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MOTOR ENGINE WORKED BY COMBUSTIBLE GAS, VAPOR, OR SPRAY.

No. 388,302. Patented Aug. 21, 1888.

Fig. 1.

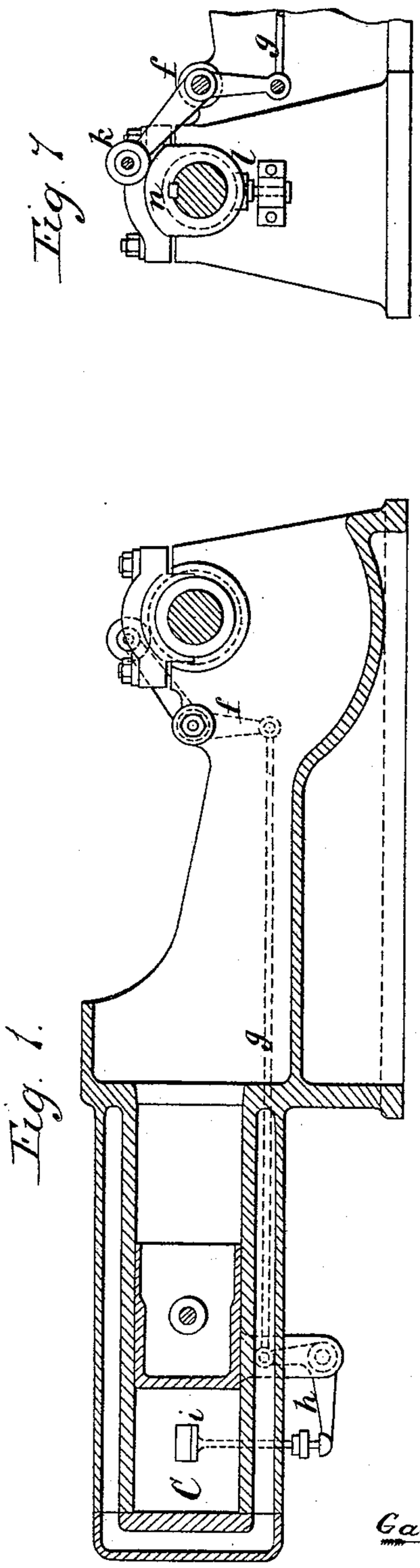

Fig. 2.

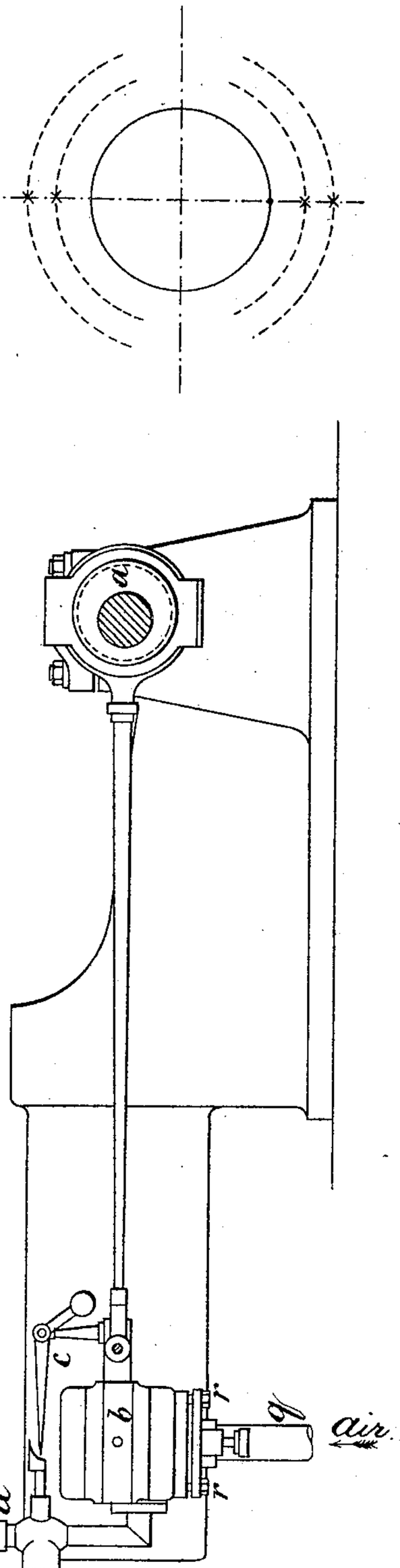

Fig. 8.

Witnesses.

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Fig. 3.

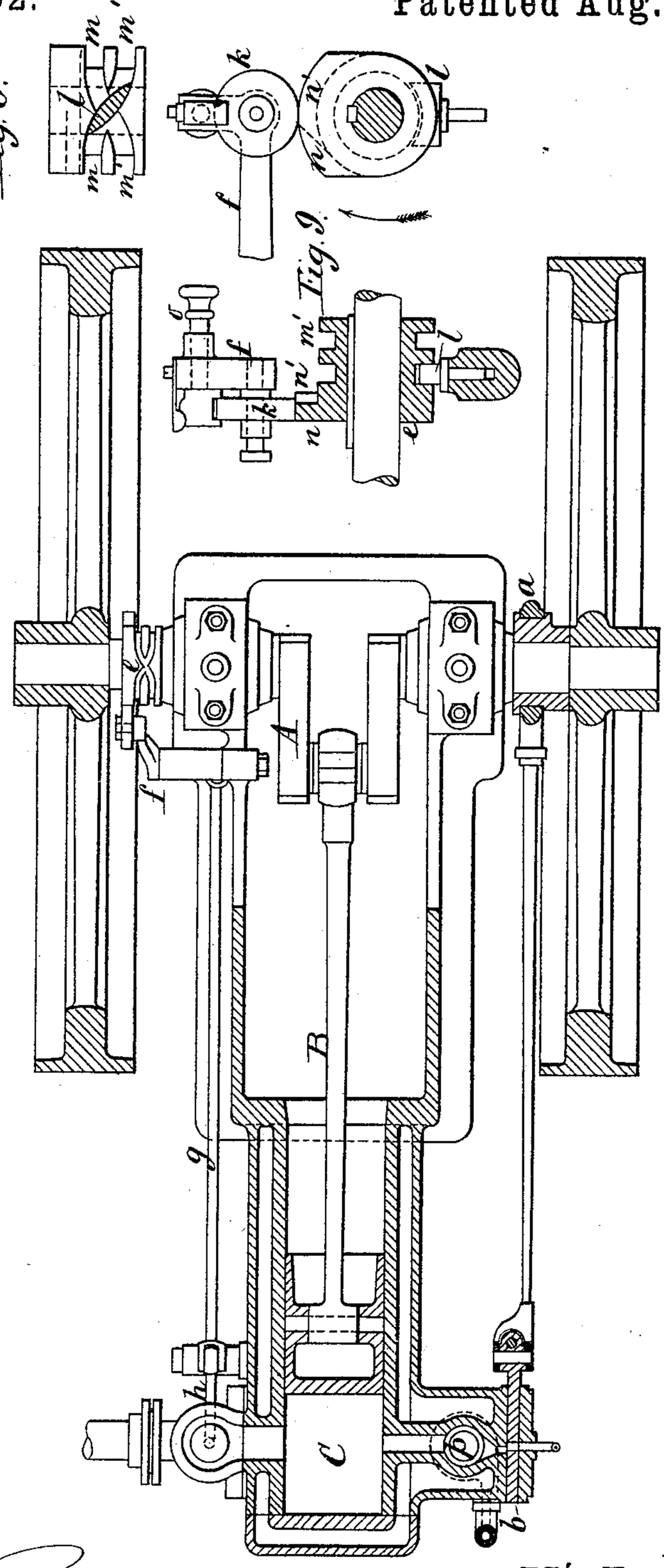

Fig. 8.

Fig. 9.

Witnesses.

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MOTOR ENGINE WORKED BY COMBUSTIBLE GAS, VAPOR, OR SPRAY.

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Fig. 4.

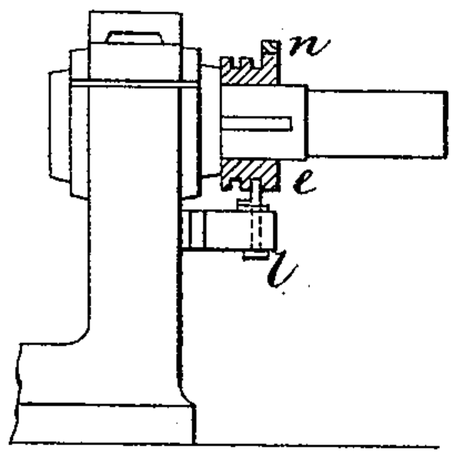


Fig. 5.

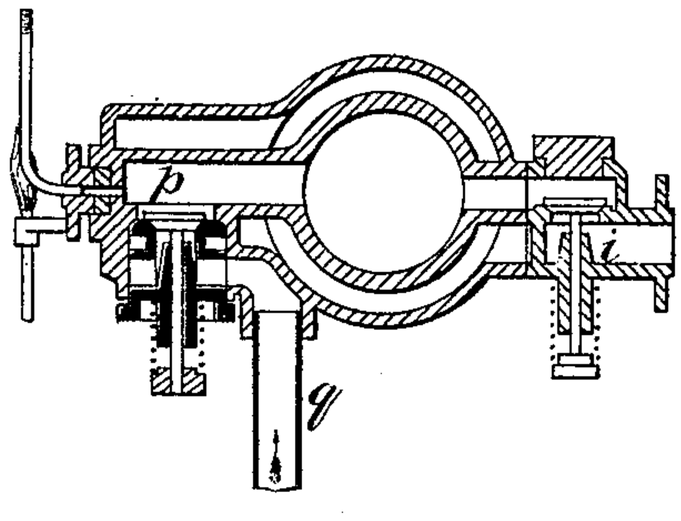
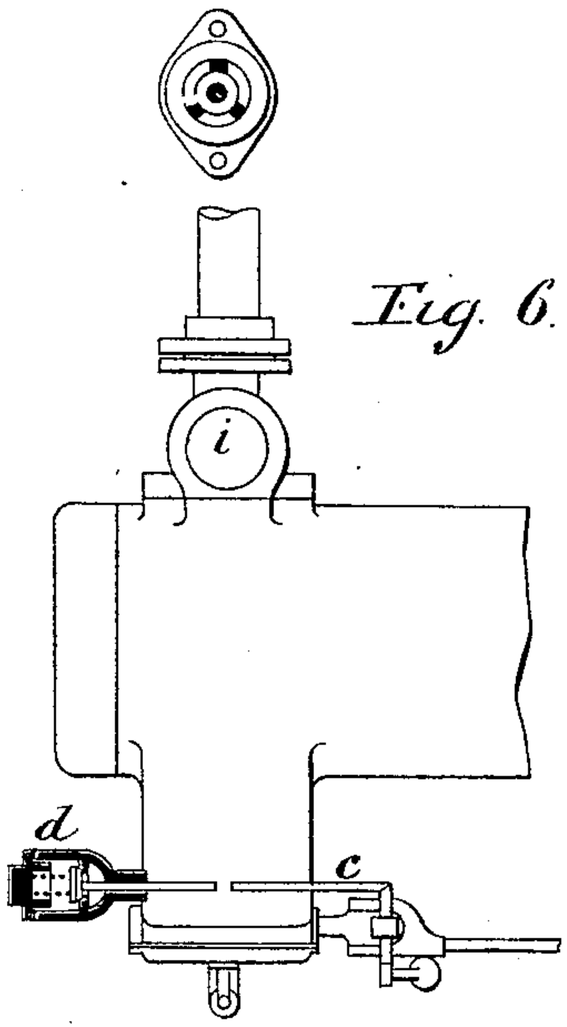


Fig. 6.



Witnesses.

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Fig. 10.

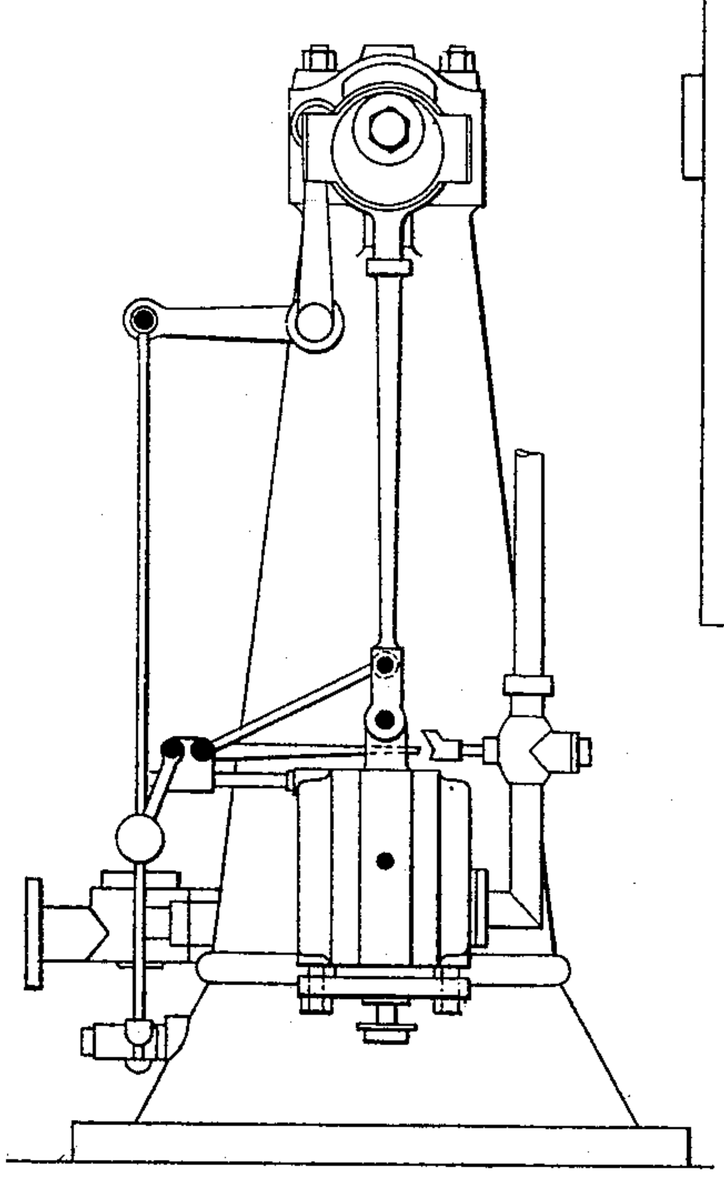


Fig. 11.

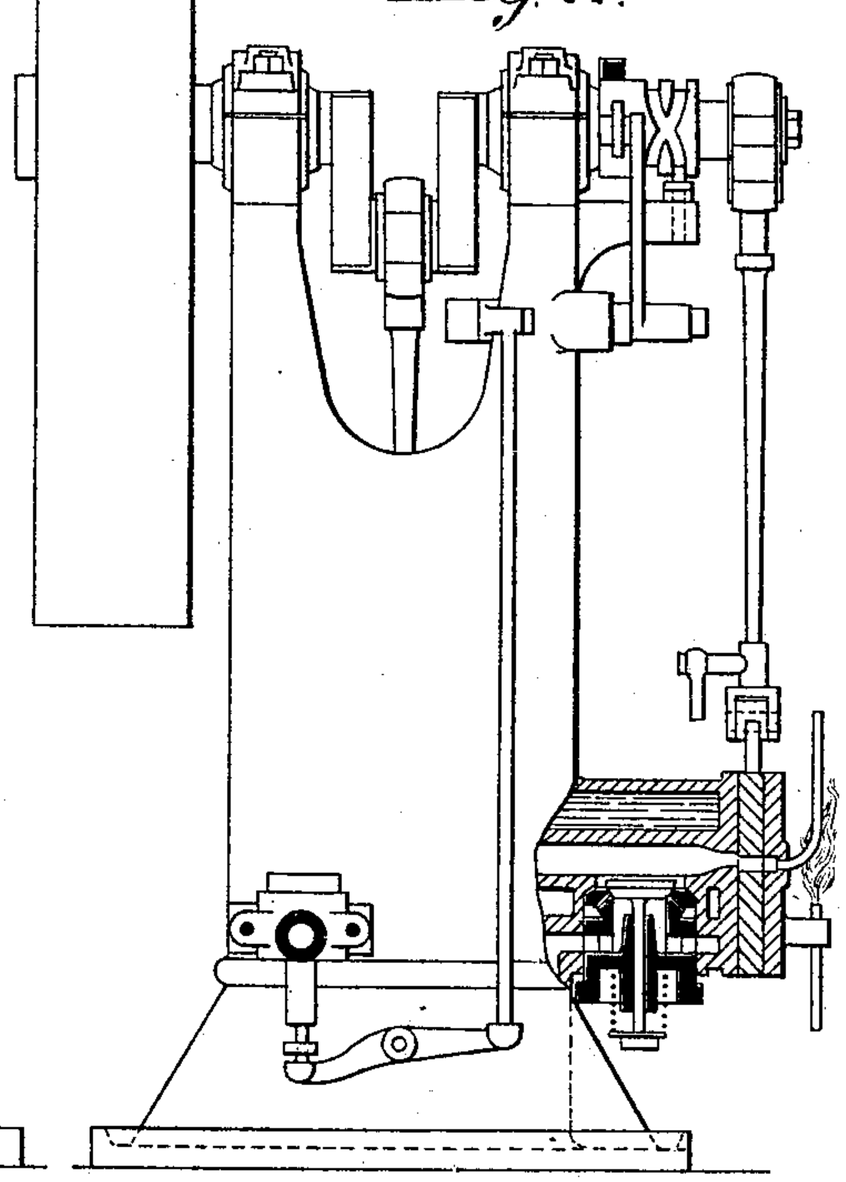
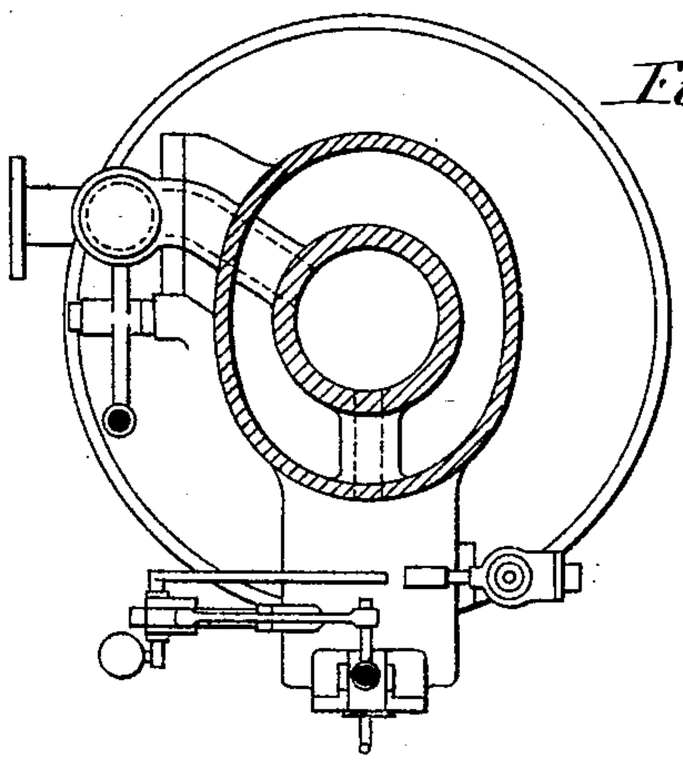


Fig. 12.



Witnesses.
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Robt Ewett.

Inventor.
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UNITED STATES PATENT OFFICE.

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

MOTOR-ENGINE WORKED BY COMBUSTIBLE GAS, VAPOR, OR SPRAY.

SPECIFICATION forming part of Letters Patent No. 388,302, dated August 21, 1888.

Application filed February 9, 1888. Serial No. 263,479. (No model.) Patented in England December 12, 1887, No. 17,108; in Belgium January 18, 1888, No. 80,307, and in Italy February 29, 1888, No. 22,886.

To all whom it may concern:

Be it known that I, NICOLAUS AUGUST OTTO, a citizen of Prussia, residing at Cologne, Prussia, in the Empire of Germany, have invented new and useful Improvements in Motor-Engines Worked by Combustible Gas, Vapor, or Spray, (for which I have obtained a patent in Belgium January 18, 1888, No. 80,307; in Italy February 29, 1888, No. 22,886, and have made application for patent in Great Britain December 12, 1887, No. 17,108,) of which the following is a specification.

This invention relates to motor-engines worked by combustible gas, vapor, or spray, which operate with a cycle of four strokes—namely, a charging, a compression, a working, and an expelling stroke—such as engines of the "Otto" type. In such engines the slide that effects the ignition of the compressed charge and the valve that allows the products of combustion to escape after the working-stroke have heretofore been worked by means of a counter-shaft driven at half the speed of the crank-shaft, in order that they may only operate, respectively, at the end of every alternate instroke and at the end of every alternate outstroke. According to the present invention the said counter-shaft is entirely dispensed with and the said igniting-slide and escape-valve are worked directly from the crank-shaft, the igniting-slide being driven by an eccentric on the crank-shaft, so as to make a to-and-fro stroke at each revolution, while the escape-valve is worked by a cam on the crank-shaft so arranged as to be automatically slid to one side thereon at every other revolution, and thus only to effect the opening of the escape-valve once in every two revolutions. The arrangements which are employed for this purpose, and which are applicable as well for horizontal as for vertical engines, are shown on the accompany drawings, in which Figures 1 to 9 show the invention applied to a horizontal engine, and Figs. 10 to 12 show it applied to a vertical engine.

Fig. 1 shows a longitudinal section of the engine. Fig. 2 shows a side view. Fig. 3 shows a sectional plan; Fig. 4, a sectional view of the shifting cam for the escape-valve; Fig. 5, a cross-section through the cylinder and admission-valve chamber; Fig. 6, a plan of the igniting-slide and section of the gas-valve; Fig. 7, a side view of the shifting cam and its lever. Fig. 8 shows a diagram of the action; Fig. 9, enlarged details of the shifting cam; Fig. 10, a side elevation of a vertical engine embodying the invention; Fig. 11, an elevation of Fig. 10, partly in section, to show the igniting-slide; and Fig. 12, a transverse sectional view of Fig. 10.

A is the crank-shaft, B the piston and piston-rod, and C the cylinder.

At the suction-stroke the piston draws a charge of mixed gas and air through the admission-valve, the air being drawn in through the pipe *q*, while the gas enters through the gas-regulating valve *d*.

The seat of the admission-valve *p* is formed in one piece with the gland or cover, through which the valve-stem passes, and in which are formed two passages, the lower one for the admission of the air, which enters thence through the central opening of the valve-seat, and the upper annular one for the gas, which passes thence through narrow converging channels to the seat of the valve, so that when this valve is open the gas impinges in a number of small converging jets upon the air passing in from the central passage, and thus the two become effectually mixed.

The upper end of the bushing, forming the valve seating and cover, is coned to fit accurately against a coned shoulder in the recess formed in the cylinder, against which it is tightly pressed by the screws *r r*, passing through the cover, thus making an air-tight joint between the two.

The igniting-slide *b* carries the pendulum regulator *c*, which, according to the speed of the engine, either opens the gas-valve or leaves it closed in the well-known manner. The gas-valve might also be so arranged as to be always open for admitting gas at the normal speed of the engine, while the pendulum regulator is so arranged as to close the valve when the normal speed is exceeded. The igniting-valve *b* effects the ignition of the cylinder-charge and is worked by an eccentric, *a*, on the crank-shaft. The ignition may be effected either by an externally-heated tube, as shown at Figs. 3, 5, and 6, or an igniting slide or valve may be used, which carries an igniting-flame in a cavity fed by the cylinder charge in the well-known manner. From the above-de-

scribed arrangement it will be seen that the slide *b* will stand at the firing position at the end of each instroke of the piston. At the one instroke it will consequently fire the compressed charge in the usual way; but at the second instroke of the piston the combustion-gases will have just been expelled, and there will be no combustible charge in the cylinder, and consequently the fact that the slide stands again at the firing position will have no effect on the engine. The discharge-valve *i* requires to be opened at the end of each working out-stroke and to be kept open during the expelling instroke. This is effected by means of the lever-transmission *f g h*, actuated by a cam, *n*, on a sleeve, *e*, on the crank-shaft.

In order to prevent the valve from being opened during the compressing instroke of the piston, the sleeve *e*, with its cam *n*, is during such stroke slid laterally upon the shaft, so that the cam *n* in revolving misses the roller *k* of the lever *f*. For effecting this motion the sleeve has a double groove, *m m'*, returning in itself formed upon it, into which gears a stud, *l*, pivoted upon a bracket on the engine-frame, as shown. The grooves *m m'* are formed parallel with each other for about three-fourths of the circumference of the sleeve, and are at a distance apart corresponding to the width of the cam. They are led into each other at the other part of the circumference, so as to cross, as shown at Fig. 8. The stud *l*, being pointed at both ends, will on the rotation of the sleeve first pass from the groove *m* into *m'*, and then at the second revolution back from *m'* into *m*, and in so doing it will cause the sleeve *e* to be shifted upon the shaft in one direction during one revolution and back again during the next one, so that during the one revolution corresponding to the expelling instroke the sleeve will be in the position for the cam to act upon the lever *f* and open the discharge-valve, while during the next revolution corresponding to the compressing instroke the cam will be shifted away from the lever. The lifting of the valve-lever takes place during that part of the revolution when the sleeve is not being shifted, this having the advantage that the shifting is effected without there being any pressure on the sleeve, and thus the wear of the sliding surfaces is prevented.

The cam *n* is provided with a second acting surface, *n'*, having a less dwell than the main one, and the roller *k* is arranged to be slid on its pin by means of a stud, *o*, so that it may either be in the position shown at Fig. 9 for ordinary working, when on the sleeve *e* being shifted to the left both cam-surfaces will be clear of the roller; but if the roller *k* be shifted to the left on its pin, then, after being acted upon by the cam-surface *n* during one revolution, it will be acted upon by the surface *n'* during the next revolution, so as to open the escape-valve during the compressing-stroke.

The roller is put in the last-named position when the engine is being started, in order that by allowing some of the cylinder charge to escape during the compression-stroke the work of starting may be rendered easier. When the engine is fully at work, the roller *k* is shifted back to the position shown, so as to open the discharge-valve only during the expelling-stroke.

Figs. 10, 11, and 12 show the invention applied to a vertical engine. The action is just the same as above described, and the parts, being indicated by the same letters of reference, they need not be further referred to.

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

1. In a gas-motor engine of the type described, the combination, with the cylinder and crank-shaft, of an igniting-slide driven by an eccentric on the crank-shaft and an escape-valve worked by an automatically-movable cam on the crank-shaft to only effect the opening of the escape-valve once in every two revolutions, substantially as described.

2. In motor-engines worked by combustible gas, vapor, or spray that operate with a cycle of four strokes, a discharge-valve that is worked by a cam on the engine-shaft, arranged to slide laterally thereon, so as only to act upon the valve at every second revolution of the engine-shaft, substantially as and for the purposes set forth.

3. In motor-engines worked by combustible gas, vapor, or spray that operate with a cycle of four strokes, a cam, *n*, for working the discharge-valve of the engine, which is situated upon a sleeve, *e*, on the engine-shaft, arranged to slide longitudinally thereon, and having a double groove, *m m'*, in which works a stationary pivoted stud, *l*, so that at one revolution the stud works in the one groove and causes the cam to act upon the lever *f* of the discharge-valve, so as to open this, while at the next revolution the stud passes into the second groove, and thereby shifts the sleeve, so that the cam revolves without acting upon the lever *f*, substantially as herein described.

4. In motor-engines worked by combustible gas, vapor, or spray that operate with a cycle of four strokes, the combination of an igniting slide or valve, *b*, worked directly from the engine-shaft A by an eccentric, *a*, and a discharge-valve, *i*, worked directly from the engine shaft A by a cam, *n*, on a sleeve, *e*, that is slid laterally thereon, so as only to actuate the discharge-valve at every alternate revolution, substantially as herein described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 26th day of January, A. D. 1888.

NICOLAUS AUGUST OTTO.

Witnesses:

PETER LANGEN,
Köln.

WILHELM RINCK,
Deutz.