E. I. BRADDOCK.

TURBINE.

APPLICATION FILED FEB. 24, 1909.

926,803.

Patented July 6, 1909.

5 SHEETS—SHEET 1.

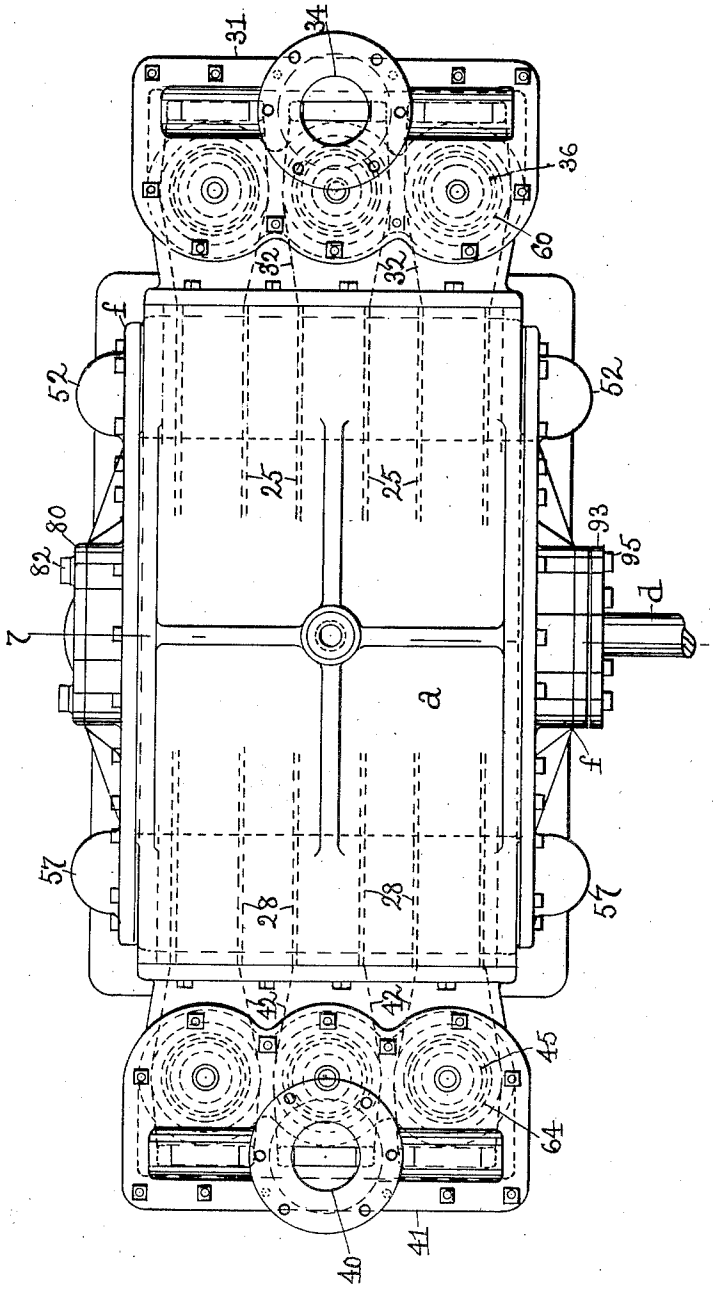


Fig. 1.

Witnesses.
C. F. Emmett
J. Murphy

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5 SHEETS—SHEET 2.

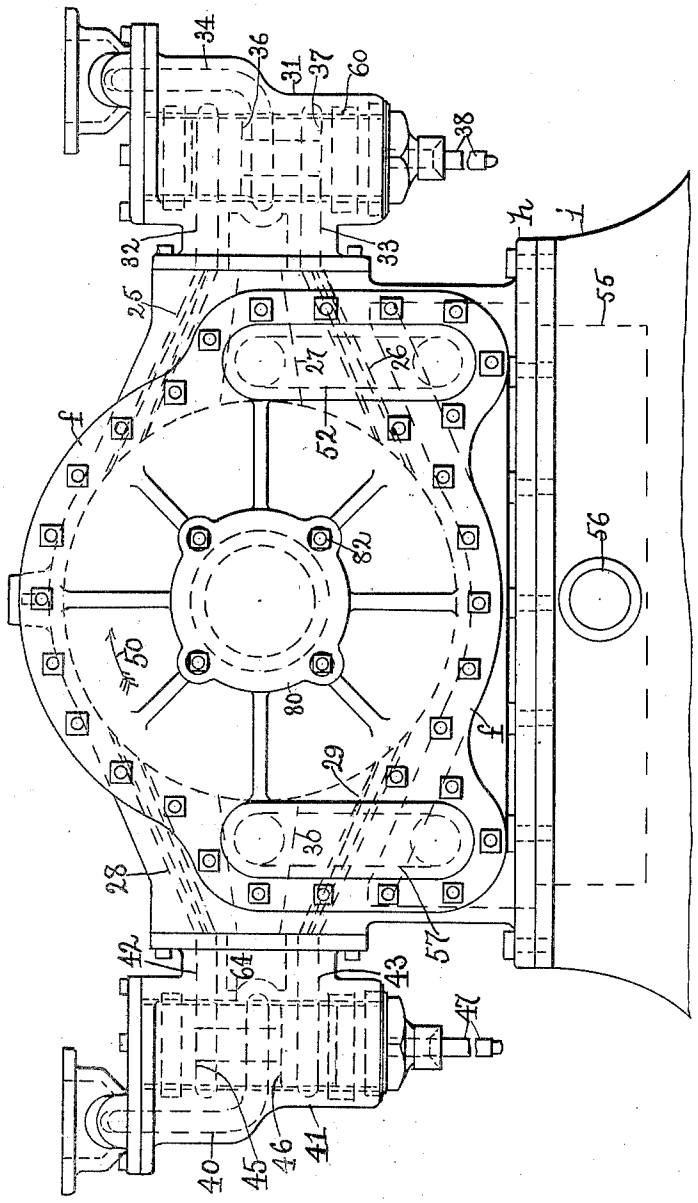


Fig. 2.

Witnesses.
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5 SHEETS—SHEET 3.

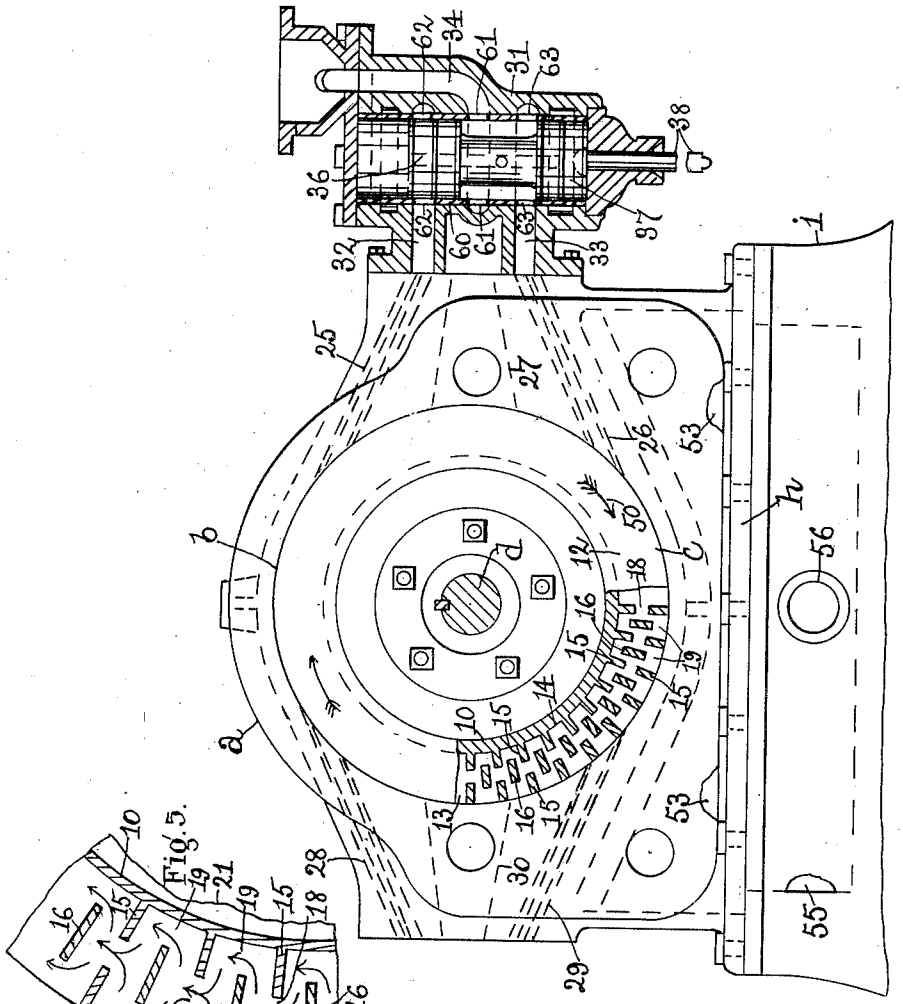

Fig. 3.



Fig. 5.

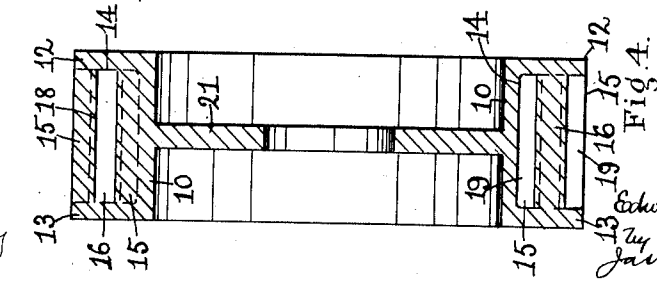

Fig. 4.

Witnesses.
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5 SHEETS—SHEET 4.

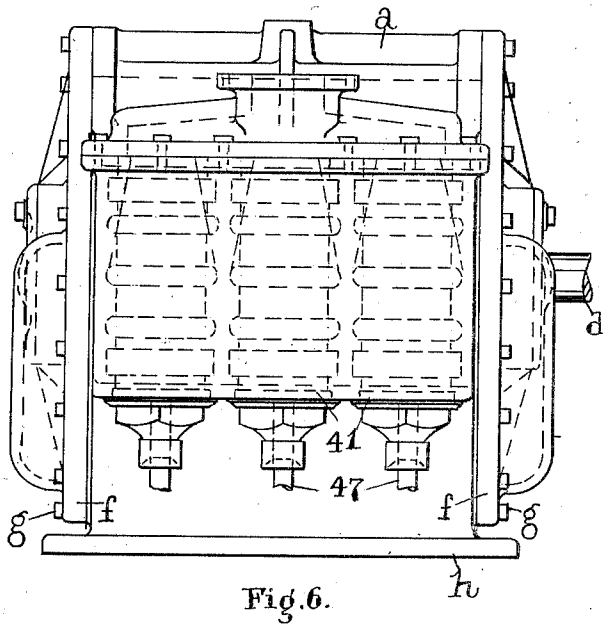


Fig. 6.

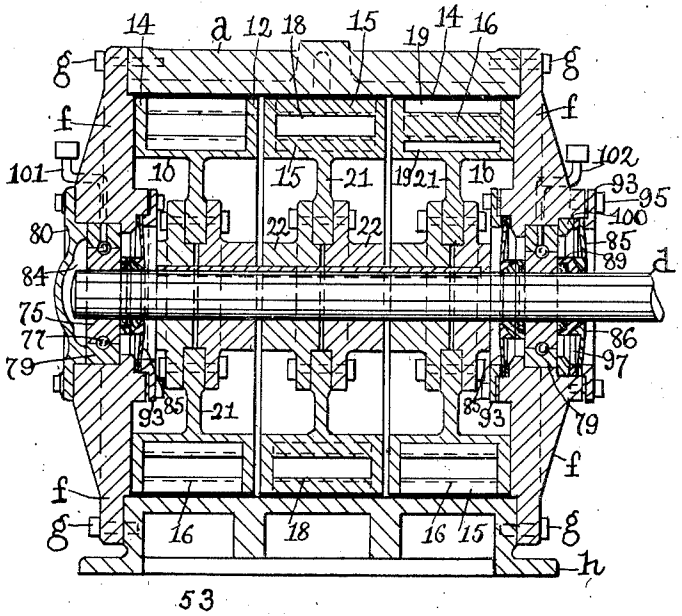


Fig. 7.

Witnesses.
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5 SHEETS—SHEET 5.

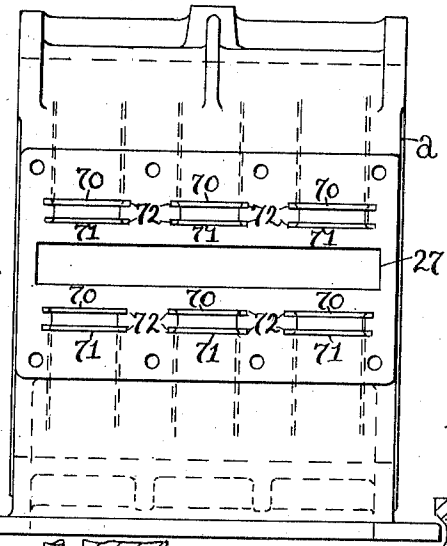


Fig. 8.

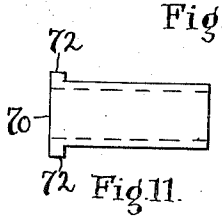


Fig. 11.

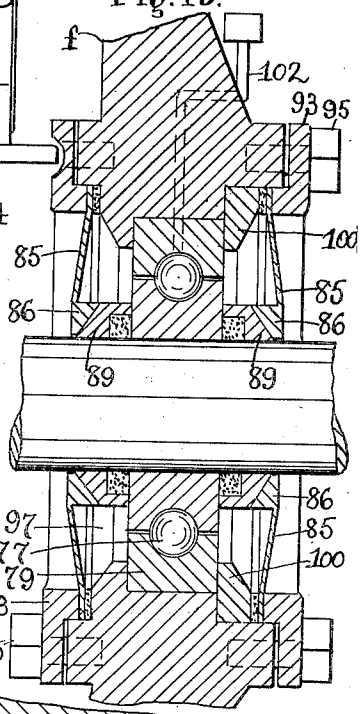


Fig. 10.

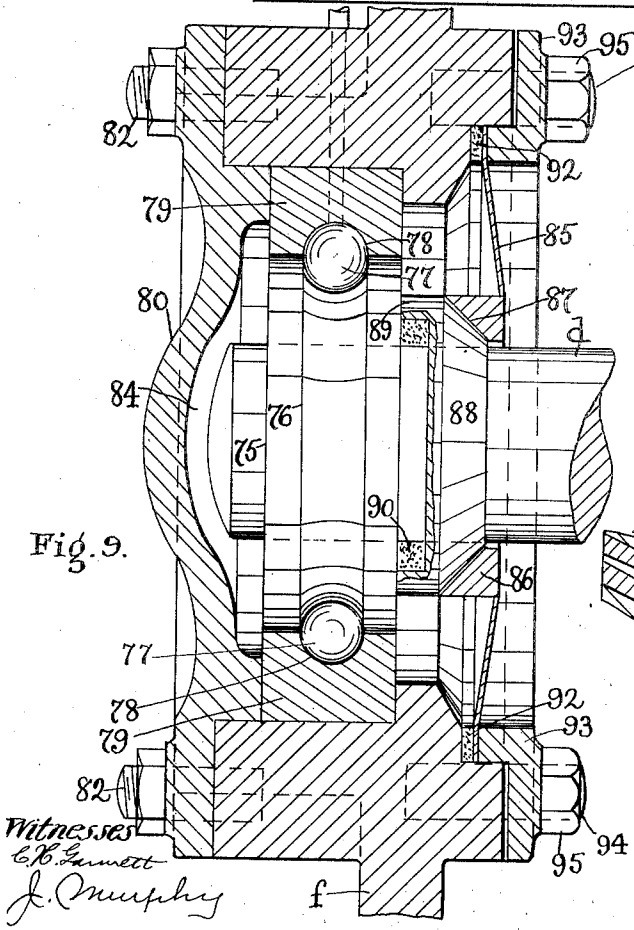


Fig. 9.

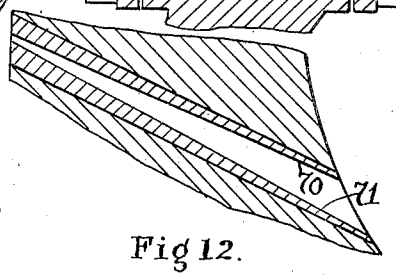


Fig 12.

Witnesses
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# UNITED STATES PATENT OFFICE.

EDWARD I. BRADDOCK, OF WINCHESTER, MASSACHUSETTS, ASSIGNOR TO BRADDOCK MOTIVE POWER COMPANY, OF BOSTON, MASSACHUSETTS, A CORPORATION OF MAINE.

## TURBINE.

No. 926,803. Specification of Letters Patent. Patented July 6, 1909.

Application filed February 24, 1909. Serial No. 479,704.

*To all whom it may concern:*

Be it known that I, EDWARD I. BRADDOCK, a citizen of the United States, residing in Winchester, county of Middlesex, and State of Massachusetts, have invented an Improvement in Turbine-Engines, of which the following description, in connection with the accompanying drawings, is a specification, like characters on the drawings representing like parts.

This invention relates to a turbine engine or motor of that class in which a piston wheel is provided with peripheral blades or vanes, and has for its object to provide a turbine engine or motor of the class described, which is economical and of increased efficiency and in which the expansion as well as the velocity of the steam or other fluid is utilized. For this purpose, the piston wheel is provided with an annular body portion having annular side flanges, which form an annular fluid chamber about the circumference of the wheel, which is separated by a plurality of sets of substantially radial blades or vanes extended transversely of the chamber from flange to flange and arranged to interrupt the continuity of the said chamber and form two sets of transversely extended throats, with the throats formed by one set of blades in line with the blades of the other set, so as to prevent a direct passage of the steam or other fluid about the wheel and utilize to the fullest extent the expansion of the steam. In the present instance the sets of blades or vanes are arranged, so that one set of blades or vanes is substantial central with relation to the annular chamber and forms throats at its ends which are in line with the blades of the other set, which are arranged so as to form substantially central throats in line with the blades or vanes of the first mentioned set.

The invention further consists in novel features of construction as will be described.

These and other features of this invention will be pointed out in the claims at the end of this specification.

Figure 1 is a plan view of a turbine engine or motor embodying this invention. Fig. 2, a side elevation of the engine shown in Fig. 1. Fig. 3, a partial elevation and section of the engine shown in Fig. 1. Fig. 4, a detail in section of one of the piston wheels. Fig. 5, a sectional detail on an enlarged scale to be referred to. Fig. 6, an end elevation of the engine shown in Fig. 1. Fig. 7, a vertical section on the line 7—7, Fig. 1. Fig. 8, a detail in elevation to be referred to. Figs. 9 and 10, enlarged details in section to be referred to, and Figs. 11 and 12, details to be referred to.

Referring to the drawings, *a* represents a casing having a circular bore or opening *b* within which are located a plurality of piston wheels *c* fast on a shaft *d*, which is supported in suitable bearings carried by side plates *f*, secured to the sides of the casing *a* as by screws or bolts *g* or otherwise. The casing *a* is provided at its bottom with a flange *h* and at its sides with a plurality of fluid passages for a purpose as will be described. The flange *h* rests upon and is secured to a hollow base *i*. Each piston wheel *c* is preferably cast in one piece and comprises as herein shown (see Figs. 3 and 4) an annular body portion 10 provided with annular side flanges 12, 13, forming an annular chamber 14, in which are located a plurality of sets of substantially radial blades or vanes 15, 16, which extend transversely of the chamber 14 from one side flange to the other so as to make a strong and durable piston wheel. The sets of blades or vanes 15, 16, are arranged with relation to one another about the piston wheel so as to interrupt the continuity of the annular chamber 14 and form a series of transversely extended throats, with the throats formed by the blades of one set in line with the blades of the other set, and in the present instance, this result is obtained by making the blades 15 of one set in two parts located in a substantially radial line and separated to form a substantially central throat 18 and arranging the blades 16 of the other set between the blades 15 in line with the throats or openings 18 and so as to leave throats 19 in line with the blades 15 (see Figs. 4 and 5). In this manner a very efficient turbine engine is obtained, inasmuch as the steam passing through a central throat or opening 18 impacts against the blade 16, and then expands substantially radially in opposite directions into the throats 19, through which the steam passes and is directed against a preceding blade 15, after which the steam expands radially inward and passes through the central throat 18 between the blades 15 and impacts against the next preceding central blade 16, and so on until the steam or other fluid reaches the exhaust as will be described. The course of

the steam is clearly indicated by the arrows in Fig. 5.

The annular body portion 10 of the piston wheel may be provided with a central web 21, which is secured to a hub 22 fast on the shaft *d*.

In the present instance, the casing *a* is provided at one end with steam inlet passages or nozzles 25, 26, for each piston wheel, and an intermediate exhaust passage 27 common to all the piston wheels, and at its opposite end with like inlet passages or nozzles 28, 29, for each piston wheel and an intermediate exhaust passage 30 common to all the piston wheels. The fluid inlet nozzles 25, 26, incline in opposite directions to each other (see Fig. 3), and the inlet nozzles 28, 29, incline in opposite directions to each other. The fluid inlet nozzles 25, 26, are supplied with steam from a valve chest 31, preferably made as herein shown and provided with outlet passages 32, 33, communicating with the nozzles 25, 26, and an intermediate inlet passage 34, which is designed to be connected with the outlet passages 32, 33, and communication with which is controlled by piston valves 36, 37, having a common stem 38, which may be actuated in any suitable manner. The piston valve 36 controls communication between the inlet passage 34 and the outlet passage 32, and the piston valve 37 controls communication between the inlet passage 34 and the outlet passage 33. As represented in Fig. 3, the valve 37 is open and the nozzle 26 is being supplied with steam, while the valve 36 is closed and the nozzle 25 is idle, being cut off from the steam supply passage 34. The nozzles 28, 29 at the opposite end of the casing communicate in a similar manner with a steam supply passage 40 in a valve chest 41, which is provided with outlet passages 42, 43 communicating with the nozzles 28, 29, and with piston valves 45, 46, controlling the supply of steam to said nozzles and having a common stem 47. The valves 45, 46 in the chest 41 are designed to work opposite to the valves 36, 37 in the chest 31, so that steam may be simultaneously admitted to the upper nozzle 28 on one side of the engine and to a lower nozzle 26 on the opposite side of the engine when the piston wheel and its shaft are driven in one direction, indicated by the arrow 50, Figs. 2 and 3, and so that when the valves 45, 36 are shifted or moved longitudinally so as to reverse the engine, the upper nozzle 25 will be connected with the steam supply passage 34 of the valve chest 31, and the lower nozzle 29 will be connected with the steam supply passage 40 of the valve chest 41. In the present instance, the engine is provided with three piston wheels mounted on the shaft *d* (see Fig. 7) and the valve chests 31, 41, are provided with a set of valves for each piston wheel. In practice the valves in the two chests 31, 41 may have their stems connected by suitable mechanism (not shown) so as to be operated automatically, or they may be manually operated.

The steam supplied to the piston wheels is permitted to expand and travel about the same for substantially one half of the circumference of the same before it meets the exhaust passages 27, 30, which as above stated are common to all the piston wheels, as represented in Fig. 8.

The exhaust passage 27 communicates at its opposite sides or ends with passages 52 in the side plates *f*, which communicate with the opposite ends of an exhaust chamber 53 formed in the lower part of the casing *a* and communicating with a chamber 55 in the upper part of the base *i*, the chamber 55 having an outlet 56 for the exhaust. The exhaust passage 30 communicates with the passages 57 in the side plates *f*, and the passages 57 communicates with the chamber 53.

The piston valves 36, 37 may be reciprocated in a sleeve or bushing 60 fitted in the valve chest 31 and having about its circumference a series of ports or holes 61, which communicate with the steam supply passage 34 and with holes 62, 63, communicating with the outlet passages 32, 33, respectively. The valve chest 41 is provided with a similar bushing 64. It may be preferred to employ the sleeves or bushings 60, 64, but it is not desired to limit the invention in this respect.

Each piston wheel may be secured to the shaft *d* in any suitable manner, and in the present instance, the web 21 is bolted to the hub 22, which is made in two parts keyed or otherwise fastened to the shaft *d*.

The passages 25, 26, 28, 29, in the casing *a* may be used as nozzles, and in practice it may be preferred to so use them when a fluid of low pressure is employed, but when the pressure of the fluid is substantially high, it is preferred to employ a nozzle having a restricted inlet end and a larger or expanding outlet end, and this result may be obtained by inserting into the said passages top and bottom plates 70, 71, (see Figs. 8 and 12), which are slid into dove-tailed guideways in the side walls of said passages. By varying the thickness of the plates 70, 71, the inlet end of the nozzle can be made narrower or wider according to the pressure of the fluid to be used, and it will be understood that the dove-tailed guideways extend into the passages so as to diverge with relation to the inlet end, and thereby enable the steam or other fluid under high pressure to expand in the nozzle itself before it reaches the piston wheel. The plates 70, 71, may be provided with lugs or projections 72 to limit their inward movement into their passages.

The shaft *d* is preferably provided with ball bearings, which may be of any suitable construction, and in the present instance one

construction of ball bearing is shown (see Figs. 7 and 9), which consists of a disk or annular member 75 fast on the shaft *d* and provided with an annular semi-circular groove 76 for the reception of balls 77, which run in a corresponding groove 78 in an annular ring 79, which is stationary, and as shown in Fig. 9, the ring 79 is secured in place by a cap 80 secured to the side plate *f* by the bolts 82. It is designed that the ball bearings should run in oil, and for this purpose, an oil chamber 84 is formed on one side plate *f* by the cap 80, which forms one side wall of said chamber, while the other side wall is formed by a metal diaphragm 85, having a central opening through which the shaft *d* extends. A fluid-tight joint around the shaft *d* is obtained by a metallic packing comprising a ring 86 attached to or forming part of the diaphragm on its inner side and provided with a beveled surface 87, which engages a correspondingly beveled surface 88 of a collar or ring 89 fast on the shaft *d* to revolve therewith. The collar or ring 89 is rendered liquid-tight on the shaft *d* by a fibrous packing 90 forced into a chamber in the collar or ring 89. A liquid-tight joint at the outer circumference of the diaphragm 85 is obtainable by a washer 92 of suitable fibrous material, which is firmly compressed against the side plate *f* by a ring 93, which engages the diaphragm and is secured to the plate *f* by the bolts 94 and nuts 95. It will be understood that the diaphragm 85 has a spring action which serves to take up the wear between the beveled surface 88 on the revolving ring or collar 89 and the beveled surface 87 on the ring 86, and that the revolution of the ring 89 wears the two beveled surfaces 88, 87, uniformly and makes a ground joint. At the other side of the engine, the shaft *d* projects beyond the side plate and an oil-tight chamber 97 is formed by two diaphragms 85 and two metallic ground joint members 86, 89, as shown in Fig. 10 and which need not be specifically described, as they are like the diaphragm 85 and ground joint members 86, 89, shown in Fig. 9 and above described, except the ball bearing ring 79 in the chamber 97 is retained in place by a detachable ring 100.

The oil chambers 84, 97, may be supplied with oil through the pipes 101, 102 carried by the side plates *f*, and which communicate with the said chambers. The metallic packing members or ground joint not only serve to keep the oil chambers 84, 97 tight, but also prevent the escape of motive fluid through the sides of the engine about the revolving shaft *d*. The rings 86 carried by the diaphragms are held in close contact with the rings 89 on the shaft by the fluid pressure acting on the diaphragms.

The operation of the turbine engine hereinshown may be briefly described as follows:— Assume that it is desired to drive the shaft *d* in the direction indicated by the arrow 50 in Figs. 2 and 3. In this case, the operator moves the valves in the valve chests 31, 41, so that the steam supply passages 34, 40 are connected with the nozzles 26, 28, and are cut off from the nozzles 25, 29. In this case steam passes into the engine through the nozzles 26, 28 and passing into the pockets or spaces between the blades 15 impacts against the said blades, expands and passes through the central throat 18 and impacts against the preceding blade 16, expands radially and passes through the throats 19 and impacts against the blades 15, until it reaches the exhaust passages 27, 30, from which it passes through the passages 52, 57 in the side plates *f*, into the exhaust chambers 53, 55, from which latter it escapes through the exhaust port 56. If it is desired to reverse the engine, the valves are moved to close the outlets 33, 42, and open the outlets 32, 43, whereupon steam passes to the engine through the nozzles 25, 29, and the piston wheels and the shaft *d* are rotated in the direction opposite to that indicated by the arrow 50.

Claims.

1. In a turbine engine or motor, an inclosing casing provided with a circular opening and with two sets of passages on opposite sides of said opening and communicating therewith to form on each side of said opening nozzles and an exhaust passage intermediate said nozzles, and provided with fluid inlet passages, valve chests attached to the opposite ends of said casing and each provided with a fluid outlet communicating with a nozzle in the casing valves in said chests controlling the passage of fluid from the said inlet passages into said nozzles, a piston wheel in the circular opening in the casing having peripheral blades or vanes, a shaft on which said wheel is mounted, side plates for said casing supporting said shaft, and passages in said side plates communicating with the exhaust passages in the casing, substantially as described.

2. In a turbine engine or motor, an inclosing casing provided with a circular opening and with passages on opposite sides thereof and communicating therewith to form nozzles and exhaust passages, valve chests attached to the opposite ends of said casing and each provided with a fluid outlet communicating with a nozzle in the casing, valves in said valve chests controlling the passage of fluid from the valve chests into the said nozzles, a piston wheel within said circular opening having peripheral blades or vanes, a shaft on which said wheel is mounted, side plates secured to said casing to close the circular opening and through one of which said shaft is extended, and an outlet for the exhaust in one of the side plates, substantially as described.

3. In a turbine engine or motor, an inclos-

ing casing provided with a circular opening and with two sets of passages on opposite sides of said opening and communicating therewith to form on each side of said opening nozzles and an exhaust passage intermediate said nozzles, valve chests having outlet passages communicating with the said nozzles, and provided with fluid inlet passages, valves in said chests controlling the passage of fluid from the inlet passages into said nozzles, a piston wheel in the circular opening having peripheral blades or vanes, a shaft on which said piston wheel is mounted, side plates for said casing supporting said shaft, and means for connecting the exhaust passages with the exterior of the casing, substantially as described.

4. In a turbine engine or motor, a piston wheel having an annular body portion provided with side flanges, and two sets of substantially radial blades or vanes extended transversely of said wheel between said flanges in staggered relation to each other, the blades of one set being extended toward a substantially central circular line about the wheel to form substantially central transversely extended throats, and the blades of the other set being arranged in line with said central throats and forming at their ends transversely extended throats in line with the blades of the other set, substantially as described.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses.

EDWARD I. BRADDOCK.

Witnesses:
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J. MURPHY.