No. 880,050. PATENTED FEB. 25, 1908.

J. SULZER.

REVERSING GEAR FOR INTERNAL COMBUSTION ENGINES.

APPLICATION FILED DEC. 5, 1905.

4 SHEETS—SHEET 1.

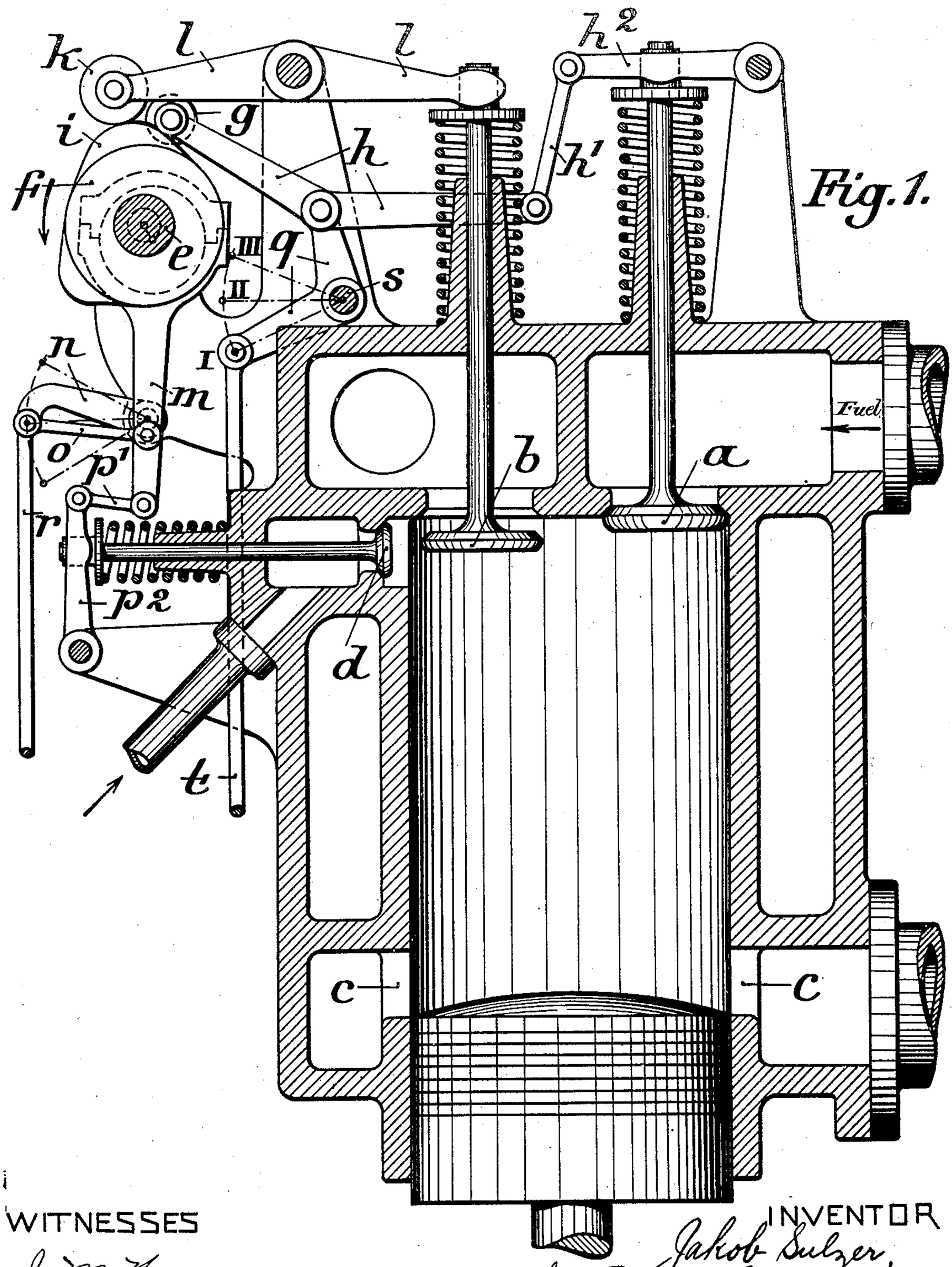

Fig. 1.

WITNESSES

J. M. Wrenn

Thos. Howe

INVENTOR

Jakob Sulzer,

by Pennie & Goldsborough

ATTORNEYS.

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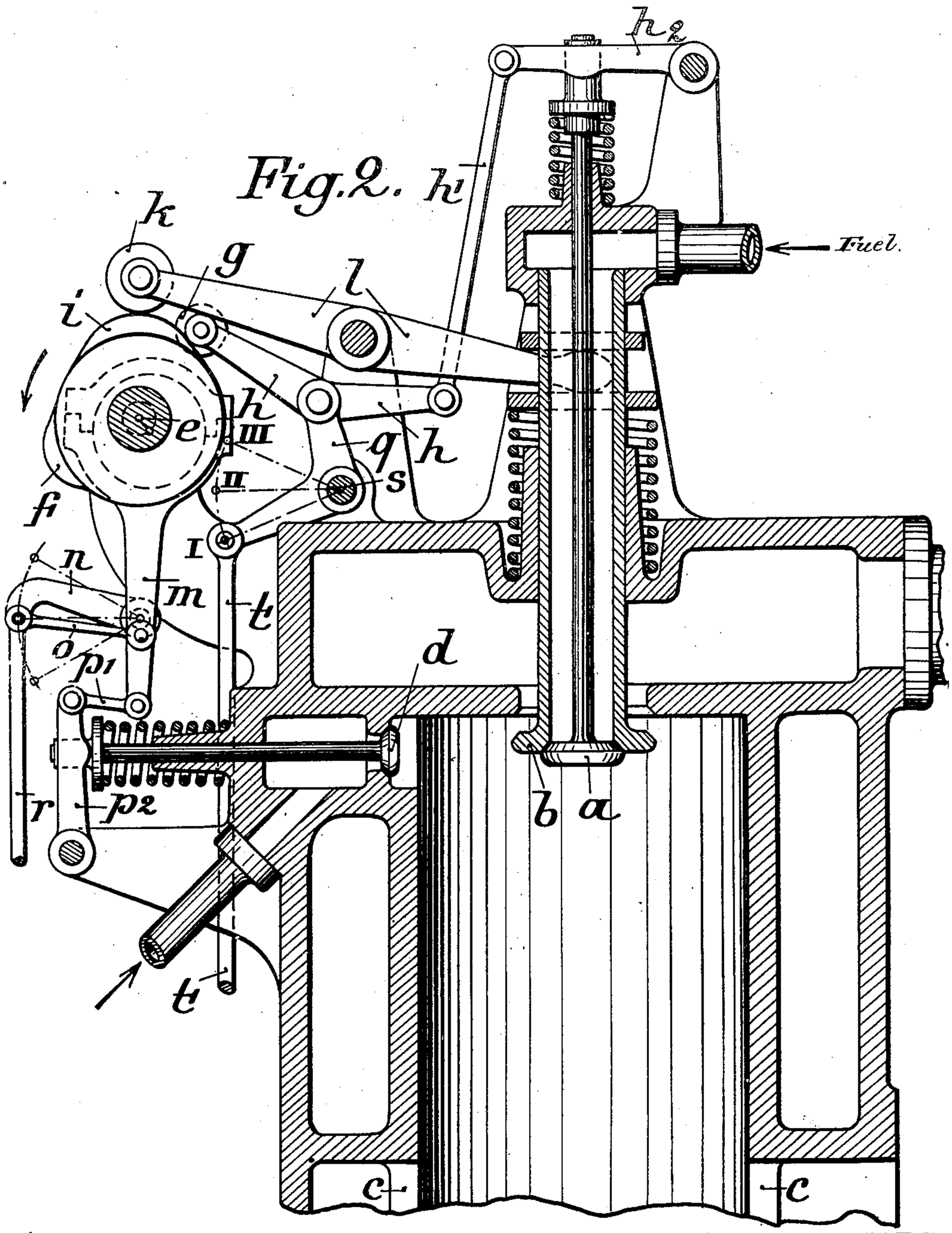
4 SHEETS—SHEET 2.

Fig. 2.



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4 SHEETS—SHEET 3.

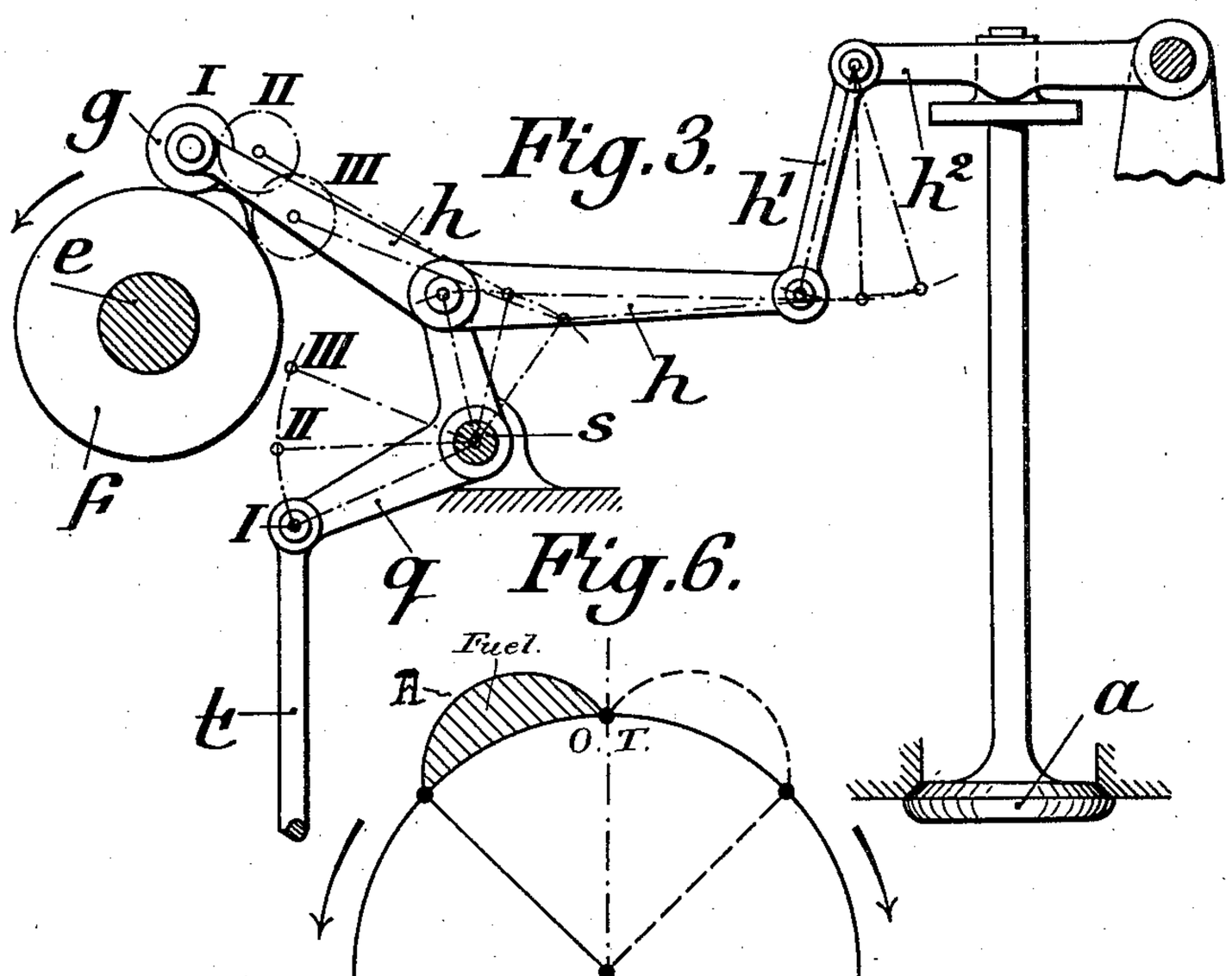


Fig. 3.

Fig. 6.

Fig. 7.

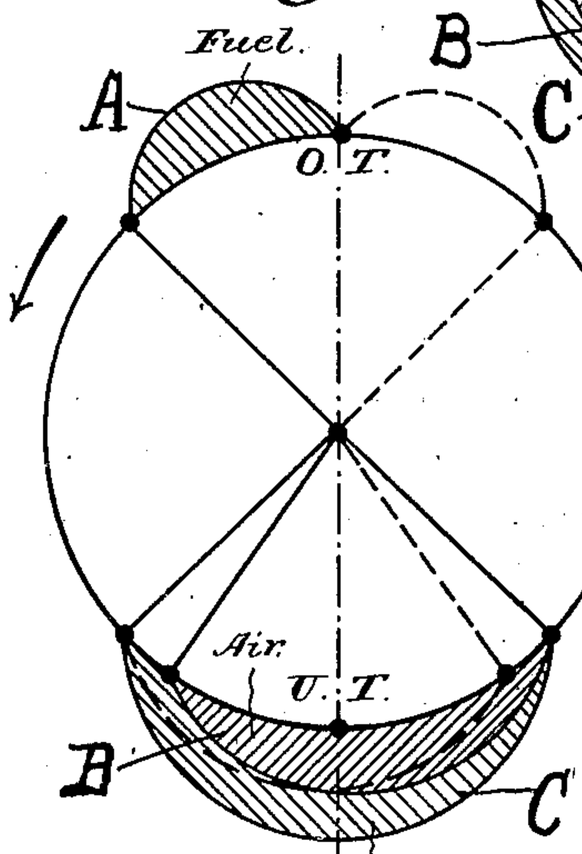
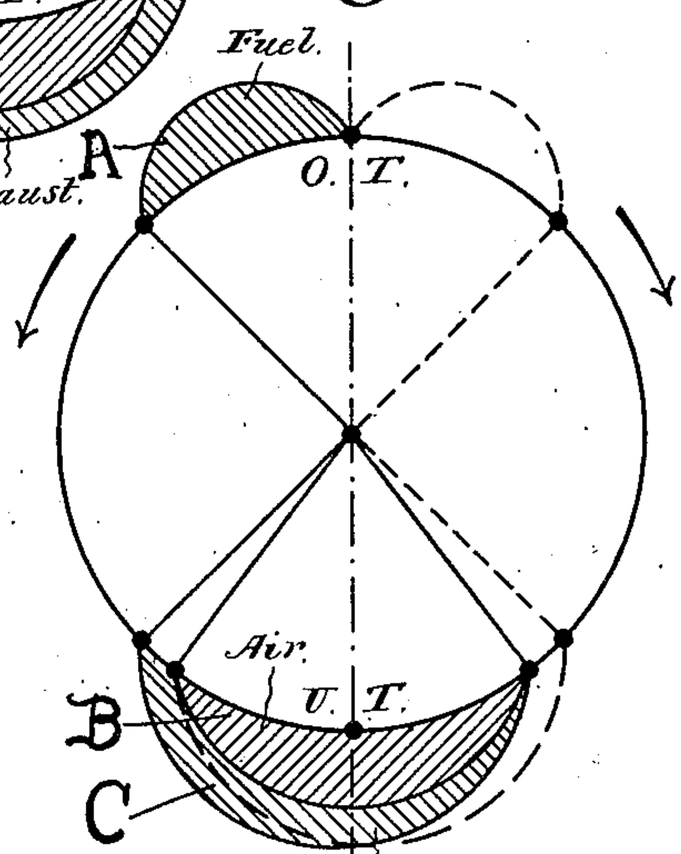


Fig. 8.



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4 SHEETS—SHEET 4.

Fig. 5.

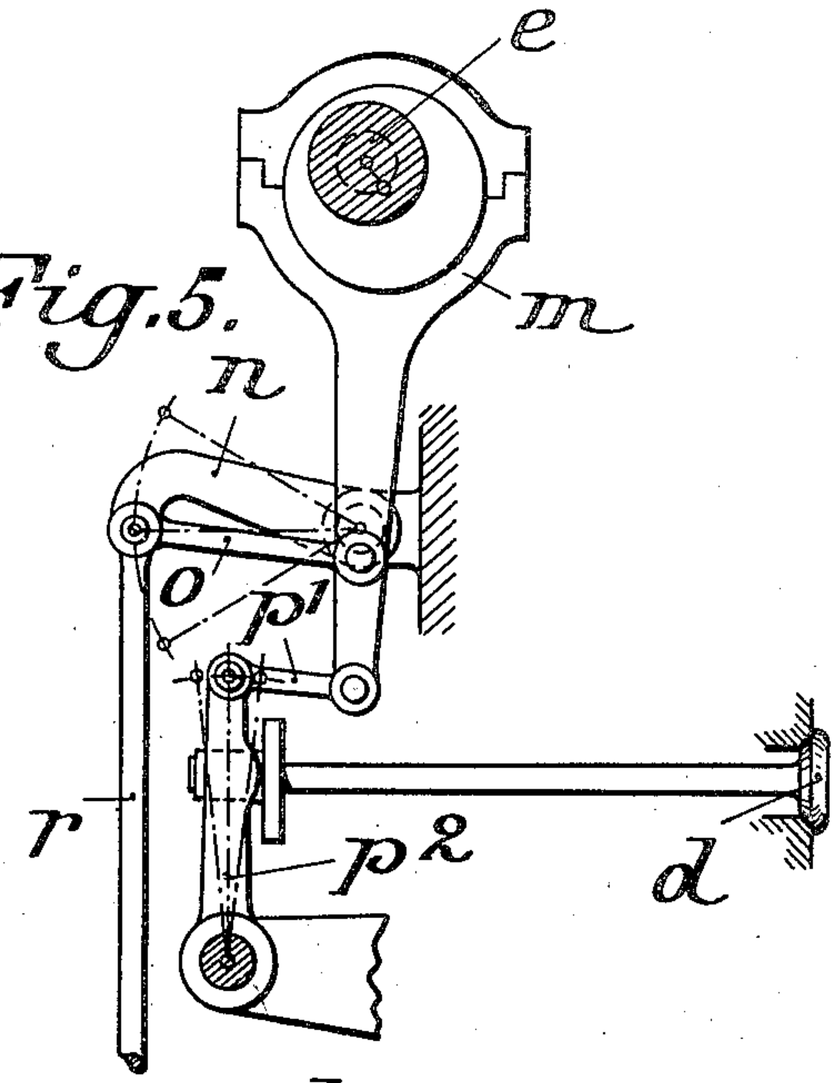
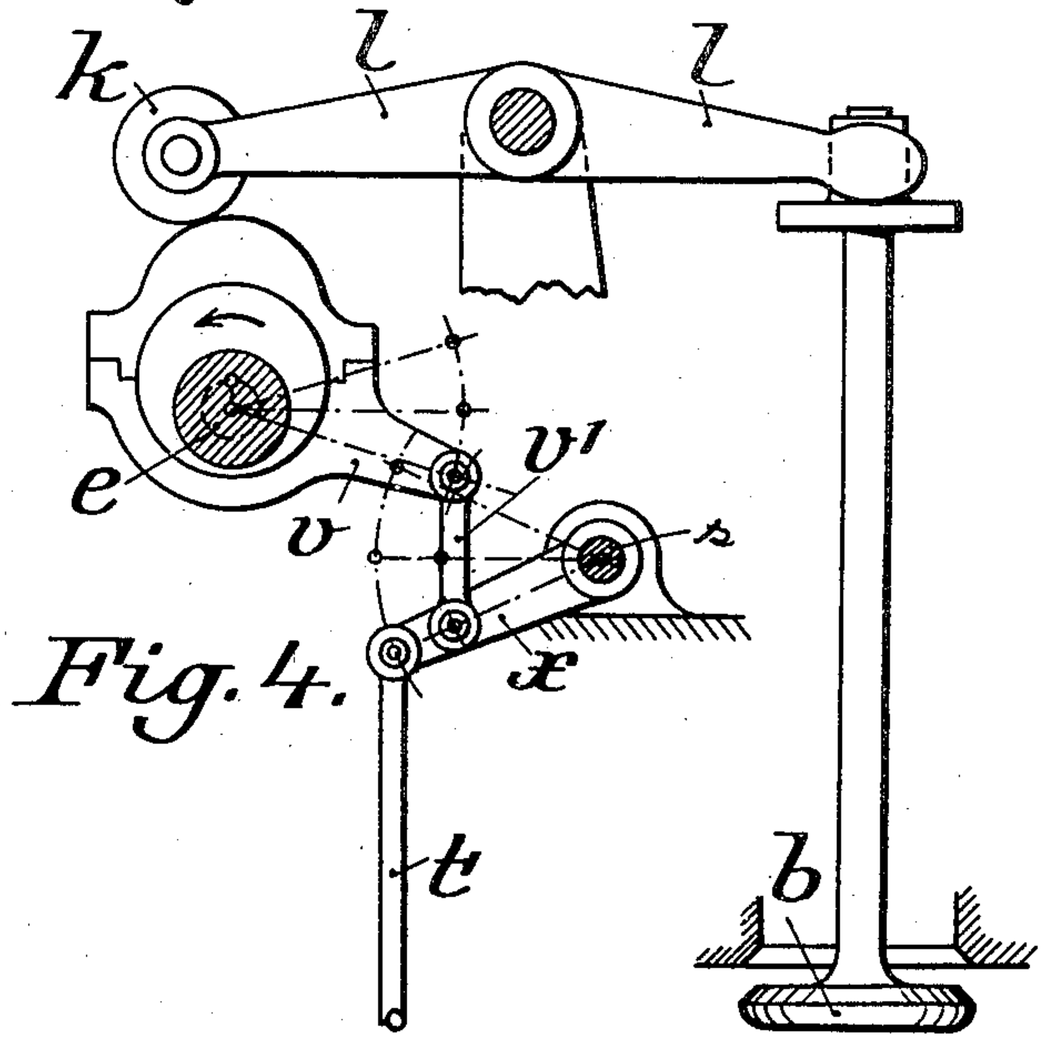


Fig. 4.



WITNESSES

J. M. Wrenn

Thos. Howe

INVENTOR

Jakob Sulzer,

by Pendleton & Goldsborough

ATTORNEYS.

UNITED STATES PATENT OFFICE.

JAKOB SULZER, OF WINTERTHUR, SWITZERLAND.

REVERSING-GEAR FOR INTERNAL-COMBUSTION ENGINES.

No. 880,050. Specification of Letters Patent. Patented Feb. 25, 1908.

Application filed December 5, 1905. Serial No. 290,369.

To all whom it may concern:

Be it known that I, JAKOB SULZER, engineer, a citizen of the Swiss Republic, residing at Winterthur, 97 Langgasse, Switzerland, have invented certain new and useful Improvements in Reversing-Gear for 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.

This invention relates to a reversing gear for internal combustion engines, wherein the roller which controls the fuel admission gear is moved into a middle position, beyond the range of the actuating cam, for the position of rest, and into either of two extreme positions, corresponding respectively with the forward and backward running of the engine, one of the said extreme positions being on one side of the cam surface and the other on the other side, both within range thereof.

In the accompanying drawings, Figure 1 is a longitudinal section through the head of the cylinder of a two-stroke engine the valves of which are operated by gear according to the invention; Fig. 2 is a like section showing a modification wherein the valves are arranged coaxially, instead of side by side as shown in Fig. 1. Fig. 3 shows in elevation the gear for operating the admission of the fuel, the three positions of the parts, namely those for forward and reverse motion and that for stopping, being indicated. Fig. 4 shows in elevation the device for reversing the operation of the second valve in the upper end of the cylinder, which may serve either as air admission valve or as exhaust valve. In the former case the exhaust gases escape slots in the lower end of the cylinder, while in the latter case the air is admitted through these slots. Fig. 5 shows in elevation an example of a device for reversing and for starting the engine by means of a compressed gaseous fluid. Fig. 6 is the diagram of the crank movement in the case in which the air admission and the exhaust are not reversed by the gear; Fig. 7 is the like diagram when the air admission is reversed together with the admission of the fuel; and Fig. 8 is the like diagram when the exhaust through the valve is reversed together with the admission of the fuel.

The fuel is admitted into the working cylinder through the valve *a*, the air through the valve *b* or through the slots *c* controlled by the piston; if *b* is the air admission valve, the openings *c* are the exhaust, and if the latter admit the air the valve *b* is the exhaust. At a suitable part of the upper end of the cylinder is a valve *d* for the admission of a compressed gaseous fluid for reversing.

The valves are operated by a shaft *e*. The valve *a* derives its movement from the cam *f* through the roller *g* and the system of levers *h*, *h'*, *h²*, and the valve *b* from the cam *i* through the roller *k* and the lever *l*. The reversing valve *d* is moved by the eccentric *m* on the shaft *e* through the lever *n* turning on a fixed point and the lever system *o*, *p'*, *p²*; for the purpose of reversing the lever *n* is moved from the dead point position shown, between the extreme position indicated on both sides, by the rod *r*.

As shown in Fig. 3, the valve *a* is controlled with aid of the bell crank *q* turning with the shaft *s*; when this crank is moved into either of its two extreme positions I or III it brings the roller *g* and the lever *h* into the position for forward or backward running as the case may be. In its middle position II the bell crank *q* lifts the roller *g* so high that it is not operated by the cam *f*.

The operation of the valves and of the slots controlled by the working piston is apparent from the diagram Fig. 6. The hatched surfaces A indicate the point of time and the duration of the opening of the valve *a* while the hatched surfaces B and C indicate the same for the valve *b* and the slots *c*, in relation to the position of the crank. The air admission valve *b* is opened for such period that it begins to open and closes under equal angular movement of the crank from the lower dead point U T, so that a reversal of this valve for both directions of running is not necessary. In Fig. 7 the same diagram is shown for a reversible air admission valve *b*, which for both directions of running is opened later than the exhaust opening is and is closed simultaneously therewith. In like manner diagram Fig. 8 shows the duration of the opening of the valve *b* when this is the exhaust valve and the slots *c* are for air admission. In all these diagrams the openings for one direction of running are shown in full lines and those for the reverse direction in dotted lines.

In internal combustion engines operated with fluid combustible, the admission valve

for the latter opens at the upper dead point O T of the piston and closes after a certain portion of the angular movement of the crank. In explosion engines wherein the fuel is admitted during the compression stroke of the working piston or earlier, the fuel admission valve is opened correspondingly earlier. If the engine is operated with fluid combustible gradually burned the cylinder head must obviously be correspondingly changed from that shown in the drawings; the method of reversal, however, remains the same.

The reversal valve *d* is actuated by the eccentric arm *m* driven from the shaft *e*, through the levers *o*, *p'* and *p²*. The lever *o* is pivoted on a lever *n* which is in turn pivoted to a stationary part of the engine frame. The lever *n* may be moved from the dead point shown in Figs. 1 and 5 by means of the rod *r*, and when so moved carries the pivotal point of the lever *o* from the dead point shown to either of the extreme positions, for the purposes of reversal.

When the bell crank *q* is brought into the middle position II by aid of the rod *t* so that the roller *g* is beyond the range of the cam *f*, the admission of fuel is stopped. The lever *n* may now be moved into its upper extreme position, whereupon the valve *d* admits compressed gaseous fluid into the cylinder to oppose the working piston and the engine comes to rest, or is braked. The pressure under which the said compressed fluid enters the cylinder is preferably such that the fluid can be introduced at any desired moment into the cylinder. The bell crank *q* is then moved into its other end position, whereby the fuel is admitted at the point of time corresponding with the new direction of running. At the same time that the bell crank *q* is shifted the reversing lever *n* is brought back to its middle position (Fig. 5). It follows from the example described that either the valve *a* or the valve *d* is moved by the rotation of shaft *e*. In normal operation the valve *a* is moved, but in the intermediate time (when the direction of running of the motor is being reversed) the valve *d* is moved.

When the air admission or the exhaust (when the valve *b* is used for the latter) is to be reversed as well as the fuel admission, the reversal of the valve *b* is accomplished by mechanism such as is shown for example in Fig. 4. The cam on the shaft *e* is formed as an eccentric whose strap carrying the cam swelling is connected through arm *v*, link *v'* and lever *x* with the shaft *s*. By turning the lever *x* from its middle position into either of its two extreme positions, corresponding respectively with forward and backward running, the opening of the valve *b* can be controlled as indicated in the diagrams 7 and 8. This arrangement can also be used as a starting device. The mechanism is also applicable to a four-stroke cycle engine. It is appropriate for all cases in which the crank shaft is required to revolve in either direction, for instance for ships, and as a substitute for reversing mechanism only suitable for small loads, such as clutches, shifting cams or rotatable propeller blades.

Having now particularly described the nature of my said invention and the best means I know of carrying the same into practical effect, I claim:

1. In a reversal gear for internal combustion engines the combination with a fuel admission gear of a roller carried by said fuel admission gear, an actuating cam and means for moving the roller into a middle position beyond the range of the actuating cam and into either of two extreme positions within the range of the cam and corresponding respectively with the two directions of running of the engine, substantially as described and for the purpose set forth.

2. In a reversal gear for internal combustion engines the combination with a fuel admission gear of a roller carried by said fuel admission gear, an actuating cam, means for moving the roller into a middle position beyond the range of the actuating cam and into either of two extreme positions within the range of the cam and corresponding respectively with the two directions of running of the engine, an air admission valve, means for opening the air admission valve for both directions of running at a certain period of the crank movement after the exhaust begins to open and means for closing the air valve at the same time that the exhaust is closed, substantially as described and for the purpose set forth.

3. In a reversal gear for internal combustion engines the combination with a fuel admission gear of a roller carried by said fuel admission gear, an actuating cam, means for moving the roller into a middle position beyond the range of the actuating cam and into either of two extreme positions within the range of the cam and corresponding respectively with the two directions of running of the engine, an air admission valve, an exhaust valve, means for opening the latter at a certain period of the crank movement before the air admission valve begins to open and means for closing the exhaust valve at the same time that the air admission valve is closed substantially as described and for the purpose set forth.

In testimony whereof I have affixed my signature, in presence of two witnesses.

JAKOB SULZER.

Witnesses:

AUGUST MARKLIN,

EMIL FREIMANN.