(No Model.) 3 Sheets—Sheet 1.

S. M. MILLER.

GAS ENGINE.

No. 553,352. Patented Jan. 21, 1896.

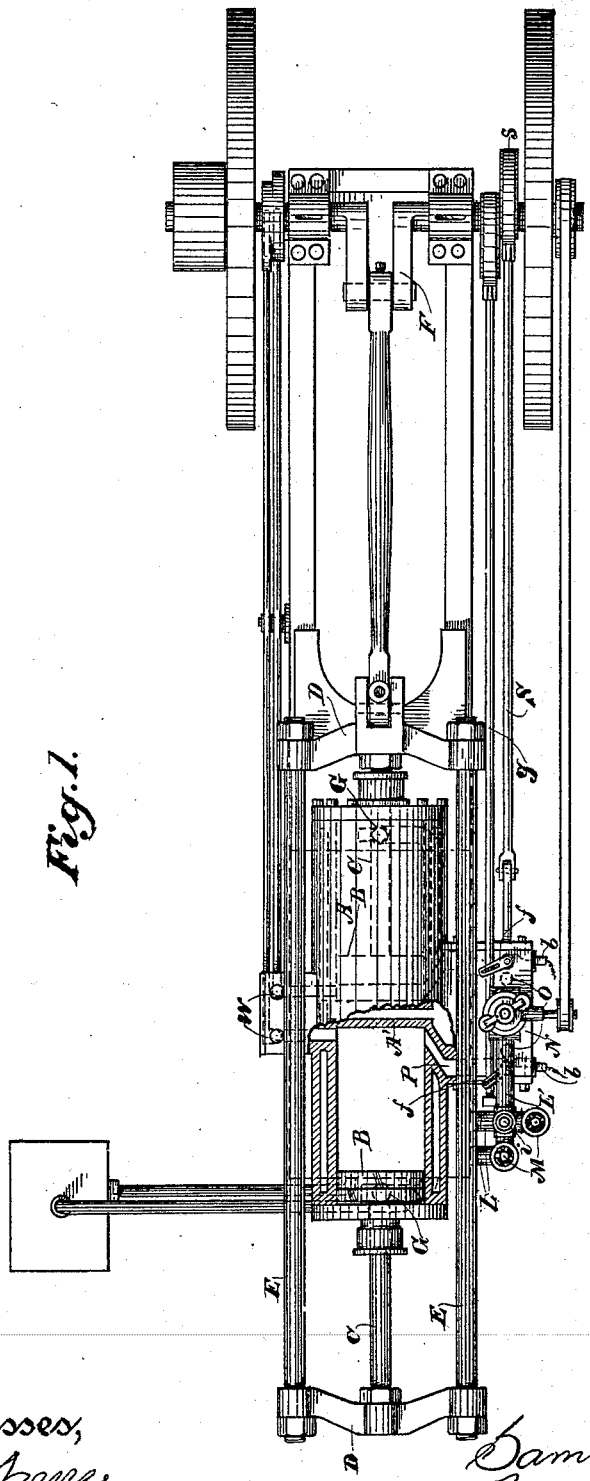

Fig. 1.

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Fig. 2.

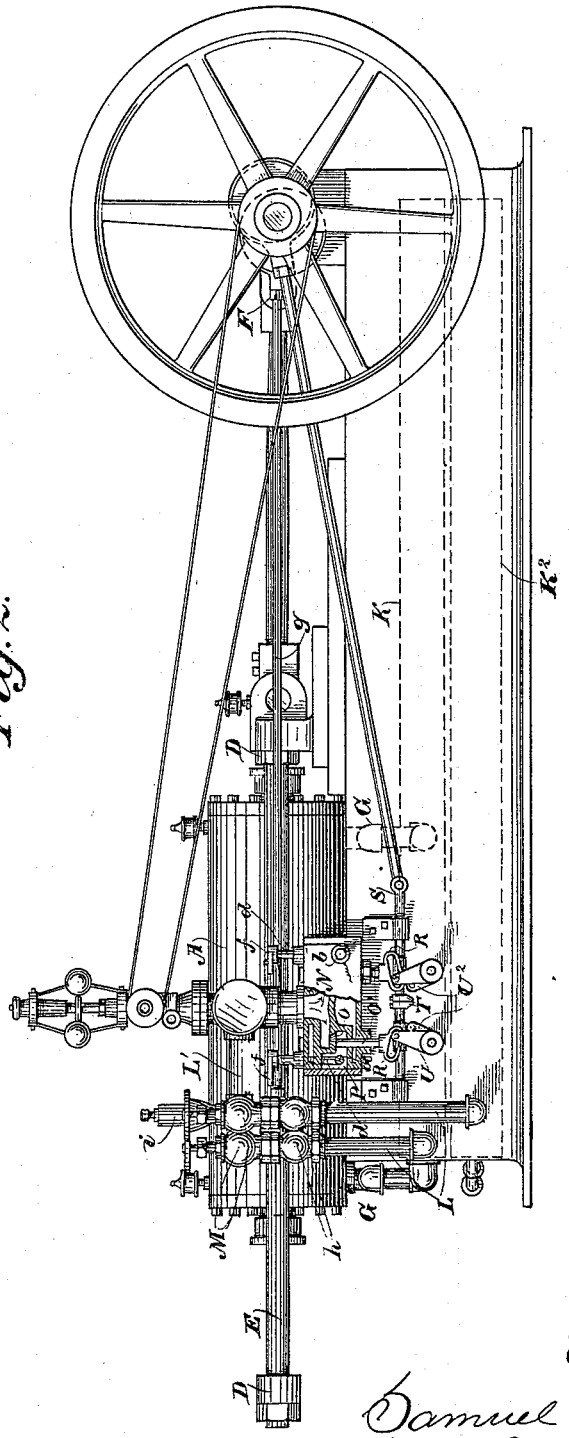

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Fig. 3.

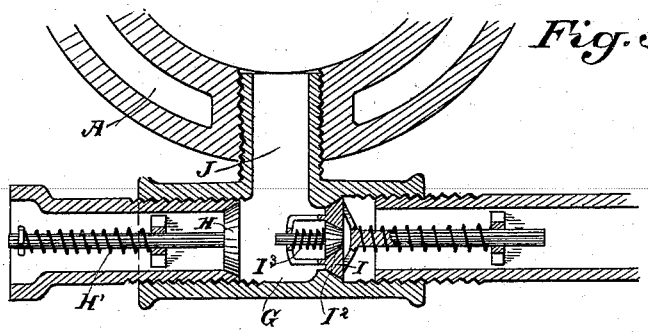


Fig. 4.

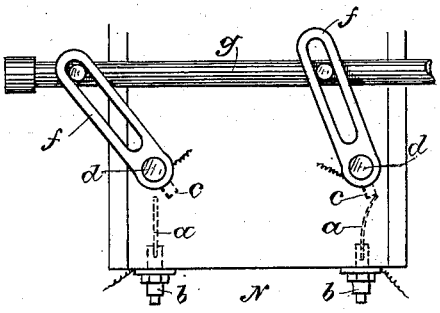


Fig. 5.

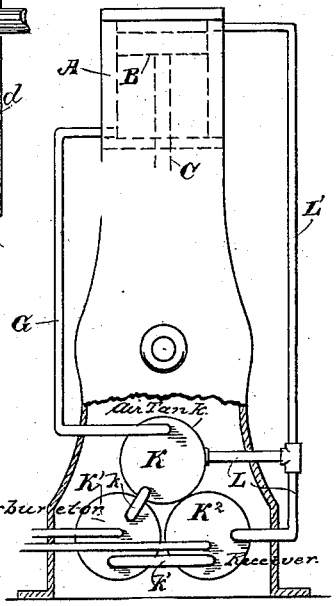


Fig. 6.

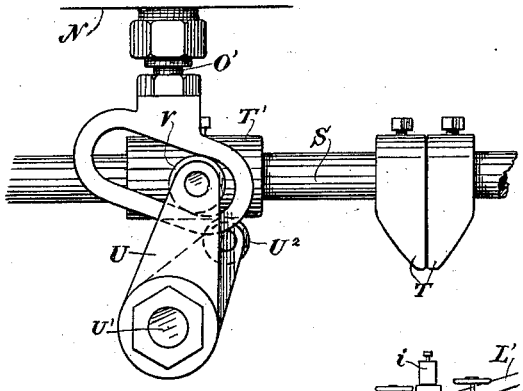
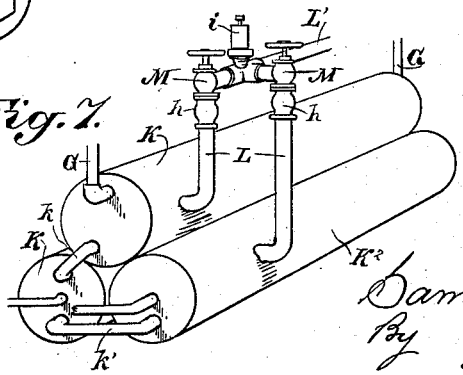


Fig. 7.



Witnesses,
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Inventor,
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UNITED STATES PATENT OFFICE.

SAMUEL M. MILLER, OF STOCKTON, CALIFORNIA, ASSIGNOR TO KROYER, MAYES & JACKSON, OF SAME PLACE.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 553,352, dated January 21, 1896.

Application filed June 7, 1895. Serial No. 552,025. (No model.)

To all whom it may concern:

Be it known that I, SAMUEL M. MILLER, a citizen of the United States, residing at Stockton, San Joaquin county, State of California, have invented an Improvement in Gas-Engines; and I hereby declare the following to be a full, clear, and exact description of the same.

My invention relates to improvements in gas-engines.

It consists in a novel means for supplying an explosive mixture to the engine-cylinder, and in certain details of construction which will be more fully explained by reference to the accompanying drawings, in which—

Figure 1, Sheet 1, is a plan view of the engine. Fig. 2, Sheet 2, is a side elevation with partial section of valve-chamber. Fig. 3, Sheet 3, is a sectional elevation of air-inlet-valve connections. Fig. 4 is an enlarged view of part of igniting device. Fig. 5 is a view showing a single-cylinder engine. Fig. 6 is an enlarged view of valve-actuating mechanism. Fig. 7 is a perspective view of the air-reservoir and generator.

The object of my invention is to provide such improvements in engines of this class as will produce more frequent and regular explosions and more even impulses from the engine to the parts propelled thereby.

A is the cylinder of my engine, made single if desired, as in Fig. 5, or of sufficient length to allow of the use of two pistons B B and a central diaphragm or head A′, which divides the cylinder in two separate and distinct parts, as in Fig. 1. The cylinders are shown in the present case closed at both ends, so that the piston and one end of the cylinder act as a pump to supply air and provide an explosive mixture under pressure in an independent reservoir, while the said mixture is admitted to the opposite side of the piston to act first by direct pressure and then with an explosive action; but the compressing-pump may also be made separate and driven directly from the main engine with the same result.

When the engine is made double each piston B has a piston-rod C extending outwardly through suitable stuffing-boxes in the opposite heads of the cylinder, and these rods are connected with cross-heads D, which in turn are united by side rods E, so that the pistons reciprocate simultaneously, one piston moving outwardly from the center while the other is moving toward the center.

The cross-head D nearest to the crank-shaft is connected with a slide moving upon suitable guides to preserve a parallel motion, and this slide is connected by the usual rod with the crank F upon the crank-shaft of the engine.

In connection with the engine-cylinder is a vaporizer or carburetor and receiver, into which air is pumped by the engine-piston itself, or by a pump driven thereby, so that the air becomes impregnated with the gasoline or other hydrocarbon vapor to such an extent as to become explosive, and at the same time is compressed sufficiently to allow it to be introduced directly into the cylinder on the opposite side of the piston by the opening of a suitable valve, so that it can be exploded and an impulse communicated to the piston without the usual compression of the vapor or gas in the working end of the cylinder by the movement of the piston itself. This may be caried out in various ways. If a single-cylinder engine is employed, as shown in Fig. 5, the air is drawn into one end of the cylinder through a suitable valve and is then forced by the return of the piston into the carburetor, from which the explosive mixture is returned under sufficient pressure to the opposite end of the cylinder, and when the piston has reached the proper point to receive the impulse the mixture is exploded. In addition to the explosive action I am also enabled to utilize the pressure of the gas when first introduced, so that the engine may be started from any point before the middle of the stroke without depending entirely upon the explosive action. While in motion each impulse of the piston is commenced by the pressure of the explosive mixture when admitted and is completed by its explosion.

In Fig. 1 I have, as before stated, shown two independent cylinders in line with each other, so that they operate alternately.

Various forms of valve mechanism may be employed. In the present case I have shown a valve-chamber G in the form of a T having one end provided with an air-inlet valve H

and the opposite end with a valve I, through which the air is forced into the carburetor and receiver, as will be hereinafter explained. The intermediate tube J of the T opens directly into the cylinder, so that when the piston B moves away from the outer head of the cylinder the valve H will be opened by atmospheric pressure and the air drawn into the cylinder. A spring H′ of sufficient tension causes the valve H to close as soon as the atmospheric pressure is removed or sufficiently reduced, and the valve is then closed. Upon the return of the piston B the valve I will be opened against the pressure upon the opposite side and the air will be delivered through a suitable conducting-pipe into the air-reservoir or carburetor. In the present case I have shown this apparatus as comprising three cylinders K, K′ and K², but any suitable or well known form of carburetor and reservoir may be used which is capable of resisting pressure. The air from the engine-cylinder is first forced into the cylinder K, and in the present case, where two engine-cylinders are shown, it is obvious that each piston B will alternately force air into this receiving-cylinder. From the cylinder K air passes through suitable connecting-pipes *k* to the generator K′, which contains any suitable hydrocarbon for the purpose, and any suitable arrangement of carburetor or mixture, such as are well known in the art and which I do not especially describe here. Other pipes *k*′ connect this carburetor with the receiver K², into which the vapor flows freely.

L L are pipes by which the chambers K and and K² are connected, with suitable regulating cocks at M by which the communication between the two may be regulated to any desired extent. From these pipes L another pipe L′ leads through a governor mechanism to the valve-chamber N, and when the valves within the chamber N are opened the explosive vapor is allowed to pass into each of the engine-cylinders alternately between the pistons and the central head or diaphragm.

In the present case I have shown a conical or poppet valve O through which vapor is admitted from the valve-chamber through a suitable passage P into the cylinder. This valve has a stem O′, and to the lower end of the valve-stem is fixed a rigid inclined open link R. Each of the cylinders is provided with a valve of this description, and each of the valve-stems has a link R, as shown.

S is a slide-rod reciprocating in suitable guides adjacent to the links, and this rod is actuated by an eccentric or cam *s* properly set upon the crank-shaft and connected with the slide-rod by an eccentric-rod, as shown. Upon this slide-rod are fixed collars T.

U U are rocker-arms turning upon fulcrum-shafts U′ at one end, the other ends having rollers V which are adapted to travel inside of the links or yokes R.

The operation will then be as follows: Whenever the collar T, moving with its rod S, strikes the rocker-arm U², a projection from it, or a rocker-arm U fixed upon the same shaft U′, it causes the latter to move about its fulcrum-point U′, and the roller V will move up the incline of the yoke R, thus allowing the valve O to be forced away from its seat and allow a charge of gas to enter the inner end of the engine-cylinder when the piston is at the proper position to receive an impulse. The eccentric is so set with relation to the crank that the operation of the valve will admit the gas or vapor into the cylinder ready for ignition, approximately just after the crank has passed the center and the piston has begun its return stroke. The condensation of gas and vapor in the receiver is to such a degree that when admitted into the engine-cylinder by the opening of the valve it will first act upon the piston to move it by direct pressure, and after the piston has moved a certain determined distance and the desired quantity of gas has been admitted the valve is closed and the charge is ignited, thus propelling the piston the remainder of its stroke with increased power.

The compression of the explosive mixture may be varied to suit conditions, size of engine, &c. I do not desire to limit myself in this particular.

An important feature of this operation is the application of the power directly to the piston through which the air is compressed into the carburetor. As soon as the movement of the eccentric carries the collar T back out of contact with the rocker-arm U², the pressure of a second collar T′ upon the arm U² moves the rocker-arm U back again, and the inclination of the link or yoke R is such that the roller V will immediately travel down the incline and thus force the valve up and hold it closed against its seat until again opened in the same manner.

In order to maintain a regular pressure within the air-reservoir, and not to exceed a certain pressure, it is necessary to employ a relief-valve. This relief-valve is shown in the present case in the form of a conical valve I², which has its seat in the valve I through which the air passes from the cylinder to the reservoir. The valve I² is normally closed by a spring I³ of a tension equal to the desired pressure in the reservoir. Whenever this pressure is exceeded it will be manifest that the valve I² will be opened whenever the piston B recedes from that end of the cylinder, and instead of drawing air in through the valve H a portion of the air within the reservoir may escape through the valve I² into the cylinder, or if the pressure is very nearly maintained a portion of the air to fill the cylinder would be drawn through this relief-valve I² and the remainder through the valve H. The operation is automatic and keeps the pressure constant within the reservoir.

The exhaust-valves W of the engines are located near the inner ends of the cylinders,

and are actuated by a cam driven from the main crank-shaft, with suitable connecting rods and mechanism whereby the valves are alternately opened when the pistons are returning toward the center, to allow the waste products to escape.

In order to ignite the charge of gas, I prefer to use an electric spark. One of the electrodes, *a*, enters the ignition-chamber through a suitable insulator *b*, which enters the ignition-chamber, and the other electrode, *c*, is oscillated therein so that at the proper time the contact is made between the electrodes *a* and *c*. The electrode *a* may be made elastic or yielding, so that the contact will be sufficiently complete without undue pressure upon an unyielding point.

In order to oscillate the shafts *d* and the electrode *c*, I have shown crank or rocker-arms *f* fixed to the ends of the shafts *d*, exterior to the ignition-chambers, and these are actuated by a rod *g* connected with an eccentric or eccentrics upon the main shaft, so set with relation to the crank as to form contact and produce a spark to ignite the charge of gas when the piston and crank are in the proper position to be impelled by the explosion.

In order to prevent accident from what is sometimes known as "back-firing," I have shown the pipes through which the air and vapor pass provided with check-valves *h*, which close in such a way as to prevent any return of flame through these valves. The valve O will ordinarily close sufficiently to prevent any difficulty of this sort, but in case of accident, delay, or leakage, these supplemental check-valves cut off any connection with the cylinder, and any excess of pressure that may take place in the pipes or passages by reason of ignition therein will be allowed to escape through a suitable valve at *i* opening to the atmosphere.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a gas engine, independent cylinders in line axially, having pistons adapted to reciprocate therein, cross-heads and side rods whereby the piston-rods are united so that the pistons move simultaneously in their respective cylinders, valve-controlled passages through which air is admitted to the outer ends of the cylinders when the pistons are moving inwardly, and exit valves and passages through which the air is delivered, and a carburetor and receiver into which the air is forced under pressure, alternately from each cylinder.

2. In a gas engine, the combination, of two cylinders, closed at both ends, standing in line with each other, having pistons reciprocating therein, and connected with a crank shaft, air inlet and outlet passages and valves connecting with the cylinders whereby the cylinders act alternately to pump air, a carburetor and receiver, a passage leading from the receiver to the valve chamber and passages from the valve chamber to the cylinders, valves controlling said passages and an automatic relief valve connected with the outlet passages from the cylinders whereby the pressure within the receiver is regulated.

3. In a gas engine, independent cylinders in line axially having pistons adapted to reciprocate therein, and connected together, and with a crank shaft so that the pistons move simultaneously in their respective cylinders, air inlet and outlet passages and valves connecting with the outer ends of the cylinders whereby the pistons act alternately to pump air, a carburetor and receiver into which the air is forced under pressure, a passage leading from said receiver to a valve chamber, passages from the valve chamber to the inner ends of the cylinders, valves controlling said passages and a mechanism connected with the crank shaft whereby said valves are alternately opened to admit air to the respective cylinders.

4. In a gas engine, a cylinder closed at both ends, a piston reciprocating therein and connected with a crank shaft, air inlet and outlet passages, and valves connecting with one end of the cylinder whereby the piston acts to pump air, a carburetor and receiver into which said air is forced under pressure, a passage leading from said receiver to the opposite end of the cylinder, and a valve controlling said passage, an inclined yoke fixed to the valve stem, a rocker arm engaging said yoke and a slide rod actuated by an eccentric upon the main crank shaft whereby the valve is opened periodically to admit the gas under pressure to the cylinder behind the piston.

5. In a gas engine, independent cylinders in line axially having pistons adapted to reciprocate therein and connected together, and with a crank shaft so that the pistons move simultaneously in their respective cylinders, air inlet and outlet passages and valves connecting with one end of the cylinders whereby the pistons act alternately to pump air, a carburetor and receiver consisting of independent chambers into one of which the air is first received, pipes connecting the two whereby the air passes through the hydrocarbon contained in the second cylinder, a vapor chamber connecting with both the air and carbureting chambers, and pipes extending therefrom to the valve chamber of the engine whereby the mixed air and vapor are delivered therethrough into the engine cylinder by the opening of the valve.

6. In a gas engine, two cylinders closed at both ends, standing in line with each other, having pistons reciprocating therein and connected with the crank shaft, air inlet and outlet valves and passages connecting with one end of the cylinders, a carburetor and receiver with which the outlet passage connects whereby air is pumped into said carburetor and receiver by the reciprocation of the pistons, a valve chamber and valve mov-

able therein, and passages connecting the same with the receiver and with the opposite end of the engine cylinder, means for periodically opening the valve to admit the explosive gas into the cylinder under pressure, means for igniting the charge after it has been so admitted and a device to prevent back firing, consisting of supplemental check valves in the air and vapor pipes, and an escape or relief valve through which the pressure resulting from such explosion can escape.

7. In a gas engine, a cylinder closed at both ends, a piston reciprocating therein and connected with the crank shaft, air inlet and outlet valves and passages connecting with one end of the cylinder whereby the piston reciprocating therein, acts as a pump to draw the air in and force it through the outlet valve, a carburetor and receiver into which the air is forced under pressure, a valve chamber communicating with the opposite end of the cylinder, a valve movable therein and mechanism by which it is operated to admit a charge of explosive gas from the receiver to that end of the engine cylinder, an igniting device consisting of stationary and movable electrodes, and mechanism comprising the slotted rocker arm on the axis of the movable electrode and a rod reciprocating in a straight line and connected with said arm, by which said electrodes are periodically brought into contact.

8. In a gas engine, the combination of two cylinders, closed at both ends, standing in line with each other having pistons reciprocating therein, piston rods extending through the outer ends of the cylinders and connecting with cross-heads, which cross-heads are united by rods exterior to the cylinders whereby the pistons reciprocate simultaneously within their cylinders, air inlet and outlet passages and valves connecting with the outer ends of each of the cylinders whereby each piston acts as a pump to draw in a charge of air and to force it out upon its return, pipes connecting with the outlet valve chambers and with a carburetor and receiver into which the air is forced under pressure alternately from each of the cylinders, a valve chamber and valves connecting with the inner adjacent ends of each of the cylinders, and pipes leading from the carburetor and receiver to said valve chamber and valves, a mechanism connecting with the main crank shaft whereby the valves are opened to admit a charge of gas under pressure alternately to the inner ends of each of the cylinders whereby the engine is rendered double acting.

9. In a gas engine, two cylinders closed at both ends, standing in line with each other, each having a piston reciprocating therein and connected with the crank shaft, a carburetor and reservoir adapted to contain explosive vapor under pressure, exterior to the cylinders, passages and valves connecting with one end of the cylinders whereby the engine piston serves to compress air into the carburetor, other passages and valves connecting the reservoir with the opposite end of the cylinders whereby the explosive mixture is admitted under pressure to start the piston from that end of the cylinders before the charge is exploded.

10. In a gas engine, independent cylinders, closed at both ends, standing in line axially, having pistons adapted to reciprocate simultaneously in their respective cylinders, and connected with a crank shaft, a receiver exterior to the cylinder into which an explosive mixture is compresssd, and valves and mechanism actuated by the engine whereby said explosive mixture is admitted to the working end of the cylinder when the piston thereof has approached that end, and the piston is started by direct pressure from the reservoir before explosion takes place.

11. The improvement in gas engines consisting in the combination with two cylinders, closed at both ends, standing in line with each other, each having a piston reciprocating therein and connected with a crank shaft, of a reservoir exterior to the cylinder into which an explosive mixture is compressed, valves and actuating mechanism by which the explosive mixture is admitted to the end of the cylinder to start the piston from that end by direct pressure, and an igniting mechanism whereby the compressed mixture is exploded after the piston has been so started.

In witness whereof I have hereunto set my hand.

SAMUEL M. MILLER.

Witnesses:
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GEO. E. CRANE.