G. B. COLLIER.

ELASTIC FLUID TURBINE.

APPLICATION FILED SEPT. 13, 1909.

1,047,918. Patented Dec. 24, 1912.

4 SHEETS—SHEET 1.

Fig. 2

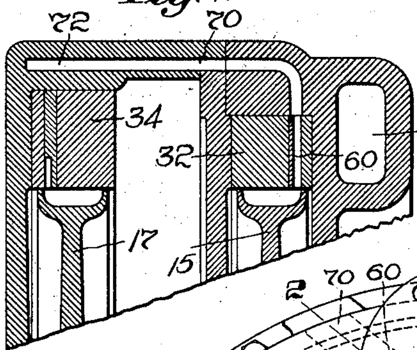


Fig. 3

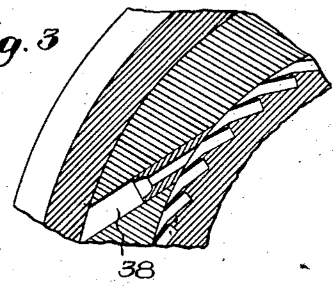
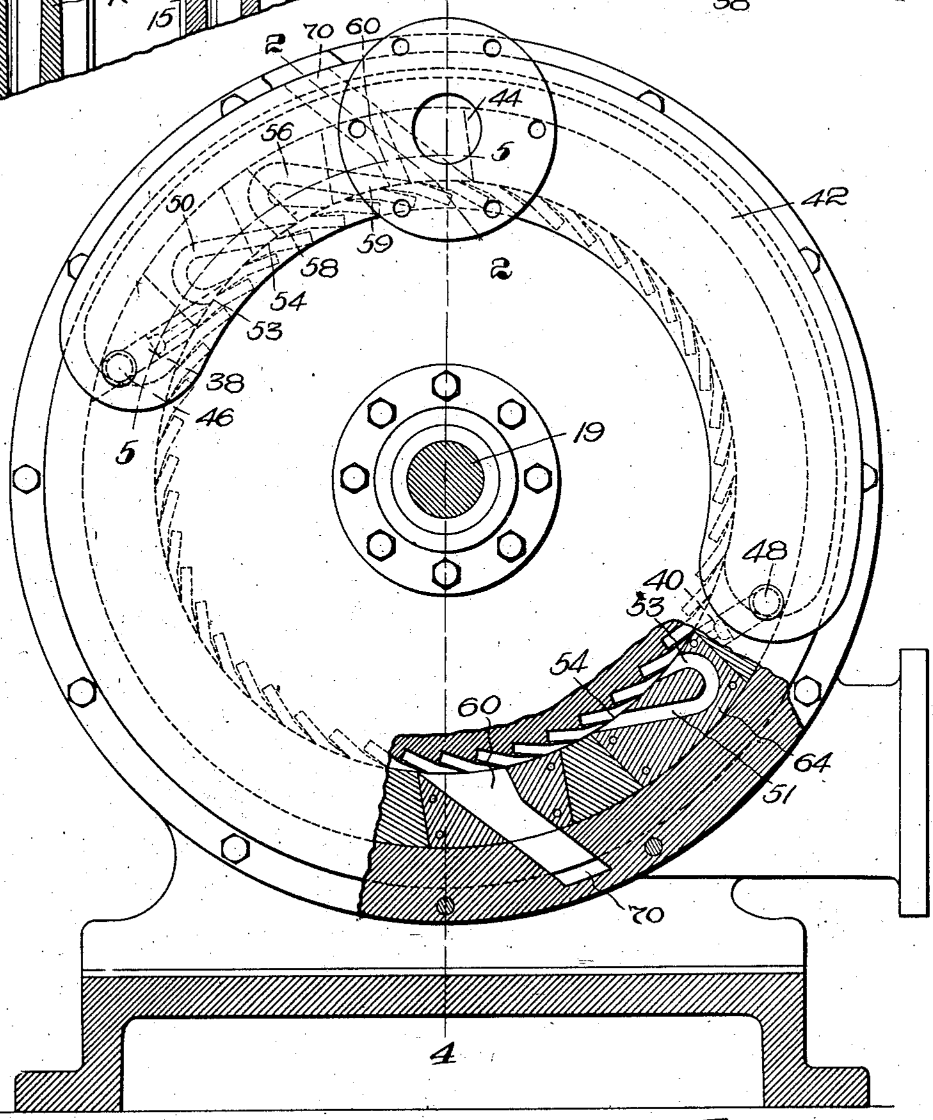


Fig. 1



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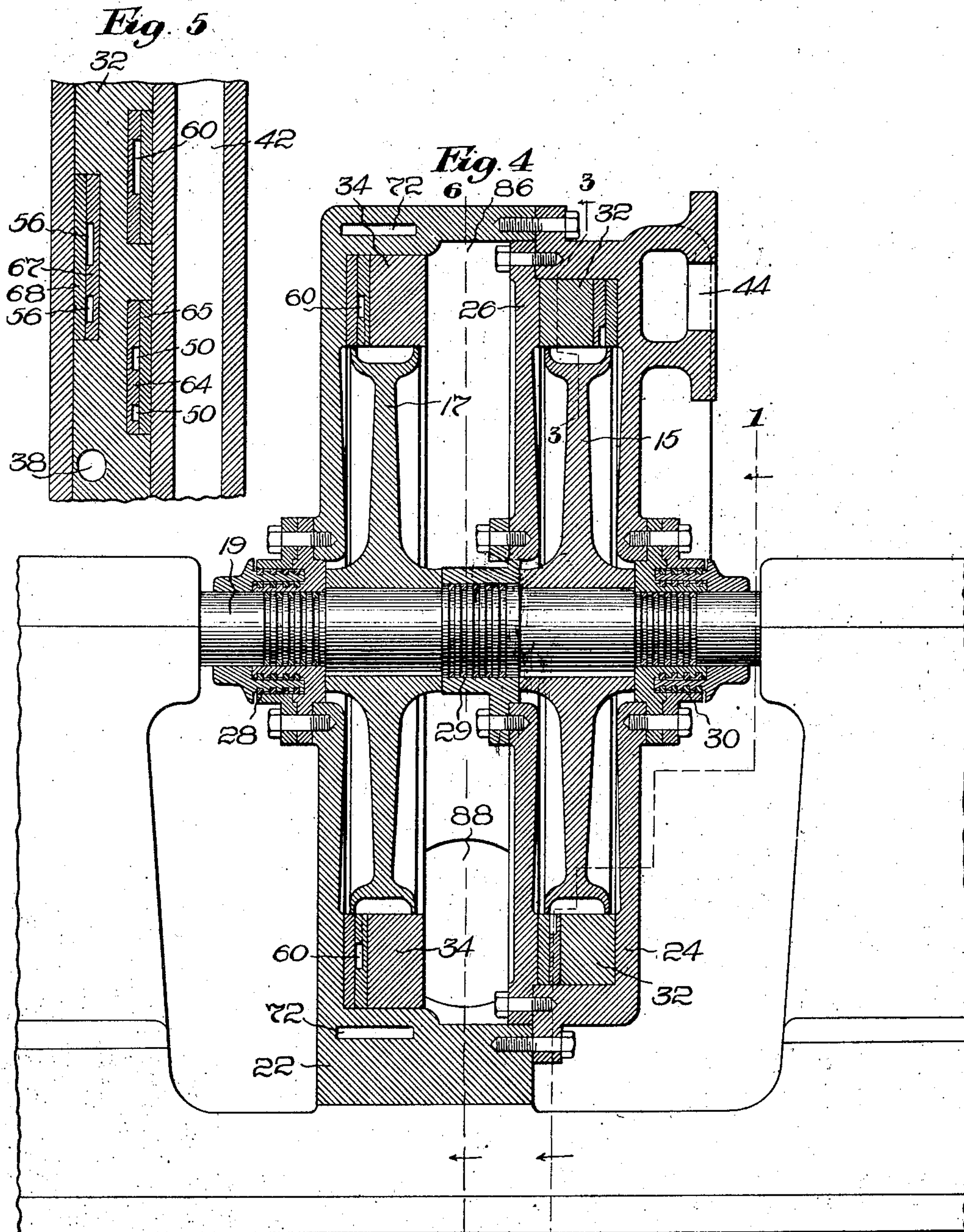
4 SHEETS—SHEET 2.



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4 SHEETS—SHEET 3.

Fig. 7

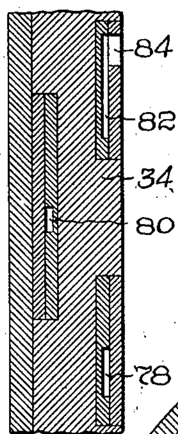


Fig. 8

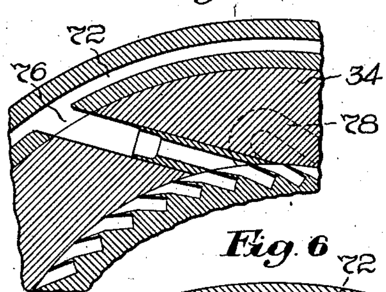


Fig. 9

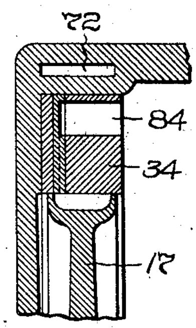
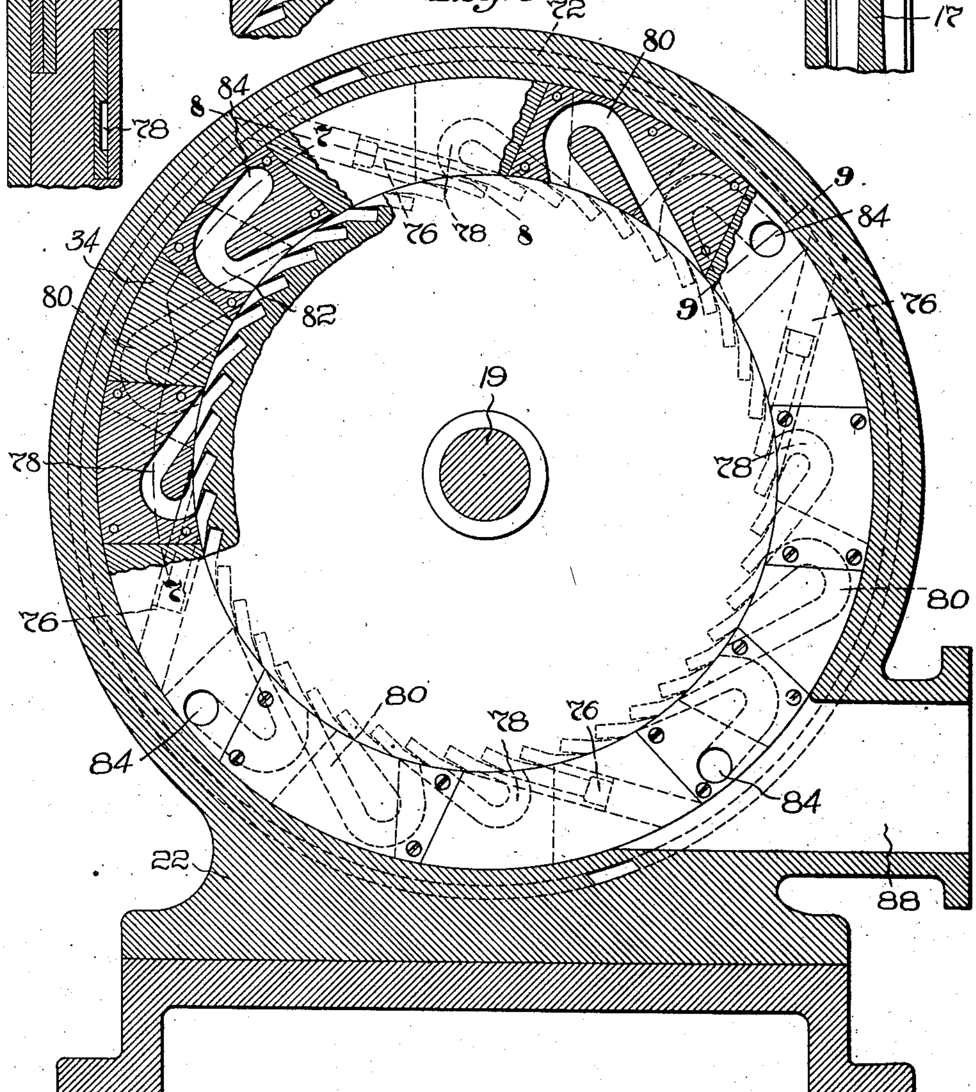


Fig. 6



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4 SHEETS—SHEET 4.

Fig. 10

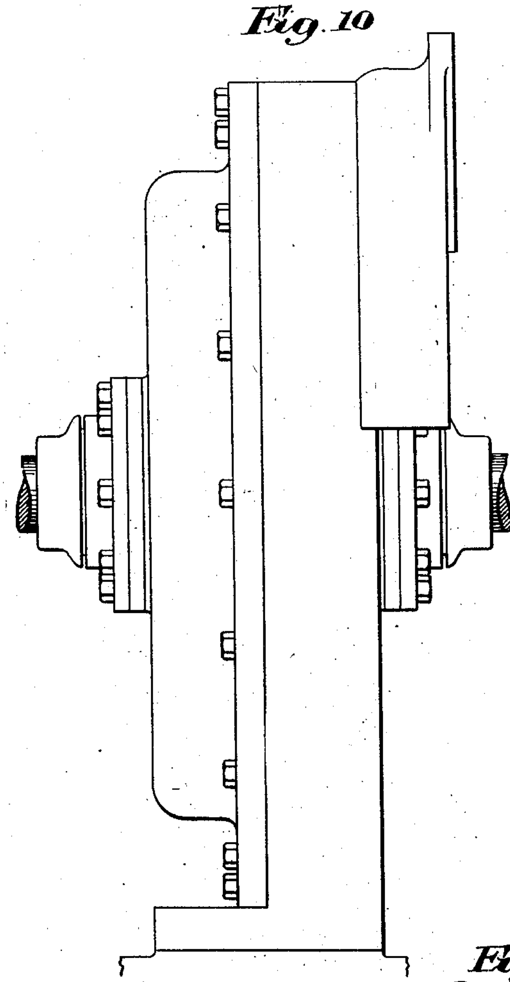


Fig. 11

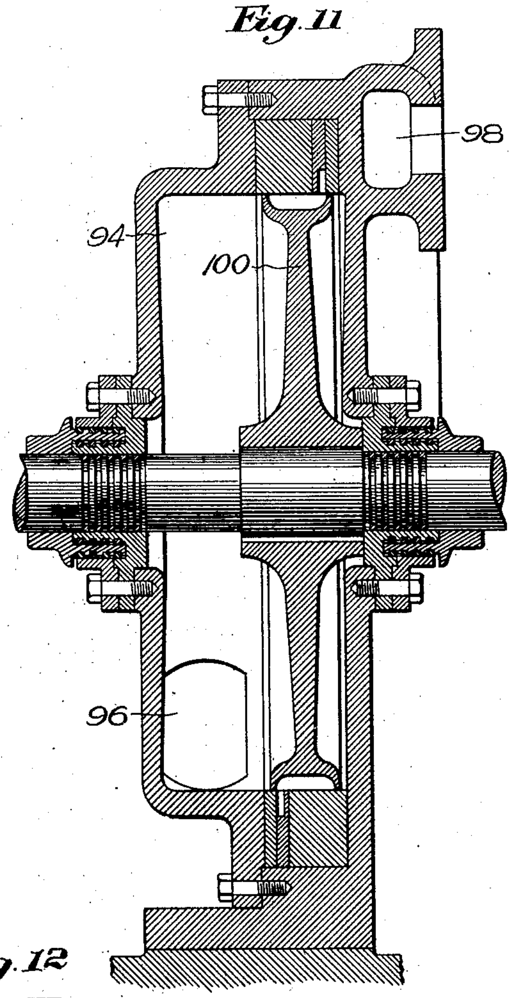
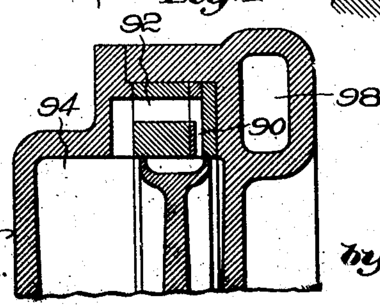


Fig. 12



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UNITED STATES PATENT OFFICE.

GUY B. COLLIER, OF KINDERHOOK, NEW YORK.

ELASTIC-FLUID TURBINE.

1,047,918. Specification of Letters Patent. **Patented Dec. 24, 1912.**

Application filed September 13, 1909. Serial No. 517,370.

To all whom it may concern:

Be it known that I, GUY B. COLLIER, a citizen of the United States, a resident of Kinderhook, county of Columbia, State of New York, have invented an Improvement in Elastic-Fluid Turbines, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

This invention relates to elastic fluid turbines and more particularly to the construction and organization of the parts which distribute the elastic fluid for driving one or more rotors.

Among other objects the invention is designed to utilize the elastic fluid with the highest efficiency and with minimum loss.

The invention comprehends features of construction by which such object is attained in high degree in a simple and durable organization.

The character of the invention may be best understood by reference to one practicable embodiment thereof shown for illustration in the accompanying drawings, in which—

Figure 1 is an end elevation (partly in section on the line 1—1 of Fig. 4) of an illustrative steam turbine embodying the present invention. Fig. 2 is a detail section on a line 2—2 of Fig. 1. Fig. 3 is a detail section on a line 3—3 shown in Fig. 4. Fig. 4 is a vertical section on a line 4—4 of Fig. 1. Fig. 5 is a detail section on a line 5—5 shown in Fig. 1. Fig. 6 is a section on a line 6—6 of Fig. 4. Fig. 7 is a detail section on a line 7—7 of Fig. 6. Fig. 8 is a detail section to be referred to. Fig. 9 is a section on a line 9—9 of Fig. 6. Fig. 10 is a side elevation of a modified form of turbine hereinafter referred to. Fig. 11 is a vertical section through the axis of the rotor shaft of the turbine shown in Fig. 10. Fig. 12 is a detail section of the construction shown in Figs. 10 and 11, corresponding to Figs. 2 and 9 of the construction shown in Figs. 4 and 6.

Referring now to Fig. 4, the illustrative construction there shown comprises a primary rotor 15 and a secondary rotor 17 both fixed upon the rotor shaft 19. The two rotors are inclosed preferably in separate casings as for instance an annular casing 22 supported upon the bed of the machine and containing the rotor 17; and an annular casing 24 containing the rotor 15 and secured to the casing 22. A partition 26 dividing the combined casings into chambers for the respective rotors, may be supplied conveniently by a cover plate secured to and closing the inner face of the casing 24.

Appropriate labyrinth or other packing 28, 29 and 30 may be provided at the outer extremities of the casings and the separating partition 26.

The stators for the respective rotors 15 and 17 may comprise each an annulus 32 or 34 in which suitable nozzles and guides for applying and distributing steam or other elastic fluid may be suitably mounted, for example as hereinafter described.

For the purposes of the specific illustrative machine, the rotor buckets, preferably of semi-circular shape, may be milled out of the solid rims of the rotors and may be of the Pelton type as illustrated in Figs. 1 and 3.

For convenience the description will be confined for the present to the rotor 15, its stator 32 and immediately associated parts.

The initial distribution of steam to the rotor 15 preferably takes place at a plurality of points simultaneously, as for instance, through nozzles in the oppositely disposed passages 38 and 40 shown in dotted lines in Fig. 1, a nozzle in the passage 38 being shown in section in Fig. 3. Preferably steam is supplied to passages 38 and 40 from the same source, as from a semi-annular steam chest 42 (Figs. 1 and 4) which may be formed as part of the casing 24. The chest 42 has an inlet 44. A duct 46 connects the chest 42 with the passage 38 and a like duct 48 connects the chest 42 with the passage 40. If desired, throttle valves of any suitable construction may be provided for the nozzles as by locating a hand valve in a duct 46 or 48. Any suitably proportioned nozzles may be used. Proper inclination of the nozzles relative to the buckets may be readily predetermined by one skilled in the art in accordance with the general requirements which the turbine is designed to fulfil. As illustrated in Fig. 3 a nozzle may be mounted in a passage 38 formed by boring through the annulus or guide ring 32.

In the construction shown in the drawings, the steam initially applied to the rotor by a nozzle 38 or 40, may be recovered and applied again to the rotor. For instance, as illustrated, a guide 50 (Fig. 1) or 51 may be provided, having a receiving end 53 to take the steam from the buckets, and an outlet end 54 from which the steam is again introduced to the buckets. The steam applied to the buckets through the outlet ends 54, 54 may be recovered by guides 56 having receiving ends 58 and outlet ends 59. If desired, the steam applied to the buckets through the outlet ends 59 may be recovered and reapplied to the rotor as many times as practicable. The successively acting guides shown in the drawings suffice, however, to illustrate the character of the invention. After its final application to the rotor, the steam may be conducted away to another stage or to an exhaust, as the case may be, by an outlet 60 hereinafter referred to more in detail.

The guide 50 may be conveniently provided by a passage formed in one or both of mating blocks 64 and 65 (Fig. 5) countersunk into the sides of the annulus or guide ring 32, and there held in any practicable manner as by machine screws. The next guide 56 may be formed in like manner by mating blocks 67, 68 also countersunk in the guide ring 32. The outlet 60 may be similarly provided by mating blocks mounted in the guide ring 32. The successive pairs of mating blocks are preferably arranged in the staggered relation shown in Fig. 5 to alternate on opposite faces of the guide ring 32. This permits the successively acting guides to be arranged as close together as may be practicable, in a generally circumferential direction, and also permits the parts to be assembled conveniently, compactly, and with a simple economical construction. It will be noted that each guide 50 and 56, in the specific illustrative arrangement, is disposed throughout its length in a plane substantially perpendicular to the axis of rotation of the rotor—the successive guides being disposed respectively in parallel planes. Thus, referring again to Fig. 5, the steam stream moves first through the nozzle of the passage 38 into a rotor bucket, then toward the right through the bucket to the receiving port 53 of the guide 50, thence in a generally circumferential direction toward and through the outlet port 54 of the guide and into a rotor bucket, then through the bucket toward the left and into the receiving port 58 of the guide 56, then in a generally circumferential direction toward and through the outlet port 59 of the guide 56 into a rotor bucket, then through the bucket toward the right again into the receiving end of the outlet 60. The arrangement of this staggered path to be pursued by the stream admits of a highly compact, convenient and economical construction.

It has been attempted heretofore to practise the general idea of recovering the steam initially applied to the rotor, and thereafter reapplying it; but the manner in which this has been essayed prior to this invention has given rise to serious losses in efficiency and difficulties of construction which are substantially obviated by the construction embodying this invention.

To obtain maximum efficiency for any given bucket angle and peripheral speed of buckets, and to reduce losses from shock, eddies, etc., the nozzle or other agency for introducing steam to the rotor, is preferably arranged to deliver its steam stream at an "introduction angle" predetermined with due regard to the absolute velocity of the delivered stream—the expression "introduction angle" being employed for brevity to designate the angle between the axis of the delivered steam stream, and the tangent to the mean radius of the receiving bucket at the point of entrance of the stream. In other words, the introduction angle is less for a lesser absolute steam velocity than for a greater. Following this general preference, the illustrative construction shown in the drawings, has the outlet ports of the steam guides 50 and 56 arranged to deliver their streams at introduction angles predetermined with relation to the absolute velocity of the delivered streams.

When the stream has been once introduced to the buckets by the initial nozzle of the passage 38, it suffers a loss in relative velocity while passing through the buckets, so that the absolute velocity, when the stream is taken off the buckets and enters the guide 50, is less than the initial absolute velocity. Consequently, the stream, when reapplied to the buckets by said guide, has a less absolute velocity than it had at the nozzle. Following therefore, the general rule discussed in the preceding paragraph, the preferred embodiment of the invention has a steam guide 50 (Fig. 1) arranged to deliver a steam stream to the buckets at a less introduction angle than that of the steam stream entering the buckets from the nozzle; the same is true of the guide 51. In like manner the successively acting guide 56 is arranged to introduce a steam stream at a still less introduction angle corresponding to a further loss of velocity of the steam in passing from the guide 50 through the buckets to the guide 56. There may be as many guides 50, 56, etc., as practicable, acting successively to take the steam off and reapply it to the buckets. When the steam has passed through the successively acting guides, it may be received and conducted to another stage or to an exhaust, as the case may be, by an outlet 60 (Fig. 1) already referred to.

Aside from the determination of the above described introduction angles, it is of importance, in order to maintain the highest practicable efficiency, to determine the proper reception angles at which the steam shall be taken into the guides from the buckets. In taking the steam from the buckets, the reception angle between the axis of the stream received by a guide and the tangent at the center point of the guide inlet port is preferably determined with due regard to the relative velocity of the steam just before leaving the buckets. In other words, the reception angle is greater for a relatively low absolute velocity just as the steam enters the guide, than for a higher velocity. Accordingly the preferred embodiment of this invention has the inlet end of the guide 50 arranged to take the steam stream from the buckets at a reception angle appropriate to the prevailing absolute steam velocity which is less than the initial velocity at the introduction of the stream to the buckets by the nozzle.

The inlet end of the guide 56 is arranged to take the stream from the buckets at a greater reception angle than that of the guide 50, appropriate to the fall in absolute velocity since the last preceding introduction of the stream to the buckets from the guide 50. Similar successive increases in the described reception angles of successive guides are preferably provided for if more than the specifically described guides be employed.

To recapitulate—the specific embodiment of the invention shown in the drawings is constructed and arranged to apply and reapply the elastic fluid to the buckets at progressively decreasing angles, to take off steam from the buckets at progressively increasing angles. Such an arrangement contributes to reduce losses from shock and eddies and from other causes; and also provides for applying the steam to the buckets at increasingly effective angles as the absolute velocity of the steam decreases, hence contributing much to the improvement in efficiency of action and reduction of steam consumption. As the velocity of the steam decreases in passing from guide to guide, the cross sectional areas of successive guides are progressively increased, as shown in the drawings, to allow the slower moving mass to pass out in proper time.

An arrangement involving the essential characteristics of the construction just described may be used in a single stage turbine as illustrated in Figs. 10, 11 and 12 and hereinafter more fully referred to, or may be used in the double stage turbine shown in Fig. 4. Likewise the substance of this invention may be applied to a turbine of any practicable number of stages unnecessary to be specifically illustrated or described herein.

Referring now to Figs. 1 and 2; for the purposes of the specific double stage turbine shown for illustration, the outlet 60 which receives the steam after its passage through the successively acting guides, communicates with a duct 70 extending through part of the casings 22 and 24 to an annular steam chest 72 (see Fig. 4) in the casing 22 which supplies steam to a nozzle or nozzles for the rotor 17 of the second stage. A view of the second stage of the turbine, in section on the line 6—6 of Fig. 4 is shown in Fig. 6. Projecting toward the rotor 17 from the annular steam chest 72 are the nozzle passages 76, 76 having nozzles of any appropriate design. There may be four of these nozzles preferably disposed around the rotor as illustrated in Fig. 6; or there may be any other practicable number of them. Associated preferably with each nozzle is one or more guides 78 and 80. When a plurality of successively acting guides 78, 80 are employed, they are preferably related as to introduction angle, reception angle and cross sectional areas, in a manner similar to that already described in connection with the guides 50 and 56 illustrated in Fig. 1. The steam may be finally taken from the second stage buckets by an outlet 82 communicating with a passage 84 which passes in a generally axial direction through the annulus or guide ring 34, and opens into an exhaust chamber 86 provided within the casing 22. The chamber 22 has an exhaust outlet 88. Each guide 78 and 80, and the outlets 84 may be formed and assembled with the guide ring 34 in the manner already described in connection with the guides 50, etc., of the first stage.

As will be appreciated by those skilled in the art, the machine hereinbefore described is well adapted for running at a medium speed and for small powers as for driving ventilating fans, centrifugal pumps, etc.

Some of the features of the invention may be advantageously employed in connection with a single stage turbine such as is shown in Figs. 10, 11 and 12. The arrangement of nozzles, guides, etc., may be the same as or similar to that already described. Referring particularly to Fig. 12, a final outlet 90 which receives the steam after its final passage through the buckets, may communicate with a duct 92 opening into an exhaust chamber 94 having an outlet 96 shown in Fig. 11. This single stage turbine may be provided with a steam chest 98 similar to the chest 42 shown in Fig. 4. One or more nozzles each, if desired, with a guide or guides, together with the rotor buckets, constitute the steam path of the single stage turbine.

It is to be understood that the specific embodiments of the invention shown in the drawings have been disclosed merely for purposes of illustration, and the proper scope of the invention is by no means limited thereto. On the contrary, the specific constructions shown and described may be variously changed and modified by addition, omission, substitution of equivalence or the like, all within the proper scope of the subjoined claims. It is not indispensable that all the features of the invention be used conjointly, since they may be used to advantage separately.

I claim—

1. In an elastic fluid turbine, the combination of a rotor; means to introduce the elastic fluid initially to the rotor; and a guide in a plane substantially parallel to the plane of the rotor to recover the fluid initially so introduced and to introduce it to the rotor in a direction more nearly perpendicular to a radius of the rotor at the point of introduction, than the direction of initial introduction of the fluid.

2. In an elastic fluid turbine, the combination of a rotor; means to introduce the elastic fluid initially to the rotor; and a plurality of successively acting means in planes substantially parallel to the plane of the rotor to recover the fluid initially so introduced and to re-apply it a plurality of times at progressively decreasing introduction angles.

3. In an elastic fluid turbine, the combination of a rotor; means to introduce the elastic fluid initially to the rotor; a plurality of successively acting recovery means in planes substantially parallel to the plane of the rotor to take the fluid from the rotor at progressively increasing reception angles; and a plurality of successively acting applying means to apply the fluid at progressively decreasing introduction angles.

4. In an elastic fluid turbine, the combination of a rotor; means to introduce the elastic fluid initially to the rotor; and a plurality of means to recover from the rotor the fluid initially so introduced, said recovery means being in planes substantially parallel to the plane of the rotor and constructed for progressively increasing reception angles; and means to re-apply the fluid recovered by said first acting recovery means.

5. In an elastic fluid turbine, the combination of a rotor; a guide member disposed substantially concentric with the rotor and overlying the buckets of the latter; and a plurality of guides in said member positioned alternately adjacent opposite sides thereof.

6. In an elastic fluid turbine, the combination of a rotor having peripheral buckets opening tangentially and formed with rounded bottoms; means initially to introduce and direct the elastic fluid into said buckets on one side thereof whereby the fluid is whirled within the buckets and discharged backwardly from the opposite side thereof; and guide means to receive the fluid thus discharged and return it to the buckets at a point on the same side of the rotor as that on which the discharge occurred whereby the fluid is returned to the buckets on that side and receives thereupon in the buckets a whirl in the contrary direction, said guide means having an introducing angle less than that of the means for initially introducing the elastic fluid to the rotor.

7. In an elastic fluid turbine, the combination of a rotor having peripheral buckets formed with rounded bottoms; and a staggered steam path including said buckets, means initially to introduce the fluid to the rotor and guides located at different sides of said rotor for introducing the fluid to the rotor at progressively decreasing angles, each of said guides having provision for receiving the fluid from the rotor and reintroducing it to the rotor on the same side as received but at a different point.

8. In an elastic fluid turbine, the combination of a rotor having peripheral buckets formed with rounded bottoms; a staggered steam path including said buckets, means initially to introduce the fluid to the rotor and guides located at alternate sides of said rotor for receiving the fluid from the rotor at progressively increasing angles, each of said guides having provision for reintroducing the fluid to the rotor on the same side as received but at a different point.

9. In an elastic fluid turbine, the combination of a rotor having peripheral buckets formed with rounded bottoms; and a staggered steam path including said buckets, means initially to introduce the fluid to the rotor, and guides located at different sides of said rotor for receiving the fluid from the rotor at progressively increasing angles and introducing the fluid to the rotor at progressively decreasing angles, each of said guides being arranged to introduce the fluid to the rotor on the same side as received from the rotor.

10. In an elastic fluid turbine, the combination of a rotor having peripheral buckets

formed with rounded bottoms; means initially to introduce the fluid to one side of the rotor, and guide means to receive and reintroduce the fluid at the opposite side of said rotor, the angle of reintroduction being less than the angle of said initially introducing means.

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

GUY B. COLLIER.

Witnesses:

LAURENCE A. JANNEY,

EVERETT S. EMERY.