L. V. BARNABÉ.

TURBINE.

APPLICATION FILED APR. 10, 1911.

1,008,106.

Patented Nov. 7, 1911.

3 SHEETS—SHEET 1.

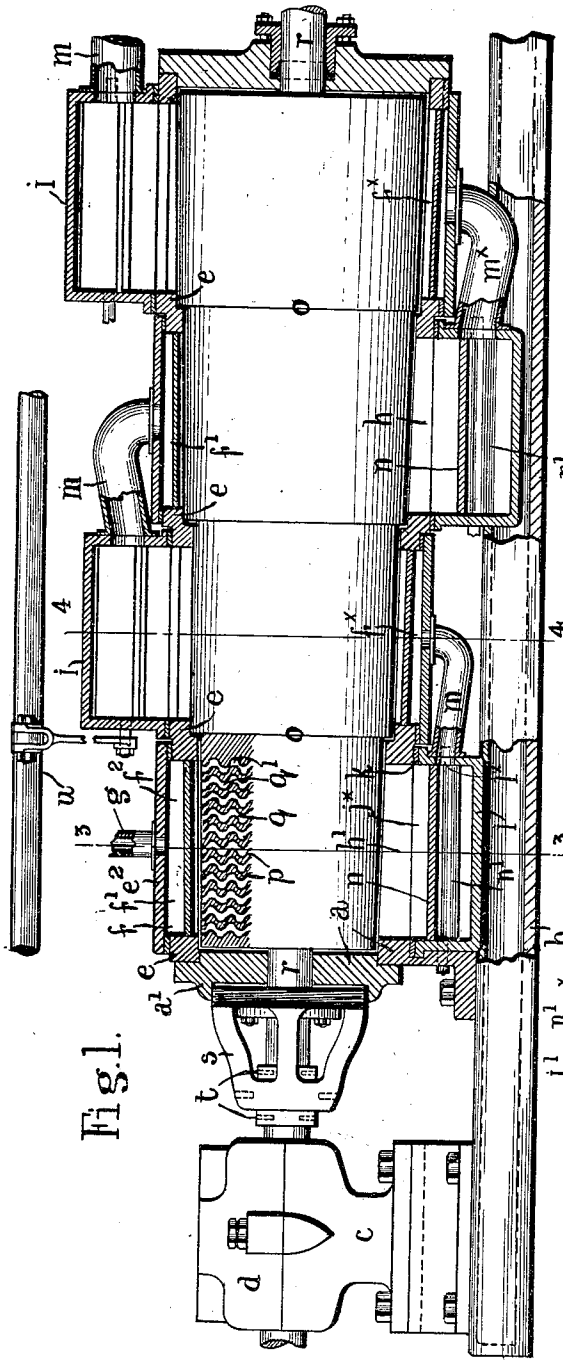

Fig. 1.

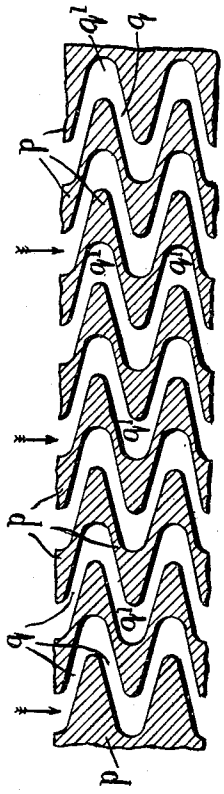

Fig. 5.

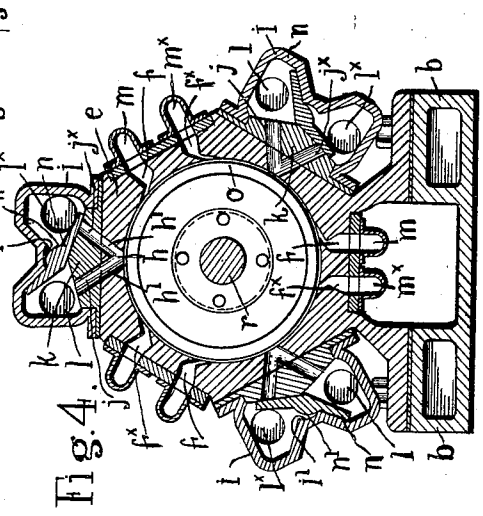

Fig. 4.

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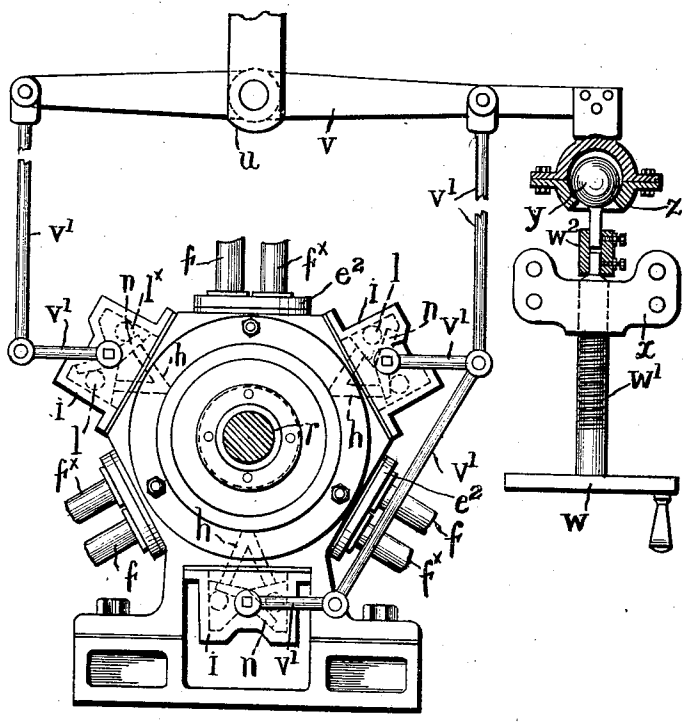
3 SHEETS—SHEET 2.

Fig. 2.



WITNESSES

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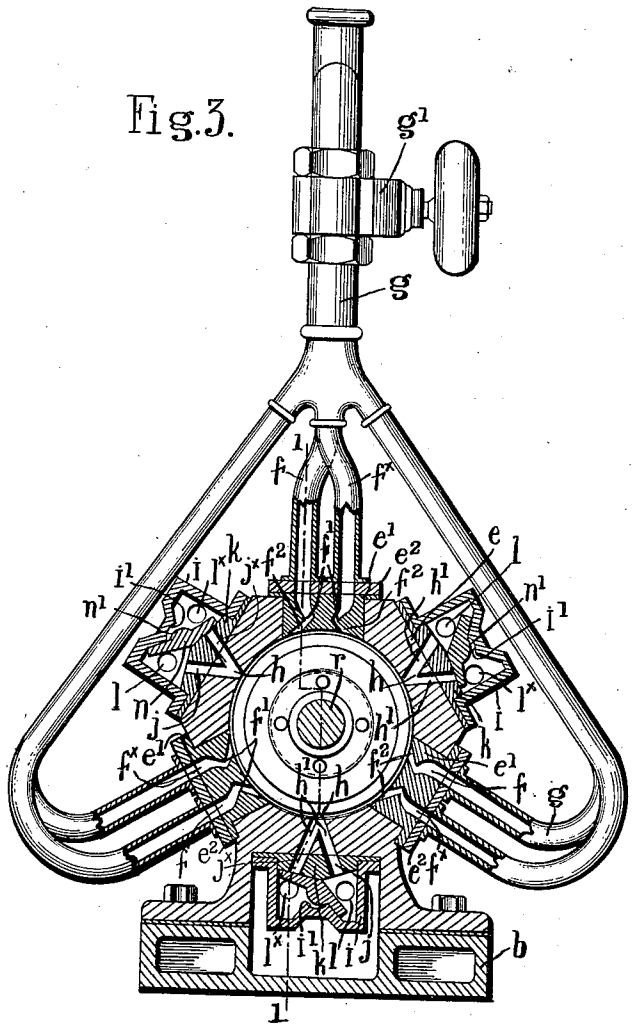
3 SHEETS—SHEET 3.

Fig. 3.



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UNITED STATES PATENT OFFICE.

LUIGI VINCENZO BARNABÉ, OF LONDON, ENGLAND.

TURBINE.

1,008,106. Specification of Letters Patent. Patented Nov. 7, 1911.

Application filed April 10, 1911. Serial No. 620,034.

To all whom it may concern:

Be it known that I, LUIGI VINCENZO BARNABÉ, a subject of the King of Italy, residing at London, England, have invented a certain new and useful Improvement in Turbines, of which the following is a specification.

This invention relates to turbines, and in particular to turbines of the circumferential flow type.

The invention has for its object to provide a multistage turbine having improved means for the removal of exhaust from one part of the rotor and the re-admission thereof to another part of the rotor in such manner as to utilize the expansion of the steam as advantageously as possible; to provide improved means for controlling all of the inlets and exhausts from a single point; to dispense with removable parts, so far as the inlet and exhaust ports are concerned; and to enable the space between the rotor and the stator to be adjusted so that leakage of steam may be minimized or avoided and the relative positions of the parts regulated.

The turbine is of the kind having oppositely disposed inlets arranged in pairs with exhaust ports interposed between each pair of inlets. According to the present invention said turbine has two or more stages, and the aforesaid exhausts in each stage are connected to an inlet of the next stage or, in the case of the final stage, to the final exhaust, and are adapted to be simultaneously controlled.

The improved turbine also has its vanes arranged in staggered form or in a series of zigzags which has heretofore only been done in connection with a simple or single stage turbine; and moreover such staggered or zigzag vanes are formed in an improved way. If desired, however, plain longitudinal vanes may be employed.

A further feature of the improved turbine is the form and mode of arrangement of the inlets, which have mouths in the form of long narrow slots extending parallel with the drum, in a well known way; but such inlets are each provided with a constricted or contracted portion immediately anterior to the mouth, which latter is enlarged or flared relatively to said constricted or contracted portion. The inlets are moreover formed or arranged within stationary blocks in the stator, or within the stator itself.

The exhaust ports are in the form of single openings each branching outwardly however into two passages which are selectively controlled by a common valve which permits the steam to pass away to the forward driving or the reverse driving inlet of the next stage; and these valves are all operated by a single mechanism so that the several exhausts may be simultaneously connected to the respective succeeding stages.

The adjustment of the space between the stator and the rotor is effected by an adjustment of the body of the rotor as a whole relatively to the stator rather than, as heretofore, of movable parts on the rotor. For this purpose the rotor is slightly tapered or coned externally and the stator correspondingly tapered or coned internally, and means are provided for adjusting the rotor longitudinally in one direction or the other so that the coned surfaces can be brought nearer together or farther apart as desired.

The invention will now be described more fully with reference to the example thereof illustrated in the accompanying drawings in which:—

Figure 1 is a sectional elevation, taken approximately on the irregular line 1—1 of Fig. 3, of a four-stage steam turbine of the type referred to, embodying the features of my invention; Fig. 2 is an end elevation thereof; Figs. 3 and 4 are cross sections thereof, taken approximately on the lines 3—3 and 4—4 respectively of Fig. 1; and Fig. 5 is a diagram on an enlarged scale of a portion of the series of blades on the rotor shown in Fig. 1.

In the said drawings, a is the end frame of the machine; e is the stator portion; i, i are the exhaust boxes; o is the rotor; and u is the shaft for operating the exhaust valves. The end frame a is mounted on a base b which also carries standards c supporting the journal boxes d.

The stator e is provided at suitable intervals with a series of pairs of oppositely directed inlets f and f^x for forward and reverse driving respectively. These inlets are sharply angled at f^1; and it will be seen in Fig. 3 that in the high pressure stage—that is to say the stage receiving live steam direct from the boiler through the steam pipes g and valve g^1—the said inlets are formed in blocks e^1 and are contracted in the neighborhood of the angles f^1 but are again en-

larged toward their mouths f^2, which latter are in the form of long narrow slots extending longitudinally of the blocks e^1. These blocks are preferably removable from the stator for convenience of construction, being held in place by plates e^2 screwed or otherwise detachably secured to the stator; but otherwise said blocks are not movable with regard to the rotor vanes. In Fig. 4 which shows a second or expansion stage the inlets f, $f^\times$ are shown as formed in the stator itself, and as terminating at the constricted portions f^1, that is to say without being widened at their mouths, though they are preferably expanded or larger in width than the first stage inlets before the points f^1, the object being to deliver the steam with only a slight throttling of area of normal discharge from the exhaust ports of the earlier stage. The removable blocks may be used in this stage also if desired.

Between each pair of inlets f, $f^\times$ and the next pair is an exhaust opening h formed in the stator. Said exhaust openings are in the form of single slits or channels at their inner ends, but branch outwardly at h^1 on approaching the exhaust boxes i, with which they communicate through openings j, $j^\times$ formed in plates or blocks k, which latter form the bases of the exhaust boxes i. Within each of these exhaust boxes there are two openings, l and $l^\times$, which communicate with pipes m and $m^\times$ leading respectively to the forward driving and to the reverse driving inlets of the next stage. Between the openings l and $l^\times$ is a valve n which is so formed as to divide the exhaust box into two chambers in either of its extreme positions. For this purpose the valve n is preferably made of a flattened V-shape, the upper surface of the block k is of an inverted V-shape, and the middle part of the top of the exhaust box is also more or less V-shaped but provided on the underside of the apex of the V with a hollow i^1 in which a corresponding projection n^1 on the valve may have a rolling fit when said valve is thrown to reverse the turbine.

The rotor o is formed in a number of stages of different diameters; it is however to be understood that it could be formed with stages of equal diameters but with the vanes arranged at increased intervals apart or of greater capacity to allow for the expansion of the steam. p p represent the blades which are, in the example shown, zigzag in form and extend in a generally circumferential direction around the drum. The spaces or channels q, q, between the blades are preferably formed in the manner shown by grooving or lowering the surface of the drum on both sides of the blades p; and preferably the portions q^1 q^1 at the angles of the zigzags, or some of them, are wider than the sides or straight portions of the zigzags so that the steam may be allowed a certain amount of expansion at said angles with subsequent contraction in the comparatively narrow or straight portions.

The shaft r is slidably mounted in the end frame a which carries an annular, internally screw threaded boss a^1 into which is inserted the base, correspondingly screw threaded, of a spider or skeleton frame s. The head of the spider s is held between two fixed collars t, t, on the shaft, so that by turning the spider by means of a tommy wrench or otherwise, said spider is screwed more or less into the boss a^1 and carries with it the shaft and the rotor, the latter being thus moved endwise relatively to the stator. The stages of the rotor are individually tapered, and the stator is correspondingly formed internally and therefore, by adjusting the rotor endwise within the stator one way or the other, the space between its periphery and the stator is diminished or increased so that steam leakage can in the former case be minimized.

The device for effecting the simultaneous opening and closing of the exhaust valves n is shown at u and comprises a rock shaft extending lengthwise of the turbine and carrying fast thereon a series of levers v which are connected by means of links v^1, v^1, with the several valves n. The rock shaft u may be actuated in any suitable way; in the example illustrated it is actuated by means of a hand wheel w having a screw threaded stem w^1 which rides in a correspondingly threaded stationary socket x. The free end of the stem w^1 is connected with one of the levers v by a universal joint comprising a ball y secured to the stem by a muff w^2 and engaging in a socket z carried by one of the levers v. By turning the hand-wheel w the shaft u is rocked and the levers v throughout its length are correspondingly rocked and are caused to actuate the several sets of exhaust valves n.

What I claim is:—

1. A multistage circumferential flow turbine the stages of which have oppositely disposed permanent inlets arranged in pairs between each of which pairs of permanent inlets is an exhaust opening bifurcating into separate passages connected to inlets of the next stage or, in the case of the final stage, to the final exhaust, and a single valve adapted to control the two exhaust passages.

2. A multistage circumferential flow turbine the stages of which have oppositely disposed inlets arranged in pairs between each of which pairs of inlets is an exhaust connected to an inlet of the next stage or, in the case of the final stage, to the final exhaust, in which the said exhaust ports are in the form of openings leading into passages, which are selectively controlled by a valve, and in which the several valves for the

exhaust passages are simultaneously operated by or from a common controlling device.

3. A multistage circumferential flow turbine the stages of which have oppositely disposed inlets arranged in pairs between each of which pairs of inlets is an exhaust, in which said inlets extend the width of the rotor, and are provided with a constructed or contracted portion and an enlarged mouth.

4. A multistage circumferential flow turbine the stages of which have oppositely disposed inlets arranged in pairs between each of which pairs of inlets is an exhaust connected to an inlet of the next stage or, in the case of the final stage, to the final exhaust, having its rotor of tapered or conical form and its stator correspondingly formed, and a part outside of the turbine proper, engaging with the rotor shaft and adapted to be screwed in one direction or the other relatively to the stator to move the shaft and rotor.

5. A multistage circumferential flow turbine the stages of which have oppositely disposed inlets arranged in pairs between each of which pairs of inlets is an exhaust connected to an inlet of the next stage or, in the case of the final stage, to the final exhaust, having zigzag grooves or channels which between the vanes or blades are wider at their apexes or angular parts, than at the sides or straight portions thereof.

6. A multistage circumferential flow turbine the stages of which have oppositely disposed inlets arranged in pairs between each of which pairs of inlets is an exhaust connected to an inlet of the next stage or, in the case of the final stage, to the final exhaust, in which said inlets extend the width of the rotor and are provided with a constricted or contracted portion and an enlarged mouth in the case of the first stage the inlet ports of the succeeding stages having expanded portions terminating in contracted openings to deliver the steam with only a slight throttling of the area of normal discharge from the exhaust ports of the first and succeeding stages.

In witness whereof I have hereunto set my hand in the presence of two subscribing witnesses.

LUIGI VINCENZO BARNABÉ.

Witnesses:
CHARLES FINOLI,
ALLEN PARRY JONES.