No. 676,449. Patented June 18, 1901.

H. SCHWARZ.

GAS, PETROLEUM, OR LIKE INTERNAL COMBUSTION ENGINE.

(Application filed Dec. 19, 1900.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 3.

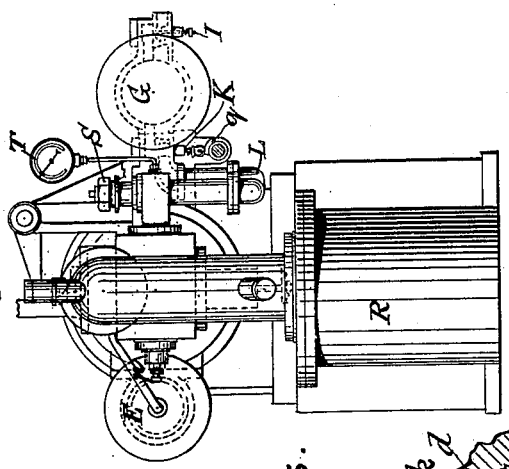

Fig. 4.

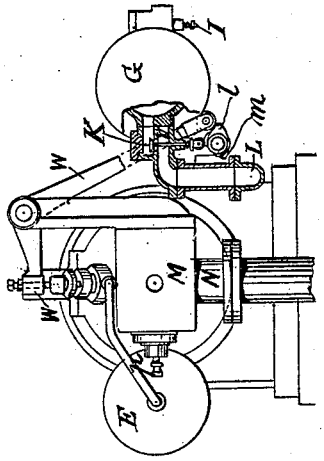

Fig. 5.

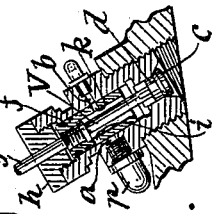

Fig. 1.

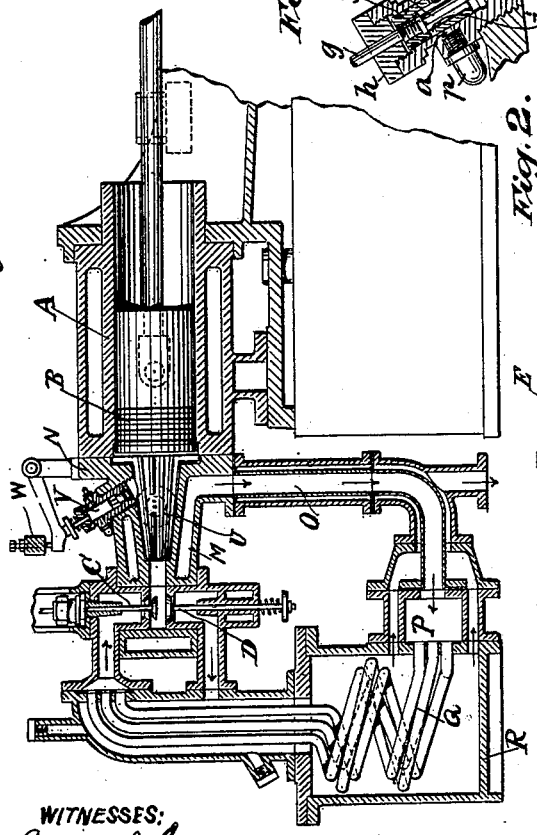

Fig. 2.

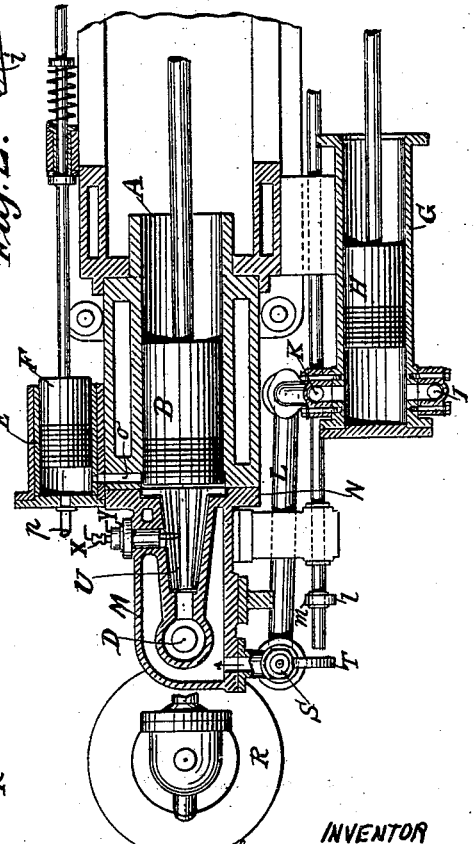

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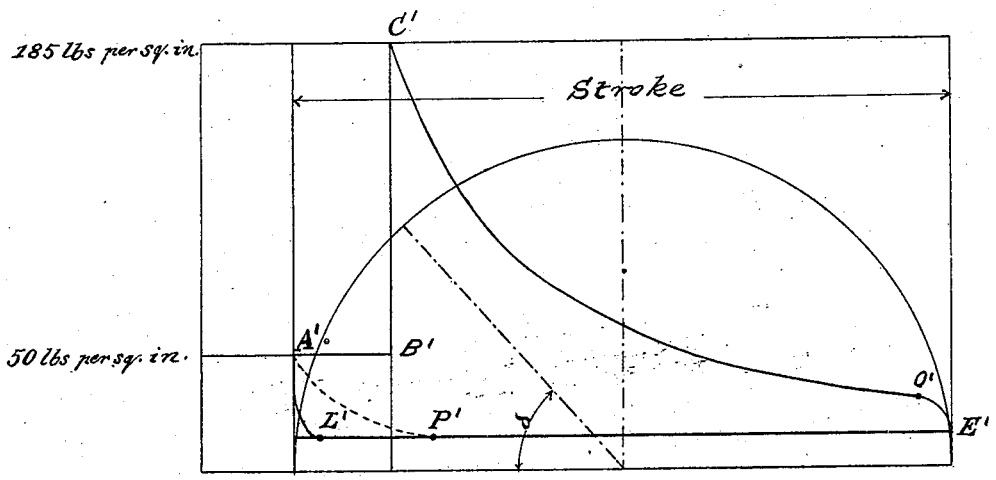
Fig. 6.



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UNITED STATES PATENT OFFICE.

HANS SCHWARZ, OF MANCHESTER, ENGLAND.

GAS, PETROLEUM, OR LIKE INTERNAL-COMBUSTION ENGINE.

SPECIFICATION forming part of Letters Patent No. 676,449, dated June 18, 1901.

Application filed December 19, 1900. Serial No. 40,427. (No model.)

To all whom it may concern:

Be it known that I, HANS SCHWARZ, a citizen of the Republic of Switzerland, whose post-office address is 4 Corporation street, Manchester, in the county of Lancaster, England, have invented new and useful Improvements in Gas, Petroleum, or Like Internal-Combustion Engines, (for which I have made application for patents in Germany, No. 15,471, dated December 20, 1899, and in Great Britain, No. 20,759, dated November 17, 1900,) of which the following is a specification.

My invention relates to improvements in two and four stroke cycle gas, petroleum, benzin, and like internal-combustion engines, and has for its object to provide means for preparing the combustible charge, whereby a great saving of gas or oil is attained and the engine will run more regular and much steadier than heretofore has been the case. This I attain by first heating the compressed air before entry into the working cylinder by the exterior of a chamber in the cover of the working cylinder, containing an incandescent ribbed metal body, afterward by the exhaust-gas, and finally, in entering the working cylinder, by the said body, which is rendered incandescent by the heat resulting from the explosion of the combustible charge in the working cylinder, and, secondly, by forcing gas or oil heated by the exhaust-gas into the heated air in the working cylinder. I attain these objects by the mechanism illustrated in the accompanying two sheets of drawings, in which—

Figure 1 is a vertical section; Fig. 2, a sectional plan; Fig. 3, an end view of the engine; Fig. 4, a sectional end view of the engine with silencing-box removed, and Fig. 5 a vertical section of the injection-valve on an enlarged scale. Fig. 6 is a diagram of the cycle of operation of a two-stroke engine.

Similar letters refer to similar parts throughout the several views.

A is the working cylinder; B, the working piston; C, the air-inlet valve, and D the exhaust-valve of the working cylinder. At the side of the latter a small cylinder E is employed, which by the channel *o* communicates with the working cylinder A and by the pipe *p* with the injection-valve V. The piston F of the cylinder E is placed under the influence of a spring and actuated, as usual, by a cam on the crank-shaft. (Not shown.) On the other side of the working cylinder A an air-cylinder G is employed, the piston H of which is, as usual, actuated by a crank-arm on the crank-shaft. (Not shown.)

The air-cylinder G has an air-inlet and an air-delivery valve I and K, respectively, which latter is operated by a cam *q* and by means of a pipe L connected with the jacket M of the cover N of the working cylinder A. From the jacket M a pipe O leads to an air-chamber P, in which the air drawn in by the piston H is stored. The said air-chamber communicates also with coiled pipes Q, inclosed in the exhaust-silencing box R and leading to the air-inlet valve C on the working cylinder, which serve to preliminarily heat the said air. The coiled pipes Q may, however, be substituted by a number of cast-iron pipes furnished externally with a large number of ribs, as will be readily understood.

The crank of the working-cylinder piston B is set in advance of that of the air-pump piston H to the angle δ shown in diagram Fig. 6, so that the air compressed in the air-cylinder is forced into the air-chamber P during the period of filling the working cylinder A with air.

As the temperature of the air passed through the heated pipes O and Q and over the incandescent body is considerably increased in the working cylinder—*i. e.*, the working air being allowed to expand in the said pipes and working cylinder—it is necessary that during each period of air compression the air-pump will supply the air-chamber P only with so much air as is required to keep its pressure constant. This I attain by forming the compression-space in the air-pump cylinder G slightly larger than usual, while the maximum compression in the air-pump cylinder does only slightly exceed the compression of the charge. The pressure of the stored compressed air is controlled by a safety-valve S and indicated on a pressure-gage T.

In the cover N of the working cylinder is employed the incandescent ribbed body U, and above the same the gas or oil injection valve V. (Shown in Fig. 5 enlarged.) To the interior of the gas or oil injection valve V

lead two ports *a b*, *a* of which communicates by the pipe *p* with the exhaust compression-pump E and *b* with the usual gas or oil pump. (Not shown.) The disk *c* of the gas or oil injection valve V has a piston-like extension *d*, so that the injection-valve will not open until shortly before the end of its lift. The said injection-valve is guided in a hollow piston *f*, which is secured upon the valve-spindle *g* and adapted to slide in the valve-body, which latter is closed by a lid *h*. The piston *f* of the injection-valve V is formed with two ports *i k*, *i* of which is adapted to come in and out of register with the port *a*, leading to the exhaust compression-pump, and *k* with the port *b*, leading to a gas or oil pump. (Not shown.) The piston-like extension *d* of the injection-valve disk *c* serves to cause the highly-compressed exhaust-gas in the exhaust-pump E to compress, and thereby heat the gas or oil in the injection-valve during its lift before it opens. The lever W actuates the injection-valve V and is oscillated by two cams *l m*, the cam *l* causing the admittance of the gas or oil into the working cylinder and the cam *m* relieving the injection-valve V to such an extent that the port *a* is slightly uncovered, while through the piston-like extension *d* on the injection-valve spindle *g* the interior of the injection-valve is still cut off from the working cylinder A, so that the pressure remaining in the same is for the moment reduced to one atmosphere or any other suitable pressure.

On the side of the cover of the working cylinder two pole-terminals X Y are employed, which are suitably connected with an electric ignition device.

The size of the clearance-space is reduced in the diagrams shown in Figs. 6 and 7 to the diameter of the working cylinder.

When working the engine on the two-stroke-cycle principle, (see diagram Fig. 6) it operates as follows: Shortly before the working piston has arrived at the end of the instroke—position L′—the air-inlet valve of the working cylinder and the delivery-valve of the air-pump open simultaneously, which causes a part of the air in the said heated pipes to be steadily forced forward into the working cylinder behind the forward-moving working piston, while the exhaust-gas remaining in the working cylinder is forced into the exhaust-pump. The layerwise contact with the incandescent body of the air entering the working cylinder considerably facilitates the equalization of the temperature between air and the said incandescent body. The air-inlet valve closes when the working cylinder has been supplied with the amount of air necessary for the charge (see position B′ of the working piston, diagram Fig. 6) and shortly afterward the delivery-valve of the air-pump when its piston has arrived at the end of its instroke. During the period of filling the working cylinder with compressed and heated air the gas or oil pump forces the necessary quantity of gas or oil into the injection-valve. Directly after the air-inlet valve has closed the exhaust-pump piston moves inward, and at its inner position the injection-valve opens and the heated gas is shotwise forced into the working cylinder by the highly-compressed exhaust-gas, mingled with a small volume of heated air, and this mixture then ignited by an electric spark. The combustion mixture expands in the working cylinder until the working piston has nearly reached the end of its outstroke, when the exhaust-valve opens (position O′ of the working piston, diagram Fig. 6) and the exhaust-gas is driven through the same into the silencing-box, the said valve remaining open during the instroke of the working piston. When the exhaust-valve opens, the exhaust-pump piston moves outward, and the pressure of the exhaust-gas remaining in the injection-valve is relieved by the respective lever operating the valve. When the working piston is nearly at the end of the instroke, (position L′ of the working piston, diagram Fig. 6,) the exhaust-valve closes again and the cycle of operation repeats itself. The pressure of the air entering the working cylinder and that of the exhaust-gas remaining in the working cylinder can be equalized by the early closing of the exhaust-valve, as the exhaust-gas remaining in the working cylinder will then be compressed to the same pressure as the working air, (see dotted curve P′ A′, diagram Fig. 6.)

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In gas, petroleum and the like internal-combustion engines, in combination, a working cylinder, an air-compression pump, a cover for the working cylinder containing an incandescent body, a jacket around the latter communicating with the air-compression pump and a pipe passing through the exhaust-box leading to the said incandescent body, the said incandescent body and air compressed into the said jacket being heated by the heat resulting from the explosion of the working charge which air in passing through the said pipes is further heated by the exhaust and finally by the said incandescent body before entering the working cylinder, all substantially as and for the purpose set forth.

2. In gas, petroleum and the like internal-combustion engines, in combination, a working cylinder, an air-compression pump, an exhaust-pump and a cover for the working cylinder containing an incandescent body and fitted with an injection-valve, the said working cylinder communicating with the said exhaust-pump and the latter with the said injection-valve from which the gas or oil is forced into the working cylinder by the exhaust-pump and which is heated by the exhaust before entering the working cylinder, all substantially as and for the purpose set forth.

3. In gas, petroleum and the like internal-combustion engines, in combination, a work-

ing cylinder, an air-compression pump, a cover for the said working cylinder furnished with an injection-valve and containing an incandescent body, a jacket around the latter communicating with the said air-compression pump and a pipe passing through the exhaust-box conducting compressed heated air over the incandescent body into the working cylinder for expansion therein during the outstroke of the working piston and increased compression on the instroke, all substantially as set forth.

4. In combination, the working cylinder, a cover therefor having a surrounding air-jacket, an air-pump for supplying air to said jacket, an exhaust-box, pipe connections for conveying the air from said jacket through the exhaust-box, an exhaust-pump connected with the cylinder, an injection-valve connected with said cover and having a chamber for the reception of the combustible material, and a pipe connection from said exhaust-pump to said chamber for forcing the combustible mixture into the cover when the valve is opened, substantially as described.

5. In combination with the working cylinder of an explosive-engine, an exhaust-pump communicating therewith, a valve for supplying combustible material and pipe connections from said exhaust-pump to said valve whereby the contents of said exhaust-pump are caused to force the combustible material into the explosion-chamber, substantially as described.

In witness whereof I have hereunto set my hand in presence of two witnesses.

HANS SCHWARZ.

Witnesses:

ALFRED BOSSHARDT,

STANLEY E. BRAMALL.