May 9, 1933. C. H. DAVIS, JR 1,907,514

IGNITION APPARATUS

Original Filed Nov. 7, 1931

Fig 1

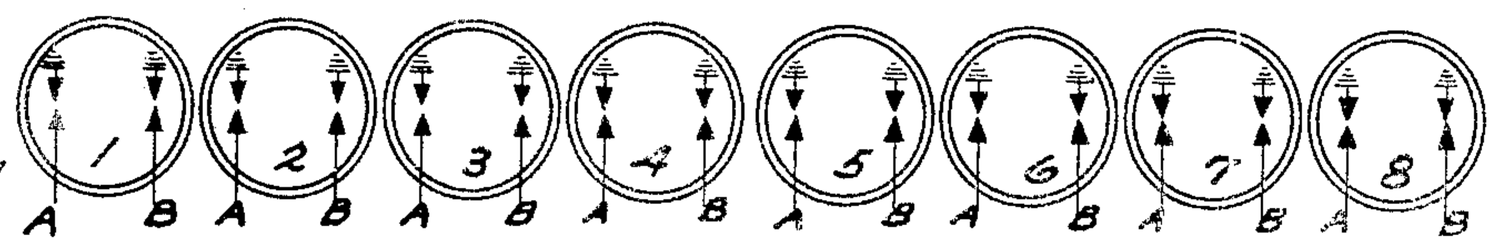
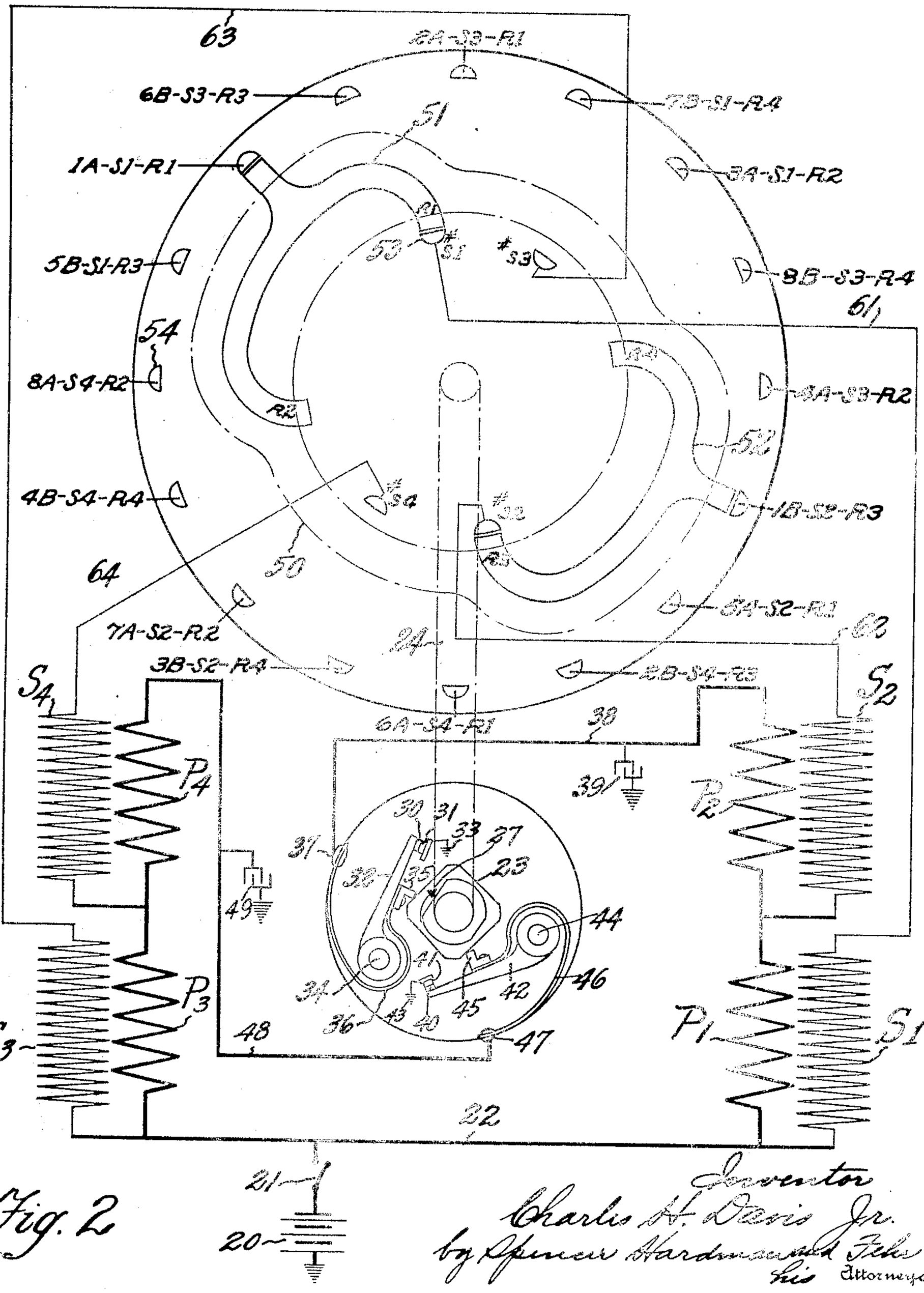


Fig. 2



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UNITED STATES PATENT OFFICE

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IGNITION APPARATUS

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This invention relates to an ignition apparatus for an internal combustion engine and more particularly engines which have a plurality of spark gaps to be fired simultaneously.

It is an object of the present invention to provide a timer-distributor unit the distributor head of which requires a relatively small number of terminal posts from which sparking impulses are distributed to the posts which are connected with spark gaps.

In order to accomplish this object the present invention provides a distributor head having concentric inner and outer rows of posts, one row of posts being connected respectively with the spark gaps and the other row of posts being connected with the terminals of the means for generating sparking impulses. This distributor head cooperates with an engine driven rotor having as many distributing conductors as there are spark gaps to be fired at the same instant. Each conductor has a main stem which moves in proximity to the posts in one row, and each conductor has a plurality of branches which move in proximity to the posts in the other row, there being but one branch of each conductor adjacent to a post of the last mentioned row while the stem of each conductor is adjacent a post in the first mentioned row at the firing period of the engine.

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

In the drawing:

Figs. 1 and 2 constitute a wiring diagram illustrating the present invention.

Referring to the drawing, Fig. 1 illustrates the cylinders of an 8 cylinder engine in which these cylinders are numbered from 1 to 8 and each cylinder has two spark plugs A and B.

Referring to Fig. 2 a storage battery 20 is connectable by switch 21 with a wire 22 connected with pairs of ignition coil primaries P1 and P2 and pairs of ignition coil primaries P3 and P4. The primaries P1, P2, P3 and P4 cooperate respectively with ignition coil secondaries S1, S2, S3 and S4. The primaries P1 and P2 are connected together in series with a circuit interrupter comprising a pair of contacts 30 and 31 attached respectively to a circuit breaker lever 32 and a ground connection 33. The lever 32 is pivoted at 34 and carries a rubbing block 35 which cooperates with a timer cam 23. The lever 32 is connected to one end of a leaf spring conductor 36 the other end of which is connected to the terminal 37 which is connected by wire 38 to primaries P2 and P1. The contacts 30 and 31 are shunted by condenser 39. Similarly, the primaries P3 and P4 are connected together in series with a circuit interrupter comprising a pair of contracts 40 and 41 attached respectively with a circuit breaker lever 42 and a ground connection 43. The lever 42 is pivoted at 44 and carries a rubbing block 45 which cooperates with a timer cam 23. The lever 42 is connected to one end of a leaf spring conductor 46 the other end of which is connected to the terminal 47 which is connected by wire 48 to primaries P4 and P3. The contacts 40 and 41 are shunted by a condenser 49. The rubbing blocks 35 and 45 are located so that their circuit breaker levers will be operated alternately by the cam 23. The cam 23 is driven by a shaft 24 which is operated at engine cycle speed, that is, engine speed for a 2 cycle engine, one-half engine speed for a 4 cycle engine.

The ignition coils, circuit interrupter and battery constitute sparking impulse generating means which is controlled by the engine through the engine driven cam 23. This sparking impulse generating means comprises a plurality of generators which are operated alternately by the engine driven cam 23. One of these generators comprises the coils P1—S1 and P2—S2 and the circuit interrupter which connects them with the storage battery; and the other sparking impulse generator comprises the ignition coils P3—S3 and P4—S4 and the circuit interrupter which connects these coils with the storage battery.

The shaft 24 drives a distributor rotor 50

the outline of which is designated in dot and dash lines. Rotor 50 carries two Y-shaped conductors 51 and 52. Conductor 51 has branches R1 and R2 and conductor 52 has branches R3 and R4 connected with a terminal. The conductors 51 and 52 move in a path between two concentric circular rows of distributor posts, the inner row being numbered 53 and the outer row 54. There are but four posts 53 connected respectively with the secondary coils S1 to S4. Hence each post 53 has been marked with a special designation indicating to which secondary it is connected. For example, post 53#*s*1 designates that it is connected by wire 61 with secondary S1. Similarly post 53#*s*2 is connected by wire 62 with secondary S2; post 53#*s*3 is connected by wire 63 with secondary S3; and post 53#*s*4 is connected by wire 64 with secondary S4. It will be noted that in the circular row of posts 53 there are two groups of posts diametrically opposite. One group includes posts *s*1 and *s*3, the other includes posts *s*2 and *s*4. These posts are spaced apart an angular distance corresponding to the firing interval which is 45° for an 8 cylinder engine. It will be noted that the distributing conductor branches R1, R2, R3 and R4 are equiangularly distant and are spaced twice the firing interval or 90° for an 8 cylinder engine. Diametrically opposite branches of the distributing conductors cooperates alternately with other diametrically opposite branches of the distributing conductors; and each branch operates two times in succession and then remains inoperative while the other branch of the same conductor is operative two times in succession. For example, assuming that the cam 23 rotates clockwise as indicated by arrow 27 in Fig. 2 it will be apparent that just as contact 30 separates from contact 31 conductor 51 will be operative to conduct a sparking impulse between post 53#*s*1 and post 54#1A—S1—R1 and that concurrently therewith conductor 52 will be operative to conduct a sparking impulse between distributor post 53#*s*2 and post 54#1B—S2—R3. The indicia 1A—S1—R1 designates that spark plug A of cylinder #1 is furnished with a sparking impulse generated in secondary S1 and distributed through the branch R1 of conductor 51. Likewise the indicia 1B—S2—R3 indicates that spark plug B of cylinder #1 is supplied with a sparking impulse generated in secondary S2 and distributed through the branch R3 of conductor 52. With this explanation the means of the indicia applied to other distributor posts 54 will be entirely clear. The use of indicia serves the purpose of a multiplicity of wires connecting post 54 with spark plugs and is preferred in this case on account of its simplicity.

For dual ignition it is customary to use two standard plugs in each engine cylinder. One double end spark plug could be used in which case the circuit of one secondary would be completed through the circuit of the other secondary in which a sparking impulse is concurrently generated. Instead of using four ignition coils two coils each with two insulated secondary terminals could be used. For example, in place of using two coils P1—S1 and P2—S2 one coil could be used and its secondary terminals would be connected respectively with post 53#*s*1 and post 53#*s*2. Similarly instead of using a pair of soils P3—S3 and P4—S4 one coil could be used having a double terminal secondary, the ends of which are connected respectively to post 53#*s*3 and post 53#*s*4.

It will be apparent from the foregoing description of the construction and mode of operation of the present invention that it is applicable to engines whose cylinders number other than 8, such as 12, 16, 20, 24 etc. Obviously the number of posts 54 in the outer row will be 2N where N is the number of cylinders and the spacing of these posts will be 360°/2N. Where double ignition is required the distributor posts 53 of the inner row will be arranged in two groups, the number of posts in each group being G. Where the number G is two or more the spacing of the posts in each group of posts of the inner row 53 will be 360°/N. The distributor rotor 50 will carry two segments 51 and 52 corresponding to the number of spark gaps to be fired simultaneously. The angular spacing of the main stems of the segments 51 and 52 is 180° ± (180°/N). The number of branches of each rotor conductor will be equal to N/2G and the angular spacing between the segment branches will be 360° G/N. The following tabulations show the values for engines having 8, 12, 16, 20 and 24 cylinders.

Tabulation #1

[G, the number of posts 53 in each group, equals 2]

Number of cylinders=	Spacing of posts 53=	Spacing of segments 51 and 52=	Number of branches for each segment=	Spacing of segment branches=
N	360°/N	180° ± (180°/N)	N/2G	360° G/N
8	45°	180° ± 22½°	2	90°
12	30°	180° ± 15°	3	60°
16	22½°	180° ± 11¼°	4	45°
20	18°	180° ± 9°	5	36°
24	15°	180° ± 7½°	6	30°

Tabulation #2

[G, the number of posts 53 in each group, equals 1]

Number of cylinders=	Spacing of segments 51 and 52=	Number of branches for each segment=	Spacing of segment branches=
N	180° ± (180°/N)	N/2G	360° G/N
8	180° ± 22½°	4	45°
12	180° ± 15°	6	30°
16	180° ± 11¼°	8	22½°
20	180° ± 9°	9	18°
24	180° ± 7½°	12	15°

This invention contemplates a distributor having circularly arranged posts connected respectively with engine spark gaps, other posts arranged consecutively with respect to the spark gap posts and connected with sparking impulse generator terminals. This distributor includes rotating conductor arms moving between the spark gap posts and sparking impulse generator posts, each arm having a plurality of branches which cooperate with the sparking impulse generator posts. At one explosion period, one branch of each arm is adjacent one of the spark generator posts and said posts are connected with a sparking impulse generator which operates at that explosion. The sparking impulse generating means comprises two devices which operate alternately. Hence, at the next explosion period branches of the distributing arms will be adjacent two of the sparking impulse generator posts, said posts being connected with another of the sparking impulse generating devices which is operated at that explosion period. The conducting arm branches and the spark generating posts are so arranged that a branch of each rotor cooperates a plurality of times in succession with spark generator posts and then another branch of each arm cooperates a plurality of times in succession with the spark generator posts. More particularly, the spark generator posts are arranged in groups, the posts in each group being relatively closely spaced, each group being respectively connected with the alternately operating sparking impulse generating devices. It will be noted that each conducting arm branch cooperates a plurality of times with the spark generator posts of each group and with those posts in succession and then another branch of the same rotor cooperates with said group of posts in succession before that arm passes into cooperative relation with another group of spark generator posts.

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 explosion periods during each engine cycle and comprising, in combination, means for distributing sparking impulses to S (a plurality of) spark gaps to be fired simultaneously at each explosion period, said distributing means comprising a head having concentric rows of posts, one row of posts numbering N x S and each post in that row being connected with a spark gap, the other row of posts numbering S or a multiple thereof, said distributing means comprising also an engine driven rotor having S distributing conductors each having a main stem which moves in proximity to the posts in the first mentioned row and each having a plurality of branches which move in proximity to the posts in the second mentioned row, there being but one branch of each conductor adjacent to a post of the second mentioned row while the stem of each conductor is adjacent a post of the first mentioned row at the firing period of the engine; and engine controlled sparking impulse generating means connected with the posts of the second mentioned row.

2. Ignition apparatus for an internal combustion engine having N explosion periods during each engine cycle and having two spark gaps firing simultaneously, comprising in combination, a distributor head having concentric rows of posts, the posts of one row numbering 2N and each being connected with a spark gap, the posts of the other row being arranged in two groups arranged diametrically opposite, the number of posts in each group being G, the spacing of the posts in each group being 360°/N if G, the number of posts, is greater than one; an engine driven distributor rotor carrying two conducting segments which rotate between said rows of posts; the segments each having a main stem rotating in proximity to the posts of the first mentioned row, the stems of the segments being spaced 180° ± (180° N), and each segment having a plurality of branches which rotate in proximity to the second mentioned row of posts, the number of branches of each segment being N/2G and the spacing of the segment branches being 360°G/N; and engine controlling sparking impulse generating means connected with the posts of the second mentioned row.

3. Ignition apparatus for an internal combustion engine having N explosion periods during each engine cycle and having two spark gaps firing simultaneously at each explosion period, comprising in combination, a distributor head having concentric rows of posts, the posts of one row numbering 2N and each being connected with a spark gap, the posts of the other row numbering four and being arranged in two diametrically opposite groups of two posts each, the spacing of the posts in each group being 360°/N; an engine driven distributor rotor carrying two conducting segments which rotate between the rows of posts, the segments each having a main stem rotating in proximity to the posts of the first mentioned row, the stems of the segments being spaced 180° ± (180°/N), and each segment having a plurality of branches which rotate in proximity to the posts of the second mentioned row, the number of branches of each segment

being N/4 and the spacing of the branches being 720°/N; and engine controlling sparking impulse generating means connected with the posts of the second mentioned row.

4. Ignition apparatus for an internal combustion engine having N explosion periods during each engine cycle and having two spark gaps firing simultaneously at each explosion period, comprising in combination, a distributor head having concentric rows of posts, the posts of one row numbering 2N and each being connected with a spark gap, the posts of the other row numbering four and being arranged in two diametrically opposite groups of two posts each, the spacing of the posts in each group being 360°/N; an engine driven distributor rotor carrying two conducting segments which rotate between the rows of posts, the segments each having a main stem rotating in proximity to the posts of the first mentioned row, the stems of the segments being spaced 180° ± (180°/N), and each segment having a plurality of branches which rotate in proximity to the posts of the second mentioned row, the number of branches of each segment being N/4 and the spacing of the branches being 720°/N; two sparking impulse generators each having two terminals connected respectively with diametrically opposite posts of the second mentioned row of posts; and engine operated means for causing said generators to function alternately.

5. Ignition apparatus for internal combustion engines having a plurality of spark gaps to be fired at each explosion period comprising, in combination, means for generating sparking impulses and having a plurality of terminals, engine operated circuit breaker means for controlling the sparking impulse generators, a distributor head carrying a circular row of posts connected respectively with spark gaps, a plurality of posts of substantially the same width as the spark gap posts of the head and arranged concentrically therewith and connected respectively with terminals of the spark generating means, a plurality of distributing arms arranged to pass between the first and second mentioned posts but out of contact therewith in order to distribute sparking impulses from the second mentioned posts to certain of the spark gap posts, each arm having a plurality of branches which cooperate with the spark generator terminal posts, and means for operating the circuit breaker means and for rotating the distributing arms.

6. Ignition apparatus for internal combustion engines comprising, in combination, generating means controlled by the engine, a distributor for distributing sparking impulses to a plurality of spark gaps to be fired in groups simultaneously at each explosion period, said distributor comprising concentric rows of distributor posts, one row of posts being connected respectively with the spark gaps of the engine and another row of posts being connected with the spark generating means, said distributor comprising a rotor carrying distributing conductors which move between the rows of posts in order to provide conducting paths between them, the number of conductors being equal to the number of spark gaps to be fired at the same time, and each conductor having a plurality of branches cooperating with the spark generator posts.

7. Ignition apparatus for internal combustion engines comprising, in combination, generating means controlled by the engine, a distributor for distributing sparking impulses to a plurality of spark gaps to be fired in groups simultaneously at each explosion period, said distributor comprising concentric rows of distributor posts, one row of posts being connected respectively with the spark gaps of the engine, and another row of posts being connected with the spark generating means, said distributor comprising a rotor carrying distributing conductors which move between the rows of posts in order to provide conducting paths between them, the number of conductors being equal to the number of spark gaps to be fired at the same time and each conductor having a plurality of branches cooperating with the spark generator posts, said branches and said spark generator posts being arranged so that the one branch of a conductor operates a plurality of times in succession alternately with another branch of the same conductor.

8. Ignition apparatus for internal combustion engines comprising, in combination, generating means controlled by the engine, a distributor for distributing sparking impulses to a plurality of spark gaps to be fired in groups simultaneously at each explosion period, said distributor comprising concentric rows of distributor posts one row of posts being connected respectively with the spark gaps of the engine and another row of posts being connected with the spark generating means, the spark generator posts being arranged in groups, said distributor comprising a rotor carrying distributing conductors which move between the rows of posts in order to provide conducting paths between them, the number of conductors being equal to the number of spark gaps to be fired at the same time, each conductor being constructed so as to cooperate with a group of spark generator posts a plurality of times in succession before passing into cooperative relation with another group of spark generator posts.

9. Ignition apparatus for internal com-

bustion engines, comprising in combination, generating means controlled by the engine, a distributor for distributing sparking impulses to a plurality of spark gaps to be fired in groups simultaneously at each explosion period, said distributor comprising concentric rows of distributor posts one row of posts being connected respectively with the spark gaps of the engine and another row of posts being connected with the spark generating means, the spark generator posts being arranged in groups, said distributor comprising a rotor carrying distributing conductors which move between the rows of posts in order to provide conducting paths between them, the number of conductors being equal to the number of spark gaps to be fired at the same time and each conductor having a plurality of branches cooperating with the spark generator posts one conductor branch cooperating with the spark generator posts of a group in succession and then another conductor branch of the same conductor cooperating with the spark generator posts of a group in succession.

10. Ignition apparatus for internal combustion engines comprising, in combination, spark generating means controlled by the engine, a distributor having a circular row of posts connected with engine spark gaps and having other posts concentric with the spark gap posts and connected with the spark generating means, and a conductor movable between the spark gap posts and the spark generator posts and having a plurality of branches each of which cooperates with the spark generator posts.

11. Ignition apparatus for internal combustion engines comprising, in combination, spark generating means controlled by the engine, a distributor having a circular row of posts connected with engine spark gaps and having other posts concentric with the spark gap posts and connected with the spark generating means, and a conductor movable between the spark gap posts and the spark generator posts and having a plurality of branches each of which cooperates with the spark generator posts a plurality of times in succession and alternately with another branch.

12. Ignition apparatus for internal combustion engines comprising, in combination, spark generating means controlled by the engine, a distributor having a circular row of posts connected with engine spark gaps and having other posts concentric with the spark gap posts and connected with the spark generating means, and a conductor movable between the spark gap posts and the spark generator posts and having a plurality of branches each of which cooperates with consecutive spark generator posts a plurality of times in succession and then another branch cooperates with consecutive spark generator posts a plurality of times in succession.

13. Ignition apparatus for internal combustion engines having N explosion periods during each engine cycle comprising, in combination, spark generating means controlled by the engine, and a distributor having a circular row of posts connected with engine spark gaps, and other posts connected with the spark generating means, at least one distributing conductor arm movable between the spark gap posts and spark generator posts, the number of arms being equal to the number of spark gaps to be fired at the same time, each arm having B branches and each arm operating $\frac{N}{BR}$ cycles of operation during each engine cycle, R being the number of times each branch operates during a cycle of operation of its arm.

14. Ignition apparatus for internal combustion engines having a plurality of explosion periods and a plurality of spark gaps to be fired at each explosion period comprising, in combination, a plurality of spark generating devices controlled by the engine for alternate operation, and a distributor having a circular row of posts connected respectively with spark gaps, and posts arranged concentrically with respect to the spark gap posts and connected alternately respectively with the spark generating devices, and a rotor carrying distributing arms moving between the spark plug posts and the spark generator posts and each having branches, each branch cooperating first with a post connected with one of the spark generating devices and then with a post connected with another of the spark generating devices.

15. Ignition apparatus for internal combustion engines having a plurality of explosion periods and a plurality of spark gaps to be fired at each explosion period, comprising, in combination, a plurality of spark generating devices controlled by the engine for alternate operation, and a distributor having a circular row of posts connected respectively with spark gaps and posts arranged concentrically with respect to the spark gap posts and connected alternately respectively with the spark generating devices, and a rotor carrying distributing arms moving between the spark plug posts and the spark generator posts and each having branches, one branch of each conductor cooperating first with a post connected with one of the spark generating devices and then with a post connected with another spark generating device, and then another branch of each conductor cooperating first with a post connected with one of the spark generating devices and then

with a post connected with another spark generating device.

16. 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 operated alternately by the engine, a distributor having circularly arranged posts connected respectively with spark gaps of the engine and having other posts arranged diametrically opposite in pairs, each pair being connected with a sparking impulse generating device, and a plurality of distributing conductor arms each having a plurality of branches so arranged with respect to the spark generator posts that, at each explosion period, a branch of an arm is located adjacent each one of a pair of diametrically opposite spark generator posts.

17. 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 impulses generating devices operated alternately by the engine, a distributor having circularly arranged posts connected respectively with spark gaps of the engine and having other posts arranged diametrically opposite in pairs each pair being connected with a sparking impulse generating device and a plurality of distributing conductor arms each having a plurality of branches so arranged with respect to the spark generator posts that, at each explosion period, a branch of an arm is located adjacent each one of a pair of diametrically opposite spark generator posts and so that each branch of an arm operates a plurality of times in succession alternately with another branch of the same arm.

18. Ignition apparatus for internal combustion engines comprising, in combination, generating means controlled by the engine, a distributor for distributing sparking impulses to a plurality of spark gaps to be fired in groups simultaneously at each explosion period, said distributor comprising concentric rows of distributor posts, one row of posts being connected respectively with the spark gaps of the engine and another row of posts being connected with the spark generating means, said distributor comprising a rotor carrying distributing conductors which move between the rows of posts in order to provide conducting paths between them, the number of conductors being equal to the number of spark gaps to be fired at the same time, and each conductor having a plurality of branches cooperating with the spark generator posts, the conductor branches being equi-angularly spaced by an amount equal to 360° divided by the total number of branches of all the arms.

In testimony whereof I hereto affix my signature.

CHARLES HALL DAVIS, JR.