

Sept. 25, 1923.

1,469,045

J. A. MacMURCHY

ELASTIC FLUID TURBINE

Filed April 18, 1922

2 Sheets-Sheet 1

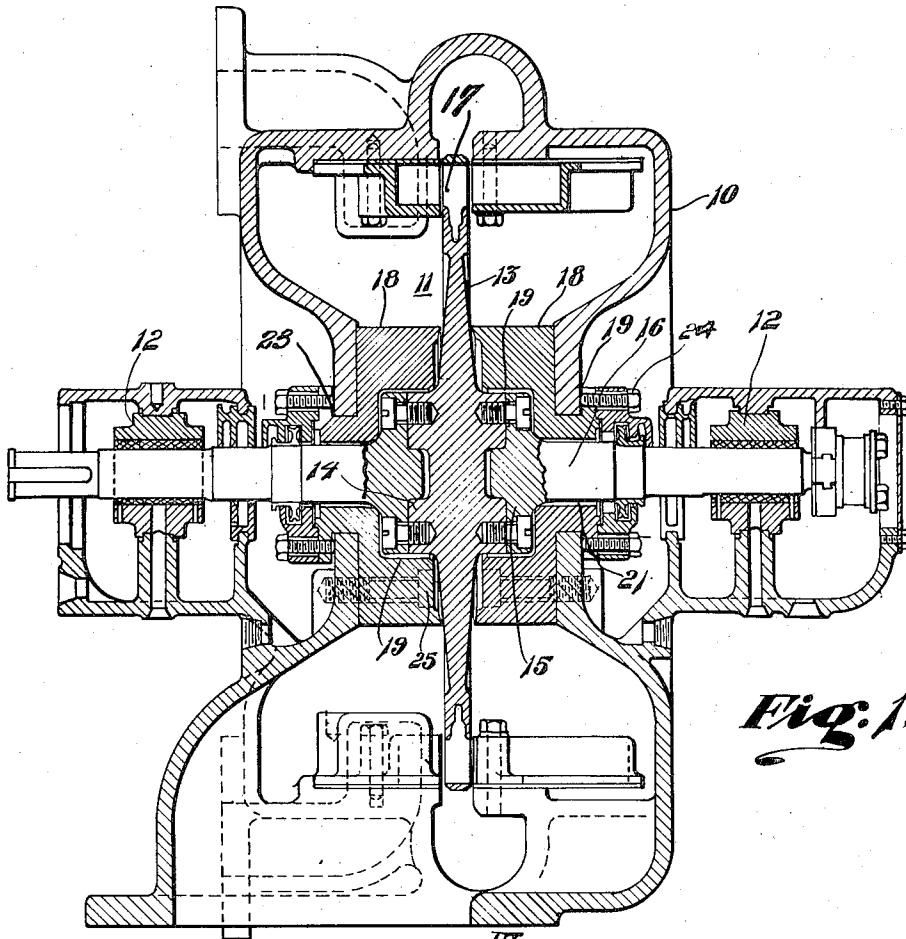


Fig. 1.

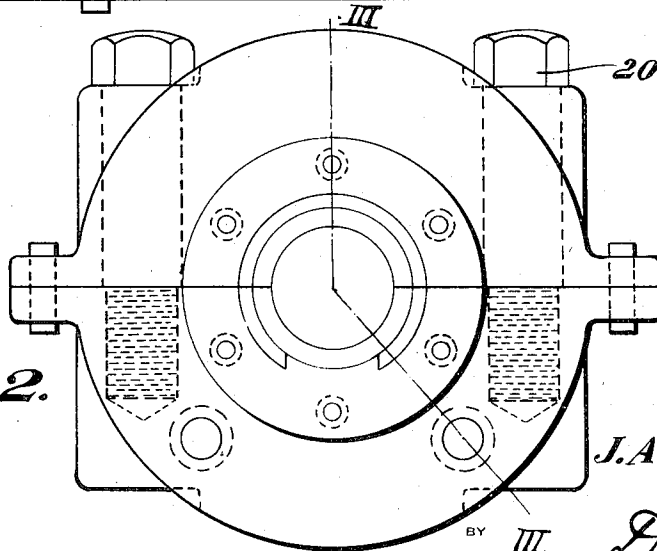


Fig. 2.

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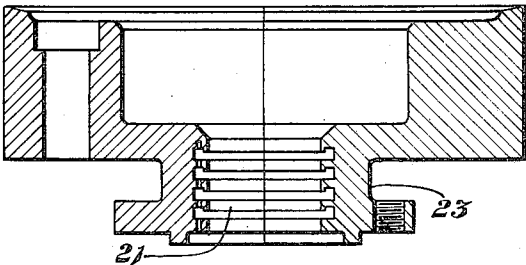


Fig. 3.

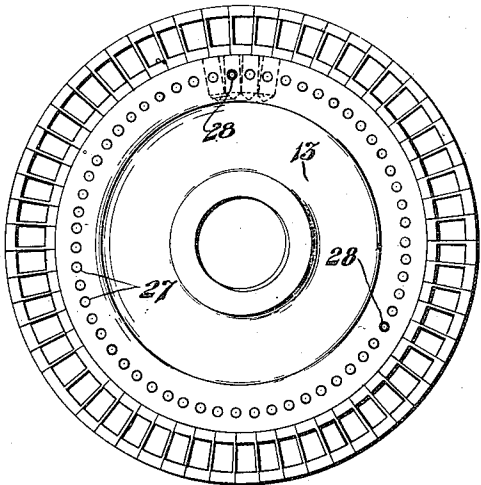


Fig. 4.

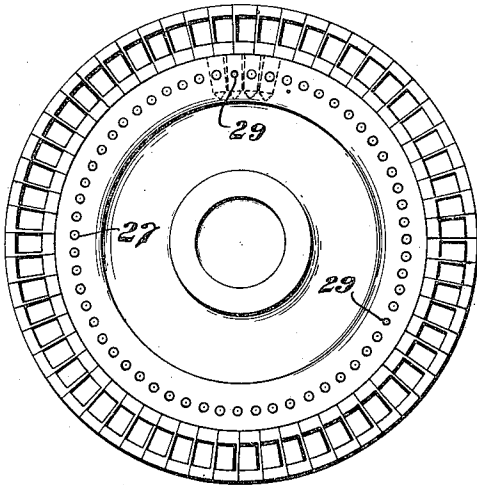


Fig. 5.

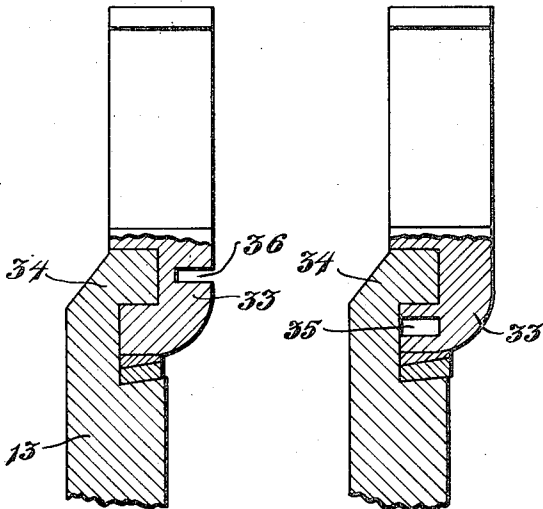


Fig. 8.

Fig. 7.

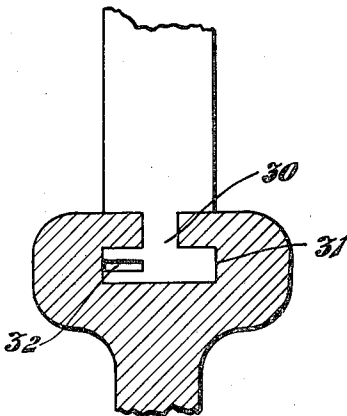


Fig. 6.

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UNITED STATES PATENT OFFICE.

JOHN ALEXANDER MACMURCHY, OF RIDLEY PARK, PENNSYLVANIA, ASSIGNOR TO
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ELASTIC FLUID TURBINE.

Application filed April 18, 1922. Serial No. 554,612.

To all whom it may concern:

Be it known that I, JOHN ALEXANDER MACMURCHY, a subject of the King of Great Britain, and a resident of Ridley Park, in the county of Delaware and State of Pennsylvania, have invented a new and useful Improvement in Elastic Fluid Turbines, of which the following is a specification.

My invention relates to a safety device for high-speed rotors, more particularly the rotors of elastic-fluid turbines, and it has for its object to provide braking means to reduce the speed of the rotating element, should it for any cause get beyond control of the speed regulating governor and any other speed control mechanism which may have been provided, the operativeness of said braking means being dependent upon a change in the position of the rotating element axis due to the breaking away of purposely weakened parts so that the rotating element becomes unbalanced.

Apparatus embodying features of my invention is illustrated on the accompanying drawings forming a part of this application in which: Fig. 1 is a longitudinally sectional view of a turbine showing my speed-limiting means applied thereto; Fig. 2 is a plan view of one of the braking rings; Fig. 3 is a sectional view taken along the line III—III of Fig. 2; and Figs. 4 to 8, inclusive, are detail views showing different ways in which one or more turbine blade sections may be weakened.

If the speed-regulating governor of a turbine becomes inoperative and the emergency stop devices fail to function, and the load be removed from the turbine, the speed of the rotating element will increase until some part of it gives way. This breaking up of the rotating element may cause very serious injury to the other parts of the turbine and at the same time may cause injury to the attendants. My invention relates more particularly to this type of apparatus and it has for its object to provide means which shall be rendered effective by the breaking away of a small purposely weakened part, thus causing the rotor to change the position of its axis of rotation by bending of

the shaft sufficiently to cause a portion of the rotating element to rub against a suitable restraining element attached to the stationary element of the machine. Such braking means is, therefore, mechanically simple and dependable for the reason that no mechanism has to be set in motion to shut off the supply of steam or other source of energy.

Referring now to the drawings for a more detailed description of my invention, I show a rotor casing 10 which contains a rotor at 11 supported by the bearings 12 carried by the casing.

The rotor at 11 is shown as being comprised by a central disc member 13 having laterally projecting hub portions 14 to which are secured the flanges 15 of the shaft sections 16, the latter being journaled in said bearings 12. The disc member 13 is provided with a row of impulse blades 17 adapted to abstract energy from steam supplied thereto by any suitable nozzle construction.

Restraining or braking rings 18 are carried by the turbine casing at each side of the disc member 13 and they are provided with recesses 19 which are closely spaced with respect to the hub portions comprised by the hub portions 14 and the flange portions 15, so that, when the rotor shaft deflects sufficiently, the hub portions contact with the walls of the recesses 19, whereupon the restraining or braking rings 18 exert a braking effect on the rotor, tending to limit its speed. The walls of the recesses 19 are spaced sufficiently close to the hub portions of the rotor that deflection of the latter is confined well within its elastic limit and yet allow ample working clearance.

The restraining or braking rings 18 are preferably made in two parts which are secured together by any suitable means, for example, by the tangential screws 20. See Fig. 2. The rings are provided with openings 21 adapted to surround the shaft sections 16. The rings are provided with external annular channels 23 adapted to receive the walls of the turbine casing 10. Screws 24 are provided for the purpose of holding the braking or restraining rings

18 in axial alignment with the bearings 12 and for clamping the rings firmly in position with respect to the walls of the turbine casing 10.

5 In accordance with my invention, one or more blades 17, have a weakened connection with respect to the rotor disc 13, so that, when the latter attains an excessive speed, the blade or blades having the weakened
10 connections give way, while the other blades are still held in place but yet resulting in the unbalancing of the rotor and the deflection thereof, until the hub portions come in contact with the walls of the recesses 19
15 of the braking or restraining rings 18, the latter then serving to exert a braking effect on the rotor to limit the speed thereof. One weakened blade is sufficient; however, I prefer to provide two weakened blades, ar-
20 ranged substantially less than 180° and preferably approximately 120° apart, for the reason that if one blade should fail to give way at the expected speed, the other blade would, in all probability, give way,
25 and if both blades should give way, the resultant unbalance is approximately the same as if only one blade should become detached. Accordingly, in Figs. 4 to 8, inclusive, I show various ways in which one or two
30 blades may be weakened by reducing the active area in stress in the connections thereof with respect to the rotor 13.

35 In Fig. 4, I show the blades 17, with the exception of one or two, secured in position with respect to the rotor by means of transverse solid pins 27. One or two of the blades are secured in position with respect to the rotor by means of tubular pins 28 of ap-
40 proximately the same diameter as the pins 27, it being understood that if two tubular pin connections are employed, they will be disposed substantially less than 180° and preferably approximately 120° apart. Since
45 the area in stress provided by the tubular type of pin may be much less than that provided by the solid pins, the tubular pins may be so designed as to shear off upon the attainment of a suitable overspeed.

50 In Fig. 5, solid pins 29 of smaller cross-sectional area than the pins 27 are provided for the accomplishment of the same purpose as the hollow pins 28 of Fig. 4.

55 It is obvious that the relatively weaker pins of Figs. 4 and 5 may be made so by using weaker or softer material. For example, steel pins of ordinary construction may be used with all the blades, except the one or two intended to become detached, as
60 hereinbefore set forth, and the latter blades may be secured in place by means of copper or other suitable weaker material. The pins made of weaker material may be made tubular or solid and of the same external diameter, as in Fig. 4, or such pins may be made

of smaller diameter, as in Fig. 5, the rela- 65 tive pin areas of the stronger and weaker materials in stress being dependent upon the relative strengths of the materials, and the approximate speed at which it is desired
70 that the weakened blade or blades shall become detached, as hereinbefore set forth.

In Fig. 6, I show a turbine blade having a T-shaped root portion 30 which fits a cor-
respondingly shaped recess 31 in the rotor. One or both of the portions of the T-head 75 may be slitted, as at 32, in order to provide less area in shearing stress so that the blade may give way at an expected overspeed.

In Fig. 7, I show a turbine blade having a root portion 33 which fits in a groove in
80 the rotor and is overhung by a portion 34 of the latter. The root portion is slitted at 35 so as to weaken the blade connection by providing less area in shearing stress.

85 In Fig. 8, I show a turbine blade fastened to its rotor by means similar to that shown in Fig. 7; but in Fig. 8, the blade is weakened by slitting the shank of the root
90 portion so as to provide less area in tensile stress.

In operation, a turbine equipped with my braking or restraining rings and with one or more weakened blades will not attain a dangerous overspeed for the reason that the
95 weakened blades will give way, causing the rotor to become unbalanced and resulting in the deflection thereof so that it comes in contact with the restraining or braking rings to limit the speed thereof.

100 While I have shown my invention in several forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications without departing from
105 the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the append-
ed claims.

What I claim is:

110 1. In a machine, the combination of a rotor, braking means for the rotor which is dependent upon deflection of the latter before a braking effect is developed and
115 means for unbalancing the rotor upon overspeeding of the latter to a predetermined amount, whereby the rotor will deflect and the braking means will limit overspeeding thereof.

120 2. In a turbine, the combination of a rotor, a member for limiting the deflection of the rotor, a row of energy abstracting elements, and connections between the elements and the rotor, one of which is weaker than
125 the rest, whereby upon attainment of a suitable overspeed, the element having the weakened connection becomes detached, resulting in unbalance of the rotor and consequent de-

flection thereof until it contacts with said member to develop a braking effect serving to limit the speed of the rotor.

3. In a turbine, the combination of a rotor, a member for limiting deflection of the rotor, a row of energy-abstracting elements, and connections between the elements and a rotor, two of said connections being weaker than the rest and spaced apart substantially less than 180 and preferably 120°, whereby, upon the attainment of a suitable overspeed, either one or both elements having the weakened connections become detached resulting in the unbalancing of the rotor and the consequent deflection and contact thereof with said member to develop a braking effect serving to limit the speed of the rotor.

4. In a turbine, the combination of a rotor, members for limiting deflection of a rotor safely within the elastic limit thereof, a row of energy-abstracting elements, and connections between the elements and the rotor, one of which is weaker than the rest, whereby, upon the attainment of a suitable overspeed, the element having the weakened connection becomes detached, resulting in the unbalancing of the rotor and the consequent deflection thereof until it contacts with the said members to develop a braking effect which serves to limit the speed of the rotor.

5. In a turbine, the combination of a rotor element having hub portions, means normally spaced from the hub portions to limit deflection of the rotor element safely within the elastic limit thereof, and means for unbalancing the rotor element upon overspeeding thereof to a predetermined extent, whereby said element will deflect and the hub portions will rub on said first means thereby developing a braking effect and serving to limit the overspeeding of the rotor element.

6. In a turbine, the combination of a casing, a rotor having hub portions, rings carried by the casing and normally spaced from said hub portions such a distance as to limit deflection of the rotor safely within the elastic limit thereof, and means for unbalancing the rotor upon overspeeding to a predetermined extent, whereby, upon overspeeding, the rotor deflects and the hub portions contact with the rings to limit the speed of the rotor.

7. In a turbine, the combination of a rotor having hub portions, means normally spaced from said hub portions at such a distance as to limit deflection of the rotor safely within the elastic limit thereof, and a row of blades carried by the rotor, one or more of the blades being weakened so that, upon overspeeds, one or more of the weakened blades become detached and the

rotor is unbalanced, whereupon the rotor deflects and the hub portions contact with said means thereby limiting overspeeding of the rotor.

8. In a turbine, the combination of a rotor element, means normally spaced from the rotor element a distance such that deflection of the rotor element is safely limited within the elastic limit thereof, and means for unbalancing the rotor element, upon overspeeding to a predetermined extent, whereupon the rotor element contacts with said means and further deflection and overspeeding are limited.

9. In a turbine, the combination of a casing and a rotor, restraining rings carried by the casing and adapted to contact with the rotor when the rotor shaft deflects a predetermined amount, and a row of blades carried by the rotor, one or more of the blades being weakened so that, upon a desired overspeed, said weakened blade or blades give way, thereby creating sufficient unbalance to cause the rotor shaft to deflect a sufficient amount to permit the rotor to rub on the restraining rings, whereby the latter exert a braking effect and serve to limit the speed of the rotor.

10. In a turbine, the combination of a rotor element, means normally spaced from the rotor element a distance such that deflection of the rotor element is safely limited within the elastic limit thereof, and a row of blades carried by the rotor element, one or more of the blades being weakened, whereby, upon overspeeding of the rotor element to a predetermined extent, the weakened blade or blades become detached and the rotor element deflects until it contacts with said means, whereupon deflection and overspeeding of the rotor are limited.

11. In a turbine, the combination of a rotor element, means normally spaced from the rotor element a distance such that deflection of the rotor element is safely limited within the elastic limit thereof, a row of blades, and fastening means for securing the blades to the rotor, one or more of said fastening means being weaker than the rest, whereby, upon overspeeding of the rotor to a predetermined extent, the weak fastening means give way and allow the blade or blades secured thereby to become detached, whereupon the rotor element is unbalanced and the latter deflects until it contacts with said means to limit overspeeding of the rotor element and deflection thereof safely within the elastic limit.

12. In a turbine, the combination of a rotor, a row of blades, and fastening means for securing the blades to the rotor, one or more of said fastening means being weaker than the rest so that the blades secured

thereby may become detached from the rotor upon overspeeds to a predetermined extent.

13. In a turbine, the combination of a rotor, a row of blades, and means cooperating with the rotor and with the blades to hold the latter in position, the means for one or more of the blades having smaller stress areas than the other blades, whereby,

upon the attainment of a predetermined speed, the means having the smaller stress areas and consequent higher unit stresses may give way allowing the blade or blades held thereby to become detached. 10

In testimony whereof, I have hereunto subscribed my name this 17th day of April 1922. 15

JOHN ALEXANDER MacMURCHY.