

(No Model.)

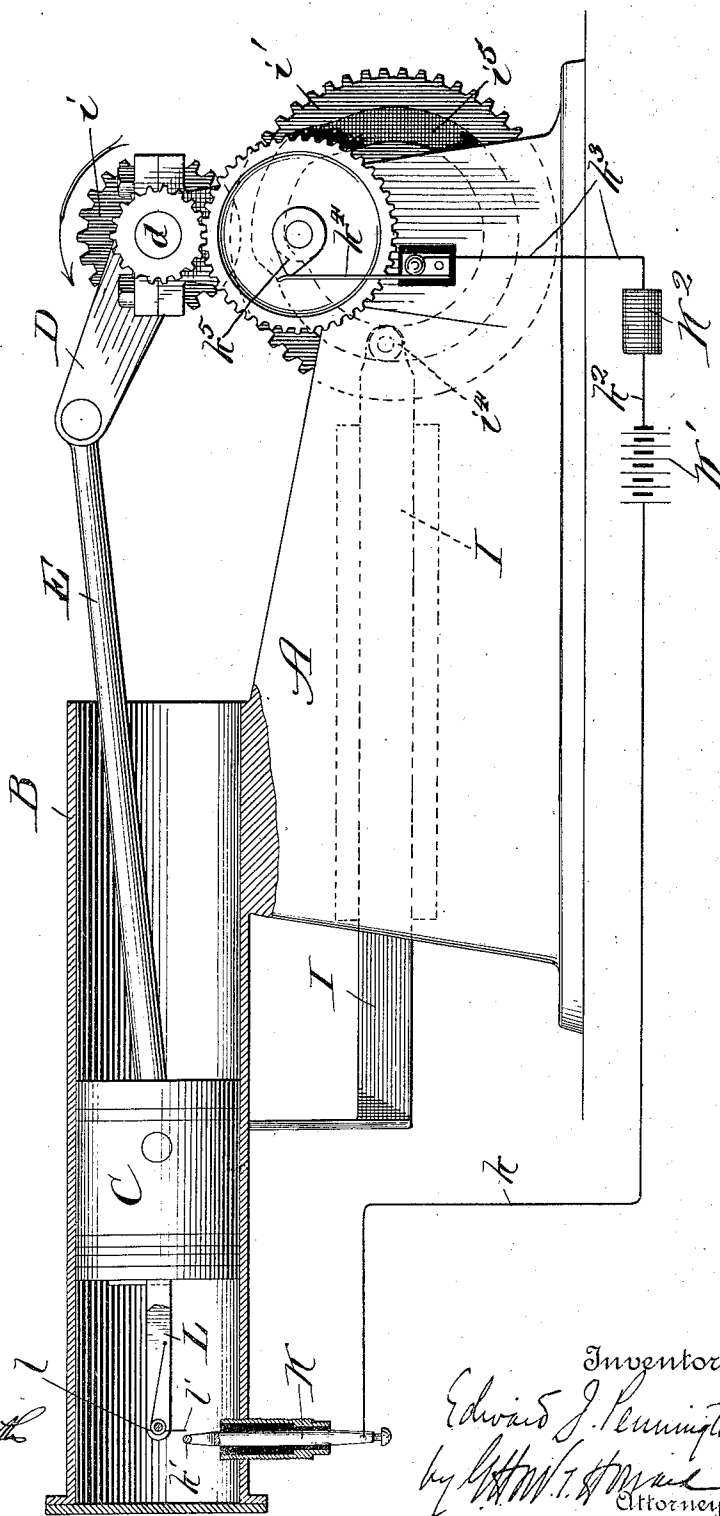
2 Sheets—Sheet 1.

E. J. PENNINGTON.
IGNITER FOR EXPLOSIVE ENGINES.

No. 586,511.

Patented July 13, 1897.

Fig. 1.



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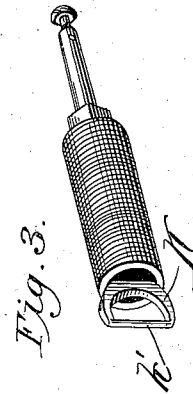
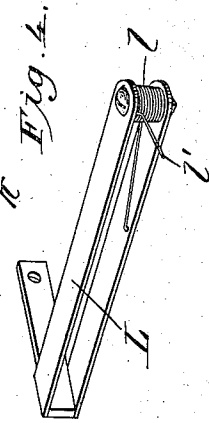
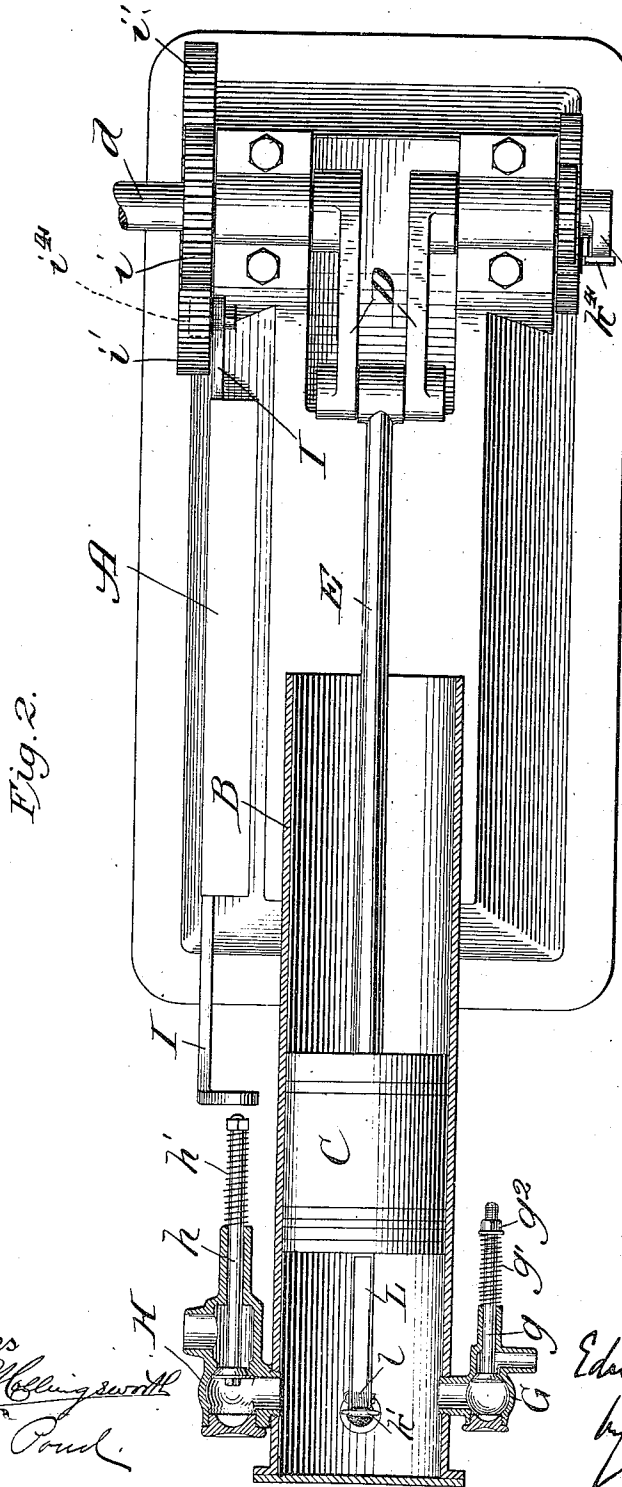
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UNITED STATES PATENT OFFICE.

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IGNITER FOR EXPLOSIVE-ENGINES.

SPECIFICATION forming part of Letters Patent No. 586,511, dated July 13, 1897.

Application filed May 13, 1895. Serial No. 549,039. (No model.)

To all whom it may concern:

Be it known that I, EDWARD J. PENNINGTON, a citizen of the United States, residing at Racine, in the county of Racine and State of Wisconsin, have invented certain new and useful Improvements in Explosion-Engines, of which the following is a specification.

This invention relates especially to that class of engines in which the useful work is to be effected by the explosion of a mixture of combustible fluid and air at the back of a reciprocating piston, and particularly to that class of engines in which hydrocarbon oils are used for the purpose of enriching a certain amount of air to make an explosive mixture.

The object of my invention is to provide a simple, economical, and efficient gas or explosion engine adapted to vaporize the hydrocarbon liquid, perfect the mixture of the gases and air and the volatilization of the explosive mixture within the cylinder, so as to cool the cylinder after each explosion of the mixed vapor and air, thus increasing the efficiency of the engine and economy of construction; and the invention consists in the features and combinations hereinafter described and claimed.

In the accompanying drawings, Figure 1 is a longitudinal sectional view of so much of an engine as is necessary to show the adaptation of my improvement; Fig. 2, a horizontal sectional plan, and Figs. 3 and 4 details hereinafter described.

In describing my improvement it will be understood that I illustrate only one form of an engine to which it may be applied, and that the engine may, by slight mechanical changes, be adapted and attached to all kinds of wheeled vehicles, boats, and stationary engines without departing from the spirit of my invention, it being understood that the invention is here claimed for all purposes to which it may be found applicable.

In the ordinary type of gas or explosive engines the gas or explosive mixture is either partially or wholly formed outside of the cylinder, various forms of carbureters, vaporizers, and volatilizers being used for that purpose, so that when the explosive mixture is admitted to the chamber a single ignition,

produced either by a flame, heated tube, or electric spark, explodes the mixture and drives the piston so as to operate an engine. The successive explosions of the gas act to heat the cylinders so rapidly and keep the same heated that very soon the efficiency of the engine is impaired and it cannot be used. To obviate this objection, various expedients have been resorted to, such as cooling the cylinder with a stream of water or water-jacketing the same to keep the cylinder at an average temperature and thus obtain a fairly-average result.

Another great objection to the present type of engines is that in excessively cold weather as the explosive mixture is admitted to the cylinder it does not volatilize with sufficient rapidity to be exploded by the firing device. To overcome this objection, the cylinder has been heated primarily or operated by outside means until sufficient heat has been stored in the cylinder-jacket to complete the volatilization of the explosive mixture, so that it can be exploded to actuate the engine.

The difficulties incident to the use of hydrocarbons in explosive-engines will probably be more thoroughly appreciated and understood when it is known that, first, hydrocarbons vaporize more readily in warm weather than in cold; second, the liquids used for carbureting air are not homogeneous, so that the lighter constituents vaporize or volatilize first, leaving a heavier and less volatile residuum which is only consumed after the explosion takes place and then imperfectly; third, the amount of vapor taken up by the air depends on the length of time the liquids are left in the same chamber, and, fourth, where carbureters are used the chief difficulty arises from the fact that the volatilization is materially affected by the intense cold produced by the evaporation of the liquid.

My present improvements are intended to obviate the above objections and to provide a simple, economical, and efficient explosion-engine whereby the cylinder combines and becomes, as it were, its own vaporizer, carbureter, and volatilizer, so that the cylinder is alternately cooled and heated by the action and

reaction taking place therein, thereby dispensing with all extraneous cooling devices. Further, by constructing and arranging the firing device as hereinafter described the mixing and perfect volatilization of the explosive mixture is provided for in the cylinder just before the final compression of the gases, and it is exploded after they have attained their final compression.

A represents the engine-frame, or so much of it as is necessary to be shown for the present purpose.

B is the cylinder, which may be made of thin steel, if desired, although any suitable material may be employed and the cylinder thickened. The cylinder is applied to or mounted upon the frame in the drawings in a horizontal position, though it may be mounted in a vertical or in inclined position.

The cylinder, as is usual in explosion-engines, is closed at one end and open at the other, and is provided with a reciprocating piston C, movably mounted therein. The piston C is connected with the crank D of the crank-shaft *d* by means of the connecting-rod E, which projects out of the cylinder, so that the reciprocating movements of the piston serve to impart the usual rotary motion to the crank-shaft.

In Fig. 2 I have shown the inlet-valve G, which is preferably, for the sake of clearly illustrating the same, shown at the side of the cylinder, though it is usual to place the same at an inclined position and near the top, so that hydrocarbon may be dropped into the valve, to be sucked in as hereinafter described. This valve may be made of any usual form, though I have shown it in the drawings as provided with a valve and stem *g*, kept normally closed by means of the helical coiled spring *g'*, which is inserted between the body of the valve and a screw-collar *g²* at the outer end of the stem. This coiled spring is of sufficient strength to keep the valve normally closed; but when a vacuum or partial vacuum is created in the cylinder by the movements of the reciprocating piston the valve is opened automatically and the desired quantity of carbon and atmospheric air drawn in to form an explosive mixture. The cylinder is also provided with an exhaust-valve H, preferably located in the drawings, for the sake of clearness, on the opposite side of the cylinder; but it will be understood that it may be located in any desired position. This valve is shown as made of substantially the same general structure as the inlet-valve, and its stem *h* is kept normally closed by means of a coiled spring *h'*. A sliding tappet I is arranged to one side of the engine-frame and adapted to be actuated from the crank-shaft by means of the gearing *i i'* at each alternate stroke of the engine, so as to mechanically open such valve at the desired time during the backward stroke of the engine and permit the consumed gases and products of combustion to escape. This sliding tappet is

provided with a roller *i⁴*, which enters a cam-recess *i⁵* of one of the gears to operate the slide at the desired time and for the desired purpose. This structure, however, is merely shown and described for the purpose of showing how the exhaust-valve may be opened mechanically, and I do not desire to be understood as limiting myself thereto, as such structures are well known in the art and made of various styles and kinds, the attachment of which to an engine would involve merely mechanical skill. The spiral spring *h'* in this valve is made of such strength that the valve is kept closed at all times and can only be opened by extra force above atmospheric pressure.

To volatilize the hydrocarbons and perfect the enrichment of the air and afterward to explode the same, I preferably arrange a rigid electrode K in the cylinder portion and near one end or about one-eighth of the movement of the crank from the final ending of the backward stroke of the piston. This electrode is preferably insulated from the engine-frame and connected by means of a wire *k* with the battery K'. To the inner end of the reciprocating piston I attach a second electrode L, which is in this instance a flexible or what I term an "elastic" electrode. During the desired backward stroke of the piston a primary spark is formed which perfects the volatilization of the hydrocarbons and the admixture of the air therewith, so that during the succeeding forward stroke of the piston a secondary spark is formed which explodes the mixture and drives the engine.

In Fig. 3 the rigid electrode K is shown enlarged and detached, the inner end, as at *k'*, being preferably made in the form of a yoke; but I do not desire to be limited to this particular form, as it may be varied to suit different circumstances and conditions. The flexible electrode is preferably made in the form of a bridge L and holds in place the coiled-spring portion *L'*. (Particularly shown in Fig. 4.) One end of the electrode, as at *L'*, projects therefrom so as to contact the rigid electrode on the cylinder during the reciprocations of the piston. This coiled-spring electrode, or, as I term it, "elastic" electrode, is made of sufficient length or of a sufficient number of coils to allow it to stretch out and recoil at each contact with the rigid electrode, or, more properly speaking, to be coiled and uncoiled at each contact, thus rendering the tempering or hardening of such electrode unnecessary. The advantage of this structure of electrode is that it is always adapted to make a flexible and uniform contact with the rigid electrode. Further, by being made elastic the speed of contact is uniform and independent of the speed of the piston, thus producing at all times what is known as a "long" spark, the reason being that the free edge of the elastic electrode is held by the edge of the rigid electrode until the limit of tension of the coiled portion is reached, when the free end is

snapped over rapidly and uniformly, whether the speed of the piston be fast or slow.

In ordinary spring or flexible contacts the flexible electrode, especially where it is located within the cylinder and exposed to the heated gases, rapidly parts with its temper and sooner or later becomes "set" and inefficient to perform the results desired. The rigid electrode is described as being attached to the cylinder at or near its closed end and the elastic electrode is attached to the reciprocating piston. It will be understood, however, that these parts may be reversed. The principal result, however, which should be obtained is that the electrodes should be so constructed and arranged, one on the cylinder and the other on the reciprocating piston, that the flexible electrode is snapped over and forms what I term a "primary" spark just before the ending of the backward or before the explosive mixture attains its greatest compression, and is snapped back after the cylinder has started on its forward motion and forms a "secondary" or explosive spark just after the mixture has attained its greatest compression, the advantages of which will be hereinafter more fully set forth.

While I prefer to arrange the electrodes as illustrated and described, I do not desire to be confined strictly thereto, as it may be found that in adapting it to various circumstances and conditions the same result is obtained by locating and arranging the electrodes so that a primary spark is formed at any time previous to final compression of the gases and the secondary or explosive spark formed any time after such final compression.

The other pole of the battery is connected by means of the wire k^2 preferably with a sparking-coil K^2 and by means of the wire k^3 connected with a brush k^4 , adapted to contact the cam k^5 at each alternate stroke of the engine to close the electric circuit with the engine-frame and piston and thereby permit the electrodes, as they contact with each other, to form the desired spark. This kind of structure, however, is well known in the art, and I merely show it to illustrate one form, though I do not desire to be limited thereto, as any kind of a mechanical circuit maker and breaker may be attached to the engine to alternately open and close the electric circuit independent of the electrodes at the desired time.

In operation the crank or fly wheel is first operated by hand, so that the piston will partake of its first forward movement. During this forward movement the mechanical circuit-breaker keeps the electric circuit broken and prevents the electrodes as they pass and contact from the formation of a spark. This forward movement of the piston creates a vacuum in the cylinder, so that atmospheric pressure tends to automatically open the inlet-valve and admit hydrocarbon and air in explosive proportions, which are immediately partially vaporized and volatilized. The

backward motion of the reciprocating piston tends to compress this vaporized explosive mixture, and as now the electric circuit is closed the electrodes, coming into contact with each other just previous to the greatest compression of the explosive mixture, form a primary spark which perfects the volatilization of the hydrocarbon and accomplishes what might be termed the "complete enrichment" of the air. The motion of the piston continuing to the end of the rearward stroke, it immediately returns in its forward motion, and the electrodes, again contacting, form a secondary or explosive spark and actuate the engine. The forward motion of the piston being energized by the exploded mixture, the piston again returns in its backward motion, and opening the exhaust-valve mechanically the products of combustion are forced out into the open air. The electric circuit being broken by a proper circuit-connector, the engine completes its backward motion and starts its return motion, when the inlet-valve opens automatically and admits a fresh supply of hydrocarbon oils and air in the proper proportions. These elements, mixing immediately, partially vaporize during the forward motion of the piston. The piston returning and a primary electric spark being formed, as the piston nears the limit of its backward motion, just before the mixture reaches its greatest compression, it perfects the volatilization of such mixture. During such volatilization the cylinder is cooled, due to the cold produced by the complete evaporation of the liquid hydrocarbons which takes place in the cylinder. On the piston returning to another forward stroke and immediately after the final compression of the mixture the secondary or explosive spark is formed and the mixture exploded and the engine reenergized. These actions and reactions take place as long as it desired to run the engine and as long as the proper supply of oils or gas and electric current or fire is furnished.

While I have described my invention with more or less minuteness and as being embodied in precise forms, I do not desire to be limited thereto unduly any more than is pointed out in the claims. On the contrary, I contemplate all proper changes in form, construction, and arrangement, the omission of parts, and substitution of equivalents, as circumstances may suggest or necessity render expedient; and while I have given my theory of the actions and reactions which take place in the cylinder I only advance such actions and reactions as theories and do not desire to be limited thereby, for it may be found that other actions and reactions take place differing radically from what I have set forth, so I do not desire to be in any way limited or bound by my statements regarding actions.

I claim—

1. In an explosion-engine, the combination of a frame portion provided with a cylinder, a reciprocating piston moving in such cylin-

der, a rigid electrode on one of such portions—the cylinder or reciprocating piston—an elastic electrode formed of a helically-coiled spring on the other portion with its free end arranged to contact the rigid electrode and be snapped thereby during the reciprocation of the piston, substantially as described.

2. In an explosion-engine, the combination of a frame portion provided with a cylinder, a reciprocating piston movably mounted therein, an electrode on such cylinder portion and an electrode on the reciprocating piston, both of such electrodes so constructed and arranged that when in an electric circuit they form a primary spark previous to the ending of the backward movement of the piston, and a secondary spark after the piston has begun its forward motion, substantially as described.

3. In an explosion-engine, the combination of a cylinder portion, a reciprocating piston mounted therein, a rigid electrode on such cylinder portion and an elastic electrode on the piston portion, both of such electrodes being so arranged when in electric circuit that a primary electric spark is formed previous to the ending of the backward stroke of the piston, and a secondary spark is formed after the piston has begun its forward motion, substantially as described.

4. In an explosion-engine, the combination of a cylinder portion, a reciprocating piston mounted therein, a rigid electrode mounted in such cylinder portion, and an elastic helically-coiled electrode mounted on such piston portion, both of such electrodes being so arranged that when an electric circuit is formed a primary spark is formed just previous to

the end of the backward motion of the piston, and a secondary electric spark is formed immediately after the piston has begun its forward motion, substantially as described.

5. In an explosion-engine, the combination of a cylinder, a reciprocating piston mounted therein, a rigid yoke electrode mounted in the cylinder portion, a supporting-bridge mounted on the piston portion, and an elastic helically-coiled-spring electrode on such supporting-bridge portion arranged in connection with the rigid electrode to form an electric spark just previous to the ending of the backward motion of the piston, and a secondary electric spark immediately after the piston has begun its forward motion, substantially as described.

6. In an explosion-engine, the combination of a frame portion provided with a cylinder, a piston movably mounted therein, and two electrodes arranged to contact with each other during the movements of the piston and form a primary spark previous to final compression of the mixture of gases and air, and a secondary exploding spark after such final compression, substantially as described.

7. In an explosion-engine, the combination of a cylinder, a reciprocating piston moving in such cylinder, a rigid electrode on one of the above-named parts, an elastic electrode on the other part with its free end arranged to contact the rigid electrode and be snapped thereby during the movements of the piston, substantially as described.

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