G. WESTINGHOUSE.

ROTARY ENGINE.

APPLICATION FILED APR. 21, 1906.

935,343. Patented Sept. 28, 1909.

4 SHEETS—SHEET 1.

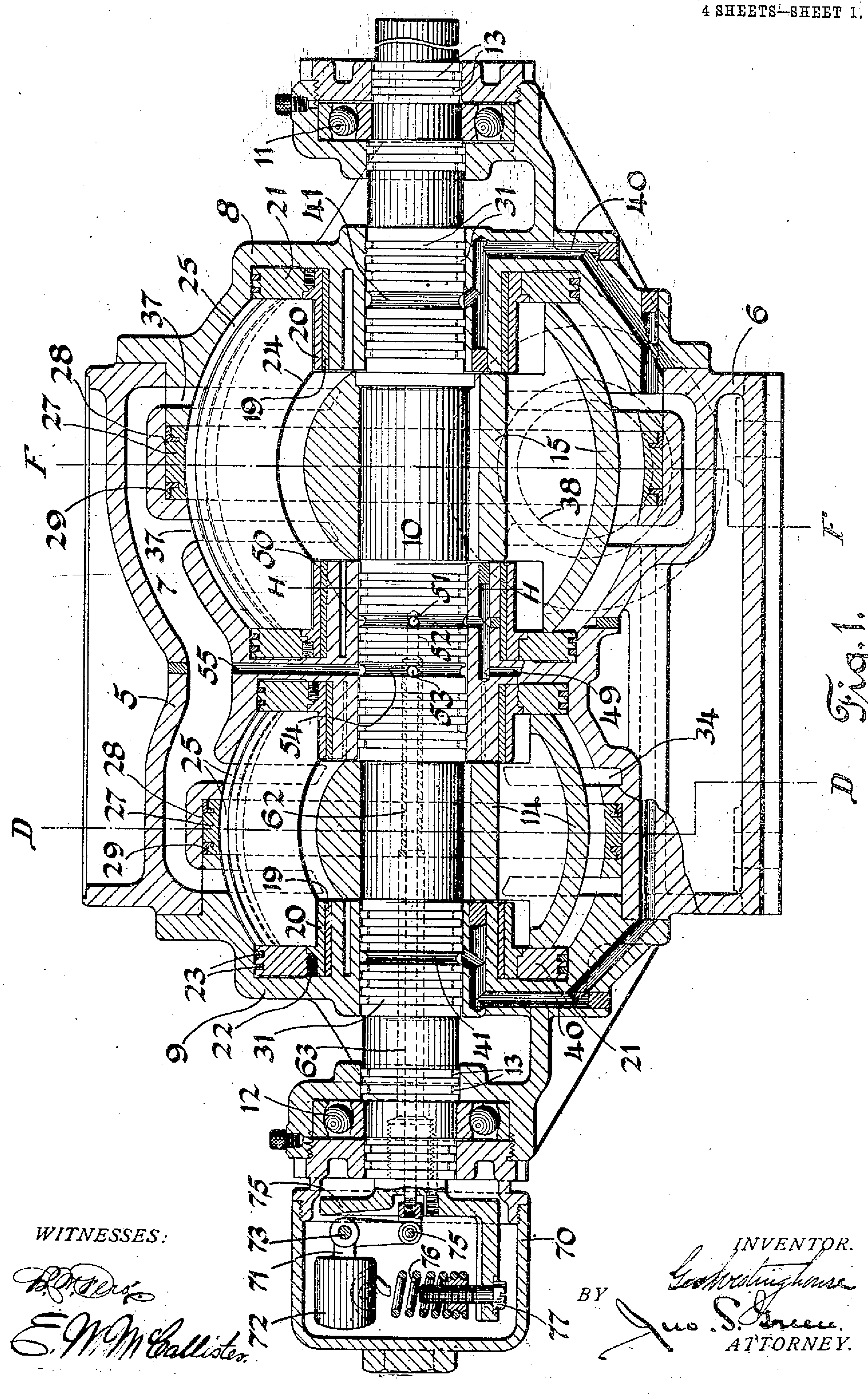

Fig. 1.

WITNESSES:

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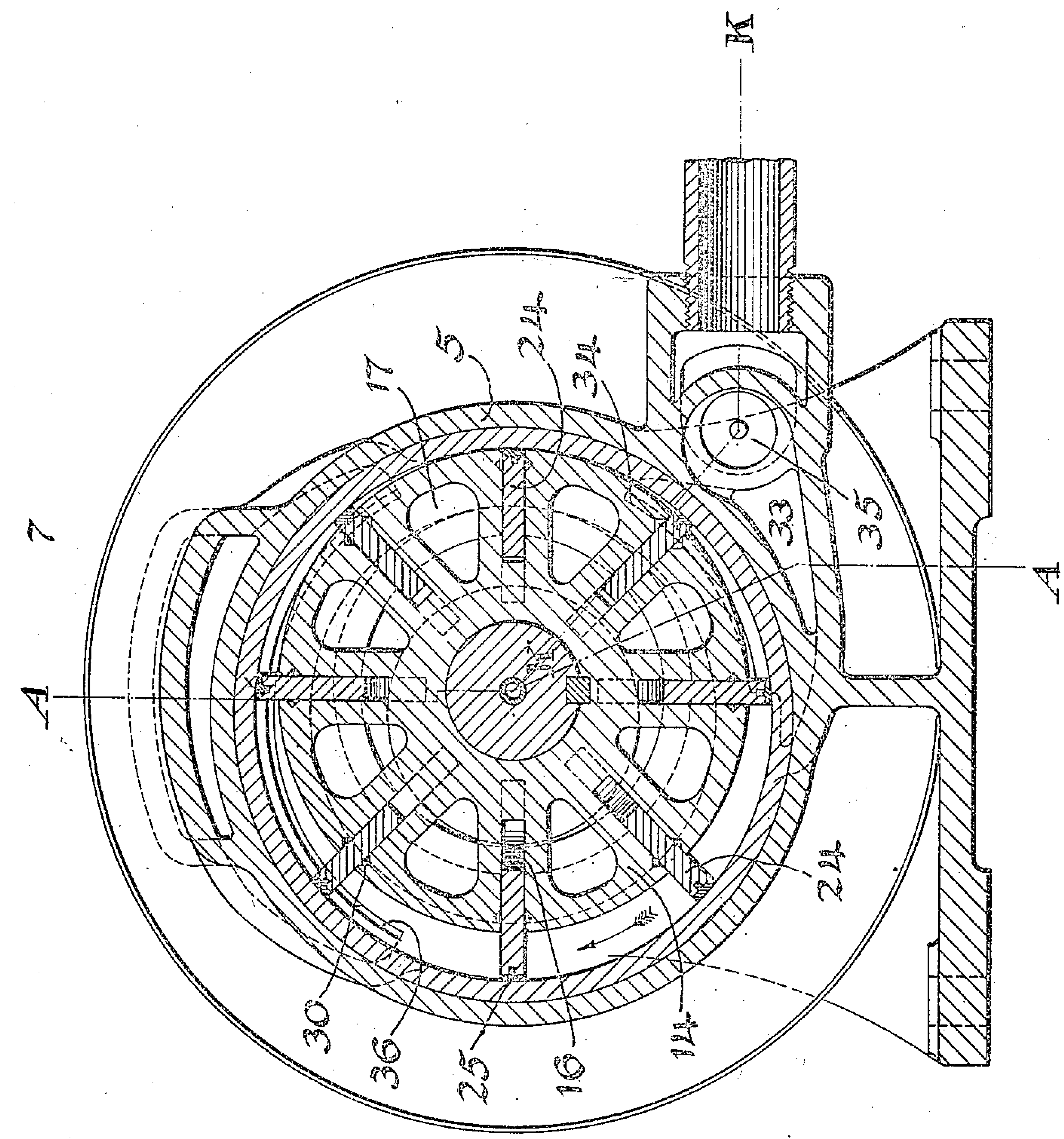

Fig. 2.

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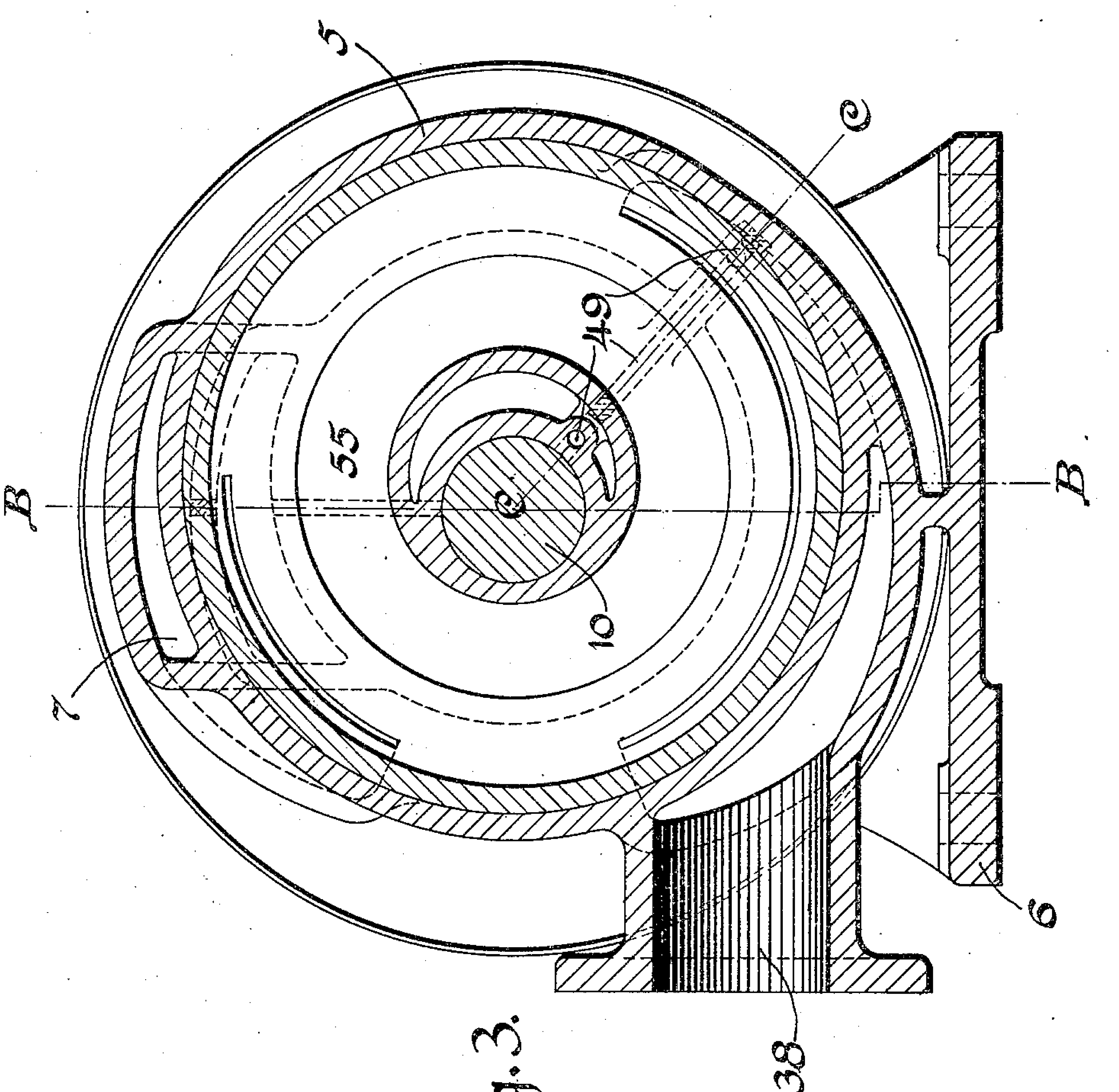

Fig. 3.

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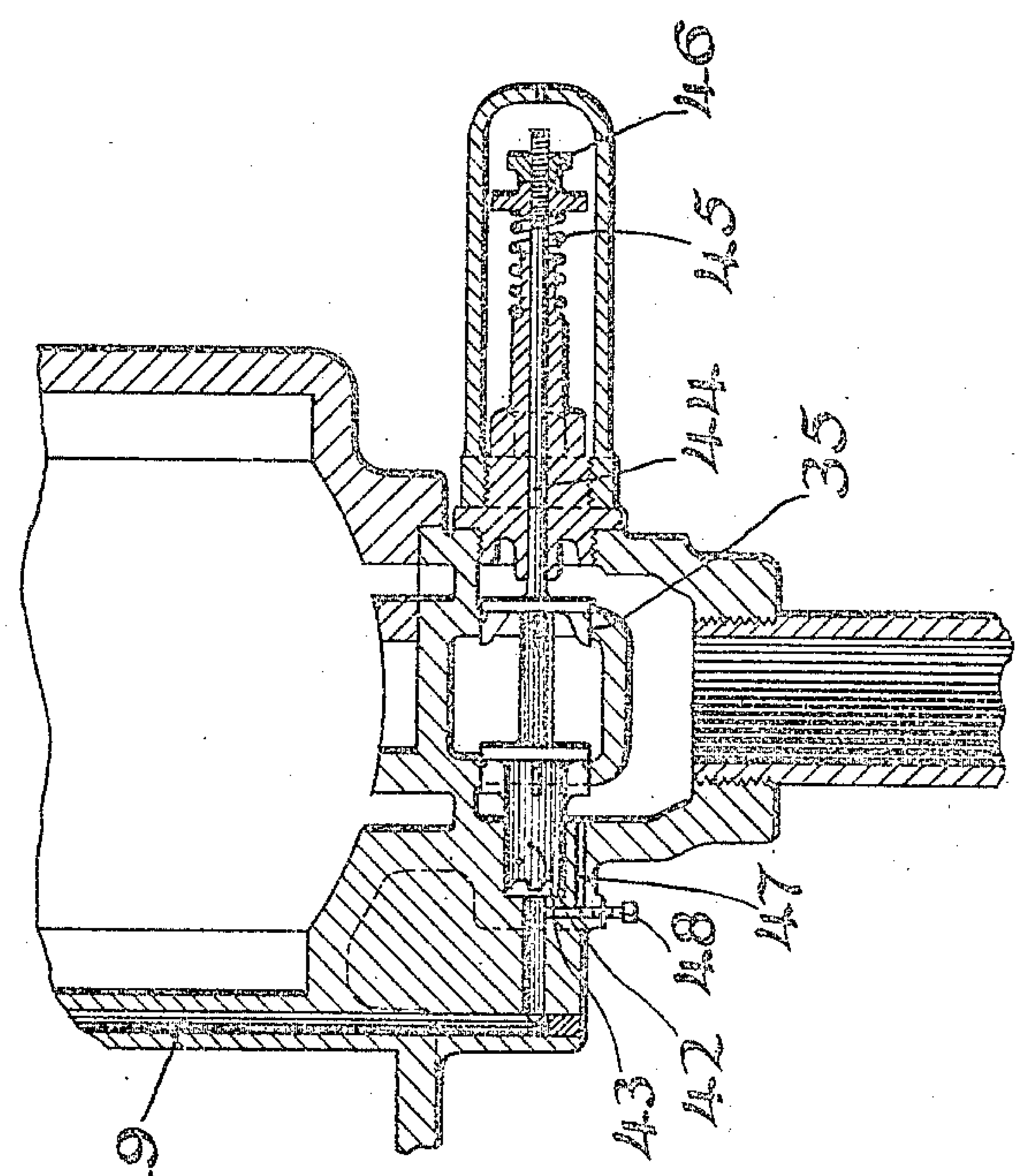

Fig. 4.

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UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, OF PITTSBURG, PENNSYLVANIA.

ROTARY ENGINE.

935,343. Specification of Letters Patent. Patented Sept. 28, 1909.

Application filed April 21, 1906. Serial No. 313,066.

To all whom it may concern:

Be it known that I, GEORGE WESTINGHOUSE, a citizen of the United States, and a resident of Pittsburg, in the county of Allegheny and State of Pennsylvania, have made a new and useful Invention in Rotary Engines, of which the following is a specification.

This invention relates to rotary engines.

An object of this invention is the production of an efficient, relatively simple and cheap rotary engine employing sliding or moving pistons.

A further object of this invention is the production of a compound engine of this class which is efficient and compact.

A further object is the production of simple and efficient governing or controlling means for engines of this class.

A still further object is the production of an engine of this class in which the ends of the pistons are reduced to a minimum size.

These and other objects, which will readily appear to those skilled in this art, I attain by means of the apparatus described in the specification and illustrated in the drawings accompanying and forming a part of this application, and throughout which similar elements are denoted by like characters.

In the drawings, Figure 1 is a sectional elevation taken on the line A—A in Fig. 2 and partially on the lines B—B and C—C of Fig. 3; Fig. 2 is a cross-sectional view taken on the line D—D in Fig. 1; Fig. 3 is a cross-sectional view taken on the lines F—F and H—H in Fig. 1; and Fig. 4 is a partial section of a portion of the governing means employed in this engine taken on the line K—K of Fig. 2.

The engine consists of high and low pressure portions arranged within a common casing, which consists of a cylinder or casing 5 provided with a base portion 6 and cored portions within the upper half to form a receiver chamber 7 connecting the high and low pressure portions. End pieces or heads 8 and 9 are bolted or otherwise secured within the ends of the casing and through these heads a shaft 10 extends. The shaft 10 is preferably journaled within suitable ball bearings 11 and 12 carried in standards, formed integrally with the heads. The ball bearings are kept oil tight by means of suitable packings 13. The high-pressure drum 14 is carried on shaft 10 within the high-pressure portion of the casing, and low-pressure drum 15 is carried by shaft 10 within the low-pressure portion of the casing. Each drum is formed in the nature of a sphere, or more truly in the nature of a double truncated sphere, the end walls of which are perpendicular to the shaft-axis. Piston-ways 16 are turned in the drums and extend from end to end thereof. The drums, which, after being machined, are in the form of a double truncated sphere, in their formation, are cast in the nature of spheres with openings 17 cored therethrough from end to end for the purpose of cutting down the weight. A shaft hole is drilled through the drums from end to end, and the ends are faced off in two planes perpendicular to the axis of the shaft. After this is done, the drums are chucked and the piston-ways are cut in a lathe. It will be seen that this forms the bottom of each piston-way concentric with the outer periphery of the drum and is an extremely cheap and simple method of manufacture. The drums are keyed or otherwise secured to shaft 10.

The walls at the ends of both cylinders extend into the cylinders in the nature of sleeves which surround the shaft and whose outer cylindrical surfaces 18 are eccentric thereto. A bushing 19 loosely surrounds each cylindrical eccentric surface, and, resting on the bushing is a flanged sleeve 20, the flange portion 21 of which is formed separately therefrom and secured thereto by means of screws 22. Between the outer surface of each flange 21 and the inner wall of the casing, which at that point is cylindrical, split packing rings 23 are interposed. These packing rings fit in grooves cut in the flange portion and bear snugly against the inner surface of the cylinder and remain stationary in relation thereto. Slidably fitting within each piston-way is a piston 24 whose inner surface is concave to conform to the bottom of the way. The outer face of each piston, which is convex, is grooved to receive packing strips or members 25. The packing strips or members 25 for each piston are formed in three parts or portions, the central portion of which is riveted or otherwise secured to the piston, while the outer portions are free to play in and out radially, and are held out by centrifugal force, to pack the joint between the cylinder and piston.

The end of each piston is squared, as

shown in Fig. 1, and the inner faces rest in contact with sleeves 20 while the outer faces rest in contact with the flange portions 21 of said sleeves. Steam flows to the spaces behind the flanges 21 and between them and the ends of the cylinders, so that the inner faces of the flanges are held in contact with the drums and piston ends. From the fact that the faces of the flanges in contact with the piston ends are eccentric to the paths of travel of the pistons, a ground fit is constantly maintained. Owing to the eccentricity of the sleeves 20, with relation to the shaft, the pistons, when not moved by centrifugal force, are moved in and out radially, relative to the axes of the pistons, and into contact with the inner surfaces of the cylinders.

In order to reduce the wear between the packing members 25 and the inner surfaces of the cylinders and to equalize the strains due to the centrifugal force of the pistons, rings 27, fitting within cylindrical chambers 28 eccentric to the shaft, are utilized. These rings bear against the outer ends of all of the pistons at their centers and are caused to float within their housings by means of steam pressure admitted behind them near the steam inlets to the high and low pressure sections. The rings are provided with packings 29, located at opposite ends, which tend to confine the steam behind the rings and maintain an equal steam pressure between them and the back walls of the chambers.

The pistons are kept tight within their respective ways by means of packings 30. Each of these packings consists of a circular V-shaped channel cut into the side of the way and into which is inserted a prism-shaped metal packing strip. Centrifugal force tends to move this radially and on account of the outer angle of the wall of the strip-slot the strip is forced in constant contact with the piston by centrifugal force and steam pressure. The shaft 10, which is stepped and flanged as illustrated in Fig. 1 for obvious purposes of manufacture, carries a series of packing rings 31 which bear against the inner surface of the eccentrics.

The steam or other motive fluid for operating the engine enters the high-pressure cylinder through a valved inlet port 33, which extends around the cylinder, as shown by dotted lines at 34, Fig. 2, and is provided with a regulating valve 35. The steam after entering the inlet port expands in the gradually-increasing steam space, rotates the high-pressure drum in the direction of the arrow in Fig. 2 and exhausts through exhaust port 36, shown in Fig. 2 partially in dotted lines. The exhaust steam from the high-pressure cylinder passes through the receiver chamber 7 to the inlet port 37 to the low-pressure section, and, in passing through the low-pressure section drives the drum 15 in the same direction as drum 14 and exhausts through the exhaust port 38.

In order to prevent any leakage of steam to the atmosphere around the shaft at the opposite ends of the engine, ports or ducts 40 lead from annular leakage grooves 41, formed at the center of each end packing device for the shaft, to the exhaust port 38 for the low-pressure cylinder.

Inlet valve 35, which is illustrated in Fig. 4, consists of a double-beat puppet valve provided with a cylindrical projection 42, which extends into a cylindrical chamber 43, formed in the valve casing to receive the same. The valve stem 44, which extends through a suitable guide, is surrounded by a helical spring 45 made adjustable by means of adjusting nuts 46 threaded on said stem. The cylinder 42 may either loosely fit into the cylindrical chamber 43 to provide a leakage passage around it or, as shown in the drawing, a leakage port 47, adjustable by means of a valve screw 48 may be provided, in order that the outer end of the cylindrical projection at times will be subjected to a pressure equal to the pressure within the valve casing proper. When the pressure in the chamber 43 equals the pressure in the valve chamber proper, the valve is balanced, except for the area of the valve stem, and, under these conditions, spring 45 yieldingly lifts and holds the valve from its seat so that steam will be admitted through the inlet port of the engine. The chamber 43 below cylindrical projection 42, by means of ports and passages 49, connects with an annular recess 50, formed in the shaft 10. Radially-drilled holes 51 connect annular recess 50 with a passage 52, located centrally of the shaft, and which, by means of radially-drilled holes 53, and an annular recess 54, formed in the shaft, and a passage 55, drilled through the upper portion of the casing, connect with the receiver chamber between the two cylinders. As, by means of the ports and passages just described connecting the chamber 43 with the receiver chamber, the inner end of cylindrical projection 42 is normally subjected to a pressure lower than the pressure within the valve casing proper, owing to the fact that leakage port 47 is adjusted so as to be smaller than the ports 49, etc., the valve 35 is held to its seat and the steam supply to the high-pressure cylinder is cut off. Spring 45 is adjusted so that when the ports and passages 49 are open to the receiver pressure, the pressure tending to close the valve 35 will overcome the tendency of spring 45 to open the valve.

The engine shaft 10 has a hole drilled at its center and extending from its end adjacent to the high-pressure section to the radial ports or passages 53. Within this hole suitable bushings 61 and 62 are driven and a pin valve 63 is adapted to slide within said bushings to open and close communication between passage 52 and radial passages 53 whereby the exhaust from the chamber 43 is opened and closed accordingly.

Carried within a governor casing 70, secured to the bearing housing adjacent to the high-pressure end of the engine, is a governor device for controlling the movement of the pin valve 63. This preferably consists of a bell-crank 71 carrying a weight 72 and fulcrumed at 73 on a disk 74 carried by the shaft. The opposite end of the bell crank is connected to the outer end of the pin valve 63, as at 75, and the movement of the weight, due to centrifugal force, is resisted by a spring 76 which is adjustable by means of a screw device 77. The spring 76 for the governor and the spring 45 for the inlet valve are each so adjusted that the outlet to the ports and passages 49, etc., will normally be throttled sufficiently to allow the inlet valve to be unseated by the spring 45 to admit the necessary amount of steam to the engine to meet the load demands. Spring 76 of the governing device is adjusted so that the governor weight, through the medium of the pin valve 63, may vary the outlet to ports and passages 49, etc., in accordance with the speed of the engine.

It will be understood that this invention is equally applicable to either compound or simple motors or pumps and that the same is not limited to a compound motor or pump, but is considered broad enough to include either single or compound apparatus.

In accordance with the provision of the patent statutes I have described the principles of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrated and that the invention can be carried out by other means.

What I claim is:

1. In a rotary engine, a casing, a shaft extending therethrough eccentrically with the interior of said casing, a substantially spherical rotor mounted on said shaft, sliding pistons carried by said rotor, and eccentrics for moving said pistons radially.

2. In a rotary engine, a casing, a substantially spherical chamber therein, a substantially spherical rotor mounted eccentrically within said chamber, curved pistons carried by and slidable radially of said rotor and a stationary eccentric bearing against the inner ends of said pistons.

3. In a rotary engine, a casing provided with a substantially spherical chamber therein, a substantially spherical rotor mounted eccentrically within said chamber, pistons or wings carried by and movable radially of said rotor, and an eccentric for moving said wings radially.

4. In a rotary engine, a stator, having a substantially spherical inner surface, a substantially spherical rotor, pistons carried by and movable radially of said rotor, and eccentric members bearing against the ends of said pistons and adapted to move the same radially.

5. In a rotary engine, a casing, a shaft extending therethrough and located eccentrically of the interior of said casing, a substantially spherical rotor mounted on said shaft, and separately controlled sliding pistons carried by said rotor and engaging the interior face of said casing.

6. In a rotary engine, a casing, a shaft extending therethrough, a substantially spherical rotor mounted on said shaft and located within said casing, radially slidable pistons mounted on said rotor and engaging the interior of said casing, and a ring surrounding said rotor for equalizing the strains due to the centrifugal force encountered by said pistons.

7. In a rotor, a casing, a rotor element located within said casing, slidable pistons mounted on said rotor and engaging the interior face of said casing, a ring surrounding said rotor and engaging said pistons, and a fluid chamber in which said ring is located.

8. In a rotary engine, a casing, a rotor element located within said casing, movable pistons mounted on said rotor element, and a floating ring surrounding said rotor and engaging said pistons.

9. In a rotary engine, a high pressure stage comprising a substantially spherical chamber and a rotor element provided with radially slidable pistons located therein, a low pressure stage receiving motive fluid from said high pressure stage and comprising a substantially spherical chamber and a rotor element provided with radially slidable pistons located therein, and means for controlling the delivery of motive fluid to said high pressure stage.

10. In a rotary engine, a high pressure stage comprising a substantially spherical chamber, a substantially spherical rotor mounted eccentrically within said chamber, pistons mounted on said rotor and eccentries engaging said pistons and a low pressure stage receiving motive fluid from said high pressure stage and comprising a substantially spherical chamber, a rotor element mounted therein, and radially slidable pistons mounted on said rotor.

11. In a rotary engine, a casing, a substantially spherical chamber located within said casing, a substantially spherical rotor located eccentrically within said chamber, and a fluid packing located between said rotor element and said casing which com-

prises a floating ring and a flanged ring concentric therewith and provided with packing strips which engage the interior face of said chamber.

12. In a rotary engine, a casing, a chamber within said casing, a rotor element located within said chamber, radially slidable pistons mounted on said element, a floating ring surrounding said rotor and engaging said pistons, and a fluid packing between said ring and said casing.

13. In a rotary engine, a casing, a rotor element, radially movable pistons carried by said rotor element and a floating ring engaging said pistons and located between said pistons and said casing.

14. In a rotary engine, a casing, a rotor element, movable pistons mounted on said element and a ring engaging the outer ends of said pistons.

15. In a rotary engine, a casing, a rotor element, movable pistons mounted on said element, packing strips located between said pistons and said casing and a floating ring engaging the outer ends of said pistons.

16. In a rotary engine, a casing, a rotor element, movable pistons mounted on said element, packing strips located between said rotor and said casing and a floating ring engaging the outer ends of said pistons.

17. In a rotary engine, a casing, a rotor element located eccentrically within said casing, pistons carried by said rotor, a member located eccentrically of said rotor and engaging with said pistons to move them radially and a floating ring engaging said pistons and located between them and said casing.

18. In a rotary engine, a casing, a rotor element located eccentrically within said casing, a plurality of independently movable pistons carried by said element, members located at each end of said element for moving said pistons radially and means engaging said pistons and operating to counteract the centrifugal force.

19. In a rotary engine, a casing, a rotor element located eccentrically within said casing, a plurality of independently movable pistons carried by said element, means, located at each end of said element, for moving said pistons radially, and means, common to all of said pistons, for counteracting the centrifugal force and decreasing the friction between said pistons and said casing.

20. In a rotary engine, a casing, a rotor element located eccentrically within said casing, a plurality of independently movable pistons carried by said element, means for moving said pistons radially of said element and means, common to all of said pistons, for counterbalancing the centrifugal force and relieving the friction between said piston and said casing.

21. In a rotary engine, a casing, a rotor element located within said casing, a plurality of independently movable pistons carried by said element, means for moving said pistons radially and means, common to all of said pistons, for counteracting the centrifugal force.

In testimony whereof, I have hereunto subscribed my name this sixth day of April, 1906.

GEO. WESTINGHOUSE.

Witnesses:
DAVID WILLIAMS,
E. W. McCALLISTER.