noted that the two posts 56 connected to the sparking impulse generator 34 are diametrically opposite each other; and that the two posts 57 connected with generator 24 are diametrically opposite. The pairs of posts 56 and 57 are angularly related depending on the number of engine cylinders as will be explained later. For an eight cylinder engine the angle is 90°. It will be noted that the rotor arms R1 and R2 are diametrically opposite and likewise R5 and R6, R3 and R4, and R7 and R8; and considering all of these arms together they are spaced angularly 45°. Assuming that cam 30 rotates clockwise, it will be noted that contact 41 is about to be separated from contact 42 thereby effecting the discharge of the generator 34 including secondaries S1 and S2 from which sparking impulses will be delivered to the posts 56#S1 and 56#S2. From these posts the sparking impulses are conducted respectively, by rotor branches R1 and R2 to distributor arms 53 and 54 respectively, and thence to posts 1A—S1—R1 and 1B—S2—R2. The indicia 1A—S1—R1 indicates that spark plug A of cylinder 1 is provided with a sparking impulse by secondary S1 and that this sparking impulse is distributed through rotor branch R1. Similarly the indicia 1B—S2—R2 indicates that spark plug B of cylinder 1 is provided with a sparking impulse by secondary S2 and that this sparking impulse is delivered through rotor branch R2. The other indicia applied to other posts 55 can easily be understood with this explanation.

When the cam 30 has rotated 45° from the position shown in Fig. 2 the rotor arms 53 and 54 will be moved adjacent posts 55#2A—S3—R5 and 55#2B—S4—R6. The rotor branches R5 and R6 will be moved adjacent posts 57#S3 and 57#S4 respectively. The contact 31 will commence to separate from the contact 32 thereby causing the discharge of generator 24 which includes secondaries S3 and S4. Hence sparking impulses generated in these secondaries will be distributed by rotors R5 and R6, respectively, to spark plug posts 55#2A—S3—R5 and

55#2B—S4—R6 respectively. 45° further rotation of the cam 30 will cause the contacts 41 and 42 to separate to discharge the generator 34, and the rotor segments R3 and R4 in conjunction with posts 56#S2 and 56#S1, respectively, will cooperate to conduct the sparking impulses. After another 45° movement of the cam 30 the rotor branches R7 and R8 will cooperate with posts 57#S4 and 57#S3, respectively, to distribute sparking impulses generated by generator 24 the discharge of which is controlled by the opening of contacts 31 and 32. Thus far has been described the operations which take place during one-half of the engine cycle or during one-half revolution of the shaft 45. Obviously, a similar succession of events will take place during the other half of the revolution of shaft 45 or during the remainder of the engine cycle. This should be apparent since, after one-half revolution of shaft 45, the rotors 51 and 52 will have exchanged places with respect to the position shown in Fig. 2.

It is therefore apparent that the present invention contemplates the use of a plurality of sparking impulse generators which are operated alternately to discharge a plurality of sparking impulses which are discharged simultaneously to provide the required number of sparking impulses during each explosion period. In the example given for an 8 cylinder engine having two spark gaps per cylinder and operating at relatively high speed, two sparking impulse generators are required to operate alternately in order that one generator may accumulate energy while the other is discharging. Each generator provides two sparking impulses through its secondary coils. Each generator might use a single secondary coil with both ends insulated and connected to a pair of posts 56 or 57.

The invention contemplates the use of as many distributor rotors as there are sparking impulses simultaneously generated, hence two rotors in the example given. Each rotor has an arm extending into proximity to a circular row of posts which are connected respectively with spark gaps. Each distributor rotor has a plurality of branches cooperating in recurrent sequence only with distributor posts connected with one of the sparking impulse generators, said branches alternating with a plurality of other branches which cooperate in recurrent sequence only with distributor posts connected with the other sparking impulse generator. For example, the rotor 51 has the branches R1 and R3 which cooperate only with the posts 56 connected with the generator 34; and these branches R1 and R3 alternate with branches R5 and R7 which cooperate only with posts 57 connected with generator 24. Similarly, the rotor 52 has branches R2 and R4 cooperating only with posts 56 connected with generator 34; and

these branches R1 and R2 alternate with branches R6 and R8 which cooperate only with posts 57 connected with generator 24.

It will be understood that the present invention is not limited to ignition for an 8 cylinder engine having two gaps fired simultaneously at each explosion period but may be applied to engines having other numbers of cylinders, for example a 12-cylinder engine the ignition wiring diagram for which is shown in Figs. 3 and 4. For a 12-cylinder engine, the ignition system using two sparking impulses generators firing alternately, as for an 8-cylinder engine, will require a 6 lobe cam 30. It is therefore apparent that the number of cam lobes must be one-half N, the number of engine cylinders. For a 12-cylinder engine the number of spark gap posts 55 is obviously 24 or twice the number of engine cylinders. As shown in Fig. 4, the total number of rotor branches is 12, that is, equal to N, the number of engine cylinders. Each rotor carries N/2 or 6 branches. The spacing of the branches is $360^\circ/N$ or 30° for a 12 cylinder engine.

Referring to Figs. 2 and 4 it will be noted that the angular spacing of posts 56 with respect to posts 57 is an even number times the angular spacing of the rotor branches. For 8-cylinder ignition as shown in Fig. 2, the angular spacing of posts 56 and 57 is 2 times 45° or 90° . For 12-cylinder ignition as shown in Fig. 4, the angular spacing of posts 56 and 57 is 2 times 30° or 60° . It is quite obvious that the angular spacing of posts 56 and 57 could be an even number times the angular spacing of the rotor branches; however, the only angular measurements of interest are those which equal 90° or less, since there are four posts 56 and 57 to be considered.

The following table shows numbers and arrangement of parts of the distributor for engines having various numbers of cylinders or explosion periods and requiring the firing of two spark gaps at each explosion period.

Cylinders or explosion periods per cycle	Cam lobes	Spark gap posts	Total rotor branches	Rotor branch spacing	Spacing of posts 56 and 57=2 or 4 times the rotor branch spacing, but not more than 90°
N.....	N/2	2N	N	$360/N$	
8.....	4	16	8	45°	90°
12.....	6	24	12	30°	60°
16.....	8	32	16	$22\frac{1}{2}^\circ$	45° or 90°
20.....	10	40	20	18°	36° or 72°
24.....	12	48	24	15°	30° or 60°

In each case set forth in this table, it is understood that two rotors are required and that each rotor must have an even number of branches, since the branches of each rotor must be divisible into two equal groups, the

branches of one group operating alternately with the branches of another group. Therefore the total number of rotor branches must be divisible by four, hence the number N, of cylinder or explosion periods per cycle must be divisible by four. In other words, while the present invention can be applied to double gap ignition for 8, 12, 16, 20, and 24 cylinder engines, it does not apply to 6, 10, 14, 18, etc., cylinder engines or to engines having odd numbers of cylinders.

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

What is claimed is as follows:

1. Ignition apparatus for an internal combustion engine having N cylinders or explosion periods per cycle, N being a number divisible by 4, and requiring the firing of two spark gaps at each explosion period, said apparatus comprising, in combination, a distributor head having 2N posts arranged in a circular row and connected respectively with spark gaps, and having two pairs of diametrically opposite sparking impulse generator terminal posts, coaxial with the spark gap posts, sparking impulse generating means, means operated by the engine for causing the sparking impulse generating means to deliver sparking impulses alternately to said pairs of posts, and two engine operated rotor conductors each having a main arm cooperating with alternate spark gap posts of the head and each having N/2 branches angularly spaced $360^\circ/N$, alternate branches of each rotor conductor forming a group of branches which cooperate only with the posts of one pair of sparking impulse generator terminal posts, the remaining alternate branches of each rotor conductor forming a group of branches which cooperate only with the post of the other pair of sparking impulse generator terminal posts, the angular spacing of said pairs of sparking impulse generator terminal posts being two or four times $360^\circ/N$, the angle being not more than 90° .

2. Ignition apparatus comprising, in combination, a plurality of sparking impulse generators each capable of generating a plurality of sparking impulses simultaneously; means for causing the generators to operate alternately; and a distributor comprising a head carrying posts connected with the spark gaps of engine cylinders and posts connected respectively with terminals of the sparking impulse generators, and a rotor carrying a plurality of distributing conductors, each conductor having an arm for distribution to certain ones of the spark gap posts of the head and each conductor having a plurality of collecting arms which cooperate only with the posts connected with terminals of one sparking impulse generator and each conduc-

tor having a plurality of other collecting arms alternating with the first mentioned collecting arms, said last mentioned collecting arms cooperating only with the posts connected with terminals of another sparking impulse generator.

3. Ignition apparatus comprising, in combination, a plurality of sparking impulse generators each capable of generating a plurality of sparking impulses simultaneously; means for causing the generators to operate alternately; and a distributor comprising a head carrying posts connected with the spark gaps of engine cylinders and posts connected respectively with terminals of the sparking impulse generators, one set of posts being located at a greater distance from the axis of the head and terminating in a plane spaced substantially from the plane of the ends of the posts located at a lesser distance from the axis of the head, and a rotor carrying a plurality of distributing conductors, each conductor having an arm for distribution to certain ones of the spark gap posts of the head and each conductor having a plurality of collecting arms which cooperate only with the posts located at the lesser distance from the axis of the head and each conductor having a plurality of other collecting arms alternating with the first mentioned collecting arms, said last mentioned collecting arms cooperating only with the posts located at the greater distance from the axis of the head.

4. Ignition apparatus for internal combustion engines having a plurality of explosion periods and requiring the firing of a plurality of spark gaps at each explosion period comprising, in combination, sparking impulse generating means controlled by the engine, a distributor head having circularly arranged posts connected respectively with spark gaps and having other posts arranged concentrically of the spark gap posts and connected to the spark generator means and spaced at different distances from the center of the head and distributing conductor arms passing between the spark gap posts and the spark generator posts and each having a plurality of branches of different lengths, the longer branches cooperating with spark generator posts closer to the center of the head and the shorter branches cooperating with spark generator posts further from the center of the head.

5. Ignition apparatus for internal combustion engines having a plurality of explosion periods and requiring the firing of a plurality of spark gaps at each explosion period comprising, in combination, sparking impulse generating means controlled by the engine, a distributor head having circularly arranged posts connected respectively with spark gaps and having other posts arranged concentrically of the spark gap posts and connected to the spark generating means and

spaced at different distances from the center of the head, and distributing conductor arms passing between the spark gap posts and the spark generator posts and each having a plurality of longer branches alternating with a plurality of shorter branches, the longer branches cooperating with spark generator posts closer to the center of the head and the shorter branches cooperating with spark generator posts further from the center of the head.

6. Ignition apparatus for internal combustion engines having a plurality of explosion periods and requiring the firing of a plurality of spark gaps at each explosion period comprising, in combination, sparking impulse generating means controlled by the engine, a distributor head having circularly arranged posts connected respectively with spark gaps and having other posts arranged concentrically of the spark gap posts and connected to the spark generating means and spaced at different distances from the center of the head, and distributing conductor arms passing between the spark gap posts and the spark generator posts and each having a plurality of longer branches alternating with a plurality of shorter branches, the longer branches cooperating with spark generator posts closer to the center of the head and the shorter branches cooperating with spark generator posts further from the center of the head, and all of the branches being equi-angularly spaced by an amount equal to 360 degrees divided by the total number of arms of all the branches.

7. Ignition apparatus for internal combustion engines having a plurality of explosion periods and requiring the firing of a plurality of spark gaps at each explosion period comprising, in combination, a plurality of sparking impulse generating devices controlled for alternate operation by the engine, and a distributor having circularly arranged posts connected respectively with spark gaps and having other posts arranged diametrically opposite in pairs and concentrically with respect to the spark gap posts, the posts of one pair of diametrically opposite posts being located at a greater distance from the center of the head and connected with one sparking impulse generating device, and the posts of another pair of diametrically opposite posts being located at a lesser distance from the center of the head and connected with another sparking impulse generating device, and a plurality of distributing conductor arms passing between the spark gap posts and the spark generator posts and each having shorter branches cooperating with spark generator posts more remote from the center of the head and longer branches cooperating with spark generator posts closer to the center of the head.

8. Apparatus according to claim 7 in which

the longer branches alternate with the shorter branches and the longer and shorter branches of one arm are respectively opposite the longer and short branches of another arm.

5 9. Apparatus according to claim 7 in which the longer branches alternate with the shorter branches and the longer and shorter branches of one arm are respectively opposite the longer and short branches of another
10 arm and in which the branches are equiangularly spaced by an angle of 360 degrees divided by the total number of branches of all the arms.

In testimony whereof is hereto affixed the
15 signature of

JOHN T. FITZSIMMONS,
*Administrator of the Estate of Charles H.
Davis, Jr., Deceased.*

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