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PATENTED JUNE 25, 1907.

F. VON HANDORFF.
TWO CYCLE GAS ENGINE.
APPLICATION FILED DEC. 12, 1904.

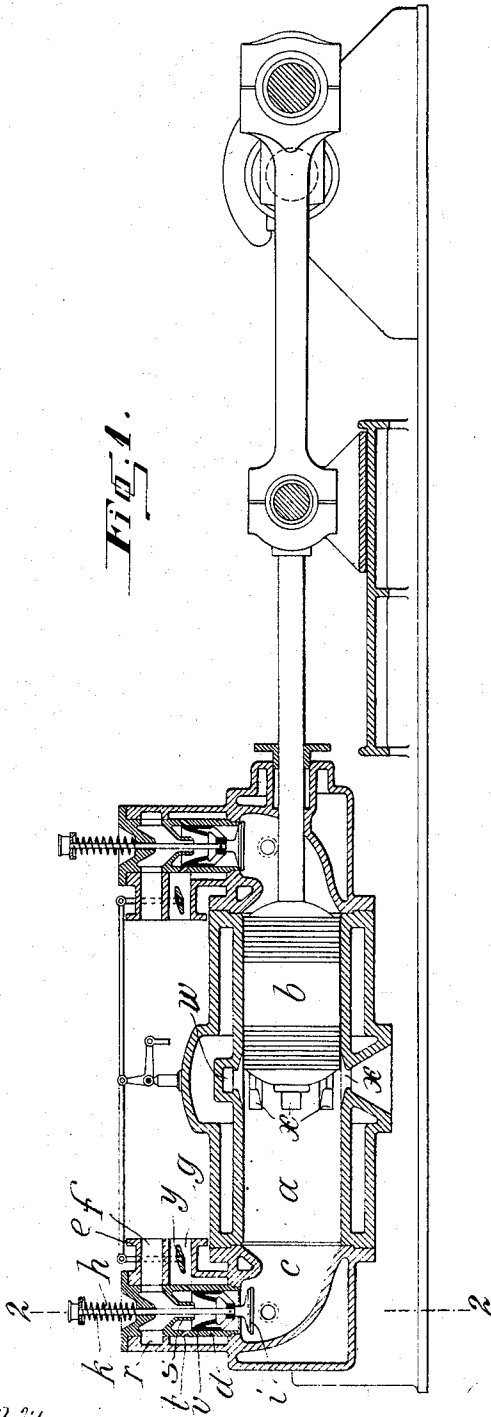


Fig. 1.

Fig. 3. Fig. 4. Fig. 5.

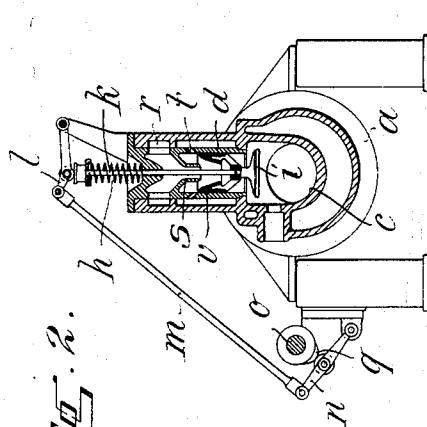
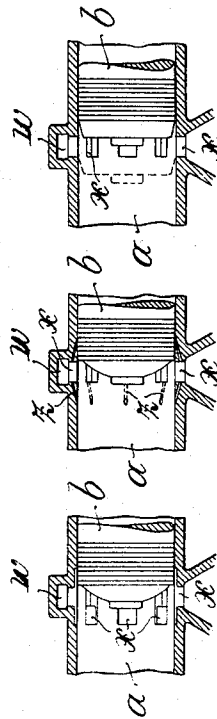


Fig. 2.

Witnesses.
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TWO-CYCLE GAS-ENGINE.

No. 858,280.

Specification of Letters Patent.

Patented June 25, 1907.

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To all whom it may concern:

Be it known that I, FRANZ VON HANDORFF, a citizen of the German Empire, residing at Frankfort-on-the-Main, Germany, have invented certain new and useful Improvements in Two-Cycle Gas-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.

This invention relates to an improved two cycle gas engine, for single or double action in which at or near the end of the exhaust stroke or at the beginning of the supply stroke the gases of combustion are removed by means of scavenging air supplied to the working-cylinder and by means of the next charge. The said gases of combustion are exhausted through conduits, arranged in the walls of the cylinder and adapted to be opened at the end of the explosion stroke, by the action of the piston. The scavenging of the working-cylinder and the introduction of the fresh charge consumes a certain amount of work, and the larger this amount of work is, the lower is the efficiency of the engine.

The object of the present invention is to reduce as far as possible the amount of work required for the purpose indicated, in order to obtain the highest possible efficiency of the engine.

According to this invention the gas is sucked by the compressed scavenging air, the filling of the working-cylinder being effected while the exhaust ports are open. The valve or slide for supplying the scavenging air and the explosive mixture is controlled by means of suitable gear, and the valve or slide for the supply of gas to the carbureter is also controlled by means of suitable gear. The amount of work required for scavenging and charging the working-cylinder is considerably reduced by using a special form of exhaust-ports, or a special form of working-piston by which the period during which the exhaust-ports are open is prolonged as much as possible. The amount of work required for scavenging and charging the working-cylinder depends upon the pressure with which the scavenging-air and the charge have to be introduced into the cylinder. Since this pressure depends on the pressure existing in the working-cylinder and on the time, which is at disposal for the scavenging and the introduction of the charge, it is obvious that

for the purpose of reducing the work consumed by the scavenging and charging effects the exhaust ports must remain open as long as possible, since while they are open the pressure in the working-cylinder is at its lowest point.

In the annexed drawings one form of the invention is shown by way of example as applied to a double-acting engine.

Figure 1 is a longitudinal vertical section of the engine, Fig. 2 a vertical cross-section on the line 2—2 of Fig. 1, Figs. 3 and 4 illustrate special forms of exhaust conduits for the working-cylinder, and Fig. 5 illustrates a special form of piston for the working cylinder.

The working-cylinder *a* in which moves the piston *b* is provided at each end with a cover or cylinder head *c* on which is mounted a valve-box *d* with a supply valve *i* and ports communicating with an air-supply conduit *f* and a gas-supply conduit *g* arranged in a nozzle *e*. The valve *i* is fixed to a spindle *k* and is adapted to be controlled by means of rods *l m n* operated by means of a cam *q* on the shaft *o*; a spring *h* tends to keep the said valve closed. The air conduit *f* leads into an annular chamber *r*, which communicates with a downwardly directed nozzle *s* formed in the valve-box *d*. The gas-conduit *g* communicates with the interior of the cylindrical valve-box *d* by means of slots *t*; a slide valve *v* for cutting off of the gas-supply is fixed to the spindle *k* within the valve-box.

The use of positively operated gear for controlling the supply of air and gas allows of exactly adjusting the quantities of scavenging air and explosive mixture to be used, and of cutting off each at its proper time.

In the wall of the cylinder *a* exhaust-slots *x* leading into the exhaust-conduit *w*, are arranged in such a manner that they are uncovered by the piston *b* near the end of the explosion stroke, so that the products of combustion can pass out of the cylinder.

The action of the engine is as follows:—When the piston *b*, which is shown in the drawing at a dead point exposes the slots *x* the products of combustion flow through said slots into the exhaust conduit channel *w* and mingle with the outer atmosphere. As soon as the pressure in the working-cylinder has fallen to a sufficiently low value the positively controlled supply valve *i* is opened, and the working cylinder is scavenged by

means of air passing through the nozzle *s* and the said valve *i*. Since the supply of gas must not take place till later, the slide valve *v* covers the slots *t* during a certain length of time. The duration of the scavenging action depends upon this length of time. As soon as the slots *t* are uncovered the air flowing through the nozzle *s* sucks gas through the said slots, so that explosive mixture passes into the working-cylinder. In the meantime the piston has commenced the compression stroke and closes the slots *x* before the explosive mixture can enter the exhaust-conduit *w*, whereupon the valve *i* and consequently also the slide valve *v* are closed. Toward the end of the compression stroke the ignition takes place and the explosion stroke commences; toward the end of the latter the described action is repeated.

As has already been mentioned the scavenging and charging of the working-cylinder takes place the more easily the more time there is at disposal for the operation, that is to say the longer the exhaust slots *x* are exposed. But the length of these slots cannot be increased at will owing to the heating of the uncooled wall-parts between them. If this heating is excessive the said wall-parts would be liable to become fractured. In order to overcome this difficulty the slots are according to the present invention made in a special manner. In the engine shown in Fig. 1 the walls of the centrally arranged slots *x* are at acute angles with regard to the axis of the cylinder, so that in the cylinder walls inclined grooves are formed, which lead to the exhaust ports communicating with the exhaust-conduit *w*, the depth of said grooves increasing toward the slots. Owing to this arrangement the uncovering of the slots *x* by the piston *b* takes place considerably earlier, and the closing thereof considerably later, without interfering with the cooling of the wall parts between the slots. Another considerable advantage is obtained by this arrangement, since the noise associated with the exhaust is considerably reduced, owing to the throttling of the gases of combustion when the uncovering of the slots *x* begins.

The exhaust-slots *x* can also be of the shape shown in Fig. 3, in which the grooves referred to are of substantially uniform depth, but with this form of construction the reduction of the noise is not so complete. The same applies to the form of construction shown in Fig. 4, in which small ducts *z* inclined with regard to the cylinder-axis, and leading from the slots *x* to the exhaust conduit *w* are provided in the wall of the cylinder.

Since the inner orifices of the slots *x* and the edges of the piston *b* are co-operating parts the period of exposure of the slots *x* can also be lengthened by giving the respective parts of the piston *b* a shape suitable for that purpose. This is illustrated in Fig. 5, in

which it will be seen that the diameter of the piston *b* is gradually reduced toward the end of the piston, so that the edges of the piston are at acute angles with regard to the inner surface of the cylinder. Owing to this arrangement the opening of the exhaust slots *x* takes place earlier, and the closing thereof later, than would be the case if the diameter of the piston *b* were uniform throughout.

The different forms of the exhaust-device shown in Figs. 1 to 5 can of course be combined in a suitable manner.

The governing of the engine in accordance with changes of load is either effected by controlling the gas-supply by means of a throttle valve *y* arranged in the gas-conduit *g* and operated by a suitable governor, or by causing a governor to control in a known manner, the stroke of the slide valve *v* through which gas is supplied.

The air for scavenging and combustion is either supplied to the engine from a compressed air chamber or it is forced directly into the working-cylinder by means of an air-pump, so that each supply stroke causes a volume of air corresponding to the stroke of the pump to enter the working-cylinder.

What I claim and desire to secure by Letters Patent is:—

1. In a two cycle gas engine, the combination of an explosive chamber, an inlet valve thereto, a supply pipe for air under pressure, a gas supply pipe, a valve controlling the gas supply, an injector in the air supply arranged to exert suction on the gas supply pipe, and means for automatically opening the inlet and gas supply valves in sequence in the order named.

2. In a two-cycle gas engine, the combination, of an explosion chamber, an inlet valve thereto, a supply pipe for air under pressure, a gas supply pipe, a valve controlling the gas supply, an injector in the air supply concentric of the gas supply, and means for automatically and positively opening the inlet and gas supply valves in sequence in the order named.

3. In a two-cycle gas engine, the combination, of an explosion chamber, an inlet valve thereto, a supply pipe for air under pressure, a gas supply pipe, an annular valve controlling the gas supply, an injector in the air supply concentric of the gas supply valve, and means for automatically and positively opening the valves in sequence in the order named.

4. In a two-cycle gas engine, the combination, of an explosion chamber, an inlet valve thereto, a supply pipe for air under pressure, a nozzle arranged as a terminus of the air supply pipe, a supply pipe for fuel under substantial atmospheric pressure, an annular slide valve concentric with the nozzle and admitting gas to the interior of said valve around the nozzle, and means for opening the

inlet valve to the explosion chamber and the gas valve concentric of the nozzle in sequence in the order named.

5. In a two-cycle gas engine, the combination, of an explosion chamber, a supply pipe for air under pressure, a nozzle arranged as a terminus of the air supply pipe, an inlet valve to the explosion chamber with its stem loosely in the nozzle, a gas supply pipe discharging concentrically of the nozzle, an annular slide valve carried by the inlet valve stem and arranged to free the gas discharge openings after the opening of the inlet valve, said annular valve having an interior conical surface concentric with the nozzle and arranged in advance thereof, and means for automatically and positively operating the inlet valve.

6. In an internal combustion engine, the combination, with a cylinder and a piston moving therein, of exhaust ports controlled by the piston and having their walls lying obliquely to the coacting piston surface and forming therewith an angle of more than 45° .

7. In an internal combustion engine, the combination, with a cylinder and a piston moving therein, of exhaust ports controlled by the piston and arranged in the walls of the cylinder with their walls lying obliquely to the axis of the cylinder.

8. In an internal combustion engine, the combination, with a cylinder and a piston moving therein, of exhaust ports controlled by the piston and arranged in the walls of the cylinder with inclined approaches.

9. In a two-cycle gas engine, the combination, with a cylinder, a piston moving therein, and exhaust ports controlled by the piston, of an explosion chamber, a supply pipe for air under pressure, a nozzle forming the terminus of the air pipe, an inlet valve, an annular gas inlet valve arranged to discharge the gas concentrically of the nozzle, and means for automatically and positively operating said valves in sequence in the order named.

10. In a two-cycle gas engine, the combination, with a cylinder, a piston moving therein, exhaust ports controlled by the piston and having their walls lying obliquely to the coacting piston surface and forming therewith an angle of more than 45° , of an explosion chamber, an inlet valve for air under pressure, a gas inlet valve, and means for automatically and positively operating said gas inlet valve.

11. In a two-cycle gas engine, the combination, with a cylinder, a piston moving therein, and exhaust ports controlled by the piston and arranged in the walls of the cylinder with their walls lying obliquely to the axis of the cylinder, of an explosion chamber, an inlet valve for air under pressure, a gas inlet valve, and means for automatically and positively operating said valves in sequence in the order named.

12. In a two-cycle gas engine, the combi-

nation, with a cylinder, a piston moving therein, exhaust ports controlled by the piston and arranged in the walls of the cylinder with their walls lying obliquely to the axis of the cylinder, of an explosion chamber, a supply pipe for the air under pressure, an inlet valve from said pipe to the explosion chamber, a gas supply pipe discharging into the air supply pipe, a valve controlling the discharge from the gas pipe, and means for operating said gas valve automatically and positively.

13. In a two-cycle gas engine, the combination, with a cylinder, a piston moving therein, and exhaust ports controlled by the piston and arranged in the walls of the cylinder with their walls lying obliquely to the axis of the cylinder, of an explosion chamber, a supply pipe for air under pressure, an inlet valve from said pipe to the explosion chamber, a gas supply pipe discharging into the air supply pipe and means for operating said valves in sequence in the order named.

14. In a two-cycle gas engine, the combination, with a cylinder, a piston moving therein, and exhaust ports controlled by the piston and arranged in the walls of the cylinder with their walls lying obliquely to the axis of the cylinder, of an explosion chamber, an inlet valve thereto, a supply pipe for air under pressure, a gas supply pipe, a valve controlling the gas supply, an injector in the air supply adjacent to the gas supply, and means for automatically and positively operating the gas supply valve.

15. In a two-cycle gas engine, the combination, with a cylinder, a piston moving therein, and exhaust ports controlled by the piston and arranged in the walls of the cylinder with their walls lying obliquely to the axis of the cylinder, of an explosion chamber, an inlet valve thereto, a supply pipe for air under pressure, a gas supply pipe, a valve controlling the gas supply, an injector in the air supply adjacent to the gas supply, and means for automatically and positively operating the valves in sequence in the order named.

16. In a two-cycle gas engine, the combination, with a cylinder, a piston moving therein and exhaust ports controlled by the piston and arranged in the walls of the cylinder with their walls lying obliquely to the axis of the cylinder, of an explosion chamber, an inlet valve thereto, a supply pipe for air under pressure, a nozzle arranged within the air supply pipe, a gas supply pipe, an annular slide valve concentric with the nozzle and admitting gas to the air supply pipe, and means for opening the inlet valve to the explosion chamber and the gas valve adjacent to the nozzle in sequence in the order named.

17. In a two-cycle gas engine, the combination, with a cylinder, a piston moving therein, and exhaust ports controlled by the

piston and arranged in the walls of the cylinder with their walls lying obliquely to the axis of the cylinder, of an explosion chamber, a supply pipe for air under pressure, a nozzle
5 arranged within the air supply pipe, an inlet valve to the explosion chamber with its stem in the air supply pipe, a gas supply pipe discharging into the air supply pipe concentric with the nozzle, a slide valve carried by the
10 inlet valve stem and arranged to free the gas

discharge openings after the opening of the inlet valve, and means for automatically and positively operating the inlet valve.

In testimony whereof I have hereunto affixed my signature in the presence of two witnesses. 15

FRANZ VON HANDORFF.

Witnesses:

JEAN GRUND,
CARL GRUND.