(No Model.) 2 Sheets—Sheet 1.

N. A. OTTO.

GAS OR OIL MOTOR ENGINE.

No. 433,809. Patented Aug. 5, 1890.

Fig. 1.

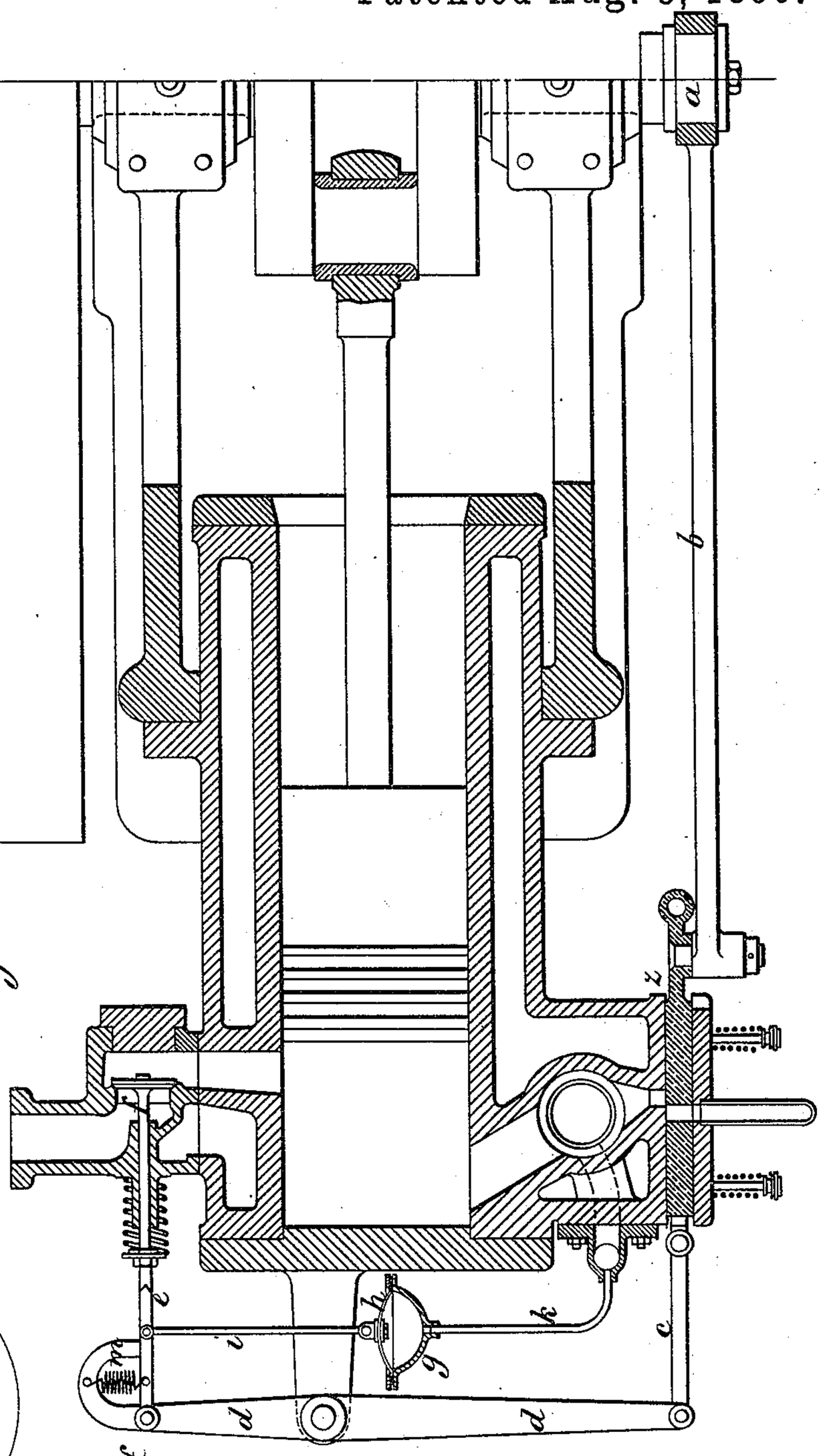


Fig. 2.

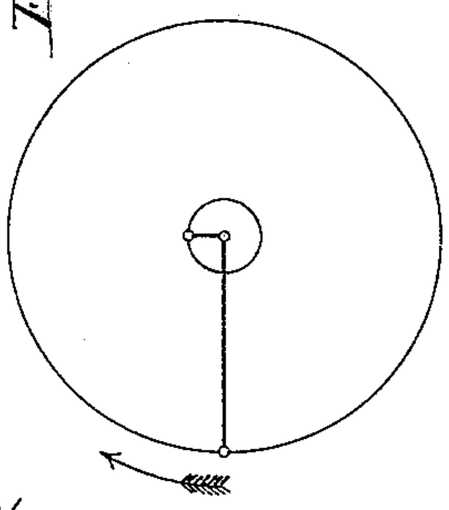
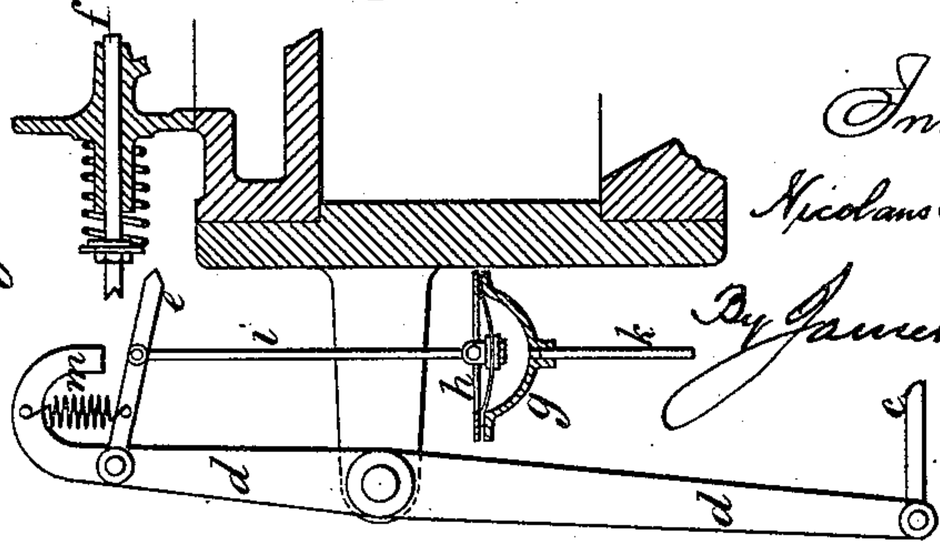


Fig. 3.



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(No Model.) 2 Sheets—Sheet 2.

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Fig. 4.

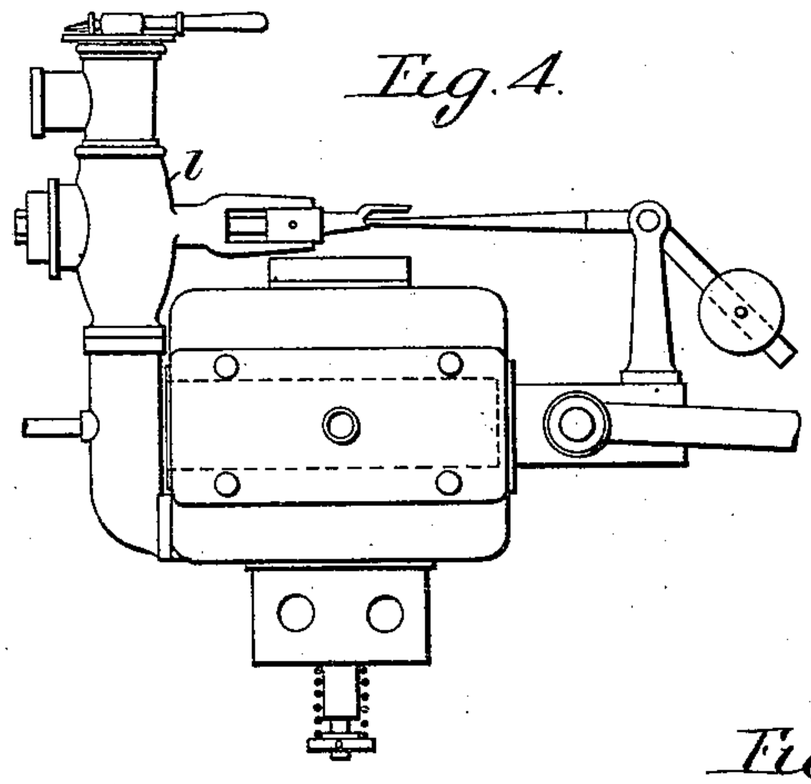


Fig. 5.

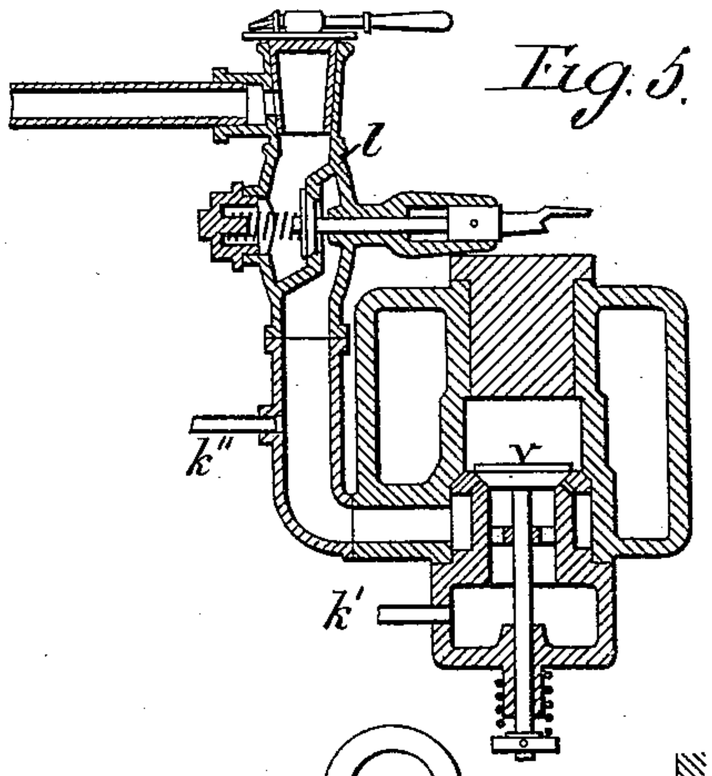


Fig. 6.

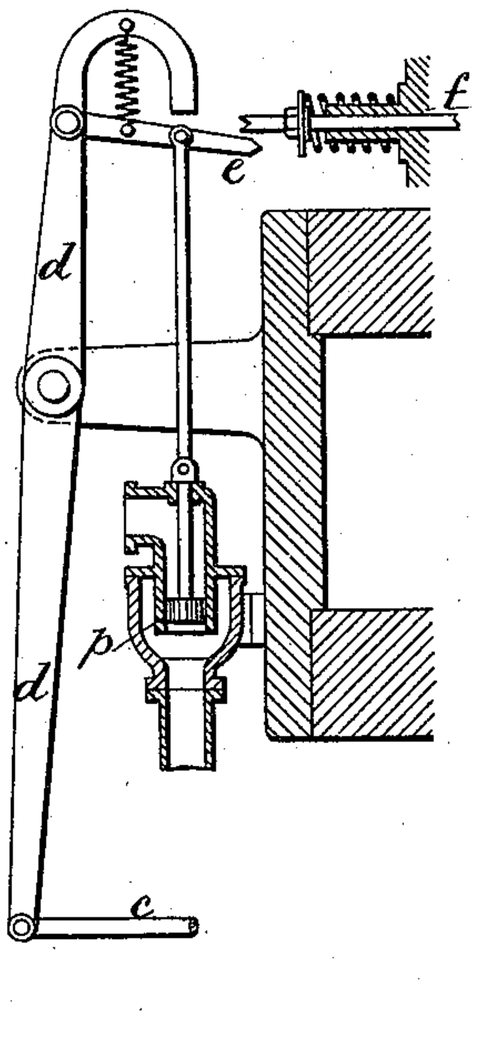


Fig. 7.

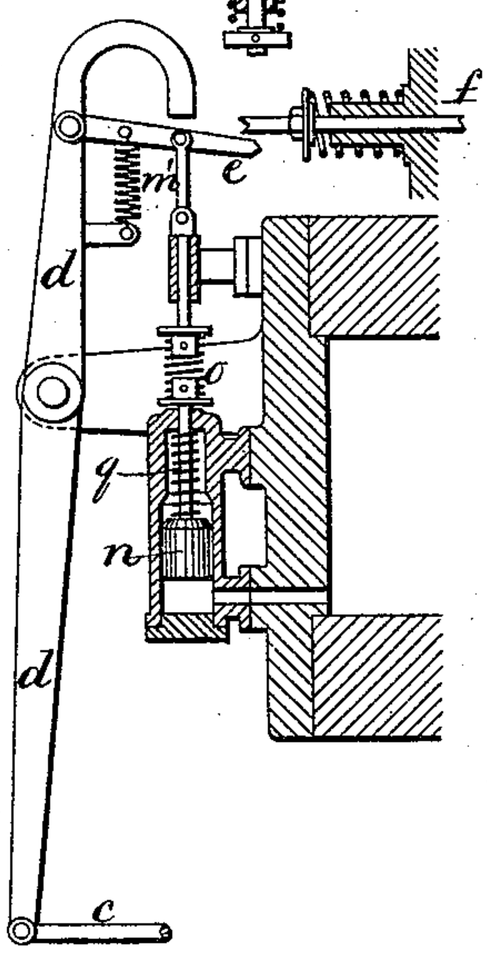
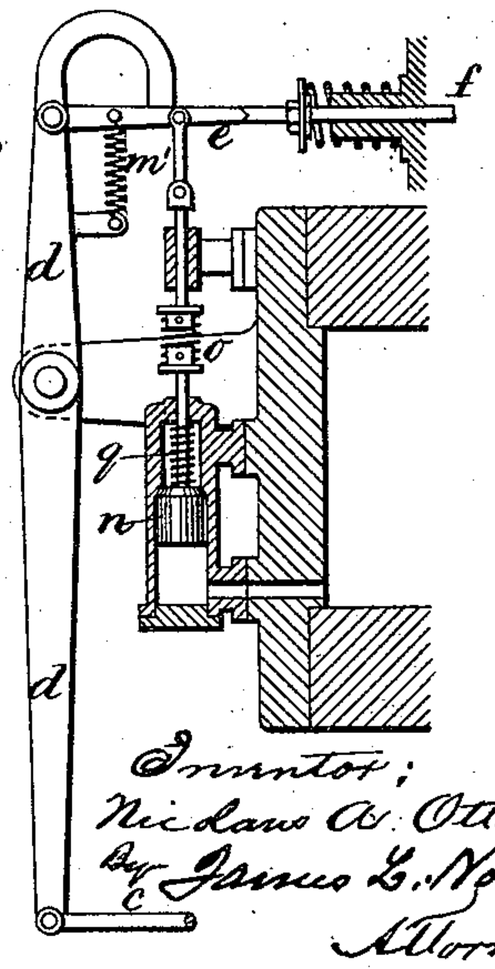


Fig. 8



Witnesses:-
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Inventor;
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Attorney.

UNITED STATES PATENT OFFICE.

NICOLAUS AUGUST OTTO, OF COLOGNE, ASSIGNOR TO THE GAS-MOTOREN-FABRIK-DEUTZ, OF KÖLN-DEUTZ, GERMANY.

GAS OR OIL MOTOR ENGINE.

SPECIFICATION forming part of Letters Patent No. 433,809, dated August 5, 1890.

Application filed April 21, 1890. Serial No. 348,894. (No model.) Patented in Belgium April 5, 1890, No. 90,095, and in Italy April 29, 1890, LIII, 332.

To all whom it may concern:

Be it known that I, NICOLAUS AUGUST OTTO, a citizen of Prussia, residing at Cologne, in the German Empire, have invented new and useful Improvements in Gas or Oil Motor Engines, (for which I have obtained patents in Belgium, dated April 5, 1890, No. 90,095, and in Italy, Vol. LIII, 332, dated April 29, 1890,) of which the following is a specification.

This invention relates to motor-engines working with a cycle of four strokes, and has for its object to provide a novel method for operating the discharge-valve without employing a counter-shaft driven through toothed gearing from the engine-shaft at half the speed of the latter.

The invention consists in utilizing the variations of pressure produced, either in the gas and air supply pipes or in the engine-cylinder, during the several strokes of the piston for acting upon mechanism connected with the discharge-valve in such a manner that this is caused to remain closed during the compressing-instroke and to be opened during the expelling-instroke. If the movement of the discharge-valve of the cylinder were effected by the engine-shaft, or by a counter-shaft revolving at the same speed without special appliances, the discharge-valve would be opened both during the discharge-stroke and during the compressing-stroke.

In order to maintain the discharge-valve closed during the compressing-stroke according to the present invention, a suitable apparatus is made to act upon the discharge-valve gear at the proper time, either A by the action of the rarefaction produced in the cylinder during the suction-stroke, or B by the action of the pressure produced during the compression or the working strokes.

I will proceed to describe various arrangements of apparatus for carrying out this method of operating, with reference to the accompanying drawings, in which—

Figure 1 shows a longitudinal section of a motor-engine with one arrangement of the said apparatus applied thereto. Fig. 2 shows a diagram of the crank and eccentric motion. Fig. 3 shows a view of the valve-gear in a different position. Figs. 4 and 5 are details of the gas and air admission apparatus, and Figs. 6, 7, and 8 show other arrangements.

Method A.—The crank-shaft of the engine, Fig. 1, has an eccentric *a* on a crank which is placed at an angle of ninety degrees to the engine-crank, as at Fig. 2, and from which, by means of a rod *b*, an igniting-slide *z* is actuated. The igniting device is here assumed to be a heated tube, but any other known igniting device may be used. A double-ended lever *d* is connected at its one end by a link *c* to the slide *z*, so as to have a to-and-fro, motion imparted to it thereby, and to the other end of the lever is pivoted a rod or pawl *e*. According to the position given to this rod it will either be made to force open the discharge-valve *f* by bearing against the notched end of its stem during the forward motion of that end of lever *d*, or it will miss the end of the valve-stem when brought into the position shown at Fig. 3, and thus allow the valve to remain closed. This shifting of the rod *e* is effected in the present case by the apparatus *g*, consisting of a hollow vessel or cup closed by an elastic or flexible diaphragm *h*, which is connected by a link *i* to the rod *e*. The cup *g* is made to communicate by a pipe *k* with the air-supply at *k'*, Fig. 5, or with the gas-pipe at *k''*.

The apparatus operates as follows: Assuming the engine to be in regular working, the gas-valve *l*, being either opened by a known governor arrangement at each forward motion of the piston, or being always in the open position and only closed when no explosive mixture is to be drawn into the cylinder, the admission of gas and air to the cylinder being controlled by the valve *v* in the well-known manner. At Fig. 4 of the drawings is shown a known form of inertia governor for the purpose of acting on the gas-valve, the governor being carried by and moving with the igniting-slide *z*. When an explosive charge is drawn into the cylinder by the forward motion of the piston, there will exist in the cylinder and in the gas and air supply pipes a pressure below that of the

atmosphere, and this reduced pressure will be transmitted through pipe *k* to the cup *g*. In consequence hereof the diaphragm *h* will be moved inward by the excess of external atmospheric pressure, and the rod *e* will be drawn thereby into the position shown at Fig. 3. On the following inward motion of the piston, during which the slide *z* will be moved to the left hand, the rod *e*, in moving forward with the end of the lever, will consequently miss the stem of the valve *f* and will move past the same, as indicated. Consequently the discharge-valve will remain closed and the cylinder-charge will be compressed. At the following forward stroke of the piston the explosion and expansion of the gases will take place. At the ensuing inward stroke the pressure within the cup *g* will have become equal to the atmosphere, so that the spring *m*, which acts upon the rod *e*, will draw the latter back into the position shown at Fig. 1, so that on the forward motion of the lever *d* the rod *e* will force open the discharge-valve.

The above-described action will be repeated at every cycle of four strokes.

Instead of the arrangement of cup with flexible diaphragm shown at Fig. 1 may be used a small cylinder, with piston *p*, fitted on the air-supply pipe, as shown at Fig. 6. The rod *e* can also be actuated by means of an inlet-valve or mixing-valve. If the pipe *k* of the apparatus *g* is connected with the air-supply pipe *k'* or gas-supply pipe *k''*, then every time that only air is drawn into the cylinder, instead of an explosive mixture, the diaphragm *h* will come into action and keep the discharge-valve closed. The known mode of regulating the speed of the engine will then take place, whereby only air is drawn in, instead of explosive mixture, is compressed and expanded, and is then discharged.

Method B.—Figs. 7 and 8 show an arrangement for the case, in which the pressure produced during the compression-stroke or during the working-stroke is utilized for actuating the discharge-valve. The rod *e* is acted upon by spring *m'*, which always tends to draw it out of gear with the valve-stem, so that on the forward motion of the lever *d* the valve is not opened thereby. To the rod *e* is connected a piston *n*, the outer end of which is coned as a valve, so as to fit on a seating formed in the small cylinder in which it works. Between the rod *e* and piston *n* is provided a spring *o*, and the space in the cylinder behind the piston *n* communicates with the engine-cylinder by a small passage. During the compression-stroke the pressure forces the piston *n* outward against its seat, thereby causing the spring *o* to be compressed. The rod connected therewith can, however, not put the rod *e* in gear with the stem of valve *f*, as by the motion of the lever *d* the rod *e* will have been moved past the stem. The ensuing pressure due to the explosion will keep the piston *n* in the same position, so that when by the backward motion of the lever *d* the end of the rod *e* has passed the end of the valve-stem the spring *o* will move back the rod in line with the stem, as at Fig. 8, so that when during the expelling-stroke the igniting-valves move to the left, thereby moving forward the outer end of lever *d*, the rod *e* will force open the discharge-valve. At the following charging-stroke the decrease of pressure in the cylinder will allow the piston *n* to be forced away from its valve-seat by the atmospheric pressure and by that of the spring *q*, whereupon the rod *e* will be drawn out of gear with the valve-stem by the spring *m'*. Instead of the small cylinder with piston *n*, may be employed any other apparatus that is moved in a similar manner to that above described by the pressure in the engine-cylinder—as, for example, the apparatus *g* with flexible diaphragm, described under method A.

I do not herein claim the apparatus shown and described, as such constitutes the subject-matter of my applications for patents filed April 21, 1890, Serial Nos. 348,895 and 348,896.

Having thus described the nature of my invention and the best means I know for carrying the same into practical effect, I claim—

In a gas or oil motor engine working within a cycle of four strokes, the method of utilizing the variation of pressure produced either in the gas and air supply pipes or in the cylinder during the strokes of the piston for actuating mechanism connected with the discharge-valve, whereby this is caused to remain closed during the compressing-instroke and to be opened during the expelling-instroke, thus dispensing with the counter-shaft heretofore employed for working the valve-gear.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 3d day of April, A. D. 1890.

NICOLAUS AUGUST OTTO.

Witnesses:
PET. LANGEN,
WILH. SPIECKER.