No. 755,062. PATENTED MAR. 22, 1904.

F. D. SHEPHERD.

STEAM TURBINE.

APPLICATION FILED AUG. 11, 1903.

NO MODEL. 4 SHEETS—SHEET 1.

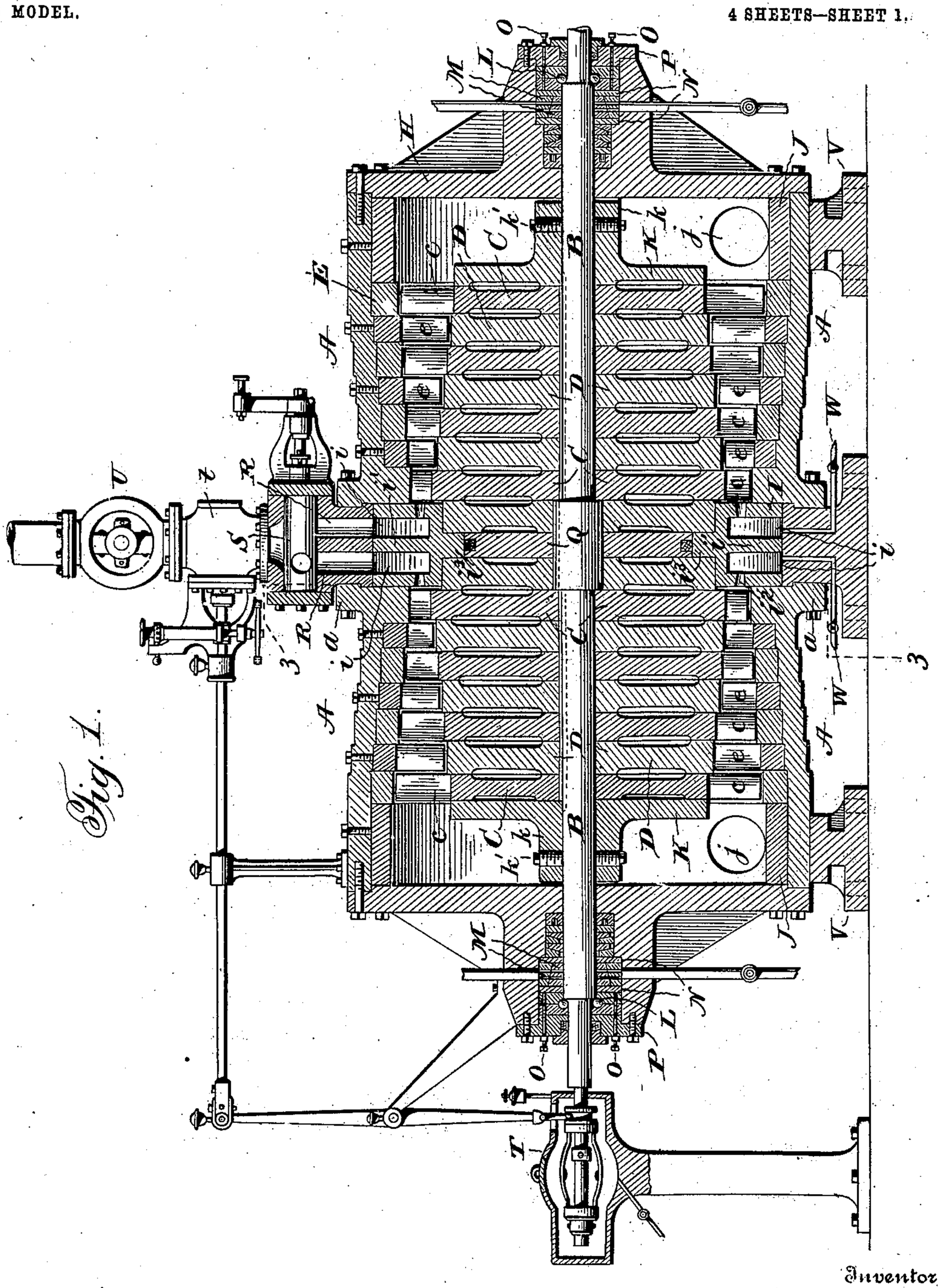

Fig. 1.

Witnesses

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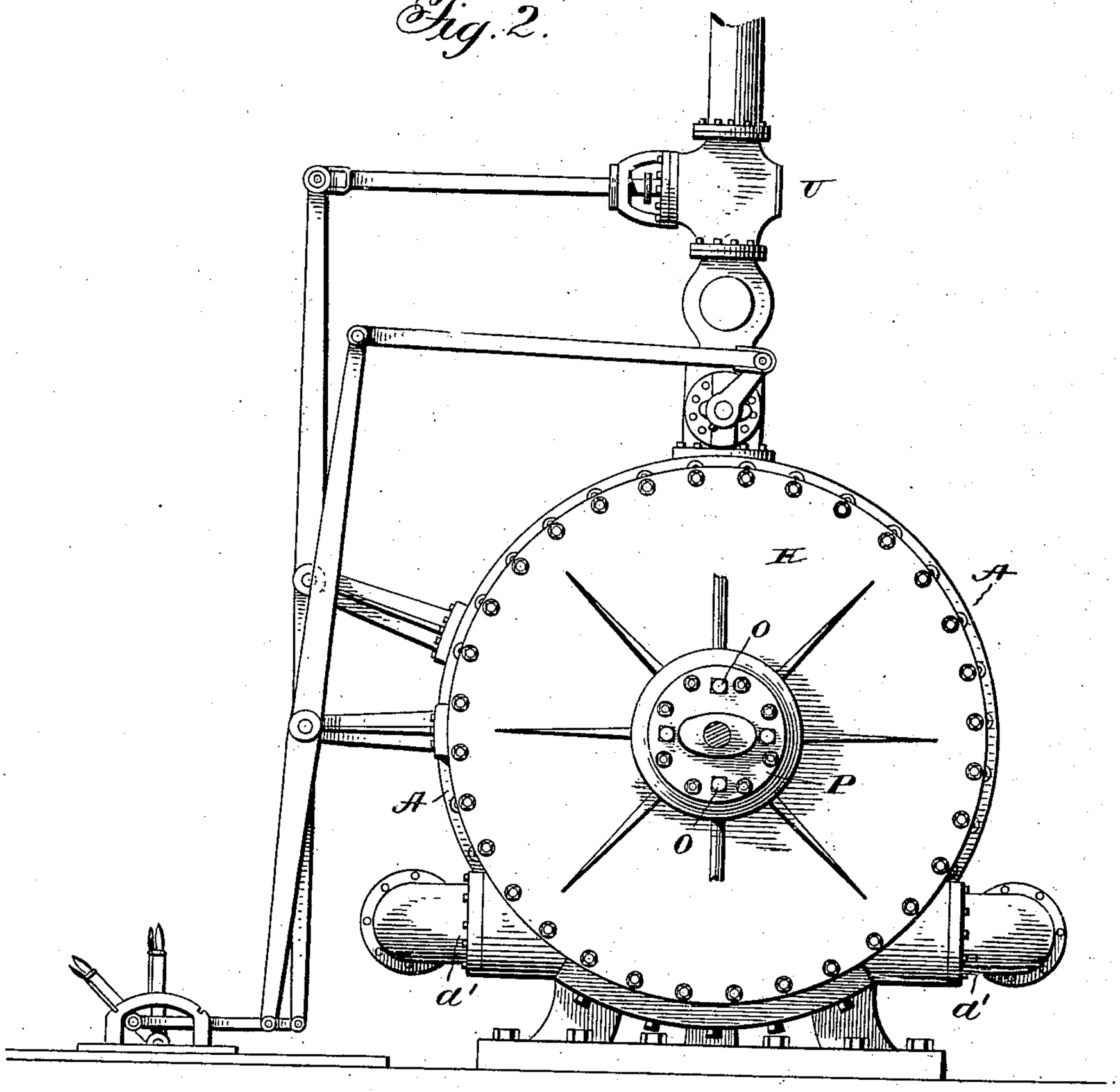
NO MODEL. 4 SHEETS—SHEET 2.

Fig. 2.



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NO MODEL. 4 SHEETS—SHEET 3.

Fig. 3.

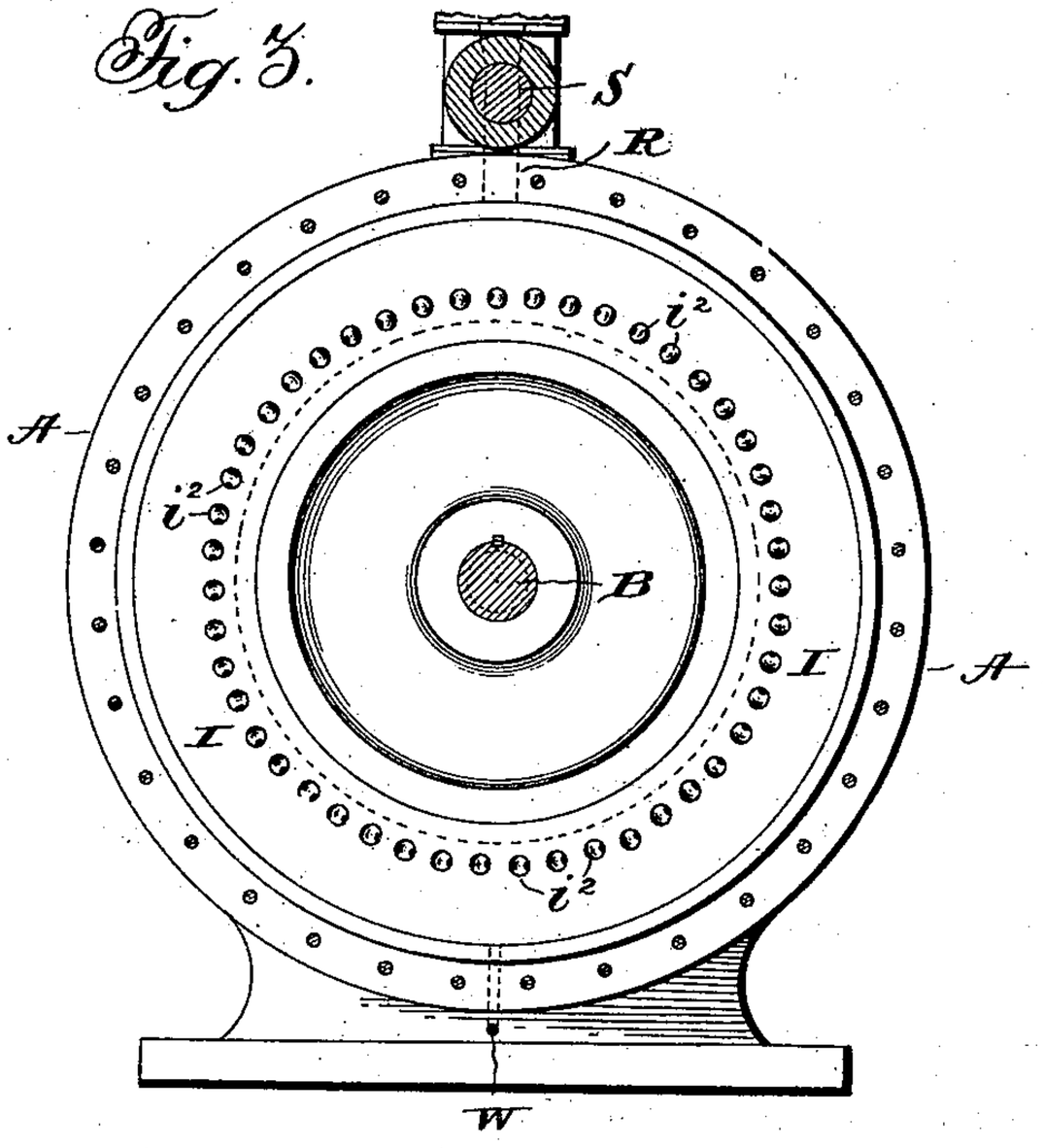
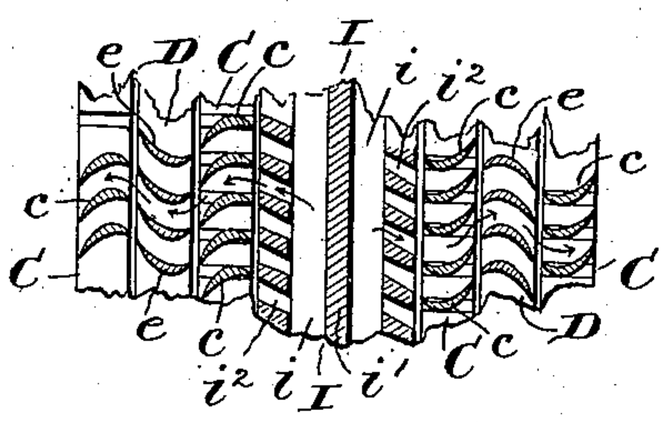


Fig. 4.



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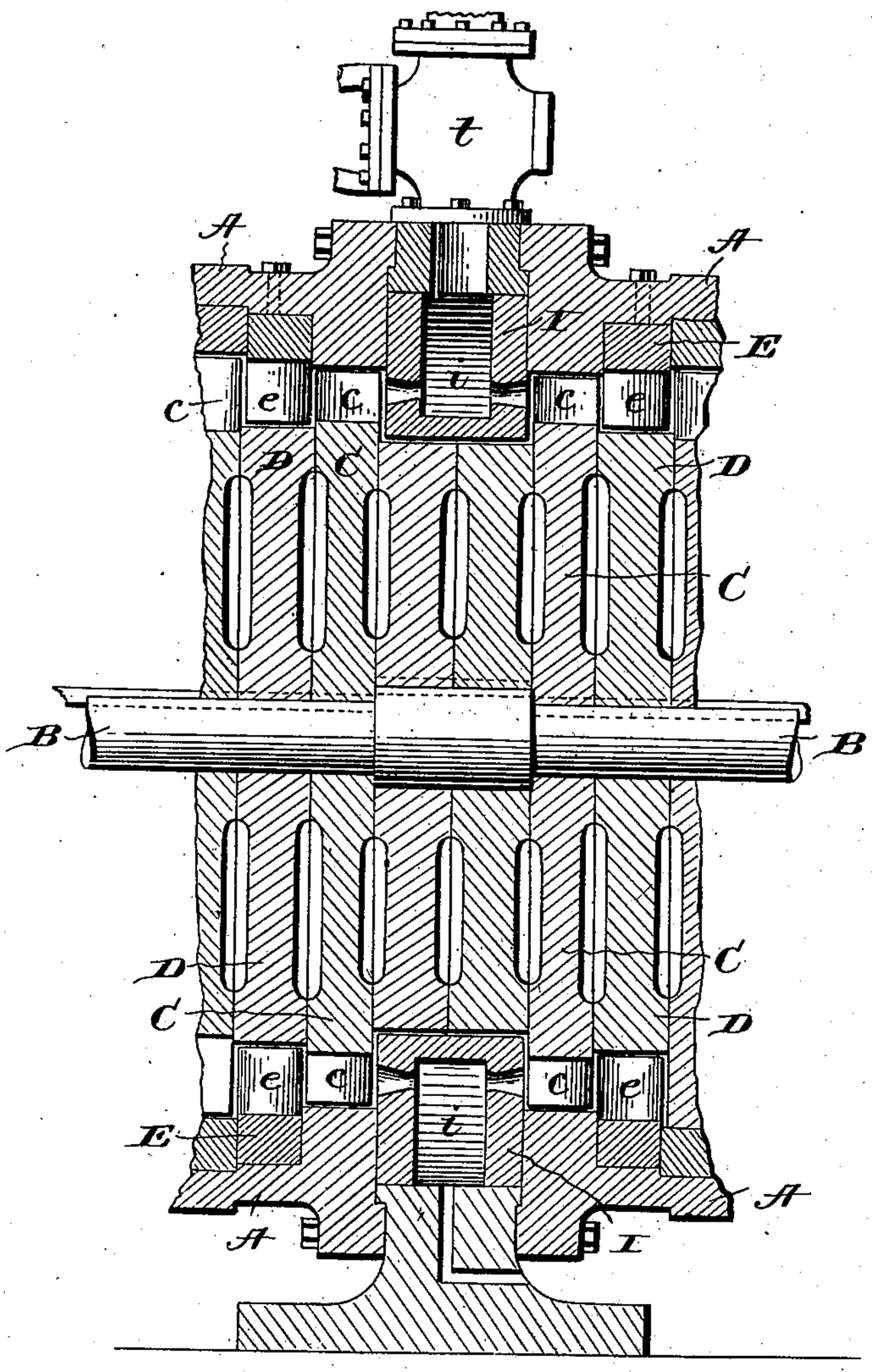
NO MODEL.

4 SHEETS—SHEET 4.

Fig. 5.



Witnesses

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No. 755,062. Patented March 22, 1904.

UNITED STATES PATENT OFFICE.

FRANK D. SHEPHERD, OF SALT LAKE CITY, UTAH.

STEAM-TURBINE.

SPECIFICATION forming part of Letters Patent No. 755,062, dated March 22, 1904.

Application filed August 11, 1903. Serial No. 169,120. (No model.)

To all whom it may concern:

Be it known that I, FRANK D. SHEPHERD, of Salt Lake City, in the county of Salt Lake, and in the State of Utah, have invented a certain new and useful Improvement in Steam-Turbines; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, in which—

Figure 1 is a vertical longitudinal section of a reversible compound steam-turbine embodying my invention. Fig. 2 is an end elevation thereof. Fig. 3 is a cross-section on the line 3 3 of Fig. 1. Fig. 4 is a detail view, partly in elevation and partly in horizontal section, to illustrate the arrangement of the steam-inlet ports and the piston and guide-blades; and Fig. 5 is a central longitudinal section of a compound double-acting turbine embodying my invention, only the central portion of the engine being shown.

The object of my invention is to provide a rotary fluid motor or engine of such construction as to be thoroughly practical, of high efficiency and economy in the use of steam or other operating fluid, using it to the best possible advantage, and capable of being readily and easily put together in building it and taken apart when necessary; and to these ends my invention consists in the engine having the construction substantially as hereinafter specified and claimed.

The object I have had more especially in view is to improve the engine for which I have been granted United States Patent No. 728,138, May 12, 1903, and it will be found that in some general particulars the engines which I have selected to illustrate my present invention are similar to the engine of said patent. As in the engine of my former patent the body of the engine is composed of sections A, which contain or constitute the cylinders, said sections being placed horizontally and joined end to end, and there are a horizontal shaft B, disks or collars C, mounted on and keyed to the shaft, having on their peripheries radially-extending blades *c*, disks or collars D, having no peripherial blades that alternate with the disks C, and rings E in the cylinders encircling and concentric with the disks or collars, alternate rings being provided with inwardly-projecting blades *e*, which extend into the spaces between the blades *c* of the disks C. The outer ends of the cylinder are close by heads H, that are bolted to the cylinders, and in said heads bearings are provided for the shaft B, the construction of which bearings will be described hereinafter. In the case of the engines illustrated there are three sections A, the middle one forming the steam chest or receiver and the other two the cylinders, and the cylinder-sections are provided at their ends next the middle sections with outwardly-extended flanges *a*, through which bolts pass into the middle section, and thus the three sections are joined together in a very simple and inexpensive manner.

Within the middle section A or the steam-chest is a ring I, in whose outer periphery, in the case of the reversible engine, are two annular grooves or chambers *i*, formed by a central circumferential partition *i'*, and in the case of the double-acting engine a single annular groove or chamber *i*. Opening from the chamber or chambers *i* through each side of the ring I is a circular series of holes or ports i^2, through which steam flows from the chamber to the pistons on both sides thereof. Each cylinder, beginning with the one next the steam-chest or the high-pressure end of the cylinder, enlarges in diameter toward its other end, and the series of rings E correspondingly enlarge in diameter, while also beginning at the end of the series next the steam-chest the disks or collars C and D are reduced in diameter outward. The inner and outer peripheries of the rings and collars, respectively, are preferably cylindrical, and as the blades of the rings and collars, respectively, are carried close to the periphery of the opposite collar or ring, as the case may be, it results that the blades of the ring or collar project beyond the periphery of the preceding collar or ring. The purpose of such arrangement is to prevent steam impinging on the ends of the blades and to compel all of it to act upon the sides thereof. Important practical differences come from the enlargement of the cylinder in the manner described: First, the successive piston-blades toward the low-pressure

end of the cylinder are increased in diameter, and therefore the steam can act with greater power, and, second, it is necessary merely to remove the cylinder-head when it is desired to remove the rings or disks and not to remove the cylinders, as is the case with the construction of my former patent. Between the last ring E of the series and the adjacent cylinder-head is a filling-ring J, which is provided with a hole or holes *j*, that register with an exhaust port or ports *a'* in the cylinder-section. Preferably more than one, preferably two, exhaust-ports *a'* are provided to enable smaller ports to be used than would be possible with one port of the same area to allow of the use of shorter cylinders, and thus reduce the length of the engine. I of course, however, do not limit myself to any particular number of ports. Suitable means are provided to prevent the ring J and the rings E, which have blades, from turning, which means may consist of screws passing through the cylinder and entering into openings or engaging seats in the rings. Between the last disk or collar C and the cylinder-head is a disk K, having a hub *k*, that extends close to but does not touch the cylinder-head, screws *k'* being passed through the hub to fasten it and its disk to the shaft B. The shaft at its longitudinal center is enlarged in diameter to form at each end of the enlargement a shoulder, against which the adjacent piston-disk abuts, and with the disk K set up against the last one of the series next to it the series of disks will be securely held in place. To insure steam-tight joints between the abutting surfaces, such surfaces are ground. It will be observed that each series of pistons is mounted entirely independent of the other, so that the pistons of one series may be removed for repairs or cleaning without any disturbance of the pistons of the other series. For the sake of lightness the disks C and D have chambers or cavities turned or formed in their sides.

The shaft-bearing in each cylinder-head is one that I have designed especially for the engine, it being a thrust ball-bearing, the balls L thereof, mounted in a retainer composed of two rings united by screws, being engaged by a shoulder on the shaft formed by reducing its diameter. Besides the balls the shaft has a ring-bearing that consists of two concentric rings M, one fitting the other and their abutting faces being conical and having small radial holes through them leading to the shaft for the supply of oil to the latter and rings N on opposite sides of the rings M. Engaging the outer rings N are screws O, that are accessible from the outside of the bearing for adjusting the ring-bearing. Oil is supplied to the shaft through the ring-bearing holes through pipes connected with a suitable source of supply. The outer end of the bearing-box, which latter is in the form of an extension from the cylinder-head, is closed by a head P, that is secured to the box by studs and nuts, and a suitable stuffing-box is provided for the shaft where it passes through said head. In the bearing-box on the inner side of the bearing-rings the shaft is suitably packed to prevent oil finding its way along the shaft and into the cylinder where it would mingle with the steam and render the latter unfit for boiler use. This packing may be of any desired construction, and it is not necessary to describe it in detail. It is intended that any end thrust of the shaft that might occur shall be taken by the ball-bearings; but if through accident this should not be accomplished damage to the engine from endwise movement of the shaft would be prevented by the coming in contact with the cylinder-head of the hub of the disk K. It is designed, however, that the two series of pistons shall balance each other to obviate any end thrust.

The description which is thus far given applies to both embodiments of my invention shown in the drawings; but as differences of construction are required in the case of the reversible engine over the double-acting engine the particulars in which the former differs from the latter will be now pointed out.

Referring more particularly to Fig. 1, it will be found that between the two pistons a partition is provided which consists of a disk Q, keyed to the shaft B, and a central inwardly-projecting annular flange *i*³ on the ring I, said disk and flange abutting and the joint between them being packed by piston-ring packing to prevent leakage of steam from one side to the other. Leakage, however, is very improbable, as the steam will be thrown outward along the sides of the internal projection of the ring I by centrifugal force. As there are two annular partition grooves or chambers *i*, separated by the partition *i''*, which respectively communicate with the two cylinders, each of said chambers, of course, has its own steam-inlet port R, and a valve S is provided for alternately placing the two inlet-ports R in communication with the source of supply of steam. Said valve may be of any desired construction; but an excellent one for the purpose is the rotary valve shown. This reversing-valve may be operated either by hand or by power. The governor-valve *t*, under the control of a governor T, mounted on the shaft B, is preferably placed on top of the reversing-valve. The throttle-valve U is preferably placed above the governor-valve, and of course the throttle-valve may be operated either by hand or by power. As will be seen by reference to Fig. 2, an arrangement of levers is shown for operating the reversing-valve and the throttle-valve. It is to be understood, however, that the construction and arrangement of the valves and their operating mechanism may be any preferred, as these have nothing to do with the invention.

The ports *i* for the passage of steam from the steam-chest of the pistons are, as will be best seen by reference to Fig. 4, inclined forwardly of in the direction of rotation of the pistons, and the general direction of the piston-blades is a rearward inclination, while the general direction of the stationary steam directing or guiding blades is the same as that of the steam-ports. It will be observed by reference to Fig. 4 that the inclination of the ports and blades of both series is in the same direction; but as the steam flows in opposite directions to the two series the effect is to produce a reverse direction of revolution, so that there is sameness of inclination of the blades only in comparison of the two series with each other. The blades in the case of both engines illustrated are made separate from the rings and attached thereto by dovetailed tenons and slots, as is done in the engine of my former patent, and the blades of a series are spaced apart, so that the discharge edge of one blade reaches to a point in line with the back of the following blade in order to insure that all the particles of steam will come in contact with the blades of the series and be directed from one series to the next. In the case of the double-acting engine there is of course no reversing-valve; but a single annular steam-chamber *i* is required, and since both series of pistons simultaneously revolve and move in the same direction the inclination of the steam-ports and the pistons and guiding-blades of the two series is not in the same but opposite directions; but as the steam flows to them from opposite directions its effect is to drive both series of pistons in the same direction, and there is of course no partition between the two cylinders, as in the case of the reversible engine.

The sections A have, preferably, a cylindrical form externally, and for supporting the engine the central section is extended downward and flanged, holes for anchor-bolts being provided in the flanges, and beneath each outer section and near the outer end thereof a saddle V is placed, being bolted to the section and provided with flanges that have holes for anchor-bolts.

It will be understood that the engine will be provided with a suitable stairway and staging to enable the engineer to conveniently get at the higher parts of the engine which may require attention, such as the valves, and that a graphite or lubricant pump will be provided for supplying lubricant to the packing-rings of the partition Q of the reversible engine; but it has not been considered necessary to illustrate these things. For the removal of water from the steam-chest when necessary a drain pipe or pipes W are provided that lead from the bottom of the steam-chest downward and outward.

It is thought the operation of each of the engines illustrated will be understood from what has already been said, so that no detailed description thereof is necessary. Steam coming from the steam-chest through the ports i^2 will act directly at high pressure upon the nearest piston, and then it will act expansively on the succeeding piston and to the best possible advantage on account of the increasing space and the successive length of the piston-blades in the progress of the steam from the steam-chest to the exhaust end of the cylinders.

I have already mentioned particulars in which I do not confine the scope of my invention to special constructions, and it is to be understood generally that changes in details of construction may be made which will involve no departure from the principle of my invention.

Having thus described my invention, what I claim is—

1. In a steam-turbine, the combination of two cylinders in line with each other, a steam-chest between the two cylinders, a series of pistons in each cylinder consisting of disks having peripheral blades that successively increase in length, and rings in each cylinder having inwardly-projecting blades, said rings being of successively-increasing diameter, the steam-chest having ports that deliver steam first to the piston with the shortest peripheral blades.

2. In a steam-turbine, the combination of two cylinders in line with each other, a steam-chest intermediate the two cylinders, a series of pistons in each cylinder having steam-engaging blades, a series of blade-carrying rings in the cylinder that increase in diameter, beginning nearest the steam-chest, and a removable head closing each cylinder end.

3. In a steam-turbine, the combination of two cylinders in line with each other, a steam-chest intermediate the cylinders, a series of pistons having fluid-engaging blades in each cylinder, a series of rings in each cylinder that increase in diameter beginning nearest the steam-chest, a removable head closing the outer end of the cylinder, and a filling-ring next the removable head having an opening or openings coinciding with the exhaust opening or openings of the cylinder.

4. In a steam-turbine, the combination of two cylinders in line with each other, a steam-chest intermediate the cylinders consisting of a chambered ring, the sides of the ring having ports, a series of pistons having steam-engaging blades in each cylinder, a shaft on which the pistons are mounted having a shoulder to engage an end one of the pistons, and a clamping-disk engaging the other end one of the pistons.

5. In a steam-turbine, the combination of two cylinders in line with each other, a steam-chest intermediate the cylinders, consisting of a chambered ring, the sides of the ring having ports, a series of pistons having steam-en-

gaging blades in each cylinder, a shaft on which the pistons are mounted, having a shoulder to engage an end one of the pistons, and a clamping-disk engaging the other end one of the pistons, said clamping-disk having a hub adapted to engage the cylinder end.

6. In a steam-turbine, the combination of two cylinders in line with each other, a steam-chest intermediate the cylinders, consisting of a chambered ring, the sides of the ring having ports, a series of pistons having steam-engaging blades in each cylinder, a shaft on which the pistons are mounted, having a shoulder to engage an end one of the pistons, a clamping-disk engaging the other end one of the pistons, a series of blade-carrying rings in each cylinder that increase in diameter successively, beginning nearest the steam-chest, and a filling-ring in the cylinder having a hole or holes alining with an exhaust port or ports in the cylinder.

7. In a steam-turbine, the combination of two cylinders in line with each other, a steam-chest intermediate the cylinders, a series of pistons in each cylinder, consisting of disks having peripheral blades that successively increase in length, beginning nearest the steam-chest, a shaft on which said disks are mounted, a shoulder or enlargement on the shaft engaging an end one of the series of disks, a clamping-disk engaging the other end piston-disk of the series, a series of blade-carrying rings in each cylinder, that successively increase in diameter beginning nearest to the steam-chest, a removable head closing the outer end of the cylinder, a filling-ring in the cylinder next the said head, having a hole or holes alining with an exhaust port or ports in the cylinder, and means for holding said spacing-ring and said blade-carrying rings from rotation.

8. In a steam-turbine, the combination of two cylinders in line with each other, a steam-chest intermediate the cylinders, outwardly-extending flanges on the two cylinders, bolts passing through said flanges into the sides of the steam-chest, a series of pistons in each cylinder, having steam-engaging blades that successively increase in length beginning nearest the steam-chest, a series of rings in each cylinder that successively increase in diameter beginning nearest the steam-chest, and a removable head closing the outer end of each cylinder.

9. In a steam-turbine, the combination of two cylinders in line with each other, a steam-chest intermediate the cylinders, a series of pistons in each cylinder, a shaft on which said pistons are mounted, a ring having two annular chambers, and separated by a partition, the side walls of said ring having ports for the passage of steam from each chamber into the cylinder, and a reversing-valve.

10. In a steam-turbine, the combination of two cylinders in line with each other, a steam-chest intermediate the cylinders which consists of a chambered ring having ports leading to the cylinders, a series of pistons in each cylinder, a shaft on which the pistons are mounted, and a partition intermediate the two series of pistons within and fitting said chambered ring.

11. In a steam-turbine, the combination of two cylinders, a steam-chest intermediate the cylinders having a two-chambered ring, ports opening through each side of the ring, a series of pistons in each cylinder, and a partition between the two series of pistons comprising a disk and an inwardly-projecting flange on said ring.

In testimony that I claim the foregoing I have hereunto set my hand.

FRANK D. SHEPHERD.

Witnesses:
CHARLES M. CHANDLER,
ORVILLE C. HATCH.