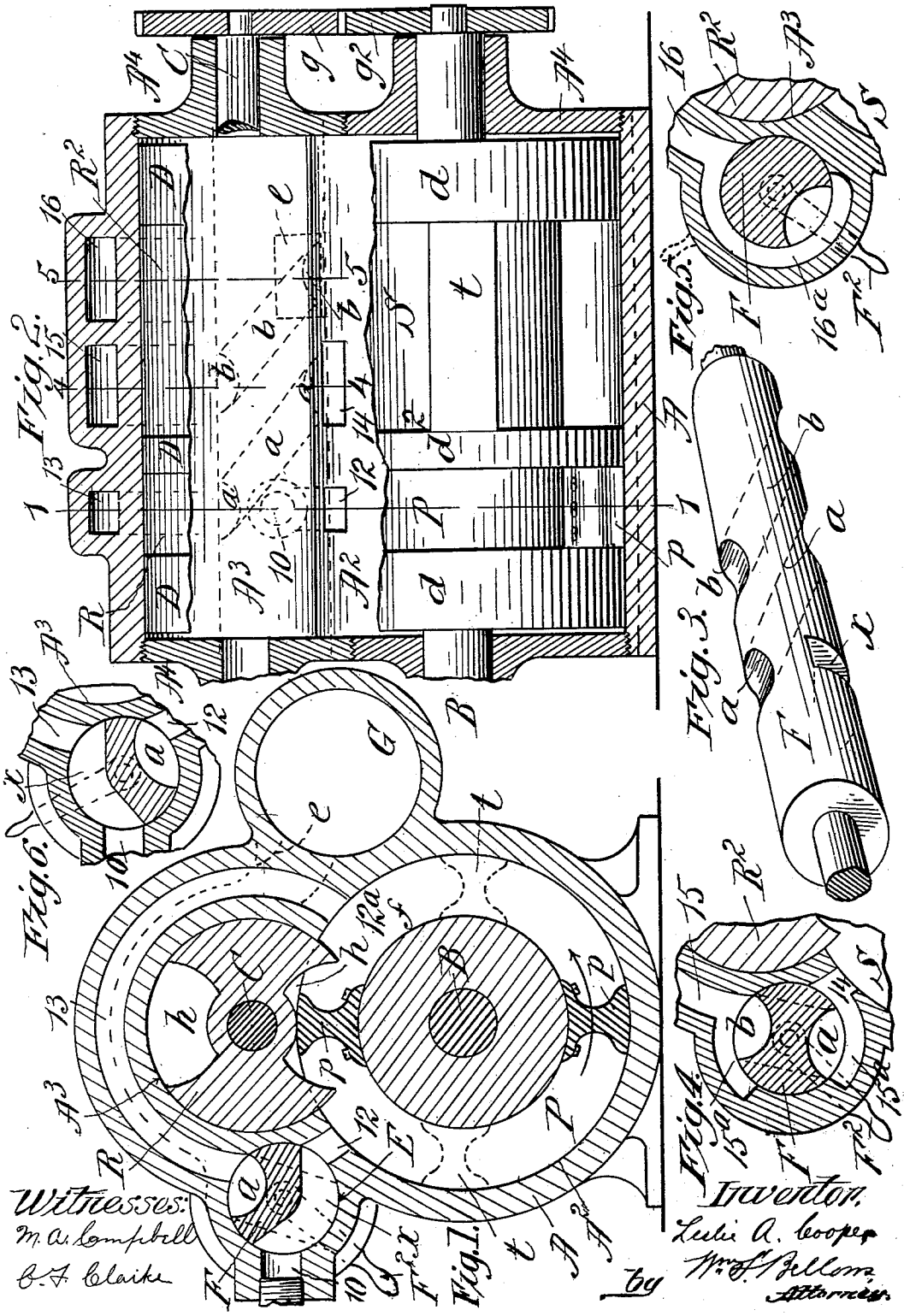
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L. A. COOPER.

ROTARY ENGINE.

(Application filed Nov. 10, 1899.)

(No Model.)



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UNITED STATES PATENT OFFICE.

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ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 655,609, dated August 7, 1900.

Application filed November 10, 1899. Serial No. 736,509. (No model.)

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 improvements in engines of the rotary-concentric-piston and rotary-abutment type.

The invention is, as regarded in some of its aspects, applicable to an improved double or compound expansion engine and, furthermore, to reversible engines of this description.

The improved engine has susceptibility for use advantageously for compressing air or other compressible fluids or gases.

One object of the invention is to produce an engine available for all of the styles of use referred to which is so simple and which is composed of so comparatively-few easily-constructed parts as to render the engine most cheap and economical, reference being had in the construction thereof to efficiency, durability, and the avoidance of elements or factors which will contribute, after protracted use of the engine, to derangement or impairment thereof.

The invention consists in certain constructions comprised in the concentric-piston rotary-abutment engine regarded both as a compound-expansion or a compound-compression engine and as a compound and reversible steam-engine, substantially as hereinafter set forth, and covered in the claims.

Another object of the invention is to so construct the engine that the active steam-pressures therein are so balanced at all times that there will be a perfectly-even motion of the running parts, as insured by the avoidance of binding in any portions of their cycles of such running parts.

An exemplification of an engine built in accordance with this invention is illustrated in the form of a double-expansion engine in the accompanying drawings, although it will be rendered manifest from the description hereinafter given in conjunction with said drawings that the principles of this invention may be carried out in a manifest way in engines in which the steam is compounded by use successively in separate steam-chambers more than twice.

In the drawings, Figure 1 is a vertical cross-sectional view of the engine. Fig. 2 is a central vertical longitudinal section through the chambered engine body or casing, portions of the rotary partitions and rotary piston-body and of the rotary abutments and non-rotary partitions which are in elevation being shown as broken away for clearer illustration of certain of the constructions involved. The line 1 1 on Fig. 2 indicates the plane of cross-section on which Fig. 1 is taken. Fig. 3 is a perspective representation of the valve for controlling the directions of passage of steam through the engine. Fig. 4 is a cross-sectional view through the portion of the engine in which the steam-controlling valve is rotatably fitted, taken on line 4 4, Fig. 2. Fig. 5 is a similar cross-sectional view, but representing the constructions of the parts intersected by the plane represented by line 5 5, Fig. 2. Fig. 6 is a view of parts taken on the same plane as Fig. 1, but showing the valve as turned to insure such directions of the steam through the engine as to result in the driving thereof in the reverse direction.

In the drawings, A represents the casing or chambered body of the engine, having at the lower portion the cylindrical space A^2, extending from end to end, and at the upper portion the cylindrical space A^3, also extending from end to end of the casing and open along its length to the space A^2. The motor-casing is provided with suitable end heads A^4, which comprise journal-hubs for the rotary piston-shaft B and the rotary abutment-shaft C. The rotary piston-shaft has end flange-walls *d d* and one or more intermediate flanges to constitute a rotary partition or partitions to separate the one steam-chamber from the next.

Inasmuch as I may construct the engine in accordance with this invention double or triple expansion or compounded to a still further extent I may employ between the end flange-walls as many suitably-separated flanges as necessary to provide a space within the engine-casing into the desired number of steam-expansion chambers.

In the present illustration two chambers are shown as separated by the rotary partition-flange d^2, P designating the primary and S the secondary steam-chamber. The piston-shaft has the enlarged body f formed thereon or attached thereto, projecting from which in each chamber are the paired opposite radial piston-wings $p\ p$ and $t\ t$, which extend longitudinally from the one rotary partition to the next and which have their extent radially to correspond to the peripheries of the rotary partition-flanges which, as seen in the drawings, closely fit the partially-cylindrical space A^2 within the engine-casing. The two piston-wings in one steam-chamber are set at about right angles to those in the succeeding steam-chamber. Rotary abutments R and R^2 are fitted for rotation in the partially-cylindrical space A^3, the same being affixed on the shaft C, which is geared at $g\ g^2$ to the rotary piston-shaft B, so that the said rotary abutments will have their rotations in conjunction with the rotary pistons, whereby the recess h in the rotary abutment for each piston will have its position properly in relation thereto for its passage by it. Provided in the aforesaid space A^3 within the upper portion of the engine-case are crescent-shaped stationary or non-rotary partitions D, corresponding to and having their reëntrant lower edges closely conforming peripherally to the rotary partitions.

The engine-case is constructed with detour-passages 13 and 15, preferably by coring out in the making of the casting. Each of these passages opens at its terminals into the steam-chamber corresponding to which it is provided at suitably opposite or separated points, and outside of and opposite the second or last steam-chamber, similarly formed by coring out in the engine-body casting, is a detour-passage 16, which is provided as a conduit for the exhaust-steam to be conveyed from the final steam-chamber after exerting its expansive action therein; but both ends of this passage 16 are closed against communication with the steam-chamber, but have connection therewith in a novel and peculiar way, to be hereinafter pointed out.

12 and 12^a represent the ports constituting the terminals of the bowed passage 13, opening at the points at opposite sides of the rotary abutments into the primary steam-chamber, the one 14 of the similar pairs of ports of the secondary chamber being seen in Fig. 2, the other end port constituting the opposite end of the passage 15 being understood as directly opposite the one 14.

At the one side of the engine-case, preferably, though not necessarily, adjacent its portion where the chamber A^2 merges into the chamber A^3, the properly bulky or thickened casting has therein a longitudinally-extending cylindrical chamber E, leading to which in a plane transversely of the engine comprised within the primary steam-chamber P is the steam-inlet opening 10. The chamber E is for the reception therein of the cylindrical and peculiarly recessed or apertured part F, which constitutes the means for controlling the direction of the steam passing through the engine and the length of which somewhat exceeds the distance from the one passage 13 to the farther passage 16. The said longitudinally-ranging chamber in which the said appliance or controlling-valve F is closely fitted for rotation intersects transversely-arranged detour-passages 13 and 15 and also the cored-out passage or opening 16. The said device has on its end the arm or operating-lever F^2 to facilitate its rotational adjustment.

The controlling-valve, as shown in Fig. 3 and as indicated in the various cross-sections thereof, comprises the cylindrical body which has at one side thereof the transverse recess or aperture x, the position of which is such that it connects the steam-inlet opening 10 with one portion of the detour-passage 13, the solid portion of the valve-body constituting the base of the recess x constituting a barrier against the passage of the steam entering the inlet-opening for the course only in the desired direction through the passage 13, whether it be, if the valve has the position of Fig. 1, directly to the primary steam-chamber through the port 12, or if the valve is overturned, as shown in Fig. 6, a course in the reverse direction to enter the steam-chamber at the other side through the port 12^a.

a represents a hole or passage through the valve-body in an oblique direction, or so that it extends from its one end which is in the plane of and opposite the recess x and which is coincident with the detour-passage 13, with a suitable endwise progression in its also transverse course, so that its opposite end terminates coincident with and opens to the next detour-passage 15. The second passage b, having also a transverse and a longitudinal direction, is provided through the said valve-body, its initial end being at the opposite side of and in a transverse plane coincident with the latter end of the aforesaid passage, while the opposite end of this hole or passage b is coincident with and opens into the aforementioned passage 16.

The passage 15 adjacent the valve-chamber E is at opposite sides of said chamber formed with the passage extension 15^a, as shown in Fig. 4, for the purpose of providing a design of practicable and easy construction.

The passage 16 is constructed in the form of a closed pocket at 16^a, having no connection with the secondary or the final steam-chamber S, while its end at the opposite side of the engine-case terminates in the outwardly-directed exhaust-port e.

The valve E may of course have its position so that no steam entering inlet-passage 10 can pass by it. The valve by having the position shown in Figs. 1, 2, 4, and 5 will insure such passage of the steam through the engine as to rotate the piston-shaft, which is

the driving-shaft of the engine, in the direction of the arrow on Fig. 1—that is to say, the steam entering the inlet-passage 10 passes through the port 12, leading directly into the primary steam-chamber, and drives the piston around until the port opening to the partially-circular passage 13 is uncovered by the piston-wing, whereupon the steam has the detour course around to the controlling-valve. It passes through the opening *a*, having the crosswise and also longitudinal direction through the valve, issuing therefrom through port 14 into the secondary steam-chamber at the same side of the engine at which the steam was admitted into the primary chamber, and after it has forced the piston-wing in the second steam-chamber around to uncover the port which forms the mouth of the second partially-circular passage 15 at the opposite side from port 14 the steam passes around in said passage 15 again to the controlling-valve, and by way of the second passage *b*, the course of which is crosswise and longitudinally through the valve, the steam is transferred into the passage 16 and is carried in a reverse direction from which it was brought through passage 15 to the exhaust-port *e* and which, as a matter of expediency, is at the side of the engine opposite the controlling-valve, the same being indicated as arranged to carry the steam into the chamber G, in which I design for the inclusion therein of appliances for the separation of the oil from the exhausting steam.

When the controlling-valve shall have been partially rotated into the position indicated in Fig. 6 for the reversal of the course of the steam, the course thereof will be traced as follows: The steam entering the inlet-port 10 instead of passing through the cross-recess *x* of the valve directly to and through the port 12 passes by way of such cross-recess into the passage 13 and reaches the primary steam-chamber through the port 12^a at the oppposite side from the port 12. The steam now driving the piston-wing around in the opposite direction passes out through port 12 and thence through the valve-passage *a* into the portion of passage 15 next above the valve. The steam thence is carried around through passage 15, entering the second steam-chamber S at the side opposite the location of the valve and port 14 and drives around the revoluble piston-wing *t* until the port 14 is uncovered by the wing, whereupon the steam passes out through port 14 and in an upward direction through the valve-passage *b* into the passage 16 and thence to and through the exhaust-opening *e*.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a rotary steam-engine of the character set forth, the engine-casing constructed with the partially-cylindrical longitudinally-extending chambers A^2 and A^3, the one thereof being along its length open to the other, the shaft B having thereon rotary pistons and rotary partitions, which latter separate the one steam-chamber P within the chambered portion A^2 of the casing from another or secondary chamber S therewithin, such casing being cast or constructed with detour-passages 13 and 15 each entering the steam-chamber corresponding to which it is provided at suitably-opposite points, an inlet-port leading to the first steam-chamber, a steamway leading from communication with the detour-passage for the first steam-chamber to the detour-passage of the second chamber, a steam-discharging passage for the latter chamber, end heads or walls for the chambered casing, stationary partitions D located in the chambered portion A^3 and adjoining the rotary partitions, and rotary abutments between the stationary partitions.

2. In a steam-engine of the compound, rotary-piston and rotary-abutment, type, an engine-casing having separated steam-chambers with radial pistons therein, and abutments corresponding thereto, and having within its wall detour-passages connecting the steam-chambers at suitably-opposite points, a cylindrical chamber E, also formed within the wall of the engine-casing, longitudinally extending and intersecting the said chamber-connecting detour-passages, a steam-inlet passage for the said first steam-chamber, a cylindrical part fitted in said longitudinal chamber having a length greater than the distance between the two detour-passages, and constructed with a crosswise and longitudinally-extending passage *a* therein and therethrough to connect the first detour-passage with the similar passage for the next steam-chamber, substantially as described.

3. In a steam-engine of the compound, rotary-piston and rotary-abutment, type, an engine-casing having separated steam-chambers with radial pistons therein, and abutments corresponding thereto, and having within its wall detour-passages connecting the steam-chambers at suitably-opposite points, a cylindrical chamber E, also formed within the wall of the engine-casing, longitudinally extending and intersecting the said chamber-connecting detour-passages, a steam-inlet passage formed through the engine-casing and extended angularly to said cylindrical chamber E opposite the first steam-chamber, a cylindrical part fitted in said longitudinal chamber having a length greater than the distance between the two detour-passages, and constructed with the transverse recess *x* adapted to register with the inlet-port and the detour-passage leading to the first steam-chamber, and also constructed with the crosswise and longitudinally-extending passage *a* therein and therethrough to connect the first detour-passage with the similar passage for the next steam-chamber, substantially as described.

4. The engine-case having the partially-cylindrical spaces A' A^2 opening the one to the

other and constructed with the detour-passages 13 and 15, and having in said cylindrical spaces rotary abutments and chamber-separating partitions, said casing being furthermore constructed with the cylindrical space intersecting the detour-passages at an intermediate portion of the length of each and with a steam-inlet leading thereto, the rotary cylindrical controlling-valve rotatably mounted and having a cross aperture or recess x at its one side connecting the steam-inlet with the portion of the first detour-passage which is to one side of the said controlling-valve, and having the obliquely-extending passage a, one end being about in the transverse plane corresponding to recess x, and having its other end opening to the next detour-passage, all whereby in its one position it will insure the passage of the steam from the inlet into the first and then into the second chamber in one direction, and upon being partially rotated to reverse the direction of the steam-passage into and through said steam-chambers, and a steam-discharging way for the second or final steam-chamber.

5. The engine-case having the partially-cylindrical spaces A' A^2 opening the one to the other and constructed with the detour-passages 13 and 15 opening to the interior of the engine-case at suitably-opposite sides, and the detour-passage 16 closed from connection with the interior of the case, and having in said cylindrical spaces rotary pistons and abutments, and chamber-separating partitions, said casing being furthermore constructed with the cylindrical space intersecting the detour-passages at an intermediate portion of the length of each and with a steam-inlet leading thereto, the cylindrical controlling-valve rotatably mounted and having a cross aperture or recess x at its one side connecting the steam-inlet with the portion of the first detour-passage which is to one side of the said controlling-valve, having the obliquely-extending passage a, one end being about in the transverse plane corresponding to recess x, and having its other end opening to the next detour-passage, and also having the second obliquely-extending passage b connecting the second passage 15 and the passage 16, substantially as and for the purposes set forth.

Signed by me at Springfield, Massachusetts, this 23d day of October, 1899.

LESLIE A. COOPER.

Witnesses:

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