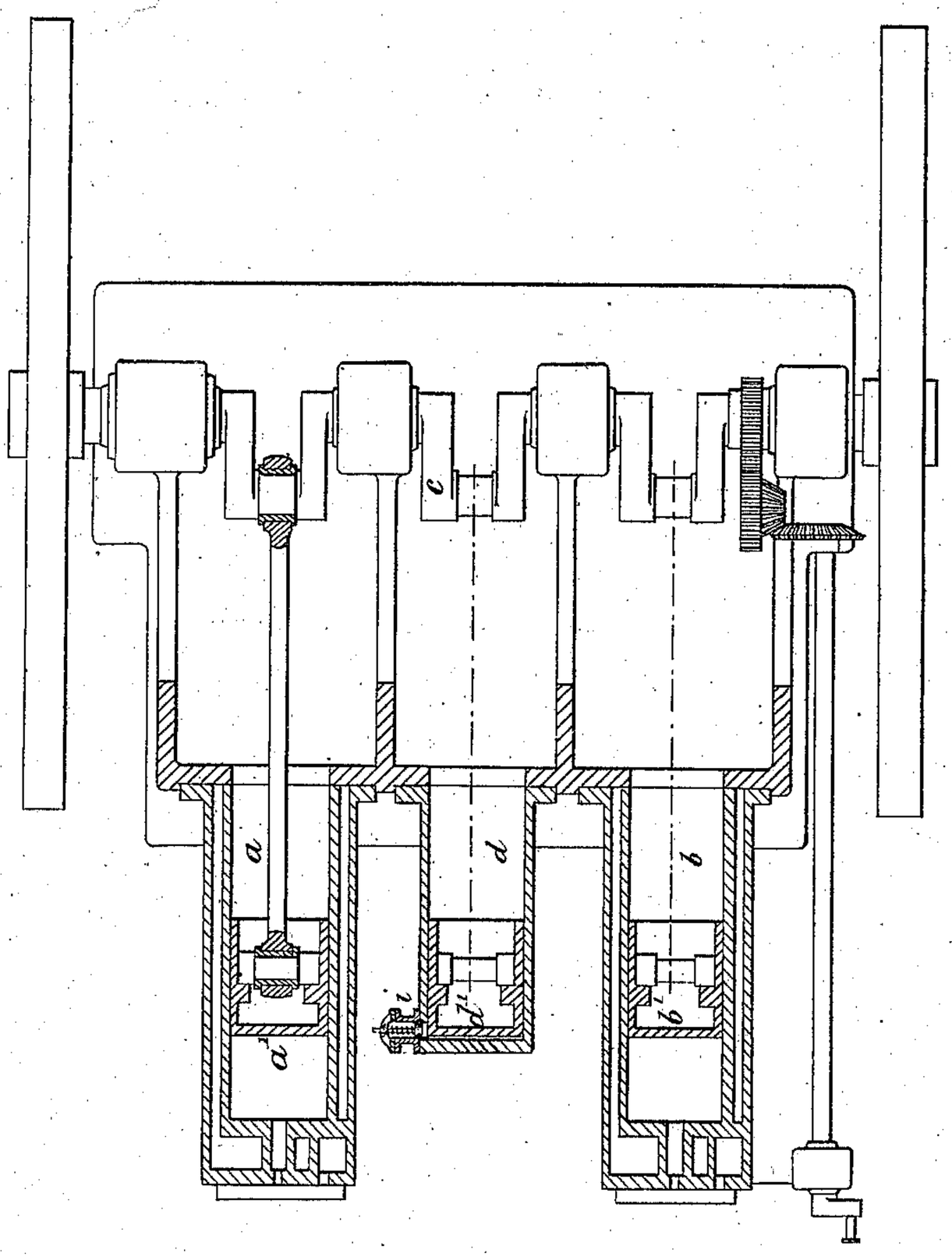
(No Model.)

N. A. OTTO.

GAS ENGINE.

No. 288,479. Patented Nov. 13, 1883.



Witnesses.

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UNITED STATES PATENT OFFICE.

NICOLAUS A. OTTO, OF DEUTZ-ON-THE-RHINE, PRUSSIA, GERMANY.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 288,479, dated November 13, 1883.

Application filed May 3, 1883. (No model.) Patented in England April 3, 1883, No. 1,677.

To all whom it may concern:

Be it known that I, NICOLAUS AUGUST OTTO, a citizen of Prussia, residing at the Gas-Motoren-Fabrik-Deutz, at Deutz-on-the-Rhine, in the German Empire, have invented a new and useful Improvement in Gas-Engines, (for which provisional protection has been obtained in Great Britain, No. 1,677, dated April 3, 1883,) of which the following is a specification.

My invention has for its object to produce a very uniform or equable motion in single-acting gas-motor engines—that is to say, those in which the admission and ignition of a combustible gaseous charge takes place on one side only of the piston.

My invention consists in combining with the gas-motor engine an auxiliary cylinder open to the atmosphere at one end and provided at its closed end with a check-valve opening outward, which cylinder has a piston connected to a crank on the engine-shaft, so arranged that it makes its outstroke simultaneously with the outstroke of the working-piston. The piston of the auxiliary cylinder, at the end of its instroke, is situated close against the closed end of its cylinder, so that when it is made to perform its outstroke during the working-outstroke of the engine-piston, a vacuum or partial vacuum will be formed behind it in the cylinder, a portion of the power produced by the combustion of the charge in the engine-cylinder being thus expended in forming such vacuum. On the return-stroke of the working-piston the power thus expended will be given out again by the pressure of the atmosphere acting against the vacuum in the auxiliary cylinder in forcing its piston inward. Any air that may have leaked into the auxiliary cylinder during the outstroke of its piston will be expelled through the before-mentioned check-valve on the return-stroke.

The accompanying drawing shows a sectional plan of a gas-motor engine having two single-acting working-cylinders *a b*, and provided with an auxiliary vacuum-cylinder, *d*, with discharge-valve *i*, according to my invention. The pistons *a' b' d'* are all connected to parallel cranks on the engine-shaft *c*, so as to make their out and instrokes together. The piston *d'* moves close up to the bottom of the cylinder *d* at its instroke, and expels any air that may leak into the cylinder through the discharge-valve *i*, so that when it is caused to perform its outstroke during the working-outstroke of the pistons *a' b'*, a vacuum or partial vacuum is formed behind it, against which the atmospheric pressure acts on the return-stroke.

From the foregoing description it will readily be seen that the unequal action of single-acting gas-motor engines will by this invention be effectually compensated and a comparatively-uniform motion be obtained without the use of large and heavy fly-wheels. As is well understood, the explosion of the combustible charge of such engines developes very considerable force during the working-outstroke of the piston, resulting in a very rapid outward motion of the piston and correspondingly rapid semi-revolution of the crank-shaft, while the remainder of the revolution of the latter and the return-stroke of the piston can only be effected by the expenditure of the *vis viva* stored up in the shaft and fly-wheel during the outstroke; hence it follows that, unless the fly-wheel be made inconveniently large and massive, so as to enable it to store up a large amount of *vis viva*, the return-stroke of the piston and second half of the revolution of the shaft will take place at a comparatively slow speed, the unsteady motion of the engine thus obtained rendering it unsuitable for work, such as driving dynamo-electric machines, requiring a very uniform motion. Now, by expending a portion of the power developed during the working-outstroke in producing a vacuum in the auxiliary vacuum-cylinder *d*, as above described, and then allowing the motive-power thus stored up to be given off during the return-stroke of the piston, it will be very evident that the power developed by the engine will practically be evenly distributed over the entire revolution of the engine-shaft, resulting in a greatly-increased uniformity of motion of the engine.

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

1. In combination with a gas-motor engine, in which the admission and combustion of the gaseous charge is effected only on one side of

the piston, a separate cylinder whose piston during the instroke of the working-piston moves close up to the bottom of the cylinder, so as to expel all the air therefrom through a discharge-valve, so that when the piston is made to perform its outstroke during the working-outstroke of the working piston or pistons, a vacuum or partial vacuum is formed behind it against which the pressure of the atmosphere acts on the return-stroke of the piston, thus giving out the power again that had previously been expended in forming the vacuum, substantially as described.

2. In gas-motor engines, the combination, with a single-acting working-cylinder, of an auxiliary cylinder, *d*, with discharge-valve *i* and piston *d'*, by whose outstroke a vacuum or partial vacuum is formed in the cylinder, and at whose instroke any air in the cylinder is expelled through the valve *i*, substantially as and for the purposes set forth.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 13th day of April, A. D. 1883.

NICOLAUS AUGUST OTTO.

Witnesses:
PH. REITMANN,
SAMUEL SPACKMAN.