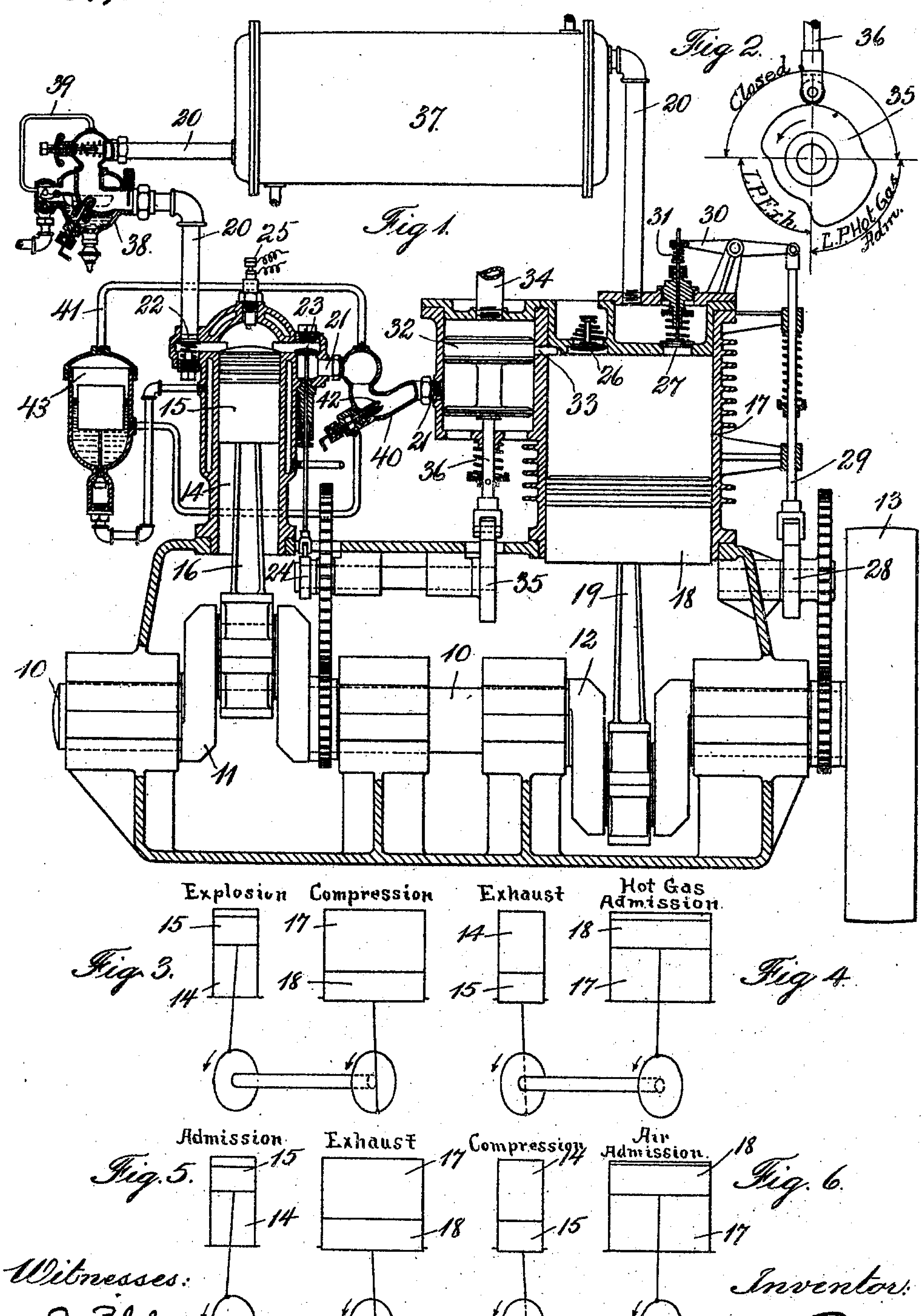
R. M. PIERSON.

COMPOUND INTERNAL COMBUSTION ENGINE.

APPLICATION FILED AUG. 14, 1906.

967,828. Patented Aug. 16, 1910.



Witnesses:

G. Blake

John A. Bolte

Inventor:

R. M. Pierson

UNITED STATES PATENT OFFICE.

ROBERT M. PIERSON, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO C. P. POWER COMPANY, OF NEWARK, NEW JERSEY, A CORPORATION OF NEW JERSEY.

COMPOUND INTERNAL-COMBUSTION ENGINE.

967,828. Specification of Letters Patent. **Patented Aug. 16, 1910.**

Application filed August 14, 1906. Serial No. 330,537.

To all whom it may concern:

Be it known that I, ROBERT M. PIERSON, a citizen of the United States, residing at New York city, in the county and State of New York, have invented certain new and useful Improvements in Compound Internal-Combustion Engines, of which the following is a specification.

This invention relates to internal-combustion engines in which both the compression and expansion processes are compounded or conducted in stages, and its object is to minimize the number of cylinders and moving parts required to perform the engine cycle, and to secure improved mechanical balance and other advantages. This object is attained by employing the same cylinder for the low-pressure stage of both the compression and expansion processes, and alternating the compressor and expander functions of the low-pressure cylinder to accommodate the phases of the high-pressure cylinder, which may be of the four-cycle type. Mechanical balance is attained by causing the high-pressure and low-pressure pistons to move in opposite directions, as for instance by mounting the cylinders alongside each other and connecting the pistons with cranks set 180° apart.

Of the accompanying drawings, Figure 1 represents a sectional view of a compound explosive engine constructed according to my invention. Fig. 2 is a view showing the cam and valve-rod for working the piston-valve on the low-pressure cylinder. Figs. 3 to 6 inclusive are diagrams of the cylinders and pistons illustrating the four phases making up the cycle of the engine.

The same reference characters indicate the same p rts in all the views.

In the drawings, 10 is a crank-shaft having two cranks 11, 12 at 180° and a fly-wheel 13.

14 is the high-pressure cylinder with trunk-piston 15 connected by pitman 16 with the crank 11; and 17 is the low-pressure cylinder having piston 18 and pitman 19 on the crank 12.

The two cylinders are connected by two conduits, one being a pipe 20 for conducting the compressed charge from L. P. cylinder 17 to H. P. cylinder 14, and the other being a pipe 21 for conducting the exhaust of the H. P. cylinder into the L. P. cylinder.

Cylinder 14 has the usual appurtenances of a four-cycle explosive engine, namely the inlet-valve 22, here shown as an automatic or suction-operated check-valve, an exhaust-valve 23 operated from a half-speed cam 24, and an igniter 25 timed to give a spark in the usual manner.

Cylinder 17 is equipped to alternately perform the functions of a compressor and an expander. I have here shown this cylinder adapted to compress a charge of pure air only, although the charge admitted might be fuel-laden.

26 is a suction-operated air-admission check-valve and 27 is an automatic pressure-operated discharge check-valve. For seating the latter with an extra pressure when the high-pressure exhaust, which may be above the compressor-discharge pressure, enters cylinder 17, I show a half-speed cam 28, rod 29, and tappet 30 acting on a heavy valve-seating spring 31, which acts only during the hot-gas-admission phase, occurring as hereinafter described.

32 represents a piston-valve which connects a port 33 in L. P. cylinder 17 alternately with the hot-gas admission-pipe 21 of said cylinder and with the exhaust-pipe 34 thereof. This valve is operated by a half-speed cam 35 acting on the valve-rod 36. Fig. 2 shows the four quadrants of said cam.

37 represents a suitable intercooler located in the compressor-discharge pipe 20 and adapted to remove the heat of compression from the charge. In this pipe beyond the intercooler 37 is placed a float-feed carbureter 38, of ordinary type except that intercooler-pressure is led to the surface of the fuel in the float-chamber through a duct 39 and the liquid fuel requires to be supplied to the float-chamber under a pressure superior to intercooler pressure.

In the hot-gas or receiver-conduit 21 is placed a jet-mixer 40 similar in construction to the carbureter 38, but receiving water instead of fuel, and spraying said water into the products of combustion passing through pipe 21, thereby conserving their heat in a lower-temperature and more stable form, which enables the resulting mixture of steam and products of combustion to be employed expansively in the low-pressure cylinder 17, much as steam would be in an ordinary steam-engine. This water-quencher for the gases is one of several types which may be used and I do not confine myself to any one type.

The operation of my invention is illustrated in a simple fashion by the four diagrammatic phases shown in Figs. 3 to 6, from which it will be seen that the H. P. motor acts like an ordinary four-cycle engine, only at higher admission, exhaust, and explosion pressures, while the L. P. motor acts alternately as compressor to supply the first-stage compression for the charge entering the H. P. cylinder and as expander to perform a second stage of expansion for the exploded gases while doing useful work. Taking these phases in order as represented by Figs. 3 to 6 they are:—

(1) Explosion in H. P. coincides with low-pressure compression in L. P., and valve 27 is the only valve opened, the air-charge being stored in the intercooler 37 during the latter part of this phase and the whole of the next one.

(2) Exhaust from H. P. coincides with hot-gas admission to L. P. and low-pressure expansion of the gases in the latter. Valve 23 is open and valve 32 is above port 33. Tappet 30 puts extra spring-pressure on valve 27.

(3) Charge-admission to H. P. coincides with exhaust of expanded gases from L. P. Valve 22 is open and valve 32 is below port 33.

(4) High-pressure compression in H. P. coincides with atmospheric air-admission to L. P., and valve 26 is the only one opened.

Thereupon the cycle is repeated. It will be noted that there is positive torque on the crank-shaft through phases (1), (2), and (3) and negative torque only during phase (4), which gives this engine an advantage over ordinary single-cylinder or double-cylinder four-cycle engines in the matter of torque and enables a comparatively light fly-wheel to be used, while the mechanical balance is as good as that of three-cylinder, four-cylinder and double-cylinder "opposed" four-cycle engines. In the matter of simplicity and reliability this engine is somewhat better than prior two-cylinder simple explosion engines since only one igniter is required, and the efficiency is far higher than that of simple explosion engines since the maximum pressure-range is very considerably extended by compounding both the compression and expansion processes. To properly stand the high explosion pressures, the high-pressure parts are heavily constructed and the cylinder and piston are of relatively-small diameter, as shown.

I do not broadly claim an internal-combustion cycle compounded on both the compression and expansion sides, but believe myself to be the first to provide a combination of high-pressure and low-pressure cylinders performing a true compound cycle in which the low-pressure cylinder is both compressor and expander for the high-pressure cylinder.

If continuous positive torque is desired it may of course be attained by a suitable duplication of the two-cylinder unit herein described, or of one or more of its cylinders, with a proper relative disposition of the phases of the respective units.

Water, pumped under a pressure superior to the H. P. exhaust pressure and (as here shown) first heated by passing through the H. P. water-jacket, is maintained at a fixed level in the float-chamber 43 of the jet-mixer 40, to which the H. P. gaseous exhaust pressure is admitted through a duct 41. Water-spray is then drawn into the hot-gas current from the spray-nozzle 42 of the mixer on the atomizer principle, as in ordinary jet carbureters.

In cases where the conditions admit of locating the high-pressure and low-pressure cylinders very close together, water-cooling of the hot gases may be omitted if desired, as they will lose very little heat in traversing a short port. In that case it may be desirable to substitute a suitable lift-valve mechanism for the sliding piston-valve 32 shown in the drawings. It will be understood that the valve-arrangements for effecting the desired sequence of operations may be varied in many particulars without departing from my invention.

Regulation of the engine for speed and load may be performed by throttling the air-suction of the low-pressure cylinder, or holding open its admission-valve for part of the compression-stroke, or in any of the well-known ways for regulating compressors, or the regulation may be applied to the high-pressure motor, by throttled charge-admission, variably-timed ignition, etc.

I claim:—

1. In a compound internal-combustion motor apparatus, the combination of a high-pressure member adapted to isolate a compressed charge and to burn and partially expand the same, and a low-pressure member adapted during alternate phases to compress the charge for said high-pressure member and to expand the gases received therefrom, together with valve-mechanism between said members for alternately admitting the charge from the low-pressure to the high-pressure member and admitting the gases from the high-pressure to the low-pressure member.

2. In a compound internal-combustion motor apparatus, the combination of a four-cycle high-pressure member adapted to isolate a partially-compressed charge, further compress and explode the same and partially expand the gases, and a low-pressure mem-

ber connected with said high-pressure member by separate efflux and influx conduits, together with valve-mechanism associated with the high-pressure member for producing its phases, and valve-mechanism associated with the low-pressure member for producing therein alternate compressing and expanding phases.

3. In combination, a high-pressure explosive compressor-motor member, a low-pressure member compounded therewith and having means which constitute it alternately a charge-compressor and an expander of the products of combustion, a conduit for conducting the charge from the low-pressure to the high-pressure member, and means for cooling the charge between said members to avoid pre-ignition.

4. An engine comprising high-pressure and low-pressure cylinders with pistons therein connected to work oppositely, valve-mechanism and ignition-mechanism for the high-pressure cylinder arranged to produce a four-stroke explosive cycle therein, a compressed-charge conduit and a hot-gas conduit connecting the two cylinders, and valve-mechanism for the low-pressure cylinder adapted to alternately produce therein a low-stage compression of the working charge, and a low-stage expansion of the exploded gases.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses, the 13th day of August 1906.

ROBERT M. PIERSON.

Witnesses:

G. W. Hopkins,

G. Blake.