Jan. 11, 1927. 1,614,235

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ELASTIC FLUID TURBINE

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Fig. 1.

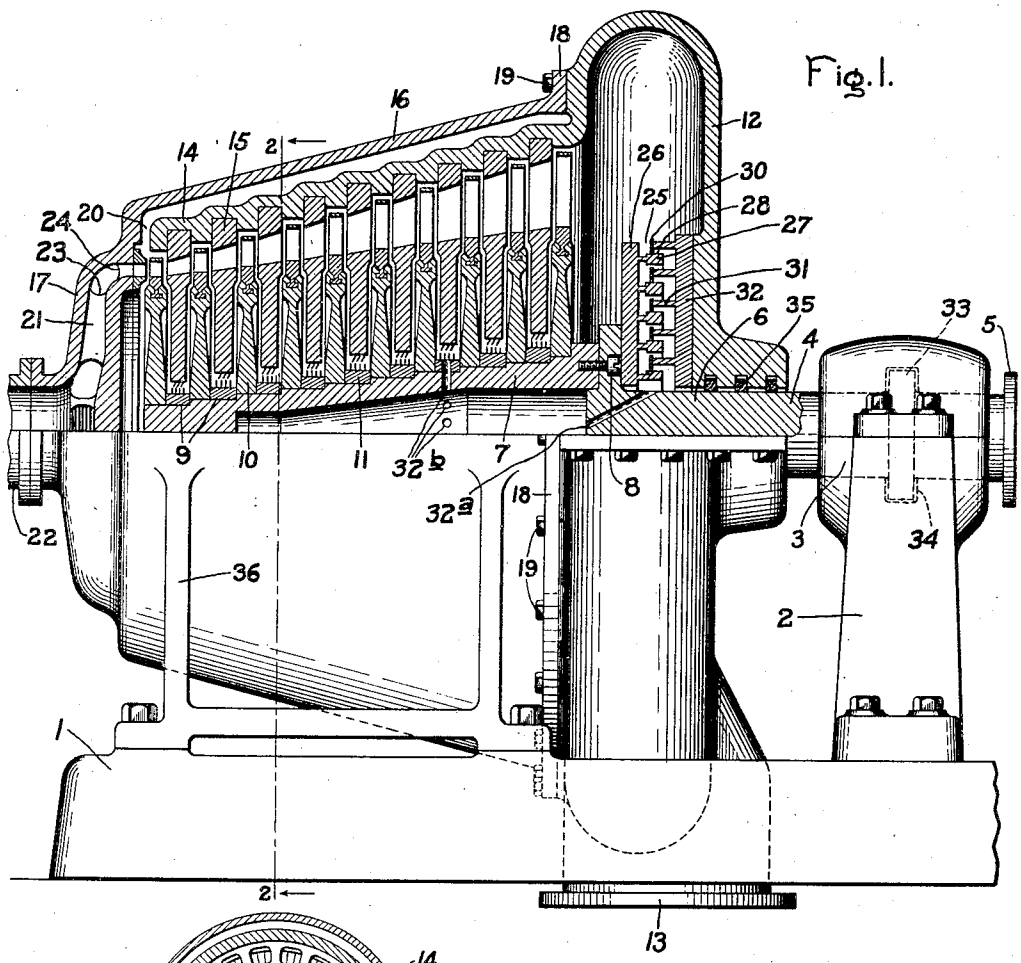
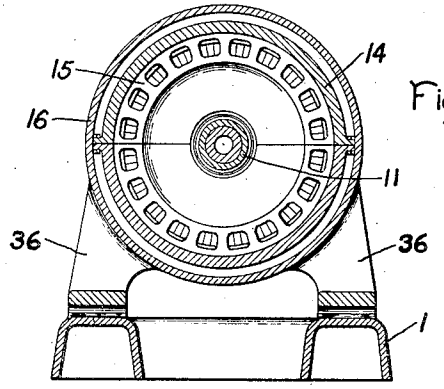



Fig. 2.




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## ELASTIC-FLUID TURBINE.

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The present invention relates to elastic fluid turbines.

Within recent years there have come into use for operating turbines, elastic fluid pressure much higher than ever before, pressures of the order of 1000 lbs. per sq. in. being now in actual use and pressures even higher than that being considered. Turbines for use with such pressures comprise usually a small high pressure unit in which the elastic fluid is used initially and from which it exhausts to one or more lower pressure units, and the present invention relates especially to a small high pressure unit of this type.

The object of my invention is to provide an improved turbine structure well adapted for use with high elastic fluid pressure of the order referred to above, and for a consideration of what I believe to be novel and my invention, attention is directed to the accompanying description and the claims appended thereto.

In the drawing, Fig. 1 is a side elevation partly in section of a turbine structure embodying my invention; and Fig. 2 is a sectional view taken on line 2—2, Fig. 1, looking in the direction of the arrows.

Referring to the drawing, 1 indicates a base plate upon which is mounted a pedestal 2 which supports a bearing 3. In bearing 3 is a shaft 4, the right hand end of which is provided with a suitable coupling flange 5 to which the shaft of a driven machine may be attached. Shaft 4 is overhung in bearing 3 and is formed preferably in two parts, a solid part 6 and a hollow part 7, fastened together by bolts 8. Hollow shaft portion 7 is solid at its high pressure or left hand end and is open at its low pressure or right hand end where it bolts to shaft portion 6. Also at its high pressure end it is smallest in diameter and increases step by step in diameter to its low pressure end, the successive steps being indicated by the reference numeral 9. Mounted on each step is a turbine wheel 10 and a diaphragm packing element 11. These may be attached to the shaft in any suitable manner. For example, they may be shrunk on and fastened with keys.

Surrounding the low pressure end of the shaft beyond the last stage wheel is an exhaust housing 12 provided with a discharge opening 13, and carried by housing 12 is an inner casing 14 in which nozzle diaphragms 15 are mounted. Preferably casing 14 is formed integral with housing 12. Housing 12 and inner casing 14 and also diaphragms 15 are formed in upper and lower halves, following the usual turbine practice, so as to facilitate manufacture and assembly.

Surrounding inner casing 14 in spaced relation to it is an outer casing 16 which is closed at its high pressure end by a head or end wall 17. The low pressure end of casing 16 is open and is attached to exhaust housing 12 in any suitable manner. In the present instance, it is shown as being provided with a flange 18 which is fastened to housing 12 by a ring of bolts 19. The annular space between casings 14 and 16 is open to the first stage of the turbine through a passage 20. In head or end wall 17 is formed an elastic fluid chest 21 to which elastic fluid is supplied by a conduit 22. Chest 21 may be formed in any suitable manner. In the present instance, it is shown as being formed by making end wall 17 of two plates connected together by webs 23 and 24, the whole being an integral structure.

At the low pressure end of the turbine is a balancing packing 25 for balancing end thrust on the turbine shaft. It may be of any suitable type. It is shown in the present instance by way of example as comprising a disc 26 attached to shaft 4 and provided with annular, axially-extending projections 27 which present packing surfaces 28. Packing against surfaces 28 are packing teeth 30 carried by projections 31 formed on a ring 32 which in turn is attached to exhaust housing 12. The inner end of packing 25 is connected to the interior of shaft portion 7 by one or more openings $32^a$ and such interior is in turn connected to a stage of the turbine of suitable pressure by openings $32^b$. With this arrangement, it will be seen that the right hand surface of disc 26 is subjected to a pressure higher than that of the left hand surface so as to produce an end thrust toward the left. In addition to the balancing packing 25 for balancing end thrust on shaft 4, I provide also a thrust bearing which in the present instance is shown as being combined with the supporting bearing 3. It comprises a collar 33 on the shaft which engages a thrust surface 34 in bearing 3. At 35 is a shaft packing which may be of any suitable type.

The casing may be supported in any suitable manner. It is shown as being provided with feet 36 which are bolted to base plate 1.

The purpose of the stepped structure of the shaft is to reduce the end thrust on the rotor, due to the elastic fluid pressure, to a minimum value. It will be clear that there is an end thrust on the rotor because of the unbalanced area of the shaft. By making the high pressure end of the shaft of the smallest permissible diameter and then gradually increasing the diameter of the shaft toward the lower pressure end of the turbine this end thrust becomes a minimum. It will be equal to the end thrust on the high pressure end of the shaft plus the pressure on the successive steps of the shaft. This gives a total pressure less than that which would exist were the shaft of uniform diameter because the elastic fluid pressure becomes less and less toward the low pressure end of the machine and hence the pressure acting upon successive steps becomes smaller from step to step.

The end thrust on the shaft is balanced in part by the balancing packing 25, the excess of pressure on the right hand face of disc 26 over that on the left hand side opposing the end thrust, and in part by the thrust bearing comprising parts 33 and 34.

The outside casing 16 and head 17, being made as an integral cylindrical structure, is strong and can be dimensioned readily to withstand the high elastic fluid pressure. It is substantially stronger than it would be were it split axially as in standard turbine practice. Furthermore, since it is a complete integral cylindrical structure, there are no axial joints to be bolted together and made pressure tight. On the other hand, the inner casing 14 which forms the diaphragm support and is split axially is subjected to a greater pressure on its outer surface than on its inner surface so that the problem of pressure and tight joints does not enter into the construction of this part of the machine. The pressure in the exhaust housing 12 is comparatively low as compared with the initial pressure so that no difficulty is experienced in making its axial joints pressure-tight.

By making the shaft 4 overhung, I avoid the use of a packing at the high pressure end of the machine which means that the leakage losses are decreased and also that there is avoided the difficult problem of providing a very high pressure packing. At the same time I dispense with one bearing.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof, but I desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. In an elastic-fluid turbine, the combination of a bearing, a shaft mounted in the bearing and having its end overhung, said shaft increasing in diameter in steps from its outer overhung end toward the bearing, a plurality of bucket wheels mounted on the successive steps of the shaft, a divided casing surrounding said bucket wheels, an exhaust hood adjacent the bearing with which the casing is connected, an outer casing surrounding said inner casing in spaced relation thereto, said casing having a head forming a closure for one end, means for supplying fluid under pressure to the space between the casings, and means connected with the shaft for balancing the end thrust thereon.

2. In an elastic-fluid turbine, the combination of a casing, an exhaust housing with which said casing is connected, a shaft bearing adjacent the exhaust housing, a shaft mounted in the bearing and extending therefrom axially into the casing, means providing a plurality of successive stages within the casing surrounding said shaft and including a plurality of bucket wheels, said shaft increasing in diameter in steps in the direction of the exhaust housing and said bucket wheels being mounted on the successive steps of the shaft, an integral cylindrical outer casing surrounding the first-named casing in spaced relation thereto, means for supplying high-pressure elastic-fluid to the space between the casings, an end head for the outer casing integral therewith, and means for balancing the end thrust on the shaft.

3. In a multistage elastic fluid turbine, the combination of a casing, an exhaust housing with which said casing is connected, a shaft bearing adjacent the exhaust housing, a shaft mounted in the bearing and extending therefrom axially into the casing, said shaft having a solid portion adjacent the bearing and a hollow portion within the casing, an integral cylindrical outer casing surrounding the first-named casing in spaced relation thereto, the space between said inner and outer casings being open to an initial stage of the turbine, whereby the elastic fluid pressure of said stage is established therein, said outer casing being secured at one end to the exhaust housing and having an end head, an elastic fluid inlet chest in said head adjacent the first stage of the turbine, means for supplying elastic fluid to said chest, a balancing packing connected with the shaft for balancing the end thrust thereon and being located in the exhaust housing, and conduit means including the hollow portion of the shaft for conveying elastic fluid from an intermediate stage to the balancing packing.

4. In an elastic fluid turbine, the combination of a bearing, an overhung shaft in said bearing, said shaft increasing in diameter in steps from its high pressure end to its low pressure end, bucket wheels mounted on successive steps of said shaft, an exhaust housing, an inner casing formed integral with the exhaust housing, diaphragms supported by said inner casing, an outer casing attached to said exhaust housing, said outer casing being in the form of a continuous cylinder and having a head formed integral therewith, and means for balancing the axial thrust on said shaft.

5. In an elastic fluid turbine, the combination of a casing, a shaft which projects into the casing, said shaft being hollow and increasing in diameter in steps from its high pressure end to its low pressure end, bucket wheels mounted on successive steps of said shaft, a balancing packing for the shaft, and conduits for conveying elastic fluid to the hollow shaft and from said hollow shaft to the balancing packing.

6. In a multistage elastic fluid turbine, the combination of a casing, an exhaust housing with which said casing is connected, a shaft bearing adjacent the exhaust housing, a shaft mounted in the bearing and extending therefrom axially into the casing, said shaft having a solid portion adjacent the bearing, and a hollow portion within the casing, an integral cylindrical outer casing surrounding the first-named casing in spaced relation thereto, said casing being secured at one end to the exhaust housing and having an integral end head, the space between the inner and outer casings being open to said first stage whereby the first stage elastic fluid pressure is established therein, a balancing packing connected with the shaft for balancing the end thrust thereon, said packing having a low pressure end communicating with the interior of the exhaust housing and a higher pressure end communicating with an intermediate stage through the hollow portion of the shaft, and means connected with the shaft providing a thrust bearing therefor.

7. In an elastic-fluid turbine, the combination of a divided inner casing for a plurality of stages, said casing having an inlet end and an exhaust end, a bearing adjacent the exhaust end, a shaft carried by said bearing, said shaft overhanging the bearing and extending axially within the casing, means providing an integral enclosing casing for the inner casing having a closed head end adjacent the inlet end of the latter, said outer casing being spaced from the inner casing, conduit means connecting the space between said casings with an initial stage of the turbine, an exhaust housing, and means connected with the shaft for balancing end thrust thereon, said means including a balancing packing communicating at one end with the interior of exhaust housing, and at its opposite end with an intermediate stage.

In witness whereof, I have hereunto set my hand this 22nd day of July, 1924.

JOHN H. DORAN.