No. 753,511. PATENTED MAR. 1, 1904.

G. J. MURDOCK.

SPARKING DEVICE FOR GAS ENGINES.

APPLICATION FILED MAR. 21, 1903.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 1,

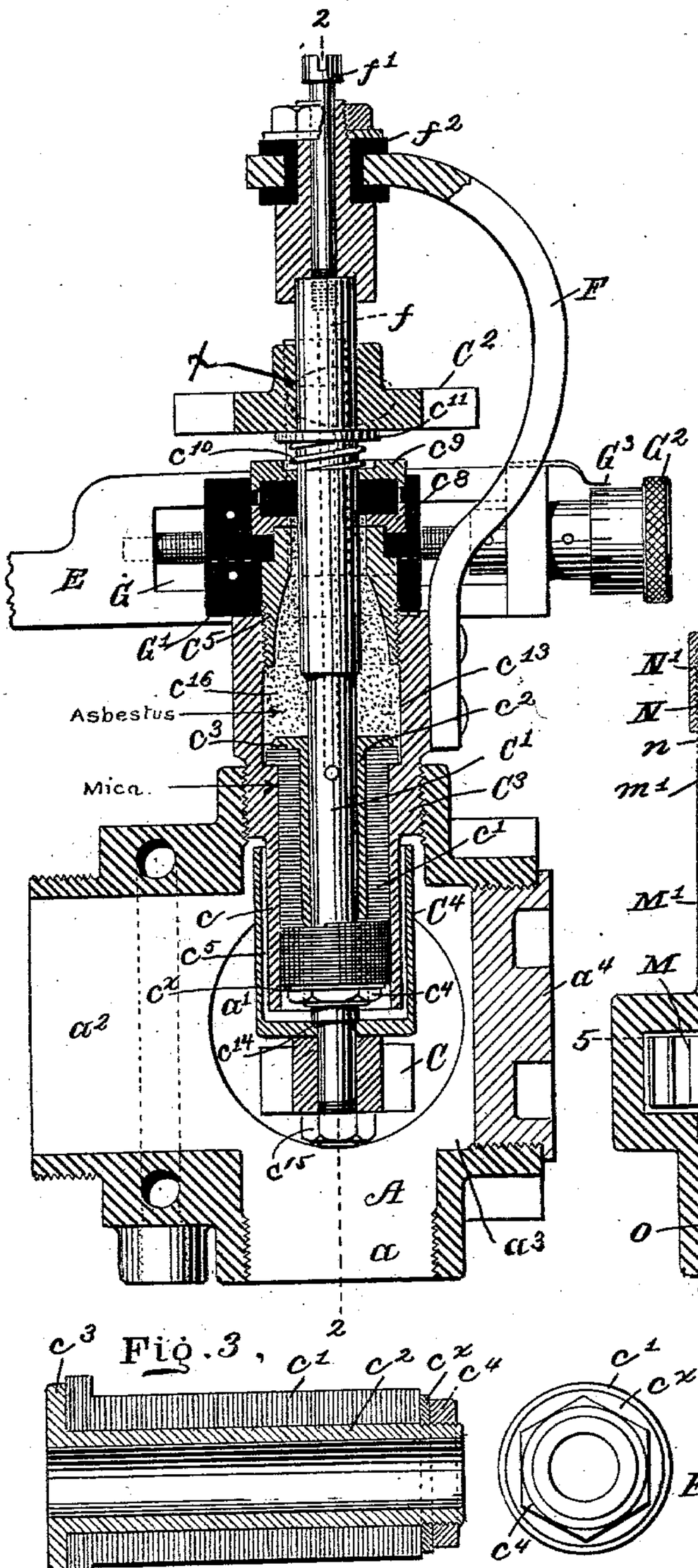

Fig. 2,

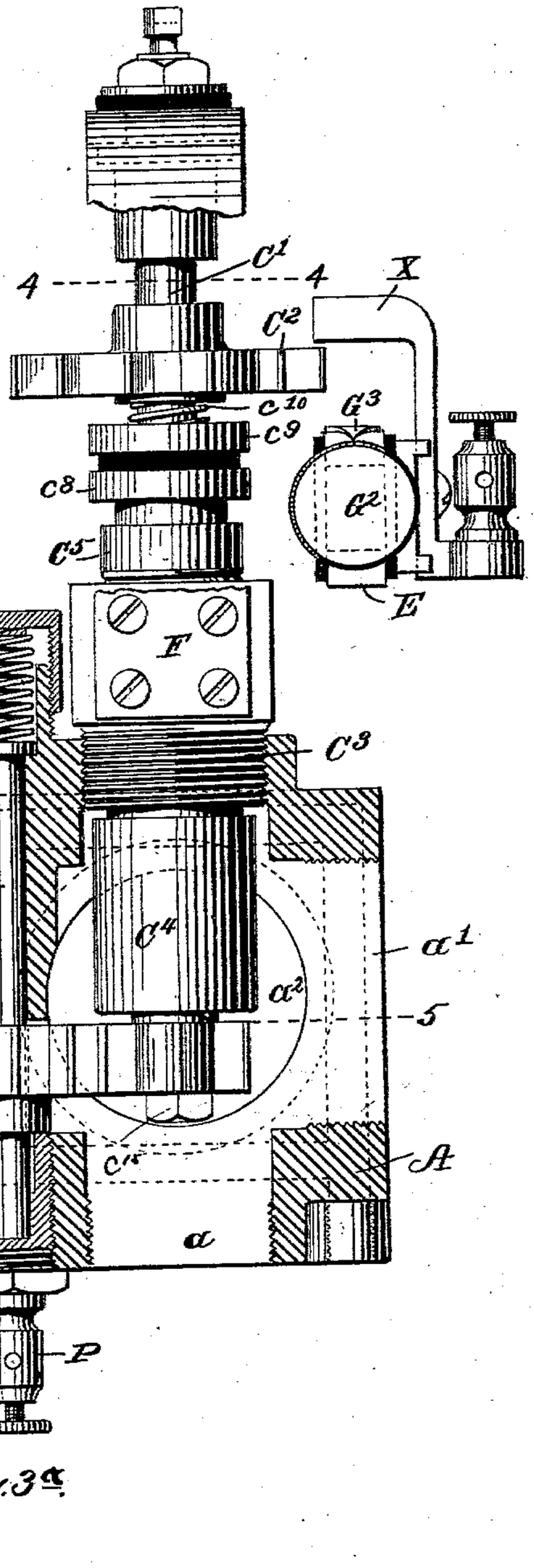

Fig. 3,

Fig. 3a.

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NO MODEL. 3 SHEETS—SHEET 2.

Fig. 4.

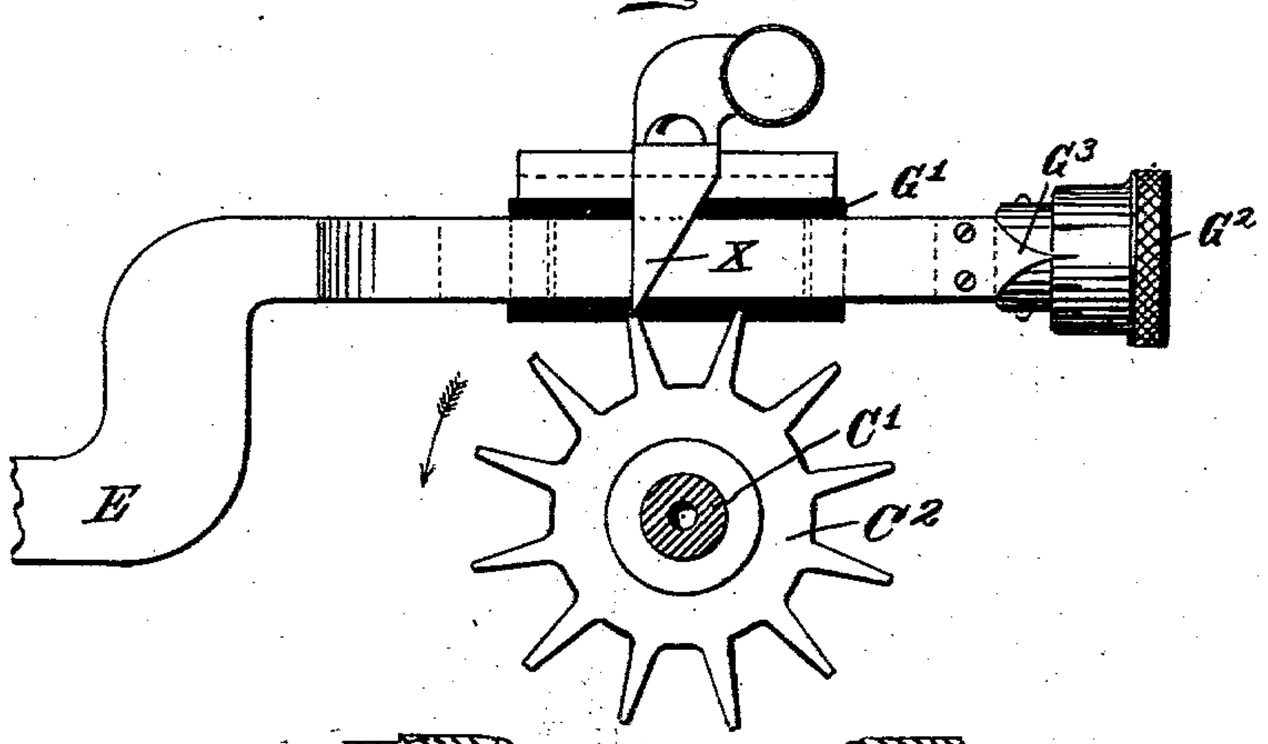


Fig. 5.

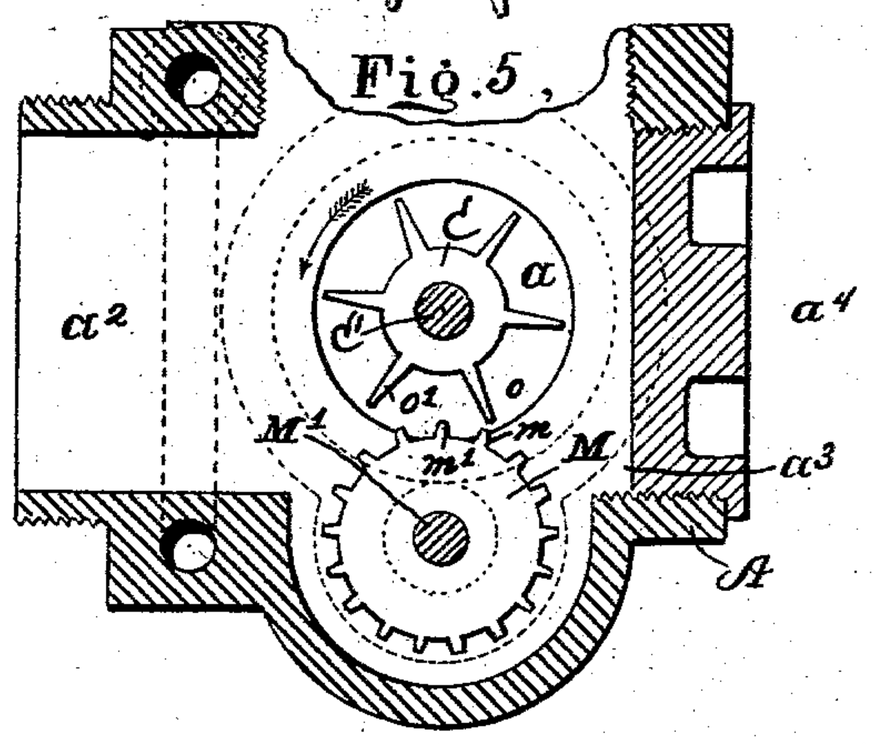
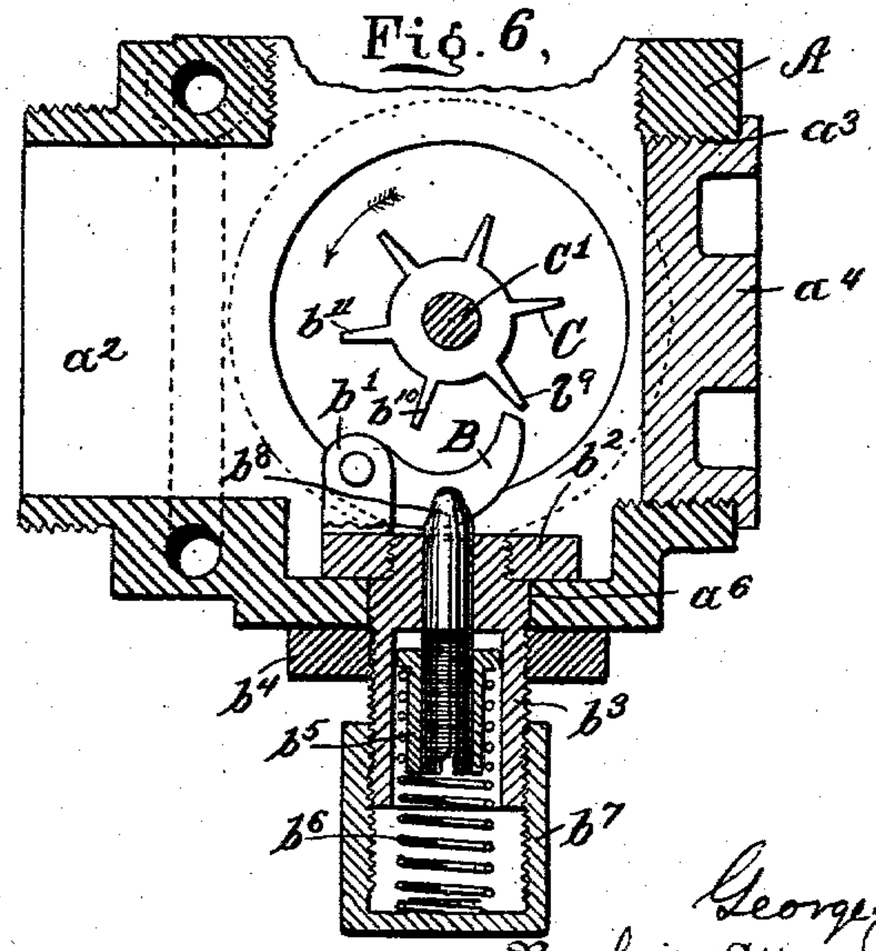


Fig. 6.



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NO MODEL. 3 SHEETS—SHEET 3.

Fig. 7.

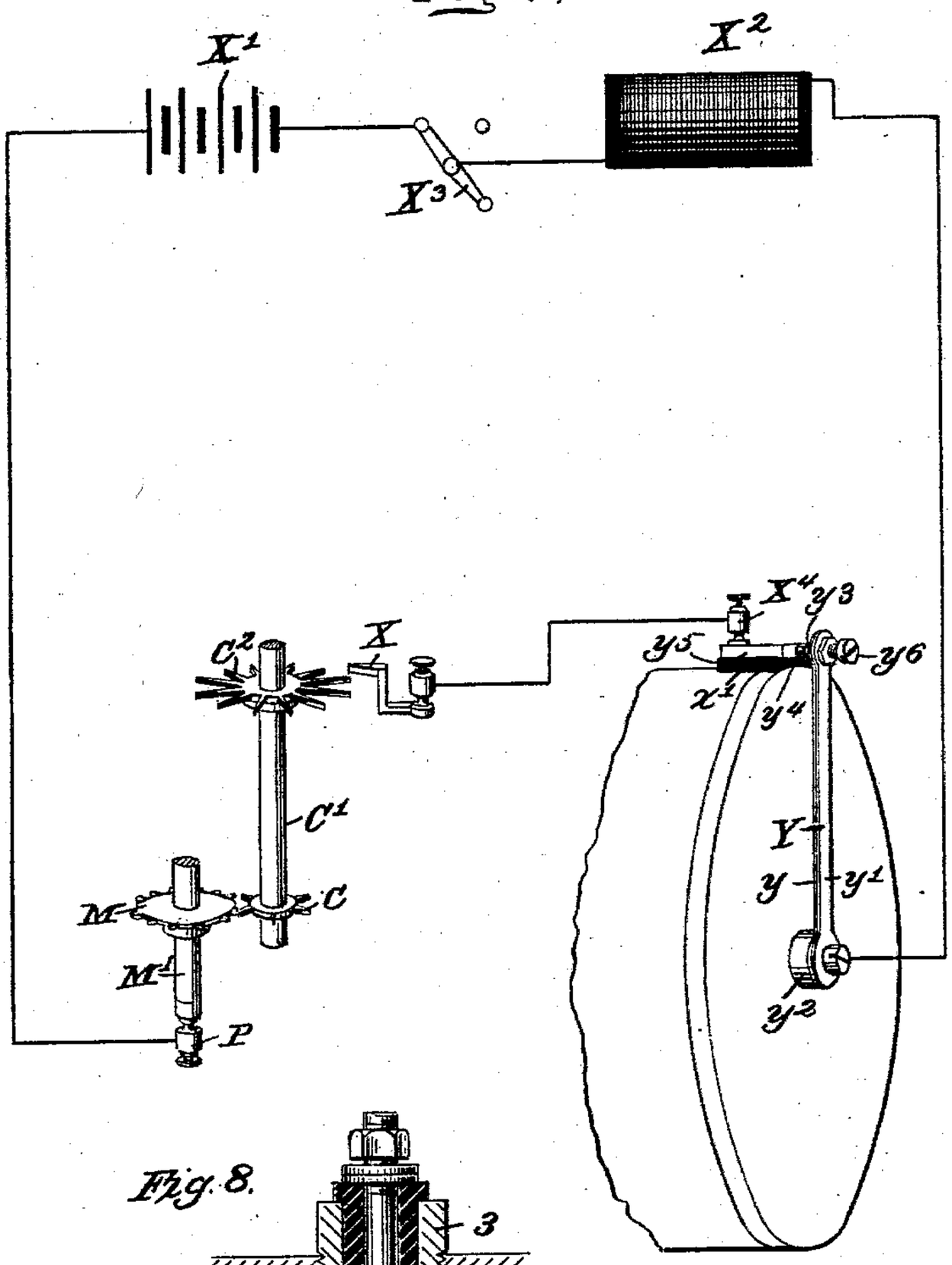
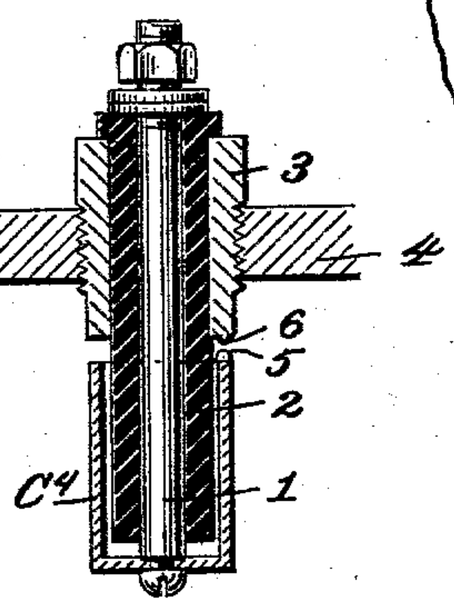


Fig. 8.



Witnesses
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No. 753,511. Patented March 1, 1904.

UNITED STATES PATENT OFFICE.

GEORGE J. MURDOCK, OF NEWARK, NEW JERSEY.

SPARKING DEVICE FOR GAS-ENGINES.

SPECIFICATION forming part of Letters Patent No. 753,511, dated March 1, 1904.

Original application filed February 11, 1903, Serial No. 142,902. Divided and this application filed March 21, 1903. Serial No. 148,982. (No model.)

To all whom it may concern:

Be it known that I, GEORGE J. MURDOCK, a citizen of the United States, residing at Newark, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Sparking Devices for Gas-Engines, of which the following is a specification.

My invention relates to gas-engines of the kind in which an explosive charge is fired by means of electric sparks produced in the combustion-chamber of the engine by making and breaking an electric circuit at proper intervals.

In carrying out my invention I provide the sparking electrodes within the combustion-chamber of the engine with multiple contacts constructed, arranged, and operated in an improved way, one of the electrodes being preferably in the form of a toothed wheel secured to the inner end of a shaft, the outer end of which carries another toothed wheel, which is actuated from the crank-shaft of the engine. In order to prevent short-circuiting across the insulation in the combustion or sparking chamber, I apply to the inner end of the shaft a bell or cup shaped shield, into which the explosive mixture is forced during the first compression stroke of the engine. The mixture within the cup having been burned upon the first explosion of the engine, the products of combustion or inert gases remain within the cup or shield and exclude the explosive mixture of subsequent charges admitted to the engine, and thereby prevent the deposit of carbon upon the surface of the insulation separating the two sides of the spark-circuit within the combustion or sparking chamber. This feature of the invention is not dependent upon the special style of sparking devices or electrodes. The details of construction of the mechanism thus briefly outlined are hereinafter fully explained.

The preferred ways of embodying my improvements are shown in the accompanying drawings, in which—

Figure 1 shows a vertical central section through the combustion-chamber of the engine and through the igniting devices. Fig. 2 shows a vertical central section through the combustion-chamber on the line 2 2 of Fig. 1 with the igniting devices in elevation. Fig. 3 is a detail view, on an enlarged scale, of a sleeve or spool carrying mica disks forming part of the insulation around the toothed-wheel shaft. Fig. 3^a is a view of the lower end of the spool. Fig. 4 is a detail view in section on the line 4 4 of Fig. 2, illustrating the manner in which the outer toothed wheel is operated. Fig. 5 shows a transverse section on the line 5 5 of Fig. 2. Fig. 6 is a view similar to Fig. 5, one of the members of the igniting devices, however, being differently constructed. Fig. 7 is a diagram of the igniter-circuit and illustrates the manner in which a thermostat is employed to open this circuit when the heat of the engine becomes excessive. Fig. 8 is a detail sectional view showing an ordinary form of electric igniter-plug with the bell or shield applied to protect the insulation from deposit of carbon, the sparking occurring at the edge of the bell.

In my application for patent, Serial No. 142,902, filed February 11, 1903, I have shown and described a complete gas-engine capable of performing all the necessary operations, and in that application I have shown and described igniting devices similar to those herein shown, described, and claimed, this application being a division of that before mentioned.

A indicates a casting within which the combustion-chamber is formed, to which latter the explosive mixture is admitted through the opening a in the manner described in my application above referred to. The casting connects with the engine-cylinder through the opening a', and the exhaust takes place through the opening a^2. The opening a^3 in line with the opening a^2 is closed by means of a plug a^4. The sparking or igniting devices are located within the combustion-chamber in line with the passage a', and between the openings a^2 a^3 there is an opening a^5, which may be closed by a plug. This latter opening is also in line with the igniting devices, and access to them may be obtained through said opening.

Referring first to the construction illustrated particularly in Fig. 6, it will be seen that a finger B is pivoted to lugs b', attached to a nut b^2 on the end of a sleeve b^3, which passes

through the opening a^6 on one side of the casting A. This finger is adapted to engage with a toothed wheel C, operated in the manner hereinafter described. It is curved or segmental in outline, and as it wears away and is adjusted inward its inner end will always maintain a proper relation with the toothed wheel C. As the end of the finger wears away a rounded surface is produced by sparks, which will allow the finger to move freely without becoming locked with the toothed wheel C. The sleeve b^3 has an exterior screw-thread and receives a nut b^4, the nuts b^2 and b^4 serving to clamp the sleeve in place on the casting A in the manner illustrated in Fig. 6. Within the sleeve is arranged a sliding block b^5, which is pressed inward by means of a spring b^6, the outer end of which bears against a cap b^7, adjustably attached to the sleeve b^3. This sleeve carries a rod b^8, which extends through the sleeve b^3 and is adapted to slide back and forth therein. The inner end of this rod is bent downward and engages the pivoted finger B. By the arrangement shown when the finger B is moved on its pivot the rod b^8 may be moved outward against the force of the spring b^6 and inward by means of the spring when the latter is released. The finger B constitutes one electrode, which I call the "ground" contact of the igniter-circuit. It will be observed that most of the parts are located outside of the combustion-chamber, the spring and all the adjusting devices being so arranged. The inward movement of the finger is limited by the inward movement of the block b^5, and by adjusting the block on the outer end of the rod b^8 this movement may be regulated. The sleeve b^3 may also be adjusted radially toward and from the toothed wheel C to control the engagement of the finger with said wheel. I may fill the cap b^7 with powdered graphite to lubricate the parts. No packing is required, and yet the connections are all gas-tight. The other electrode is the wheel C, before referred to. This wheel is preferably a star-wheel; but an ordinary toothed wheel will answer the same purpose. It is adapted to be revolved to engage and to break connection at proper times with the finger B, and it is secured to the lower end of a vertical shaft C', which extends up through the top of the casting A and carries at its upper end a toothed wheel C^2, which is operated step-by-step by devices carried by the upper rear end of a lever E, which, as described in my application for patent above mentioned, is operated from the crank-shaft of the engine. The drawings show the wheel C^2 as being provided with twelve teeth, while the wheel C is formed with six teeth. By this arrangement the igniting devices are operated to produce a spark after each two actuations of the wheel C^2, and as a plurality of teeth are employed on the wheel C the life of this wheel is made much longer than would be the case if only one tooth were used.

It is not necessary of course to insulate the ground contact from the frame of the engine; but it is important to provide efficient means for maintaining the insulation of the other electrode. Difficulties have heretofore been encountered, the most serious one of which is short-circuiting across the insulation by deposit of carbon, resulting from the exploded gases. I have devised an efficient remedy for this difficulty and effective devices for preserving the insulation that are applicable to electric igniters generally and not confined in their usefulness to the particular organizations herein disclosed. The opening in the top of the casting A is closed by means of a screw-plug C^3, and to this plug all parts of one member of the igniting devices are attached. The plug C^3 is formed with a sleeve c, which extends down into the combustion-chamber around the shaft C'. Within this sleeve is located insulating material c', preferably consisting of a vertical series of mica disks carried by a metal spool c^2. The spool is flanged at its upper end c^3 and is provided at its lower end with a nut c^4, the disks being held securely between the flange and nut. If desired, a washer $c^\times$ may be interposed between the nut and the mica disks. The nut c^4 is of smaller diameter than the sleeve c, being out of contact therewith, while the disks fit the sleeve closely. The flange c^3 is arranged slightly above the bottom of the recess c^{13} in the upper portion of the plug C^3 and is of less diameter than this recess, so that its edges do not come in contact with the walls thereof. A few of the mica disks at the top of the spool are of larger diameter than the others and rest on the bottom wall of the recess c^{13} and insulate the flange therefrom. In this way the spool is completely insulated from the plug. The shaft C' near its lower end is shouldered at c^{14} and receives a cup, bell, or shield C^4, which is held on the shaft against the shoulder by the wheel C and the nut c^{15}. The cup extends upwardly from the lower end of the shaft and surrounds the sleeve c, leaving an annular space c^5, which becomes filled with spent gases or products of the first explosion that thereafter prevent the admission to the cup of explosive mixture of subsequent charges, thereby preventing deposition of carbon across the insulation between the nut c^4 and sleeve c and rendering impossible short circuit at this point from the shaft C' through the nut c^4 to the sleeve c and thence to the frame of the engine. By using the cup C^4 this deposit of carbon to an injurious extent is entirely prevented, and the cup also acts to prevent to a material extent overheating the insulation. In gasolene-engines especially and to some extent in gas-engines not only does soot gradually accumulate on the electrodes, but small pieces of carbon are from time to time broken

off from the cylinder and explosion-chamber and are carried, together with oil and carbonized oil, to all parts of the explosion tract. The arrangement of the cup is such that these small pieces of carbon are prevented from lodging on the electrode. It will be observed that the cup opens outward—*i. e.*, away from the combustion-chamber. Its lower end facing the combustion-chamber is closed, and its upper edge is close to the wall of the chamber, and as the cup revolves any pieces of carbon that might tend to lodge on it are shaken off.

The recessed upper end of the plug C^3 is filled with asbestos c^{16}, held in place by a gland C^5, above which is located a recessed washer c^8, insulated from another washer c^9 above it, upon which bears a spring c^{10}, surrounding the shaft C′ and bearing against the under side of a collar c^{11} thereon. This spring tends to force the shaft upward, thus avoiding any contact or packing at the lower end of the cylinder, where it would be subject to heat, and also providing sufficient friction to prevent the wheel C^2 from turning or moving except when positively moved by the lever E. The upper end of the shaft C′ is connected with a frame F, attached to the plug C^3; but the shaft is insulated from the frame F in the manner indicated at f^2. It will be observed that the asbestos c^{16} extends up through the gland and also through the washer c^8, thus surrounding the shaft C′ and completely insulating it from the gland, as well as from the washer. This precise arrangement, however, is not essential, as the insulation is maintained properly by reason of the fact that the shaft cannot make contact with the gland, as it passes through a comparatively large opening therein, and the washer is held concentric on the gland by the boss on the upper end of the latter, which fits a corresponding recess in the bottom of the washer. The asbestos, therefore, primarily serves as a packing to prevent products of combustion from being forced out along the shaft. The shaft C′ is bored axially, as indicated at *f*, the passage in the shaft extending downward in the manner indicated to permit lubricating material to be carried to the point where it is needed. The top of the passage *f* is closed by a bolt *f*′.

The lever E is formed with a slot G, in which is adjustably mounted a block G′, of insulating material. This block may be adjusted by means of a thumb-screw G^2, and the amount of adjustment to obtain the required lead may be read by means of an index G^3. To this block is attached a pawl X, adapted to engage with the wheel C^2 in the manner indicated in Fig. 4. As described in my beforementioned application, the rear end of the lever E is given a back-and-forth and up-and-down movement, resulting in an elliptical movement which gives to the pawl X an elliptical movement, (indicated by dotted lines *x* in Fig. 1.) As the rear end of the lever E is moved backward it also rises, thus clearing the teeth of the wheel C^2; but as the lever E moves forward it also moves downward and engages the teeth of the wheel C^2 and turns this wheel and correspondingly moves the wheel C within the combustion-chamber. The arrangement is such that a quick break is given at the electrodes, as the peripheral speed of the wheel C is made the same as that of the engine-shaft, and two impulses must be given to the wheel C^2 before the wheel C can be operated to break the circuit and produce a spark within the combustion-chamber.

The electric circuit of the igniting devices is indicated in Fig. 7. The battery X′ is connected on one side with a switch X^3, which latter is connected with a sparking coil X^2, in turn connected through a thermostat Y with a binding-post X^4, which is electrically connected with the pawl X. The other pole of the battery may be connected to ground. In the diagram it is shown as being connected by wire with binding-post P of the ground contact M. The pawl X makes contact with the wheel C^2 and through the wheel C^2, shaft C′, and wheel C electrical connection is made with the ground contact. While the pawl X engages each tooth of the wheel C^2, the electric circuit is made and broken every other time that the pawl and wheel thus engage, because the wheel C has only half as many teeth as the wheel C^2. The arrangement is such that no sparking occurs at the wheel C^2, because when the pawl X breaks connection with the wheel C^2 the circuit is open at the wheel C and contact B or M. In Fig. 6 the end of the contact B is shown as being arranged between two of the teeth of the wheel C, having just passed the tooth b^9 and produced a spark. When the wheel C^2 is moved one step by the action of the pawl X on one of its teeth, the wheel C will be moved until the next tooth b^{10} is brought close to the end of the contact B, but not into connection with it. The next movement given to the wheel C^2 by the pawl X will cause the wheel C to move in such manner as to cause the contact B to wipe across the tooth b^{10}, producing a spark and then assuming a position between the tooth b^{10} and the tooth b^{11} similar to the relative position of the teeth and contact shown in Fig. 6. The other teeth on the wheel C operate in connection with the contact B in a similar way. It will now be understood that the circuit is both made and broken between the electrodes B and C, while the pawl X is engaged with the wheel C^2 and that every other time that the pawl X engages the wheel C^2 the circuit is broken at the electrodes. It will also be understood that the electrode C is normally disconnected from the battery and is only connected therewith during the time that the pawl X engages the wheel C^2, at which time the wheel C is in engagement with the grounded electrode.

Accidents sometimes occur in gas-engines by reason of the fact that the circulation of water is stopped when the engineer forgets to turn on the water or the water falls below the proper level in the stand-pipe. When this occurs, the excessive heat causes the oil to carbonize and the piston to cut the cylinder. To guard against accidents of this kind, I employ a thermostat which is adapted to open and close the circuit of the igniter and stop the engine by suspending the operation of the igniting devices when the heat of the engine rises to a predetermined degree. The thermostat Y is attached to the rear end of the cylinder. It may be of any suitable construction, but preferably consists of two strips y y' of dissimilar metal, such as brass and soft steel. The brass strip is preferably placed next to the cylinder, as the brass expands more than the steel. Both strips are attached to a plug y^2, secured to the cylinder, and the upper ends of the strips carry a contact-point y^3, coöperating with a contact-point y^4 on the base y^5 of the binding-post X^4, which latter is insulated from the engine by means of a block of insulating material x'. The sensitiveness of the thermostat may be regulated by a set-screw y^6, and by this device the thermostat may be set to operate—that is, to break the circuit when any desired degree of heat has been reached. Normally the circuit is closed through the thermostat; but when excessive heat occurs the upper end of the thermostat will tip outward, and thus break the circuit at the contacts y^3 y^4, and therefore the operation of the igniting devices will be suspended, and as no explosion occurs the engine will come to rest and will remain at rest until the circulation of water has commenced again and the heat of the cylinder falls to the predetermined degree.

Instead of employing a contact-finger B in connection with the star-wheel I prefer to employ a ground-contact in the form of a toothed wheel M. By so doing multiple contacts are afforded on both members of the igniting devices and no adjustment is required. This modification is shown in Figs. 2 and 5. The wheel M is secured to a shaft M′, which extends through a vertical opening in the casting A. At its upper end the shaft M′ is formed with a flange or collar m', against the outside of which bears a spring N, arranged within a cap N′, which engages a threaded boss n of the casting. The lower end of the shaft enters a socket in a screw-plug O, removably secured in a threaded socket in the bottom of the casting A, and at its outer end carrying a binding-post P, to which a ground-wire may be connected. The spring N exerts a yielding pressure on the shaft M′, holding the wheel M in proper vertical position, but preventing it from turning except when positively actuated by the star-wheel C. This wheel M may be connected to the shaft M′ by a feather-and-groove connection. The shaft M′ may be removed by withdrawing the cap N′, while the wheel may be taken out through the opening a^5. In other respects the construction of the apparatus shown in Figs. 2 and 5 is similar to that shown in Figs. 1 and 6. In the special construction shown the wheel M has seventeen teeth and the wheel C has six. In Fig. 5 the two members C and M are so related that the teeth o on the star-wheel has just broken connection with the tooth m on the wheel M, thereby producing a spark. The next movement given to the wheel C^2 will cause the tooth o' on the wheel C to move almost into contact with the tooth m' on the wheel M, while the next movement of the wheel C^2 will cause the tooth o' to make contact with the tooth m', thereby completing the circuit, and as the two wheels revolve together the teeth o' and m' will separate, thus breaking the circuit, with a resulting spark. It will be observed that when the pawl X first engages the wheel C^2 (the parts being arranged as shown in Fig. 5) the circuit is not closed by the first movement given to the wheel C^2. When the pawl next engages the wheel C^2, the circuit is still open; but as the wheel is turned by the pawl during this second engagement the circuit is both made and broken at the electrodes C and M, so that when the pawl leaves the wheel C^2 no sparking occurs.

I have described two modifications of my invention; but the mechanism may be still further modified without departing from the novel features involved in the constructions illustrated. The igniting devices instead of being applied to an outside or supplemental combustion-chamber, as shown, may be applied to the rear end of a cylinder, as is sometimes done, and the devices for automatically stopping the engine by opening the igniting-circuit may be applied to explosive-engines of various types.

Fig. 8 shows an ordinary igniter-plug, combining an electrode or terminal 1, surrounded by insulation 2, contained in a plug 3, screwing into the wall 4. The cup, bell, or shield C^4 is attached to electrode 1 and extends around the insulation 2. As shown, sparking is designed to occur between a projection 5 on the edge of the cup and one, 6, on the end of plug 3. The igniter-circuit may be arranged, equipped, and broken in any usual or suitable way.

I claim as my invention—

1. The combination of combustion-chamber, two electrodes therein, electrical connections therefor, and means for giving a step-by-step movement to one of said electrodes and for causing it to both make and break the circuit during each alternate movement only.

2. The combination of a combustion-chamber, a battery, an electrode within the combus-

tion-chamber connected to battery, another electrode within said chamber normally disconnected from battery, and means for giving a step-by-step movement to said last-mentioned electrode to cause it to both make and break the circuit during each alternate movement only.

3. The combination of a combustion-chamber, a battery, an electrode within the combustion-chamber connected to battery, a toothed wheel within the combustion-chamber normally disconnected from battery and adapted to engage said first-mentioned electrode, a shaft to which said wheel is connected, another toothed wheel outside the combustion-chamber carried by said shaft and having a larger number of teeth than the wheel within the combustion-chamber, and devices engaging said outer wheel while the circuit is broken at the electrodes, and which causes the toothed electrode to both make and break the circuit during a single impulse.

4. The combination of a combustion-chamber, a grounded electrode therein, a toothed wheel within the combustion-chamber adapted to engage the grounded electrode, a shaft to which said wheel is connected, another toothed wheel outside the combustion-chamber carried by the shaft and having a larger number of teeth than the wheel within the combustion-chamber, and means for actuating the outer wheel which is in engagement therewith while the circuit is being made and broken at the inner wheel, and which separates therefrom while the circuit is broken at said inner wheel.

5. The combination of a combustion-chamber, a rotary toothed electrode therein, a toothed wheel engaging said electrode, and means for operating said wheel.

6. The combination with a combustion-chamber, of a rotary toothed electrode therein, a toothed wheel engaging said rotary electrode, electrical connections for said wheel, and means for giving a step-by-step movement to the star-wheel to cause its teeth to engage those of the said first-mentioned electrode.

7. The combination with a combustion-chamber, of a rotary toothed grounded electrode therein, a toothed wheel within the combustion-chamber having formed thereon a less number of teeth than are formed on said grounded electrode, electrical connections for the wheel, and means for giving a step-by-step movement to the wheel to cause its teeth to engage the teeth of the grounded electrode and to break connection therewith at proper intervals.

8. In an electric igniter for internal-combustion engines the combination with an igniter terminal or electrode and its insulation, of a rotary gas holder or cup adapted to retain inert products of combustion and thereby protect the insulation from deposition of carbon from subsequent explosions.

9. The combination of a combustion-chamber, an electrode therein, a shaft to which it is attached, insulating material surrounding the shaft, and a cup or bell carried by the shaft within the combustion-chamber rotating therewith and surrounding such insulation.

10. The combination of the combustion-chamber, an electrode within it, a shaft to which the electrode is attached, insulating material surrounding the shaft, and a cup or bell closed at its end facing the combustion-chamber and surrounding the insulation but open near the wall of the combustion-chamber and having a space within it to receive and confine gases.

11. The combination of the combustion-chamber, an electrode within it, a rotary shaft to which it is connected, and with which it revolves, a plug through which the shaft passes, insulating material interposed between the shaft and the plug, and a cup or bell within the combustion-chamber surrounding the shaft and insulation, and which is closed at its end facing the combustion-chamber, but is open at its end close to a wall of the combustion-chamber.

12. The combination of a combustion-chamber, an electrode within it, a shaft to which the electrode is secured, a plug through which the shaft passes, and which is formed with an inwardly-projecting sleeve, insulating material contained in the sleeve, and a cup or bell surrounding the sleeve, but leaving a space around the sleeve within the bell to receive gases.

13. The combination of a combustion-chamber, an electrode within it, a rod or shaft to which the electrode is attached, insulating material interposed between the rod and the casing of the combustion-chamber, and a cup or bell secured to and rotating with said shaft and surrounding the insulating material, but leaving a space around the insulation to receive gases.

14. The combination of the combustion-chamber, an electrode therein, a rotary shaft to which the electrode is attached, a stationary frame or bracket against which the outer end of the shaft bears, and a spring for pressing the shaft outward against the bracket.

15. The combination of a combustion-chamber, a toothed wheel therein, a shaft to which it is secured, an outer toothed wheel, a pawl engaging therewith, an operating-lever for said pawl, and an adjustable block of insulating material to which said pawl is attached and which is carried by said lever.

In testimony whereof I have hereunto subscribed my name.

GEORGE J. MURDOCK.

Witnesses:
KATHARINE MACMAHON,
A. M. PARKINS.