No. 794,608. PATENTED JULY 11. 1905.

R. H. GOLDSBOROUGH.

TURBINE.

APPLICATION FILED MAR. 14, 1906.

3 SHEETS—SHEET 1.

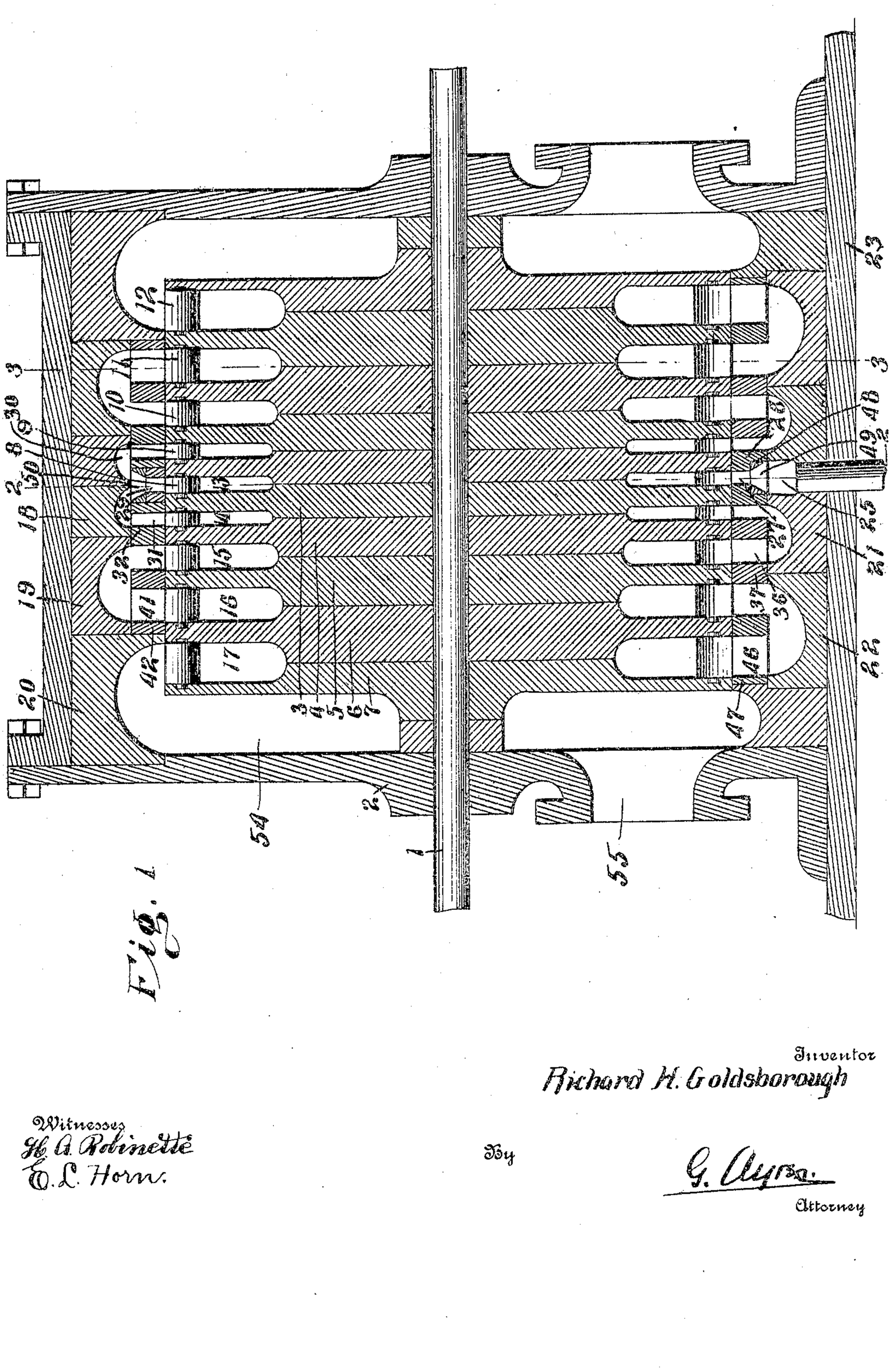

Fig. 1.

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3 SHEETS—SHEET 2.

Fig. 2.

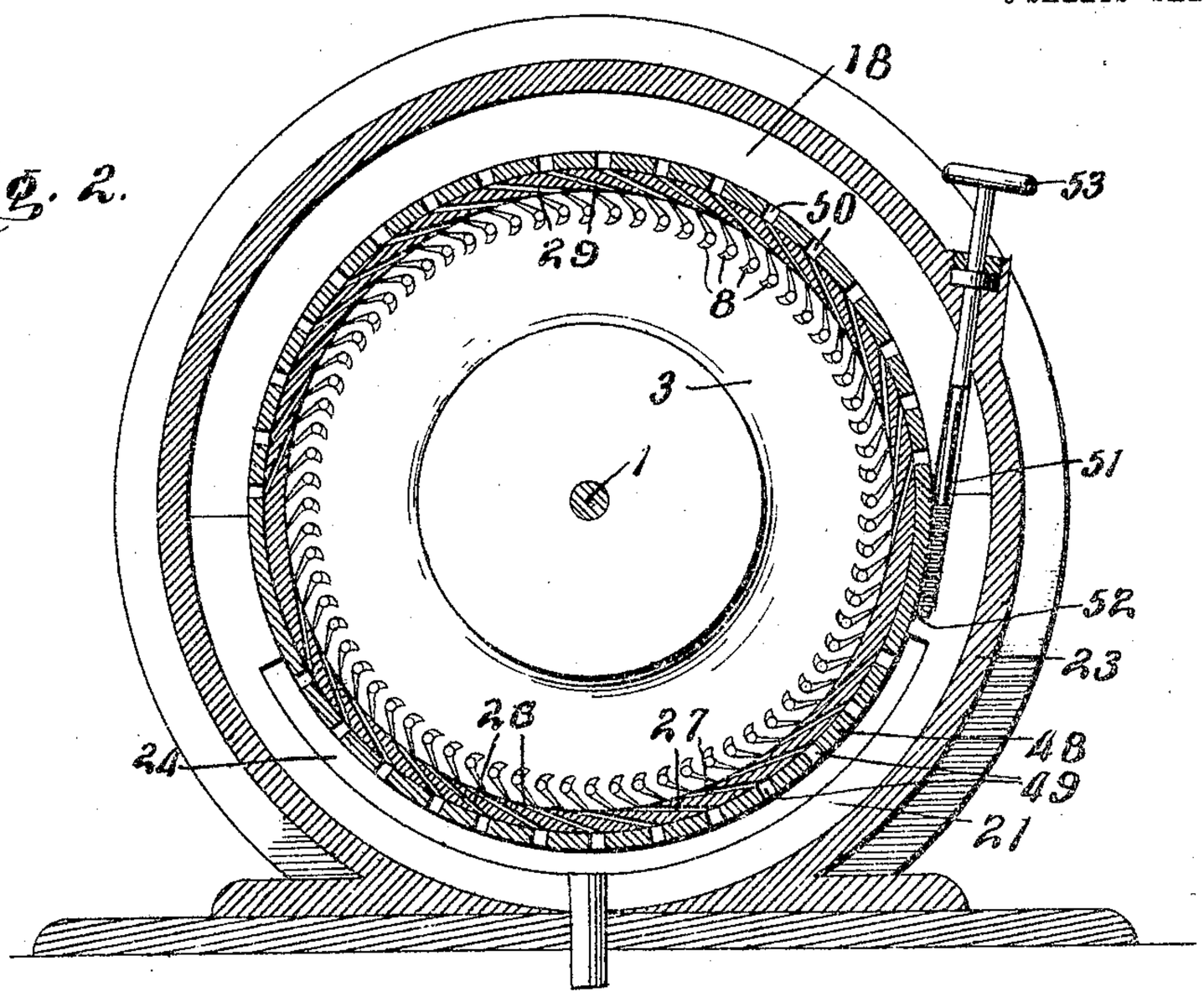
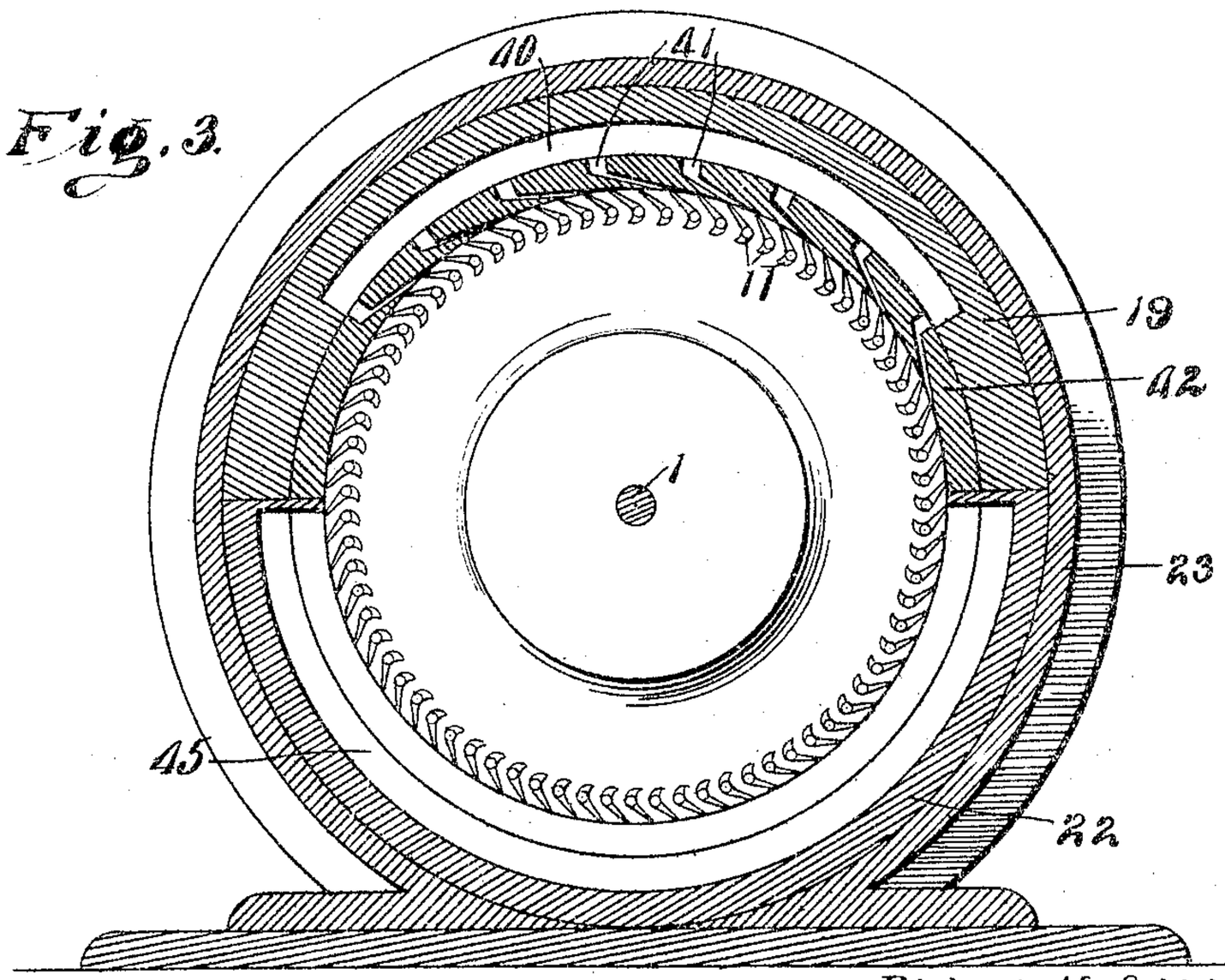


Fig. 3.



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3 SHEETS—SHEET 3.

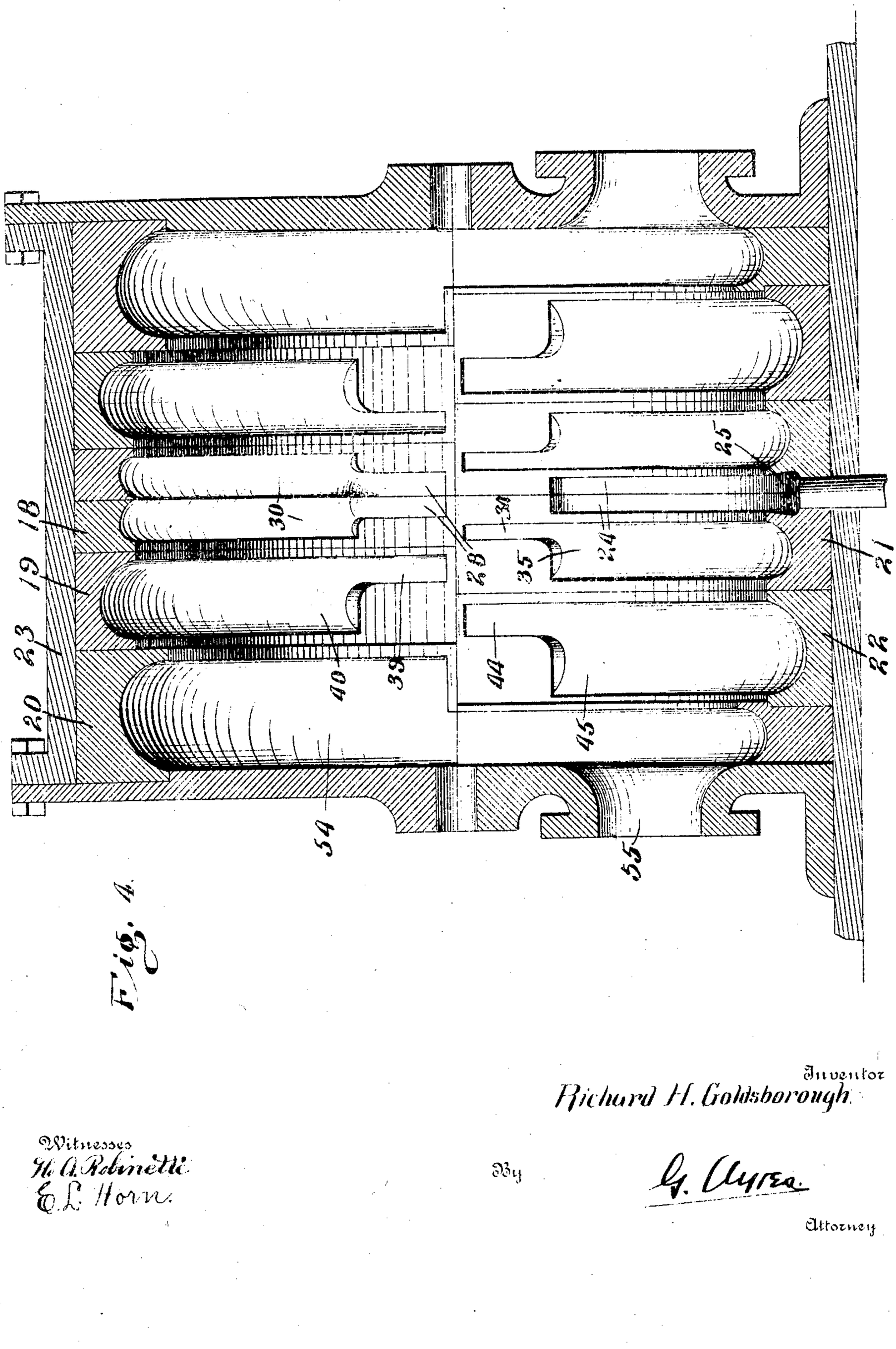

Fig. 4.

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No. 794,608. Patented July 11, 1905.

UNITED STATES PATENT OFFICE.

RICHARD H. GOLDSBOROUGH, OF WASHINGTON, DISTRICT OF COLUMBIA.

TURBINE.

SPECIFICATION forming part of Letters Patent No. 794,608, dated July 11, 1905.

Application filed March 14, 1905. Serial No. 249,988.

To all whom it may concern:

Be it known that I, RICHARD H. GOLDSBOROUGH, a citizen of the United States, residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Turbines, of which the following is a specification.

My invention relates to turbines; and it consists in the constructions, combinations, and arrangements herein described and claimed.

The objects of my invention are to provide a compound type of turbine capable of operating in a highly-efficient manner at relatively low speeds.

A further object of my invention is to provide a simple form of compound turbine which can be conveniently governed to produce a highly-efficient operation under great ranges of load.

A further object of my invention is to provide a simple and compact form of turbine capable of developing large power and which can be conveniently assembled and stripped.

In the accompanying drawings, forming a part of this application, and in which similar reference-symbols indicate corresponding parts in the several views, Figure 1 is a vertical axial sectional view illustrating a preferred embodiment of my invention. Fig. 2 is a sectional view, on a reduced scale, taken on the line 2 2 of Fig. 1. Fig. 3 is a sectional view, on a reduced scale, on the line 3 3 of Fig. 1; and Fig. 4 is a view similar to Fig. 1 with the rotor and port-rings removed, the interior of the casing being shown in elevation.

Referring to the drawings, 1 indicates a turbine-shaft suitably journaled in the heads 2 of the turbine-casing and carrying two sets of disks 3, 4, 5, 6, and 7. An initial series of vanes 8 is secured between the adjacent end disks 3 3 of said two sets and intermediate of two lateral sets of annular series of vanes 9, 10, 11, and 12, secured between the several disks 4, 5, 6, and 7, said respective series of vanes circumscribing annular chambers 13, 14, 15, 16, and 17, formed in the corresponding disks. Two similar sets of arc-shaped members 18, 19, 20, 21, and 22 are secured within the shell 23 of the turbine-casing and provided with deflecting-passages, to be hereinafter described, the arc-shaped members 18, 19, and 20 of each set coöperating with the members 21 and 22 thereof to constitute cylinders. The abutting side faces of the two members 21 are provided with recesses 24, which register to form an arc-shaped steam-chest 25, extending angularly through somewhat less than one hundred and eighty degrees, as shown especially in Figs. 1, 2, and 4. A port-ring 26 is positioned within the arc-shaped members 21 21 and 18 18 and provided with a set of admission-ports 27, constructed to receive steam from the chest 25 and direct it at an efficient angle about a portion of the periphery of the annular series of vanes 8.

The two arc-shaped members 18 are provided with deflecting-passages 28, constructed to receive steam from a set of discharge-ports 29, formed in the port-ring 26, said deflecting-passages and set of discharge-ports preferably extending about the periphery of the annular series of vanes 8 through a greater number of degrees than that subtended by the set of admission-ports. (See Fig. 2.) An adjustable governing or cut-off ring 48 is rotatably mounted on the port-ring 26 and provided with a plurality of apertures 49 and 50, arranged to register, respectively, with the admission-ports 27 and discharge-ports 29 in said ring. Any suitable automatically-controlled or manually-operated means may be employed for shifting the governing-rings. I have illustrated for this purpose a worm 51, meshing with worm-teeth 52 on the governing-ring and provided with an actuating hand-wheel 53, external to the turbine-casing. This construction enables the steam admission and discharge of the vanes 9 to be regulated by a single adjustable means and provides a very efficient means for conveniently governing the turbine.

Each deflecting-passage 28 is constructed to laterally deflect the steam received from the discharge-ports 29 and is provided with a widened portion 30 for conducting such steam to the entrance-orifices of a set of admission-ports 31, formed in a curved port member 32 and constructed to direct the steam at an efficient angle inwardly through a portion of

the periphery of the corresponding annular series of vanes 9. The steam is discharged outwardly through a portion of the periphery of the annular series of vanes 9 into a deflecting-passage 34, formed in the arc-shaped member 21, said deflecting-passage being provided with a widened portion 35 for directing such discharge to a set of admission-ports 36 in a curved port member 37 and constructed to direct the steam at an efficient angle inwardly through a portion of the periphery of the corresponding annular series of vanes 10. The steam is discharged outwardly through a portion of the periphery of the annular series of vanes 10 into a deflecting-passage 39, formed in the arc-shaped member 19, said deflecting-passage being provided with a widened portion 40 for directing such discharge to a set of admission-ports 41 in a curved port member 42 and constructed to direct the steam at an efficient angle inwardly through a portion of the periphery of the corresponding annular series of vanes 11. The steam is discharged outwardly through a portion of the periphery of the annular series of vanes 11 into a deflecting-passage 44, formed in the arc-shaped member 22, said deflecting-passage being provided with a widened portion 45 for directing such discharge to a set of admission-ports 46, formed in a curved port member 47, surrounding the lower portion of the periphery of the corresponding annular series of vanes 12. Each arc-shaped member 20 is provided with a deflecting-passage 54, constructed to receive the exhaust from the vanes 12 and to deflect the same laterally into the interior of the turbine-casing, from which it can be discharged through suitable conduits 55 to the atmosphere or into a condenser.

It will be noted that the discharge from each annular series of vanes occurs through a portion of its periphery larger than that subtended by the admission-ports and that the vanes of the successive annular series are formed of progressively-increased width. This construction provides very satisfactorily for the expansion of the actuating-steam in passing through the successive series of vanes; but other arrangements could be employed for this purpose, if desired. Any desired number of the annular series of vanes 9, 10, 11, and 12 can, obviously, be provided with discharge-ports by a construction similar to that illustrated in reference to the annular series of vanes 8. In the construction illustrated the steam is directed upward through the five annular series of vanes 8, 10, 10, 12, and 12 and downward through the four annular series of vanes 9, 9, 11, and 11, thereby producing an unbalanced system in which there is an excess of upward pressure, tending to balance the weight of the rotor. It will be obvious that the deflecting-passages could be arranged to direct the steam upwardly through all or any desired number of the annular series of vanes for the purpose of increasing the effective upward pressure for balancing the rotor.

In the operation of my invention steam or other actuating medium is maintained at any desired pressure within the arc-shaped chest 25, from which it is directed by the admission-ports 27 against the vanes 8 and into the annular chamber 13 circumscribed thereby. The steam thus directed into the annular chamber passes through that portion of the annular series of vanes 9 which is subtended by the set of discharge-ports 29 and is discharged through the latter. As shown especially in Fig. 2, the aggregate area of the discharge-ports exceeds that of the admission-ports, and hence the pressure of the steam will be regenerated adjacent the inner edges of the vanes which are subtended by the set of exhaust-ports and which thereby act to materially reduce the cross-section of the steam-current flowing to said exhaust-ports. The steam discharged through the ports 29 into the deflecting-passages 28 is deflected laterally thereby in both directions and conducted by the widened portions 30 of said passages to the entrance-orifices of the set of admission-ports 31. The steam is directed by the admission-ports 31 against the vanes 9 and into the annular chamber 14 circumscribed thereby. The steam thus directed into the annular chamber 14 passes through that portion of the annular series of vanes which is subtended by the deflecting-passage 34. The steam is deflected by the passage 34 and conducted by the widened portion 35 thereof to the entrance-orifices of the set of admission-ports 36, which direct it against the vanes 10 and into the annular chamber 15 circumscribed thereby. The steam passes from the annular chamber through that portion of the annular series of vanes which is subtended by the deflecting-chamber 39. The deflecting-passage 39 conducts the steam to the set of admission-ports 41, by which it is directed through the annular series of vanes 11 and into the deflecting-passages 44, which conduct it to the final series of vanes 12, all in a manner similar to that just described.

I have illustrated and described a preferred embodiment of my invention; but obviously many modifications could be made therein within the spirit and scope of my invention.

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

1. In a turbine, the combination of a turbine-wheel, an annular series of vanes carried thereby, a set of admission-ports positioned along a portion of said annular series of vanes, and a set of discharge-ports positioned along a diametrically opposite portion of said annular series of vanes, substantially as described.

2. In a turbine, the combination of a turbine-wheel, an annular series of vanes carried

thereby, and a port-ring provided with a set of admission-ports and with a diametrically opposite set of discharge-ports, substantially as described.

3. In a turbine, the combination of a turbine-wheel, an annular series of vanes carried thereby, and a port-ring surrounding said annular series of vanes, said ring provided with a set of admission-ports and with a diametrically opposite set of discharge-ports, substantially as described.

4. In a turbine, the combination of a turbine-wheel, an annular series of vanes carried thereby, a set of admission-ports positioned along a portion of said annular series of vanes, a set of discharge-ports positioned along a diametrically opposite portion of said annular series of vanes, and a common governing means for said admission and discharge ports, substantially as described.

5. In a turbine, the combination of a turbine-wheel, an annular series of vanes carried thereby and circumscribing an inner annular chamber, a port-ring surrounding said annular series of vanes and provided with independent sets of admission-ports and discharge-ports, and a governing-ring adjustably mounted on said port-ring for controlling said sets of ports, substantially as described.

6. In a turbine, the combination of a turbine-wheel, an annular series of vanes carried thereby and circumscribing an inner annular chamber, a port-ring surrounding said annular series of vanes and provided with independent sets of admission-ports and discharge-ports, and a governing-ring adjustably mounted on said port-ring and provided with apertures for controlling the ports of said sets, substantially as described.

7. In a turbine, the combination of a turbine-wheel, an annular series of vanes carried thereby and circumscribing an inner annular chamber, a port-ring surrounding said annular series of vanes and provided with independent sets of admission-ports and discharge-ports, a governing-ring adjustably mounted on said port-ring for controlling said sets of ports, and means for adjusting said governing-ring, substantially as described.

8. In a turbine, the combination of a rotor, a plurality of annular series of vanes carried thereby and circumscribing inner annular chambers, a set of admission-ports positioned along a portion of each of said series of vanes, means for conducting the discharge from another portion of each of said series of vanes, and means for conducting the discharge from each series of vanes to the admission-ports of the next succeeding series of vanes, substantially as described.

9. In a turbine, the combination of a rotor, an initial series of vanes carried thereby, annular series of vanes carried by said rotor laterally to said initial series, means for conducting steam successively through different portions of said initial series of vanes, and means for subsequently conducting the steam successively through different portions of said lateral series of vanes, substantially as described.

10. In a turbine, the combination of a rotor, an initial series of vanes carried thereby, annular series of vanes carried by said rotor laterally to said initial series, means for conducting steam successively inwardly and outwardly through said initial series of vanes, and means for subsequently conducting the steam successively inwardly and outwardly through said lateral series of vanes, substantially as described.

11. In a turbine, the combination of a rotor, an initial series of vanes carried thereby, annular series of vanes carried by said rotor laterally to said initial series, a set of admission-ports positioned along a portion of each of said series of vanes, means for conducting the discharge from another portion of each of said series of vanes, and means for conducting the discharge from each series of vanes to the admission-ports of the next succeeding annular series of vanes, substantially as described.

12. In a turbine, the combination of a rotor, an initial series of vanes carried thereby, annular series of vanes carried by said rotor laterally to said initial series, means for conducting steam successively inwardly and outwardly through said initial series of vanes, means for subsequently conducting the steam successively inwardly and outwardly through said lateral series of vanes, and means for governing the inward and outward flow of steam from said initial series of vanes, substantially as described.

13. In a turbine, the combination of a rotor, an initial series of vanes carried thereby, annular series of vanes carried by said rotor laterally to said initial series, a set of admission-ports positioned along a portion of each of said series of vanes, means for conducting the discharge from another portion of each of said series of vanes, and means for conducting the discharge from each series of vanes to the admission-ports of the next succeeding series of vanes, and means for governing the admission and discharge of said initial series of vanes, substantially as described.

14. In a turbine, the combination of a rotor, an initial series of vanes carried thereby, annular series of vanes carried by said rotor laterally to said initial series, a set of admission-ports positioned along a portion of each of said series of vanes, means for conducting the discharge from another portion of each of said series of vanes, means for conducting the discharge from each series of vanes to the admission-ports of the next succeeding series of

vanes, and a common means for governing the admission and discharge of said initial series of vanes, substantially as described.

15. In a turbine, the combination of a rotor, an initial series of vanes carried thereby and circumscribing an inner annular chamber, annular series of vanes carried by said rotor laterally to said initial series and circumscribing inner annular chambers, a port-ring provided with admission and discharge ports for said initial series of vanes, means for conducting steam through successive portions of each of said lateral annular series of vanes, and a governing-ring adjustably mounted on the port-ring of the initial series of vanes for controlling the admission and discharge ports therein, substantially as described.

16. In a turbine, the combination of a rotor, an initial series of vanes carried thereby and circumscribing an inner annular chamber, annular series of vanes carried by said rotor laterally to said initial series and circumscribing inner annular chambers, a port-ring surrounding the outer periphery of each of said initial series of vanes and provided with a set of admission-ports and a set of discharge-ports, means for conducting steam through successive portions of each of said lateral series of vanes, and a governing-ring adjustably mounted on the port-ring of the initial series of vanes for controlling the admission and discharge ports therein, substantially as described.

17. In a turbine, the combination of a rotor, an initial series of vanes carried thereby and circumscribing an inner annular chamber, annular series of vanes carried by said rotor laterally to said initial series and circumscribing inner annular chambers, a port-ring surrounding the outer periphery of said initial series of vanes and provided with a set of admission-ports and a set of discharge-ports, means for conducting steam through successive portions of each of said lateral series of vanes, a governing-ring adjustably mounted on the port-ring of said initial series of vanes and provided with apertures adapted to register with the admission and discharge ports therein, and means for adjusting said governing-ring, substantially as described.

18. In a turbine, the combination of a rotor, an initial annular series of vanes carried thereby, a lateral set of annular series of vanes carried by said rotor at each side of said initial series, means for conducting steam successively through different portions of said initial series of vanes, means for conducting the steam from said initial series of vanes to said two lateral sets of vanes, and means for conducting the steam successively through different portions of the several series of vanes in the respective sets, substantially as described.

19. In a turbine, the combination of a rotor, an initial annular series of vanes carried thereby, a lateral set of annular series of vanes carried by said rotor at each side of said initial series, a port-ring surrounding said initial series of vanes and provided with a set of admission-ports and a set of discharge-ports, deflecting-passages for conducting steam from the discharge-ports of the initial series of vanes to the adjacent series of vanes in each of said two lateral sets of vanes, and deflecting-passages for conducting steam from said lateral series of vanes to the next succeeding series of vanes in the respective sets, substantially as described.

20. In a turbine, the combination of a casing, a rotor, an initial annular series of vanes carried thereby, a lateral set of annular series of vanes carried by said rotor at each side of said initial series, a port-ring surrounding said initial series of vanes and provided with a set of admission-ports and a set of discharge-ports, and arc-shaped members positioned in said casing and provided with deflecting-passages for conducting steam from the discharge-ports of the initial series of vanes to the adjacent series of vanes in each of said two lateral sets and for conducting steam from each of said lateral series of vanes to the next succeeding series of vanes in the respective sets, substantially as described.

21. In a turbine, the combination of a rotor, an initial annular series of vanes carried thereby, a lateral set of annular series of vanes carried by said rotor at each side of said initial series, means for conducting steam successively through different portions of said initial series of vanes, means for conducting the steam from said initial series of vanes to said two lateral sets of vanes, and means for governing the flow through said initial series of vanes, substantially as described.

22. In a turbine, the combination of a rotor, an initial annular series of vanes carried thereby, a lateral set of annular series of vanes carried by said rotor at each side of said initial series, means for conducting steam successively through different portions of said initial series of vanes, means for conducting the steam from said initial series of vanes to said two lateral sets of vanes, means for conducting the steam successively through different portions of the several series of vanes in the respective sets, and means for governing the steam-flow through said initial series of vanes, substantially as described.

23. In a turbine, the combination of a rotor, an initial annular series of vanes carried thereby, a lateral set of annular series of vanes carried by said rotor at each side of said initial series, a port-ring surrounding said initial series of vanes and provided with a set of admission-ports and a set of discharge-ports, deflecting-passages for conducting steam from the discharge-ports of the initial series of vanes to the adjacent series of vanes in each of said two lateral sets of vanes, deflecting-passages

for conducting steam from said lateral series of vanes to the next succeeding series of vanes in the respective sets, and means for governing the admission and discharge ports of said initial series of vanes, substantially as described.

24. In a turbine, the combination of a rotor, an initial series of vanes carried thereby and circumscribing an inner annular chamber, a lateral set of annular series of vanes carried by said rotor at each side of said initial series and circumscribing inner annular chambers, a port-ring surrounding said initial series of vanes and provided with a set of admission-ports and a set of discharge-ports, deflecting-passages for conducting steam from the discharge-ports of the initial series of vanes to the adjacent series of vanes in each of said two lateral sets of vanes, deflecting-passages for conducting steam from said lateral series of vanes to the next succeeding series of vanes in the respective sets, and a governing-ring adjustably mounted on the port-ring of said initial series of vanes for controlling the admission and discharge ports therein, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

RICHARD H. GOLDSBOROUGH.

Witnesses:

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EDWIN S. CLARKSON.