No. 707,727. Patented Aug. 26, 1902.

R. SCHULZ.

STEAM TURBINE.

(Application filed May 10, 1901.)

(No Model.) 6 Sheets—Sheet 1.

Fig. 1.

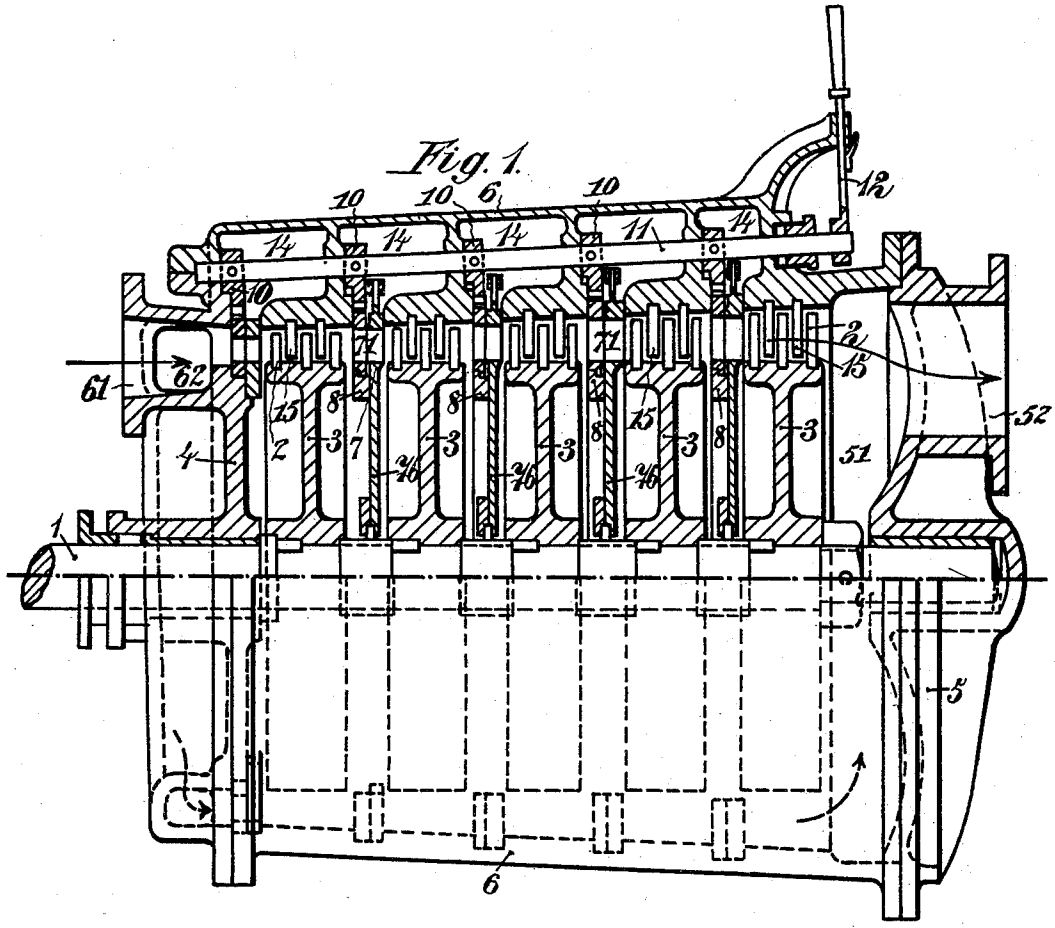
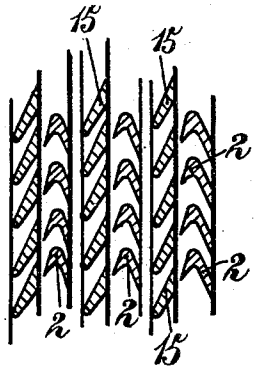


Fig. 8.



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No. 707,727. Patented Aug. 26, 1902.

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(No Model.) 6 Sheets—Sheet 2.

Fig. 2.

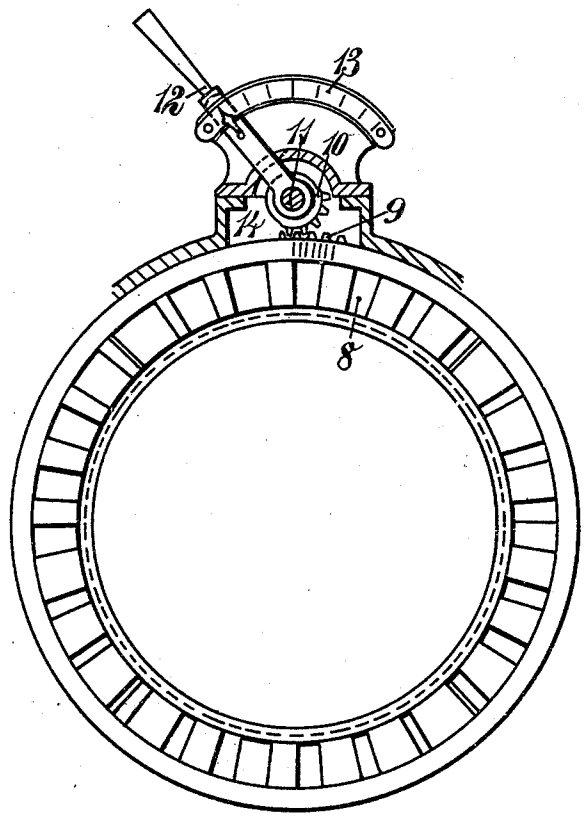

Fig. 4.

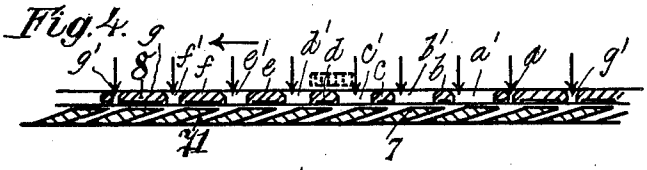

Fig. 5.

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(No Model.) 6 Sheets—Sheet 3.

Fig. 3.

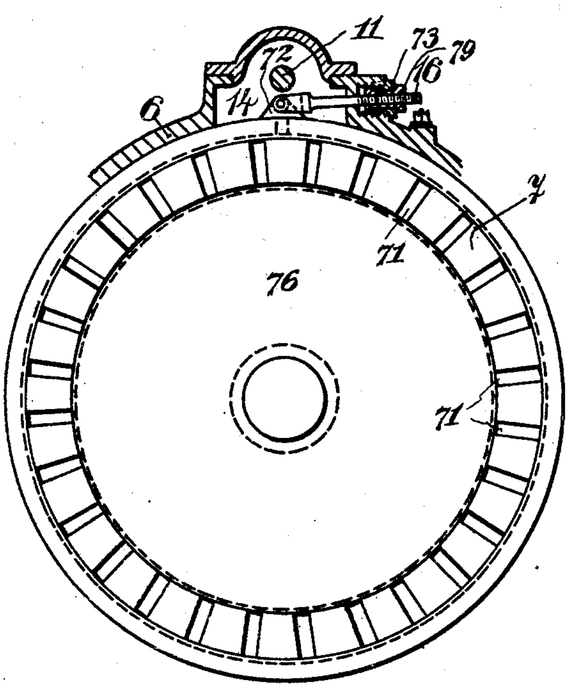


Fig. 6.

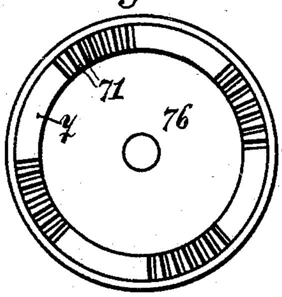
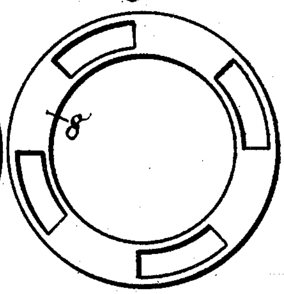


Fig. 7.



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(No Model.)

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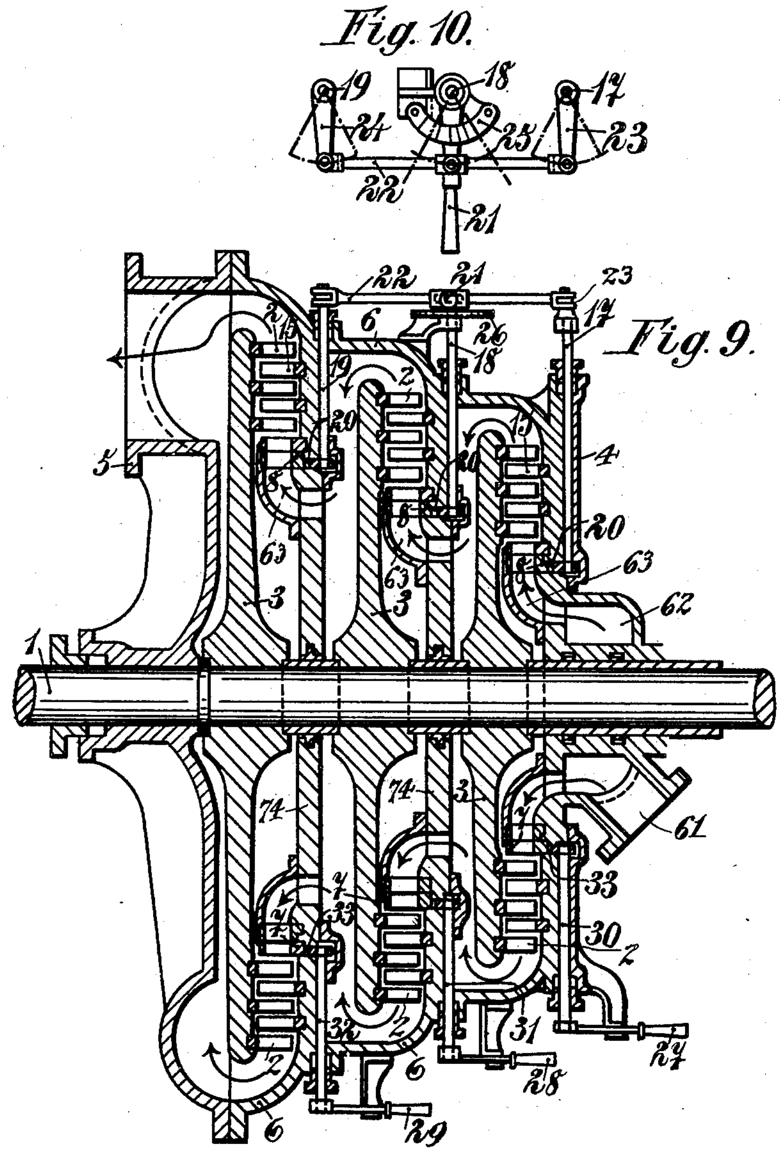

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(Application filed May 10, 1901.)

(No Model.) 6 Sheets—Sheet 5.

Fig. 11.

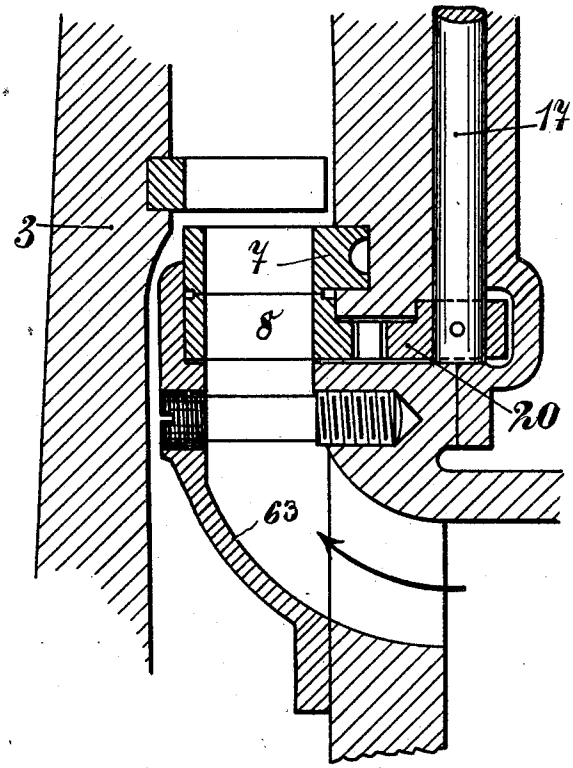
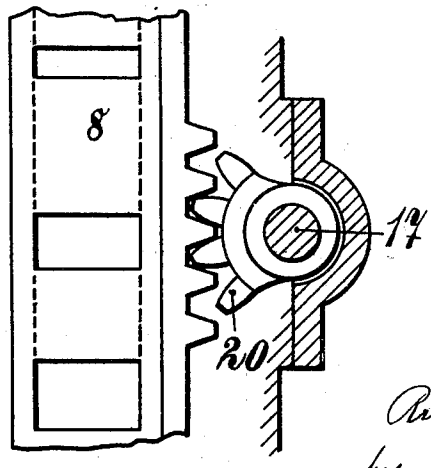


Fig. 12.



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No. 707,727. Patented Aug. 26, 1902.

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STEAM TURBINE.

(Application filed May 10, 1901.)

(No Model.) 6 Sheets—Sheet 6.

Fig. 13.

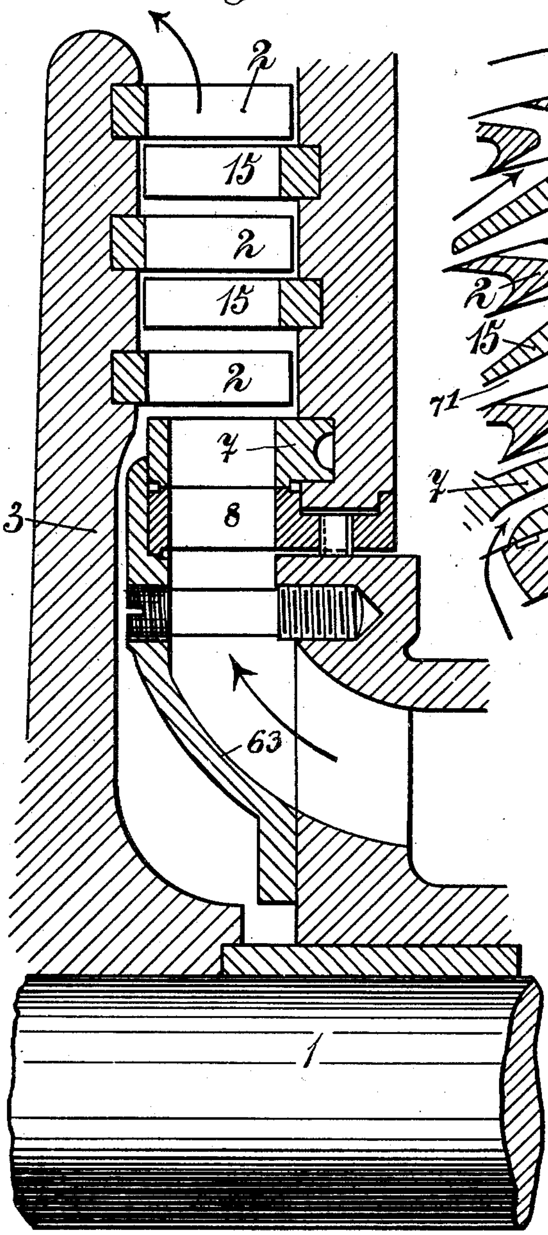
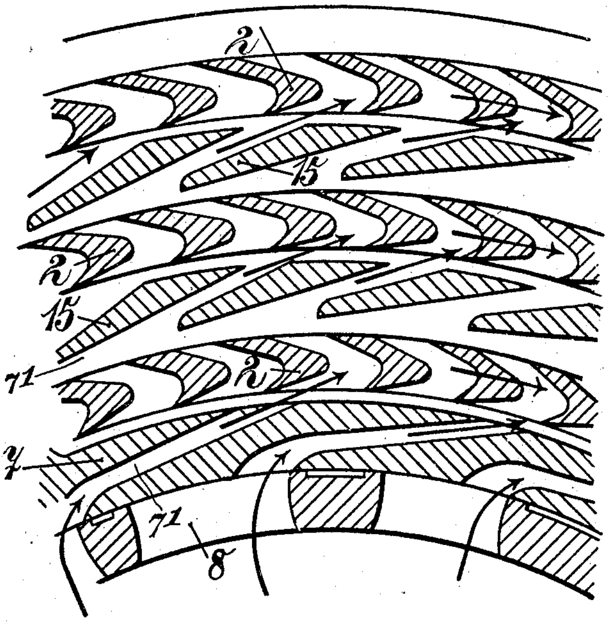
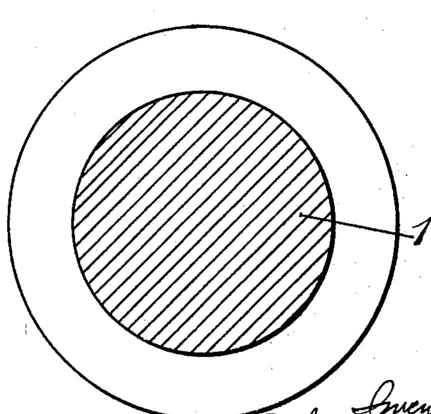


Fig. 14.





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UNITED STATES PATENT OFFICE.

RICHARD SCHULZ, OF BERLIN, GERMANY.

STEAM-TURBINE.

SPECIFICATION forming part of Letters Patent No. 707,727, dated August 26, 1902.

Application filed May 10, 1901. Serial No. 59,651. (No model.)

To all whom it may concern:

Be it known that I, RICHARD SCHULZ, a subject of the German Emperor, residing at Berlin, Germany, have invented certain new and useful Improvements in Controlling Mechanism for Steam-Turbines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters and figures of reference marked thereon, which form a part of this specification.

My invention relates to controlling or valve mechanism for steam-turbines and is applicable to both radial and axial turbines in which there are one or more turbine wheels arranged upon the same shaft, and has for its object a novel construction of valve and other details, which will be more fully described in the accompanying specification, and particularly pointed out in the claims.

Referring to the drawings, in which like parts are similarly designated, Figure 1 is an axial turbine, partly in longitudinal vertical section and partly in side elevation. Fig. 2 is a front view of one form of the valve and its operating mechanism. Fig. 3 is a view of the valve-seat and its adjusting device. Fig. 4 is a section showing the development of one-fourth of the ring-valve shown in Fig. 2, the ports being wide open. Fig. 5 is a similar view showing nearly all of the ports closed. Fig. 6 shows another form of valve-seat, and Fig. 7 a ring-valve to coöperate therewith. Fig. 8 is a partial sectional view through the gates and buckets of the turbine. Fig. 9 is a vertical sectional view of a radial turbine provided with three turbine wheels; Fig. 10, a plan view showing means for operating the valves of said turbine. Fig. 11 is an enlarged partial vertical section showing means for adjusting the valve of a radial turbine. Fig. 12 is a plan view of the same; Fig. 13, a partial vertical sectional view of a radial turbine; and Fig. 14 is substantially a transverse section of the same through the buckets, gates, valve-seat, and valve.

Turbines operate most economically when they develop their highest power, and the steam-passages between the gates and buckets are calculated so as to develop such. Steam when entering such turbines, as described, loses a great deal of its power when acting upon the first turbine wheel. It has been the practice in order to diminish the power developed in such machines to throttle the steam just before or while it enters the machine, whereby much of its force is lost.

The present invention has for its object to avoid throttling of the steam before its entrance into the machine to regulate the quantity supplied to the several turbine wheels by providing a suitable mechanism for regulating the feed of steam from one turbine wheel to another, and I accomplish this by interposing between the turbine wheels a suitable valve-seat, which may or may not be adjustable and on which moves a valve controlling ports in said seat.

Referring to Figs. 1 to 3, 1 is a shaft of an axial turbine upon which is keyed a plurality of turbine wheels 3, each wheel carrying at its periphery one or more series of buckets 2 within a suitable casing 6, the interior of which is provided with a suitable number of gates 15, arranged to coöperate with the buckets that are secured to and moving with the several turbine wheels.

Between the adjacent turbine wheels are partitions 76, that divide the casing 6 into a number of substantially steam-tight chambers that have provided near their peripheries valve-seats containing ports 71, and adjacent to the valve-seats and coöperating therewith are the valves 8. (Here shown as ring-valves.)

At the entrance end of the turbine is a steam connection 61, leading to the inlet-chamber 62, formed in the head 4 of the turbine, and between this chamber and the first turbine wheel is a valve and seat. Steam after passing through the turbine from end to end enters an exhaust-chamber 51, closed by an end plate or head 5 and leading by steam connection 52 to a suitable exhaust-pipe.

Formed at one side of the casing 6 are chambers 14, one opposite each turbine wheel, through all of which passes a valve operating or controlling rod 11, moved by the operating-lever 12, which carries an index-hand arranged to move over the scale 13. This rod has secured to it in each one of the chambers a sector-gear 10, coöperating with gear-teeth 9 on

the edge of the ring-valve 8. Each one of the valve-seats, Fig. 3, is provided with ears 72 or equivalent devices, which are pivoted between the forked end of adjusting-rods 16, that pass out of the casing 6 at one side of its respective chamber 14. This rod 16 has an outer threaded end secured in a suitable stuffing-box 73 and carries a suitable nut 79 for moving the rod. By turning this nut on the end of the screw-rod 16 the valve-seat and the partition 76, when formed in one piece with this valve, can be rotated from side to side in the chambers 14, whereby all of the valve-seats in a turbine provided with a plurality of turbine wheels can be adjusted—that is, rotated relatively to one another.

Referring to Figs. 9 and 10, the former shows a radial turbine—to wit, one in which the steam passes from the center of the turbine wheel outward—and it is necessary in such a construction to provide similar valve-seats and valves; but the ring-shaped seats and valves in this case must be so formed that the steam will pass radially through them instead of in a direction parallel to the axis, as in the case of the axial turbine just described.

To the shaft 1 of the turbine is secured a plurality of radial turbine wheels 3, separated by fixed partitions 74, and each turbine wheel is provided with a series of buckets 2, coöperating with a series of gates 15, secured to the casing 6 of the turbine. Steam enters at the smallest turbine wheel near its center by steam-inlet 61 into a steam-chamber 62 and is directed radially from the center to the periphery of the wheel by means of annular passages 63, said passages being connected with or forming part of the inlet-chamber 62. On this passage is movably seated the ring-valve 8, and above it, secured movably in a partition 74 or in one of the turbine heads 4, is the valve-seat 7. The ring-seat is provided with steam-passages that are larger at their entering side than at their delivery side and are turned to direct steam against the buckets in a direction substantially parallel with the entering edge of the buckets. Between each one of the turbine wheels are similar annular passages 63, which direct steam leaving one of the turbine wheels radially outward through the next adjacent turbine wheel. The valve 8 is provided with a tooth-sector, Figs. 10 and 12, which gears with a small one, 20, attached to rods 17 18 19, that pass out of the casing 6 through suitable stuffing-boxes at any convenient point. The several rods have secured to their outer ends short crank-arms 23, 24, and 21, the last-mentioned of which is prolonged into an operating-handle and carries an index that is movable over a scale 25. All of the crank-arms are connected to the common rod 22, so that by moving the handle 21 through a given arc the other crank-arms will be moved through a corresponding arc, which motion will be conducted by means of the several rods 17 18 19 and pinions 20 to the valves 8 to move the latter. Each one of the ring-shaped valve-seats 7 is similarly operated, being provided with a sector-gear on one edge coöperating with a sector-pinion 33, secured on rods 30 31 32, each of which rods projects through the casing at a suitable point and is provided with hand operating-levers 27 28 29, each ring being capable of being independently rotated in order to set these rings in different relative positions—to wit, to maintain a successively larger passage for steam between successive turbine wheels for the given position of valves.

Referring to Figs. 4 and 5, which are developments, in section, of a quadrant of the ring valve and seat, which latter is provided with twenty-eight openings, seven in each quadrant, the openings in the valve being arranged to register with those in the seat, but arranged in such a manner that by a slight motion of the valve the ports will be successively closed, as shown in Figs. 4 and 5, wherein all the ports in each quadrant can be closed except one when the valve is thrown to extreme position. The structure is shown in Figs. 2, 4, and 5, where the partitions a, b, c, d, e, f, and g successively increase in width and the spaces or ports between them, a', b', c', d', e', f', and g', successively decrease in width and are larger in area on the entry than on the delivery side. These ports through the valve register with those 71 through the valve-seat, said ports 71 being substantially the same distance apart and of substantially the same cross-sectional area. Thus it will be seen that when the ring-valve 8, Fig. 4, is thrown toward the left to its full extent it will assume the position shown in Fig. 5, in which all the ports 71, controlled by a set of ports a', b', and c' in the ring-valve, will be closed, except that one 71 controlled by the widest port a', as shown in said Fig. 5. A further movement of the ring-valve than shown in said Fig. 5 would of course tend to close the port 71, over which the port a would be about to move; but the remaining ports would begin to successively open. It will thus be seen that this further movement is not necessary.

In Fig. 14 is shown a radial turbine in which the ring-valve 8 is provided with ports of the same relative construction; but said ports instead of being radial slots are peripheral slots, and the ports 71 in the valve-seat are larger at the entering than at the delivery side. Of course this arrangement of ports need not be strictly maintained.

In Fig. 7 I have shown a modification of a valve and in Fig. 6 a modification of the ports formed through the valve-seat, whereby on rotating the valve 8 the ports, which are arranged in four sets, one set in each quadrant, will be successively closed.

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

1. In a turbine, the combination with a ring-shaped valve-seat provided with ports, of a

ring-valve having ports successively decreasing in area and coöperating with those in the seat, and means for rotating both valve and seat, substantially as described.

2. In a turbine, the combination with a ring-shaped valve-seat provided with ports, of a ring-shaped valve having ports successively decreasing in area and coöperating with those in the seat, and means for rotating both valve and seat in opposite directions, substantially as described.

3. In a steam-turbine, the combination with a valve-seat having equidistant ports therethrough, said ports larger at their entering than at their delivery side, of a ring-valve, divided into a suitable number of divisions and provided with a number of ports in each division, the ports in each division successively decreasing in area, substantially as described.

4. In combination, an annular valve-seat provided with ports, a ring-valve coöperating therewith, the ports through said valve in each quadrant successively wider, substantially as described.

5. In combination, an annular valve-seat provided with ports equidistant from one another and larger at their entering than at their delivery side, and a ring-valve whose ports in each quadrant are successively larger, substantially as described.

6. In combination, a valve-seat provided with ports equidistant from one another and a valve provided with ports on its periphery, the ports in each quadrant successively larger, both valve and seat organized to be rotated, substantially as described.

7. In a steam-turbine, in combination with the several turbine wheels, of partitions separating the several wheels and provided with valve-seats, said partitions independently rotatable and a series of ring-valves coöperating with said seats and each provided with gear-teeth, and pinions arranged on a common shaft gearing with the respective valves to simultaneously move an equal extent, substantially as described.

8. In a turbine, the combination with a plurality of wheels, of partitions independently rotatable and a rod pivoted to each partition and extending through the casing of said turbine, a series of ports arranged in said partitions to form valve-seats, ring-valves coöperating with said seats and means for simultaneously moving said valves, substantially as described.

9. In a turbine, the combination with a tubular ring-shaped valve-seat, of a tubular ring-shaped valve coöperating therewith, both having ports arranged in their peripheries and each adjustable with respect to the other, substantially as described.

In testimony that I claim the foregoing as my invention I have signed my name in presence of two subscribing witnesses.

RICHARD SCHULZ.

Witnesses:
JOHANNES HEIN,
WOLDEMAR HAUPT.