J. McKECHNIE.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED NOV. 23, 1911.

Patented Nov. 25, 1913.

1,079,422.

3 SHEETS—SHEET 1.

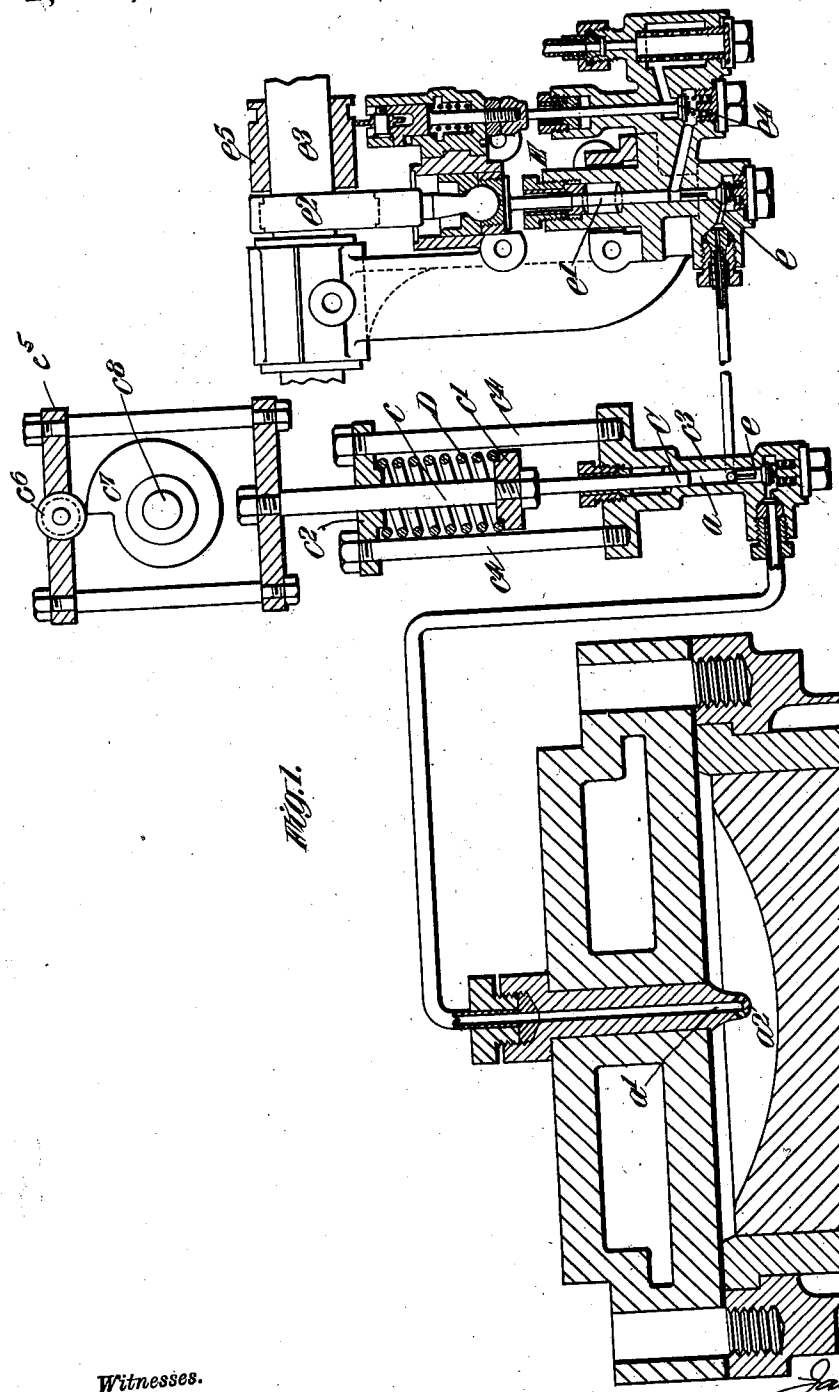


Fig. 1.

Witnesses.

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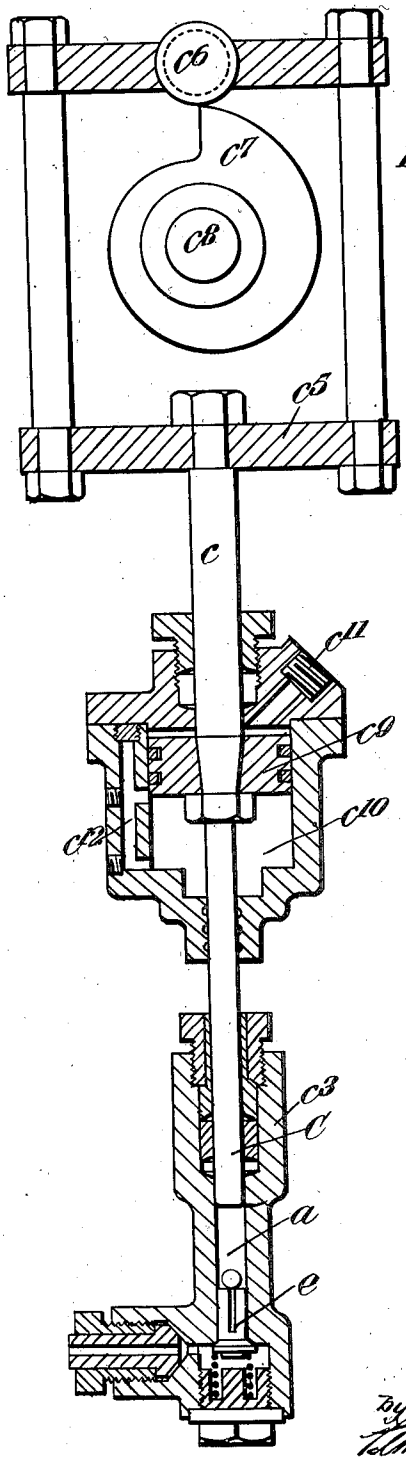


Fig. 2.

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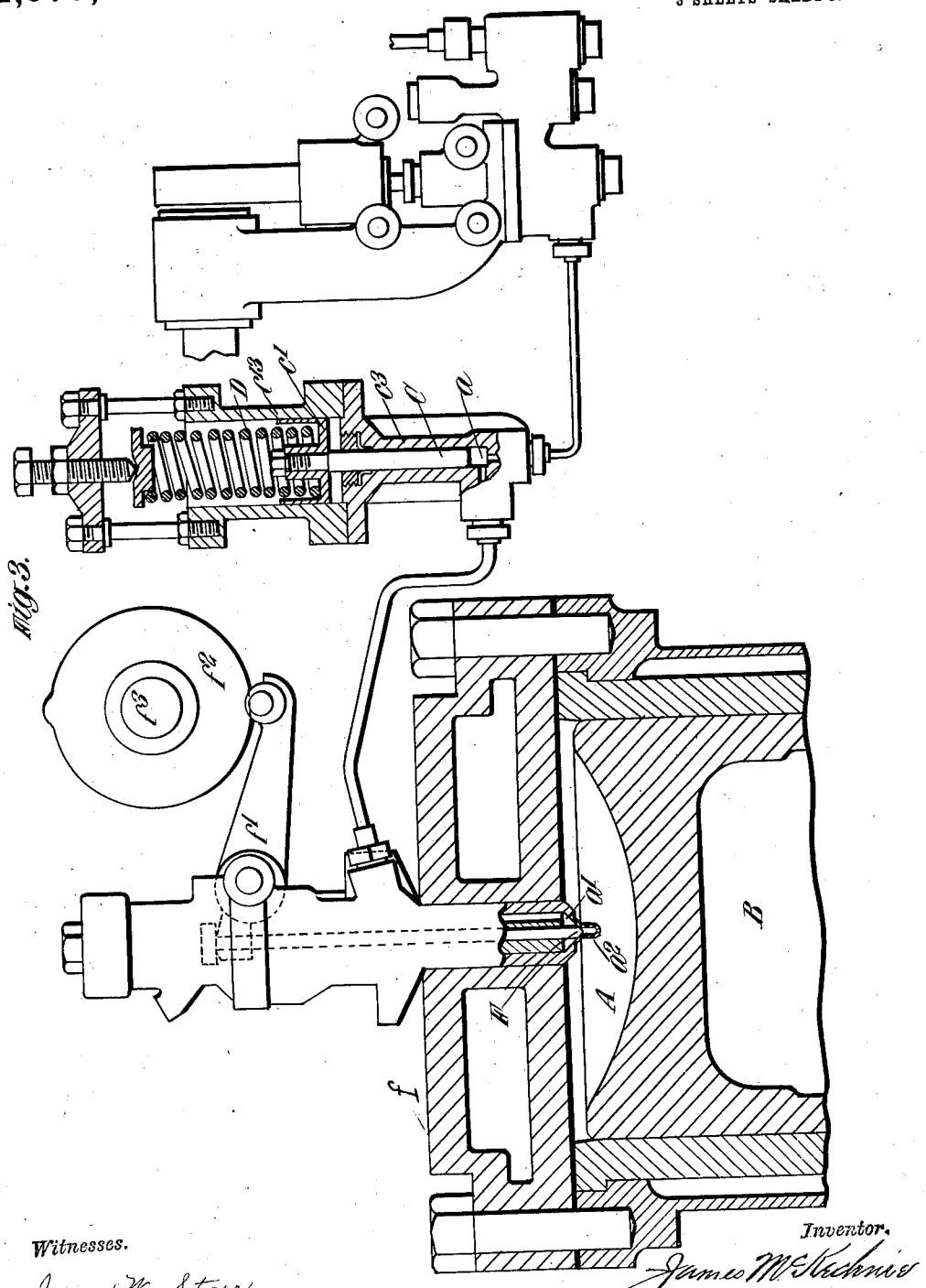
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3 SHEETS—SHEET 3.



Witnesses.

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UNITED STATES PATENT OFFICE.

JAMES McKECHNIE, OF BARROW-IN-FURNESS, ENGLAND, ASSIGNOR TO VICKERS LIMITED, OF BARROW-IN-FURNESS, ENGLAND.

INTERNAL-COMBUSTION ENGINE.

1,079,422. Specification of Letters Patent. Patented Nov. 25, 1913.

Application filed November 23, 1911. Serial No. 661,995.

To all whom it may concern:

Be it known that I, JAMES McKECHNIE, a subject of the King of Great Britain, residing at Naval Construction Works, Barrow-in-Furness, in the county of Lancaster, England, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

This invention relates to internal combustion engines for burning crude and the heavier fuel oils, and to that type of engine in which the fuel is sprayed into the engine cylinder about the time that the piston arrives at the inner end of the compression stroke, a charge of air previously admitted into the cylinder being compressed during the aforesaid compression stroke to a very high degree of compression which raises the temperature of the air to a sufficient extent to ignite the fuel as soon as it is sprayed into the cylinder. In this class of engine it has been customary to introduce the fuel into an atomizer preparatory to its entrance to the cylinder, and to discharge the fuel from the atomizer by highly compressed air which enters the atomizer from a storage tank connected with an air compressor.

The present invention has for its chief object to dispense with the aforesaid air compressor and storage tank, and to substitute therefor a simple and efficient device for introducing the fuel into the cylinder in the form of spray which will materially simplify the construction of the engine, and reduce its cost of manufacture.

According to this invention the fuel is injected into the cylinder suddenly and as a spray through fine holes without any admixture of air and under an extremely high spring pressure, in such a manner that on entering the cylinder (where the pressure though still very high is much below that to which the liquid has been subjected) the fuel spray instantly vaporizes owing to the sudden reduction of pressure in conjunction with the high temperature of the compressed air into which it enters. To effect this sudden injection at the extremely high pressure necessary I employ a powerful spring acting on a piston or plunger in a chamber into which a definite charge of liquid is forced by a pump, the spring being compressed either by the liquid or by external means. When the charge is allowed to pass into the cylinder, either by opening a needle valve or releasing the spring, it is forced with great velocity under the extreme pressure given by the spring, through the fine holes at the cylinder end of the inlet passage into the cylinder, vaporizing at the moment of entry.

In order that my said invention may be clearly understood and readily carried into effect, I will describe the same more fully with reference to the accompanying drawings, in which:—

Figure 1 is a sectional elevation of fuel introducing apparatus constructed in accordance with this invention. Fig. 2 is a detached view of a pneumatic arrangement for operating the fuel introducing plunger, and Fig. 3 is a sectional elevation of a modified arrangement of fuel introducing apparatus.

A indicates the engine cylinder, B the piston, C the fuel introducing plunger and D the spring.

As shown in Fig. 1, the spring D is in the form of a powerful coiled metal spring that encircles a rod c which forms a continuation of the plunger C. This spring is confined between a disk c' carried by the rod c and a cross piece c^2 which is connected to the plunger casing c^3 by the bolts c^4. The upper end of the rod c terminates in an open frame c^5 which carries a roller c^6 for engagement with a cam c^7 mounted upon a shaft c^8 driven from any convenient part of the engine. The charge of fuel to be forced into the cylinder A is admitted into a chamber a from a suitable measuring pump E which is separated from such chamber by a non-return valve e. This pump comprises a plunger e' operated from an eccentric e^2 on a shaft e^3 which may be driven from any convenient part of the engine, the inlet valve e^4 of the pump being controlled from a cam e^5 slidably mounted upon a key on the shaft e^3 and adapted to regulate the amount of time that the inlet valve is to remain open during the downward or delivery stroke of the plunger e. The chamber a is arranged in open communication with the

cylinder A through a passage a' having a cap a^2 with a number of small spraying apertures, the arrangement being such that when the engine piston B is at or about the inner end of its compression stroke, the spring is released by the action of the aforesaid cam, with the result that the plunger C forces the fuel under heavy pressure (for example from 2000 to 6000 lbs. per square inch) through the small apertures in the form of a spray into the engine cylinder A, whereupon the compressed charge of air therein ignites the fuel in the usual manner.

In the alternative arrangement shown in Fig. 2, a pneumatic spring is substituted for the metal spring shown in Fig. 1. For this purpose the rod c is fitted with a piston c^9 that is inclosed within a cylinder c^{10} supplied through the passage c'' with air at high pressure. The action in this case is the same as that already described, the air admitted under pressure to the cylinder c^{10} being further compressed therein as the cam c^7 raises the plunger C to the upper end of its stroke. As soon as the stepped portion of the cam clears the roller c^6, the compressed air in the cylinder c^{10} acting upon the piston c^9 instantaneously forces the plunger C to the lower end of its stroke with the result that the fuel admitted from the measuring pump E to the pump casing c^3 below the plunger C is subjected to heavy pressure and suddenly ejected in the form of a spray into the engine cylinder A through the aforesaid apertures in the cap a^2. Any hammering action of the piston c^9 upon the lower end of the cylinder c^{10} is prevented by a by-pass c^{12} which enables compressed air to pass from the upper portions of the cylinder to the lower portion and thereby to form an air cushion for the piston as the latter reaches the lower end of its stroke.

In some cases it may be desirable to admit the fuel to the engine cylinder through a mechanically operated needle or other appropriate valve. In the example shown in Fig. 3, F represents a valve that enters the chamber a and normally closes the outlet thereof to the engine cylinder. This valve is situated within a casing f carried by the upper end of the engine cylinder and is connected with a lever f' to which a rocking motion is imparted at the appointed time through the intervention of a cam f^2 fixed upon a shaft f^3 driven from any suitable part of the engine. The passage a' is in direct communication with the fuel actuating plunger C and, in the example shown, such plunger is actuated by a coiled metal spring D although a pneumatic spring may be substituted therefor if so desired. The mechanically operated valve F takes the place of the cam or other device for releasing the spring D and owing to the fact that such valve closes the fuel passage to the engine cylinder, any fuel delivered by the plunger c' of the fuel measuring pump raises the fuel actuating plunger C against the pressure of the spring D and itself becomes subject to heavy pressure. As soon as the valve F is opened, the spring D at once forces the plunger C to the lower end of its stroke, thereby discharging the fuel into the engine cylinder in the form of a spray through the apertures in the cap a^2. Any hammering between the disk c' and the top of the plunger casing c^3 is conveniently prevented by inclosing such disk in a cylinder c^{13}, the air within the cylinder below the disk c' acting as a cushion as the disk approaches the top of the casing c^3.

The invention hereinbefore described may be applied to engines of the two or four cycle type.

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

1. In an internal combustion engine of the kind in which liquid fuel is injected into a charge of compressed air in the cylinder, a fuel pressure chamber having a resilient pressure applying member, means for supplying liquid fuel to the pressure chamber, and engine driven mechanism connected mechanically to the resilient member and adapted to gradually store energy in the resilient member and subsequently to quickly release it to suddenly inject the liquid fuel under extreme pressure from the pressure chamber into the engine cylinder.

2. In an internal combustion engine of the kind in which liquid fuel is injected into a charge of compressed air in the cylinder, a fuel pressure chamber having a piston, a resilient pressure applying member effective on the piston, means for supplying liquid fuel to the pressure chamber, and engine driven mechanism connected mechanically to the resilient member and adapted to gradually store energy in the resilient member and subsequently to quickly release it to cause the piston to suddenly inject the liquid fuel under extreme pressure from the pressure chamber into the engine cylinder.

3. In an internal combustion engine of the kind in which liquid fuel is injected into a charge of compressed air in the cylinder, a fuel pressure chamber adapted to receive the liquid fuel unmixed with air, a powerful spring adapted to subject the fuel to extreme pressure, a pump supplying the fuel to the said pressure chamber, and a power driven cam adapted to compress the spring during the supply of unmixed liquid fuel to the chamber and to release the spring for the sudden injection of the fuel into the cylinder.

4. In an internal combustion engine of the kind in which liquid fuel is injected into a

charge of compressed air in the cylinder, a fuel pressure chamber adapted to receive the liquid fuel unmixed with air, a plunger working in said chamber, a piston mounted on said plunger, a powerful spring acting on the piston, a pump supplying the fuel to the pressure chamber, and a power driven cam adapted to compress the spring and to release it suddenly for the sudden injection of the unmixed liquid fuel into the cylinder.

In testimony whereof I affix my signature in presence of two witnesses.

JAMES McKECHNIE.

Witnesses:

HENRY KING,

JNO. R. CASWELL.