R. HARRISON.

ELASTIC FLUID TURBINE.

APPLICATION FILED OCT. 8, 1910.

1,010,905.

Patented Dec. 5, 1911.

2 SHEETS—SHEET 1.

Fig. 1.

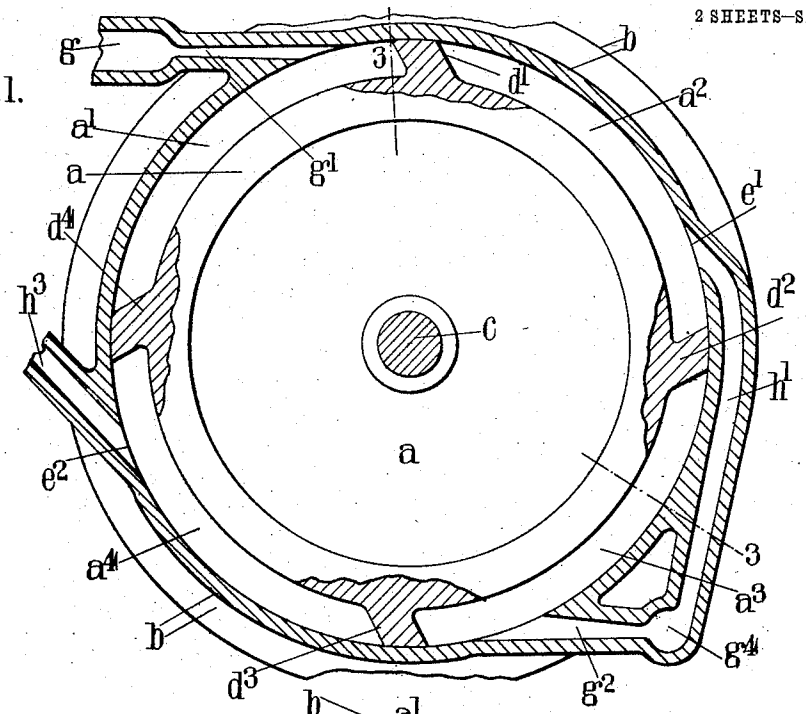
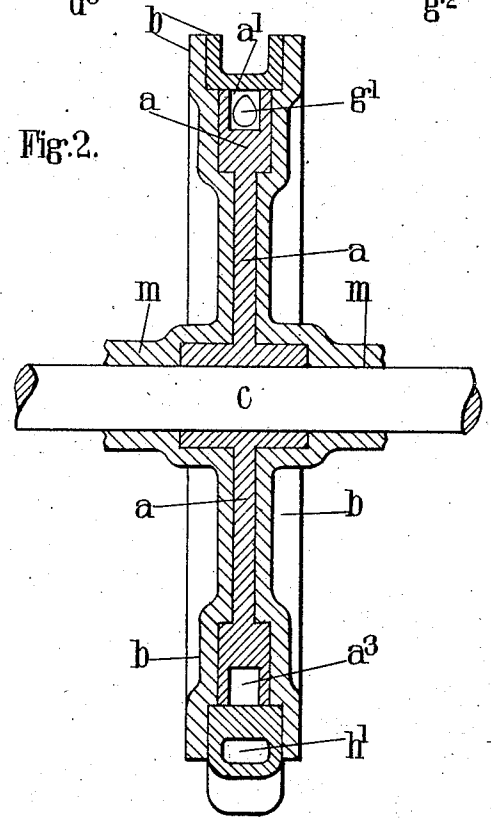


Fig. 2.



WITNESSES

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2 SHEETS—SHEET 2.

Fig. 3.

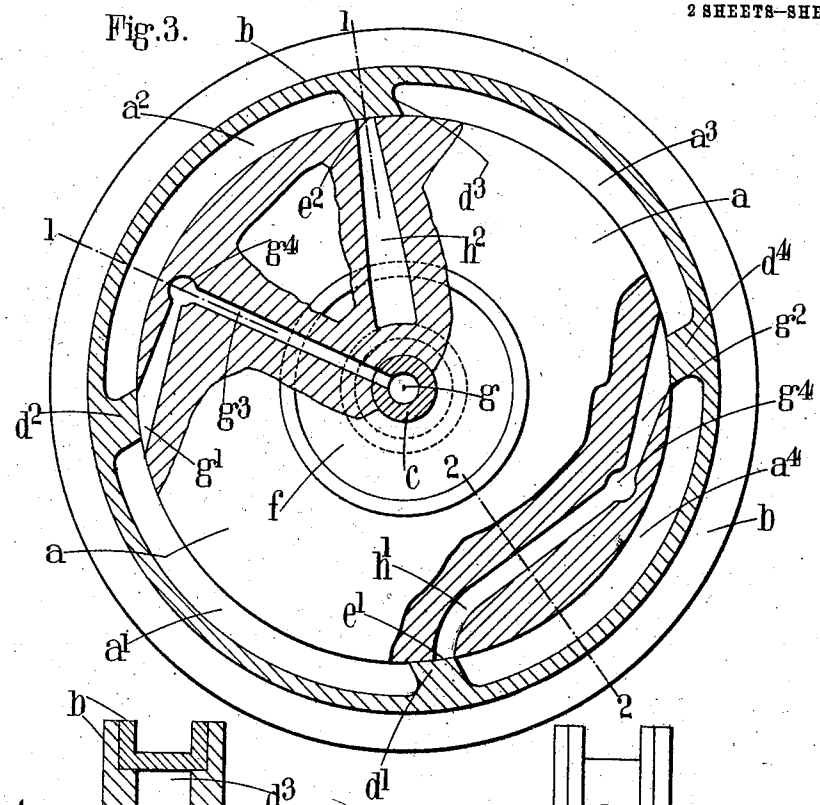


Fig. 4.

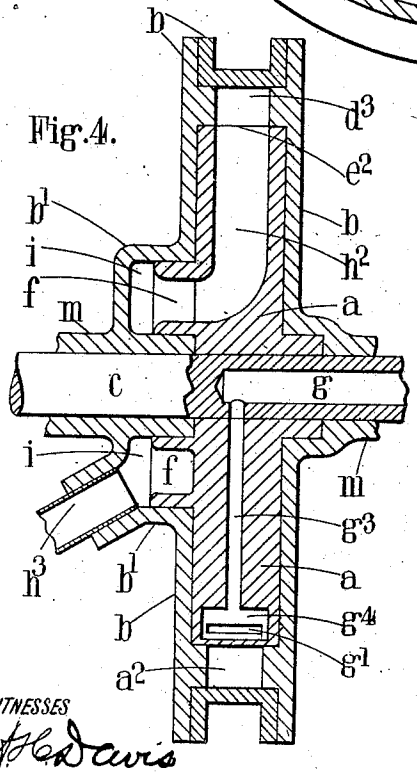
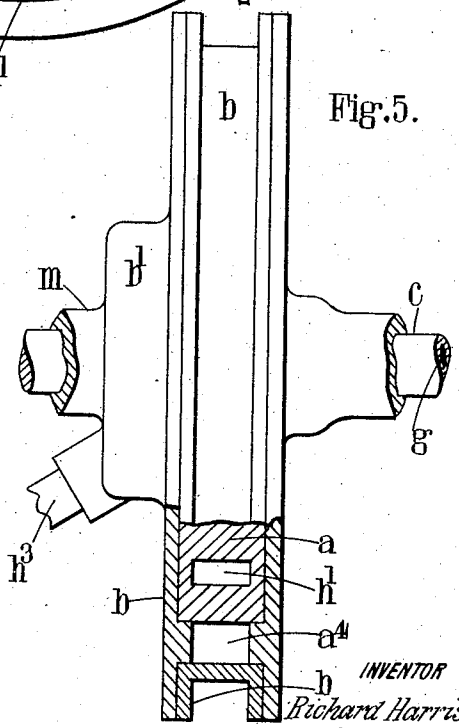


Fig. 5.



WITNESSES

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UNITED STATES PATENT OFFICE.

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ELASTIC-FLUID TURBINE.

1,010,905. Specification of Letters Patent. Patented Dec. 5, 1911.

Application filed October 8, 1910. Serial No. 586,000.

To all whom it may concern:

Be it known that I, RICHARD HARRISON, a subject of the King of Great Britain, and resident of 58 Chancery Lane, in the county of London, England, engineer, have invented certain new and useful Improvements in Elastic-Fluid Turbines, of which the following is a specification.

My invention refers to improvements in elastic fluid turbines and the only form of turbine to which the said invention is applicable comprises a rotor mounted upon a shaft and revolving within a fixed cylindrical casing, and depending for its action upon the impact and continued action, through a large arc of rotation, of two or more steam jets issuing in a substantially tangential direction from the circumference of the rotor or the casing and acting upon vanes or abutments formed upon or fixed to the inner circumference of the cylindrical casing or the periphery of the rotor as the case may be, the steam nozzles, exhaust openings, and vanes or abutments being arranged in such a manner that no exhaust opening shall be open to any section of the annular channel between the cylindrical casing and the rotor until the steam has been cut off from such section.

In turbines of this type the number of exhaust openings must be equal to that of the nozzles and the number of vanes or abutments must be double that of either. And further, the angles contained between the lines drawn from the centers of the circumferential faces of adjoining vanes or abutments to the axis of the rotor must be equal to the angle formed by the like lines from the centers of adjoining steam nozzles and exhaust openings, and the circumferential length of each vane or abutment must be such that the exhaust opening is covered by it before the adjoining and corresponding nozzle is opened by the adjoining vane or abutment. The said vanes or abutments are so placed and are of such a number that the annular channel between the rotor and the casing is divided into a series of equal sections, which sections are of considerable length so that the steam after admission may act through a considerable distance, before it passes to the exhaust, in contradistinction to the steam action being restricted to momentary impacts.

The invention has for its object to produce an efficient turbine of simple and strong construction having the steam nozzles, exhaust openings, and connecting channels so arranged that the work to be done by the steam shall be distributed over two or more stages arranged around the circumference of a single rotor.

For the purpose of this invention all the nozzles are what are known as expansion nozzles, for example such as Laval nozzles. Live steam is admitted to the first nozzle, and the issuing jet having entered the first section of the annular channel between the casing and the rotor and having acted upon a vane or abutment through an arc of rotation corresponding to the arc formed by one section of the annular channel, the exhaust steam passes away from the said section of the annular channel through the first exhaust opening and is led by means of a suitable connecting channel to the second nozzle and, having acted upon a vane or abutment, passes away from that section of the annular channel through the second exhaust opening, and so on through the requisite number of nozzles until the last exhaust opening is reached, whence it is led through a suitable pipe or channel to a condenser or to the outer air.

Each nozzle is so formed and adjusted, and the number of nozzles employed is such, that the steam shall be so expanded in each successive nozzle that the desired pressure and the same velocity shall be attained at the mouth of each nozzle, and that each nozzle shall pass a like weight of steam, and that the desired total expansion of the steam shall be effected.

Means may be provided for the purpose of maintaining the temperature of the steam during its passage through the turbine, such as by jacketing the turbine or any part or parts thereof with live steam.

The steam supplied to the initial nozzle and to the steam jacket may be superheated.

The mouths of the nozzles are preferably of the same width as the annular channel.

It has been proposed to construct elastic fluid turbines with pockets formed upon the periphery of the rotor, or upon the inner circumference of the casing, and to bring two or more of the said pockets into connection during the revolution of the rotor, by means of channels formed either in the cas-

ing or in the body of the rotor. Such inventions were not, however, applied to turbines of the type to which the present invention is only applicable, neither were the means adapted for carrying out the said proposals similar to the arrangement hereinbefore described.

I will now proceed to describe my invention with reference to the accompanying drawings which are diagrammatic and from which the nature of my invention will be more clearly understood.

Figure 1 is a transverse section of a turbine constructed in accordance with this invention, in which the steam nozzles and exhaust openings are formed in the cylindrical casing and the vanes or abutments on the periphery of the rotor. Fig. 2 is a longitudinal section taken on the line 3—3, Fig. 1. Fig. 3 is a transverse section of a similar type of turbine to that shown in Figs. 1 and 2, but having the steam nozzles and exhaust openings formed in the rotor and the vanes or abutments on the cylindrical casing. Fig. 4 is a longitudinal section taken on the line 1—1, Fig. 3. Fig. 5 is a longitudinal section taken on the line 2—2, Fig. 3.

The same reference letters indicate like parts in all the figures.

a is the rotor mounted upon a shaft c revolving in bearings m formed integrally with the side covers of the cylindrical casing b. The annular channel between the rotor a and the cylindrical casing b is divided into sections a^1, a^2, a^3 and a^4 by the vanes or abutments d^1, d^2, d^3 and d^4.

g is the live steam inlet.

g^1 is the first and g^2 the second nozzle.

e^1 and e^2 are the first and second exhaust openings respectively, and h^3 is the final exhaust opening to a condenser or to the atmosphere.

Referring to Figs. 1 and 2, the rotor a is mounted upon the shaft c and has formed on or fixed to its periphery, vanes or abutments d^1, d^2, d^3 and d^4. The casing b consists of a cylindrical shell and two side covers. The first and second nozzles g^1, g^2 and the exhaust openings e^1, e^2 are in the cylindrical shell, and the side covers of the casing b carry the bearings m in which the shaft c rotates. A suitable connecting channel h^1 serves to lead the exhaust steam from the exhaust opening e^1 to the second nozzle g^2. As shown in Figs. 1 and 2, each section of the annular channel is formed by the periphery and side flanges of the rotor a and the inner circumference of the cylindrical shell of the casing b and two vanes or abutments. The rotor a with its vanes or abutments d^1, d^2, d^3, d^4 is of such dimensions that it shall revolve freely within the casing b but with a minimum clearance in order that friction and leakage losses may be minimized. The action of the turbine constructed as lastly described is as follows:— Live steam passes from the inlet passage g to the initial nozzle g^1 in which it is expanded to the desired degree, and the issuing jet impinges upon the vane or abutment d^1 and continues to act thereon until the first exhaust opening e^1 is uncovered to the annular section a^1 by the passage beyond it of the vane or abutment d^1. When the exhaust opening e^1 is uncovered as above described, the first nozzle g^1 is closed to the annular section a^1, and opened to section a^4 by the passage of the vane d^4. When the exhaust opening e^1 communicates with the annular section a^1, the exhaust steam therefrom is led by the connecting channel h^1 to the second nozzle g^2. The further expanded steam, issuing from the mouth of the nozzle g^2, then acts upon the vane or abutment d^2 until the passage of the latter beyond the last exhaust opening e^2, when the exhaust from the section a^2 is carried away by the pipe h^3 to the condenser or to the atmosphere. As previously described with reference to the nozzle g^1, at the moment of the annular section a^2 being opened to the exhaust opening e^2, the nozzle g^2 is closed to the section a^2 and commences its action on the vane or abutment d^1, the action of the nozzle g^1 commencing upon the vane or abutment d^3 at the same time.

In the modification shown in Figs. 3, 4 and 5, live steam passes from an axial channel g formed in the shaft c to the radial passage g^3 formed in the body of the rotor and thence to a base chamber g^4, from which latter originates the initial nozzle g^1. The first exhaust opening e^1 communicates with a passage h^1 in the body of the rotor, which passage leads to the base chamber g^4 from which the second nozzle g^2 originates. The second exhaust opening e^2 communicates, by means of the radial passage h^2 in the body of the rotor, with the axial exhaust chamber f formed in this case in the rotor and opening into the exhaust box or chamber i formed by a portion b^1 of a side cover of the cylindrical casing. The exhaust finally passes from the exhaust box i through the pipe or channel h^3 to a condenser or to the outer air. The vanes or abutments d^1, d^2, d^3 and d^4 are formed upon or fixed to the inner circumference of the cylindrical shell of the casing b, the side covers of which have also formed integrally with or fixed to them the bearings m in which the shaft c carrying the rotor a revolves. The connection between the main steam pipe and the axial steam passage g in the shaft c is kept pressure-tight by means of a suitable stuffing box or similar device. The action of this modification is similar to that hereinbefore described with reference to Figs. 1 and 2, the vanes or abutments and the steam noz-

zles and exhaust openings being so arranged with relation to each other that no annular section can be open at the same time to a steam inlet and an exhaust opening, and further that the exhaust steam from any section which has just passed from the initial nozzle is carried to the second nozzle whence, after having done further work on a vane or abutment, it is carried by the final exhaust opening to a condenser or to the atmosphere.

It must be understood that, although only two nozzles and exhaust openings are shown together with four vanes or abutments, I do not limit myself to this number, but that in carrying out this invention, whatever number of nozzles are employed, there must be an equal number of exhaust openings and twice the same number of vanes or abutments.

Although it is hereinbefore stated that the nozzles employed for the purpose of this invention are expansion nozzles, it should be understood that they need not necessarily be divergent.

Suitable means such as labyrinth packing may be provided for preventing leakage.

Suitable provision is made for the lubrication of the working parts.

Claims.

1. In a turbine of the type described, the combination of a casing constituting a fixed member, and a rotor member arranged within the casing and forming therewith an annular channel, one of said members having vanes or abutments which divide the annular channel into sections of considerable length for the action of the steam, and the other member having expansion nozzles and exhaust openings arranged alternately, the first of said expansion nozzles conducting the live steam to a section of said annular channel to act on one of said vanes or abutments and the last exhaust opening leading from one of said sections of the annular channel to the outside of the turbine, and a connection between each of the remaining exhaust openings and the succeeding expansion nozzle to convey the steam from one section of the annular channel to the succeeding section.

2. In a turbine of the type described, the combination of a cylindrical casing member, a rotor member mounted within the casing and forming therewith a channel between the periphery of the rotor and the inner circumference of the casing, vanes or abutments on one of said members and spaced apart dividing the said channel into sections of considerable length, whereby the steam has a continued action through a large arc of rotation, expansion steam nozzles and exhaust openings in the other member, the expansion nozzles directing the steam in a substantially tangential direction from the circumference of the said member, the said vanes or abutments, the expansion steam nozzles and the exhaust openings being arranged as described whereby steam is shut off from each section of the annular channel before such section is opened to the exhaust, the first of said expansion steam nozzles admitting live steam to the said annular channel and the last exhaust opening leading from said channel to the outside of the turbine, and a connection between each remaining exhaust opening and the succeeding expansion steam nozzle for the passage of the steam, whereby the work to be done by the steam is distributed over a plurality of stages arranged around the circumference of the rotor.

3. In a turbine of the type described, the combination of a cylindrical casing member, a rotor member mounted concentrically within the casing and forming therewith an annular channel between the periphery of the rotor and the inner circumference of the cylindrical casing, vanes or abutments on one of said members and dividing the said annular channel into equal sections of considerable length, and expansion nozzles and exhaust openings in the other member, the expansion nozzles and exhaust openings being equal in number, and the number of each being one half that of the vanes or abutments, the said vanes or abutments the expansion nozzles and the exhaust openings being disposed as described, whereby when the steam is cut off from each section of the annular channel such section is opened to the exhaust, the first of said expansion nozzles admitting the live steam to the said annular channel and the last exhaust opening leading from the turbine, the turbine being provided with a passage connecting the exhaust opening of one section of the annular channel with the expansion nozzle discharging into the succeeding section, the said expansion nozzles being adjusted whereby the desired degree of total expansion is effected and the weight and velocity of the steam passing through each expansion nozzle is the same.

RICHARD HARRISON.

Witnesses:

GORDON MELVILLE CLARK,

COLIN C. M. GIBSON.