(No Model.)

2 Sheets—Sheet 1.

E. D. DEBOUTTEVILLE & L. P. C. MALANDIN.

STARTING GEAR FOR GAS ENGINES.

No. 411,644. Patented Sept. 24, 1889.

Fig. 1.

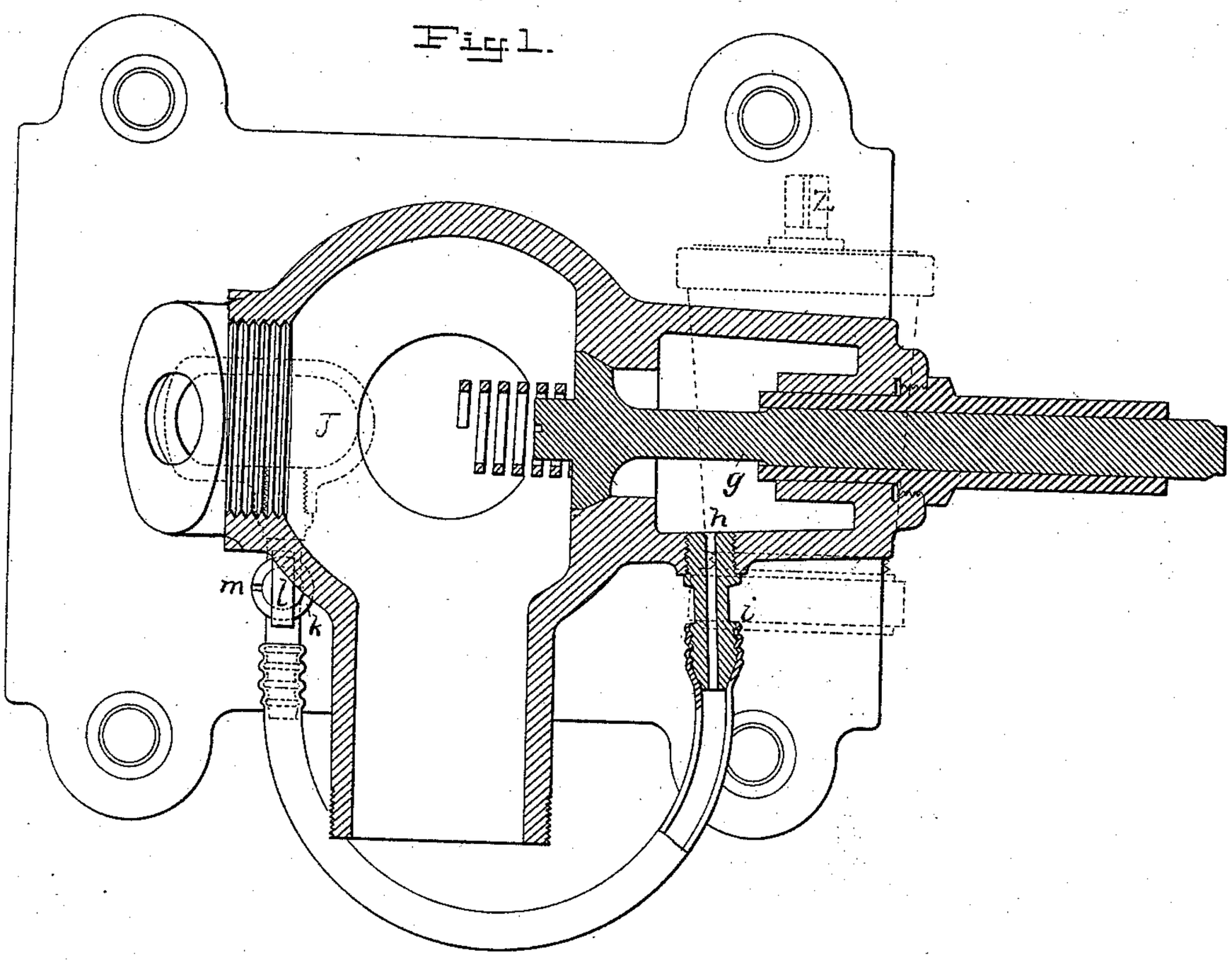


Fig. 2.

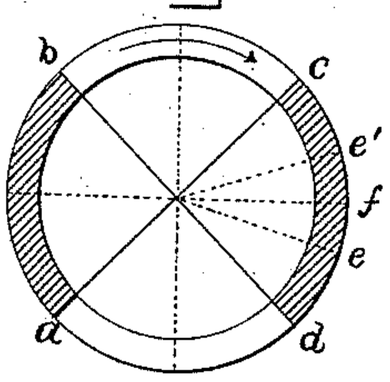


Fig. 3.

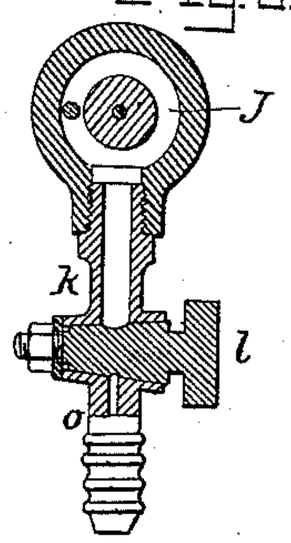


Fig. 4.

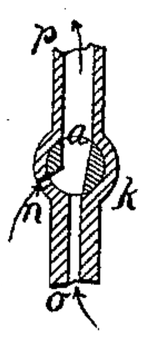
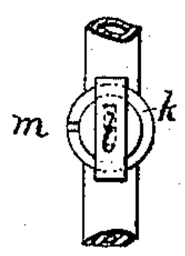


Fig. 5.



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(No Model.) 2 Sheets—Sheet 2.

E. D. DEBOUTTEVILLE & L. P. C. MALANDIN.

STARTING GEAR FOR GAS ENGINES.

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Fig. 9.

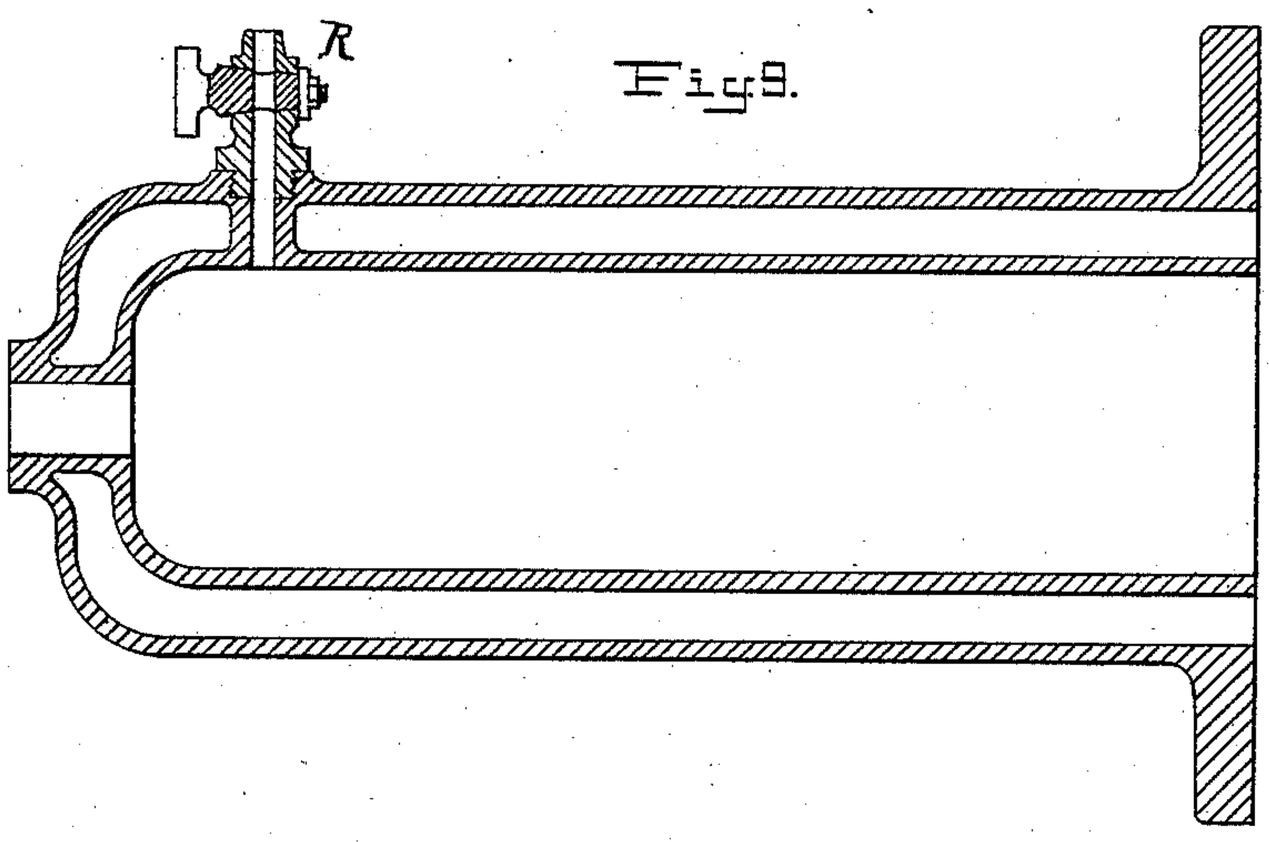

Fig. 8.

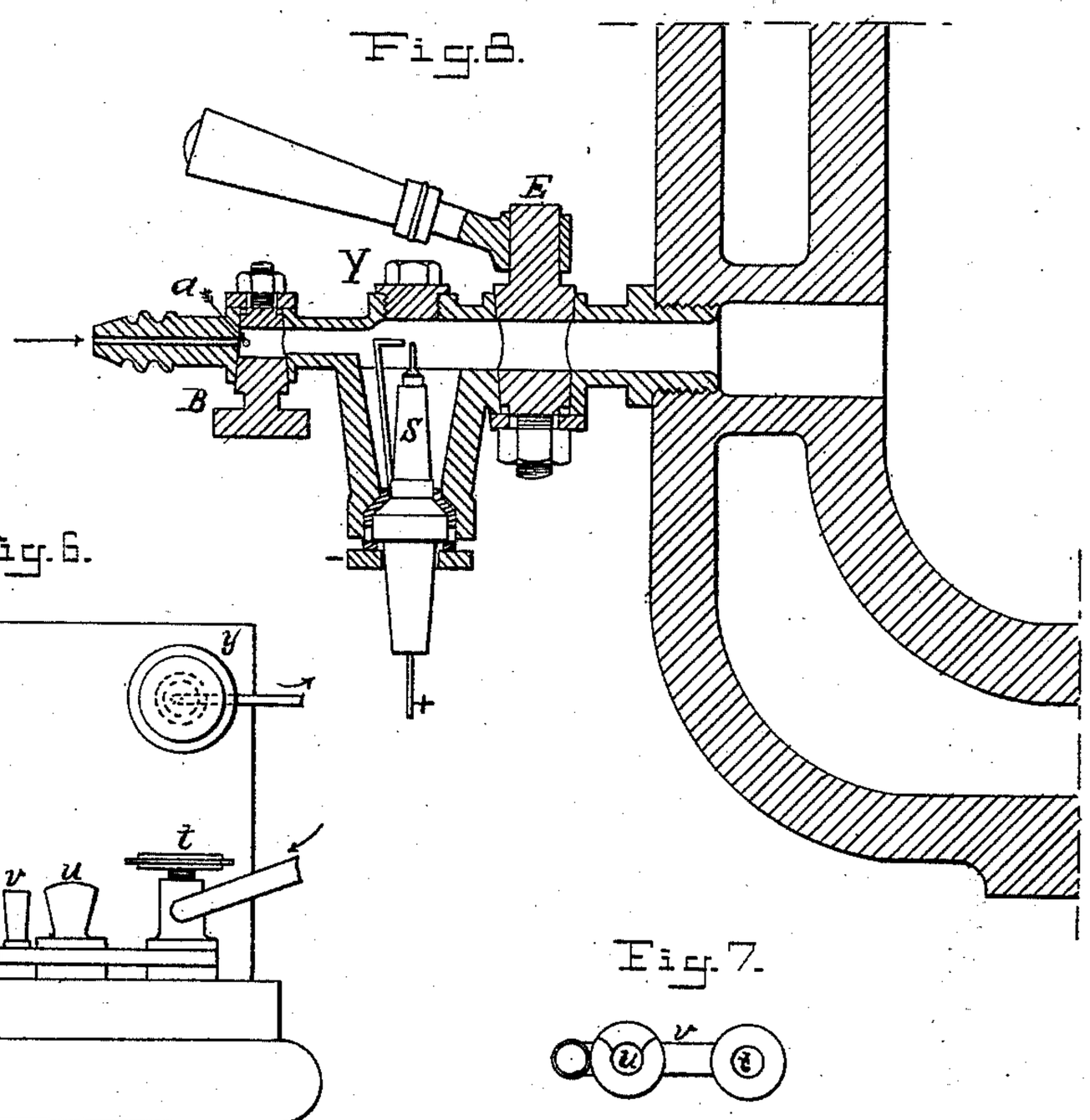

Fig. 6.

Fig. 7.

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UNITED STATES PATENT OFFICE.

EDOUARD DELAMARE DEBOUTTEVILLE AND LÉON PAUL CHARLES MALANDIN, OF FONTAINE-LE-BOURG, FRANCE.

STARTING-GEAR FOR GAS-ENGINES.

SPECIFICATION forming part of Letters Patent No. 411,644, dated September 24, 1889.

Application filed February 4, 1889. Serial No. 298,661. (No model.) Patented in France January 16, 1888, No. 188,161; in Italy February 18, 1888, No. 23,061; in England February 24, 1888, No. 2,805; in Spain May 18, 1888, No. 7,946, and in Belgium August 24, 1888, No. 83,003.

To all whom it may concern:

Be it known that we, EDOUARD DELAMARE DEBOUTTEVILLE, engineer, and LÉON PAUL CHARLES MALANDIN, mechanician, residing at Fontaine-le-Bourg, canton de Clères, (Seine-Inférieure,) in the Republic of France, have invented Improvements in Starting-Gear for Gas-Engines, (for which we have obtained Letters Patent in France, No. 188,161, January 16, 1888; Italy, No. 23,061, February 18, 1888; Great Britain, No. 2,805, February 24, 1888; Spain, No. 7,946, May 18, 1888; Belgium, No. 83,003, August 24, 1888,) of which the following is a specification.

The difficulty heretofore experienced in starting gas-engines, especially those of considerable power, has proved a serious obstacle to the general use of these engines in practice. Many special methods have been proposed with a view to facilitating the starting of the engines, but have not been found to work satisfactorily.

The present invention has for its object a new system of starting-gear applicable to gas-engines. This starting-gear is illustrated in the figures on the annexed drawings, the same letters of reference indicating corresponding parts in all the figures.

Figure 1 of the accompanying drawings is an elevation partly in section, illustrating starting-gear arranged according to this invention and suitable for a motor of twenty-five horse-power, working with poor gas, for example. This view shows the admission-valve box and gas-chamber *g*. It also represents in dotted lines an ignitor J, which is connected with the gas-box *g* by a three-way cock *k*, connected to a branch *h* by means of a rubber tube *i*. Fig. 2 is a diagram illustrating the four periods or cycles of the engine, with the division for the explosion period, special starting division. Fig. 3 is an elevation of the three-way cock *k*, fitted onto the chamber of the ignitor *j*, which is shown in section in this figure with the two insulated conducting-wires. The cock *k*, which should be as perpendicular as possible, should not exceed an angle of twenty degrees to work well. Fig. 4 shows the cock *k* in section. Fig. 5 is a view, in elevation, of the said cock. Fig. 6 is an end view, in elevation, of the induction or transformer coil. Fig. 7 is a plan of a commutator or switch arrangement. Fig. 8 is a view of my improved starting-gear as independently applied to any gas-motor. Fig. 9 represents the working-cylinder provided with a cock.

The motor being at rest, the fly-wheel is turned by hand so as to bring the connecting-rod to the dead-point forward—that is to say, to the point *c*, Fig. 2. This point is where the explosion takes place when the engine is running. The strength of one man is enough to turn the fly-wheel for the one or two necessary revolutions if the motor does not exceed twenty-five horse-power. For a motor exceeding this a winch or other suitable gear may be employed to turn the fly-wheel. When the connecting-rod is at the dead-point *c*, a gas-cock Z, placed on the valve-box *g*, Fig. 1, is opened in the ordinary position for starting. Then the three-way cock *k* is opened as indicated in Figs. 1, 3, 4, and 5. The fly-wheel then is turned so as to bring the connecting-rod a little beyond the angle of ninety degrees—*i. e.*, approximately to the point *e*. The fly-wheel must be turned slowly in order to give the gaseous mixture time to fill the cylinder. The gas entering at *o*, Figs. 3 and 4, mixes thoroughly with the air entering at *n* and penetrates to the ignition-chamber, and passes on into the working-cylinder of the motor. It must be understood that during this time the vibration of the hammer or contact-maker of the coil is stopped, so that the spark cannot pass between the two ends of the platinum wire. The three-way cock *k* is now shut, a small stop *m* preventing the key *l* from turning through more than a quarter-turn. The fly-wheel is then turned backward to bring the connecting-rod in a position corresponding with the point *e'*, a little in front of the position *f*, Fig. 2. This is done in order to slightly compress the mixture in the cylinder, thus facilitating ignition and giving a longer stroke to the connecting-rod at

starting, and a more effective action. The connecting-rod being at *e'*, a spark is caused pass, as hereinafter explained. The mixture is thus exploded, and the piston is driven forward with such energy as to impart to the fly-wheel the velocity necessary to start the motor.

I will now describe the starting of the hammer or contact-maker of the induction-coil when the proper time has arrived for igniting the explosive mixture. In ordinary coils the terminals *s* and *t*, Fig. 6, receive the wires coming from the battery, and the upper terminals *x y* carry the wires which conduct the current to the ignitor. In the new arrangement this is likewise the case; but the terminal *s* only is connected to one of the poles of the coil, the terminal *t* being insulated and an auxiliary terminal *u* introduced in its place, being connected to the other pole of the coil, Figs. 6 and 7. The vibrating hammer or contact-maker having been previously regulated to vibrate immediately on the passage of the two currents of the battery, this current is interrupted by means of a contact-maker *v*, which opens the circuit. Then, when the proper moment has arrived for igniting, it is simply necessary to set this contact-maker *v* on the terminal *u*. The current of the battery is then transmitted to the second pole of the coil, and the hammer or contact-maker commences to vibrate, establishing the electric current which produces the spark in the ignitor. This simple methed of starting is equally applicable to motors worked by town gas or poor gas or petroleum-vapor, or, in fact, to any motor worked with explosive gas.

The system of starting hereinbefore described can also be applied to gas-motors whose explosion is produced by a gas-jet and, in general, to all descriptions of gas-motors. This application is illustrated in Fig. 8 of the drawings, a four-cycle motor being selected for the sake of illustration. In this particular case the starting is effected as follows: The apparatus is screwed to the cylinder of the motor or to one of the sides of the compression-chamber. The gas-inlet is put in communication with the admission-cock of the gas, as hereinbefore described. The stop-cock E and a three-way cock B, corresponding to the cock marked *k* in Figs. 3 and 4, are opened. The fly-wheel is turned, as hereinbefore described, to draw in and compress the explosive mixture. Then the cock B is shut and the spark caused to pass in the terminal *s*. The explosion then takes place, the piston is driven forward, and the fly-wheel acquires sufficient velocity to enable the following cycle to take place. The starting being thus effected, the cock E is shut immediately after the ignition. It must be understood that in the first instance the parts must be placed in the positions for starting the engine in the ordinary way. A stopper Y enables the points of the platinum wires in the ignitor to be adjusted without removing the terminal *s*. As a single electric spark suffices for the explosion in this special case, it is possible so to arrange the coil that the spark is only produced between the platinum points for the short period of time sufficient for igniting the gaseous mixture.

It is evident that the construction of the parts hereinbefore described with reference to the accompanying drawings may be modified in various ways without departing from the principle of the invention.

In order to start the engine without the exertion necessary to draw in the gaseous mixture by hand during a certain part of the stroke and to partially compress this mixture, we fix on the upper part of the cylinder a cock R, placed over the compression-chamber, as indicated in Fig. 9 of the drawings. The system works on the same principle; but the connecting-rod must be at the point *f*, Fig. 2—that is to say, at ninety degrees—for starting the motor at any moment. This position is obtained when the motor is stationary either by suitably manipulating the cock R or by means of a winch or gear acting on the fly-wheel until the required position is obtained. The starting is then effected as follows: The cock R and the cock *l*, Fig. 3, are put wide open, and the cock Z, Fig. 1, is then put in the starting position. The incombustible gases in the interior of the cylinder escape into the open air through the cock R, being expelled by the force with which the gaseous mixture enters through the cock *l*.

What actually takes place is this: The gas entering under pressure through the hole *o*, Fig. 4, draws with it, at *a p*, atmospheric air entering at *n*. The cylinder is then quickly cleared of the inert gases which it contained and is filled with an explosive mixture at atmospheric pressure. The cocks R and *l* are then closed and the spark is caused to pass, as hereinbefore set forth. The motor is set in motion by this force, and the power stored up in the fly-wheel is sufficient to insure the starting of the largest engines.

We claim as our invention—

1. The combination of a gas-engine and an ignition-chamber with a connecting-pipe leading from the gas-supply to the ignition-chamber, the said pipe having a three-way cock, one way opening to an air-supply passage, as and for the purposes set forth.

2. The combination of a gas-engine and an ignition-chamber, with a connecting-pipe having a three-way cock opening also to an air-supply passage, and an electric igniting device, substantially as described, and for the purpose specified.

3. The combination of a starting-gear for gas-engines, consisting of an ignition-chamber and a connecting-pipe having a three-way cock with an electric igniting device, and a

circuit-opener or switch in the circuit of the induction-coil, as and for the purposes specified.

4. A starting-gear for gas-engines, consisting of a three-way cock, air and gas supplies communicating therewith, an ignitor, and a stop-cock between the ignitor and the cylinder, substantially as set forth.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

EDOUARD DELAMARE DEBOUTTEVILLE.
LÉON PAUL CHARLES MALANDIN.

Witnesses:
ADRIEN MAZE,
LÉON MAZE.