E. THOMSON.

IGNITING APPARATUS FOR GAS ENGINES.

APPLICATION FILED APR. 5, 1906.

1,021,219.

Patented Mar. 26, 1912.

2 SHEETS—SHEET 1.

Fig. 1

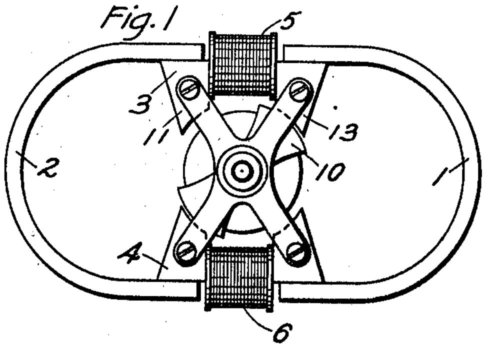


Fig. 2

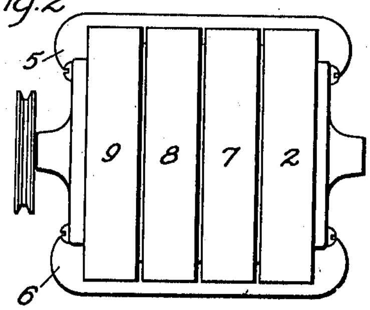


Fig. 3

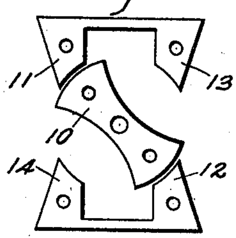


Fig. 4

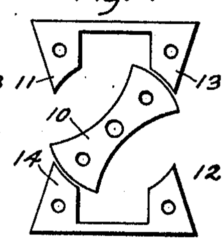


Fig. 5

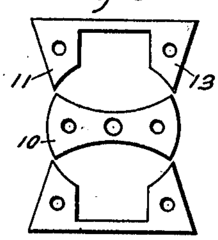


Fig. 6

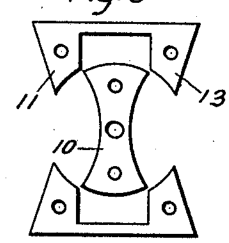


Fig. 7

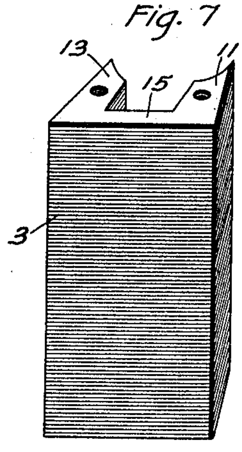


Fig. 8

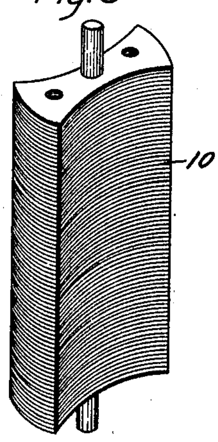
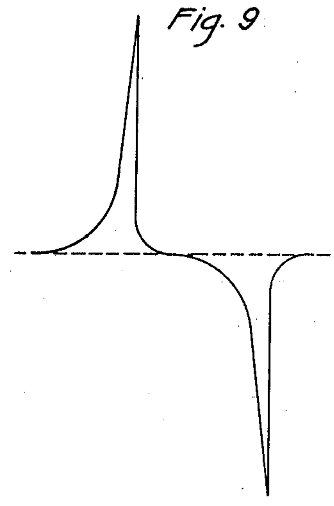


Fig. 9



Witnesses:

Benjamin B. Hull

Helen Orford

Inventor:

Elihu Thomson

By Albert G. Davis

Att'y.

E. THOMSON.

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2 SHEETS—SHEET 2.

Fig. 10

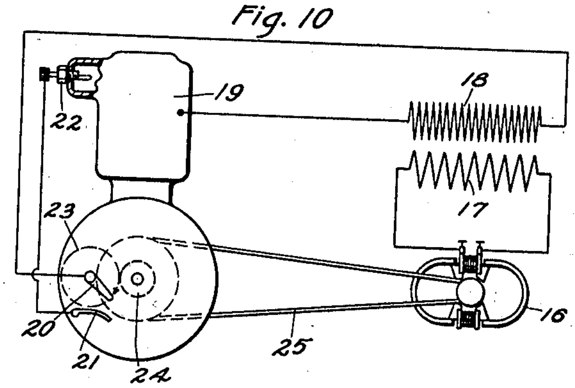


Fig. 11

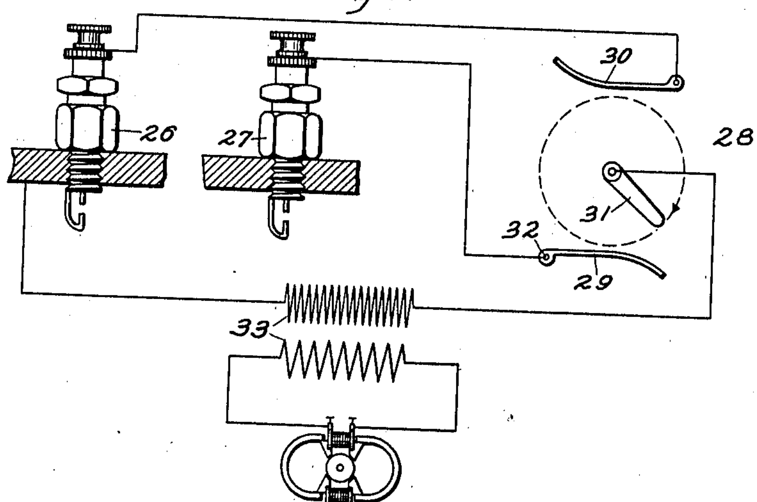


Fig 12

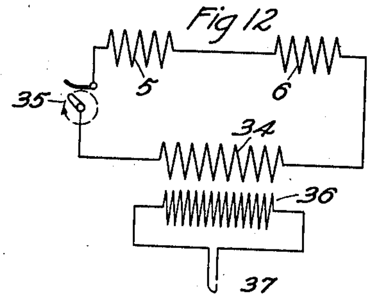


Fig. 13

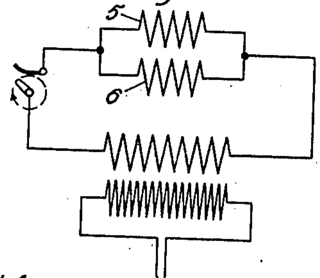
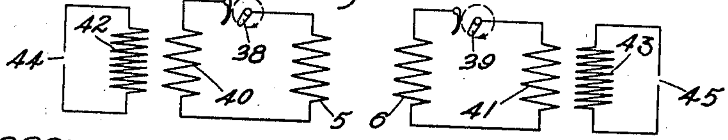


Fig. 14



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Elihu Thomson

By Albert G. Davis

Att'y.

UNITED STATES PATENT OFFICE.

ELIHU THOMSON, OF SWAMPSCOTT, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

IGNITING APPARATUS FOR GAS-ENGINES.

1,021,219. Specification of Letters Patent. **Patented Mar. 26, 1912.**

Application filed April 5, 1906. Serial No. 310,034.

To all whom it may concern:

Be it known that I, ELIHU THOMSON, a citizen of the United States, residing at Swampscott, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Igniting Apparatus for Gas-Engines, of which the following is a specification.

This invention relates to improved means for producing spark ignition of gasolene, gas and oil engines, and embodies various novel arrangements of a dynamo and the other parts of the system whereby the ignition is reliable, and furthermore, can be timed to suit the speed of the gas or other engine without the employment of hand levers or other complicated mechanism such as is commonly used to effect this result.

The details of my invention will be better understood by reference to the following description taken in connection with the drawing forming a part of this specification.

Figure 1 is an elevation of my improved form of dynamo; Fig. 2 is an end elevation of the same; Figs. 3, 4, 5 and 6 are diagrams showing the polar projections of the dynamo represented in Fig. 1, and illustrating various positions of the rotating element of the dynamo with respect to these polar projections; Fig. 7 is a perspective view of a polar projection; Fig. 8 is a perspective view of the rotating element of the dynamo; Fig. 9 is a representation of the pressure wave generated by the dynamo; Fig. 10 shows one means for applying my improved form of dynamo to a gas engine to produce ignition of the charge in the engine cylinder; Fig. 11 shows my improved system as applied to a two cylinder engine and equipped with a selective distributer for automatically delivering current to the respective cylinders at proper time intervals; Fig. 12 shows a system in which the two coils of the dynamo are connected in series through a timing device to the low potential winding of a transformer, the high potential winding of which is connected directly to the two contacts of the spark plug; Fig. 13 represents a similar system with the two dynamo coils in parallel; Fig. 14 represents a system applicable to a two-cylinder engine in which the two coils of the dynamo supply two separate spark plugs through separate transformers.

The dynamo represented in Figs. 1 and 2 comprises a plurality of permanent magnets 1 and 2 arranged in the same plane and with thin, like poles presented toward each other. The poles are magnetically bridged by laminated polar projections 3 and 4, on which are mounted the generating coils 5 and 6. One of these polar projections is clearly shown in perspective in Fig. 7 and embodies a central portion 15 on which the generating coil is wound. Two protruding pole tips 11 and 13 extend outward beyond the coil. I prefer to make these polar projections 3 and 4 of considerable length, and subject them not only to the magnetic flux from the magnets 1 and 2, but also to that of other pairs of similar magnets arranged side by side along the polar projections, as shown in Fig. 2, in which the magnets 7, 8 and 9 correspond in all respects to the magnet 2, and coöperate with other magnets arranged on the opposite side of the polar projections. The rotor or movable element 10 of this dynamo is shown in perspective in Fig. 8, and consists merely of a shaft carrying a plurality of iron laminations arranged one above another and secured to the shaft. This rotor when set in motion between the polar projections 3 and 4 produces a change in direction of the magnetic flux threading the coils 5 and 6, and thereby generates an electromotive force which I make use of in developing a spark in the engine to be controlled.

According to the arrangement shown in Figs. 1 and 2, the polar projection 3 is in contact with the north poles of eight magnets, and the projection 4 is in contact with the corresponding south poles of the same magnets so that a vertical magnetic flux is established through the space in which the rotary element 10 lies. When the rotor is in the position shown in Fig. 3, the magnetic flux will thread through it from the pole tip 11 to the pole tip 12, and very little magnetic flux will pass through the tips 13 and 14. When the rotor assumes the position shown in Fig. 4, the main flux will traverse the tips 13 and 14 and very little will pass through the other pole tips. Assuming a left hand rotation for the rotor, Fig. 5 shows its position midway between the two positions illustrated in Figs. 3 and 4, which position is approximately that at which the magnetic flux shifts from the pole tip 11 to the pole tip 13, and by so doing cuts through the coil normally mounted on the narrow connecting piece 15. By making the rotor of considerable length I am able to make this shifting over of the magnetic flux very abrupt, and as a consequence I am able to secure a pressure wave having a very sharp peak at the maximum point, as shown diagrammatically in Fig. 9. Fig. 6 shows the second mid-position when the flux is about to shift back to the pole tip 11, assuming a left-hand rotation. The peculiarities of design and operation embodied in the dynamo above described give the peculiar wave form shown in Fig. 9, and the height of the positive and negative peaks is determined by the speed of rotation of the element 10 and the number of turns in the coils 5 and 6; so that by varying either or both of these factors I can secure any variation in the maximum value of the pressure wave within very wide limits. I find that by making the coils 5 and 6 of many turns I can develop a maximum pressure well adapted for operating spark plugs without the interposition of step-up transformers or other auxiliary apparatus, thus making the entire equipment very light in weight and very simple in construction and in operation.

Under certain conditions I find it desirable to make the dynamo coils 5 and 6 of a comparatively small number of turns, and to interpose a transformer between the dynamo and the spark plugs. Such a system is shown diagrammatically in Fig. 10 in which the dynamo 16 is shown connected permanently to the terminals of the transformer primary 17, thereby supplying energy to the high potential coil 18 of the transformer which has one terminal grounded to the frame of the engine 19, and the other terminal connected to a rotating selector 20 which operates to deliver current to a receiving shoe 21 at the proper time interval, so that when the current jumps from one electrode of the spark plug 22 to the other electrode, and thence returns through the frame to the transformer, the spark so produced will occur just at the time the explosive charge in the engine cylinder is ready for ignition. The rotating contact finger 20 is rigidly connected to the gear wheel 23 meshing with the gear 24 carried by the gas engine, these two gears having such diameters that the contact finger 20 makes one rotation to every two of the gas engine shaft, and consequently produces an igniting spark every second revolution of the engine. The dynamo 16 may be driven in any suitable manner, as by a belt 25 driven by a pulley on the gas engine axle. The continuous rotation of the dynamo 16 develops a continuous series of peaked waves in the transformer secondary 18, though these pressure waves are utilized only during the brief interval when the selector 20 is in proximity to the receiving shoe 21. If desired, the electrical circuit between the members 20 and 21 may be completed by mechanical contact, but I prefer to separate the parts sufficiently to prevent such contact, and to rely on the electromotive force of the electrical energy to break down this gap and establish electrical connection through the spark so formed. This arrangement obviates entirely the mechanical wear of one part on another, and furthermore provides means for the automatic "advance," of the spark as the engine speed increases, this effect being produced in part by the increase in dynamo voltage as the speed goes up, and in part by the curved shape of the receiving shoe 21, for it will be readily understood that as the voltage goes up, the current will jump to the contact shoe before the revolving selector 20 reaches the position corresponding to the minimum distance between the two elements and will therefore give an automatic advance of the spark directly proportional to the increase in speed. By curving the receiving shoe 21 away from the arc of the rotating finger 20, I can secure any desired relation between the speed and the spark advance.

By using a belt drive between the dynamo 16 and the gas engine I am able to secure a speed much higher than that of the engine, and in fact so high that each spark discharge in the engine cylinder may embody several complete cycles of the dynamo current. Maximum speeds as high as three thousand revolutions per minute may be used, as the revolving element is small and consists merely of iron laminations without windings of any sort thereon. This method of connecting the dynamo to the gas engine obviates the necessity for synchronous speeds between the two, and thus makes it possible to remove the dynamo from the engine frame for repairs and to return it to its position without danger of disarranging the phase relation between the dynamo current and the engine piston, this difficulty being one commonly experienced with geared igniters. The high speed makes it possible to obtain a maximum voltage from the dynamo coils and in fact with a fine winding for the generator coils I am able to deliver a sharp hot spark to the spark plug of the engine without the use of a transformer to raise the voltage of the dynamo. The fact that each discharge at the spark plug embodies several complete cycles of current makes unnecessary any adjustment in position of the dynamo field to compensate for the "time advance" in the spark as is common practice when the dynamo runs in synchronism with the gas engine, this adjustment being necessary to prevent the selector or contact device from completing the circuit at the instant when the pressure wave is very low, for in such cases the voltage might not be sufficient to generate a spark to ignite the engine charge.

Fig. 11 shows my improved system applied to a two-cylinder engine represented by the two spark plugs 26 and 27, which alternately receive current from the selector distributer 28. This distributer is similar to the one shown in Fig. 10, except that it includes two receiving shoes 29 and 30 by which the charges are led to the two spark plugs. This distributer embodies the feature of automatic "advance" described in connection with distributer 20, for when the revolving finger 31 approaches the receiving shoe 29, the electrical discharge will jump across the intervening gap and the distance jumped will depend on the voltage of the dynamo which in turn is dependent on the speed of the gas engine. While I contemplate adjusting the curve of contact shoe 29 to secure the exact relation desired between speed and advance of the spark, thereafter depending entirely on the automatic action of the device, it will be understood that other adjustments may be made, if desired, by shifting the shoe 29 about its pivotal support 32, thereby increasing the minimum distance of the spark gap and also re-adjusting the other distances through which the spark must jump as the engine speeds up.

Although I have shown only two spark plugs to represent a two-cylinder engine it will be understood that the system is equally applicable to four-cylinder engines by merely adding other receiving shoes around the arc of the rotating selector 31. If desired I may dispense with the transformer 33 and connect the dynamo directly across the circuit.

Fig. 12 is a diagram of the connections of the dynamo showing the two coils 5 and 6 connected in series through a transformer primary 34 and a selector distributer 35. The high potential transformer winding 36 is connected directly to the two terminals of the spark plug 37. This arrangement simplifies the high potential circuit as all interruptions of current take place at the selector in the low potential circuit. Fig. 13 shows a similar arrangement in which the coils 5 and 6 are connected in parallel to combine their out-put.

Fig. 14 shows coils 5 and 6 connected through individual distributers 38 and 39 to transformer primaries 40 and 41, which in turn supply energy to the high potential windings 42 and 43 connected to the spark gaps 44 and 45 of a multiple cylinder engine, thereby making each cylinder independent to a certain extent from other cylinders of the engine.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. The combination with an explosive engine, of sparking terminals for igniting the explosive charge of said engine, means for developing electrical energy for supplying said sparking terminals, and means for determining the instant at which said energy is delivered to said terminals and for automatically advancing the discharge with respect to the engine piston as the speed of the engine increases including a rotating arm and a receiving shoe, said shoe beng curved away from the arc of the rotating arm.

2. The combination of an explosive engine, a dynamo for developing energy to explode the charge of said engine, and automatic means for advancing the time of explosion as the speed of the engine increases including a rotating arm and a movable receiving shoe, said shoe being curved away from the arc of the rotating arm and at a sparking distance therefrom.

3. In an igniting system for explosive engines, a current distributer comprising a rotating arm, a receiving shoe at a sparking distance from said rotating arm but out of contact therewith, and a circuit including a spark plug and a source of power connecting said rotating arm with said receiving shoe, said receiving shoe being curved away from the arc of the rotating arm as to automatically advance the discharge with respect to the engine piston as the speed of the engine increases.

4. The combination with a multi-cylinder engine, of a plurality of spark plugs therefor, a receiving shoe connected with each spark plug, a rotating arm movable to a sparking distance from each of said receiving shoes, and a source of electrical energy for causing current to jump from said rotating arm to each of said shoes in succession, said receiving shoes being curved away from the arc of the rotating arm so as to automatically advance the discharge with respect to the engine piston as the speed of the engine increases.

5. The combination with an explosive engine, of a source of electrical energy delivering a peaked current wave, and a circuit

connected therewith including a spark plug, a rotating arm and a receiving shoe at a sparking distance away from said arm, said shoe being curved away from the arc of the rotating arm so as to automatically advance the discharge with respect to the engine piston as the speed of the engine increases.

In witness whereof, I have hereunto set my hand this second day of April, 1906.

ELIHU THOMSON.

Witnesses:
JOHN A. McMANUS, Jr.,
PHILIP F. HARRINGTON.