(No Model.)

C. BENZ.

GAS ENGINE.

No. 316,868. Patented Apr. 28, 1885.

Fig. 1.

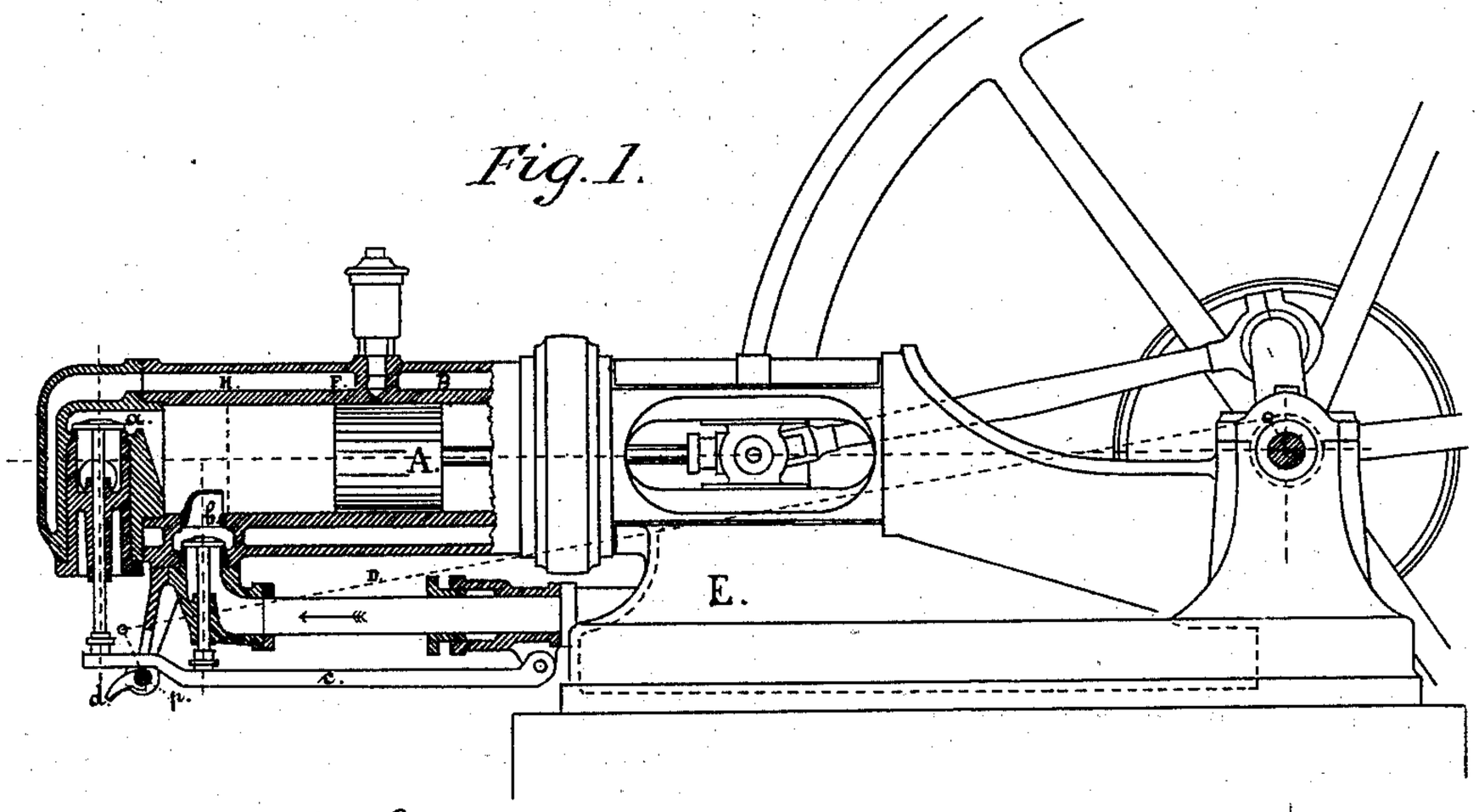


Fig. 3.

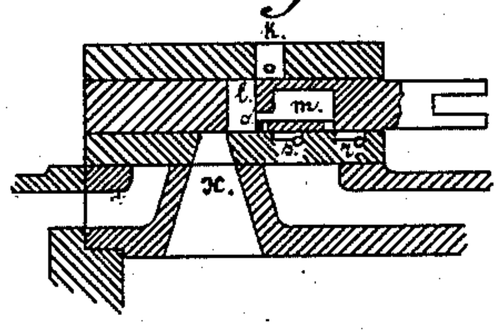


Fig. 2.

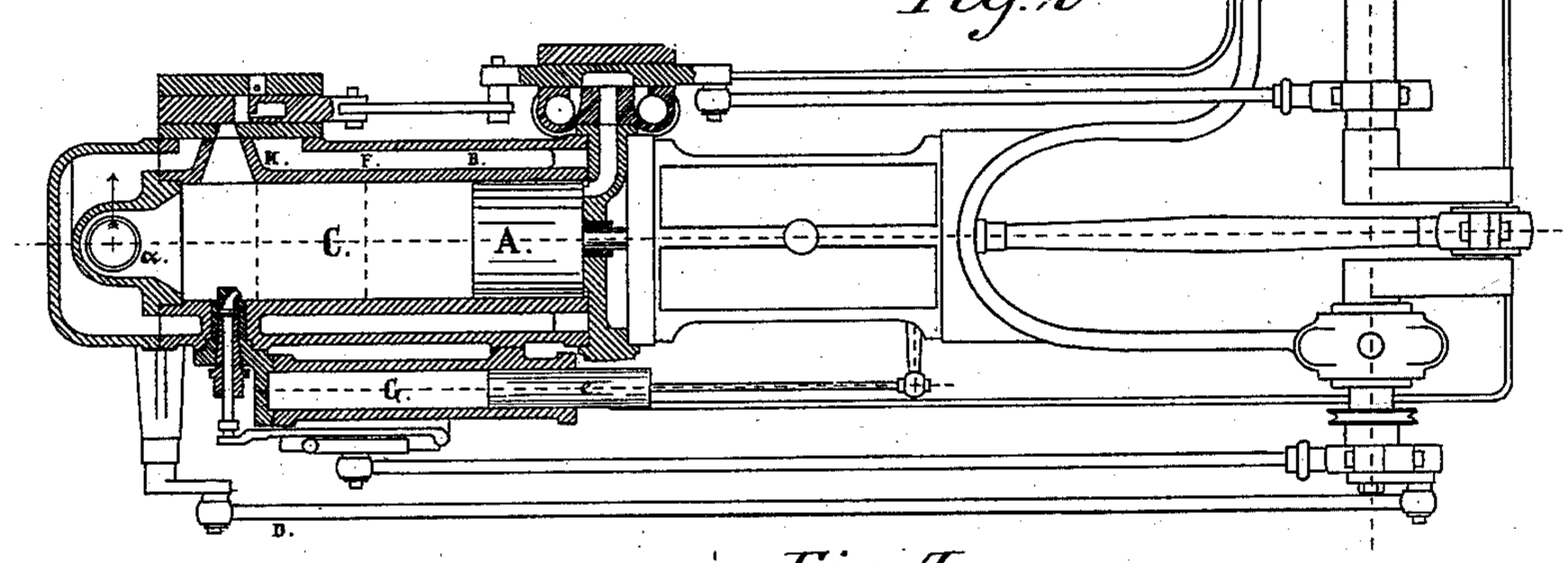
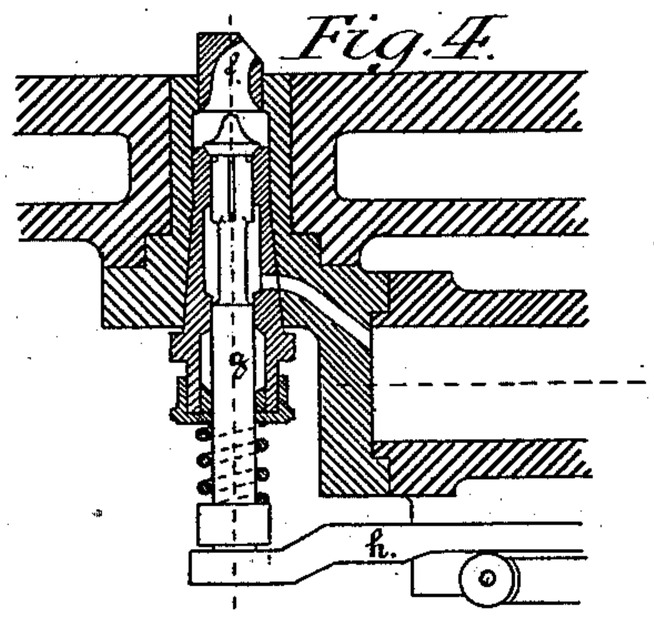


Fig. 4.



Witnesses.

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GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 316,868, dated April 28, 1885.

Application filed June 10, 1884. (No model.)

To all whom it may concern:

Be it known that I, CARL BENZ, of Mannheim, Baden, Germany, have invented a new and useful Improvement in Gas-Engines, of which the following is a full, clear, and exact specification.

My invention relates to that class of gas engines in which an explosion occurs at every revolution of the fly-wheel shaft, the said explosion serving to turn the fly-wheel during one half of its revolution, while the other half is caused by the energy previously stored up in the fly-wheel.

In the further description reference will be made to the accompanying drawings, of which Figure 1 is partly a vertical section and partly an elevation, and Fig. 2 a horizontal section, of a gas-engine embodying my invention, while Figs. 3 and 4 show the principal valves in detail.

The cylinder C of the gas-engine contains a piston, A, the extreme positions of which are indicated in Fig. 1 by the lines B and H, while the middle position is indicated by the dotted line F. The line B coincides in Fig. 2 with the inner (or left-hand) face of the piston. A valve, *a*, connects the interior of the cylinder with the atmosphere, while the valve *b* connects the cylinder with a vessel, E, filled with air at a pressure of about one-tenth above that of the atmosphere by means of a pump.

Gas is supplied to the cylinder at the proper time by means of a pump, G, communicating with the gas conduit by an ordinary gas-suction valve, and with the cylinder by a specially constructed valve illustrated by Fig. 4, and hereinafter more fully described.

The ignition of the combustible charge is controlled by a specially constructed slide-valve. (Shown in Figs. 2 and 3, and hereinafter more fully described.)

In order to facilitate the comprehension of the details, I will first describe the general operation of the engine.

When the piston reaches its dead-center at B, the valves *a* and *b* (shown in Fig. 1) are successively opened by means of the rod D. The valve *a* is opened first and allows the gas of combustion contained in the cylinder at more than atmospheric pressure to escape into the atmosphere until equilibrium has been established between the inside of the cylinder and the atmosphere. Thereupon atmospheric air, compressed in the air-vessel E, enters the cylinder through the valve *b* and drives out the gases of combustion still contained in the cylinder through the valve *a*. These actions take place before the piston has completed the first half of its stroke, limited by the line F. On the arrival of the piston at F the valves *a* and *b* are closed and the cylinder contains comparatively pure air at atmospheric pressure. In order to obtain an explosive mixture it is necessary to add a certain quantity of combustible gas and to compress the mixture. The supply of gas is effected during the second half of the stroke by the gas-pump G, placed at the side of the cylinder, and the compression of the mixture by the power-piston. The supply of gas takes place during the whole passage of the piston from F to H, and the required proportion for combustion is not obtained until the piston has reached its dead-center. The operation of the engine may be thus divided into three stages—namely, first, discharge of the product of combustion and supply of fresh air, which period corresponds to one-quarter of a revolution of the fly-wheel shaft; second, compression of air in the cylinder and simultaneous supply of combustible gas—duration, one-quarter of a revolution; third, ignition and combustion of the combustible gas mixture and transmission of energy to the fly-wheel—duration, one-half of a revolution. The discharge of the products of combustion and the filling of the cylinder with atmospheric air commence when the piston is in its dead-center at B, and are completed on the arrival of the piston at the line F. In order to obtain this result, I may employ an oscillating lever set in motion from the crank-shaft of the engine by means of a connecting-rod, so as to lift the valve *a* and keep it open during one-quarter of a revolution, the valve *b* being meanwhile allowed to open under the influence of the air-pressure in the air-vessel. This valve will only begin to lift after the excess of pressure in the power-cylinder has been removed in consequence of the opening of the valve *a*, and it will at once close after the pressure in the air-vessel has sunk to that of the atmosphere. In order to avoid sudden shocks and to diminish the wear and tear of this valve-gear, I prefer to employ the mechanism represented by Figs. 1 and 2. This

mechanism comprises a lever, *c*, and a wiper, *d*, mounted on the shaft *p*, which is adapted to obtain a rocking motion from the crank-shaft of the engine and to impart the same to the wiper *d*. The circumference of this wiper forms an evolute placed so as to lift the lever *c* during the required period, the lifting motion being first very slow (commencing with the inner or shortest radius of the evolute) and afterward rapid. As this slow motion takes place when the valves begin to rise, and also immediately before they come again in contact with the seat, (during the return,) vibrations, noise, and wear and tear are reduced to a minimum.

The gas-pump G mentioned above has a piston, *e*, connected with the cross-head of the engine, so as to share the motion of the engine-piston. On the forward motion of the engine-piston, in consequence of the explosion, the pump-piston is also going forward and draws gas from the gas-supply pipe through an ordinary pump-valve. This gas must not, however, be pressed into the engine cylinder at the commencement of the return motion of the piston, because, as already observed, during the first half of the return motion of the engine-piston the valve *a* is open and would allow a great portion of the gas to escape with the products of combustion. For this reason a special device must be used instead of an ordinary valve—for instance, that represented by Fig. 4 of the drawings. This device consists chiefly of a valve, *f*, provided with a counter-piston, *g*, having the same sectional area as the valve-opening, so that the pressure of the gas in the pump-barrel cannot open the valve. The valve is further held to its seat by a spring placed outside the valve-casing, as shown, until the lever *h*, which is connected with the crank-shaft, presses against the valve-spindle, and thereby opens the valve, so as to establish communication between the interior of the engine-cylinder and the pump. The opening of the valve *f* commences when the piston has performed half its return stroke, at which moment the engine-piston has arrived at F and the valves *a* and *b* are again closed. The valve *f* closes again when the two pistons have arrived at the end of their stroke. At this moment the explosion takes place, the power-piston is thereby driven to the opposite end of the cylinder, and the series of operations is repeated in the manner described.

In order to maintain the pressure in the air-vessel E, the portion of the engine-cylinder situated between the engine-piston and the crank-shaft or the front side of the cylinder is utilized as an air-pump, so as to press into the air-vessel at every stroke a quantity of air equal to the volume of the engine-cylinder.

In gas-engines working with compression, the igniting flame, burning in the interior of a slide-valve, is liable to be extinguished as soon as the flame comes in contact with the compressed gas and air mixture contained in the engine-cylinder—that is to say, at the moment when the ignition should take place. The construction represented by Fig. 3 has for its object to avoid this fault, the small pipe *r* serves to admit air and gas, and the pipe *s* combustible gas alone. The slide-valve has a port, *l*, and at the side of the latter a chamber, *m*, communicating with the port through a small opening, *o*, and provided at the base with two perforations leading to recesses in the valve-face, in which are situated the pipes *r* and *s*. If the slide-valve moves to the right, the chamber *m* will be filled through the pipe *r* with air and gas in the proportions necessary to make an explosive mixture, which then passes through the opening *o*. Into this opening is also admitted coal-gas from the pipe *s* and mixes with the previously-admitted combustible mixture in sufficient quantity to render the mixture inexplosive. After having reached the port *l* the mixture will be ignited by the flame continually burning in the port *k*, and will produce a flame at the aperture *o* until the valve moves again to the left, so as to arrive in the position represented by the drawings. During this motion the gas-inlet *s* and then the gas and air inlet *r* are closed. By the closing of the inlet *s* the mixture in *m* is again rendered explosive, and the explosion in the chamber *m* causes the flame to strike into port *x*, which is at this moment opened, while the communication of port *l* with port *k* is cut off. The port *x* leads to the interior of the engine-cylinder and communicates the explosion to the gaseous mixture contained in the same.

What I claim is—

1. A valve, *f*, provided with counter-piston *g*, and placed in the conduit between the engine-cylinder and the gas-supply, substantially as described.

2. The combination of a cylinder and valve-face with an igniting-valve having a port, *l*, and a chamber, *m*, communicating with each other through aperture *o*, an air-supply pipe, *s*, and an auxiliary gas-supply pipe, *r*, the valve-face being provided with a pair of recesses adapted to communicate with the chamber *m* and with the pipes *s* and *r* in such a manner that by the motion of the valve the gas is cut off earlier than the air and that at the moment when the valve-port communicates with the cylinder the chamber *m* possesses an explosive mixture, substantially as described.

The foregoing specification of my improvement in gas-engines signed by me this 22d day of April, 1884.

CARL BENZ.

Witnesses:
MAX ROSE,
JOSEPH BRECHT.