No. 674,397. Patented May 21, 1901.

A. B. DE BOUVAND.

EXHAUST VALVE MECHANISM.

(Application filed Oct. 26, 1900.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 3.

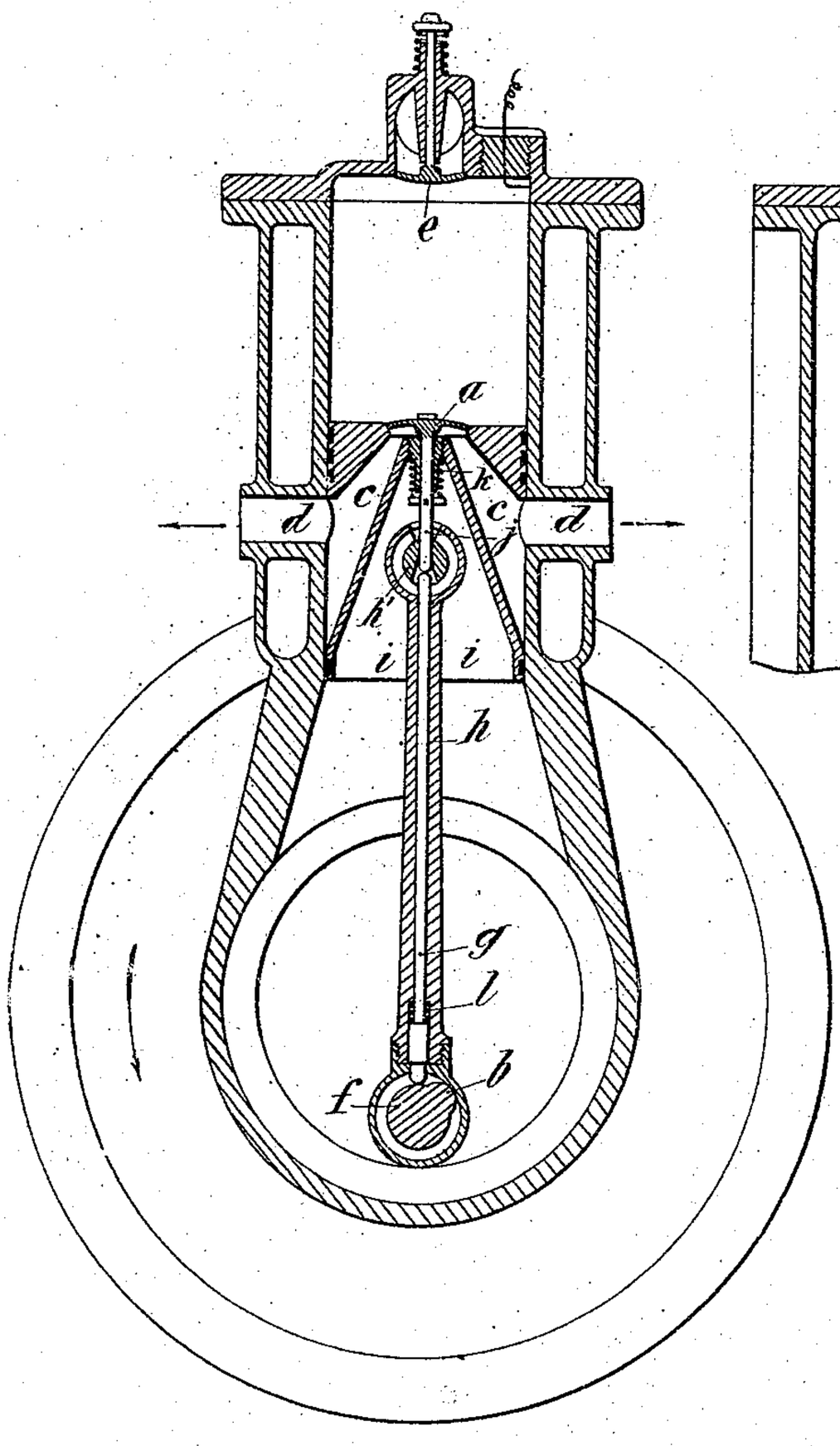

Fig. 5.

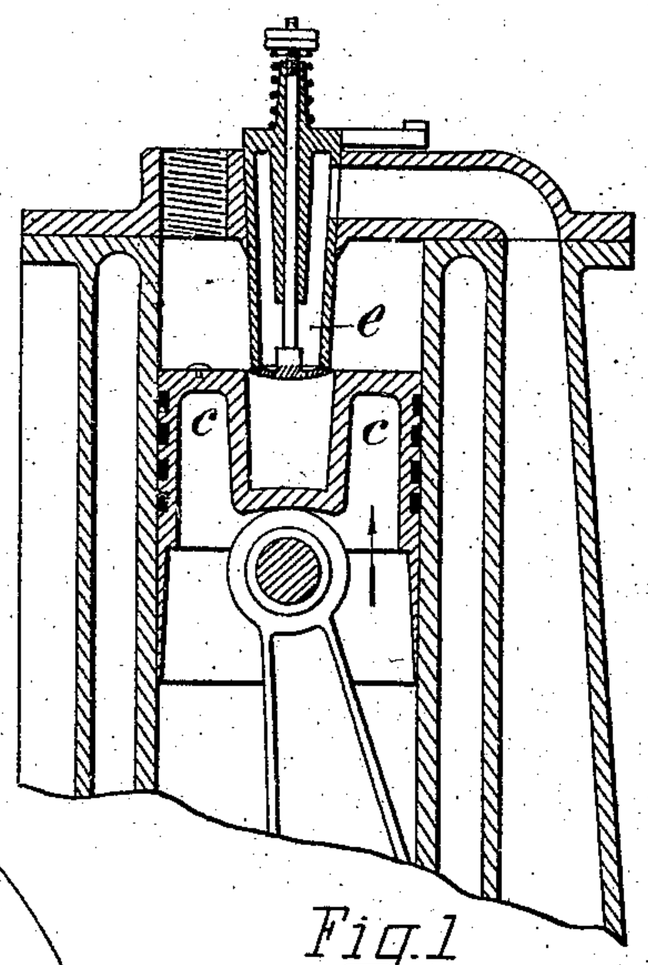

Fig. 1

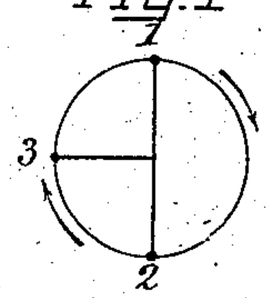

Fig. 2.

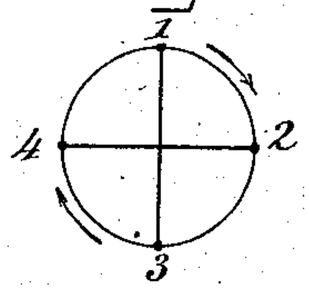

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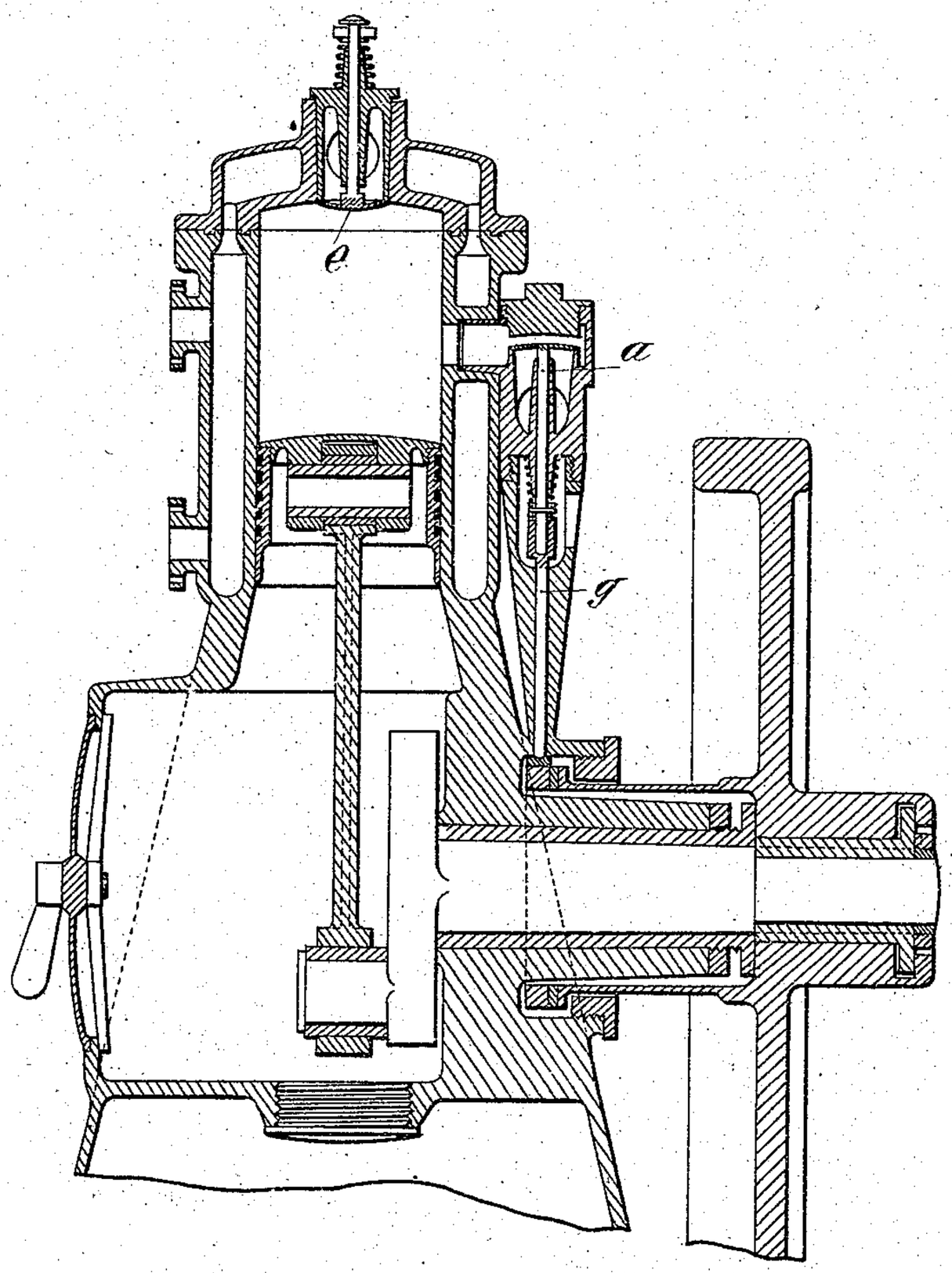
Fig. 4



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UNITED STATES PATENT OFFICE.

ANDRÉ BONNARD DE BOUVAND, OF PARIS, FRANCE.

EXHAUST-VALVE MECHANISM.

SPECIFICATION forming part of Letters Patent No. 674,397, dated May 21, 1901.

Application filed October 26, 1900. Serial No. 34,401. (No model.)

To all whom it may concern:

Be it known that I, ANDRÉ BONNARD DE BOUVAND, clerk, of 19 Rue de Provence, in the city of Paris, Republic of France, have invented an Improved Exhaust-Valve Mechanism for Gas-Engines, of which the following is a full, clear, and exact description.

This invention relates to an improved motor worked by oil, gas, or other hydrocarbons with a cycle of four phases, or, in other words, to a motor in which an explosion takes place at every two revolutions of the crank.

This invention will be better understood in the following specification with reference to the accompanying drawings, in which—

Figure 1 is a theoretical view of the cycle at the second revolution of the crank. Fig. 2 is another theoretical view of the cycle at the second revolution of the crank. Fig. 3 shows in vertical section a motor constructed according to my invention. Figs. 4 and 5 show in vertical section two modifications of my improved motor.

In the several figures the same characters of reference denote like parts.

As shown in Fig. 1 of the drawings, the cycle upon which the operation of my motor is based is the following: In the first revolution, the piston being at the top of its stroke at 1, an explosion first takes place, followed by the expansion of the gases during the whole stroke of said piston, the latter coming down from 1 to 2. Then the piston returns from 2 to 3 and half the burned gases are driven back through the valve *a*, operated by a cam *b*, and escape through channels *c* and *d*. The piston being in 3 at halfway of its upward stroke, the valve *a* is closed. The piston goes farther up from 3 to 1, where it reaches the end of its stroke, by compressing to five atmospheres, for instance, the remaining half of the burned gases. Said compression being the essential feature of the cycle may be called "negative." In the second revolution the piston being at the top of its stroke comes back down to half the stroke, which causes an expansion to take place for bringing the gas to the atmospheric pressure; but as vacuum is being made within the cylinder from 1 to 2 the valve *e* opens and the piston sucks during the other half of its stroke the explosive mixture, filling the body of the cylinder, while the burned gases follow the piston by occupying the lower part of the cylinder. It will thus be marked that at the end of the downward stroke of the piston in 3, Fig. 3, the content of the cylinder consists of two quite distinct layers, the upper part comprising the fresh gases and the lower part containing the burned gases. It will also be seen that the volume of fresh gases sucked equals that of the gases which are driven back from 2 to 3 at the first revolution. The piston being at the end of its downward stroke at 3 comes up back; but at the same time the valve *a* opens during half of the upward stroke of the piston up to 4, as in the first revolution, and the layer of the remaining burned gases is exhausted. This makes a second exhaustion in a motor with four phases, or in a motor in which an explosion takes place at every two revolutions. The piston going farther up from 4 to 1, the valve *a* closes and the fresh gases are compressed to five atmospheres within the body of the cylinder. The piston being at the top of its stroke in 1, the explosion takes place and the cycle is started once more. It will be noted that in this cycle there are seven phases and also that the two active and negative compressions have the same value. By means of said cycle I may at will entirely exhaust the burned gases or keep the same. For instance, if the stroke of the piston equals one hundred and twenty millimeters and if the compression-chamber has twenty millimeters that gives a length of one hundred and forty millimeters to the cylinder. When the piston is coming down, if the exhaust closes at seventy millimeters the suction will also be of seventy millimeters. The displaced volumes being equal, the burned gases will then be exhausted in this case.

If we are to keep a part of the burned gases, supposing the exhaust-valve closes at half the downward stroke of the piston—that is to say, at sixty millimeters—the suction will be equal and there will remain twenty millimeters of burned gases.

Both processes possess their respective advantages. When the burned gases are completely exhausted, the operation of the motor

is more active, but the expansion is less considerable. When the burned gases are only partly exhausted, the power diminishes, but the expansion is prolonged.

There must be noted that the piston-valve may serve for the suction and that the inlet-valve operated in this case by a gear connected to the motor-shaft may serve for the exhaust. The cycle would be effected in the same manner, the order in which the gas layers are arranged being only inverted.

In Fig. 3 of the drawings I have shown the cam *b* as being arranged upon the crank *f* of the main shaft, such cam acting upon a rod *g*, located in the connecting-rod *h* and pivoted at *h'* upon the piston *i*. The rod *g* pushes in its turn the rod *j* of valve *a* when the same is required to be raised. A spiral spring *k* draws back the valve *a* upon its seat, and a spiral spring *l* maintains the rod *g* in contact with the cam *b*.

In Fig. 4 of the drawings the outlet-valve *a* is located on the side of the cylinder.

In Fig. 5 of the drawings the inlet-valve *e* comes down within the cylinder and the piston-head is provided with a recess, in which it engages at the end of the stroke.

It must be noted that in the motors with a cycle of four phases, or providing an explosion at every two revolutions, the outlet-valve opens at every two revolutions during half of the backward stroke of the piston, thus avoiding every demultiplication due to gearings or the like.

The forms, details, accessories, materials, and sizes of my improved motor may of course vary without departing from the principle of my invention. I can also build motors with two, three, or four cylinders, balanced or not.

I claim—

1. The combination with a cylinder and piston, and crank and crank-pin, of a pitman having one end sleeved on said pin and its opposite end pivoted to the piston, a valve in said piston and means working longitudinally of the axis of said piston-rod for opening said valve, substantially as described.

2. The combination with the cylinder, piston, crank and crank-pin, of a piston-rod pivoted at one end to the piston and sleeved on said crank-pin, a rod working axially of said rod, a cam on said pin coacting with said rod, a valve in the piston and a stem on the valve coacting with said axially-working rod, substantially as described.

3. The combination with a cylinder, piston, crank and crank-pin, of a piston-rod sleeved on said pin, a spring-pressed rod working axially of the rod, a cam on the crank-pin coacting therewith, a valve in said piston, a spring for holding the same seated, a stem carried by said valve coacting with the axially-arranged rod, and a pivotal connection between the piston and piston-rod providing a guide for the coacting ends of the valve-stem and axially-arranged rod, substantially as described.

The foregoing specification of my improved oil-motor signed by me this 15th day of October, 1900.

ANDRÉ BONNARD DE BOUVAND.

Witnesses:
EDWARD P. MACLEAN,
MAURICE H. PIGNET.