R. VARLEY.

IGNITION SYSTEM FOR EXPLOSION ENGINES.

APPLICATION FILED MAY 10, 1907.

915,390. Patented Mar. 16, 1909.

2 SHEETS—SHEET 1.

Fig. 1.

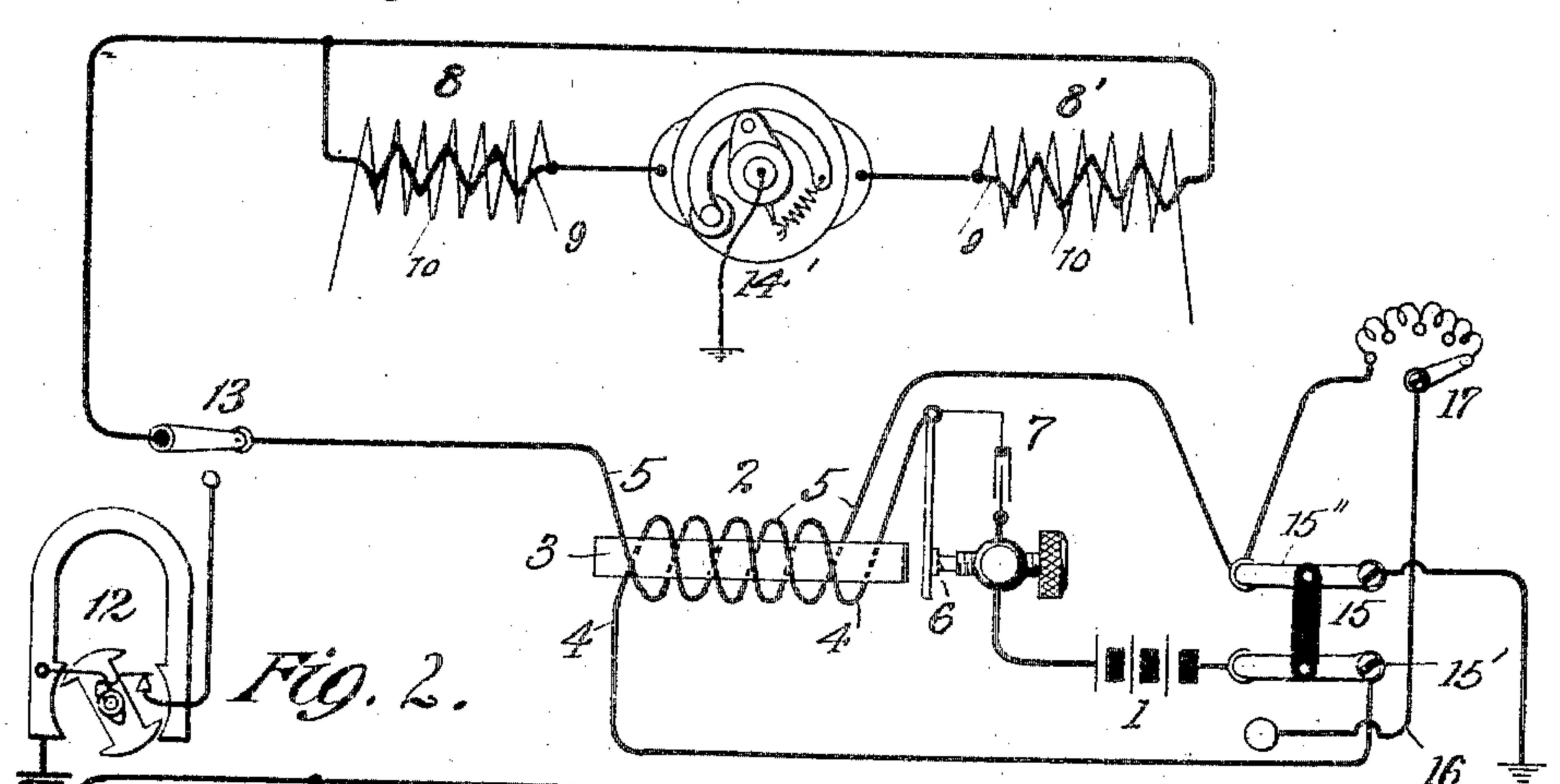
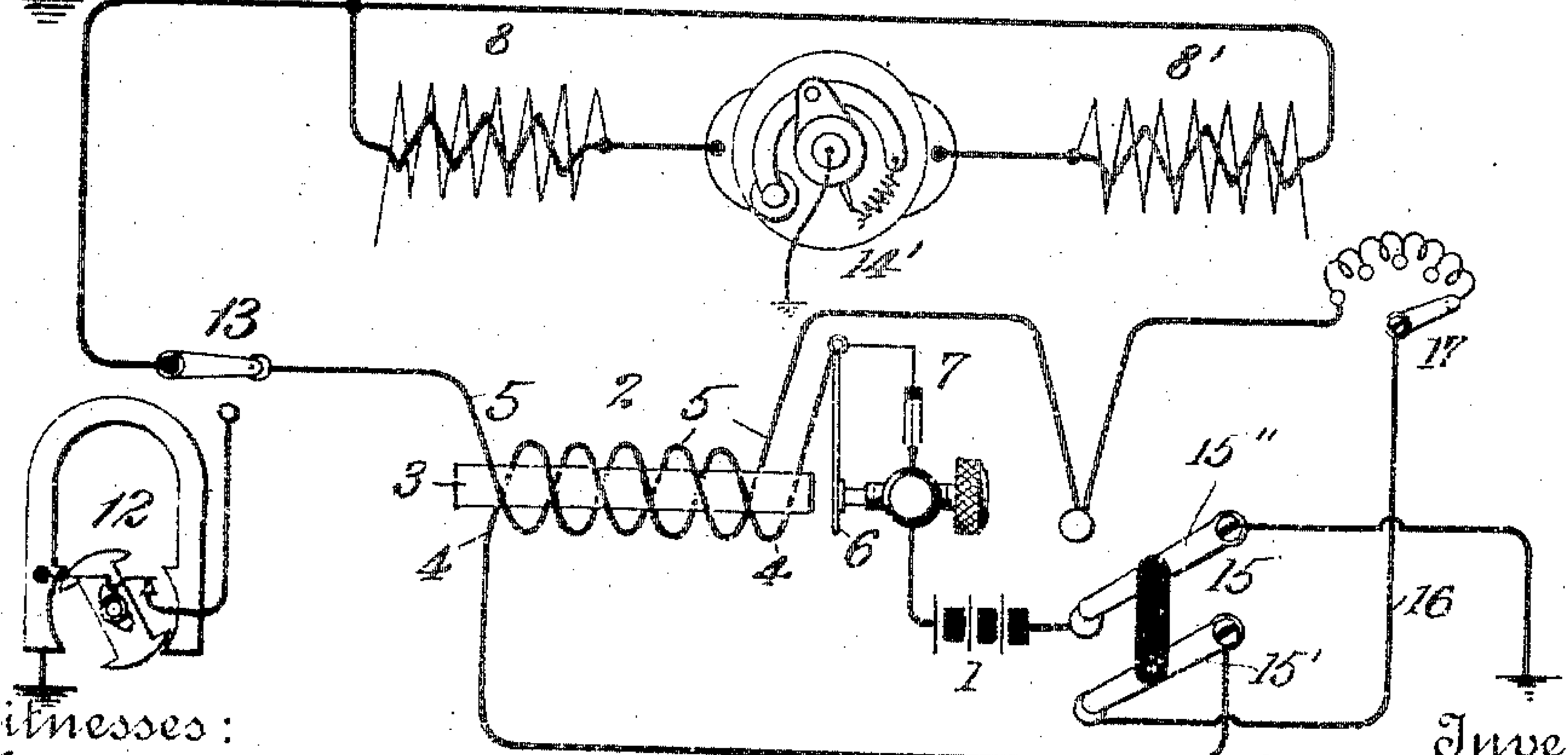


Fig. 2.



Witnesses:

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Richard Varley

By his Attorneys

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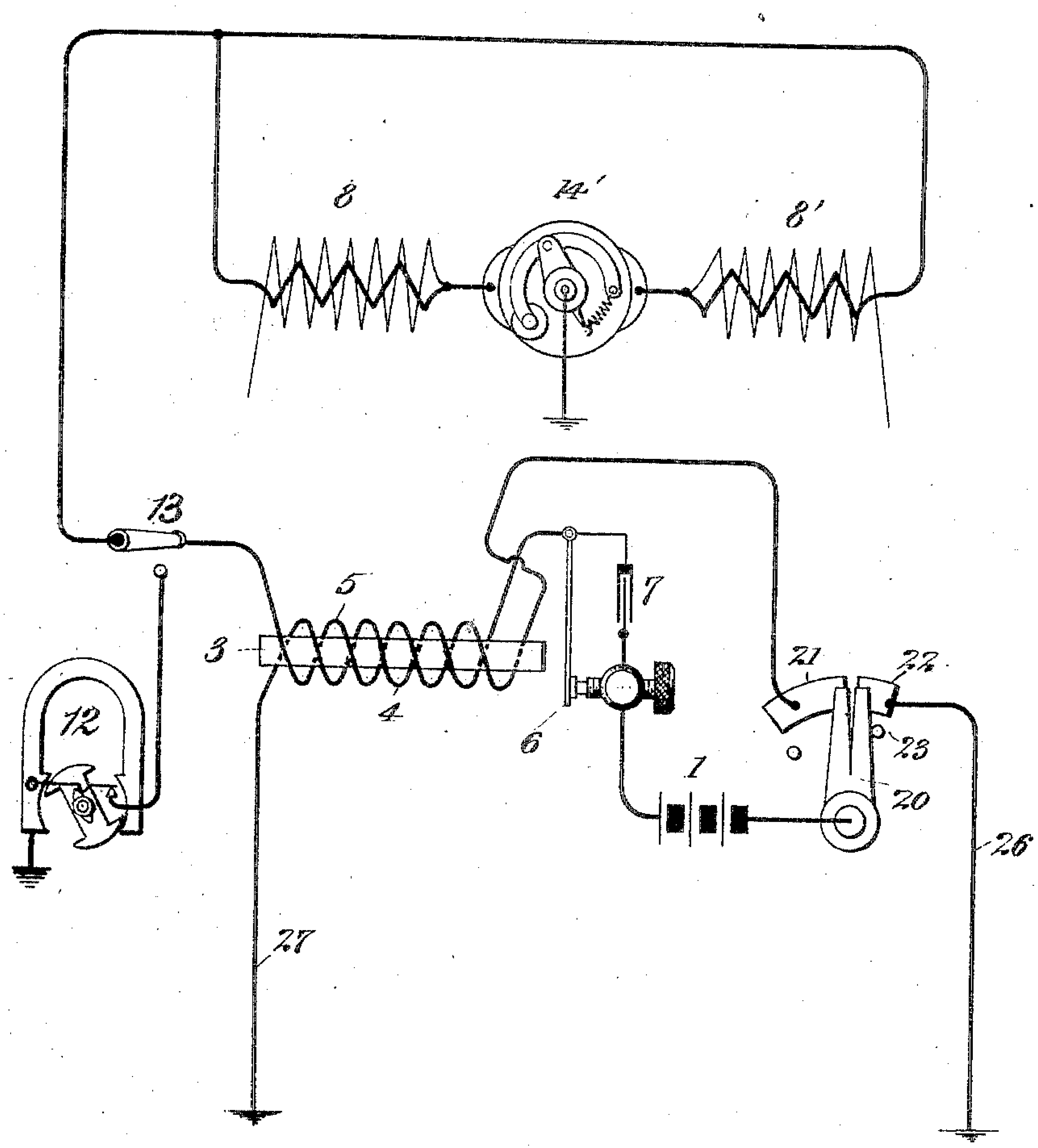
2 SHEETS—SHEET 2.

Fig. 3.



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UNITED STATES PATENT OFFICE.

RICHARD VARLEY, OF ENGLEWOOD, NEW JERSEY, ASSIGNOR TO VARLEY DUPLEX MAGNET COMPANY, A CORPORATION OF NEW JERSEY.

IGNITION SYSTEM FOR EXPLOSION-ENGINES.

No. 915,390. Specification of Letters Patent. Patented March 16, 1909.

Application filed May 10, 1907. Serial No. 372,864.

To all whom it may concern:

Be it known that I, RICHARD VARLEY, a citizen of the United States, residing at Englewood, in the county of Bergen and State of New Jersey, have invented certain new and useful Improvements in Ignition Systems for Explosion-Engines, of which the following is a full, clear, and exact description.

My invention relates to ignition systems for explosion engines where an induction coil or coils are used to impel a spark or cascade of sparks across the points of suitable spark plugs within the engine cylinders.

The method of jump spark ignition is now very commonly employed, but the discharge is sometimes obtained from a single coil, sometimes from a plurality of coils, sometimes with a battery, and sometimes with a dynamo. In case of battery ignition, a vibrator is ordinarily employed, either directly actuated by the coil or coils and forming a part thereof, or located in a separate part of the circuit. In case of dynamo ignition, a vibrator is not used, and the coils are made heavier, with massive iron cores in order to secure a large amount of energy in a single discharge. In dual-ignition systems, it is sometimes desired to use the same coil, first in connection with a dynamo and then in connection with a battery and vibrator. Perfectly satisfactory results cannot be ordinarily secured, however, since the heavily self-inductive coil adapted for dynamo use does not work properly in a vibrator circuit. The inductance is so high that it takes an appreciable time for the current to rise to its full value after each interruption and circuit closure, so that the vibrator works very slowly and sluggishly. The induction coils adapted for use with vibrators must be as little self-inductive as possible in order to prevent the vibrator from being sluggish in its movement.

The above considerations show the need for improvement in ignition systems for explosion engines, and particularly in cases where a battery and dynamo are used as alternative sources of current in the same system.

By the present invention, I obtain a high potential discharge for the jump spark by a different principle, and it will be observed that although a vibrator is used to produce a cascade discharge, there is no restriction upon the self-induction or impedance of the induction coil. In other words, the induction coil or coils may be made as large and massive, and with as much iron as is necessary, to secure the best efficiency. In this way it is obvious they are perfectly adapted to the purposes of dynamo ignition. By my invention they are also made suitable to the purposes of battery and vibrator ignition.

With these objects in view, the invention consists in the method and in the features of construction and combination hereinafter set forth, and finally pointed out in the appended claims.

In the drawings: Figure 1 is a diagrammatic view of an ignition system embodying the principles of my invention; Fig. 2 is a view of the same with a switch moved to its alternate position, and Fig. 3 shows a modification.

In order that the invention may be perfectly understood, I will consider briefly the action of an ordinary induction coil. In the ordinary induction coil, a primary E. M. F. of four to six volts potential is stepped up to an electromotive force of perhaps fifty thousand volts. This enormous increase in the voltage is due partly to the ratio of the number of primary to the number of secondary turns, and which may be termed the transformer effect. This ratio, however, only accounts for a fraction of the voltage increase. There is another factor and which may be termed the "kick" and which accounts for a great multiplying effect in the voltage. This is the effect of the very abrupt termination of the primary current flow as distinguished from the mere voltage drop. The primary current is entirely broken across a condenser in such a way that it is compelled to almost instantly cease to flow, and as the electromotive force induced in the secondary is proportional to the rate of change in the magnetic field as well as the ratio of the turns, there is a great multiplication in the induced secondary E. M. F. (about one hundred to two hundred fold) produced by the abruptness of the primary current interruption, and altogether independent of the ratio between the number of turns in the primary and in the secondary.

The above principles may be summed up as follows: A large induction coil with a massive core is necessary to secure a powerful spark. Such an induction coil requires considerable time to become "charged" and is therefore adapted for use with dynamo ignition where the dynamo also has inductance and only a single spark is attempted to be obtained. With a vibrator and a battery such a coil having high inductance does not ordinarily work well, becasue it requires too long a time for the current to attain its full strength in the primary, so that either the vibrator works slowly or sluggishly, or the sparks are very feeble. But (except for the effect of resistance) there is always bound to be at least a voltage increase proportional to the ratio between the turns in the primary and the secondary windings, no matter how heavy and massive the coil, nor how much its self inductance may be. Accordingly if an ignition system includes a massive coil adapted to the purposes of dynamo ignition, this may always be operated at its full efficiency to secure a voltage increase proportional to the ratio of its primary and secondary windings. By the present invention such a coil is used in this way in conjunction with certain other apparatus operating on the "kick" principle, which together with said coil affords all the functions of a single induction coil of low inductance especially designed to work in a battery and vibrator circuit.

In carrying out the present invention I have one small low inductance coil in which the electromotive force is stepped up exclusively by the "kick", and another separate more massive coil in which the electromotive force is stepped up wholly by the transformer effect. Since the latter coil does not have anything to do with the vibrator circuit it may be as large and massive as desired, and suitable to use with dynamo ignition. It really constitutes under these circumstances a transformer. On the other hand, the coil in which the phenomenon of voltage increase is obtained by the "kick" may have an equal number of turns in the primary and secondary, and may be in the form of a small double wound supplemental magnet of low inductance adapted to operate the vibrator, when a vibrator is used for primary current interruption. When used in this way a special and very important advantage is secured as will later more fully appear.

Referring to Figs. 1 and 2 of the drawings, 1 indicates a battery or source of electric energy. 2 denotes the first induction coil above mentioned which secures the voltage by a "kick" produced by a condenser. This coil has a magnetic core 3, a primary winding 4, a secondary winding 5, and a vibrator armature 6 which acts to close the circuit of the battery through the primary 4. 7 is a condenser which operates to secure the abrupt circuit rupture required. 8 (or 8′) denotes the second coil mentioned and which operates by the transformer phenomenon. This coil may be as large and massive as desired, having a primary 9 and a secondary 10. But while the primary and secondary 4 and 5, of coil 2, may have substantially the same number of turns or windings of fairly coarse wire, the primary and secondary 9 and 10 of coil 8 have a ratio in their number of turns to produce any desired voltage increase. The action is as follows: Assuming that the switch 15 is in the position of Fig. 1, a circuit is completed from the battery 1, through the primary 4, and armature 6, energizing the core 3, and attracting the armature 6 to break the circuit. This circuit being ruptured very abruptly, a current is induced in the secondary 5 which may have one hundred or two hundred times as high a voltage as the original battery or current source 1. The voltage applied to primary 9 is accordingly stepped up to say five hundred volts, and whatever this voltage, the E. M. F. at the spark plug 11 is as much greater as the ratio of the number of turns between the primary 9 and the secondary 10. The available electromotive force of the secondary circuit is bound to be at least this amount (barring certain corrections due to resistance). The resulting electromotive force delivered at the spark plug, is, however, by virtue of the double action, fully as great as if a single induction coil were used in which the voltage increase was secured at once. The necessary sparking voltage being thus secured with a battery and vibrator circuit, I will point out the additional advantages which are attained, and which are not secured with an ordinary induction coil. The first of these advantages lies in the fact that the coil 8 of large size and self-induction is admirably suited to dynamo ignition.

The second advantage of the present arrangement lies in the fact that the heavy inductance of the coils 8 and 8′ does not have any effect, or substantially no effect on the rate of vibration of the vibrator 6, or the action of the coil 2. It will be observed that the vibrator 6 is in an entirely separate circuit from the primary winding 9, so that the inductance of this circuit does not affect the current from the battery through the primary 4. Accordingly, the current in the winding 4 rises quickly to its proper value and the vibrator 6 vibrates with substantially its normal periodicity due to its resiliency. A quick cascade of sparks is therefore sesured at the plugs notwithstanding the heavy inductance of the coil 8. This result would not be secured if the vibrator was in the circuit of the primary 9, in which case the spark cascade would be very slow and the engine would miss explosions. A still further important function is secured by my present arrangement, which is that the circuit of the battery 1 is closed continuously through the primary 4, so that the vibrator 6 acts continuously. This is advantageous for high engine speeds at which the period of circuit closure is so small that a stationary vibrator does not have time to get iteslf in motion. But, as the vibrator 6 is in continuous vibration, this difficulty does not apply to my present invention. The system is in condition to deliver the spark cascade immediately that the circuit of the primary 9 is closed by the circuit controller 14.

The above arrangement is adapted to give perfect results with dynamo ignition or with battery ignition. It is further adapted to give perfect results at the highest engine speeds, since the vibrator works with its normal rapidity, notwithstanding the high inductance of the coil, and is further operating all the time so that it does not have to overcome a momentary inertia whenever the circuit is controlled to produce the spark. All conditions for perfect ignition are thereby secured, except that if the battery circuit is to be constantly closed, there is a fairly high current consumption.

In Fig. 2 the switch 15 is moved to its alternate position, which gives a different arrangement of circuits, designed to secure the greatest possible economy in battery current consumption. In this position the current from the battery 1 flows through the circuit breaker 6 and primary 4 to blade 15′ of switch 15, and through a wire 16, to a resistance device 17, and from thence through secondary 5, and the coils 8 and 8′, to the circuit controller 14′. The circuit controller intermittently grounds this end of the circuit and the other end is permanently grounded at this time by the switch blade 15″. A single circuit is thereby intermittently completed and which includes both the coil 2 and the primary of one or another of the coils 8, 8′. Under these circumstances, the two windings of the coil 2 act together to produce a simple magnet, so that this coil constitutes merely an auxiliary vibrator at this time. It has no effect whatever to inductively increase the voltage and the coils 8, 8′; act both by the "kick" and by the transformer effect. Of course the action of the vibrator is very sluggish under these circumstances, and not suitable to high speeds or large power, but for slow running on level roads it works well enough, and the battery consumption is very economical. Whenever high speeds or large power is required it is a very simple matter to throw the switch 15 to the other position whereupon the apparatus is in condition to work with absolutely perfect efficiency, whether the dynamo or the battery is the source of primary current. This is true because the dynamo always operates only with the single large massive coil 8 or 8′, which is designed to be perfectly suitable for this purpose. On the other hand, when the switch 13 is thrown to connect the battery in circuit, the switch 15 must be displaced to give the circuit conditions diagrammatically shown in Fig. 1, which correspond to the highest possible efficiency obtainable with a battery and trembler coil. Thus the apparatus can be made to operate with as high efficiency as is theoretically obtainable whether a dynamo or battery constitutes the current source.

In Fig. 3 there is shown a form of the invention in which a slightly different type of switch is used in place of the double pole switch 15 of Figs. 2 and 3. 20 indicates a switch blade, and 21 and 22 are contacts therefor. The switch blade is slotted or formed so that it is capable of engaging both the contacts 21 and 22 at its right-hand position of throw, determined by the stop 23. At the left-hand position of throw of the switch arm 20 engagement is made exclusively with the contact plate 21. The winding 4 of coil 2 is connected through the battery 1 to the switch blade 20. The contact plate 21 is connected to the winding 5, and the contact plate 22 is permanently grounded at 26. Substantially the same functions are secured as in Figs. 2 and 3. At the left-hand position of the switch blade 20 a continuous circuit is formed from the battery 1, through winding 4, ground at 27 to the grounded arm of the circuit controller 14′, coil 8 or 8′, winding 5, contact plate 21, switch blade 20, back to battery 1. This circuit is identical with that of Fig. 3 already described. When the switch blade 20 is moved to its right-hand position, a closed circuit is formed from battery 1, through winding 4, to ground at 27, the other side of the battery 1 being now permanently grounded through the contact plate 22. At the same time the secondary circuit of the coil 2 is properly completed since contact plates 21 and 22 are now bridged so that the circuit including winding 5 and the primary of coil 8 or 8′ is permanently grounded at one end 26, and intermittently grounded at the other end 14′. The closure of this circuit enables it to operate in exactly the same way as the circuits already fully considered in Fig. 1.

What I claim, is:—

1. In an ignition system for explosion engines, an induction coil having a primary circuit including a source of electric energy and adapted to be intermittently broken, an additional coil having its primary in circuit with the secondary of the first coil, and means for connecting the primary and secondary of the first coil in series with one another when desired.

2. In an ignition system for explosion engines, an induction coil having a primary circuit including a source of electric energy and adapted to be intermittently broken, an additional coil having its primary in circuit with the secondary of the first coil, and a single switch for connecting the primary and

secondary of the first coil in series with one another when desired.

3. In an ignition system for explosion engines, an induction coil having its primary circuit adapted to be intermittently broken and including a source of electric energy, a plurality of induction coils, means for successively connecting their primaries to the secondary of the first mentioned coil, and a switch for connecting the primary and secondary windings of the first mentioned coil in series with one another.

4. In an ignition system for explosion engines, an induction coil having a vibrator whereby its primary circuit is intermittently broken, said circuit including a source of electric energy, a plurality of induction coils, means for successively connecting their primaries to the secondary of the first mentioned coil, and a switch for connecting the primary and secondary windings of the first mentioned coil in series with one another.

In witness whereof, I subscribe my signature, in the presence of two witnesses.

RICHARD VARLEY.

Witnesses:

WALDO M. CHAPIN,

MAY BIRD.