No. 785,408. PATENTED MAR. 21, 1905.

L. A. COOPER.

ROTARY ENGINE.

APPLICATION FILED SEPT. 14, 1904.

2 SHEETS—SHEET 1.

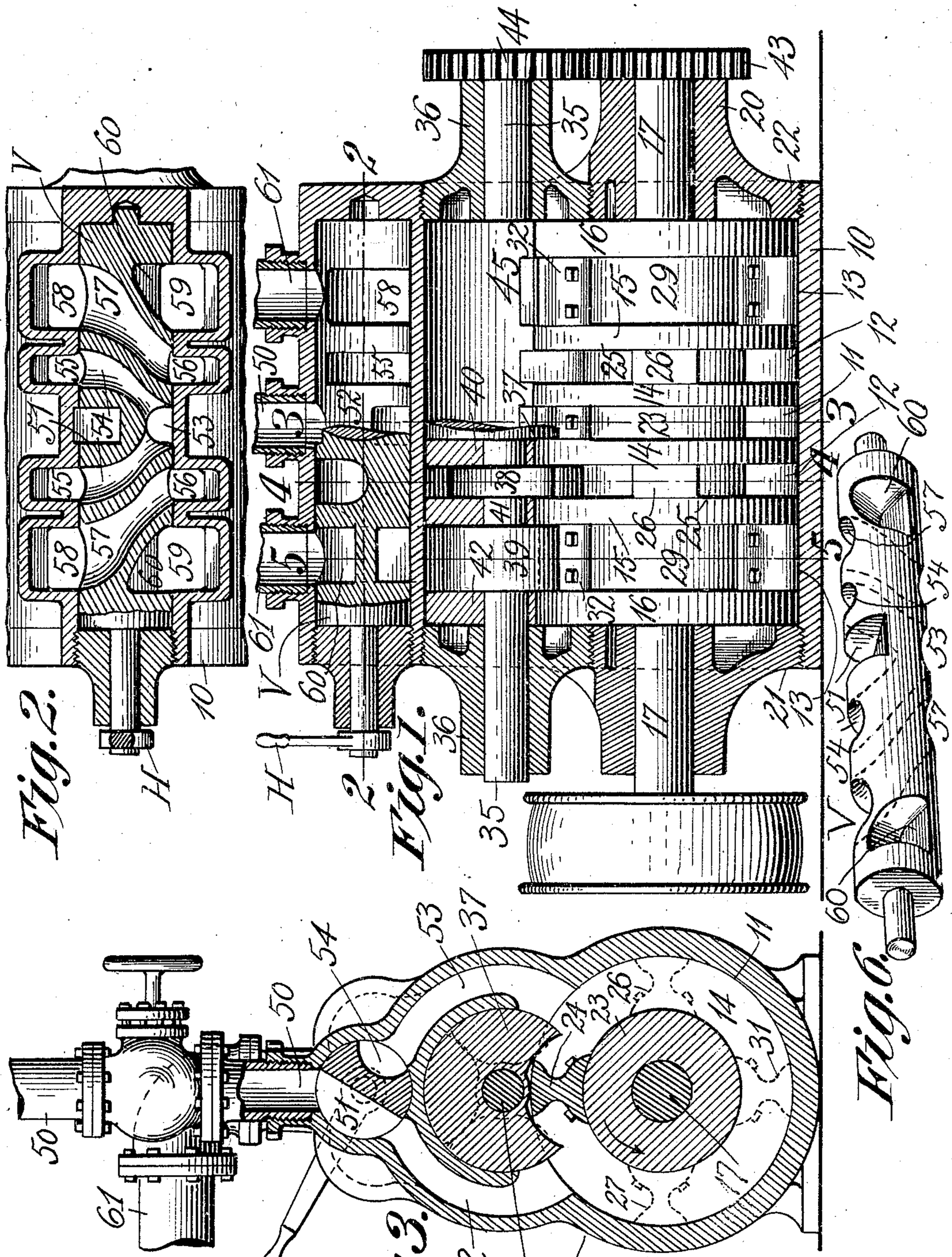

Fig. 2.

Fig. 1.

Fig. 6.

Fig. 3.

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2 SHEETS—SHEET 2.

Fig. 3.

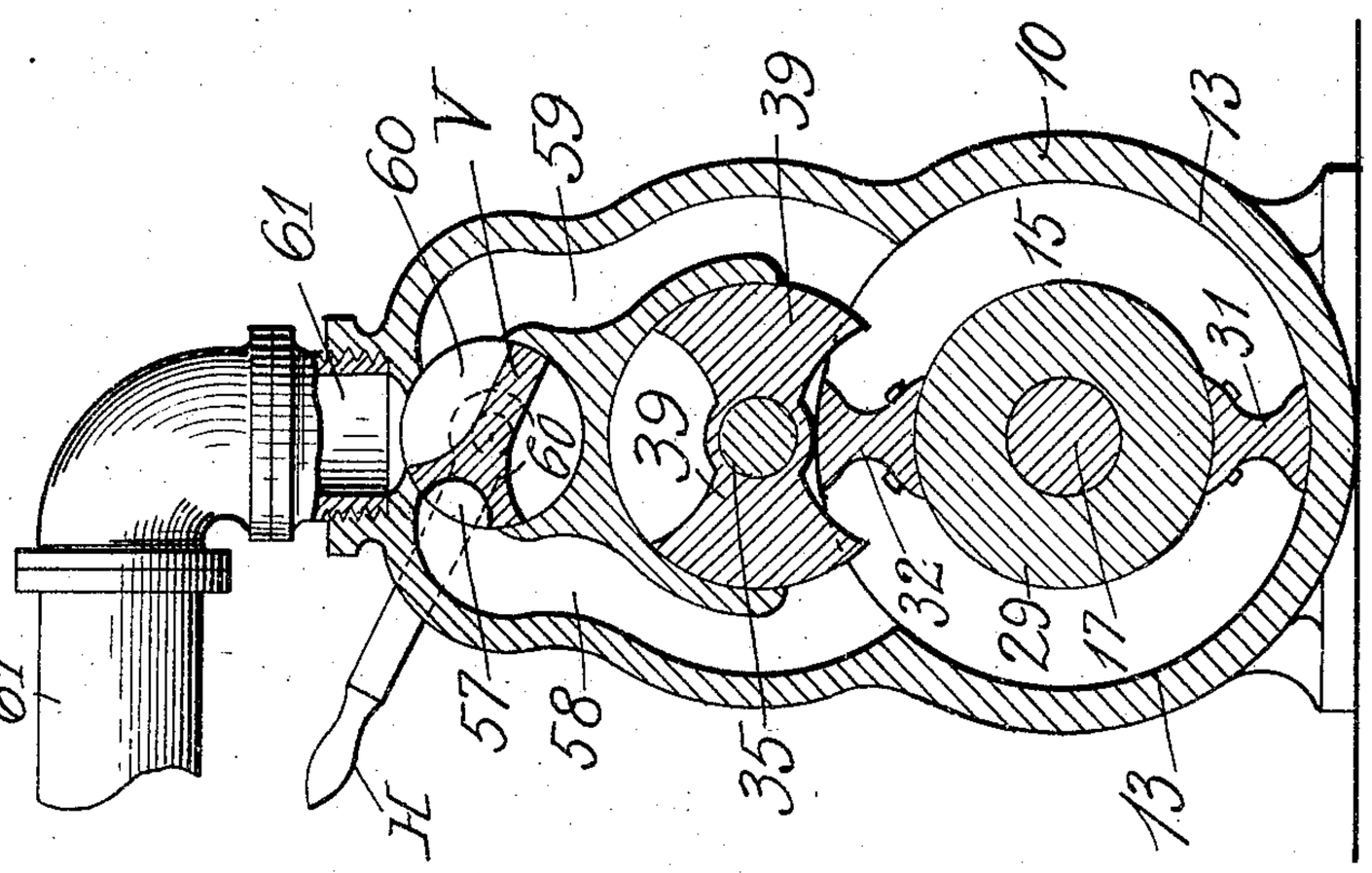
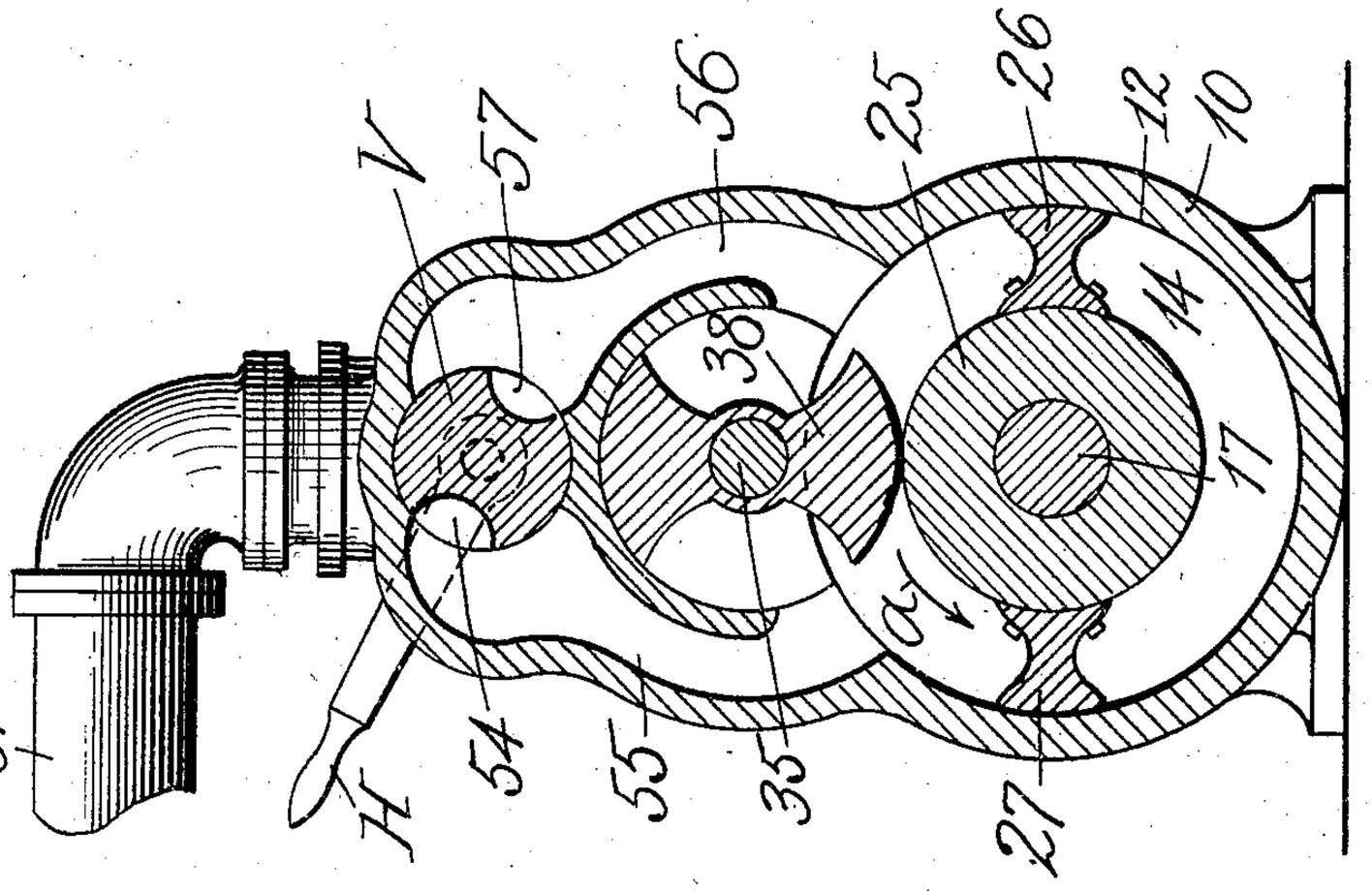


Fig. 4.



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UNITED STATES PATENT OFFICE.

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ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 785,408, dated March 21, 1905.

Application filed September 14, 1904. Serial No. 224,476.

To all whom it may concern:

Be it known that I, LESLIE A. COOPER, a citizen of the United States of America, and a resident of Springfield, in the county of Hampden and State of Massachusetts, have invented certain new and useful Improvements in Rotary Engines, of which the following is a full, clear, and exact description.

This invention relates to steam-engines, and more especially to that class thereof which are generally known as the "rotary concentric piston" and "rotary abutment" type; and it has for one of its objects the provision of a multiple-expansion engine in which the steam is expanded in opposite directions from the high-pressure chamber or cylinder.

My invention has, furthermore, for its object the provision of such an engine comprising a plurality of rotary piston-wings which are successively subjected to the action of the steam in a series of expansion-chambers, the organization being essentially such as to avoid the necessity of close frictional fits between said wings and the inner surfaces of the respective cylinders.

My invention has, furthermore, for its object the provision of a valve whereby the steam is successively conducted to the expansion-chambers disposed at opposite sides of the high-pressure chamber, and consequently tending to balance the pistons and valve longitudinally of their axes, inasmuch as the pressure is thus gradually reduced in opposite directions until the steam is finally exhausted from the last of the expansion-cylinders and at the extreme ends of the valve.

Further objects of my invention will be attained by the particular construction of the valve and other parts, as will be hereinafter described, and pointed out in the claims.

In the drawings, in which similar characters denote similar parts, Figure 1 is a longitudinal section of a steam-engine embodying my invention. Fig. 2 is a horizontal section on line 2 2 of Fig. 1. Figs. 3, 4, and 5 show vertical transverse sections on lines 3 3, 4 4, and 5 5, respectively, as indicated in Fig. 1; and Fig. 6 is a perspective view of the valve.

Briefly stated, my improved engine comprises a centrally-disposed high-pressure cylinder or chamber from which the steam may be conducted at first to a pair of first-expansion cylinders disposed at opposite sides of the high-pressure chamber, and the steam may then be conducted to a pair of second-expansion cylinders adjacent the first-compression cylinders, respectively, and so on to any number of further-expansion cylinders within the scope of operative efficiency.

From the foregoing it should be understood that my improved engine may be built so as to comprise one high-pressure chamber connected with one, two, or more pairs of expansion-cylinders in successive order endwise oppositely therebeyond.

In the drawings, 10 denotes the engine-casing, comprising a cylindrical space extending from end to end thereof and constituting a chamber which may be divided into a series of cylindrical chambers to form a centrally-disposed high-pressure cylinder 11, a pair of first-expansion cylinders 12, and a pair of second-expansion cylinders 13, each expansion-chamber preferably being larger in area than the preceding one, and consequently reducing the steam-pressure proportionately.

Mounted for rotation in the cylindrical space above mentioned is a preferably unitary member comprising a series of disks, the centrally-disposed pair of which, 14, serve to limit the high-pressure chamber 11 and serve as end walls for the same, while at the same time said disks, in conjunction with disks 15, form the first-expansion chambers 12. The disks 15 in turn coöperate with end disks 16 to form the second-expansion chambers 13, as clearly shown in Fig. 1. The entire device as a unit is journaled with its trunnions or shaft 17 in bearings 19 20, respectively, provided on the heads 21 22 of the casing and shown in screw-threaded engagement therewith. Each adjacent pair of disks is connected by a central body portion and by one or more piston-wings, so that in the construction shown the disks 14 are spaced by the body portion 23 and are united by a piston-wing 24. In a like manner each of the disks 14 is spaced from its companion disk 15 by a body portion 25 and united therewith by a pair of piston-wings 26 27, the center line of which is pref-

erably at a right angle with the center of the wing 24. Again, each disk 15 is spaced from its companion disk 16 by a body portion 29 and united therewith by a pair of piston-wings 30 31 in central alinement with the piston-wing 24 and at right angles with the piston-wings 26 27, as will be readily understood.

From the foregoing it will be seen that the disks above described constitute rotary partitions dividing the cylindrical space of the casing into five chambers, and it should of course be understood that this number is not by any means limited and also that the same may be less, if so desired—as, for instance, the engine may comprise one high-pressure and one pair of expansion chambers, making three in all.

Coöperative with the piston-wings are a series of abutments mounted for rotation on a shaft 35, disposed above the piston member and journaled in bearings 36, held in the engine-casing. The shaft has a central abutment 37, moving in conjunction with the piston-wing 24, and a pair of abutments 38, (only one being shown,) coöperating with the wings 26 27, while abutments 39 are adapted to cooperate with the wings 31 32 of the second-compression cylinders. These abutments rotate between stationary partitions 40 41 42 in contact with the disks 14, 15, and 16, respectively. The shafts 17 and 35 are geared to move in unison by gears 43 44, secured thereto, respectively, and the abutments are rotated in a cylindrical chamber 45, provided therefor in the engine-casing.

Disposed above the rotary abutment member is a valve V, provided with a series of passages for conducting the steam from one chamber into the next expansion-chamber, as follows: Steam is admitted through a pipe 50, passes the cut-away portion 51 of the valve V, and traverses through the channel 52 into the high-pressure chamber 11 and then around the body portion 23, through channel 53 and valve-ducts 54, into the first-expansion chambers 12 12. (See Fig. 4.) Here it meets the abutment 38, contacting with the body 25 and also the piston-wing 27, therefore rotating the shaft 17 in the direction indicated by the arrow *a*. The rotation results in moving the high-pressure piston 24 in a similar direction and from beneath the abutment 37 until it has passed the lower end of the channel, and high-pressure steam becomes then effective in operating the piston-shaft, the steam in front of the wing 24 being, however, cut off from the supply, and consequently expanding in the first expansion chamber, which it enters through a channel 55. As the wings 27 revolve around the axis of the shaft 17 they will finally uncover the channel 56 to the steam whereby it has thus far been actuated, and the first-expansion steam may then pass through valve-ducts 57 into channels 58 and the second-expansion chambers 13, where it follows the piston 31 until the mouth of channel 58 has been passed by the wings 32 and the second expansion takes place, finally resulting in discharging the second-expansion steam through channels 59 and cut-away pockets 60 of the valve V into the exhaust-pipes 61. (See Fig. 5.) The valve V is normally stationary, but may be partially rotated by a handle H to reverse the admission of steam, and consequently reverse the rotation of the engine.

In view of the fact that the several cylinders or chambers are consecutively brought into action it is obvious that the moving parts may be quite free from frictional fit, since any leak of steam will only have the effect of increasing the steam-pressure in the next succeeding chamber.

The chambers 12 12, designated "first-expansion" chambers, are secondary to the high-pressure chamber 11, in which under a certain organization of the engine the steam might be expansively employed, as by having a valve operating to cut off the steam admission within the period of the piston-wing cycle, and the terms "first expansion" and "second expansion" are somewhat arbitrarily employed herein.

This engine is one economically and highly efficiently using the steam, and this compound engine, moreover, is seen to be of a simple, compact, and cheaply-built construction.

Having thus described my invention, I claim--

1. The combination with an engine-casing comprising a cylindrical high-pressure chamber and a plurality of cylindrical expansion-chambers disposed at opposite sides of the high-pressure chamber, of a shaft carrying radial pistons in the respective cylindrical chambers, and a valve for connecting the high-pressure chamber with the first-expansion-chambers and for connecting one pair of expansion-chambers, with the next pair of expansion-chambers.

2. The combination with an engine-casing, having a cylindrical opening therein, of a piston member, disks carried thereon and rotatable therewith, closely edgewise fitting the said cylindrical opening in the engine-casing, and dividing said casing into a high-pressure chamber and a plurality of expansion-chambers disposed at opposite sides of the high-pressure chamber, and ways for the admission of steam into the high-pressure chamber, and therefrom to the oppositely-located expansion-chambers.

3. The combination with an engine-casing having a cylindrical opening therein, of a piston-shaft separated disks carried thereon and for dividing said casing into an intermediate high-pressure chamber and a plurality of expansion-chambers disposed at opposite sides of the high-pressure chamber, and piston-wings uniting each pair of adjacent disks.

4. The combination with an engine-casing,

of a rotary piston-shaft having separated disks for dividing said casing into an intermediate high-pressure chamber and a plurality of expansion-chambers at opposite sides thereof, and having radial pistons, rotary abutments coöperative with said pistons, and a valve having ducts for connecting the high-pressure chamber with the next, and oppositely-located expansion-chambers.

5. The combination with an engine-casing comprising a high-pressure chamber and pairs of expansion-chambers, one of each pair being disposed at opposite sides of the high-pressure chamber, of a valve having ways for connecting the high-pressure chamber with a pair of oppositely-located expansion-chambers and for connecting such pair of expansion-chambers with the next pair of expansion-chambers.

6. A steam-engine having in its casing: cylindrical rotary-piston space, an adjacent rotary-abutment space, and a cylindrical valve-space, a steam-inlet leading to the valve-space at an intermediate part of the casing, transversely oppositely arranged steam-passages, at the intermediate part of the casing extending from the valve-space to the cylindrical rotary-piston space, further transversely opposite passages, opposite and endwise beyond said first-named passages, and connecting the valve-space and the rotary-piston space, in combination with the engine-shaft carrying the separated partition-forming disks and the radial piston-wings, the shaft carrying the rotary abutments connected to run with the piston-shaft, the stationary partitions in the rotary-abutment space in the planes of the partition-disks, the rotary valve fitted in the valve-space having an intermediate transverse steamway 51, and having the opposite pair of steamways 54, leading from an adjoined port opposite the way 51 through the valve, terminating oppositely endwise beyond the said way, and enabling transfer of steam from the intermediate partitioned cylinder-space to the secondary expansion cylinder-spaces, and means for exhausting the steam from said secondary spaces.

7. In a steam-engine of the rotary concentric piston type, an engine body or casing having longitudinally-ranging and adjoined rotary-piston and rotary-abutment receiving openings, a piston-shaft having a separated pair of high-pressure-chamber-inclosing partitions, and one or more pairs of secondary-expansion-chamber-inclosing partitions arranged oppositely beyond the high-pressure chamber and toward each end of the casing, and having the radial pistons in the respective cylinder-chambers, the rotary abutments arranged in the transverse planes of such cylinder-chambers and coöperating with the pistons therein, and partitions between the rotary abutments in the planes of the chamber-inclosing partitions, the engine-casing furthermore having transversely opposite pairs of steam-passages in the planes of the respective cylindrical steam-chambers and oppositely connecting thereinto, also having a steam-inlet connecting with one side steam-passage leading to the intermediate and high-pressure cylinder-chamber, steamways endwise oppositely arranged and obliquely connecting the other side steam-passage connected with said intermediate chamber with the steam-inlet passages endwise oppositely arranged, and both at the same side of the engine, which lead into the secondary expansion cylinder-chambers and exhaust-ways from the latter chambers.

8. In a steam-engine of the rotary concentric piston type, an engine-body having longitudinally-ranging and adjoined rotary-piston and rotary-abutment receiving openings, a piston-shaft having a separated pair of high-pressure-chamber-inclosing partitions 14, pairs 15 15, of separated secondary-expansion-chamber-inclosing partitions arranged as shown, and having the radial pistons 24 and 26 26, in the respective cylinder-chambers, the rotary abutments 37 and 38 38, and partitions 40 and 41 41, between the rotary abutments, the engine-casing furthermore having the intermediate pairs 52, 53 and 55 56, 55 56, of transversely opposite steam-passages, in the planes of the respective cylindrical steam-chambers, and oppositely connecting thereinto, also having a steam-inlet 51, connecting with one steam-passage 52, steamways 54 54 connecting the steam-passage 53 with the steam-inlet passages 55 55 and exhaust-ways 57 57 in connection with the steam-passages 56 toward opposite ends of the engine.

9. In a steam-engine, in combination, the casing having an intermediate high-pressure cylindrical chamber, and one or more pairs of separated secondary expansion-chambers at either side and in axial alinement therewith, the piston-shaft having the radial piston-wings the rotary abutments coöperating with the piston-wings, and the casing having a steam-inlet passage, and passages at opposite sides of the casing connecting into the respective high and paired secondary chambers, and endwise-located exhaust-passages, a valve having ducts for the passage of steam from the inlet to the high-pressure chamber, from such chamber into the chambers secondary thereto and out from the last pair of chambers to the exhaust-passages, said valve being movably mounted and effective to reverse the steam-inlet into the high-pressure and secondary cylindrical chambers to securing an opposite driving of the pistons and engine-shaft.

10. In a steam-engine of the character described the engine-body having an intermediate inlet-passage and steam-exhaust passages toward the opposite ends of the body, and

having longitudinally-ranging rotary-piston, and rotary-abutment receiving openings, partitions in series and separation in the piston-receiving opening, dividing the same into a middle primary and high-pressure chamber and secondary chambers at each side thereof, the piston-shaft having the piston-wings, the rotary abutments and partitions therebetween and in the transverse planes of the cylinder-separating partitions, the engine-casing furthermore having the pairs of transversely opposite steam-passages, in the planes of the respective primary and secondary steam-chambers and oppositely connecting thereinto, a rotatable and reversing valve, located in a valve-chamber intersecting the steam-inlet and steam-exhaust and the transversely opposite cylinder-connecting steam-passages, having a transverse steamway 51, and having obliquely-arranged steamways in pairs and terminating at either side endwise beyond the way 51, and having ways, as 60 for connecting the endwise-located secondary cylindrical chambers with the steam-exhaust passages.

Signed by me at Springfield, Massachusetts, in presence of two subscribing witnesses.

LESLIE A. COOPER.

Witnesses:
WM. S. BELLOWS,
GERTRUDE R. DRISCOLL.