No. 789,760. PATENTED MAY 16, 1905.

H. ROESKE.

TURBINE.

APPLICATION FILED MAY 31, 1904.

3 SHEETS—SHEET 1.

fig. 1.

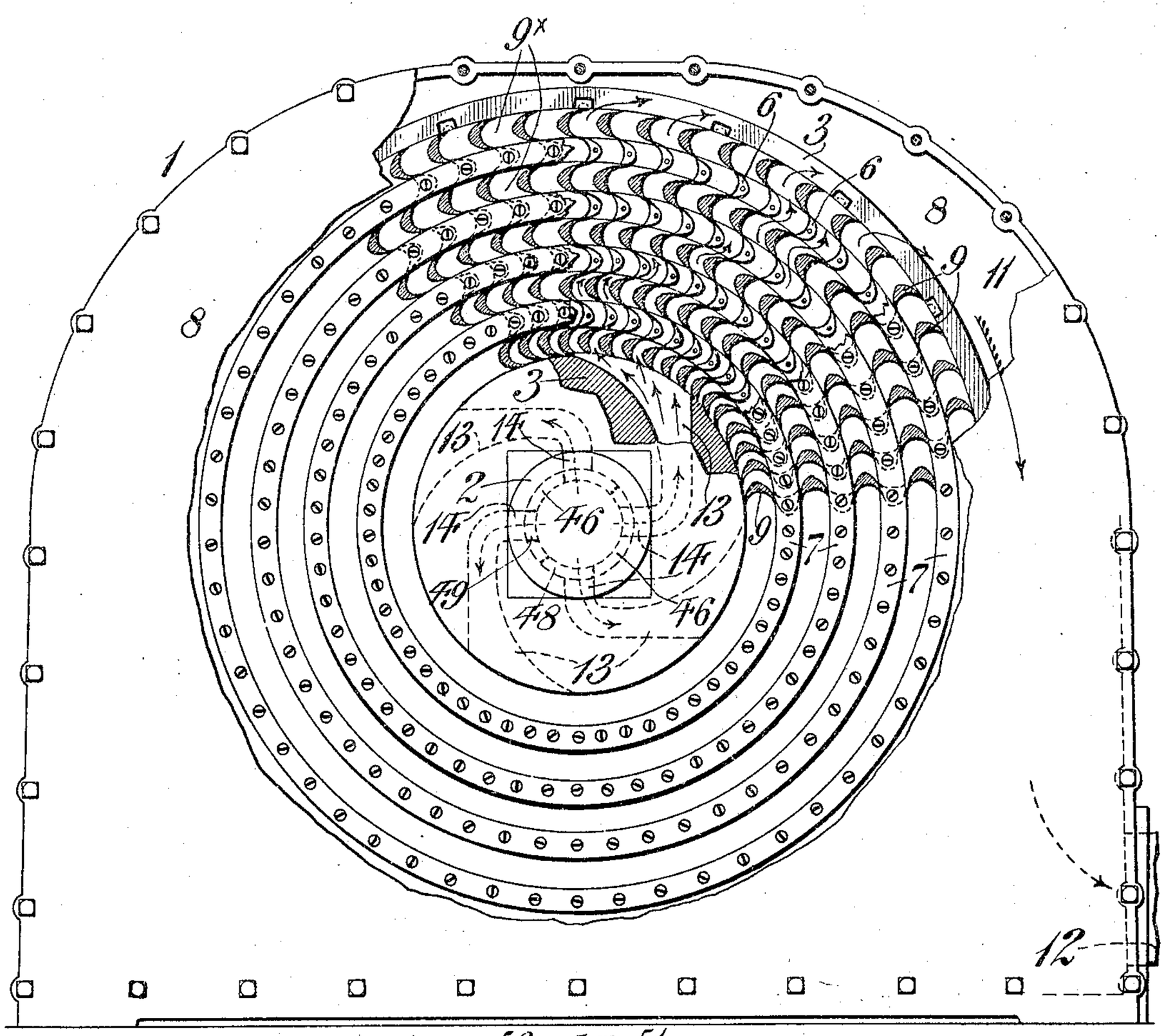
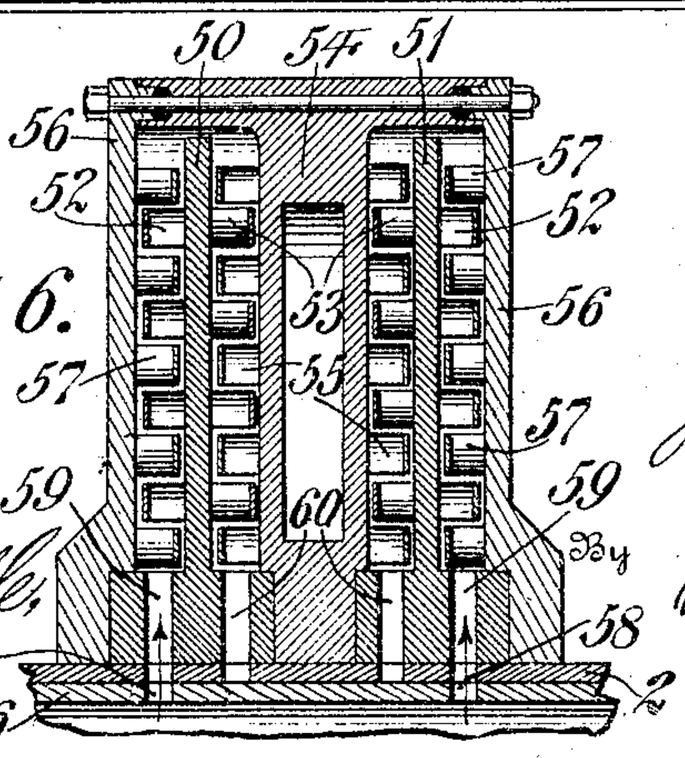


fig. 6.



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3 SHEETS—SHEET 2.

Fig. 2.

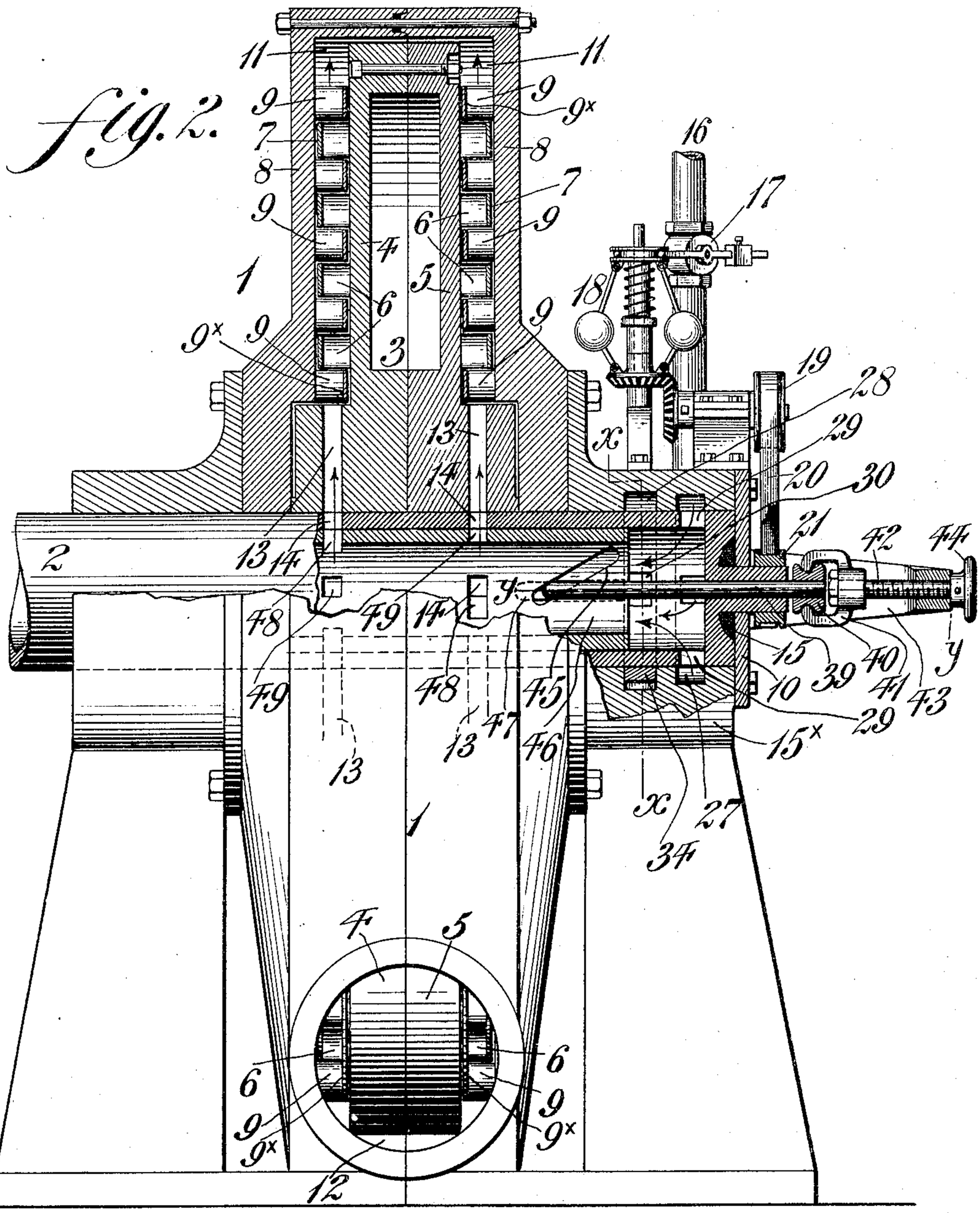
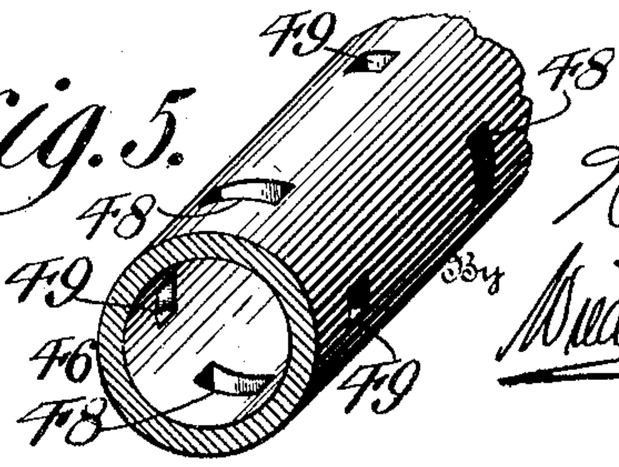


Fig. 5.



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3 SHEETS—SHEET 3.

Fig. 3.

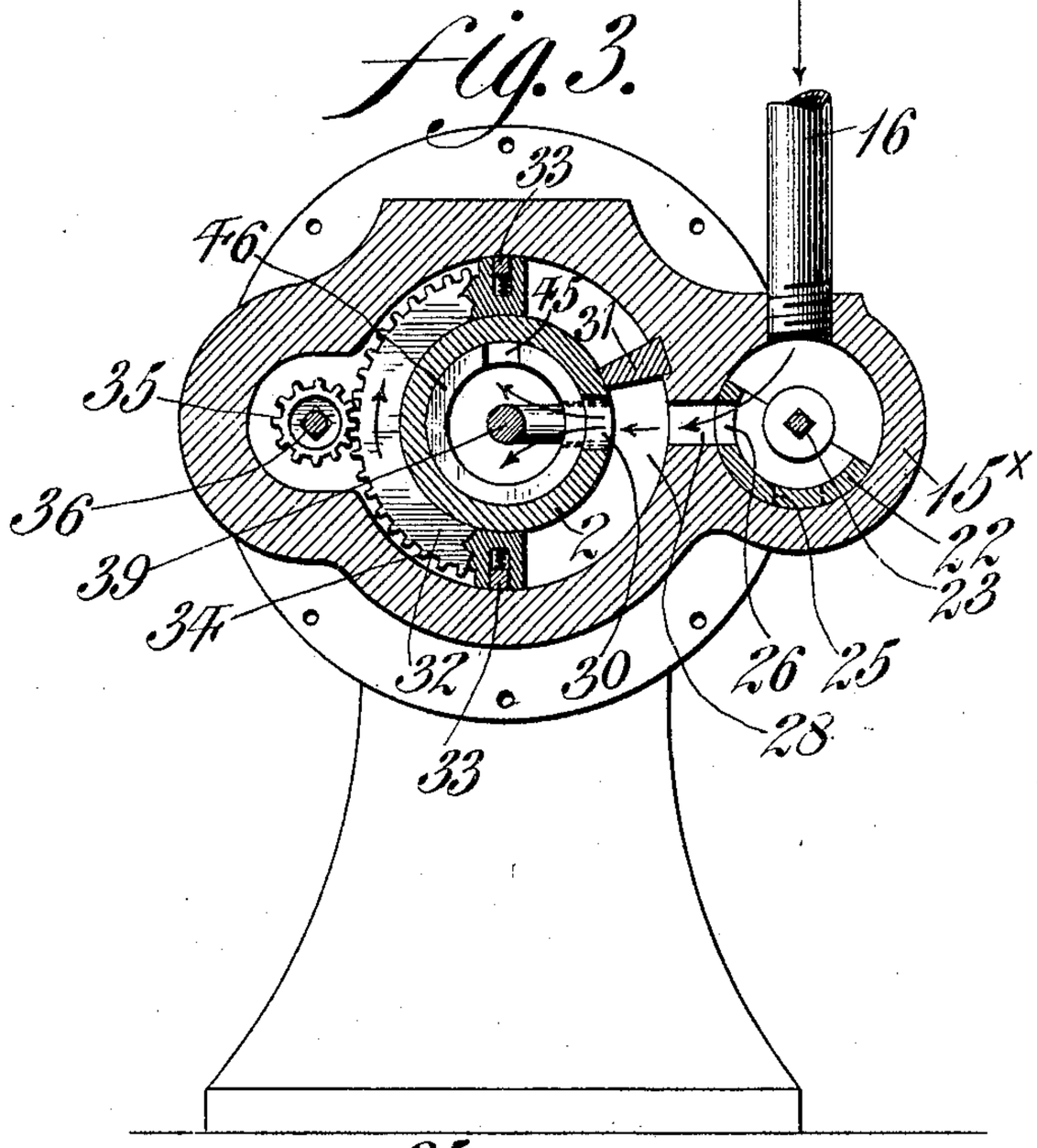
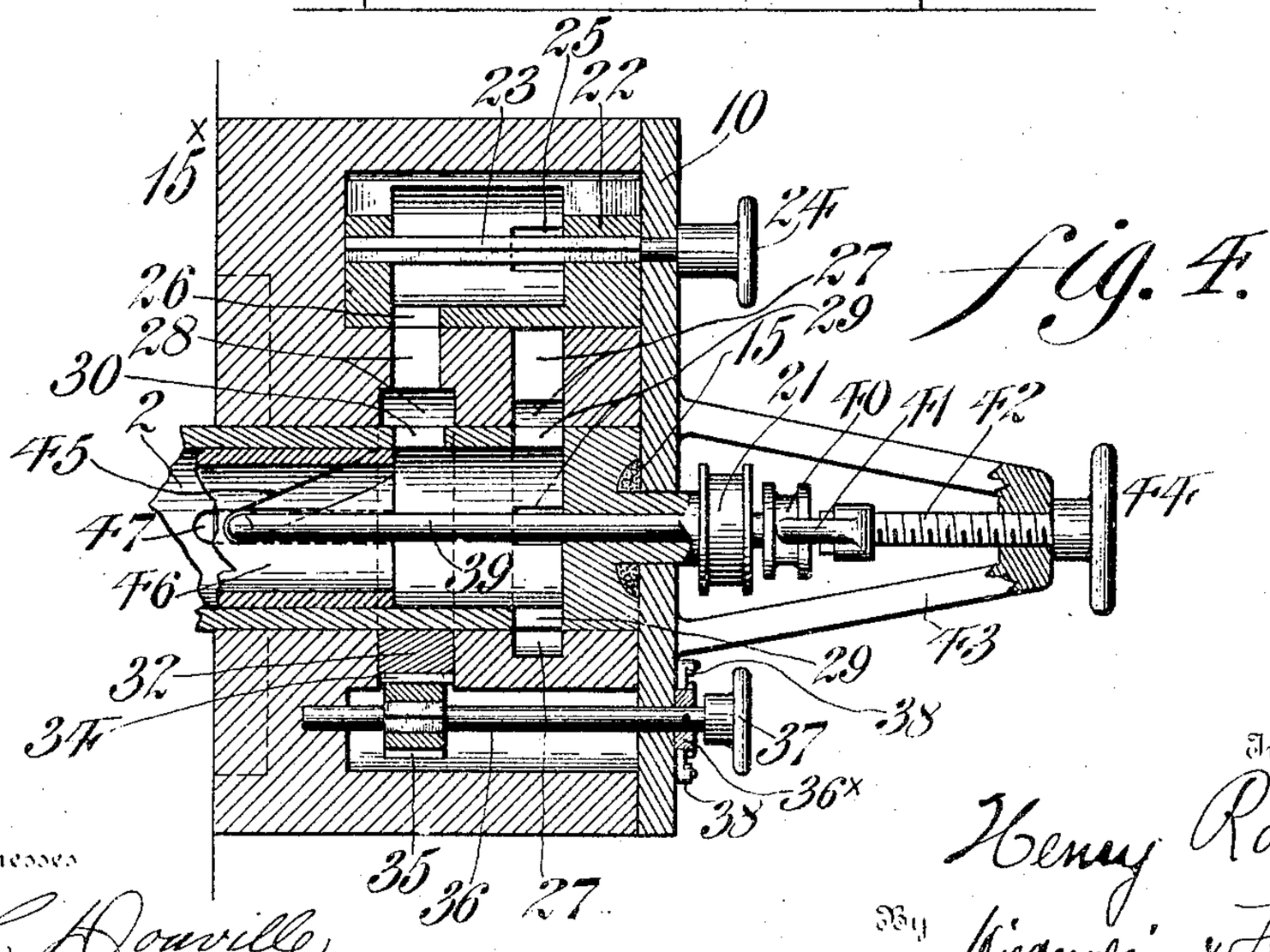


Fig. 4.



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UNITED STATES PATENT OFFICE.

HENRY ROESKE, OF PHILADELPHIA, PENNSYLVANIA.

TURBINE.

SPECIFICATION forming part of Letters Patent No. 789,760, dated May 16, 1905.

Application filed May 31, 1904. Serial No. 210,353.

To all whom it may concern:

Be it known that I, HENRY ROESKE, a citizen of the United States, residing in the city and county of Philadelphia, State of Pennsylvania, have invented a new and useful Improvement in Turbines, of which the following is a specification.

My invention relates to turbines in which steam or any expansive fluid is used as a source of motive power.

It provides improved means for utilizing the expansive force of the fluid for balancing the wheel, for admitting the fluid either continuously or intermittently, for throttling the admission, and for reversing the engine.

It further consists of novel features of construction, all as will be hereinafter fully set forth.

Figure 1 represents in side elevation a turbine-engine embodying my invention, a part of the casing being broken away to show the operative portion of the machine. Fig. 2 represents the device partly in vertical section and partly in end elevation. Fig. 3 is a transverse vertical section through the line *x x*, Fig. 2. Fig. 4 is a horizontal section through line *y y*, Fig. 2. Fig. 5 represents in fragmentary perspective a cut-off sleeve. Fig. 6 is a partial transverse vertical section of a modified form of the device.

Similar numerals of reference indicate corresponding parts in the figures.

Referring to Figs. 1 to 5 of the drawings, 1 designates a casing in which is mounted a suitable shaft 2, keyed to which is a wheel 3, shown as of similar right and left parts 4 and 5, on the sides of which are annular projecting rows of buckets 6. The outer faces of the buckets 6 may be connected by an annular band 7. The annular walls 8 of the casing 1 are provided with alternate annular projecting rows of buckets 9, connected by bands $9^{\times}$. The outer row of buckets open into an annular space 11, surrounding the wheel 3, and are provided with a discharge-opening 12 in the casing 1. Steam-ports 13 in the wheel 3 connect with lateral apertures 14 in the shaft 2 and lead to the inner row of buckets 9. As clearly shown in Fig. 1, the buckets 6 and 9 face in reverse direction and are of the same number in each of the annuli, so that the spaces between the buckets progressively increase from the inner to the outer row. I have shown five annuli 9 in the case and four annuli 6 at each side of the wheel 3; but it is evident that these numbers may be increased or diminished, as desired.

At one side of the casing 1 is a plate or closure 10, against which the end of the shaft 2 abuts. A packing 15 may be provided, if desired, to prevent leakage. Adjacent this end of the shaft is a valve-casing $15^{\times}$, through which steam is admitted by a pipe 16, in which may be placed a valve 17, controlled by a governor 18 of any desired form, the pulley 19 on the governor being connected by a belt 20 to a pulley 21 on the projecting end of the shaft. Within the chamber $15^{\times}$ is a valve 22, mounted on a shaft 23, which extends through the plate 10 and is provided exterior of the plate with a hand-wheel 24. In the valve 22 are two lateral apertures 25 and 26, opening, respectively, into ports 27 28 in the casing 1, which ports connect with apertures 29 and 30 in the tubular shaft 2. The port 27 is shown as extending entirely around the shaft 2, and, as shown, a plurality of apertures 29 is provided in the shaft communicating therewith. The port 28 is provided with an abutment 31, which bears against the shaft 2. In the port is a segmental valve 32, provided with packings 33 to insure a fluid-tight joint and having a segmental rack 34 meshing with the pinion 35 on the shaft 36, which projects through the plate 10 and is provided exterior thereof with a hand-wheel 37. A ratchet-wheel $36^{\times}$ on the shaft 36 engages with suitable pawls 38 on the plate 10 to prevent the improper rotation of the shaft. Passing through an axial aperture in the end of the shaft 2 is a rod 39, having at its outer end a grooved pulley 40, with which engages a yoke 41, mounted on a screw 42, which engages in a bracket 43, extending from the end of the engine, the screw 42 being provided with a hand-wheel 44. The inner end of the

rod 39 is laterally bent to pass through a diagonal slot 45 in a sleeve 46 within the shaft 2, and also to pass through a longitudinal slot 47 in the shaft 2 itself. The sleeve 46 is provided with apertures 48 and 49, adapted to register with the apertures 14 in the shaft 2. As shown, the apertures 48 and 49 are placed quadrantly on the sleeve 46, the apertures 48 being at least twice as wide as the apertures 49.

The operation is as follows: Steam or other fluid is admitted through the pipe 16 to the valve-chamber 15^x. When the valve 22 is turned to the position shown in Fig. 1 of the drawings, steam will be continuously admitted, through the port 27 and apertures 29, to the interior of the shaft 2. From thence it will pass through the apertures 48 and 49 of sleeve 46, through apertures 14 of the shaft 2, and through the ports 13 to the buckets 9 of the casing and 6 of the wheel. It will be seen in Fig. 1 that the ports 13 are curved and so formed as to admit the steam tangentially to the inner row of buckets 9 in the casing-wall 8. It is evident that by reason of the curved shape of the buckets 9 the steam will be deflected so as to impinge against the inner row of buckets 6 on the wheel. It is also evident that the steam in passing from the inner row of buckets on the wheel to the second row of buckets on the casing will react so as to give additional energy to the movement of the wheel and that these processes of impact and reaction will continue until the outer row of buckets 9 is reached, when the steam will be discharged into the casing and through the discharge-opening 12. It is obvious that the discharge may be to the air or to a condenser, as desired. It is also obvious that the steam is permitted to expand by reason of the progressive increase in the size of the spaces between the buckets, since, as shown in the drawings, the said buckets 6 and 9 are of equal number on each of the annuli and in addition the buckets from the inner to the outer annuli are on the same degree-line or in a line from a common center, and by reason of this expansion of the steam it will part with a very large portion of its kinetic energy, the effect of which is evident. The buckets, as shown in the drawings, are thicker at their middle than at their ends, thus making the passage-ways therebetween narrow at the middle in order to check the velocity of the steam at those points, while the divergent outlet-port of the one passage by meeting the divergent receiving-port of the next provides room for an expansion of the steam at the moment of such check, and as this expansion takes place on the line of motion of the wheel it offers compensation resulting in a more moderate speed of the turbine without loss of power. As the expansion from step to step calls for correspondingly more room, the buckets are of equal shape and size and an equal number of them are equally distanced on degree-lines common to all in the various annuli, as before stated. When it is desired to reduce the volume of steam supplied to the engine, the valve 22 may be set as shown in Fig. 4 of the drawings. In this case the port 27 will be closed and steam will pass into the port 28, with which, as shown, there connects but one aperture 30 in the shaft 2. At each rotation of the shaft steam will begin to enter this aperture as soon as it passes the abutment 31 and will continue to enter until the aperture 30 is closed by the segmental valve 32. It is obvious that by turning this valve by means of the hand-wheel 37 the arc of each revolution during which steam is admitted to the shaft may be widely varied. As the force of the steam against one side of the segmental valve 32 would tend to rotate it in the direction of the arrow, Fig. 3, I provide the pawls 38 on the plate 10 to prevent this improper rotation. Another method of throttling the steam admission, which may be used whether the admission is continuous or intermittent, is by means of the rotation of the sleeve 46 within the tubular shaft 2. It is obvious that this relative rotation may be produced by turning the hand-wheel 44, which acts, through the screw 42, yoke 41, and pulley 40, to move the shaft 39 longitudinally. The inner end of the shaft 39 engaging in the angularly-disposed notches 45 and 47 turns the sleeve 46 in the shaft 2 so as to throw the narrower ports 49 in the sleeve out of register with the ports 14 in the shaft, at the same time leaving the wider ports 48 in register. It will be noted from Fig. 5 that the ports 48 and 49 are so placed in the sleeve 46 that steam will be admitted alternatively to each side of the wheel 3. As shown, steam will be admitted to each side of the wheel twice in each revolution of the shaft. It is obvious that by setting the rod 39 in an intermediate position the apertures 49 in the sleeve will partially register with the apertures 14 in the shaft, so that an alternate considerable and minor supply of steam will be given to each side of the wheel 3.

In Fig. 6 of the drawings I have shown the wheel as having two radial plates 50 and 51, each of which is provided at each side with rows of buckets 52 and 53, the buckets facing in opposite directions. The casing is in this form of construction provided with a middle partition 54, provided with an annular series of buckets 55. The outer walls 56 of the casing have annular series of buckets 57. It will be seen from the drawings that the buckets 55 and 57 face in opposite directions, being adapted in each case to coöperate with the adjacent buckets in the wheel. By proper ports 58 in the sleeve 46 or by any other well-known means, which it is not necessary to illustrate or explain, steam may be alterna-

tively admitted through the passages 59, as shown by the arrow, to the buckets between the walls 50 of the wheel and the outer walls 56 of the casing or between the inner wall 54 of the casing and the walls 51 of the wheels. It is obvious that the effect will be to rotate the wheel in opposite directions, thus securing a reversing turbine which is at the same time balanced by the equal admission of steam on both sides of a central partition.

In turbines of this character with which I am acquainted the annuli of stationary and movable buckets have been made adjacent to and upon the periphery of the wheel. By disposing my buckets laterally on the wheel, as shown, and having the same of equal size and number I am able to progressively increase the space between the buckets, (see Fig. 1,) whereby steam may be expanded practically to exhaust-pressure, thus greatly reducing the speed of the device. In addition I am able to place a large number of annuli of buckets on the wheel without making it unduly wide or clumsy. In addition it will be noted that the wheel is perfectly balanced, so that no end thrust or side pressure is produced, and that a given horse-power may be developed from a far lighter and smaller wheel.

It will be evident that various changes may be made by those skilled in the art which may come within the scope of my invention, and I do not, therefore, desire to be limited in every instance to the exact construction herein shown and described.

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

1. A turbine comprising a rotary wheel having annuli of laterally-disposed projecting buckets of approximately semi-elliptical form, the buckets of each annuli being arranged on the same degree-line and each of said annuli having an equal number of buckets and means for impinging a motive fluid against said buckets.

2. A turbine, comprising a rotary wheel having annuli of laterally-disposed projecting buckets of approximately semi-elliptical form integral therewith, said buckets being equal in number and of equal size on each of said annuli and being arranged on the same degree-line, whereby the spaces between said buckets increase in proportion to the distance from the center, and means for impinging a motive fluid against said buckets successively from the inner to the outer annulus.

3. A turbine comprising a rotary wheel having annuli of laterally-disposed projecting buckets of approximately semi-elliptical form, said buckets on each annuli being on the same degree-line and a casing inclosing said wheel and having annuli of stationary buckets alternating with annuli of buckets on the wheel and operative to direct the motive fluid thereagainst, said stationary buckets being arranged on each annuli in the same degree-line.

4. A turbine comprising a rotary wheel having annuli of laterally-disposed projecting buckets of approximately semi-elliptical form on each of its sides, said buckets being arranged on the same degree-line and means for impinging a motive fluid against said buckets.

5. A turbine comprising a rotary wheel having annuli of laterally-disposed projecting buckets of approximately semi-elliptical form on each of its sides, said buckets being arranged on the same degree-line and a casing inclosing said wheel and having annuli of stationary buckets alternating with the annuli of buckets on the wheel and operative to direct the motive fluid thereagainst, said stationary buckets being arranged on the same degree-line.

6. A turbine comprising a tubular shaft, a wheel rotatable with said shaft having annuli of laterally-disposed buckets, said buckets being arranged on the same degree-line and a casing inclosing said wheel and having annuli of stationary buckets alternating with the annuli of buckets on the wheel and operative to direct a motive fluid thereagainst, said stationary buckets being arranged on the same degree-line and said shaft and said wheel having ports for admitting a motive fluid to impinge against said buckets, and means for admitting such motive fluid to said shaft.

7. A turbine comprising a rotary wheel having integral annuli of equally-sized and laterally-disposed projecting buckets of semi-elliptical form with the minor axis concaved on each of its sides, said buckets being equal in number on each of said annuli, facing on one side in opposite direction to the other and being arranged on the same degree-lines, and means for alternatively impinging a motive fluid against the buckets facing in each direction, whereby said wheel may be rotated in either direction.

8. A turbine comprising a rotary wheel having a plurality of radially-extending portions provided with integral annulus of equally-sized and laterally-disposed projecting buckets of semi-elliptical form with the minor axis concaved, the buckets on opposite sides of each of said radially-extending portions being equal in number on each of said annuli and arranged on the same degree-lines to face in opposite directions and a casing having stationary walls at each side of each of said radially-extending portions provided with buckets as described and adapted to coöperate with the adjacent buckets on said wheel and to direct the motive fluid thereagainst.

9. A turbine comprising a rotary wheel having a plurality of circular walls provided with

annuli of laterally-disposed buckets, the buckets on opposite sides of said walls facing in opposite directions, a casing having exterior walls and a wall intermediate said circular walls, all said walls having annuli of buckets alternating with the annuli of buckets on the wheel and operative to direct a motive fluid thereagainst, a tubular shaft on which said wheel is mounted, said wheel and said shaft having ports for admitting the motive fluid to impinge against said buckets, means for controlling said ports and means for admitting such motive fluid to said shaft.

10. In a rotary engine, a rotary tubular shaft, means for admitting a motive fluid either continuously or intermittently to said shaft and separate manually-operative means for controlling the volume of such motive fluid admitted by such intermittent means.

11. In a rotary engine, a rotary tubular shaft having a lateral port for the admission of a motive fluid and manually-adjustable rotatable means for closing said port during a portion of the rotation of said shaft.

12. In a rotary engine, a rotary tubular shaft having a lateral port for the admission of a motive fluid, a casing providing a chamber around said shaft into which said port opens and a manually-operative segmental valve for adjusting the arc of said chamber.

13. In a rotary engine, a rotary tubular shaft having a lateral port for the admission of a motive fluid, a casing providing a chamber around said shaft into which said port opens, a manually-operative segmental valve for adjusting the arc of said chamber and means for locking said valve in position.

14. In a rotary engine, a rotary tubular shaft having a lateral port for the admission of motive fluid, a casing providing a chamber around said shaft into which said port opens, a segmental valve in said chamber provided with gear-teeth, a pinion meshing with said teeth, a shaft on which said pinion is mounted extending out of said casing and a pawl and ratchet on said shaft for locking said valve in position.

15. In a rotary engine, a tubular shaft having a lateral port for the emission of a motive fluid, a sleeve within said shaft mounted to rotate therein and rotating therewith having a lateral port normally registering with the port in said shaft and manually-controllable means extending out of the engine for rotating said sleeve and thus adjusting the register of the ports in said shaft and said sleeve.

16. In a rotary engine, a tubular shaft having a lateral port for the emission of a motive fluid, a sleeve in said shaft rotating therewith having a port normally registering with the port in said shaft, adjacent slots in said shaft and said sleeve disposed at an angle with each other, a rod extending out of the engine rotatable with said shaft and engaging in both said slots and manually-operative means for adjusting said rod whereby the register of the ports in said shaft and said sleeve may be adjusted.

17. In a rotary engine, a rotary tubular shaft having lateral ports for the emission of a motive fluid, a sleeve in said shaft and rotating therewith having lateral ports registering with the ports in said shaft, certain of said ports in either said shaft or said sleeve being of greater width than the others, and means extending out of the engine for relatively moving said sleeve in said shaft, whereby certain of said ports are moved out of register.

18. A turbine comprising a rotary wheel having annuli of laterally-disposed buckets, the buckets being thicker at their middle part and in each annuli arranged on the same degree-line and each of said annuli having an equal number of buckets and means for impinging a motive fluid against said buckets.

19. A turbine comprising a rotary wheel having integral annuli of equally-sized and laterally-disposed projecting buckets of semi-elliptical form with the minor axis concaved, said buckets being equal in number on each of said annuli and being arranged on the same degree-lines, whereby the spaces between said buckets increase in proportion to the distance from the center and means for impinging a motive fluid against said buckets successively from the inner to the outer annulus.

20. A turbine comprising a rotary wheel having integral annuli of equally-sized and laterally-disposed projecting buckets of semi-elliptical form with the minor axis concaved, said buckets being equal in number on each of said annuli and being arranged on the same degree-lines and a casing inclosing said wheel and having annuli of stationary buckets alternating with annuli of buckets on the wheel and operative to direct a motive fluid thereagainst, said stationary buckets being equal in form, size and number to those on the wheel and being arranged on the same degree-lines.

21. A turbine comprising a rotary wheel having integral annuli of equally-sized and laterally-disposed projecting buckets of semi-elliptical form with the minor axis concaved on each of its sides, said buckets being equal in number on each of said annuli and arranged on the same degree-lines and means for impinging a motive fluid against said buckets.

22. A turbine comprising a rotary wheel having integral annuli of equally sized and formed and laterally-disposed projecting buckets on each of its sides, said buckets being equal in number on each of said annuli and arranged on the same degree-lines and a casing inclosing said wheel and having integral annuli of stationary buckets alternating with the annulus of the wheel and operative to direct the motive fluid thereagainst, said

stationary buckets being equal in form, size and number to those on the wheel and arranged on the same degree-lines.

23. In a turbine of the radial-flow type, having annuli of projecting buckets of approximately semi-elliptical form, with the minor axis concaved, the number of buckets on the annulus of the movable element being equal to the number of buckets on the annulus of the stationary element, the concaved faces of the movable and stationary buckets being one above each other on degree-lines common to both.

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