May 9, 1933. C. H. DAVIS, JR., ET AL 1,907,515

IGNITION APPARATUS

Filed Nov. 14, 1931 2 Sheets-Sheet 1

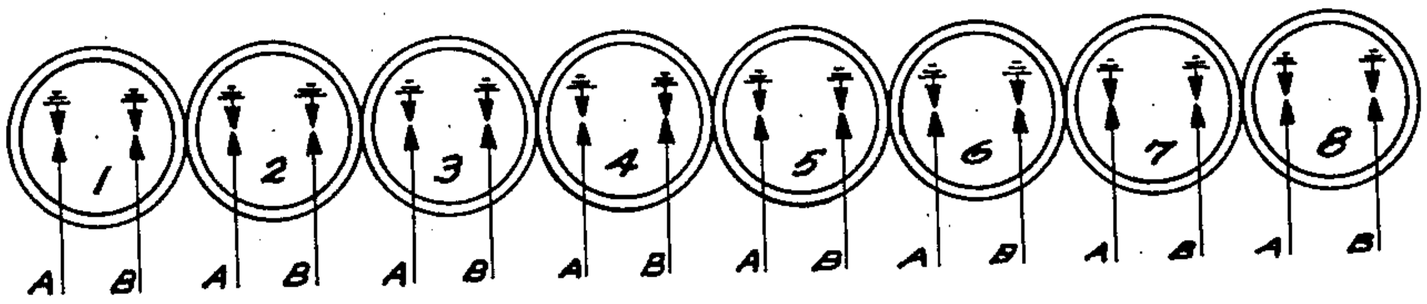

Fig. 1

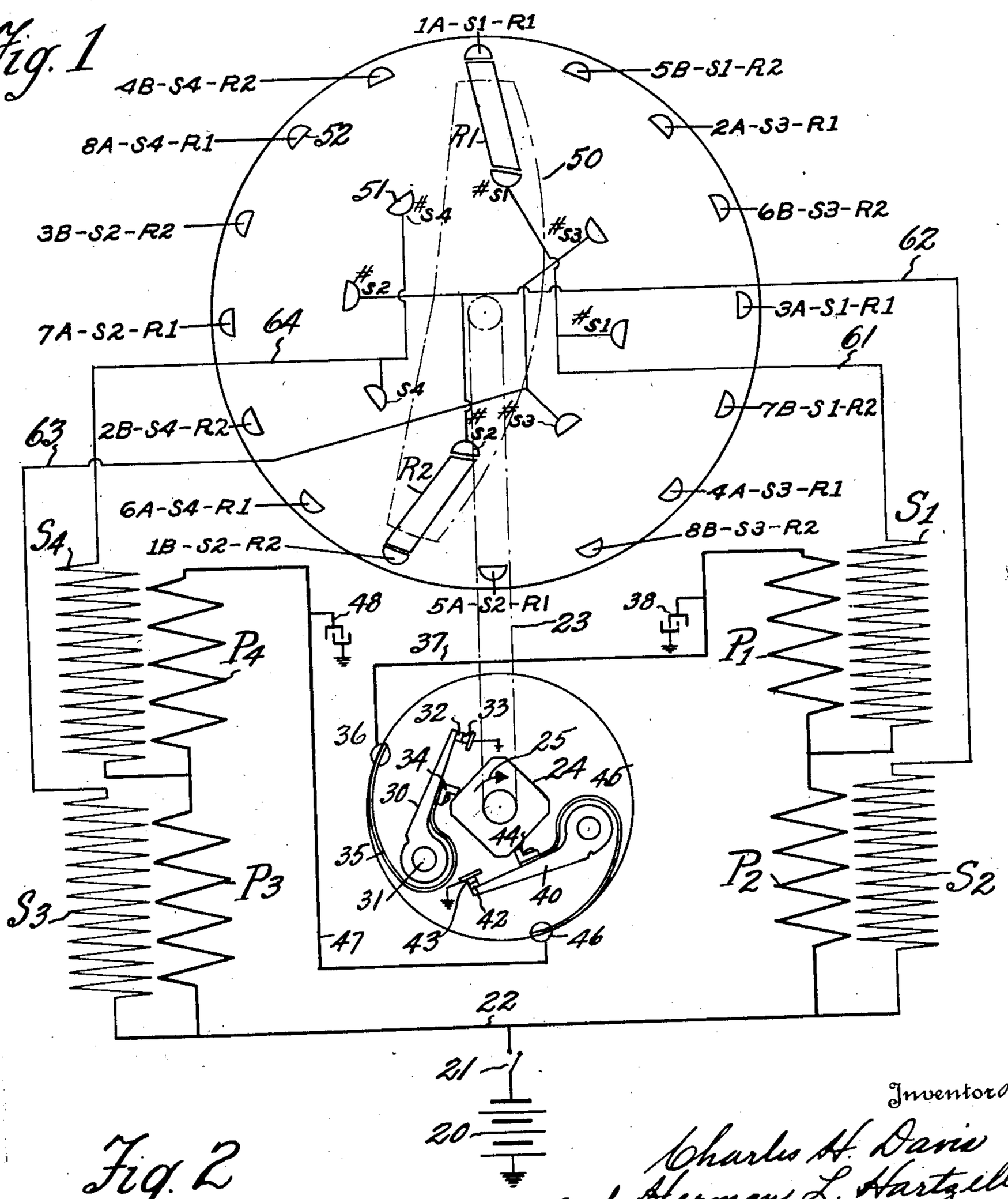

Fig. 2

Inventors
Charles H. Davis
and Herman L. Hartzell
By Spencer Hardman and Fehr
their Attorneys

May 9, 1933. C. H. DAVIS, JR., ET AL 1,907,515

IGNITION APPARATUS

Filed Nov. 14, 1931 2 Sheets-Sheet 2

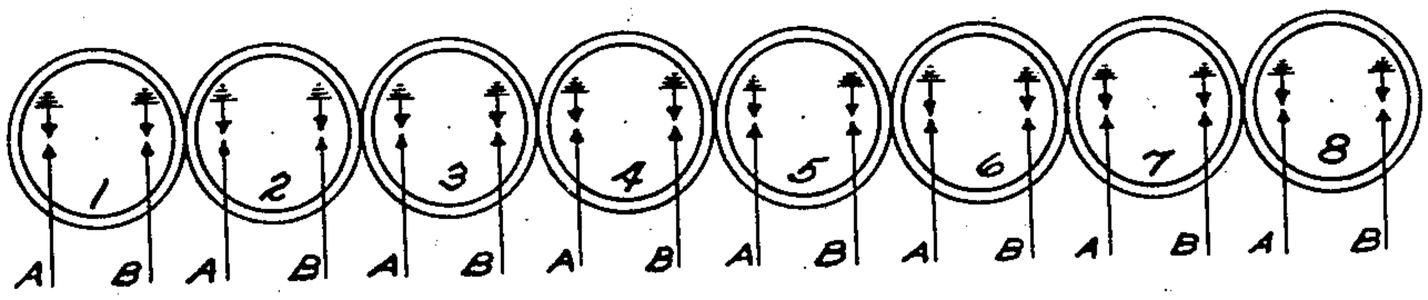

Fig. 3

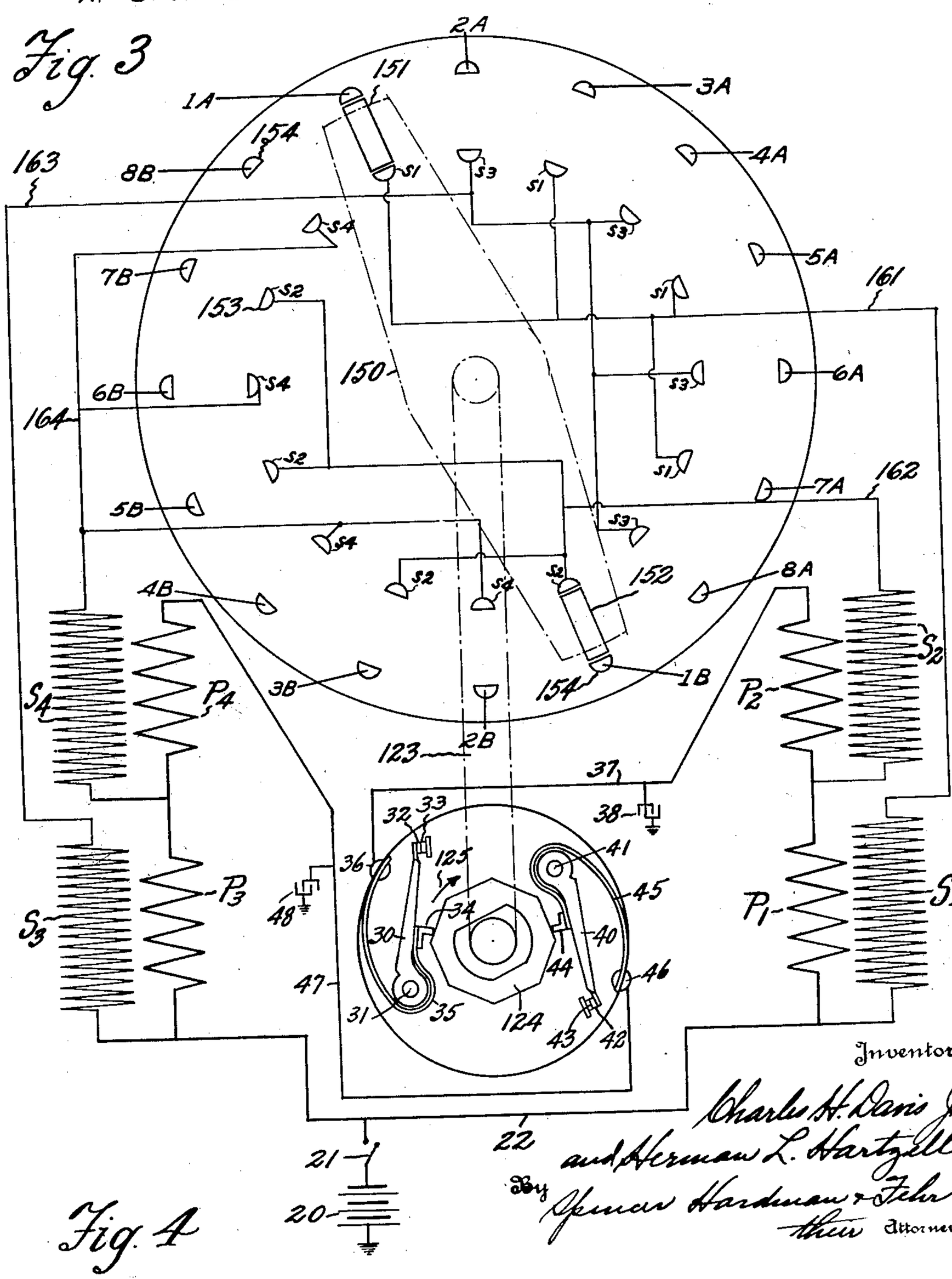

Fig. 4

Inventors
Charles H. Davis Jr.
and Herman L. Hartzell
By Spencer Hardman & Fehr
their Attorneys

Patented May 9, 1933 1,907,515

UNITED STATES PATENT OFFICE

CHARLES HALL DAVIS, JR., AND HERMAN L. HARTZELL, OF ANDERSON, INDIANA, ASSIGNORS TO DELCO-REMY CORPORATION, OF ANDERSON, INDIANA, A CORPORATION OF DELAWARE

IGNITION APPARATUS

Application filed November 14, 1931. Serial No. 574,996.

This invention relates to ignition apparatus for internal combustion engines and more particularly to engines having a plurality of explosion periods during each engine cycle and requiring the firing of a plurality of spark gaps at each explosion period.

One example of a type of such ignition apparatus is that disclosed in my copending application Serial No. 563,073 filed September 16, 1931. This application discloses ignition apparatus comprising a distributor for distributing sparking impulses to a plurality of spark gaps to be fired in groups simultaneously at each explosion period. This distributor comprises concentric rows of distributor posts, one row of posts being connected respectively with the spark gaps of the engine, and said distributor comprises a rotor carrying distributing conductors which move between the rows of posts in order to provide conducting paths at each explosion period, the number of conductors being equal to the number of spark gaps to be fired simultaneously. The other row of posts of the distributor head is connected with sparking impulse generating means controlled by the engine. My said application discloses a distributor head having terminal posts which are connected with sparking impulse generating means equal in number to the number of spark gaps to be fired at each explosion period; and the number of sparking impulse generator terminals is equal to the number of said posts of the head. In order that such a distributor will provide ignition for an engine having a greater number of explosion periods than there are spark gaps to be fired at each explosion period, each distributing conductor arm is so constructed that it cooperates a plurality of times during each cycle of operation of the distributor with each terminal post connected with a sparking impulse generator.

The present application provides for the simultaneous firing of a plurality of spark gaps at each explosion period through the agency of sparking impulse generating means combined with a distributor which employs distributing conductor arms of simple design and a sufficient number of sparking impulse generator terminal posts so arranged with respect to the conductor arms that at successive firing intervals, each arm will cooperate successively with the sparking impulse generator terminal posts of the head. By reason of this arrangement, each conducting arm may be constructed as a simple bar conductor since it does not cooperate with each sparking impulse generator terminal post of the head more than once before passing into cooperative relation with another terminal post.

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 two forms of the present invention are clearly shown.

In the drawings:

Figures 1 and 2 together constitute and diagrammatically illustrate a form of invention of an ignition apparatus in which the drive shaft of the ignition timer distributor unit rotates at cycle speed, that is, engine speed for a two-cycle engine and one-half engine speed for a four cycle engine.

Figures 3 and 4 taken together constitute a wiring diagram forming a modified form in which the shaft of the timer distributor unit rotates at one-half cycle speed, that is, one-half engine speed in a two-cycle engine, or one-fourth engine speed for a four-cycle engine.

Referring to Figures 1 and 2, Figure 1 illustrates diagrammatically the cylinders of an eight-cylinder engine, the cylinders being numbered from 1 to 8. Each cylinder has two spark plugs A and B.

In Figure 2, 20 designates a storage battery which is connected by an ignition switch 21 with a wire 22 connected with primary coils P1 and P2 connected in series with a circuit interrupter and connected with primary coils P3 and P4 by a second circuit interrupter.

The timer distributor unit, hereafter called the distributor, is operated by a main drive shaft 23 which, in this form of invention,

is driven at cycle speed, that is, engine speed for a two-cycle engine, or one-half engine speed for a four-cycle engine. The shaft 23 drives a cam 24 which, in this invention, rotates clockwise as indicated by arrow 25. The circuit interrupter to which the primary coils P1 and P2 are connected comprises a lever 30 pivoted at 31 carrying a contact 32 cooperating with a stationary contact 33 which is grounded. The lever 30 carries a rubbing block 34 which cooperates with the cam 24, and is connected with one end of the leaf spring conductor 35, the other end of which is attached to a terminal 36 connected by a wire 37 with the coils P1 and P2 in series. The circuit interrupter to which primary coils P3 and P4 are connected comprises a lever 40 pivoted at 41 carrying a contact 42 cooperating with a stationary contact 43 which is grounded. The lever 40 carries a rubbing block 44 which cooperates with the cam 24, and is connected with one end of the leaf spring conductor 45, the other end of which is attached to a terminal 46 connected by a wire 47 with coils P3 and P4 in series.

The timer contacts 32, 33 are shunted by a condenser 38 and the contacts 42 and 43 by a condenser 48.

The rubbing blocks 34 and 44 are located with respect to the axis in the cam 24 so that the pairs of the contacts will be separated alternately, that is, every 45° of rotation of the shaft 23 for an eight cylinder engine.

The primary coils P1, P2, P3 and P4 cooperate respectively with secondary coils S1, S2, S3 and S4, one end of each coil being grounded through the primary circuit and the battery.

The main distributor shaft 23 drives a rotor block 50, indicated by dot-and-dash lines in the drawings. Block 50 carries rotor segments R1 and R2, which move in a path located between two concentric rows of distributor posts or terminals, the posts of the inner row being numbered 51 and the posts of the outer row 52. The posts of the inner row have special numbers to designate to which secondary winding these posts are connected. It will be observed that there are two posts 51 #*s*1 connected by wire 61 with the secondary S1. There are two posts 51 #*s*2 connected by a wire 62 with the secondary S2. There are two posts #*s*3 connected by wire 63 with secondary S3. There are two posts 51 #*s*4 connected by wire 64 with secondary S4.

The outer row of the distributor posts 52 have special numbers that designate to which spark plugs of the engine cylinders they are to be connected. For example, it will be noted that when the timer circuit breaker lever 30 is about to be moved counterclockwise by the cam 24 to separate the contact 32 from the contact 33, rotor R1 is located between distributor post 51 #*s*1 and distributor post 52 #1A—S1—R1, and that rotor R2 is located between the distributor post 51 #*s*2 and distributor post 52 #1B—S2—R2. The designation 1A—S1—R1 means that post 52 is connected with spark plug A of the cylinder 1, that a sparking impulse for that spark plug is generated in secondary S1 and that rotor R1 serves to conduct the sparking impulse. Similarly, the designation IB—S2—R2 indicates that at the instant of contact separation the sparking impulse generated in secondary S2 is conducted by rotor R2 to a distributor post 52 which is connected to spark plug B of cylinder 1. With this explanation the meaning of the other indicia applied to the other distributor posts 52 should be quite clear.

In the form of invention shown in Figures 1 and 2 the distributor shaft 23 rotates at engine cycle speed consequently the rotor block 50 makes one complete revolution during each engine cycle. At each 45° of movement of the rotor block 50 a sparking impulse is generated and the pairs of coils P1—S1, and P2—S2 are operated alternately with the pairs of coils P3—S3, and P4—S4. Each rotor R1, R2 cooperates with one of the inner rows of distributor posts 51 and with every other post 52 of the outer row.

Two standard spark plugs may be used in each cylinder but one double gap spark plug could be used in place of the two standard plugs in which case one secondary circuit would be completed through the circuit of the other secondary in which a sparking impulse is generated at the same time. Instead of using four separate coils with grounded secondaries, two coils may be used with insulated secondaries. For example, the coil P2—S2 could be omitted and one end of the secondary S1 would be connected as shown and the other end could be connected with distributor posts 51 #*s*2. Likewise instead of coils P3—S3 and P4—S4, one coil could be used and one end of the secondary of that coil could be connected with distributor post 51 #*s*3 and the other end connected with distributor post 51 #*s*4.

Referring to Figures 3 and 4, it will be noted that Figure 3 is a duplicate of Figure 1, but has been repeated for the sake of convenience in explaining Figure 4. The primary circuits P1, P2, P3 and P4 are the same as in Figure 2 with the exception that the circuit interrupters are operated by an eight-lobe cam 124 which is rotated by a distributor drive shaft 123 which turns at one-half cycle speed, that is, one-half engine speed for a two-cycle engine or one-fourth engine speed for a four-cycle engine. The

rubbing blocks 34 and 44 are so located that they will be operated alternately by the cam 124. For an eight-cylinder engine the rubbing blocks would be angularly spaced $180° \pm 22\frac{1}{2}°$. The shaft 123 drives a distributor rotor 150 which carries distributing segments 151 and 152 which move in a path between two concentric circular rows of distributor posts, the inner row being designated by numeral 153 and the outer row by numeral 154. Each post 153 has a special designation to designate with which secondary coil it is connected. It will be observed that there are four posts #*s*1 alternating with four posts #*s*3. The four posts #*s*1 are connected by wire 161 with secondary S1. The four posts #*s*3 are connected by wire 163 with secondary S3. There are four posts 153 #*s*2 alternating with four posts 153 #*s*4. The four posts #*s*2 are connected by wire 162 with secondary S2 and the four posts #*s*4 are connected by wire 164 with secondary S4.

Each of the posts 153 is radially opposite a post 154. Each post 154 has an indicia designating to which spark plug it is connected. Assuming, for example, that the cam 124 is rotating clockwise, as indicated by arrow 125 in Figure 4, it will be apparent that the contacts 32 and 33 are about to separate to effect a generation of the spark impulse in secondary S1 and S2. The sparking impulse in secondary S1 will be conducted by rotor segment 151 from one of the posts 153 #*s*1 to a post 154 #1A, the latter indicia designating that this post is connected to spark plug A of cylinder 1. At substantially the same instant a sparking impulse generated in the secondary S2 will be conducted by rotor segment 152 from a post 153 #*s*2 to a post 154 #1B, the latter indicia designating that this post is connected to spark plug B of cylinder 1. The shaft 123 rotates at one-half cycle speed. Therefore, four lobes of cam 124 will operate upon each of the circuit breaker rubbing blocks 44, 34, thereby producing eight interrupter openings alternately and thereby effecting eight instances of generation of sparking impulses. At each instant of sparking impulse generation two sparking impulses are generated, thus making a total of 16 spark impulses generated during each one-half revolution of cam 124. These 16 sparking impulses are conducted by the rotor segments 151 and 152 during each one-half revolution of the rotor 150.

This form of the invention is adapted for engines where it is more convenient to obtain a distributor drive from a shaft which is driven by the engine at one-half cycle speed. Where such a shaft is available this form of the invention is desirable since no gearing is required between the distributor shaft and the engine shaft.

As in the first form of the invention one double gap spark plug may be used in the place of two standard spark plugs 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. As in the first form of the invention two double end coils could be used in place of four standard coils. By the term "double end" is meant the coil in which the secondary has two insulated terminals, each connectible with a distributor post.

It will be noted that in both forms of the invention the sparking impulse generator terminals are fewer in number than the terminal posts of the distributor head to which the generator terminals are connected. Therefore, each generator terminal is connected with a group of a plurality of sparking impulse generator terminal posts of the head. Each group of posts alternates with posts of another group.

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 internal combustion engines having a plurality of explosion periods during each engine cycle comprising, in combination, 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, the posts of one row being connected respectively with the spark gaps of the engine, said distributor comprising a rotor carrying distributing conductors which move between the rows of posts in order to provide a conducting path between certain pairs of posts, the number of conductors being equal to the number of spark gaps to be fired at the same time; a plurality of sparking impulses generating devices having terminals connected respectively with certain groups of posts of the other row, and engine operated means for controlling said devices.

2. Ignition apparatus for internal combustion engines having a plurality of explosion periods during each engine cycle comprising, in combination, a distributor for distributing sparking impulses to a plurality of spark gaps to be fired in groups at each explosion period, said distributor comprising concentric rows of distributor posts, the posts of one row being connected respectively with the spark gaps of the engine, said distributor comprising a rotor carrying distributing conductors which move between the rows of posts in order to

provide a conducting path between certain pairs of posts, the number of conductors being equal to the number of spark gaps to be fired simultaneously at each explosion period; a plurality of sparking impulses generating devices, each device having as many sparking impulse terminals as there are spark gaps to be fired simultaneously at each explosion period, said terminals being respectively connected with certain groups of posts of the other row, and engine operated means for discharging said devices alternately.

3. Ignition apparatus for internal combustion engines having a plurality of explosion periods during each engine cycle comprising, in combination, a distributor for distributing sparking impulses to a plurality of spark gaps to be fired in groups at each explosion period, said distributor comprising concentric rows of distributor posts, the posts of one row being connected respectively with the spark gaps of the engine, said distributor comprising a rotor carrying distributing conductors which move between the rows of posts in order to provide a conducting path between certain pairs of posts, the number of conductors being equal to the number of spark gaps to be fired at the same time, a plurality of groups of ignition coils, each group comprising as many secondary coils as there are spark gaps to be fired at the same time, said secondaries being connected respectively with certain groups of posts of the other row; and engine driven circuit interrupters operated alternately to control the groups of coils.

4. Ignition apparatus for internal combustion engines having a plurality of explosion periods during each engine cycle, comprising in combination, a distributor for distributing sparking impulses to a pluralty of spark gaps to be fired at the same time, said distributor comprising inner and outer concentric rows of distributor posts, the posts of the first row being equal in number to the total number of spark gaps and being connected respectively with said gaps, the number of posts of the second row being equal to the number of engine cylinders, a distributor rotor carrying conductors which move between the rows of posts in order to provide a conducting path between certain pairs of posts, the number of conductors being equal to the number of spark gaps to be fired at the same time; a plurality of sparking impulses generating devices having terminals connected respectively with certain groups of posts of the second row; a current source; circuit interrupters respectively for controlling connection between the current source and the devices for generating sparking impulses; a cam for operating said interrupters; and a shaft making one revolution per engine cycle for driving the cam and rotor.

5. Ignition apparatus for internal combustion engines, comprising in combination, a distributor for distributing sparking impulses to a plurality of spark gaps to be fired at the same instant, said distributor comprising concentric rows of distributor posts, the number of posts in each row being equal in number to the total number of spark gaps, the posts of one row being connected respectively with the spark gaps, a distributor rotor carrying conductors which move between the rows of posts in order to provide a conducting path between certain pairs of posts, the number of conductors being equal to the number of spark gaps in a cylinder to be fired at the same instant; a plurality of sparking impulse generating devices having terminals connected respectively with certain groups of posts of the other row; a current source; circuit interrupters respectively for controlling connections between the current source and the devices for generating sparking impulses; a cam for operating said interrupters; and a shaft making one-half revolution per engine cycle for driving the cam and rotor.

6. Ignition apparatus for internal combustion engines having N explosion periods during each engine cycle and comprising, in combination, a distributor for distributing sparking impulses to S spark gaps to be fired at the same instant, said distributor comprising inner and outer concentric rows of posts, N x S posts in one row, and N posts in the other row, a distributor rotor carrying S conductors which move between the rows of posts; two groups of sparking impulse generating devices each group having S secondary terminals, each secondary terminal being connected with a plurality of posts of the other row; two circuit interrupters respectively controlling said devices; a cam having N/2 lobes for operating the interrupters alternately; and a shaft operated by the engine and making one revolution during each engine cycle.

7. Ignition apparatus for internal combustion engines having N explosion periods during each engine cycle and comprising, in combination, a distributor for distributing sparking impulses to S spark gaps to be fired at the same instant; said distributor comprising concentric rows of N x S posts in each row, a distributor rotor carrying S conductors which move between the rows of posts; two groups of sparking impulse generating devices each group having S secondary terminals, each secondary terminal being connected with a plurality of posts of one row; two circuit interrupters respectively controlling said devices; a cam having N lobes for operating the interrupters alternately; and a shaft operated by

the engine and making one-half revolution during each engine cycle.

8. Ignition apparatus for internal combustion engines having a plurality of explosion periods during each engine cycle comprising, in combination, 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, the posts of one row being connected respectively with the spark gaps of the engine, said distributor comprising a rotor carrying distributing conductors which move between the rows of posts in order to provide a conducting path between certain pairs of posts, the number of conductors being equal to the number of spark gaps to be fired at the same time; sparking impulse generating means having a plurality of terminals fewer than the posts not connected with spark gaps, said terminals being connected respectively with groups of said last mentioned posts, the posts of a group connected with one sparking impulse generator terminal alternately with posts of another group connected with another sparking impulse generator terminal, and means for controlling the sparking impulse generating means.

9. Ignition apparatus for internal combustion engines comprising, in combination, 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 spark gaps of the engine, sparking impulse generating means having terminals connected with another row of distributor posts, and said distributor including distributing conductor arms, each arm cooperating with alternate posts of the row of posts connected with spark gaps and each arm cooperating with all of the sparking impulse generator terminal posts in succession and but once with each of said posts during a cycle of operation of the distributor.

10. Ignition apparatus for internal combustion engines comprising, in combination, 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 spark gaps of the engine, sparking impulse generating means having terminals connected with another row of distributor posts, the sparking impulse generator terminals being fewer in number than said other row of distributors and being connected respectively with groups of said posts, the posts of a group connected with one sparking impulse generator terminal alternating with posts of another group of posts connected with another sparking impulse generator terminal, and said distributor including distributing conductor arms, each arm cooperating with alternate posts of the row of posts connected with spark gaps and each arm cooperating with all of the sparking impulse generator terminal posts in succession and but once with each of said posts during a cycle of operation of the distributor.

11. Ignition apparatus for internal combustion engines comprising, in combination, 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 spark gaps of the engine, sparking impulse generating means having terminals connected with another row of distributor posts, the sparking impulse generator terminals being fewer in number than said other row of distributors and being connected respectively with groups of said posts, the posts of a group connected with one sparking impulse generator terminal alternating with posts of another group of posts connected with another sparking impulse generator terminal, and said distributor including distributing conductor arms passing between the rows of posts and cooperating with all of the sparking impulse generator terminal posts in succession and but once with each of said posts during a cycle of operation of the distributor.

In testimony whereof we hereto affix our signatures.

CHARLES HALL DAVIS, JR.
HERMAN L. HARTZELL.