O. LIETZENMAYER.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED MAR. 4, 1907.

1,056,699.

Patented Mar. 18, 1913.

2 SHEETS—SHEET 1.

Fig. 1.

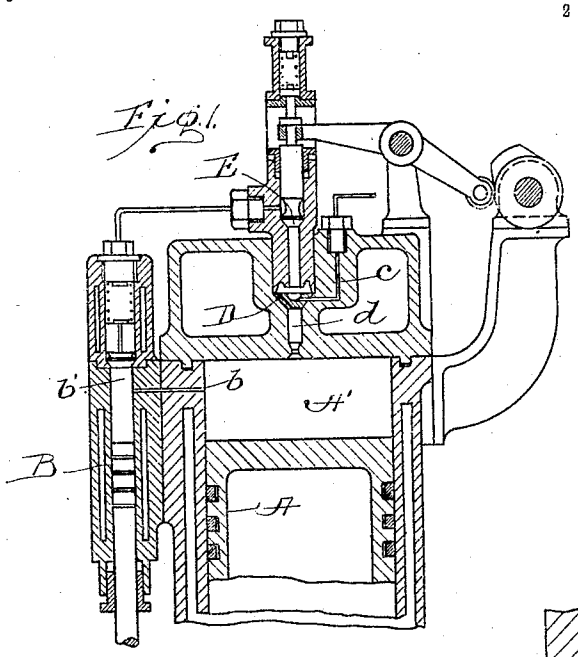
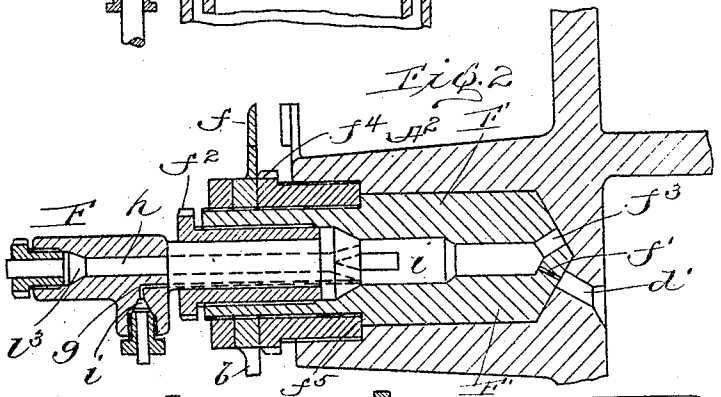


Fig. 2.



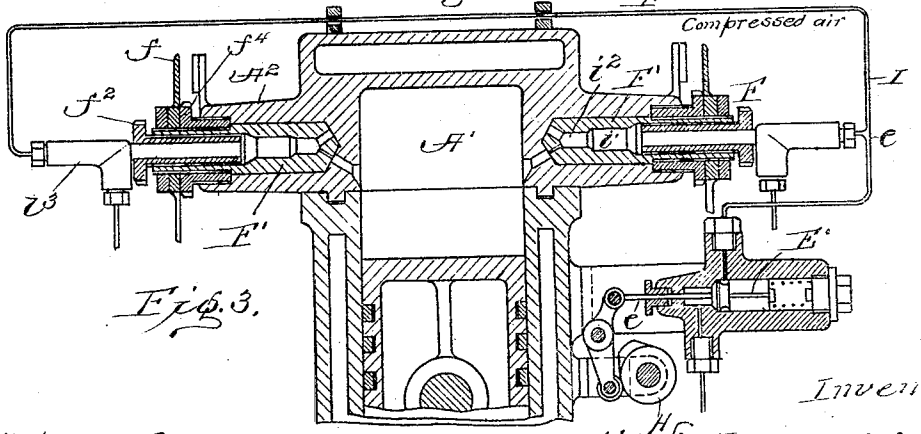


Fig. 3.

Witnesses

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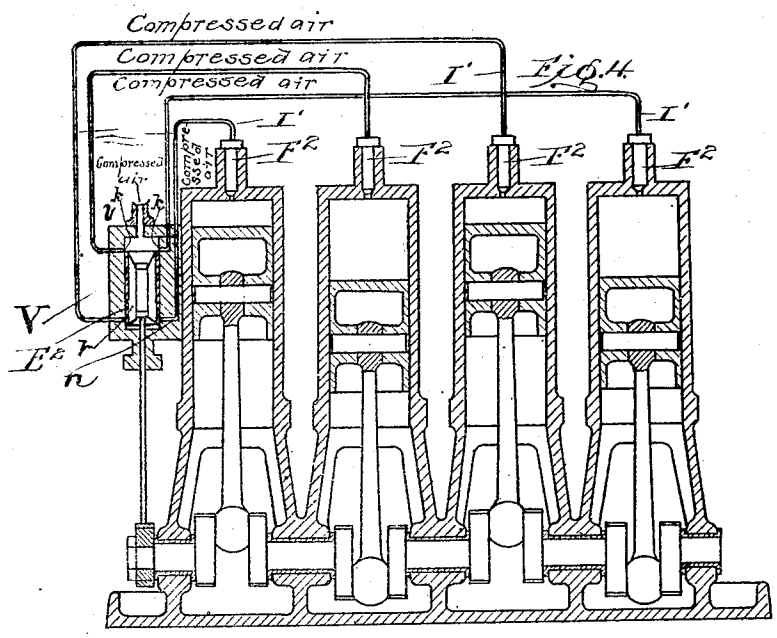
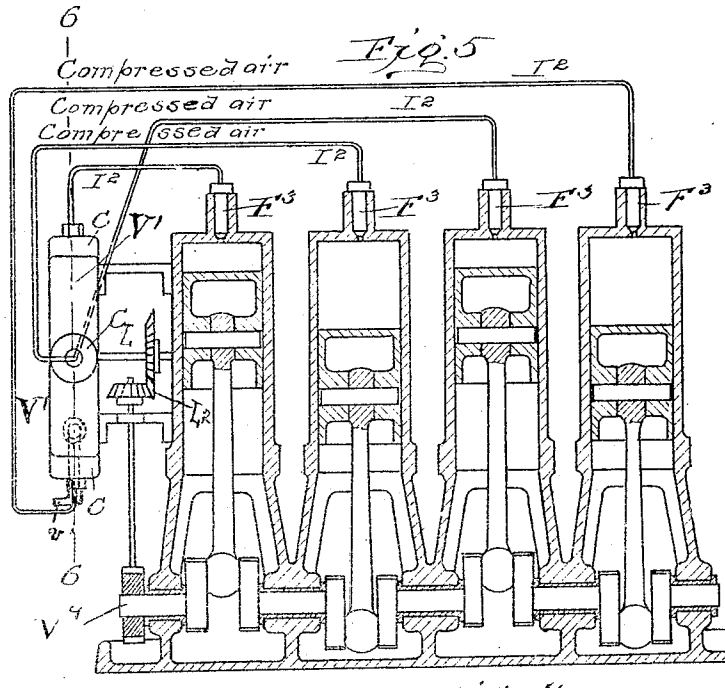
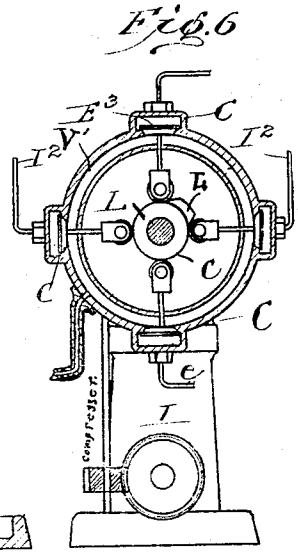
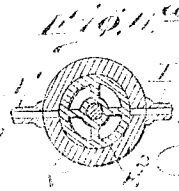
2 SHEETS—SHEET 2.









Witnesses

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INTERNAL-COMBUSTION ENGINE.

1,056,699. Specification of Letters Patent. Patented Mar. 18, 1913.

Application filed March 4, 1907. Serial No. 360,455.

To all whom it may concern:

Be it known that I, OTTO LIETZENMAYER, subject of the King of Wurttemberg, residing at Munich, Bavaria, Germany, have invented certain new and useful Improvements in Internal-Combustion Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The present invention relates to internal combustion engines.

The object of the invention is to provide such engines with fuel injecting devices in which the amount of fuel injected can be regulated and in which a simple manipulation of the injecting device will enable the same to serve also for starting the engine with compressed air.

Another object of the invention is to facilitate the removal of one injector, in the case where a plurality of such injectors are employed for one engine, without stopping the engine.

Still another object of the invention is to provide means whereby a plurality of engines forming a compound engine may be fed with fuel at the proper times by the action of a single source of compressed air.

With these objects in view my invention in its preferred embodiment comprises the means and combinations of parts to be herein below described and to be particularly pointed out in the claims.

In the drawings: Figure 1 is a detail sectional view of one embodiment of my invention; Fig. 2, a similar view of a modified form of fuel supplying device; Fig. 3, a similar view of another embodiment of the invention; Fig. 4, a sectional view of a multiple cylinder engine showing the manner of applying my invention thereto; Fig. 4ª is a cross-section of the valve-chest shown in Fig. 4. Fig. 5, a similar view of another modification; Fig. 6 is a vertical cross-section of the valve-chest shown in Fig. 5.

Referring to Fig. 1 of the drawings, A is the piston of an engine, in this case assumed to be a four-cycle engine. The piston draws in air on its first downward stroke through the usual inlet valve and compresses this on its first upward stroke to the temperature of ignition. At the upper dead point, which is the moment of highest compression, the introduction of the fuel spray occurs and thereby the combustion of the mixture takes place so that the expanding gases drive the piston downward and do useful work. On the second upward stroke the piston drives out the products of combustion through the usual exhaust port.

The air pump B, Fig. 1, serves for the production of the over-pressure or super-compression which sprays the fuel into the working chamber at the moment of highest compression. In the particular embodiment of the invention here shown the pump receives a supply of compressed air from the working chamber through the passage *b*, said passage being closed when the piston B passes the same at the end of the compression stroke of the main piston A, the air thus trapped in the pump cylinder *b'* being further compressed to the desired extent to produce a super-compression for injecting the fuel into the working chamber. This super-compressed air for spraying, of course, can be furnished by a separate air pump taking its supply from the outer air.

The fuel is fed through the pipe C into a suitable receptacle or chamber, as for example, a pan D, prior to the compression stroke. In this pan it is prepared for combustion by the heat of compression and at the moment of ignition is injected into the combustion chamber through the duct *d* by means of the super-compressed air from the pump chamber *b'*. The moment of injection, which is identical with the moment of ignition is precisely determined by the air valve E.

By the separate arrangement of the air valve E and the fuel supplying pan D and duct *d*, it is possible without difficulty to control several fuel-supplying means from one valve, and thereby to so construct the fuel-supplying devices that they may be removed from the engine one at a time for purpose of inspection, cleaning and repair without opening the working cylinder, and even while the engine is in operation.

One method of arranging the fuel-supplying means or injector whereby the above-mentioned results, that is the cutting off of communication between the fuel injector and the working chamber of the cylinder, may be obtained is illustrated in Fig. 2. In this example, the injector device, F, for supplying fuel is mounted within a shell F' formed as a cock and provided with a handle *f* whereby

said shell may be turned from the outside during the operation of the engine, to shift the mouth f' of the fuel inlet away from the passage d' leading into the working chamber of the cylinder A'. Thereupon by unscrewing the collar f^2 from the cylindrical shell F' the injector device may be removed for cleaning during the operation of the engine. The shell F', as will be seen from the drawing, is fitted into a cylindrical or slightly conical sheath or casing A^2 forming part of the head of cylinder A'. It is held against displacement therein, but so as to enable it to be turned as above stated, by a screw-threaded collar or thimble f^4, threaded into said sheath A^2 and bearing against a shoulder f^5 on the shell. Moreover, by making the injector shell F rotatable as described, it is possible to provide different size inlets to the combustion cylinder during the operation of the engine, whereby the injector may serve also as a means for starting the engine with compressed air. An apparatus arranged for this purpose could work for example as follows: At starting, the petroleum or other fuel, which ordinarily would pass through the duct g into the injector space i, is shut off. The compressed air for starting the engine passes through the duct h to the injector, and the shell F is turned in such a manner as to bring the passage f^3 into register with the opening d' of the cylinder, whereby the correspondingly greater quantity of air required for starting may enter the working chamber without throttling. As soon, now, as this compressed air starts the engine, the fuel is admitted to the injector and after the resulting ignition, the injector shell F is rotated to bring the smaller opening f' which is more suitable for the necessary spraying of the fuel, into register with the passage d'. In this way the injector device serves also as a starting means.

In Fig. 3 is illustrated a form of the invention in which a plurality of fuel-supplying devices (two in this instance) are employed for the purpose of obtaining a better mixture of air and fuel, these various fuel-supplying devices, however, being controlled from a common controlling means. In this example, F are the injector devices, and E' is the compressed air inlet valve, which is actuated by the rod e from the cam H. Upon the opening of the valve E', the compressed air can pass through the pipe I to both injector devices and blow the fuel from the chambers i', through the passages i^2 into the working chamber, which will take place simultaneously and under similar conditions at both injectors because of the fact that the air supply for both is controlled by a valve mechanism common to both injector devices. In the pipe system I may be placed check valves.

Fig. 4 shows a four cylinder machine, assumed to be of the two-cycle variety. In this construction the fuel injectors, F^2, which may be of the construction and arrangement represented in Fig. 1, are supplied with compressed air at the proper times by the following means: An air-chest, V, communicates by means of a pipe, v, with a compressed air supply and by means of the system of pipes, I', I', etc., with the injectors F^2, F^2, etc., said pipes terminating in ports k, which are alternately opened and closed by the slide-valve, E^2, actuated from an eccentric, V^4, on the shaft of the four-cylinder engine. The parts are so arranged that the respective ports are opened at the moment of the corresponding compressions in the individual cylinders. The slide valve as shown in Fig. 4, and particularly in Fig. 4^a is open interiorly so as to permit the passage of the compressed air thereto.

It will be noted that, under the arrangement of Fig. 4, the ports k of the air-chest V, are opened in pairs, so that two alternate engine cylinders of the four-cylinder machine are simultaneously supplied with fuel at each stroke of the valve. These engines, represented in Fig. 4, are two-cycle engines. The liquid fuel is fed to the fuel injector in the usual way, that is to say, periodically and under sufficient pressure to enter the chamber i, where it remains until forced out by the compressed air and somewhat in advance of the time when the compressed air valve admitting the compressed air to the injector is opened.

In Figs. 5 and 6 is shown a four cylinder engine, whose injectors are indicated at F^3, each of which is in communication with its own air inlet valve E^3 through a pipe system I^2. These valves, E^3, as shown, are seated in the outer periphery of the ring or annular air chest, V', which annular air chest is in communication with a compressed air supply by means of a pipe, v', for example. The valves, E^3, are normally closed down on their seats, thereby cutting off the communication between the air chest, V', and the pipes I^2 and hence the injectors, F^3. They are caused to rise *seriatim* from their seats in the valve casings by a cam, L', keyed to shaft, L, actuated by gearing L^2, deriving its motion from the main shaft of the multiple engine, as shown. If now, the cranks of the individual cylinders are displaced for example, by 180° (in 4 cycle operation) then the air valves E^3 are arranged around the control shaft L at 90° apart, whereby again it becomes possible to control the supply of fuel to all cylinders with one cam device. The cam shaft for this purpose is geared up so as to rotate at one-half the angular speed of the crank shaft.

Having thus fully described my invention, what I claim as new and desire to se-

cure by Letters-Patent of the United States, is:—

1. In an internal combustion engine, the combination, with a working chamber, an air and fuel mixing chamber communicating with said working chamber, a second independent and removable air and fuel mixing chamber arranged outside the working chamber, and a communication between said removable air and fuel mixing chamber and the working chamber, of devices for injecting fuel and compressed air into the mixing chambers, and means independent of the working parts of the engine for cutting off the communication between the removable mixing chamber and the working chamber.

2. In an internal combustion engine, the combination with a working chamber, and a plurality of independent removable fuel injector devices, each injector device comprising a fuel receptacle, and a fuel and a compressed air duct, and provided with means for cutting said injector devices off from communication with the working chamber.

3. In an internal combustion engine, a working chamber having an inlet duct for the injection of fuel, in combination with a fuel injector device adapted to communicate with said working chamber through said duct, said fuel injector device comprising an outer casing and a rotatable shell arranged within the same, said shell being provided with a plurality of ducts of different sizes each of which is adapted to register with the inlet duct of the working chamber.

4. In an internal combustion engine, a working chamber having an inlet duct for the injection of fuel, in combination with a fuel injector device adapted to communicate with said working chamber through said duct, said fuel injector device comprising an outer casing and a rotatable shell arranged within the same, said shell being provided with a plurality of ducts of different sizes each of which is adapted to register with the inlet duct of the working chamber, and means for supplying compressed air to said injector device.

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

OTTO LIETZENMAYER.

Witnesses:

LOUIS MUELLER,

GEORG KÄNNER.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."