No. 646,160. Patented Mar. 27, 1900.

A. WATKINS.

COMPOUND ROTARY ENGINE.

(Application filed Nov. 21, 1898.)

(No Model.) 5 Sheets—Sheet 1.

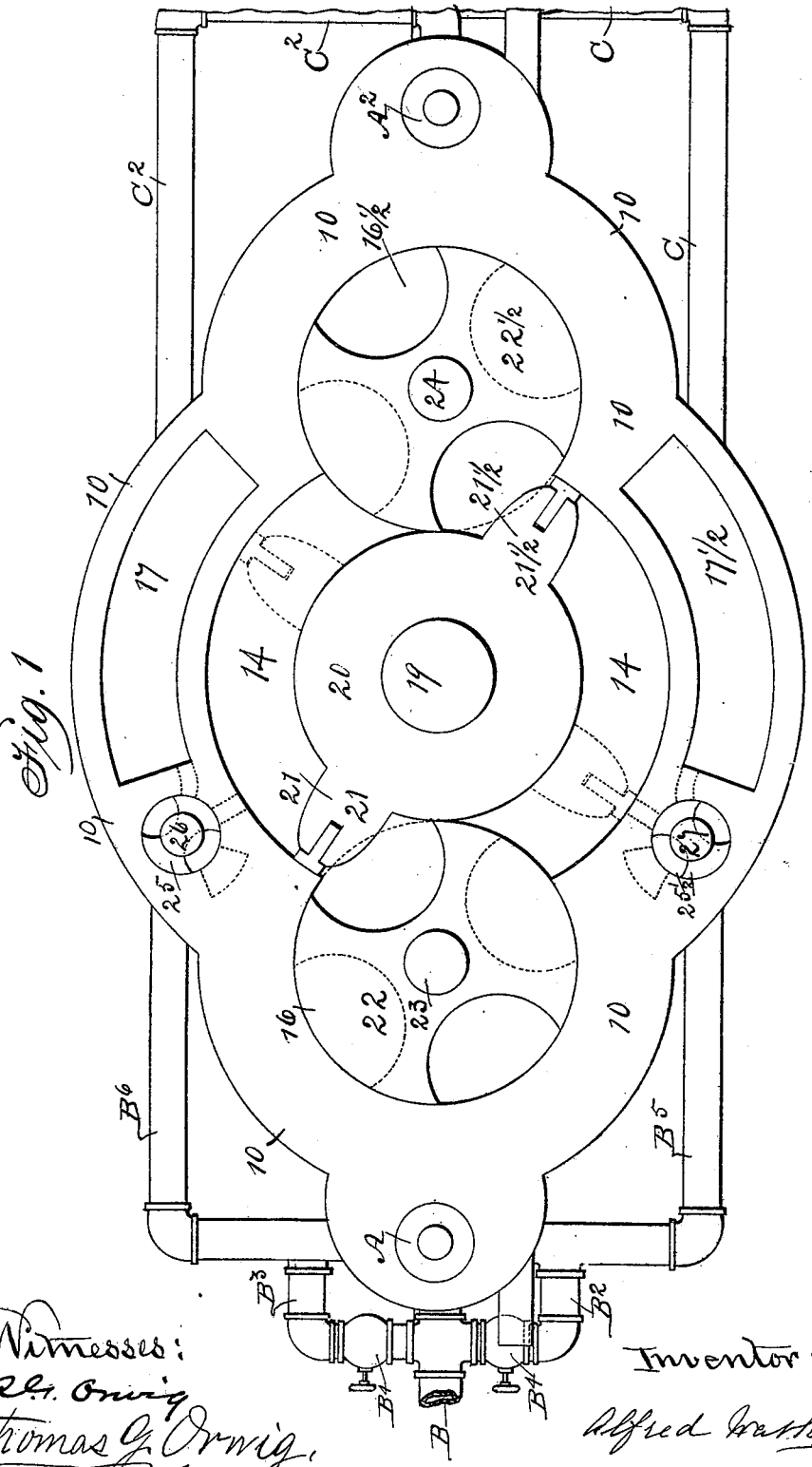

Fig. 1

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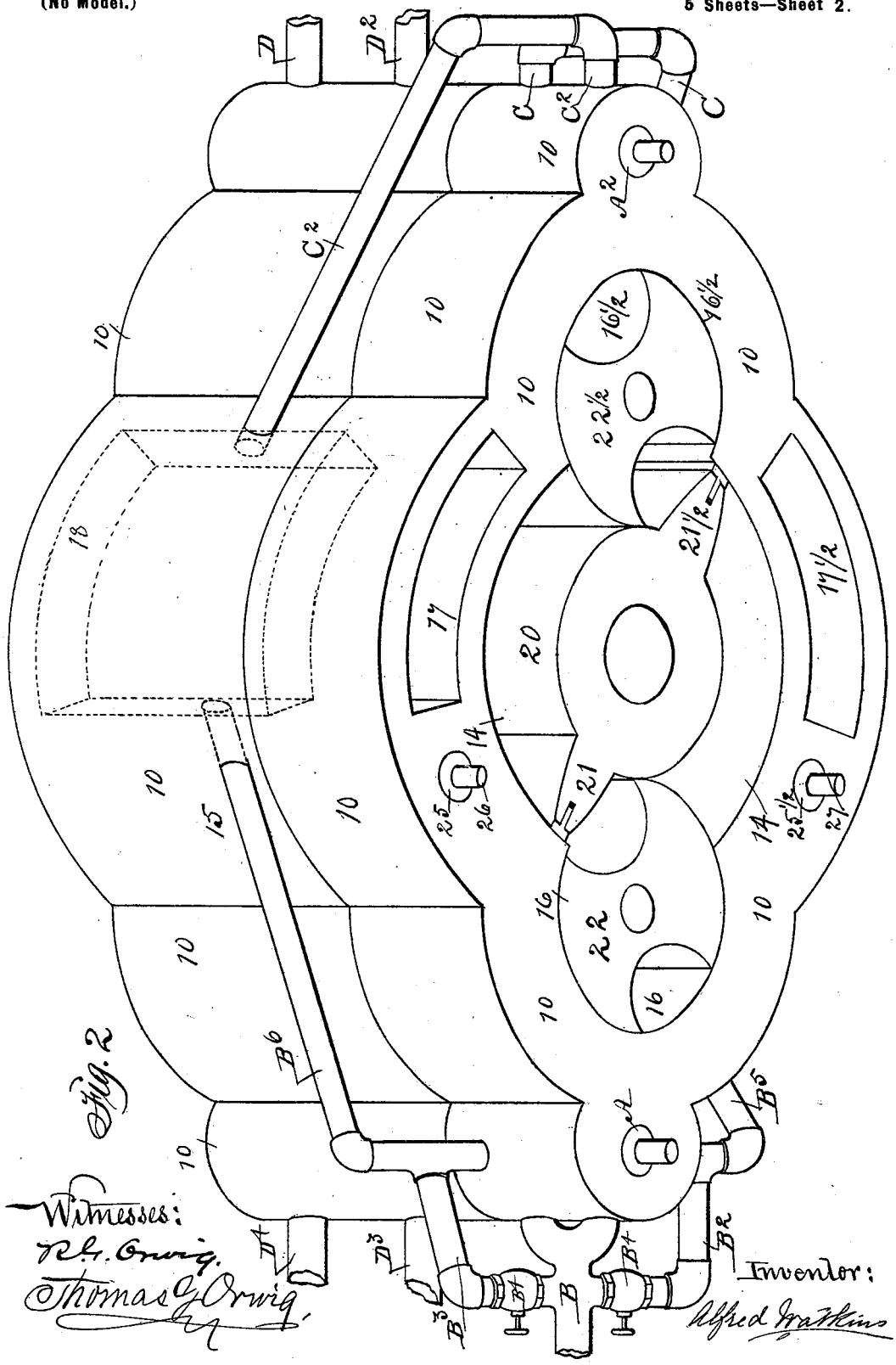

Fig. 2.

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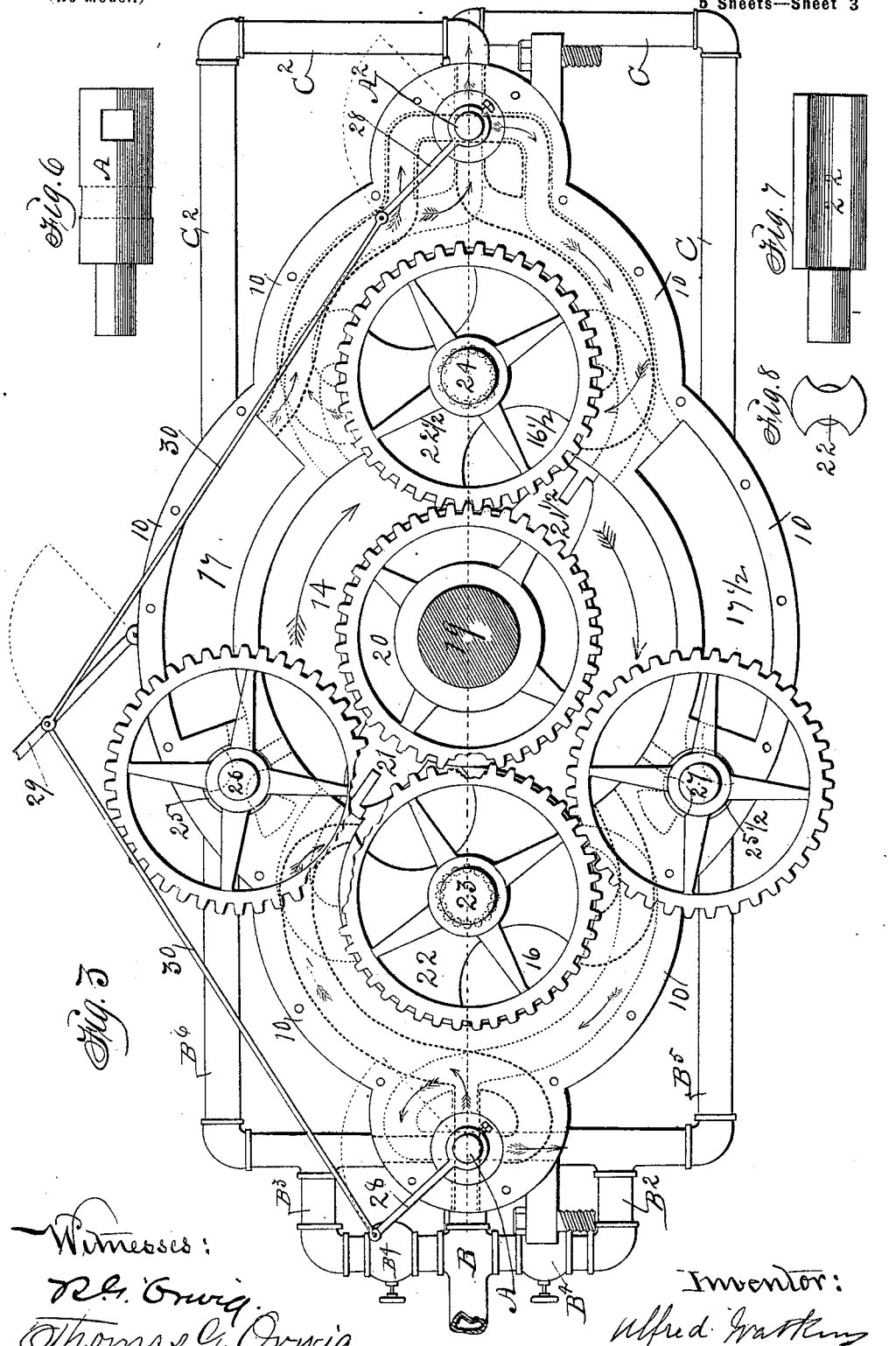

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(No Model.) 5 Sheets—Sheet 4.

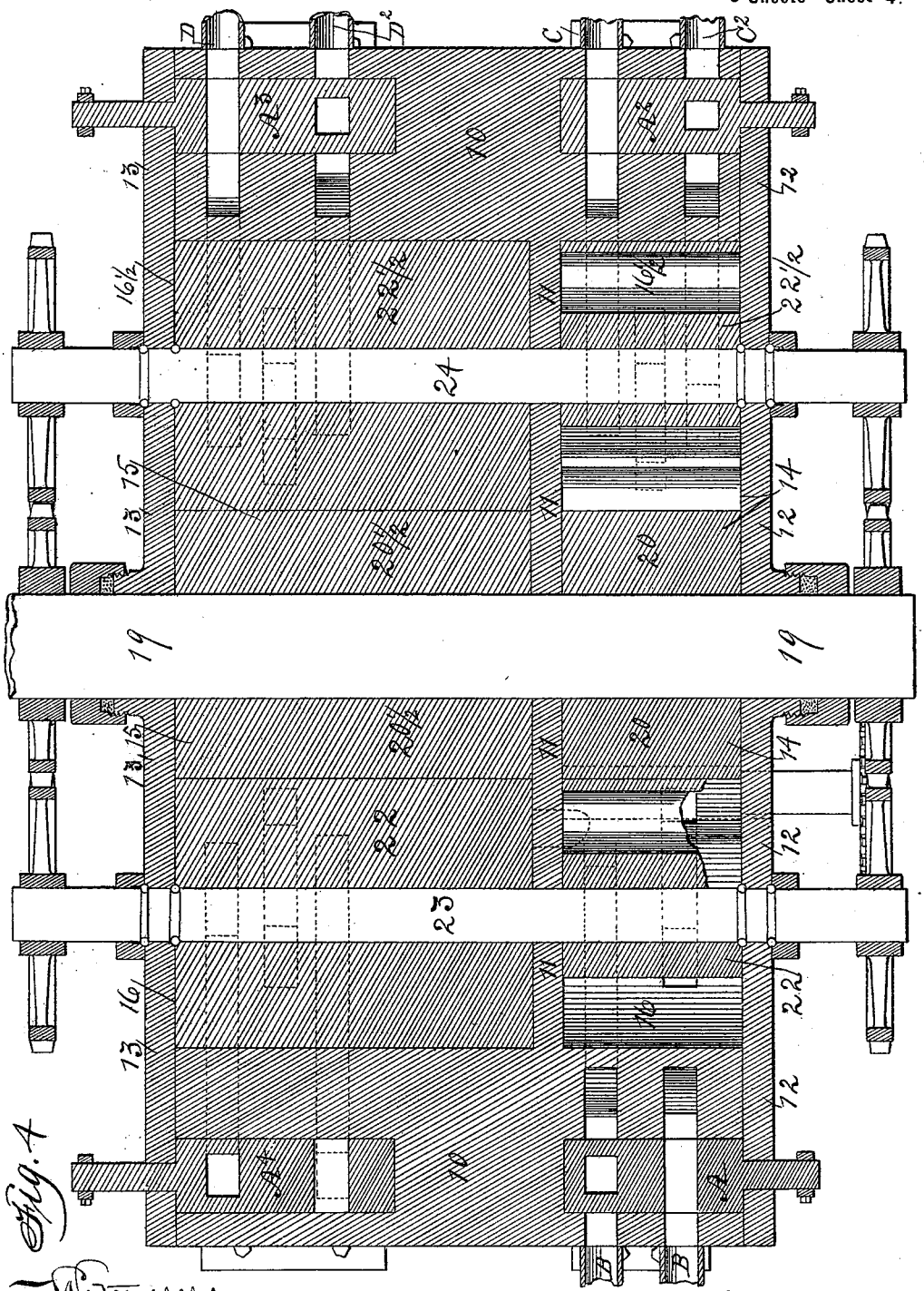

Fig. 4.

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(No Model.) 5 Sheets—Sheet 5.

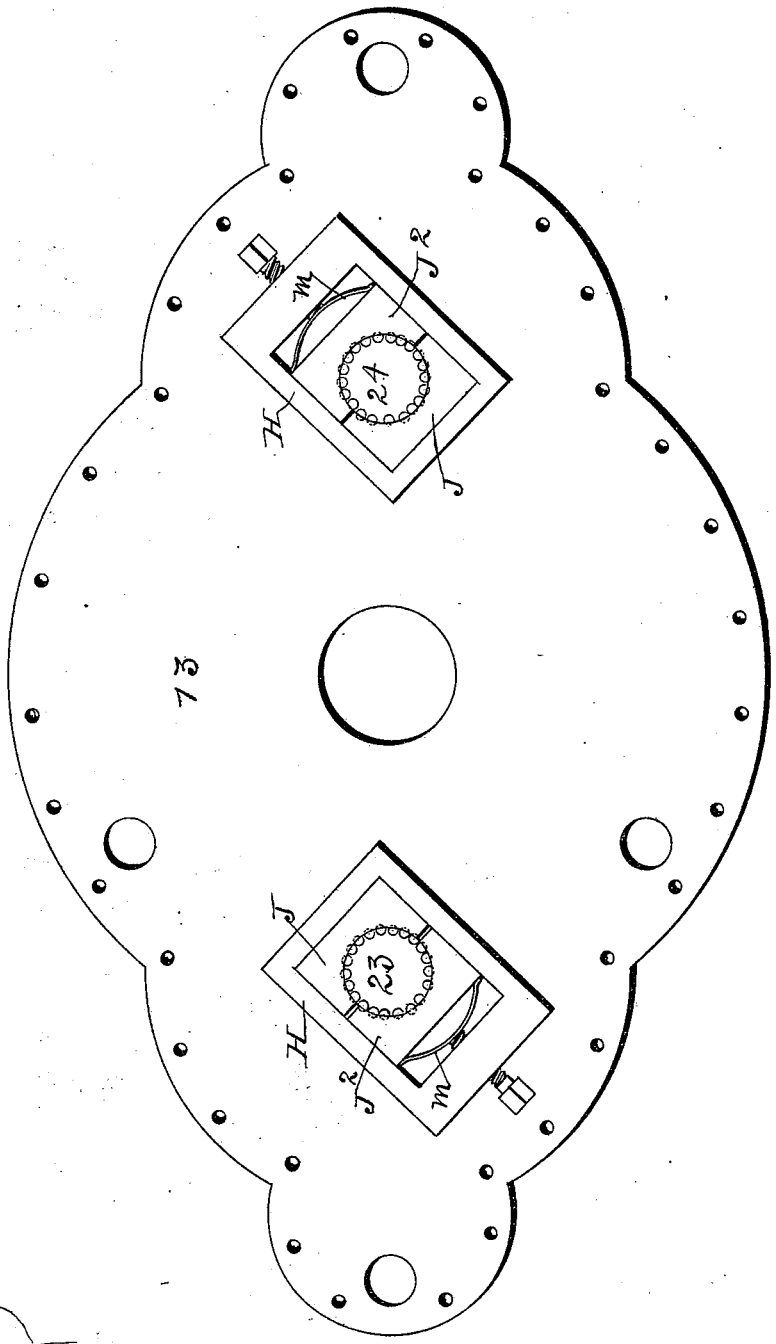

Fig. 5.

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UNITED STATES PATENT OFFICE.

ALFRED WATKINS, OF DES MOINES, IOWA.

COMPOUND ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 646,160, dated March 27, 1900.

Application filed November 21, 1898. Serial No. 697,113. (No model.)

To all whom it may concern:

Be it known that I, ALFRED WATKINS, a citizen of the United States, residing at Des Moines, in the county of Polk and State of Iowa, have invented a new and useful Compound Rotary Engine, of which the following is a specification.

My main object is to provide a compound rotary steam-engine adapted to utilize all the expansive force of steam, and thereby increase the maximum force obtained from cylinders of any given size, as required to reduce the minimum cost of steam-power.

A further object is to utilize steam to prevent the cooling and condensation of steam in the cylinders, as required to prolong the expansive force of steam and its utility as it passes through the engine.

A further object is to adapt an engine in form and size to be advantageously used for all the various purposes of a stationary engine, for locomotives, and marine vessels.

A further object is to use the initial force of steam in distinct steam-chambers and upon a number of distinct pistons simultaneously to increase the power of the complete engine at the will of the operator.

A further object is to provide circular chambers and rotary gates for regulating the passage of steam relative to different steam-chambers and the two concentric cylinders, to thereby reduce the force, friction, and wear required to actuate the operating mechanism.

My invention consists in the construction, arrangement, and combination of operative parts with two cylinders joined end to end and in concentric position with one and the main shaft, as hereinafter set forth, pointed out in my claims, and illustrated in the accompanying drawings, in which—

Figure 1 is a plan view, and Fig. 2 a perspective view, of the casing or two cylinders that are joined at their inner ends and in concentric position with each other and the main shaft. The cap or head is removed and the valves and rotary gates and the hub and pistons shown in their respective chambers and positions relative to each other and the steam pipes and passages. Fig. 3 shows the external gear-wheels that transmit power and motion from the main shaft to actuate the gates in concert with each other as required to open and close steam passage-ways leading from the supply-pipe and through intermediate chambers to the exhaust-pipe. Means for reversing the engine is also shown in this figure. Fig. 4 is a transverse sectional view of the casing or two eccentric cylinders connected at their inner ends. Dotted lines indicate the steam passage-ways communicating with the valves and the chambers for the rotary gates. Fig. 5 is an outside face view of one end of the engine, showing the yielding or cushioned ball-bearings of the shafts of the rotary gates. Fig. 6 is a view of one of the rotary valves used for regulating the passage of steam and reversing the engine. Fig. 7 is a side view, and Fig. 8 an end view, of one of the auxiliary rotary gates.

The numeral 10 designates the casing and outer wall of the two cylinders, connected at their inner ends and in concentric position with each other. A partition 11 is preferably formed integral with the wall 10. Caps or heads 12 and 13 are fixed to the ends of the wall.

14 and 15 are the two distinct cylinders.

16 and 16½ are circular chambers of uniform size and shape that intersect the cylinders and are designed to receive rotary gates.

17 and 17½ are auxiliary steam-chambers in the wall of the case, communicating with the cylinder 14, and 18 and 18½ are corresponding chambers communicating with the cylinder 15.

The main shaft 19 extends through bearings in the centers of the heads 12 and 13, and hubs 20 and 20½ in the cylinders are fixed to the shaft, and each hub has two pistons 21 and 21½, provided with suitable packing on their ends adapted to engage the inner faces of the cylinders with which they come in contact. In each circular chamber 16 and 16½ is fitted a rotary gate (all uniform in size and shape) for opening and closing steam passage-ways that communicate therewith, and 23 and 24 are shafts in bearings in the heads 12 and 13 and extend through the centers of the chambers 16 and 16½ to operate the rotary gates 22 and 22½, that are fixed to said shafts. These shafts are connected with the main shaft by means of gear-wheels of uniform size, as clearly shown in Fig. 3 and as required to rotate in concert with the main shaft 19. Rotary gates

25 and 25½, of uniform size and corresponding in shape with the gates 22 and 22½, are fitted in corresponding bores that extend into the end portions of the walls of the cylinder 14. These gates also have fixed gear-wheels on the outer ends of their shafts 26 and 27 to engage the mating gear-wheels fixed to the rotary gates 22 and 22½, as required to actuate them to open and close the steam passage-ways that communicate between the two cylinders, as indicated by dotted lines in Figs. 1 and 3.

A and A^2 are rotary plug-valves fitted in bores at the lateral extensions of the case 10 and cylinder 14. Each valve has an arm 28 connected with a lever 29 (fulcrumed to the case, as shown in Fig. 3) by means of rods 30 in such a manner that the valves can be readily actuated by means of the lever as required to reverse the engine. A duplicate of this reversing mechanism is provided for the cylinder 15. The rotary valves therefor are clearly shown in Fig. 4.

B is a forked pipe fixed to the case to communicate with bores leading to the rotary valve A, as required to introduce steam to the chamber 16 and the cylinder 14 through passage-ways that extend through the casing from the valve A to the chamber 16, that intersects the cylinder 14 and the rotary gate 22 in the chamber 16. The said passage-ways are indicated by dotted lines in Fig. 3. From the cylinder 14 passage-ways extend through cylinder-casing and pipe C^2, as shown by arrow, into large steam-chamber 18, and in reversing goes through cylinder-casing and pipe C into large steam-chamber 18½.

B^2 and B^3 are elbow-shaped pipes connected with the pipe B, and each is provided with a valve B^4.

B^5 and B^6 are pipes extending from the pipes B^2 and B^3 to bores intersecting the steam-chambers 18 and 18½, that communicate with the cylinder 15, as required to allow steam to pass through direct from the pipe B through the pipes B^2 and B^3. It is obvious that by opening the valves B^4 steam can pass through the several passages to the distinct chambers at the same time as required to utilize the initial steam force upon a plurality of distinct pistons simultaneously.

C^2 is a pipe that is connected with the rotary valve A^2, as required to conduct last exhaust-steam from cylinder 14 into steam-chamber 18.

C is a corresponding pipe for conducting steam when reversed from the valve A^2 into the chamber 18½.

A^3 and A^4 are rotary valves that communicate with rotary gates 22 in chambers that intersect the cylinder 15 in the same manner as the chambers 16 and 16½ intersect the cylinder 14. Exhaust-pipes D, D^2, D^3, and D^4 communicate with the valves A^3 and A^4 and the cylinder 15.

The shafts 23 and 24, that carry rotary gates 25 at their end portions, are journaled in yielding bearings that allow the peripheries of the gates to come in contact with the hub 20 and the surfaces of the concaves in the gates that are engaged by the pistons 21 without producing undue friction and on the peripheries of the rotary gates. Angular frames H are formed on or fixed to the outside faces of the heads 14 and 15, as shown in Fig. 5, and bearings J, fitted in the same frames in such a manner that they can slide outward or away relative to the rotating hub 20. Springs *m*, placed in the frames, engage the bearings J^2 and normally press them toward the shafts 23 and 24. Annular grooves in the shafts are fitted with balls to reduce friction. It is obvious that the shafts thus provided with yielding bearings, packing, or cushioning on the surfaces of the rotary gates can be dispensed with, so that their faces that come in contact with the walls of the chambers will be relieved from undue friction and wear.

In the practical operation of my invention when steam enters the engine through the pipe B and valve A and the passage-way leading from the valve into one of the chambers 16 it will first enter one of the concaves in the rotary valve 22 in that chamber and press the piston 21 in the direction indicated by the arrows in the cylinder 14, as shown in Fig. 3, and press upon one of the pistons 21. After the piston has advanced one-sixth part of the circumference of the cylinder and toward the chamber 16½ the supply of steam will be cut off by the simultaneous motion of the said rotary gate 22 in the said chamber 16. About half of the steam then confined in the cylinder between the piston 21 and chamber 16 and gate 22½ will pass through the passages leading from the cylinder to the rotary gate 25 and from thence into the chamber 17 in the wall of the cylinder 14. The motion of the pistons being continued at the same time until the hub 20 and shaft 19 have made a quarter-revolution, about half of the remaining steam passes into the chamber 18 through gate 25, as shown by dotted lines F^3. The rotary gates being properly connected with the main shaft 19 by means of gear-wheels, as shown in Fig. 3, it is obvious they will move in concert therewith, so that the rotary gates 22 22½ and 25 25½ will be actuated at proper intervals, as required to open and close the steam passage-ways communicating with the gates and the distinct chambers through which the steam is passed. The steam which has passed into steam-chamber 17 from cylinder 14 now passes through opening marked by dotted lines, following the arrows through rotary valve A^2, entering chamber 16½ near steam-chamber 17½, thence forcing piston 21½ in direction of arrow, as shown in cylinder 14. Meanwhile the initial steam is entering again into chamber 16 and forcing pistons, as before. The steam from chamber 17 after forcing the pistons one-fourth of circumference of cylinder one-half of steam exhausts through gate 25 near steam-

chamber 17½ into steam-chamber 18½ in walls of large cylinder. The remaining steam is forced by next piston through passage-ways and rotary valve A, pipe B^5, into chamber 18½ with minimum of resistance of exhaust-steam. The steam-chambers 17 and 17½ will receive exhaust-steam through passage-ways, as indicated by dotted lines in Fig. 3. The steam now which has been used in cylinder 14 and conveyed to steam-chambers 18 and 18½ will pass from there to cylinder 15, forcing piston around, as shown in cylinder 14, and finally exhausting through D^2 and D^4 in Fig. 2 in forward motion and through D and D^3 in reverse motion. It is obvious that steam thus admitted through the pipe B at one end of the engine will repeatedly set upon the pistons 21 and 21½ in each of the cylinders 14 and 15. Steam in passing from the cylinders and through the chambers 16 and 17 in their walls shows that practically all the expansive force of the steam will be utilized in jointly operating the pistons in the two distinct cylinders to transmit and concentrate power to rotate the main shaft 19.

Reversing the position of the lever 29 will reverse the motion of the engine and steam will pass through the passages leading from the valve A to the chambers 17½ and 18½ and finally exhaust through the pipes D^3 and D′ in place of D^2 and D^4. Chamber 17 becomes void in reverse motion and chamber 17½ is void in forward motion.

Having thus described the construction and function of each element and subcombination, what I claim as new, and desire to secure by Letters Patent therefor, is—

1. A cylinder-casing 10 having segmental chambers 17 and 17½ in its walls communicating at their ends with the chamber in the cylinder, circular chambers 16 and 16½ intersecting the cylinder-chamber, and communicating with the segmental chambers passages for steam leading from the exterior of the case into the circular chambers and means for regulating the flow of steam through said passage to operate upon a rotary hub and pistons in the cylinder in the manner set forth for the purposes stated.

2. In a rotary engine, two concentric cylinders, a main shaft journaled in the ends of the cylinders, a hub having radial extending pistons fixed to the shaft in each cylinder two circular chambers intersecting each cylinder, two segmental chambers in the wall of each cylinder, steam passage-ways leading from the cylinder to the ends of said segmental chambers steam passage-ways leading from the end of each segmental chamber to a cylinder, and passage-ways leading from the exterior into the circular chambers, to operate in the manner set forth for the purposes stated.

3. In a rotary engine, two concentric cylinders, a main shaft journaled in the end of the cylinders, a hub having radial extending pistons fixed to the shaft in each cylinder, two circular chambers intersecting each cylinder, two segmental chambers in the wall of each cylinder, steam passage-ways leading from the end of each segmental chamber to a circular chamber, and passage-ways leading from the exterior into the circular chambers, rotary valves in said passages and means for automatically operating the valves in concert with rotary hubs and pistons in the cylinders to operate in the manner set forth for the purposes stated.

4. In a steam-engine, a cylinder-casing having a forked pipe B communicating with two parallel passages leading to a rotary plug-valve A fitted in a bore that intersects said parallel passages, a cylinder-chamber communicating with said valve, a circular chamber intersecting the cylinder-chamber, a rotary gate in the circular chamber, and two segmental chambers in the wall of the cylinder communicating at each end with the cylinder-chambers and means for regulating the passage of steam between the segmental chambers and the cylinder-chamber arranged and combined to operate in the manner set forth.

5. In a steam-engine, a cylinder-casing having a forked pipe B communicating with two parallel passages leading to a rotary plug-valve A fitted in a bore that intersects said parallel passages, a cylinder-chamber communicating with said valve a circular chamber intersecting the cylinder-chamber, a rotary gate in the circular chamber and two segmental chambers in the wall of the cylinder communicating at each end with the cylinder-chambers and means for regulating the passage of steam between the segmental chambers and the cylinder-chamber a rotary gate having concaves in its periphery fitted in each of the passage-ways leading from the cylinder-chamber to the segmental chambers in the wall of the cylinder arranged and combined to operate in the manner set forth.

6. In a rotary engine, two concentric cylinders each having two segmental chambers in its walls, passages leading from each end of each segmental chamber to the cylinder, rotary gates fitted in bores intersecting said passage-ways two circular chambers intersecting each cylinder-chamber, rotary gates fitted in said circular chambers steam-passages leading from the exterior to the said rotary gates, rotary plug-valves fitted in bores intercepting said passages leading to the circular valves, arranged and combined as shown and described for the purposes stated.

7. In a rotary engine, two concentric cylinders each having two segmental chambers in its walls, passages leading from each end of each segmental chamber to the cylinder, rotary gates fitted in bores intersecting said passage-ways two circular chambers intersecting each cylinder-chamber, rotary gates fitted in said circular chambers' steam-passages leading from the exterior to the said rotary gates, rotary plug-valves fitted in bores intercepting said passages leading to the cir-

cular valves, rotatable hubs having radially-extending pistons fitted in the cylinders and means for operating all the rotary gates in concert with the hubs, arranged and combined as shown and described for the purposes stated.

8. In a rotary engine, a casing having two concentric cylinders, a main shaft in concentric position with the two cylinders, a hub in each cylinder fixed to said shaft and provided with pistons extending radially therefrom, two circular chambers intersecting each cylinder-chamber, a shaft in concentric position with each circular chamber, a rotary gate having concaves in its periphery in each circular chamber and connected at its end with the main shaft by means of gear-wheels, two segmental chambers in the wall of each cylinder communicating at each end with the cylinder-chamber, a rotary gate having concaves in its periphery fitted in a bore intersecting passage-ways leading from the segmental chambers to the cylinder-chamber fixed to shafts and connected therewith by means of gear-wheels on their ends and the wheels on the ends of the shafts extending through the circular chambers, and means for conveying steam from the exterior into one of the circular chambers, all arranged and combined to operate in the manner set forth for the purposes stated.

9. In a rotary engine, two concentric cylinders, each having two segmental chambers in its walls communicating with the cylinder-chambers, a steam-supply pipe communicating with the cylinder-chambers, rotary valves in the passages leading from the supply-pipes to the cylinders, pipes connected with the supply-pipe and the segmental chambers and means for regulating the passage of steam to and from the cylinders and segmental chambers shown and described to simultaneously introduce initial steam into distinct chambers for the purposes stated.

10. A compound rotary engine comprising a case, two cylinders in concentric position and each cylinder provided with two segmental steam-chambers in its wall, two circular chambers intersecting the chambers of the cylinder, a main shaft in concentric position with the cylinders, a hub having radial pistons in each cylinder fixed to said shaft, shafts extended through the circular chambers in parallel position with the main shaft and a rotary gate having concaves in its periphery in each circular chamber and fixed to one of said shafts, steam passage-ways leading from the cylinder-chambers to the segmental chambers, rotary gates having concaves in their peripheries in bores intersecting said passage-ways fixed to shafts, gear-wheels on the ends of each shaft, rotary valves fitted in bores in the case intersecting steam passage-ways from the exterior of the case to the circular chambers and cylinder-chambers, each valve provided with an arm and connected with a lever, an induction-pipe having branches communicating with the segmental chambers and cylinders, valves in said branch pipes and exhaust-pipes, all arranged and combined to operate in the manner set forth for the purposes stated.

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