No. 785,166. PATENTED MAR. 21, 1905.

F. A. HASELWANDER.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED MAY 23, 1901.

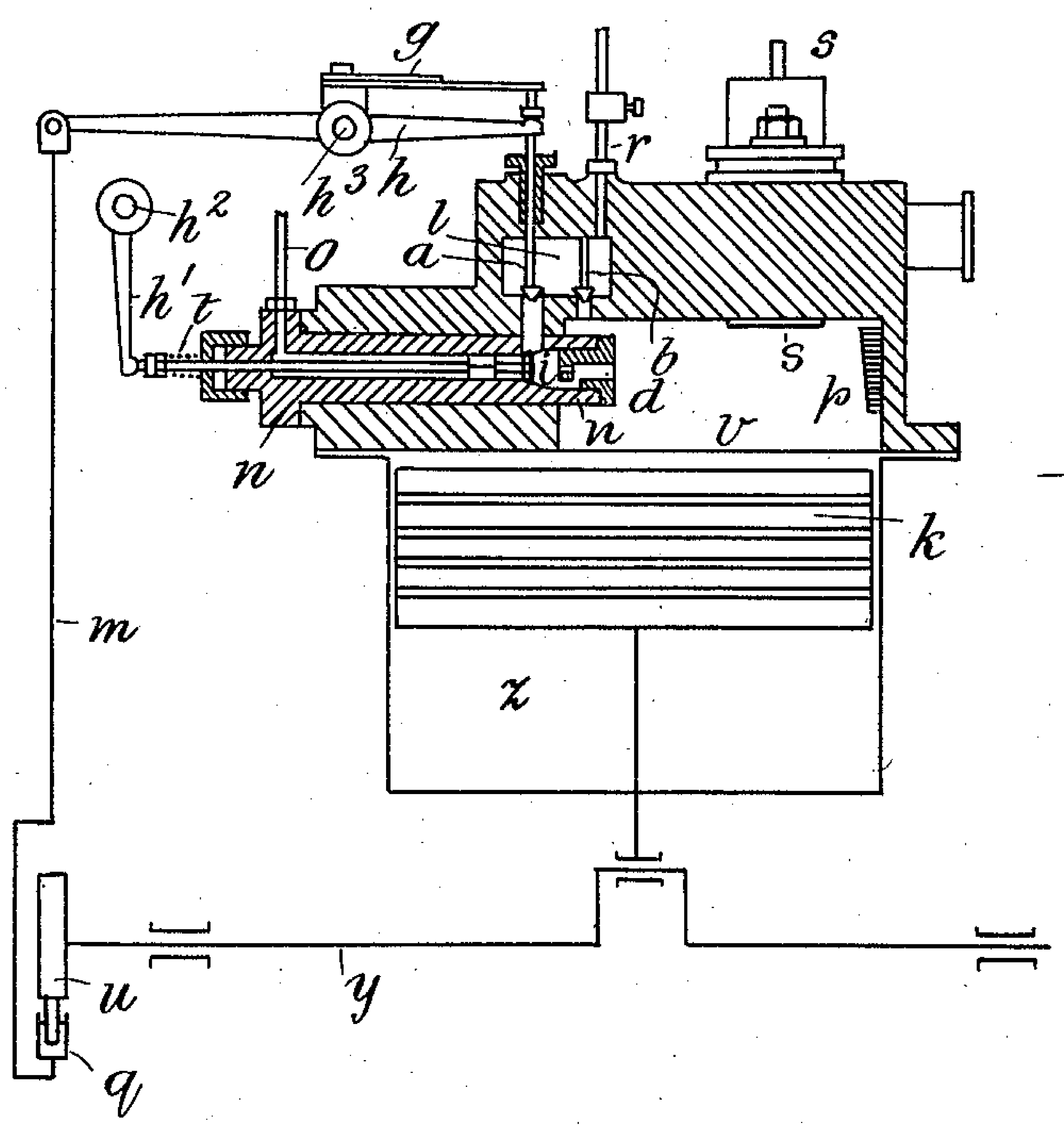

Fig:1.

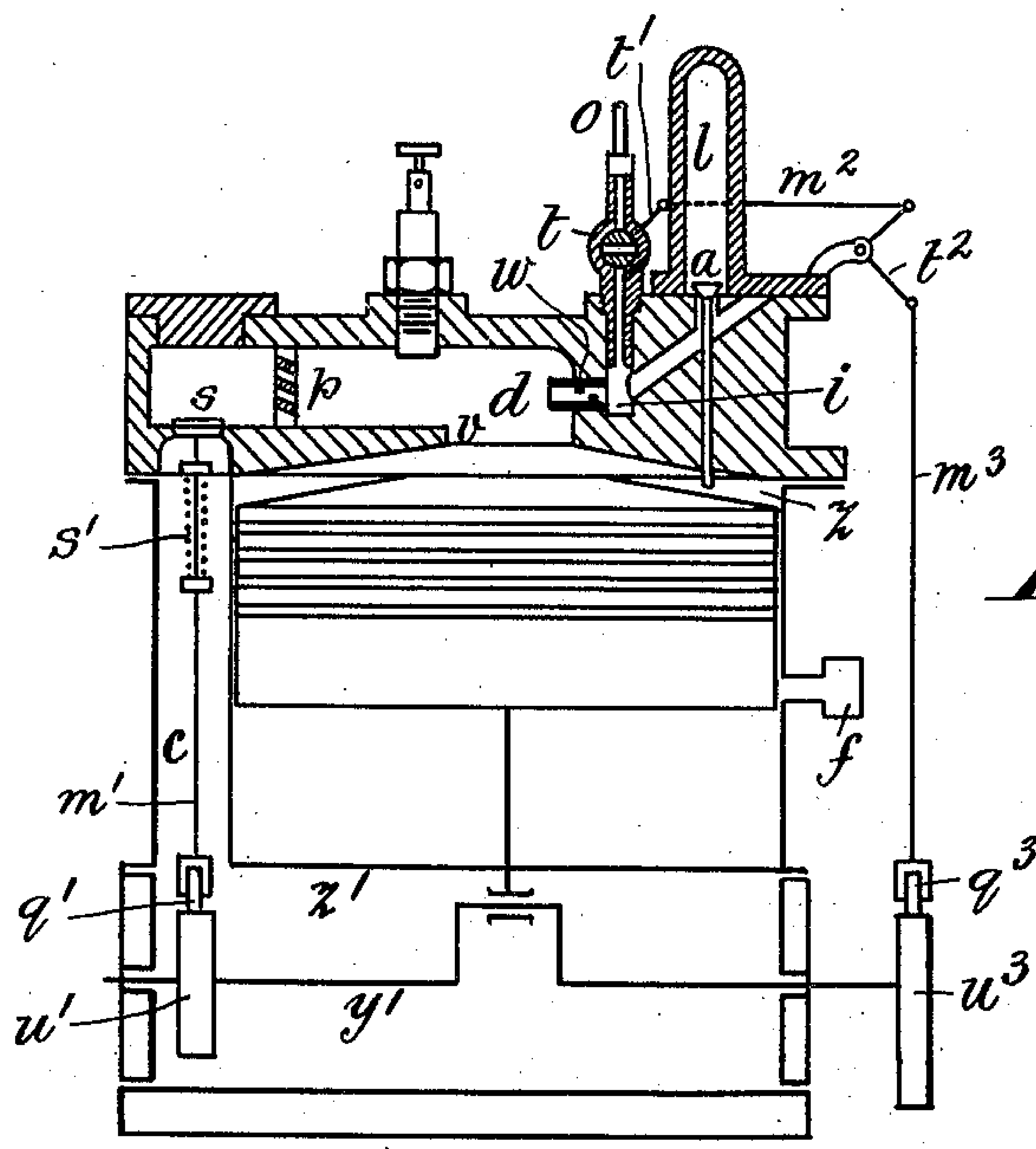

Fig:2.

Witnesses

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No. 785,166. Patented March 21, 1905.

UNITED STATES PATENT OFFICE.

FRIEDRICH AUGUST HASELWANDER, OF MANNHEIM, GERMANY.

INTERNAL-COMBUSTION ENGINE.

SPECIFICATION forming part of Letters Patent No. 785,166, dated March 21, 1905.

Application filed May 23, 1901. Serial No. 61,584.

To all whom it may concern:

Be it known that I, FRIEDRICH AUGUST HASELWANDER, a subject of the Emperor of Germany, residing at 1 Käferthalerstrasse, Mannheim, in the German Empire, have invented a new and useful Improved Internal-Combustion Engine, of which the following is a specification.

In combustion-engines which only allow the fuel and compressed air to meet just before the expansion begins an apparatus, such as an air-pump, is necessary to inject the combustible dispersed in compressed air into the combustion-chamber with a certain force. The present invention renders superfluous such an apparatus (which increases the cost of the engine) by the removal from the combustion-chamber during the explosion and increase of pressure at the beginning of the preceding working stroke of the gas required for injection and spraying, which gas must be under a pressure exceeding the pressure in the combustion-chamber at the end of the compression-stroke. The principle of this new engine and its cycle of operations is illustrated by the examples described below, with reference to the accompanying drawings, in which—

Figure 1 illustrates a four-stroke engine, and Fig. 2 a two-stroke engine, according to the new system.

In Fig. 1 *l* is a gas-chamber which is connected with the combustion-chamber *v* or the injection device *d* by means of two ports which can be closed by the valves *a* and *b*. The valve *a* is closed by spring or other pressure, by means of a spring *g*, for instance, and is adapted to be operated by the rocking lever *h*, pivoted on shaft h^3, to the outer arm of which lever is connected a rod *m*, working by means of a roller *q* on a cam *u* on the crank-shaft *y*. *n* is the valve-box for the fuel; (in this case liquid;) *t*, the fuel-valve receiving liquid fuel by pipe *o*; *d*, an injection-nozzle; *i*, a space divided off in the valve-box between the head of valve *t* and the nozzle *d*. The cycle is as follows: During the suction stroke of the piston *k* fresh air comes through the automatic or operated air-inlet valve *s* into the combustion-chamber *v* and into the interior of the cylinder *z* above the piston. At the same time the fuel-valve *t* is operated by the lever h', mounted on shaft h^2, which latter is operated by any suitable means—such, for instance, as the means which operates the valve *a*—and a certain quantity of fuel flows out of the fuel-supply pipe *o* into the front space *i* without, however, coming out of *d*. The combustible remains in *i* during the compression-stroke which follows. Before or after the end of the compression-stroke the valve *a*, which can be controlled by a spring or the like—such, for instance, as *g*, Fig. 1—is pushed up by means of the lever *h*, operated by cam *u* and rod *m*, and the pressure is equalized between the gas-chamber *l*, which, for example, was filled with gas of a pressure of twenty kilograms per square centimeter, and the combustion-chamber *v*, in which the working air was compressed, for example, to fifteen kilograms per square centimeter, so that the gas flowing toward *v* rushes with the combustible out of *i*, forming spray in the nozzle *d* and issuing out of the latter into *v*. The combustion then takes place either by spontaneous combustion, by igniting at the hot walls of the cylinder, or at heat containing walls or blocks *p*, or else by electric or other "external" ignition. During the combustion an increase of pressure arises exceeding that of the compression at the end of the compression-stroke, (about twenty kilograms per square centimeter, for example,) so that the pressure in *v* is greater than that in *l*, causing combustion-gas to flow through the automatic return-valve *b* to *l*. The gas-chamber is consequently again charged for the next injection. The piston *k* moves downward in the usual manner during the expansion-stroke and then follows the exhaust-stroke during which the products of combustion escape through a suitable exhaust-valve. (Not shown in the drawings.) With the next suction-stroke the aforesaid cycle recommences.

The above illustration explains the principle of the invention, but there may be several modifications.

All the valves, injecting devices, and like parts may be of any suitable form other than that shown and they may be operated by any suitable means. The air-chamber l can also have any suitable form, and, if desired, a plurality of any or all of these parts may be employed, as will be readily understood, without departing from the scope of the invention. The connecting-passages of the valves a b are preferably of such a length and section that the flame of combustion cannot readily pass therethrough. Moreover, it will be obvious that the use of the valve b is not essential, as a may serve as a return-valve, being positively raised by the lever h for the injection, but being forced up automatically by the explosion to admit the gases under explosive pressure.

The supply of combustible can take place at different times and in several ways. In some cases it may be supplied under pressure from any convenient source, at the moment of the opening of a, for example. The delivery of the combustible can also be differently arranged, if desired, without departing from the scope of this invention. The exact structure and the position of the parts receiving the combustible before its injection, such as the chamber i, Fig. 1, also depends on the kind of fuel used, and if necessary heating or cooling devices of known construction may be employed, as will be understood.

The new motor can also be used with weak mixtures not capable of acting alone by means of the compression. The new method of injection then serves to strengthen such mixtures and to make them capable of ignition.

The regulation can be effected in any known way—*e. g.*, by varying the quantity of fuel supplied or the period during which the fuel-valve is open, by early or retarded opening of the gas-chamber valve a, or finally by the various methods of misfire. The motor can be started by hand or by any of the various starting methods. With low degrees of compression the motor until it becomes sufficiently warm is preferably supplied with easily-volatilized fuel or the rebounding wall or block p may be previously heated.

In order to be able to produce the necessary excess of pressure when first starting or when gas is lost from l, the latter has another special pipe r, which is normally closed, but which can be connected to any suitable source of air or gas under pressure. The first excess of pressure in l can also be attained by igniting a suitable explosive substance therein.

The same principle as described above for a four-stroke motor can also be applied without essential alterations in the construction to six-stroke or two-stroke motors. The arrangement shown in Fig. 1 is suitable for six-stroke cycle-motors.

In Fig. 2 is illustrated a two-stroke motor according to the new system, showing a simplified form of the essential parts by way of example. The letters correspond to those in Fig. 1 or indicate like parts. The cycle of working is as follows: During the explosion-stroke of the piston k air was compressed on its under side in the ordinary way in a closed crank-chamber z', communicating with channel c. Said air might also be supplied from another suitable source. Just before the end of the stroke the piston uncovers an exhaust-port f, through which the products of combustion escape. The air-inlet valve s is opened by means of the excess of pressure of the previously-compressed air or by a mechanical device, such as the rod m', connected to roller q', which works on a cam u' on the crank-shaft y. The valve is normally held closed by a spring s'. The air flows through the passage c and valve s to v and z above the piston, completely expelling the burned gases. The fuel cock or valve t is also opened and a certain quantity of combustible let in from o is deposited in the trough i. Said cock or valve t may be operated from the crank-shaft by the device shown diagrammatically in Fig. 2, consisting of the arm t', link m^2, elbow-lever t^2, rod m^3, and roller q^3, operated by the cam u^3 on the crank-shaft y. During the return stroke of the piston the exhaust-port f is covered, the valve s is closed, and the air shut in above the piston k is compressed, while beneath the piston air is subsequently drawn into the crank-chamber in this arrangement. Just before the end of the compression-stroke the piston pushes on the end of the spindle a' of the valve a and opens said valve, so that gas flows with excess of pressure from the gas-chamber l through the passage j, takes the combustible from i with it, and thoroughly sprays it in the nozzle d, which in this example contains baffle projections n and injects the spray toward v preferably onto a rebounding wall, which in this example is shown made up of lattice-like plates p. The ignition, combustion, and increase of pressure ensue as in the other construction, whereby the gas-chamber l is again charged with highly-compressed gas entering through d, i, passage j, and the valve a, which latter is slightly open at the change of stroke.

In conclusion it may be mentioned that instead of liquid fuel finely-divided solid fuel might be used.

What I claim is—

1. In an internal-combustion engine the combination with the cylinder and piston of a small chamber so arranged that it will remain approximately at the temperature of the cylinder during working, a passage connecting said chamber to the cylinder beyond the farthest point reached by the piston during compression, a non-return valve in said passage, a receptacle in the combustion-chamber of the cylinder, means for feeding the combustible to said receptacle, a passage leading from said chamber to the receptacle and means whereby the gases at the pressure of an explosion imprisoned in the said chamber

may be allowed to pass out through the latter passage in order to inject the combustible into the fully-compressed charge of air in the combustion-chamber.

2. In an internal-combustion engine the combination with the cylinder and piston of a small chamber so arranged that it will remain during working approximately at the temperature of the cylinder and a passage communicating therewith from the combustion-chamber beyond the farthest point reached by the piston in the compression-stroke, a non-return valve in said passage whereby gases will be allowed to enter said small chamber at the highest explosion-pressure and will be imprisoned therein, and means for injecting the combustible into the fully-compressed air in the combustion-chamber by means of the charge retained in said small chamber.

3. In an internal-combustion engine the combination with the cylinder and piston of a small chamber so arranged that it will remain during working approximately at the temperature of the cylinder, a non-return valve adapted to allow gases at the highest pressure of explosion to enter said chamber from the combustion-chamber and to become imprisoned in the chamber, an outlet-pipe leading from said chamber, means for delivering the combustible to the front of said outlet-pipe and means adapted to allow the charge imprisoned in said chamber to pass out through said pipe and to inject and spray the combustible into the fully-compressed charge of air in the cylinder.

4. In an internal-combustion engine, the combination with the cylinder and piston of a small chamber so arranged that it will remain approximately at the temperature of the cylinder during working, means for allowing explosion-gases to enter said cylinder at the highest pressure of explosion, means for delivering the combustible into the combustion-chamber when the pressure therein is low, and means adapted to allow the charge of explosion-gases imprisoned in said chamber to spray the combustible into the combustion-chamber when the compression therein is high.

5. In an internal-combustion engine, the combination with the cylinder and piston of a small chamber so arranged that it will remain approximately at the temperature of the cylinder during working, means for allowing explosion-gases to enter said cylinder at the highest pressure of explosion, means for delivering the combustible into the combustion-chamber when the pressure therein is low, means adapted to allow the charge of explosion-gases imprisoned in said chamber to spray the combustible into the combustion-chamber when the compression therein is high, and means for igniting the combustible mixture in the combustion-chamber.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

FRIEDRICH AUGUST HASELWANDER.

Witnesses:

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CONRAD ZIMMER.