No. 891,078. PATENTED JUNE 16, 1908.

H. JUNKERS.

EXPLOSION ENGINE.

APPLICATION FILED JUNE 12, 1905.

3 SHEETS—SHEET 1.

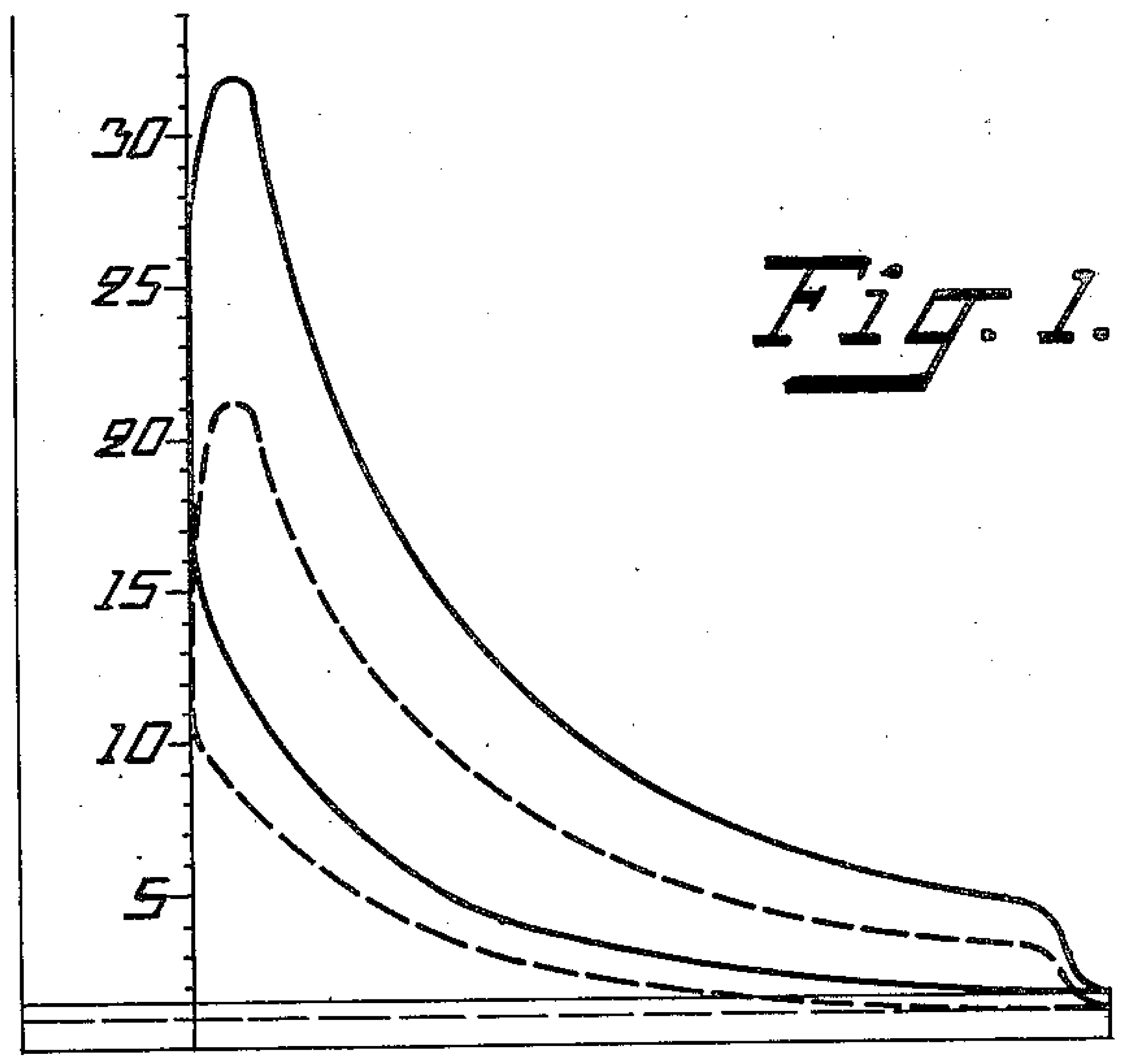

Fig. 1.

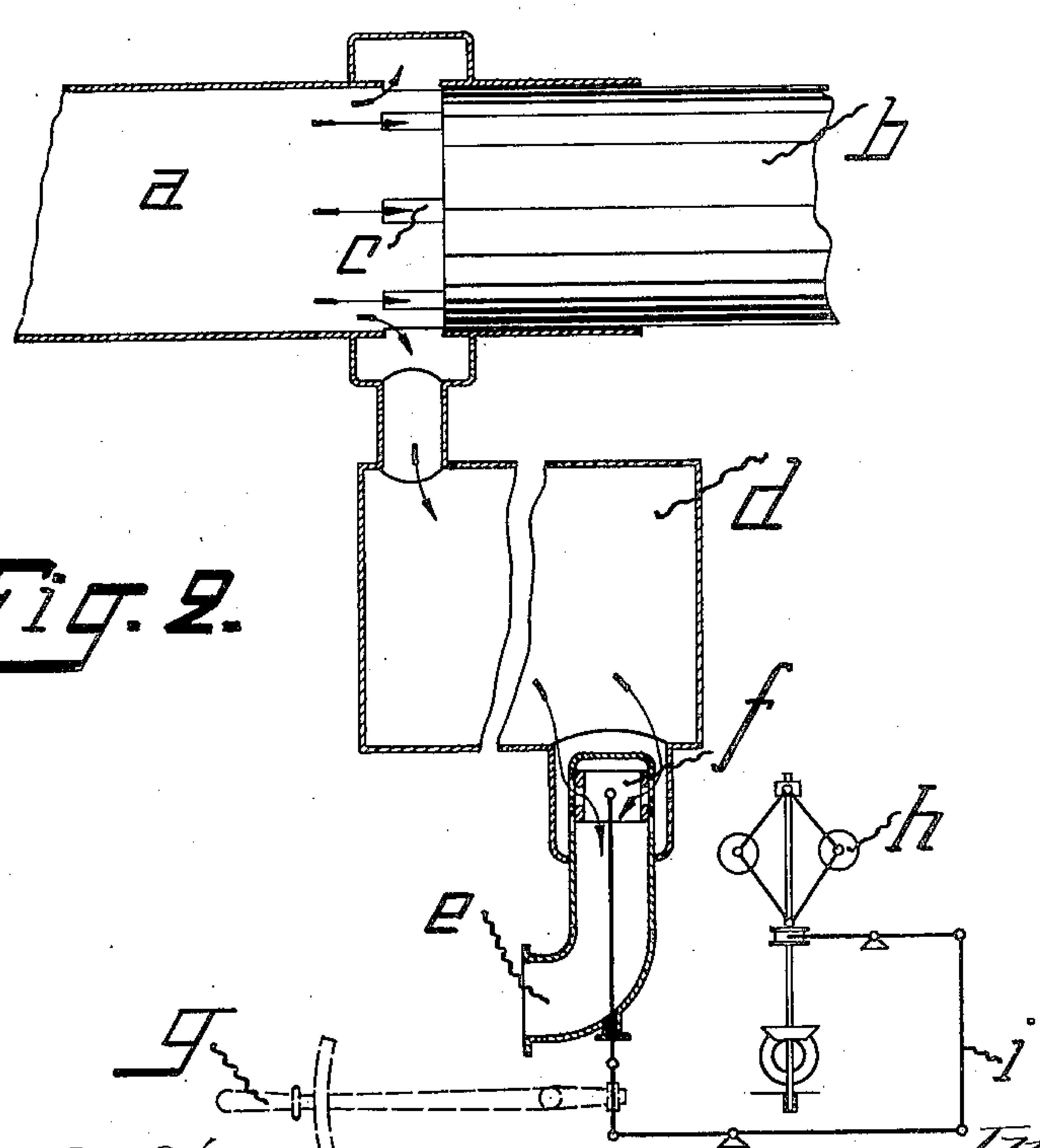

Fig. 2.

Witnesses;
Wm. T. Jones.
C. D. Kesler

Inventor
Hugo Junkers
By James L. Norris.
Atty.

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3 SHEETS—SHEET 2.

Fig. 3.

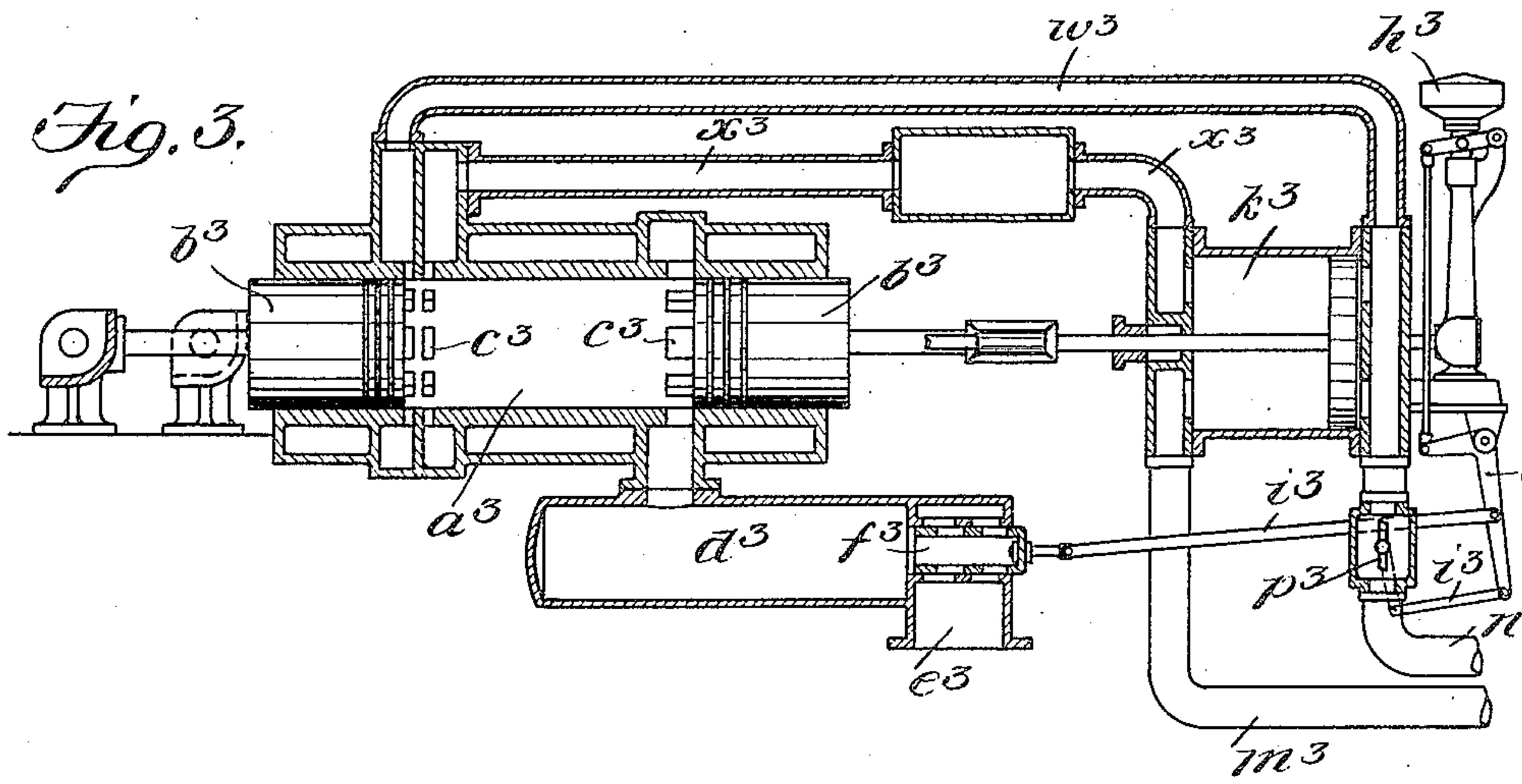
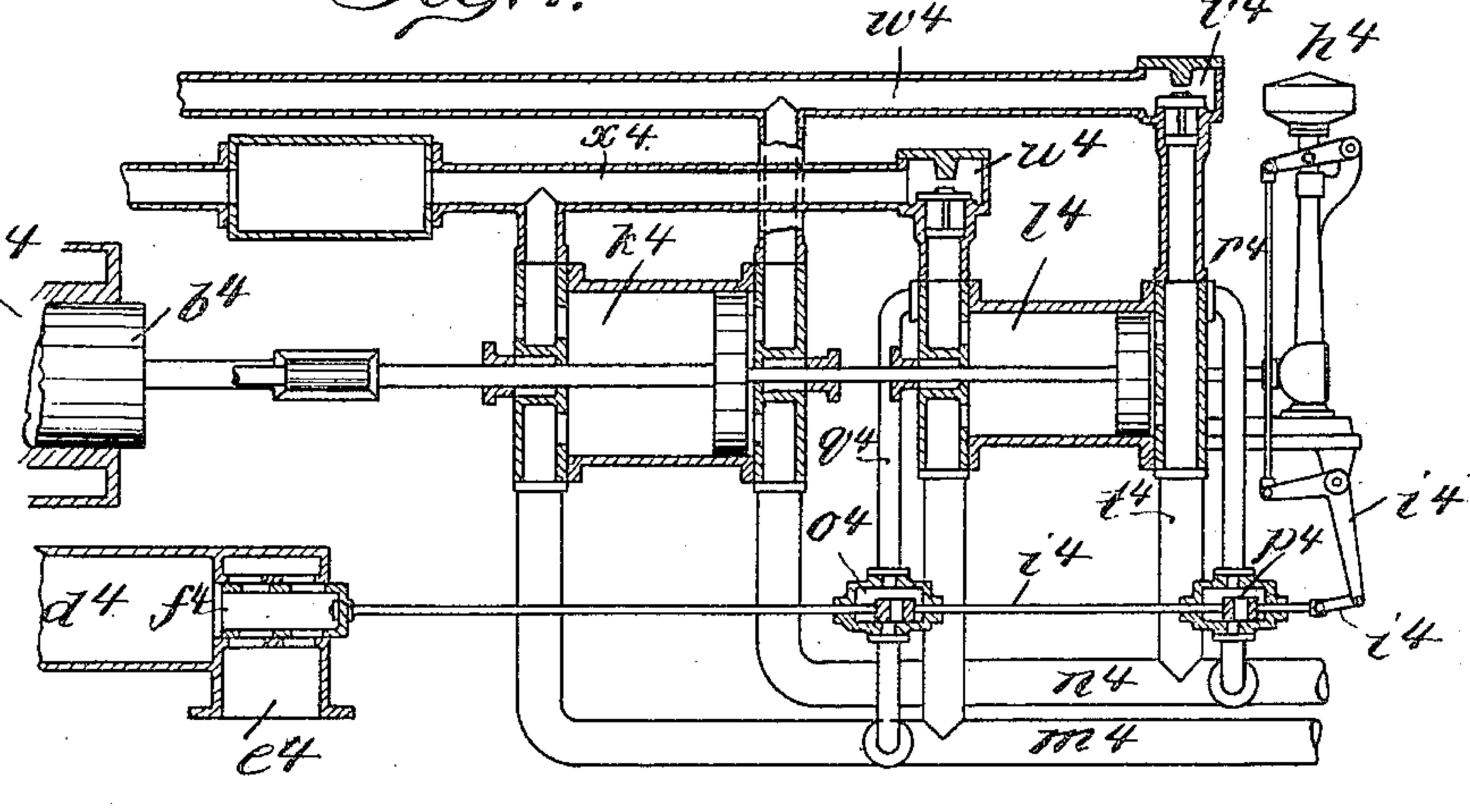


Fig. 4.



Witnesses

H. O. Vanderen

C. L. Kesler

Inventor

Hugo Junkers

By James L. Norris

Atty.

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3 SHEETS—SHEET 3.

Fig. 5.

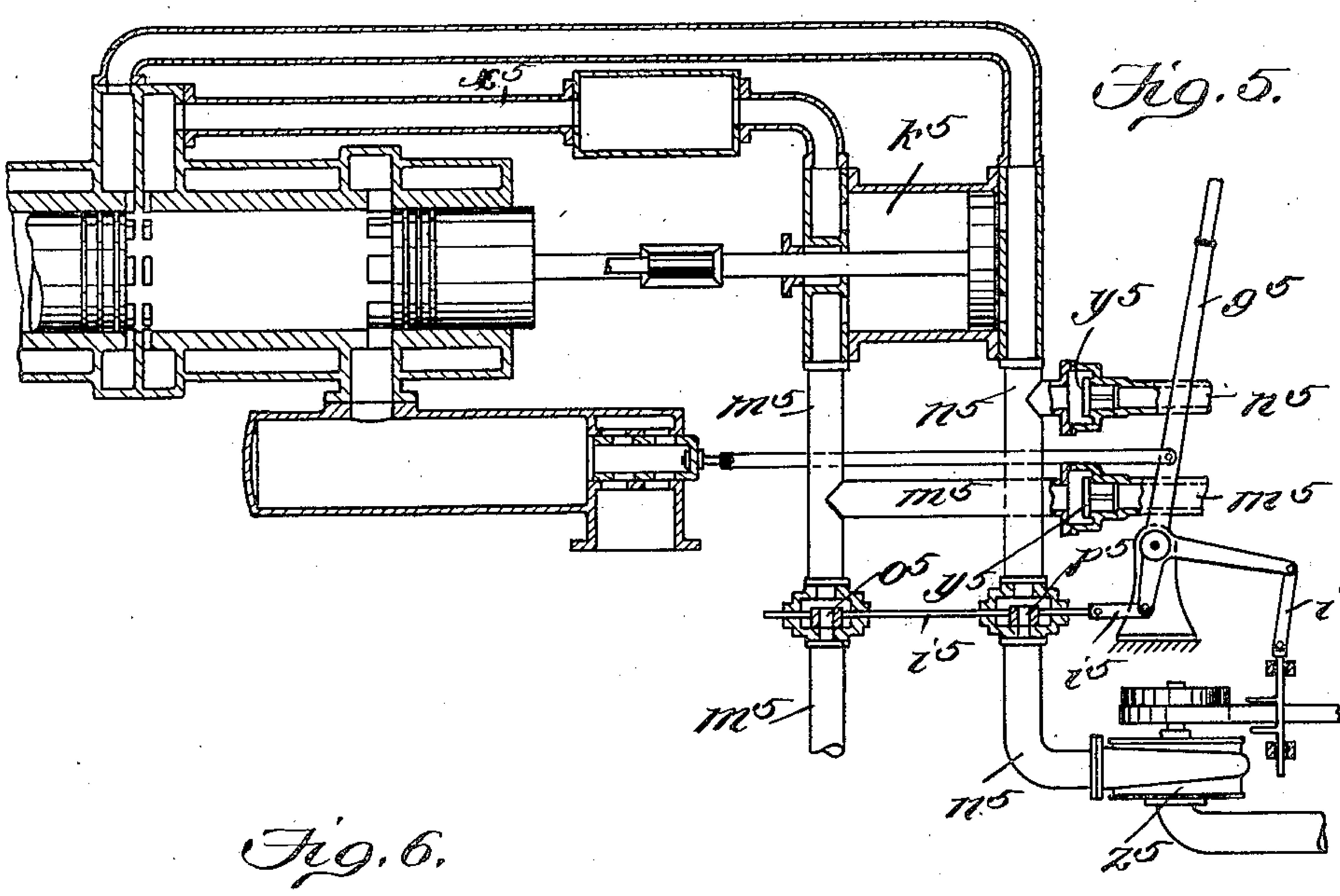


Fig. 6.

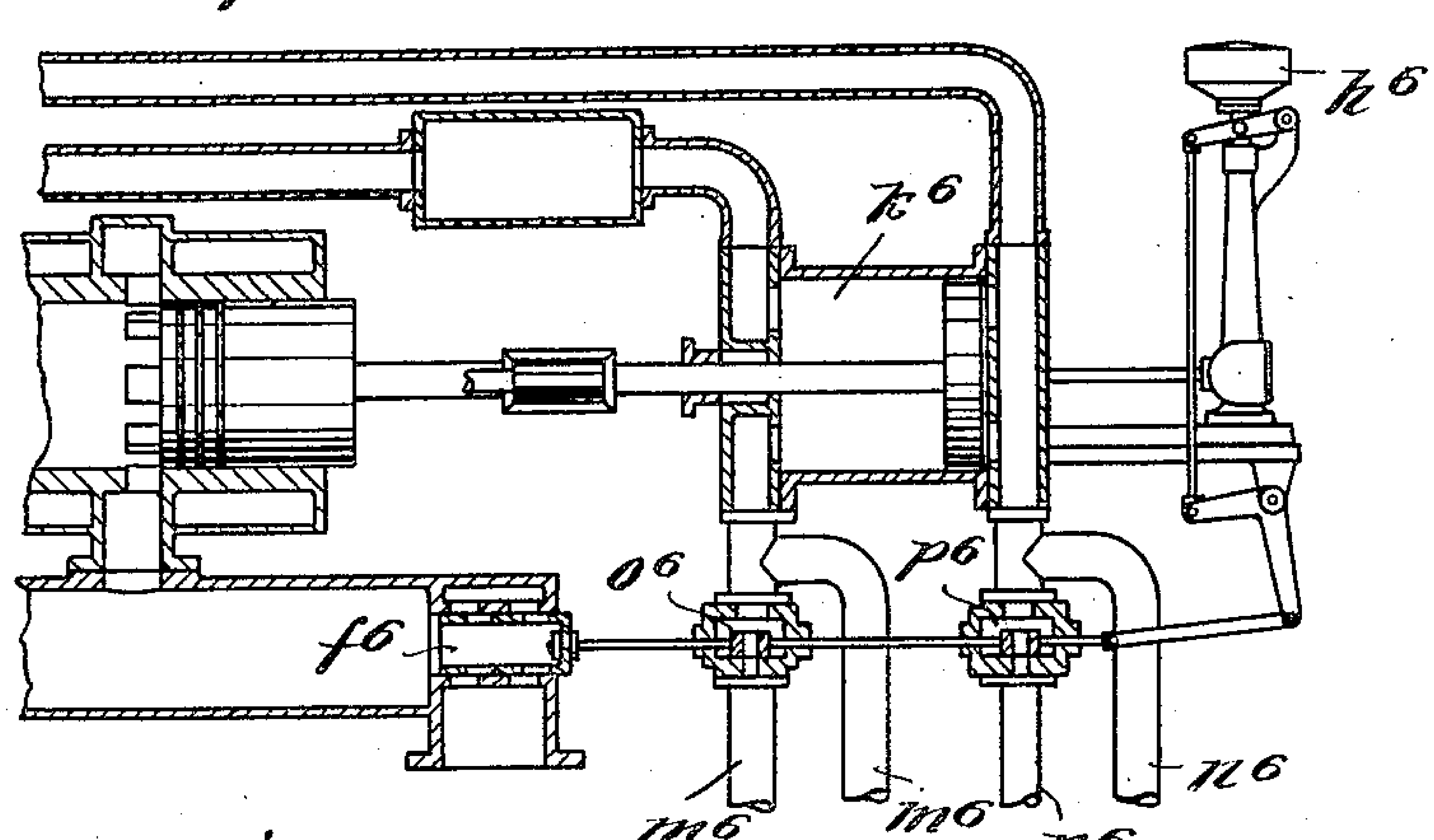
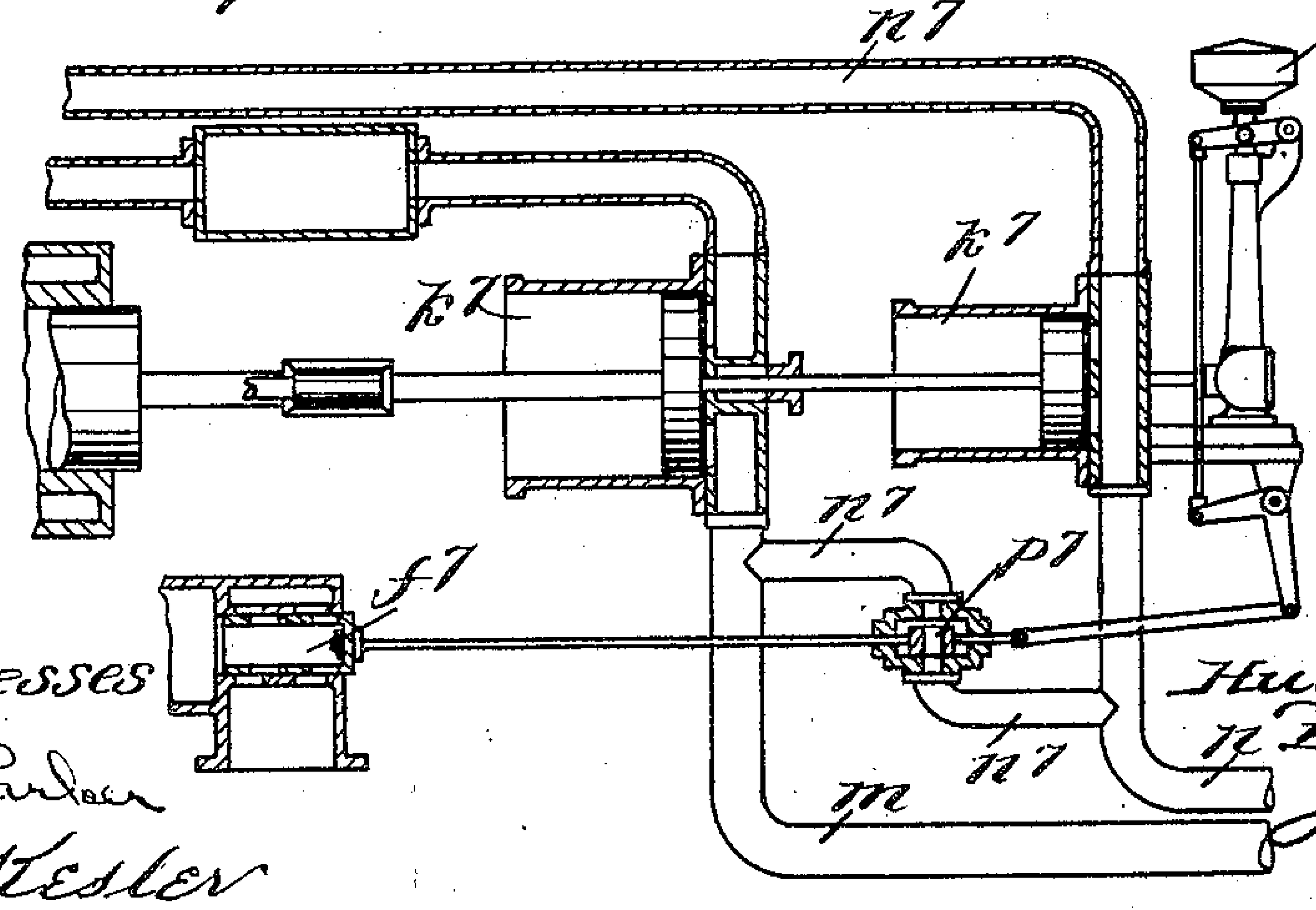


Fig. 7.



Witnesses

A. O. Parker

C. L. Kesler

Inventor

Hugo Junkers

By James L. Norris

Atty.

UNITED STATES PATENT OFFICE.

HUGO JUNKERS, OF AACHEN, GERMANY.

EXPLOSION-ENGINE.

No. 891,078. Specification of Letters Patent. Patented June 16, 1908.

Application filed June 12, 1905. Serial No. 264,842.

To all whom it may concern:

Be it known that I, HUGO JUNKERS, a subject of the King of Prussia, residing at Aachen, in the Empire of Germany, have invented certain new and useful Improvements in and Relating to Explosion-Engines, of which the following is a specification.

This invention has for its object the governing and temporary increase of the duty of two-stroke-cycle explosion-engines with separate charging or compressing pumps. It is based on the fact that the duty of the engine is directly proportional to the weight of the explosive mixture present in the working cylinder at the beginning of the compression and that this weight, under otherwise similar conditions, is itself proportional to the pressure at which the filling of the working cylinder with the mixture takes place.

In the drawings: Figure 1 is a diagrammatical view of variable conditions of pressure in a cylinder of an engine showing in full lines the conditions at 1.5 atmospheres initial pressure, and in dotted lines the conditions of pressure when the filling of the cylinder takes place under atmospheric pressure; Fig. 2 is a view partly in section of a working cylinder and piston of an engine with the throttling device associated therewith; Fig. 3 shows an engine with simultaneous regulation of the exhaust and of the gas pump. Fig. 4 is an engine with an auxiliary gas and air pump; Fig. 5 is an engine to which gas and air can be supplied at a high pressure; Fig. 6 an engine with an auxiliary gas pipe; and Fig. 7 an engine with an air pump of much larger size which in case of need also pumps gas.

In Fig. 1 of the drawing, two diagrams are shown, of which the one in dotted lines shows the pressure-conditions when filling of the working cylinder takes place under atmospheric pressure, and the one drawn in full lines shows the conditions at 1.5 atmospheres initial pressure. It can be seen from the diagram that, at similar positions of the piston, the pressure in the diagram drawn in full lines stands throughout in the same proportion to the pressure in the diagram drawn in dotted lines, as the initial pressure of the former is to the initial pressure of the latter, and that the mean pressure and therefore the indicated power or duty in the first case is likewise 50% higher than in the second.

According to the present invention, the pressure under which the exhaust of the working cylinder and the filling thereof with a new charge takes place, is altered by regulating the pressure existing in the cylinder at the end of the exhaust, this regulation being effected in such a manner that, in the normal running of the engine, the exhaust into the atmosphere takes place without back-pressure, while when a forced higher duty is required, the back-pressure in the exhaust passage is artificially increased. The governing of the engine from running light up to normal duty takes place in the usual manner.

The regulation of the back-pressure at the exhaust can be effected as follows:—In the exhaust pipe, there is arranged a shut-off device which is more or less closed, either by hand, or in the case where the speed of the engine is reduced, by the governor of the engine, or by any other automatic regulating device. Fig. 2 of the drawing shows a throttling device of this kind, which here consists of a balanced piston-valve *f* with a number of slots. The movement of the piston-valve can here be effected, as shown in dotted lines by way of example, by means of a hand-lever *g*, or as is illustrated in full lines, the piston-valve is connected by linkwork *i* to the governor *h* of the engine. Instead of the piston-valve, a shut-off device of any desired construction can be employed; even a simple throttle- or butterfly-valve is sufficient, since a perfectly fluid-tight closure is not required. In Fig. 2, *a* is the working cylinder and *b* the working piston; the exhaust of the engine takes place by way of example through the slots *c*, when the latter are uncovered by the piston, into the exhaust casing *d*. From the valve *f*, the gases flow through the exhaust-pipe *e* into the atmosphere.

Fig. 3 shows an Oechelhauser and Junkers engine with pistons adapted to run in opposite directions. The fly-wheel and gearing and also the small valves of the pumps are not shown here, in order not to interfere with the clearness.

a is the working cylinder, *b′* and *b* the working pistons, *c* the exhaust ports, *c′* the gas-inlet, *c″* the air inlet, *d* the exhaust casing, *e* the exhaust pipe, *f* the throttle valve, *h* the governor, *i*, *i′* and *i″* the link-work which actuates the throttle-valve and the valves *o* and *p*, and in this manner controls the scavenging air and the gaseous mixture.

k is a pump, the left-hand side of which throws the normal amount of air and the right-hand side the normal amount of gas; l is an auxiliary pump, the sides of which act like the pump k and which is always at work; m is the air and n the gas-suction pipe, from which the normal and the auxiliary pumps are supplied.

o and p are slide-valves; when they are open, the gas and air from the auxiliary pump return through the by-pass conduits q and r into the suction pipes m and n, if on the other hand, they are entirely or partially closed, the gases pass through the check valves u v into the main air and gas pipes w, x and from there through the ports c' c'' into the working cylinder a.

s and t are the suction pipes of the auxiliary pump.

When by reason of overloading of the engine the speed sinks, the weights of the governor fall and throttle the exhaust-pipe and at the same time also the air and gas by-passes of the auxiliary pump, so that the additional air and gas can enter the working cylinder.

It is more advantageous to arrange the throttling device in the exhaust pipe behind the exhaust casing, than between the latter and the engine, although the latter arrangement is permissible.

It is clear that, with artificial increase in the back-pressure, a complete scavenging must nevertheless take place and moreover, when there is a higher exhaust pressure, the pressure of the scavenging air must also be correspondingly high and the quantity thereof as well as that of the fuel must be correspondingly high, in order to fill the working cylinder at the higher pressure. These requirements can be fulfilled in various ways:—

(1). The charging or compressing pumps are made sufficiently large to enable them to supply the increased amount.

(2). The pumps have only the size required for normally working and on increase of the power, the extra amount of gaseous mixture needed is provided by a separate pump or a blower, which is driven in a similar manner to the ordinary charging or compressing pump or device, either from the engine itself or in any other suitable manner, for example, from the shafting or other transmission gearing, or by a separate engine, and can either continuously run light or be thrown into gear simultaneously with the throttling device by the governor or by hand.

(3). The pumps have the size required for normal working, and in the case of an extra load, the surplus is obtained by supplying the gas and air to the pumps with a preliminary compression at a higher pressure than the atmospheric. The driving can take place as in the previous case, the air can for example be taken from a blower.

(4). The increased supply of fuel can be provided in the normal or standard fuel pumps by adding fuel of a higher heat value in a gaseous or liquid form (carbureting).

(5). The gas pump is of sufficient size for normal working, while the air-pump itself, or in combination with an auxiliary device, corresponds to the increased duty and the amount of gas required for the increase in the power is simultaneously drawn in by the air pump.

In Fig. 3, a^3 is the working cylinder, in which the two pistons b^3, b^3 move in opposite directions and towards the end of their travel uncover the exhaust-ports c^3 the air-admission-apertures c^3 and the gas-admission apertures c^3.

d^3 is the exhaust-chamber, e^3 the exhaust-pipe, f^3 the throttle valve of the exhaust, h^3 the governor which is controlled by means of the linkwork i^3, i^3, i^3 simultaneously with the throttle-flap p^3, and in this manner regulates the pressure at which the working cylinder is charged with explosive mixture and also the amount of fuel.

k^3 is a pump, the left-half end of which supplies the scavenging and charging air and the right-hand side supplies the gas.

m^3 is the air and n^3 the gas suction pipe, in which the throttle-flap p^3 is arranged.

w^3 is the pipe which conducts the gas to the working cylinder; x^3 the pipe which conducts the air to the working cylinder.

The pump k is made sufficiently large to supply the amount of gas and air required for increasing the duty. This amount of air is continually being pumped, the excess air at low duty escaping through the valve f^3 which is then quite open. In this case, the throttle-flap in the gas pipe is entirely or partially closed, so that only a small quantity of gas is drawn in. If the duty required of the engine increases above the normal, the adjusting mechanism of the governor h^3 descends and opens the throttle flap p^3 and at the same time it closes the valve f^3 to such an extent that the exhaust gases all escape from the cylinder at a high pressure; the excess air does not however escape but remains in the cylinder and in combination with the larger amount of fuel, yields a more powerful explosive mixture than at normal running, whereby the duty of the engine is increased.

In Figs. 4 to 7, corresponding reference letters have different superscript figures; so far as they are not specially explained, they have the same meaning as the corresponding reference letters in the preceding figures.

The constructional form in Fig. 4 differs from that in Fig. 3 in that the air and gas pump k^4 has only the size necessary for normal working, and an auxiliary pump l^4 is provided which is constructed like the pump k^4 and at increased duty supplies the additional amount of air and gas required. In the pipes connecting the auxiliary pump with the pipes x^4 and w^4, there are arranged check valves u^4, v^4. The auxiliary pump l^4 draws air through the pipe a^4 out of the pipe m^4 and draws gas through the pipe t^4 out of the pipe m^4. The auxiliary pump is always running and since, during normal running of the engine, the auxiliary pump is to pump neither gas nor air, by-pass conduits q^4, r^4 are provided, which are connected to m^4 and n^4 respectively, valves o^4 and p^4 being intercalated therein. In the normal running of the engine, the valves f^4, o^4, p^4 are opened, so that the working cylinder at atmospheric pressure is only charged by the pump k^4. In the maximum duty of the engine, o^4 and p^4 are entirely and f^4 is partly closed, and the amounts thrown by the pump l^4 pass through the valves u^4, v^4 into the pipes x^4, w^4.

In the engine shown in Fig. 5, there is shown a normal gas and air pump k^5; at increased duty, the additional amount of gas required is supplied from a blower z^5 to the gas pump under increased pressure. The additional amount of air required is in this case taken through the pipe m^5 for example from the blast pipe of a blast furnace when the engine is erected in a smeltering works. In the pipe m^5 there is a pipe o^5, the blower z^5 is in communication through the pipe n^5 and the valve p^3 with the gas suction pipe n^5, in which there is a check valve y^5. In the air suction pipe m^5 there is a check valve y^5. A hand lever g^5 is connected through the linkwork i^5 with the valves o^5 and p^5, and also through i^5 with the belt striking gear of the blower z^5, in such a manner that o^5 and g^5 are opened and at the same time the blower is thrown into operation. In this case, the pump k^5 receives gas and air under a high pressure, which is prevented by the valves y^5 and y^5 from escaping from the suction pipes m^5 and n^6.

The engine in Fig. 6 also has a pump k^6 of normal size. The additional amount required at high duty of the engine is obtained, as in the engine in Fig. 5, through the pipe m^6 and valve o^6 from the common blast pipe of the works, the additional amount of gas being supplied from a pipe n^6, which gas is of specially high heat value. The governor h^6 opens the valves o^6 and p^6 and at the same time closes f^6 when it descends.

The engine in Fig. 7 has a single acting air pump k^7 which is of such size that, in addition to the amount of air required at maximum duty, it can receive another part of gas, while the gas pump k^7 is only of the size required for normal working. A pipe n^7, in which there is a valve p^7, unites the gas-pipe n to the air-pipe m. The valve p^7 is opened by the governor h^7 when a high duty is required, while the valve f^7 is partly closed.

Figs. 3 to 7 are only intended to show the most important cases of how my engine may be constructed. Obviously more combinations are possible. I will not limit myself by specifying them here. To an expert they follow directly from the main types set forth.

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

1. The combination in a two-stroke cycle internal combustion engine, of a working cylinder to which a combustible mixture is supplied from a separate compression or charging pump, an exhaust conduit communicating with said cylinder, a throttling device in said conduit, and means for controlling said throttling device, the working cylinder being filled with more combustible mixture, when the throttling device has partly closed the exhaust, for the purpose of filling the working cylinder at the beginning of the compression with combustible mixture at a pressure higher than that of the atmosphere when the amount of power required from the engine increases.

2. The combination, in a two-stroke cycle internal combustion engine, of a working cylinder, a separate compression or charging pump, a conduit communicating between said compression pump and said working cylinder, an exhaust conduit communicating with said working cylinder, a throttling device in said exhaust conduit, and means for simultaneously controlling said throttling device and the operation of said charging pump in such a manner that the working cylinder is filled with a larger quantity of combustible mixture, the more the throttling device is closed.

3. The combination, in a two-stroke cycle internal combustion engine, of a working cylinder, a separate compression or charging pump, a conduit communicating between said charging pump and said working cylinder, an exhaust conduit communicating with said working cylinder, a throttling device in said exhaust conduit, a centrifugal governor for controlling said throttling device and the operation of said charging pump in such a manner that the working cylinder is filled with a larger quantity of combustible mixture, the more the throttling device is closed.

4. The combination, in a two-stroke cycle internal combustion engine, of a working cylinder to which a combustible mixture is supplied from a separate compression or charging pump, an exhaust conduit communicating with said cylinder, a throttling device in said conduit, a separate auxiliary charging pump, and means for setting the auxiliary charging pump in operation when the said throttling device is actuated.

5. In a two stroke cycle internal combustion engine having separate charging or com-

pression pumps, the combination, with the working cylinder, of means which permit the working cylinder at the beginning of the compression to be completely filled with combustible mixture at a pressure higher than that of the atmosphere, and means for throttling the exhaust at the beginning of the compression when the working cylinder is to receive combustible mixture of a pressure higher than that of the atmosphere, for the purpose of increasing the duty of the engine by throttling the exhaust.

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

HUGO JUNKERS.

Witnesses:
HENRY QUADFLIEG,
E. M. BRUNDAGE.