(No Model.) 2 Sheets—Sheet 1.

P. F. HOLMGREN.

COMPOUND VIBRATING PISTON ENGINE.

No. 430,288. Patented June 17, 1890.

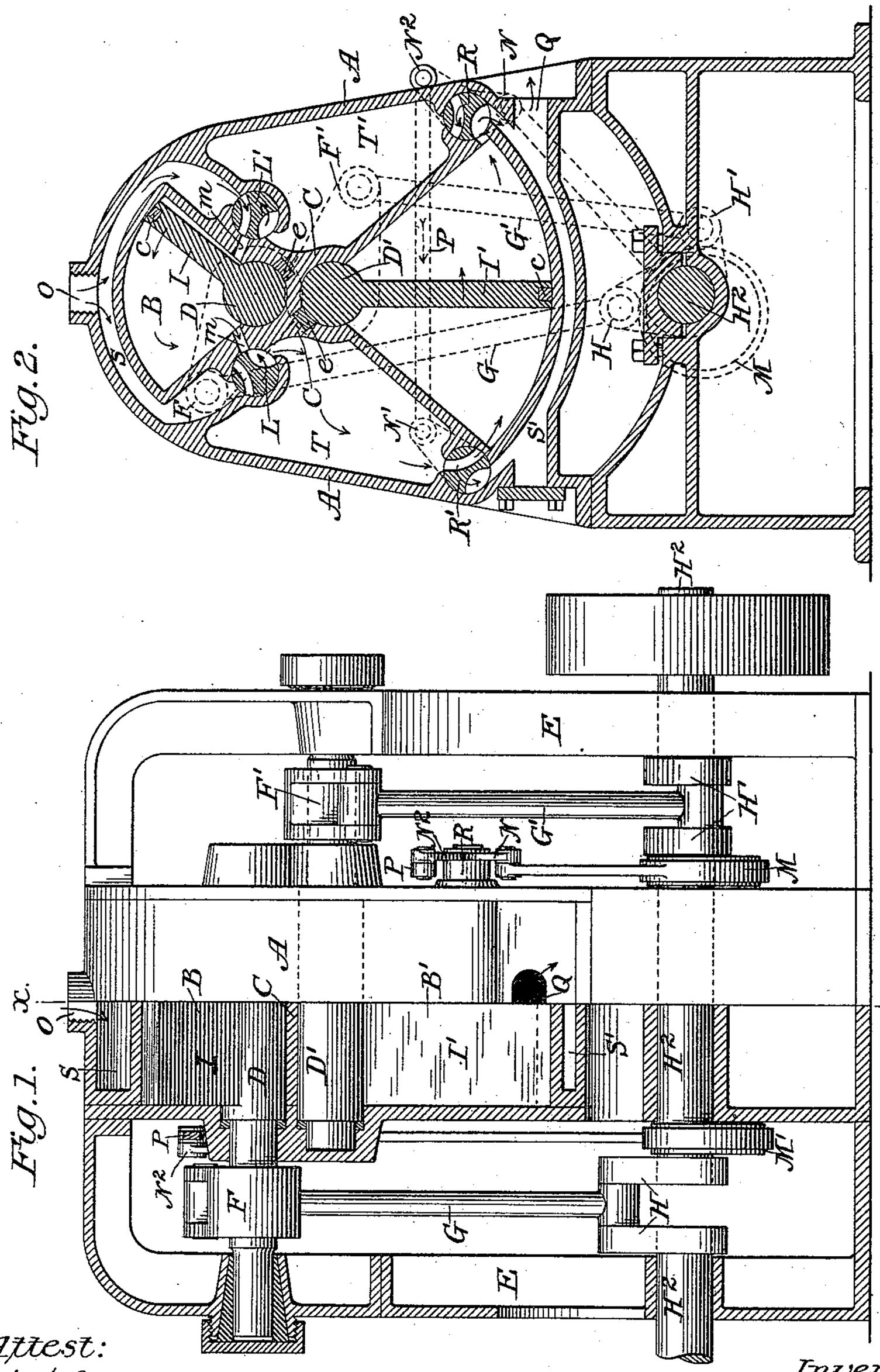

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Fig. 5.

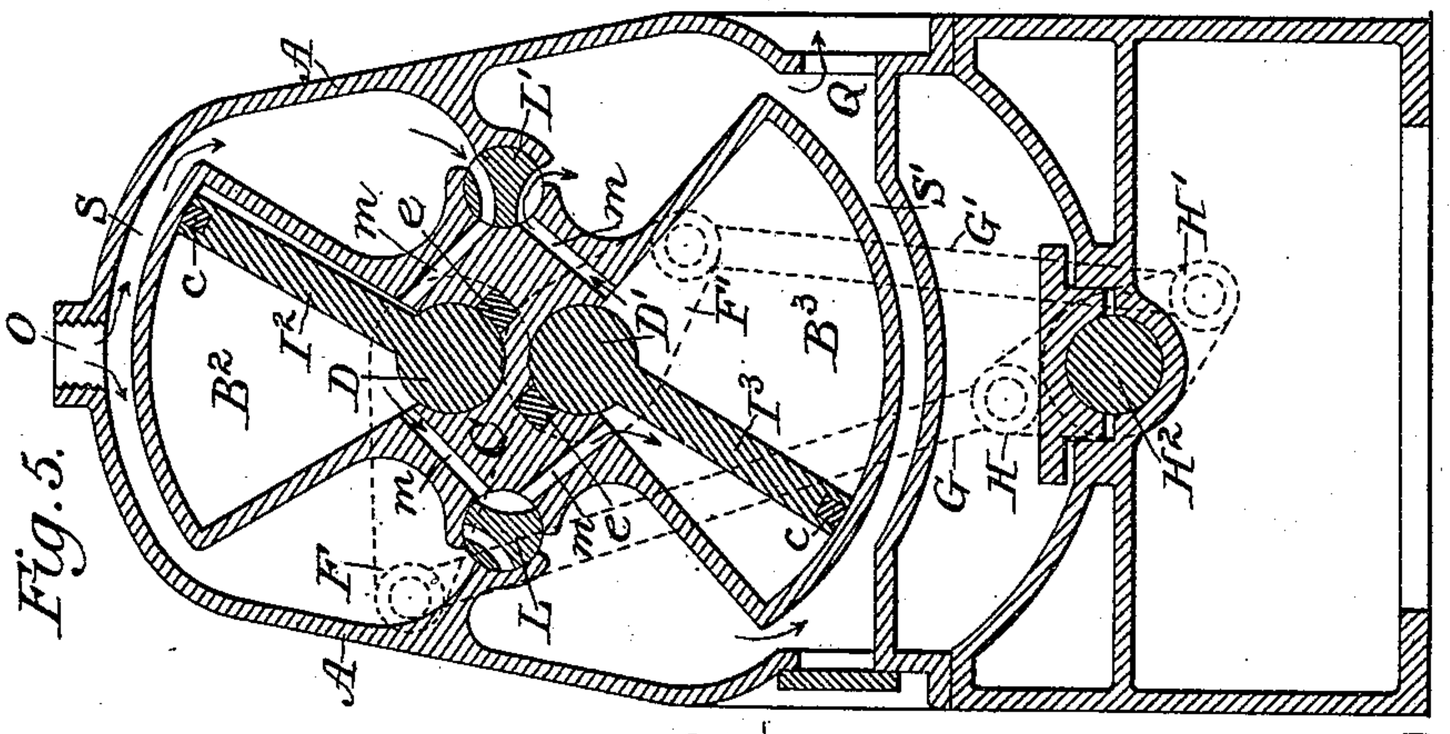


Fig. 4.

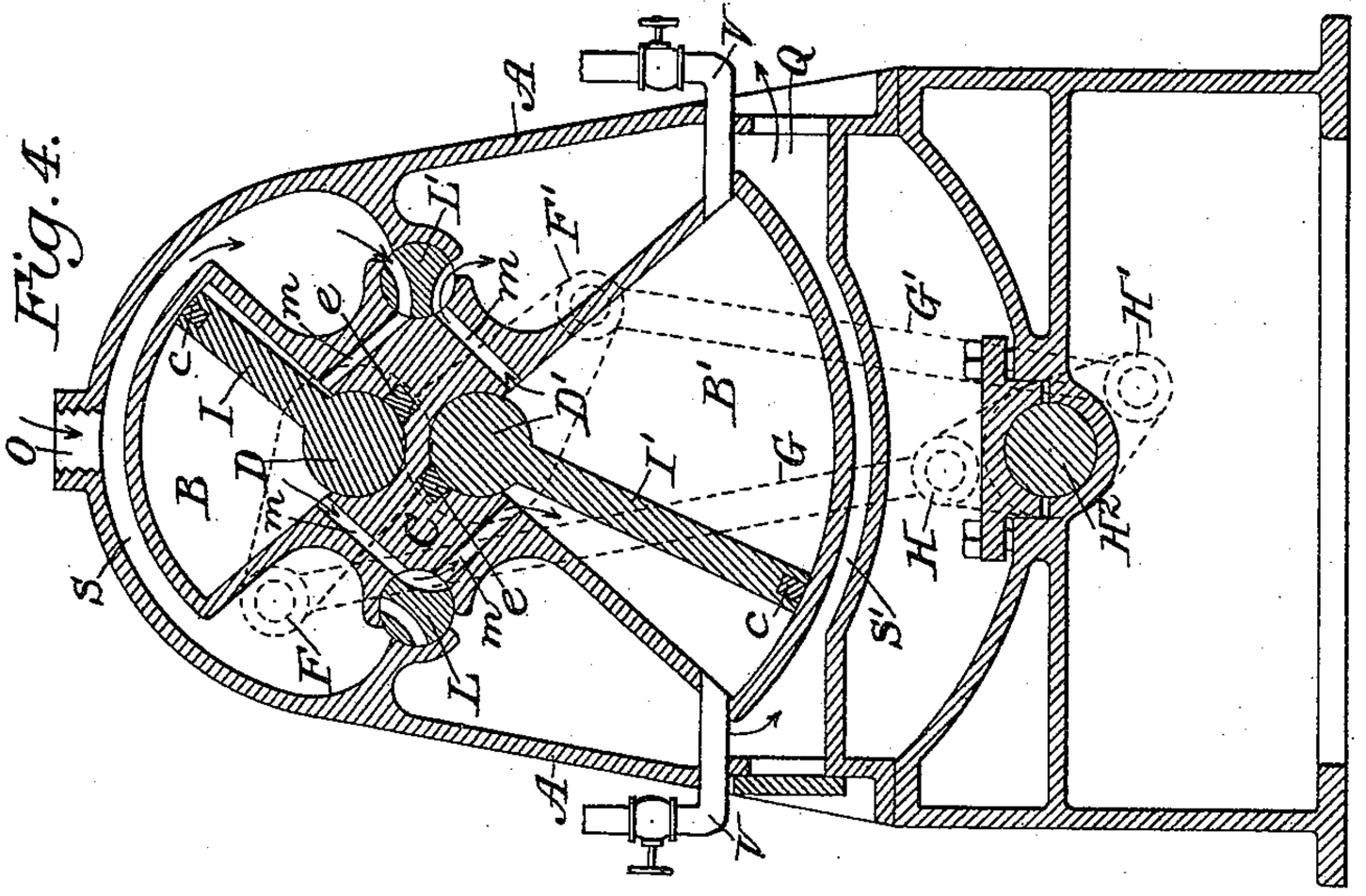
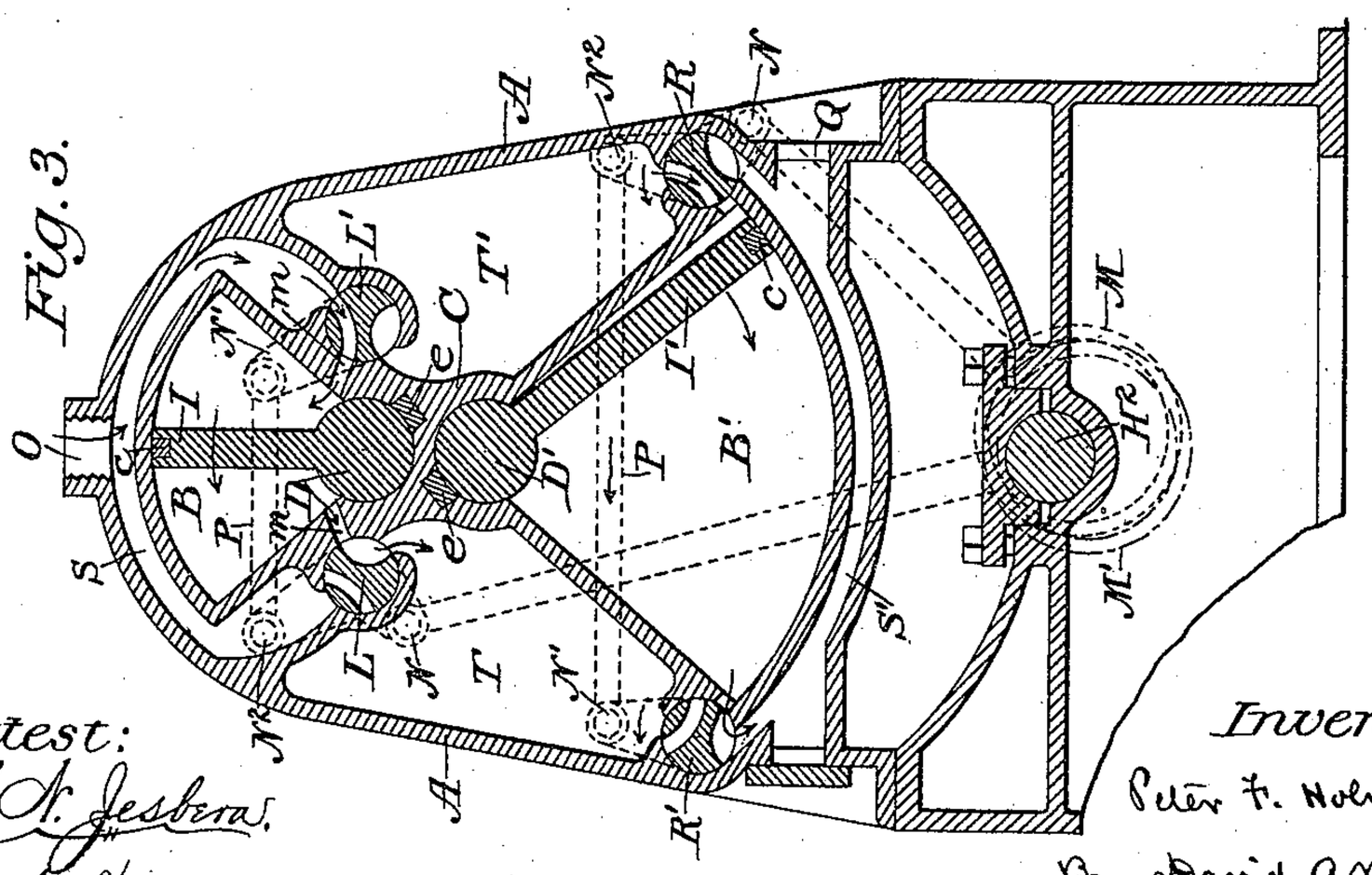


Fig. 3.



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UNITED STATES PATENT OFFICE.

PETER F. HOLMGREN, OF BROOKLYN, NEW YORK.

COMPOUND VIBRATING-PISTON ENGINE.

SPECIFICATION forming part of Letters Patent No. 430,288, dated June 17, 1890.

Application filed October 21, 1889. Serial No. 327,695. (No model.)

To all whom it may concern:

Be it known that I, PETER F. HOLMGREN, of Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Compound Vibrating-Piston Engines; and I do hereby declare that the following is a full and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, making a part of this specification.

This invention relates to that class of engines having vibrating pistons geared to a rotating shaft, and has for its object to provide a compound engine of this type in which one or the other of the pistons shall always be in an effective position to start the engine when steam or other equivalent expanding gas is admitted thereto.

It consists in combining with the main shaft two oscillating pistons vibrating upon independent rock-shafts in independent sectoral chambers of unequal area, the two chambers being connected by communicating passages controlled by suitable automatic valves, so that the steam discharged from the chamber of least area during the movement of the piston therein shall be brought to bear upon the piston in the chamber of larger area to produce its movement before being finally exhausted from the engine, substantially as is hereinafter fully described and claimed.

In the accompanying drawings, Figure 1 is a front elevation of my improved compound vibrating-piston engine; Fig. 2, a central section thereof in line *x x* of Fig. 1; Fig. 3, a similar section illustrating a change in the position of the valves and pistons therein, and Figs. 4 and 5 corresponding sections illustrating modifications in the construction of the engine.

Similar letters indicate like parts in all of the figures.

A A represent the casing of the engine, properly fashioned to inclose two sectoral chambers B B′ of unequal area, placed, preferably, one above the other, with their diverging walls radiating from two parallel proximate axial lines, preferably arranged in the same vertical plane. The central partition C, separating the two chambers, is recessed to form seats to receive and partially embrace rock-shafts D D′, severally mounted in the angle of each chamber, as shown in Fig. 2, to oscillate in suitable bearings formed in the parallel end walls of the casing, as shown in Fig. 1. The joint between each shaft and its seat in the partition C is packed steam-tight by means of a suitable packing-strip *e*, inserted longitudinally in a recess in the seat. One end of each shaft is extended out through and beyond its bearing in the wall of the casing, each on an opposite side of the engine, and is made to enter an outer bearing in a vertical standard E, extending for its support from the base of the engine, as shown in Fig. 1.

A rocker-arm F F′ is formed upon each rock-shaft D D′ intermediate the casing and the standard, and each arm is coupled by a connecting-rod G G′ to the wrist-pin of a crank H H′ upon the shaft H^2, which is mounted in suitable bearings in the lower part of the engine beneath its working-chambers. The two cranks H H′ upon the main shaft H^2 are set at an angle with each other, so that they cannot both simultaneously reach a dead-center, but the one or the other will always be in an effective working position. These rock-shafts D D′ serve as journals for piston-plates I I′, made to project within each of the sectoral working-chambers B B′. Each piston-plate is fitted to work closely between the end walls of the chamber and to sweep with its outer edge against the periphery of the curved wall thereof, the side and end joints being made steam-tight in the customary manner by means of suitable spring-seated packing-strips *c c*, fitted in the edges of the piston.

Passages are formed in the casing of the engine to establish communication between the corresponding spaces on the opposite sides of the pistons in the two working-chambers. These passages may be formed through the partition C, separating the chambers, as at *m*, (see Fig. 4,) and in the larger sizes of engines they are connected with inclosed spaces or equalizing-chambers T T′ formed within the casing between the working-chambers, as shown in Fig. 2. In the one case, as shown in Fig. 4, these communicating passages are severally governed, each by a single oscillating valve L L′, which is

also made to govern the communication between the smaller or high-pressure piston-chamber B and the steam-supply pipe O of the engine and between the piston-chamber B′ of larger area and the exhaust-chamber and port Q, so that in one position of the valve L′ steam will be admitted from the supply-pipe to the high-pressure piston-chamber, while the exhaust-passage from the low-pressure chamber will be simultaneously opened, as shown at the right hand in Fig. 4, and in the next position the steam-supply will be cut off from the high-pressure chamber B and the exhaust from the low-pressure chamber B′, while the direct communication between the two chambers will be simultaneously opened, so as to permit the steam exhausting from the high-pressure chamber B to pass into and expand within the low-pressure chamber B′ for effective work therein, as shown at the left in Fig. 4.

In the larger sizes of engines it is advantageous to so adjust the pistons as that one shall lead the other, so that at times both will be found traveling in the same direction, the stroke of the one not being yet completed when the return-stroke of the other in the same direction has begun, as is illustrated in Fig. 3 of the drawings. To permit of this result, the equalizing-chambers T T′ are interposed on each side of the engine between the two working-chambers B B′, and are made severally to receive the steam still exhausting from the high-pressure chamber after the low-pressure piston, driven by this exhaust-steam, has completed its stroke and has begun to move in the same direction as the high-pressure piston, as shown at the right in Fig. 3. The flow of exhaust-steam necessarily cut off from the low-pressure chamber is thus collected in the equalizing-chamber between the two pistons so long as they both travel in the same direction, as shown in Fig. 3, and so soon as the stroke of the low-pressure piston toward said equalizing-chamber is completed the steam meanwhile collected in the chamber is admitted against said piston, as shown at the right in Fig. 3, so as to drive it in its reverse movement until the corresponding movement of the high-pressure piston is reversed, and, as shown at the left in Fig. 2, the exhaust therefrom comes directly into play once more to move the low-pressure piston. This arrangement of intermediate equalizing-chambers T T′ necessitates the use of independent auxiliary valves R R′ to govern the exhaust-ports from the low-pressure chamber, as well as the admission of steam thereto from the equalizing-chamber. These valves are adapted each to establish direct communication through suitable ports and passages in the inclosing-walls between each equalizing-chamber T T′ and the space on the corresponding side of the piston in the low-pressure chamber B′, as shown at the left in Fig. 2, and also between said chamber B′ and the exhaust-port Q of the engine, as shown at the right in the same figure, the valve being so constructed and arranged as that when communication through it is open in the one direction it shall be closed in the other, and vice versa.

The valves L L′ R R′ are severally operated so that they shall all work in harmony and in synchronism with the movements of the engine, by means of eccentrics M M′ on the main shaft actuating rocker-arms N on the spindle of one of the valves L and R in each set, as shown by dotted lines in Fig. 3, a rocker-arm N′ on the opposite valve L′ and R′ in each set being coupled with a second rocker-arm N^2 on the first valve-spindle by means of a connecting rod or link P, so that each pair of valves L L′ R R′ shall move in unison.

The eccentrics M M′ are so adjusted with reference to the working-pistons I I′ as that the steam-ports are opened and the exhaust closed in the customary manner at the end of the stroke of the piston in each direction, the exhaust at the opposite end of the working-chamber being simultaneously opened and the steam-port thereat closed.

The outer casing A of the engine is made to inclose the walls of the working-chambers in such manner as that intermediate spaces S S′ are formed, in which the steam admitted from the boiler shall surround, more or less, the walls of the high-pressure chamber B and the exhaust-steam the walls of the low-pressure chamber B′ to prevent condensation therein.

In the operation of the engine when constructed in simplest form, as shown in Fig. 4, if the high-pressure piston I has reached the end of its stroke in either direction and its crank is upon a dead-center, the crank of the high-pressure piston I′ will have passed its dead-center and the piston itself have begun its return-stroke under the pressure of the exhaust-steam, which, by the opening of the exhaust-passage in the valve L, was allowed to pass from the high-pressure piston-chamber into the low-pressure piston-chamber so soon as the stroke of the high-pressure piston was completed and simultaneously with the opening of the steam-supply passage in the valve L′, as shown in Fig. 4. The expansion of the high-pressure steam in the low-pressure chamber against the greatly-enlarged piston-area in said chamber causes the low-pressure piston to move with the same effect as the high-pressure piston, although independently thereof, thereby compounding the effective power of the steam before it is finally discharged from the engine.

It is evident that instead of causing the exhaust-steam from the high-pressure piston-chamber to expand and operate against a piston of enlarged area it may be admitted with equal effect against a piston whose surface area corresponds more or less closely with that of the high-pressure piston, but which is permitted to work with a longer stroke in a

chamber of greater area than that of the high-pressure piston. Such a modification in the construction of the engine is shown in Fig. 5, in which I^2 represents the high-pressure piston and I^3 the independent low-pressure piston of equal area, but made to vibrate in a chamber B^3, so extended as that the length of stroke of the piston I^3 moving therein is twice as great as that of the stroke of the high-pressure piston I^2 in chamber B^2. In such case the rocker-arm F of the high-pressure piston is made twice the length of that of the low-pressure piston, so that, while the stroke of the one is twice as great as that of the other, the effect of each upon the rotating crank-shaft H^2, to which they are both coupled, shall be the same.

To facilitate starting the engine when it is at a standstill with the high-pressure piston on a dead-center, I connect steam-supply pipes V V, governed by suitable valves, with both of the equalizing-chambers, or, as shown in Fig. 4, directly with the two ends of the low-pressure piston-chamber B′. Since the low-pressure piston is always in an effective working position when the high-pressure piston is on a dead-center, the engine may under these circumstances be at once started by opening for a moment one or the other of said pipes V V.

I claim as my invention—

1. The combination, in a vibrating-piston engine, of pistons severally mounted upon independent journals to oscillate in separate sectoral working-chambers of unequal area, a single crank-shaft to which said pistons are severally coupled, passages connecting the spaces on each side of the piston in the working-chamber of least area with the corresponding spaces in the working-chamber of larger area, and automatic valves controlling said passages, and the supply and exhaust ports of the engine, substantially in the manner and for the purpose herein set forth.

2. The combination, in a vibrating-piston engine, with its sectoral working-chambers of unequal area and the pistons moving therein, of equalizing-chambers between the sectoral chambers, each connected with the corresponding spaces on one side of each piston, automatic valves controlling the communications between the equalizing and the working chambers, and means, substantially as described, for actuating said valves, whereby the exhaust-steam from the high-pressure chamber of smaller area is admitted alternately to each of the equalizing-chambers and thence to the low-pressure chamber of larger area to actuate the piston therein, substantially in the manner and for the purpose herein set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

PETER F. HOLMGREN.

Witnesses:

A. N. JESBERA,

E. M. WATSON.