No. 715,410. Patented Dec. 9, 1902.

J. H. K. McCOLLUM.

TURBINE ENGINE.

(Application filed Apr. 12, 1902.)

(No Model.)

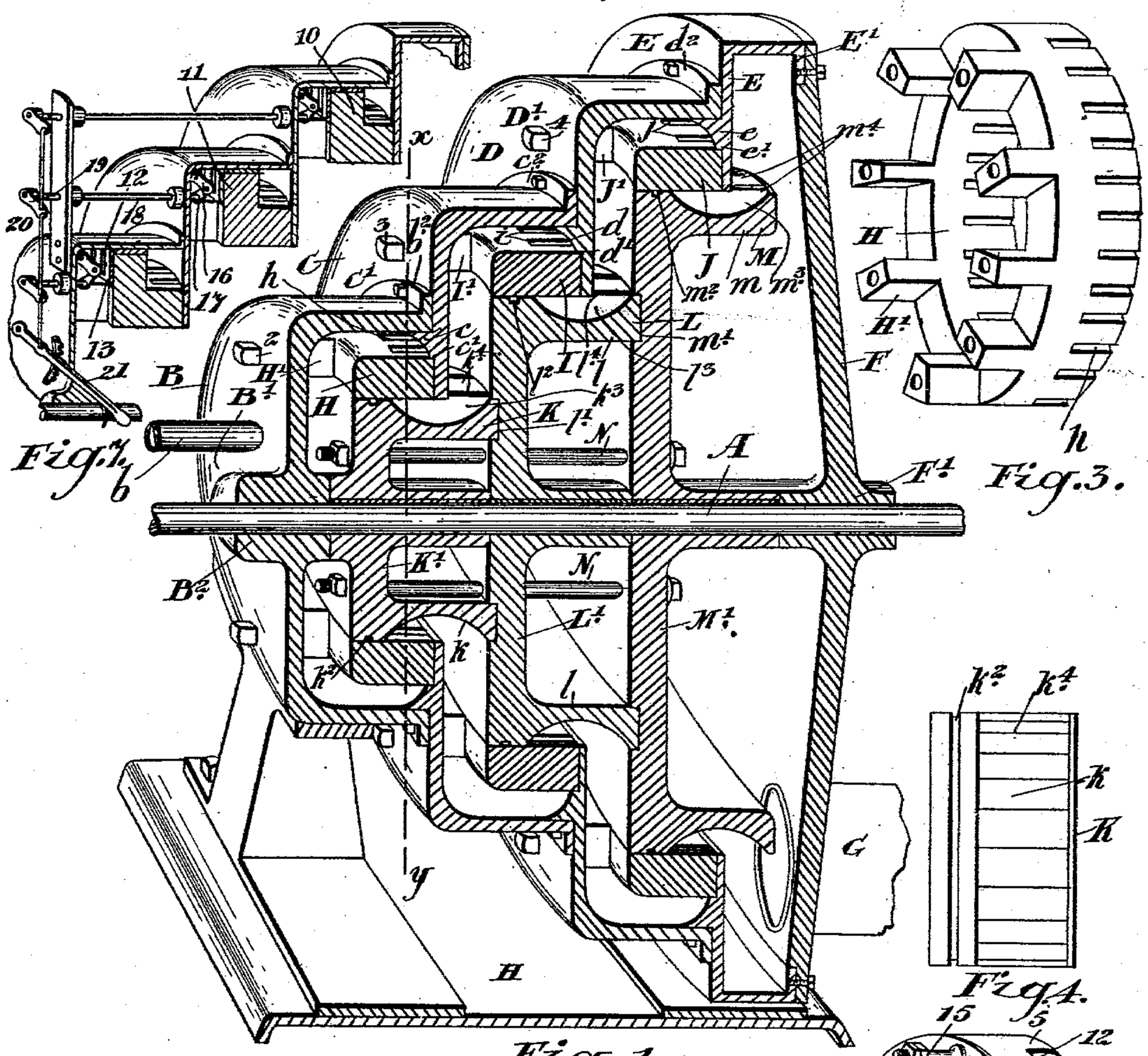

Fig. 1.

Fig. 3.

Fig. 4.

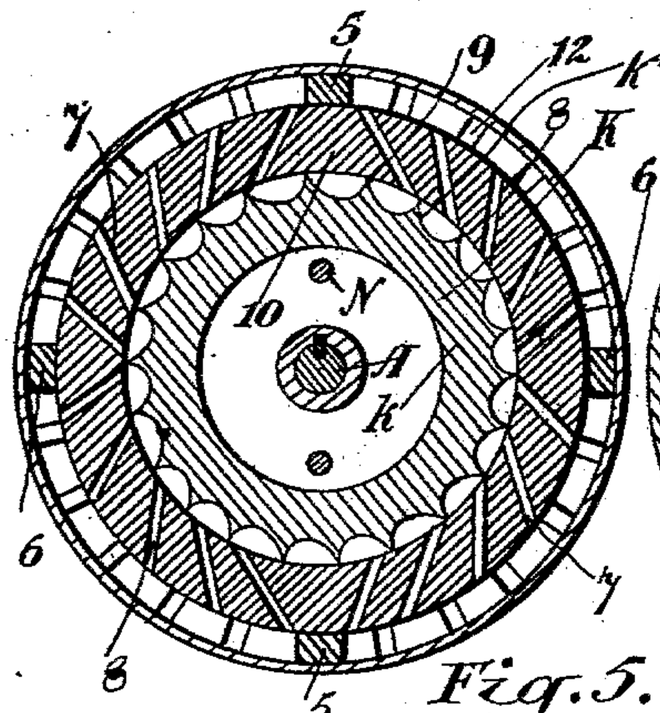

Fig. 5.

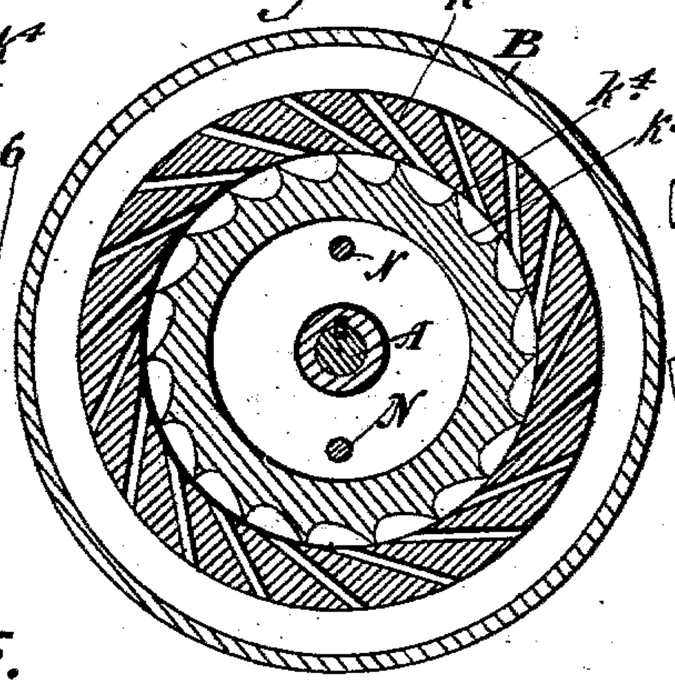

Fig. 2.

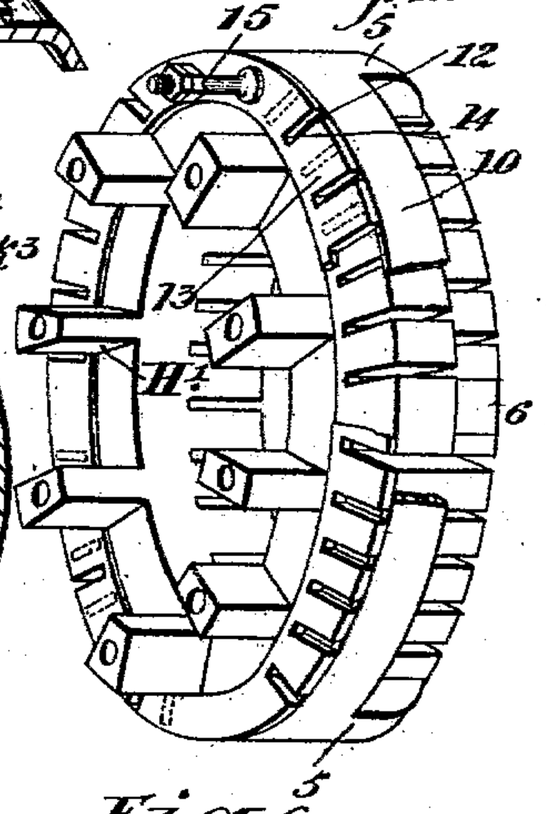

Fig. 6.

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UNITED STATES PATENT OFFICE.

JAMES HARRY KEIGHLY McCOLLUM, OF TORONTO, CANADA, ASSIGNOR OF ONE-HALF TO JOHN WYCLIFFE LOWES FOSTER, OF TORONTO, CANADA.

TURBINE-ENGINE.

SPECIFICATION forming part of Letters Patent No. 715,410, dated December 9, 1902.

Application filed April 12, 1902. Serial No. 102,571. (No model.)

To all whom it may concern:

Be it known that I, JAMES HARRY KEIGHLY MCCOLLUM, electrician, of the city of Toronto, in the county of York, in the Province of Ontario, Canada, have invented certain new and useful Improvements in Turbine-Engines, of which the following is a specification.

My invention relates to improvements in turbine-engines; and the object of the invention is to devise a rigid, strong, and cheaply-constructed engine of this class in which there will be no interior packing or wearing parts liable to wear out or prevent the use of highly superheated steam, in which any reasonable amount of end play may be allowed without being detrimental to the working of the engine or liable to cause accident or destruction to any of the parts thereof, in which the turbine may be reversed when required, and in which there will be no danger of any appreciable fan action, which is detrimental to the efficiency of the engine; and it consists, essentially, of a turbine comprising a substantially step-like cone-shaped casing having an inlet for the steam at the smaller end and an exhaust at the opposite end and suitably-supported rings concentrically secured to the interior of the casing and provided with steam-directing ports set at an angle to the radial line and corresponding coacting turbines or wheels substantially opposite each ring, having provided in its periphery pockets which form vanes to receive the force of the steam through the directing-ports in the rings, the engine being otherwise constructed so that the steam will pass through the engine in easy-flowing curves, and the wheels being so arranged in relation to the rings as to rotate close to them, the parts being otherwise arranged and constructed as hereinafter more particularly explained.

Figure 1 is a sectional perspective view of my improved turbine-engine. Fig. 2 is an end section made on the line $x\,y$, Fig. 1. Fig. 3 is a perspective view of the ring containing the directing-ports. Fig. 4 is a side view of one of my wheels. Fig. 5 is a sectional view showing the form of rings and wheel necessary for a reversing-turbine. Fig. 6 is a perspective detail showing the construction of the ring and reversing ring-valve attached thereto. Fig. 7 is a perspective detail of a portion of the casing of a turbine-engine, showing one means for actuating the reversing ring-valves.

In the drawings like characters of reference indicate corresponding parts in each figure.

A is the main shaft of the engine.

B, C, D, and E are the several casings, arranged in the form of a step-like truncated cone. The casing B has an end wall B′, into which extends the inlet-pipe *b* for the admission of steam.

B^2 is a central bearing for the shaft, formed in the center of the wall B′.

The casings B, C, D, and E are concentric to the shaft. The casing E is provided with a flange E′, to which is secured the end wall F, in the center of which is formed the end bearing F′ for the shaft A.

G is the exhaust-pipe, which communicates with the interior of the casing and extends outwardly from the wall F.

H is the bed of the engine, on which the casing is suitably supported and secured.

The casings C, D, and E are provided, respectively, with annular flanges *c*, *d*, and *e*, forming part of the end walls C′, D′, and E′, and annular shoulders *c*′, *d*′, and *e*′, formed on the same end walls. The flanges *c*, *d*, and *e*, as well as the shoulders *c*′, *d*′, and *e*′, are concentric to the shaft. The casings B, C, and D are arranged so that their peripheries are also concentric to the shaft and are provided with outwardly-extending flanges b^2, c^2, and d^2, whereby they are secured by suitable bolts to the walls C′, D′, and E′, respectively, peripherally outside and abutting the flanges *c*, *d*, and *e*, respectively, so that it will be understood that the casings likewise are, as hereinbefore described, concentric to the shaft. Within the casings and abutting the shoulders *c*′, *d*′, and *e*′ are rings H, I, and J, which are secured in position by bolts 2, 3, and 4 passing through the casings B, C, and D, respectively, into the forwardly-extending lugs H′, I′, and J′. The rings H, I, and J are provided with directing-ports *h*, *i*, and *j*, set obliquely to the radial line to the center of the shaft. The directing-ports *h*, *i*, and *j* are preferably (although not shown in the drawings) provided with rounded entrances to pro-

vide for the easy admission of the steam through the same.

K, L, and M are the turbines or wheels, which are provided with suitable hubs and are suitably secured or keyed to the shaft. The driving-wheels are provided with end disks K′, L′, and M′, supporting the rims *k*, *l*, and *m*. The end of the rim *k* fits into an annular groove *l′* in the disk L′ of the wheel L, and the end of the rim *l* fits into an annular groove *m′* in the disk M′ of the wheel M. The three wheels are preferably bolted together through their disks by means of the bolts N.

It will now be seen that there are annular spaces formed outside and in front of the wheels K, L, and M. Each of the peripheries *k*, *l*, and *m* of their respective wheels K, L, and M are provided on their rims with small annular grooves k^2, l^2, and m^2, which are designed to form a water or steam packing between the wheels K, L, and M and the rings H, I, and J, respectively. The peripheries *k*, *l*, and *m* are each provided with a plurality of pockets k^3, l^3, and m^3, preferably longitudinally arc-shaped around their entire peripheries and converging peripherally at the sides to a point so as to form walls, teeth, or vanes k^4, l^4, and m^4, and one side of which is preferably an easy-flowing curve, as indicated in Fig. 2, and the other side a quick curve. The steam is admitted through the pipe *b* and passes through the annular space within the casing B into the directing-ports *h*, where the steam passes obliquely against the vanes k^4. The steam then passes through the annular space in the casing C and the directing-ports *i* against the vanes l^4 into the annular space inside the casing D, whence the continuously-expanded steam passes through the directing-ports *j* against the vanes m^4, then into the casing E, whence the exhaust passes out through the port or pipe G.

The wheel M, if found desirable, may have a rear disk secured to it, so as to prevent the admission of the steam within the rim.

In my construction of engine it will be noticed that the rings containing the directing-ports and the rims of the wheel are all so formed that they may be easily cast and milled, so as to form the ports and the pockets forming the vanes of the most desired form. It will also be noticed that in all the rims of the wheels or turbines the vanes are formed entirely within the exterior periphery of the rim of the wheel, and consequently there will be no fan action, as would be the case were the vanes provided peripherally outside the rim. It will also be seen that the annular spaces formed around the wheels are so constructed as to form easy-flowing curves for the steam to pass through. The form shown may not be the most desired form and may be altered to present even more easy flowing curves than shown without departing from the spirit of my invention.

As has been before described, the front portions of the rims of the wheels are provided with annular grooves, and it will also be noticed that the wheels fit closely to their respective rings containing the directing-ports. It will thus be seen that the steam itself or condensed steam will form a perfect packing, so that the live steam is directed in its proper course through the annular spaces as it passes through the turbine.

In Figs. 5, 6, and 7 I show the form of ring and casing necessary to produce a reversing turbine-engine. It will be noticed that each casing is divided into an equal number of compartments by longitudinal walls 5 5 and 6 6, in this case the number of compartments being four. The directing-ports 7 and 8 in the ring in this instance are half slanted in one direction and half in the opposite direction, the directing-ports 7 opposite each other being slanted in the one direction and the directing-ports 8 in the opposite direction. The vanes 9 are formed so that each wall is of a suitable curve. The rings 10, containing the ports 7 and 8, are provided with an annular projection 11, which has end openings 12, which are controlled by a reversing ring-valve 13, provided with a corresponding number of openings 14 to the end openings 12. A pin 15 is provided on the ring 13, whereby the ring is manipulated or given a circular movement, so as to control one set of ports 7 or the other ports 8, as may be desired, this of course depending upon which way it is desired to drive the turbine. Each pin is connected by a link 16 to an arm 17 on a spindle 18, which passes through the walls of the casing and is suitably journaled and provided at its front end with arms 19, which are connected by the rods 20, to which is connected at the bottom the operating-lever 21. (See Fig. 6.) It will be seen by manipulating the lever 21 all the ring-valves 14 may be simultaneously moved so as to throw either desired set of ports 7 or 8 open for the admission of steam.

From what has now been described it will be readily understood that not only may my turbine be made to drive in one direction, but it may with equal facility be made to reverse, which is an important desideratum in engines of this class.

Among the advantages derived from an engine constructed in accordance with my invention is that there is no interior packing or wearing parts to wear or prevent the use of highly-superheated steam, that all the parts are rigid, strong, and of simple mechanical construction, capable of being made cheaply and not requiring expert fitting and placing together, as is the case in most turbines. End play, it will also be understood, will be no detriment within reasonable limits and cannot cause accident or destruction. All the curves are flowing curves, and the vanes are so formed that the skin friction is reduced to a minimum; besides, there is no fan action, as is the case in other forms of turbines of which I am aware. All steam passage-ways will be

preferably polished to minimize skin friction. From the construction of my turbine also it will be seen that by placing the turbines back to back all end thrust can be avoided.

As before stated, reversing-engines may be built according to my invention where desired, as for marine, locomotive, and other such uses.

Although I show the rings H, I, and J as secured to the front walls of the casings by means of bolts extending through forwardly-extending lugs on the rings, I may find it preferable to dispense with these lugs altogether and secure the rings to the inwardly-extending portion of the front walls of the casings to the rear of the rings. In this way it will be seen that if no lugs or bolts are provided there would be no impediment to cause skin friction or eddying of the steam in the annular spaces.

Although in Fig. 5 I show portion of the directing-ports inclined half in one direction and half in the other, it will of course be understood that any desired number of the directing-ports may be used for forward rotation and the remainder for the reverse, and in this case, of course, the compartments divided by the longitudinal walls 5 5 and 6 6 would be changed correspondingly.

It will be noticed in the drawings that the lugs H′, I′, and J′ are of the same thickness as the rings; but it will of course be understood that I do not wish to limit myself to making these lugs of the same thickness, as I may find it preferable to extend them inward radially, so that they will act in such a manner as to give greater reaction of the steam on the wheel-buckets when leaving the same. It will also be understood from this specification that the ring-valves which I describe may be varied in form if I find it necessary, so that when manipulated by a wheel-governor or otherwise more or less of the ports may be closed off, and thereby control the amount of steam admitted, and thus provide for variable loads.

I should mention that I have shown in the drawings enlarged flanges rounded at the inner side, so as to present an easy-flowing curve, whereby the steam is directed into the ports in the rings.

Although I have shown the casing and the wheels arranged in truncated-cone step-like fashion, it will of course be understood that I may make the casing of the same diameter throughout, and also the wheels.

What I claim as my invention is—

1. In a steam turbine-engine, the combination with the shaft and the casing having the periphery thereof concentric to the shaft, the inclosed ends in which the bearings for the shaft are formed and the steam inlet and exhaust at opposite ends of the casing, of the wheels suitably secured to the shaft and provided with substantially arc-shaped pockets, the walls of which form vanes substantially within the peripheries of the rims, and rings concentrically secured within the casing and fitting closely the forward portion of the rims of the wheels and having obliquely-set directing-ports located opposite the front portion of the vanes on the rims of the wheel, such rings and wheels forming with the casing steam-chambers to the front of each of the wheels and to the outside of the rings and rims of the wheels as and for the purpose specified.

2. In a turbine-engine the combination with the casing and shaft journaled therein, of a stationary ring within said casing having a plurality of oblique ports located on one edge portion, leaving the other edge portion intact, and a wheel secured to the shaft and having one portion of its periphery provided with arc-shaped buckets in opposition to said ports and having the remaining portion of its periphery located in proximity to the intact inner face of the ring, substantially as described.

3. In a turbine-engine the combination with the casing comprising a plurality of circular steam-chambers of increasing diameter and an inwardly-extending concentric flange partially separating each chamber, of a shaft journaled in said casing, a ring within each chamber secured to said flange and having a plurality of inclined steam-ports adjacent to the flange, and a wheel secured to the shaft in each chamber, each wheel having a portion of its periphery rotating steam-tight within the ring and having the remaining portion provided with pockets or vanes located partly within the ring in line with the ports and partly in the succeeding chamber, substantially as described.

4. In a turbine-engine, the combination with the wheels secured on the shaft and arranged in cone-frustum-shape step-like fashion, of the cone-frustum-shape casing comprising sections arranged in cone-frustum-shape step-like fashion, each section being suitably secured to the adjacent section, and each section after the first being provided with forwardly-extending concentric flanges rounded on the inside on which the inner periphery of each section fits as and for the purpose specified.

5. In a turbine-engine, the combination with the wheels secured on the shaft and arranged in cone-frustum-shape step-like fashion, of the cone-frustum-shape casing comprising sections arranged in cone-frustum-shape step-like fashion, each section being suitably secured to the adjacent section, and the inwardly-extending portion of each section within the casing being provided with an annular shoulder, and the ring provided with directing-ports and secured in position within the shoulder formed in the inwardly-extending portion of each section except the first, such ring closely fitting the rim of the wheels as shown and for the purpose specified.

6. In a turbine-engine, the combination with the wheels secured on the shaft and ar-

ranged in cone-frustum-shape step-like fashion, of the cone-frustum-shape casing comprising sections arranged in cone-frustum-shape step-like fashion, each section being suitably secured to the inwardly-extending portion of the adjacent section, and rings containing directing-ports arranged, so that their inner peripheries are concentric to the inner edge of the inwardly-extending portions of the section and provided with forwardly-extending lugs or projections designed to abut the inwardly-extending portion of each section, and bolts extending through the inwardly-extending portions or walls of the sections into such lugs as and for the purpose specified.

7. In a turbine-engine, the combination with the wheel and shaft, of the ring containing the directing-ports portion set obliquely one way and the remainder the reverse way as to direction of rotation and provided with an outwardly-extending flange and ring surrounding such flange, and openings extending through the flange, longitudinal walls separating the sets of openings leading to the directing-ports, and the reversing ring-valves provided with corresponding openings, so set that some of the openings are open, so as to propel the wheel in one direction and the remainder closed as and for the purpose specified.

8. In a turbine-engine, the combination with the wheel and shaft, of the ring containing the directing-ports portion set obliquely one way and the remainder the reverse way as to direction of rotation and provided with an outwardly-extending flange, and ring surrounding such flange, and openings extending through the flange, longitudinal walls separating the sets of openings leading to the directing-ports, the reversing ring-valve provided with corresponding openings so set that some of the openings are open, so as to propel the wheel in one direction and the remainder are closed, a pin secured to the reversing-ring, a link connected to the pin, an arm connected to the link on the adjacent rod and means for rotating such rod, so as to change the position of the ring and consequently the direction of rotation as and for the purpose specified.

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