Dec. 10, 1935. A. LYSHOLM 2,023,482

STEAM INLET FOR RADIAL FLOW TURBINES

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Fig. 1

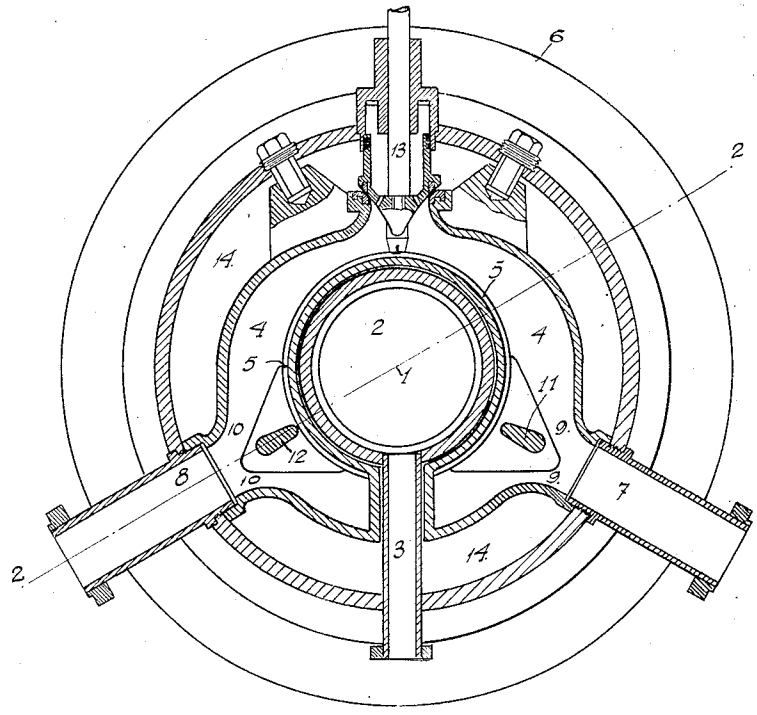
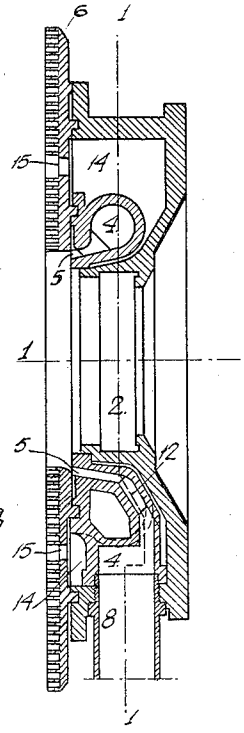


Fig. 2



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STEAM INLET FOR RADIAL FLOW TURBINES

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Fig. 3

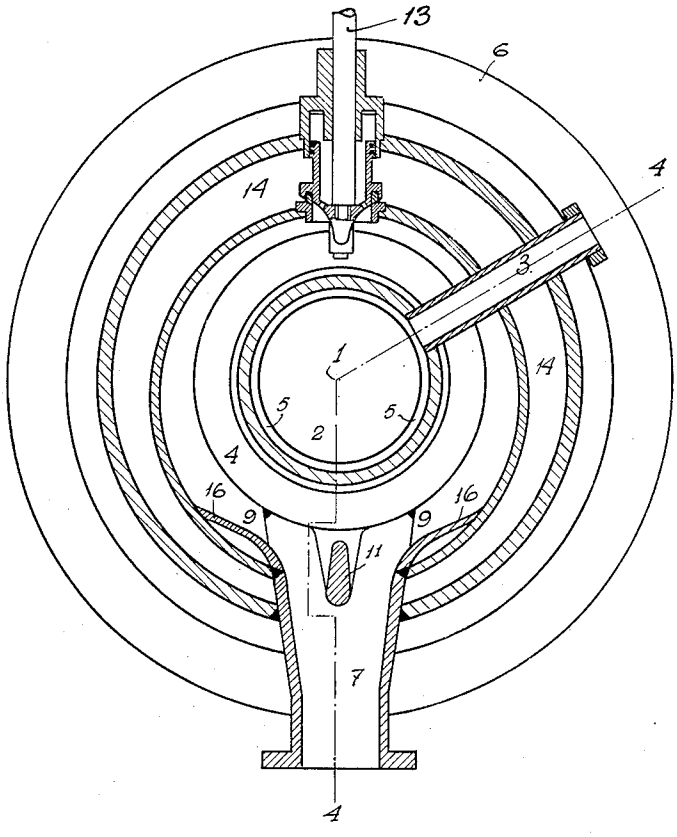
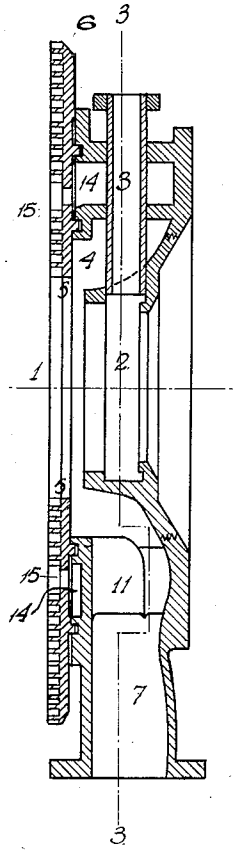


Fig. 4



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STEAM INLET FOR RADIAL FLOW TURBINES

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Fig. 5

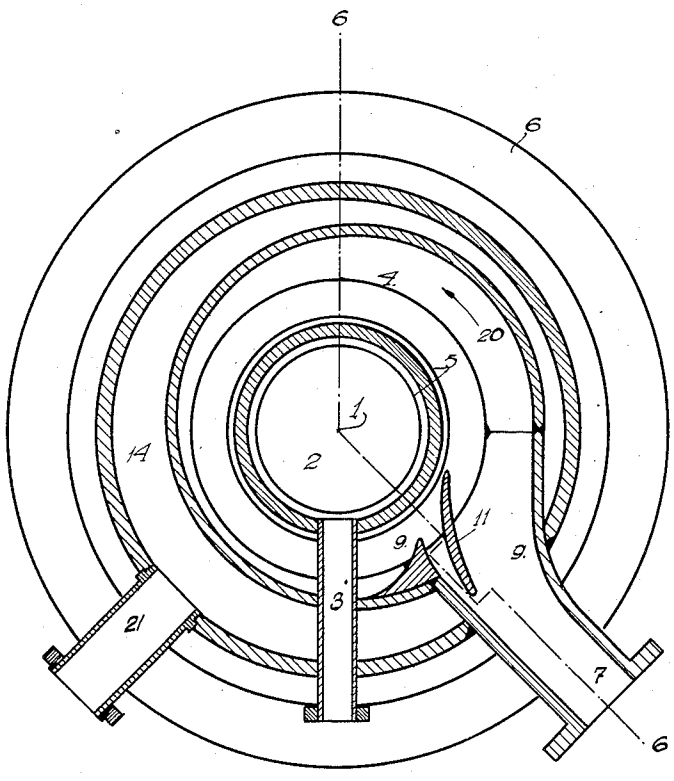
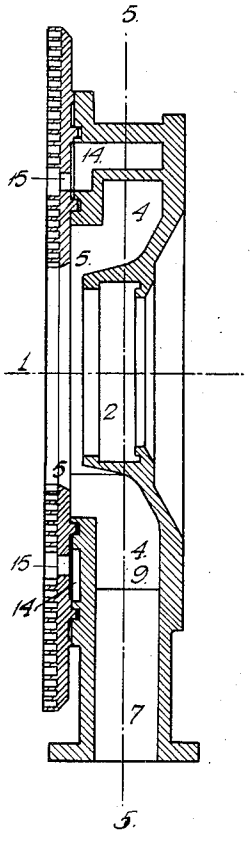


Fig. 6



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STEAM INLET FOR RADIAL FLOW TURBINES

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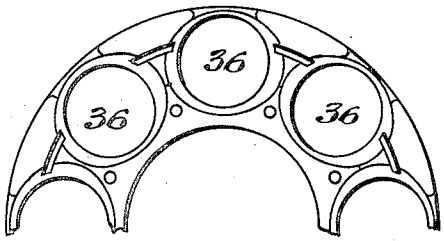


Fig. 12

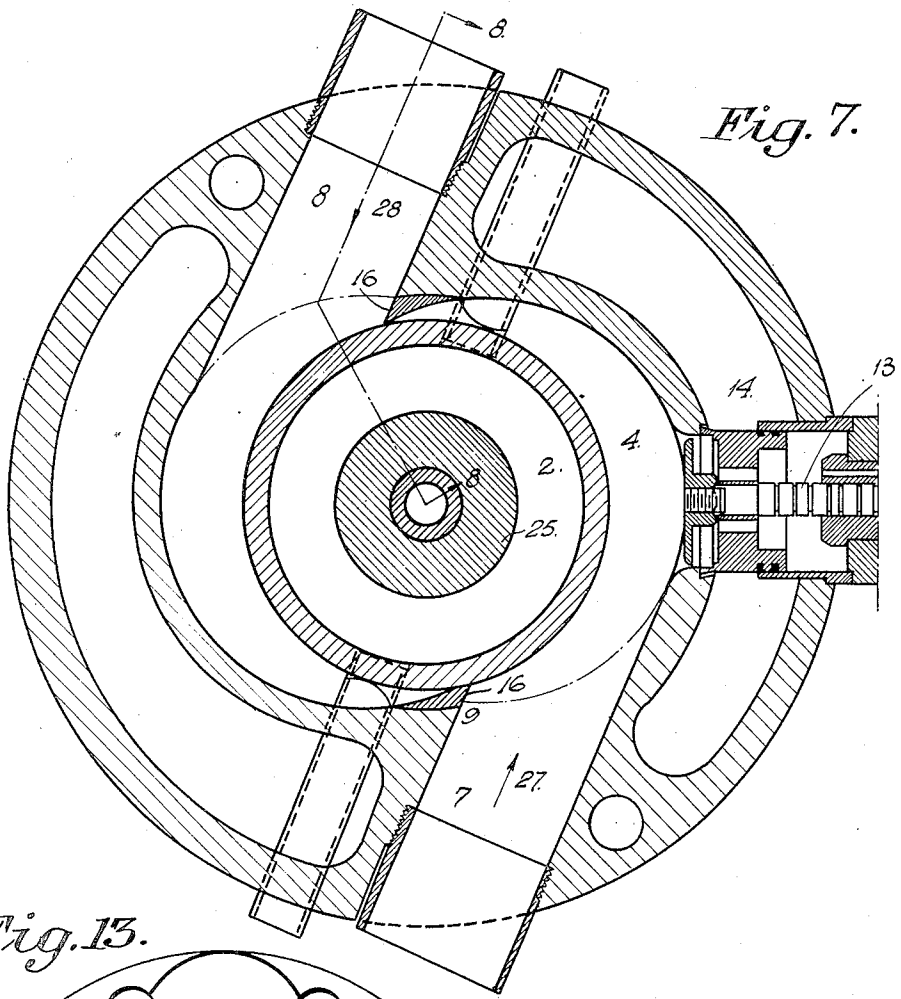
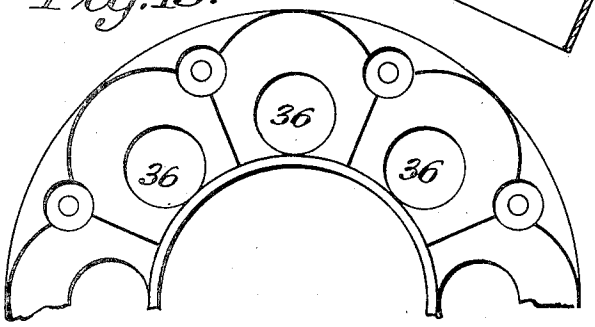


Fig. 7.

Fig. 13.



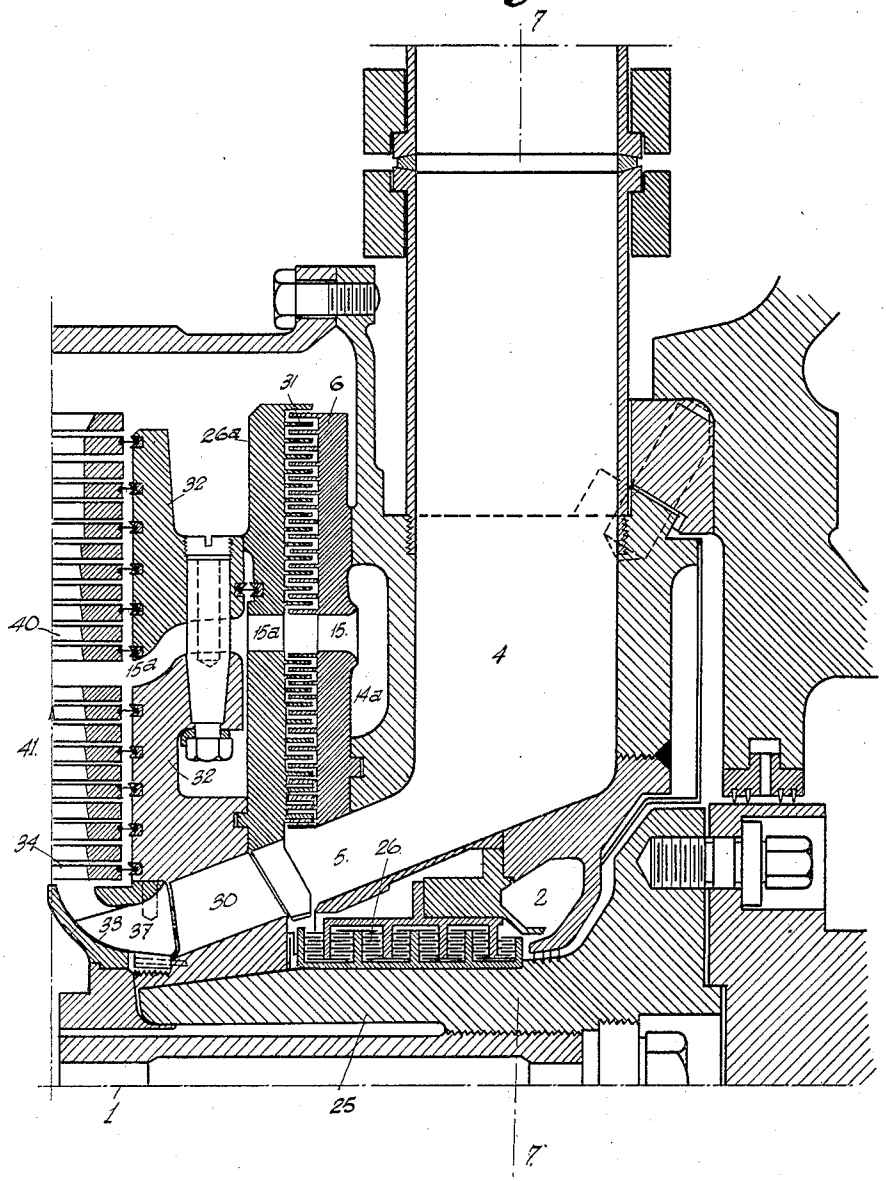
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STEAM INLET FOR RADIAL FLOW TURBINES

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Fig. 8



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Fig. 9

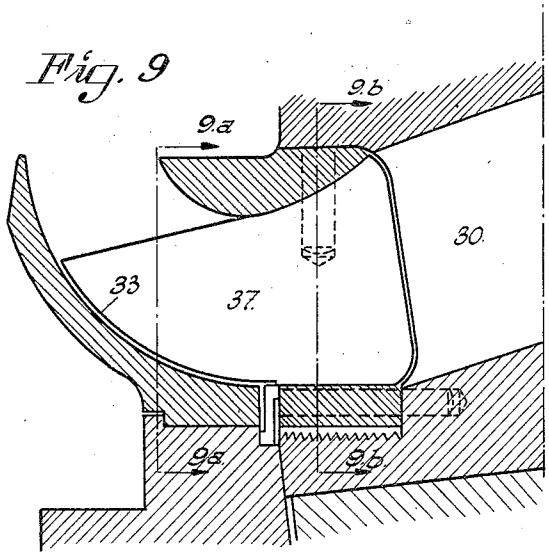


Fig. 9a

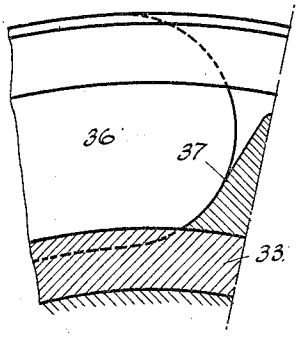
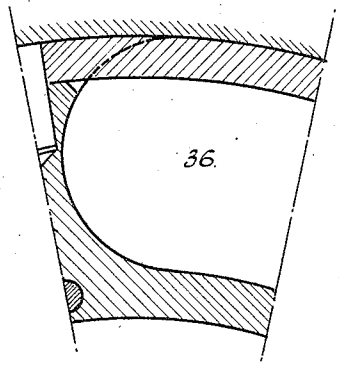


Fig. 9b



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STEAM INLET FOR RADIAL FLOW TURBINES

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Fig. 10

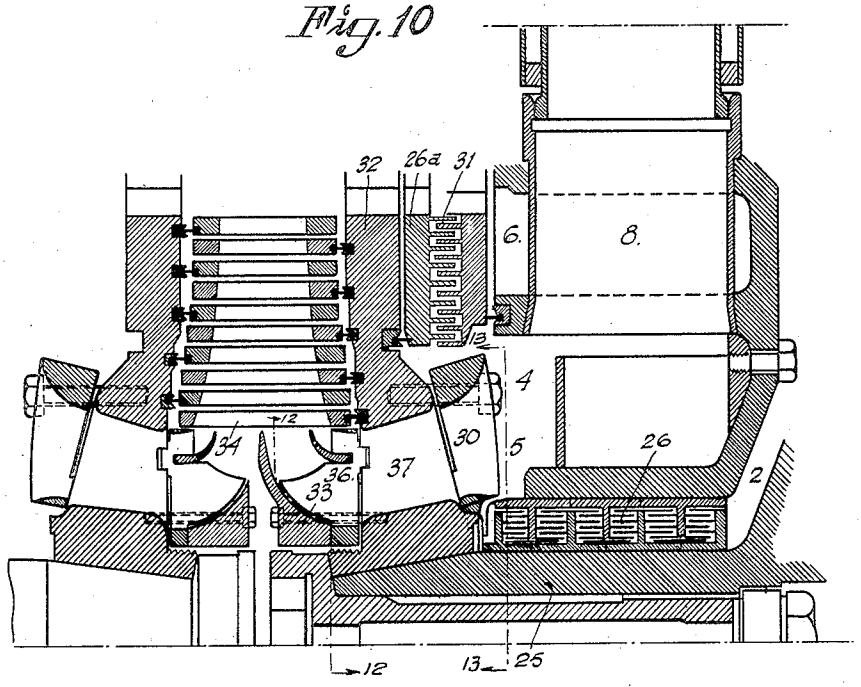
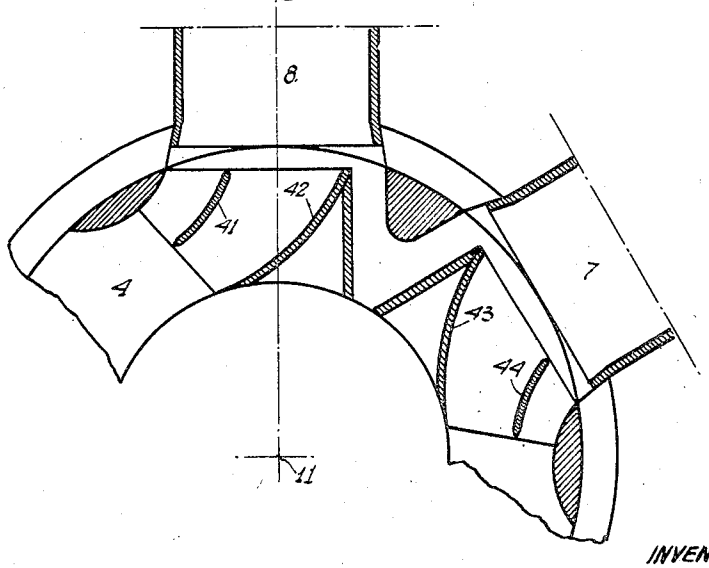


Fig. 11



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Patented Dec. 10, 1935 2,023,482

UNITED STATES PATENT OFFICE

2,023,482

STEAM INLET FOR RADIAL FLOW TURBINES

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Application July 3, 1930, Serial No. 465,505. Renewed February 20, 1935. In Sweden December 10, 1929

15 Claims. (Cl. 253—16.5)

In modern steam turbine construction, the endeavor is to construct turbine units within as small a space as possible and to obtain in such turbines the highest possible power and efficiency. With this in view, the internal construction of such turbines, that is, the blade systems and the parts cooperating therewith, have already been improved to a considerable extent and in some instances other parts of the turbine as well have been improved in order to obtain still higher turbine efficiencies.

In making such improvements, however, the losses caused by the formation of eddies and other factors in connection with the flow of steam from the throttle valve or other control apparatus to the turbine have not been properly considered. This is particularly true in the case of radial flow steam turbines having central flow admission, that is, turbines of the radial type to which the entire steam supply to the turbine is introduced at or adjacent to the axis of rotation of the turbine.

In turbines of this type the steam supply passages have heretofore caused numerous abrupt changes in direction of flow of the incoming steam and the character of the steam passages has been such as to cause considerable turbulence in the steam flow. Both of these factors cause considerable loss in the overall efficiency of the turbine. Such losses have heretofore been considered more or less unavoidable because of the difficulties connected with the distribution of the steam to the blade system of the turbine from the steam inlet passage or passages.

The present invention relates to the construction of steam inlets for such radial flow turbines and has for its object the provision of means, by which the steam is supplied to the turbine with as low losses as possible.

According to the invention, the steam inlet is so constructed that the connections between the various members for effecting the supply of steam to the turbine, that is to say to the blade system, are of stream-lined form.

Further characteristic features of the invention will hereinafter be more fully described with reference to the accompanying drawings, forming part of this specification.

Fig. 1 is a vertical section through the steam inlet part of a radial flow turbine casing built in according to the invention. Fig. 2 is a section through the same steam inlet part, taken parallel with the axis of the turbine shafts on the line 2—2 in Fig. 1, Fig. 1 being a section on the line 1—1 in Fig. 2. Figs. 3 and 4 show sections similar to Figs. 1 and 2, of a modified embodiment of the invention, Fig. 3 being a section on the line 3—3 in Fig. 4 and Fig. 4 being a section on the line 4—4 in Fig. 3. Figs. 5 and 6 show similar sections of another modified embodiment of the invention, Fig. 5 being a section on the line 5—5 in Fig. 6 and Fig. 6 being a section on the line 6—6 in Fig. 5. Fig. 7 is a section through still a further modification of the invention, being a section on line 7—7 in Fig. 8, while Fig. 8 is a vertical section through a quarter of a turbine embodying the improvements according to the invention and being a section on the line 8—8 in Fig. 7. Figs. 9, 9*a* and 9*b* are sections through details of the steam inlet, Fig. 9*a* being a section on the line 9*a*—9*a* in Fig. 9, and Fig. 9*b* being a section on the line 9*b*—9*b* in Fig. 9. Fig. 10 is a section through a part of a turbine embodying further modified details of the steam inlet according to the invention. Fig. 11 is a horizontal section through details shown in Fig. 10. Figs. 12 and 13 show diagrammatically details of the steam inlet.

Referring to Figs. 1 and 2, 1 designates the axis of rotation of the turbine, 2 the space in the casing for the turbine shaft and the shaft packing, and 3 an outlet conduit for steam leaking out through said packing. 4 designates an inlet chamber part of which is spiral in form and which around its whole circumference is in communication, by means of channels 5, with the inner or first blade ring of the blade system, as viewed in the direction of the flow of steam. 6 designates the non-rotating part of a labyrinth packing of the type used in Ljungström turbines and more clearly shown in Figs. 8 and 10, said packing being situated between the steam supply device and the blade system.

The steam inlet chamber 4 is in communication, by means of two steam supply conduits 7 and 8 with a steam throttle valve or like control device. The steam supply chamber 4 is, according to the principle of the invention, at 9 and 10 respectively connected, by stream-line spaces, with the steam supply conduits 7 and 8 respectively. The walls of the jackets which form the steam supply chamber 4 are curved having a large radius of curvature, a partition 11 and 12 respectively at each steam supply conduit assisting in turning or spreading the steam from the conduits 7 and 8, respectively, into the chamber 4 with as small losses as possible. In order to further maintain the losses as small as possible, the supply chamber 4 is made in generally spiral form in such manner that its cross-sectional area de-

creases as the distance from the supply conduits 7 and 8 increases, the decrease in cross-sectional area being proportioned in accordance with the discharge of the steam from the supply chamber to the blade system of the turbine.

The supply chamber 4 is in communication, by means of a valve device 13, with chamber 14, which is situated radially on the outside of the supply chamber 4, whereby the steam may be led over from the chamber 4 to the chamber 14, and in this manner the steam is fed through openings 15 in the labyrinth packing disk 6 to the blade system at a place which, as viewed in the direction of the flow of steam, is situated behind the first blade ring.

When the turbine is operated under an overload the additional supply of steam to chamber 14 is provided either by automatic or manual control.

In Figs. 3 and 4 the same reference numerals have been used for corresponding parts as in Figs. 1 and 2.

In this case, the supply chamber 4 is connected with a throttle valve or the like by means of one supply conduit 7 only. The connection between the supply conduit and the supply chamber is of stream-lined form so that flow in the supply chamber at the points 9 as well as the flow from the conduit 7 is regular and free from turbulence. In this form of apparatus a stream-lined partition 11 is provided to assist in diverting the steam into the annular supply chamber with minimum formation of eddies and turbulence in the steam. The supply conduit 7 is welded to the outer wall of the supply chamber, and curved walls 16 having relatively great radii of curvature are provided close to the point at which the conduit 7 joins the chamber. These curved walls assist in securing smooth flow of steam. In this form of apparatus, also, the inlet chamber 4 is connected by means of valve 13 with the overload supply chamber 14.

In Figs. 5 and 6, the same reference numerals are used for corresponding parts as in the preceding figures. The supply chamber 4 is, in this embodiment, connected with the supply conduit 7 in such a manner that the steam entering through this conduit 7 is caused to enter the chamber in tangential direction and passes through the chamber in the direction indicated by the arrow 20. The supply chamber, as will be seen from Fig. 3, is of generally spiral form, the cross-sectional area thereof decreasing progressively as the distance from the inlet conduit 7 increases. In order to cause the steam to enter in this direction and with as small loss as possible, due to formation of eddies the supply chamber 4 is, according to the invention, connected in stream-line manner with the supply conduit 7 in such a manner that the channel walls forming the connections between the supply conduit 7 and the supply chamber 4, have relatively great radii of curvature. A partition or guiding blade apparatus 11 is also provided in this case, to assist in diverting the steam in the proper direction. The supply chamber 4 in this case is not connected with the overload chamber 14 but is in communication by means of a separate supply conduit which in known manner supplies overload steam to the turbine through a separate overload control.

In Figs. 7 and 8 the same reference numerals have been used for corresponding parts as in the preceding figures.

The turbine shaft 25 is connected, by means of bolts, directly to the remaining part of the shaft of the turbine set. Surrounding the shaft are arranged labyrinth packings 26 radially on the inside of a steam supply chamber 4 which has the form of a double spiral and is in communication with two supply conduits 7 and 8 which are arranged in tangential relationship to the direction of the spiral. The steam which in the conduits 7 and 8 has the direction as indicated by the arrows 27 and 28, will only gradually and without eddy formations be diverted in following the form of the supply chamber having the form of a spiral. The connection between the supply chamber 4 and the supply conduits 7 and 8, thus, is arranged in such a manner that the steam need not be subjected to any angular alteration when passing through the same. Through the opening 5 in or under the non-rotating labyrinth packing disk 6, the steam enters a channel 30 passing through the rotating part 26*a* of the labyrinth packing 31 and through the turbine disk 32, which is a built up structure comprising several parts. The channel 30 thus is constituted by a plurality of holes of circular, elliptical or conical form situated beside one another and preferably equi-distantly spaced apart around the whole circumference of the turbine. Also these holes 30 or the prolongations 33 thereof which guide the steam towards the first blade ring 34 of the blade system, are made of stream-lined form so as to cause the least possible loss due to turbulence in the flow of steam. This supply apparatus 33 which as shown on a larger scale in Figs. 9, 9*a* and 9*b*, comprises a plurality of holes 36 situated beside each other and having partition walls 37 between them, by means of which the turbine disk 32 is supported. These partition walls are of stream-lined form which cause the least possible resistance to the flow of the steam. This is most clearly shown in Figs. 9*a* and 9*b*.

Also in this case, a valve is provided which, when the turbine is subjected to overload, is opened either automatically or manually, whereby steam is fed into the overload chamber 14, Fig. 7, wherefrom the steam passes through the channels 14*a* and 15 and through the non-rotating part of the labyrinth packing 31 and thereupon through an opening 15*a* in the rotating part 26*a* of the labyrinth packing and in the part 32 of the turbine disk, and finally into the blade system of the turbine. The steam thus enters the blade system in front of a blade ring 40 which, as viewed in the direction of the flow of steam as indicated by the arrow 41, is situated beyond the blade ring 34 to which steam is fed from the supply chamber 4. The channel 15*a*, preferably also the channel 15, consists of openings situated beside one another and of stream-lined form.

In Fig. 10 are again to be found the turbine shaft 25 and the labyrinth packing 26 which in this case is indicated only diagrammatically. Radially on the outside of the packing 26 is situated a supply chamber 4 (see also Fig. 11) which is in communication, by means of two supply conduits 7 and 8, with the throttle valve or the like. Also in this case, the supply chamber 4 is of stream-lined form for effecting smooth flow of steam to the first blade ring. In order to facilitate the diversion of the steam, guide plates 41, 42 and 43, 44 respectively are provided, which prevent the formation of eddies in the steam. The steam channel 5 situated radially inside of the non-rotating part 6 of the labyrinth packing

31, is in communication with the channel 30 which extends through the rotating parts 26 and 32. This channel 30 consists of a plurality of conically shaped openings 36 arranged beside one another in an annular part (see Figs. 12 and 13) and has, at the chamber 4 and at the outlet to the first blade ring 34, stream-lined form, so that the steam is conducted without disturbance from the supply chamber 4 to the first blade ring 34. The channels 36 passing through the turbine disk 32, are separated from each other by walls 37 which are of stream-lined form for the purpose of obtaining the best possible flow of steam.

According to the invention, the steam thus is fed to the first blade ring from the throttle valve through channels and chambers in which the resistance against the flow of the steam is very small. Energy losses due to the steam passing through these parts, are reduced in comparison with those in earlier constructions in which the supply chamber is constituted by an annular part to which the supply conduit is fitted only for the purpose of feeding steam into said chamber.

As distinguished from earlier constructions in which the supply or admission chamber is merely an annular channel to which steam is supplied from the supply conduit without control of direction of its flow, the present invention provides means whereby the flow of motive fluid is directed in a specific manner so as to produce a controlled whirling or rotational flow before the motive fluid leaves the admission chamber to flow to the inlet space radially inside of the first ring of turbine blades. In other words, before the motive fluid is admitted to the blade system of the turbine it is, in accordance with the present invention, positively directed in a definite path of what may be termed generally swirling flow which very substantially reduces the admission losses incurred with the structures heretofore employed in which motive fluid is admitted without being definitely controlled in its path of flow.

In the forms of embodiment above described, only the supply devices on one side of the turbine have been described, but obviously the above statements also apply for the supply part on the other side of the turbine which is built substantially symmetrically with respect to a central transverse plane.

What I claim is:—

1. In a radial flow turbine, means for providing central full admission of steam to the turbine comprising two spiral steam chambers extending around the turbine shaft adjacent to the axis of the turbine and on opposite sides thereof, each of said chambers having an inlet opening and having a cross sectional area progressively decreasing in the direction of steam flow away from said opening and a steam supply conduit communicating in tangential direction with each of said chambers through said openings.

2. In a radial flow elastic fluid turbine, a central admission chamber for motive fluid situated within the turbine casing in a plane transverse to the axis of rotation of the turbine and adapted to receive motive fluid from the exterior of said casing and to discharge the same with an axial component of flow through a turbine rotor to the blade system of the turbine, and a channel for conducting motive fluid inwardly of the casing to said chamber, and means comprising the walls of said chamber and of said channel adjacent to the inlet of the chamber for imparting to the motive fluid in said chamber rotational flow in said plane without abrupt change in direction from its line of inward flow through said channel.

3. In a radial flow elastic fluid turbine, a central admission chamber for motive fluid situated within the turbine casing in a plane transverse to the axis of rotation of the turbine and adapted to receive motive fluid from the exterior of said casing and to discharge the same with an axial component of flow through a turbine rotor to the blade system of the turbine, a channel for conducting motive fluid inwardly of the casing from the periphery thereof to said chamber, and means comprising the walls of said chamber and of said channel adjacent to the inlet of the chamber providing a passage arranged to impart rotational flow in the same direction to all of the motive fluid admitted to said chamber.

4. In a radial flow elastic fluid turbine, a central admission chamber for motive fluid situated within the turbine casing in a plane transverse to the axis of rotation of the turbine and adapted to receive motive fluid from the peripheral exterior of said casing and to discharge the same with an axial component of flow through a turbine rotor to the blade system of the turbine, and means providing a passage for conducting motive fluid inwardly of the casing and for delivering it tangentially of said chamber, whereby to impart rotational flow to the motive fluid in the chamber.

5. In a radial flow elastic fluid turbine, a central admission chamber for motive fluid situated within the turbine casing in a plane transverse to the axis of rotation of the turbine and adapted to receive motive fluid from the exterior of said casing and to discharge the same with an axial component of flow through a turbine rotor to the blade system of the turbine, said chamber having an outer wall curved eccentrically with respect to said axis, and means providing a channel having surface for directing motive fluid to said chamber at the inlet thereof with a tangential component of flow whereby to cause all of the motive fluid admitted to the chamber to flow rotationally therein in the same direction.

6. In a radial flow elastic fluid turbine, a central admission chamber for motive fluid situated within the turbine casing in a plane transverse to the axis of rotation of the turbine and adapted to receive motive fluid from the exterior of said casing and to discharge the same with an axial component of flow through a turbine rotor to the blade system of the turbine, and means for admitting motive fluid tangentially of said chamber to cause the rotational flow thereof within the chamber, said chamber diminishing in cross-sectional area in the direction of flow of the motive fluid.

7. In a radial flow elastic fluid turbine, a central admission chamber for motive fluid situated within the turbine casing in a plane transverse to the axis of rotation of the turbine and adapted to receive motive fluid from the exterior of said casing and to discharge the same with an axial component of flow through a turbine rotor to the blade system of the turbine, and means for admitting motive fluid in generally tangential direction to said chamber to cause rotational flow thereof within the chamber, said chamber being of spiral form and of diminishing cross-sectional area in the direction of flow of the motive fluid.

8. In a radial flow elastic fluid turbine, a rotor comprising a shaft portion and a disc-like portion, said rotor having a plurality of openings therein providing communication between axially oppo-

site sides of the rotor, a casing, a central admission chamber for motive fluid situated within the casing axially to one side of said rotor and in a plane transverse to the axis of rotation, said chamber having an outlet in communication with said openings and means for conducting motive fluid to the chamber from the exterior of the casing and for directing the motive fluid tangentially into the chamber whereby to cause rotational movement of the fluid in the chamber.

9. In a radial flow elastic fluid turbine, a rotor comprising a shaft portion and a disc-like portion, said rotor having a plurality of openings therein providing communication between the axially opposite sides of the rotor, a casing, a central admission chamber for motive fluid situated within the casing axially to one side of said rotor and in a plane transverse to the axis of rotation, said chamber having an outlet in communication with said openings, and means for conducting motive fluid to the chamber from the exterior of the casing and for directing the motive fluid into the chamber in a direction having a tangential component of flow whereby to cause rotational movement in one direction of all of the fluid in the chamber.

10. In a radial flow elastic fluid turbine, a rotor comprising a shaft portion and a disc-like portion, said rotor having a plurality of openings therein providing communication between axially opposite sides of the rotor, a casing, means providing a central admission chamber for motive fluid situated within the casing axially to one side of said rotor in a plane transverse to the axis of rotation and having an outlet in communication with said openings, and means providing one or more channels for conducting motive fluid inwardly of the casing to said chamber, said means comprising stationary fluid guiding surface arranged to cause rotational flow in the same direction of all of the motive fluid admitted to the chamber.

11. In a radial flow elastic fluid turbine, a rotor comprising a shaft portion and a disc-like portion, said rotor having a plurality of openings therein providing communication between axially opposite sides of the rotor, a casing, a central admission chamber for motive fluid situated within the casing axially to one side of said rotor in a plane transverse to the axis of rotation and having an outlet in communication with said openings, and means providing a passage for admitting motive fluid to said chamber tangentially thereof.

12. In a radial flow elastic fluid turbine, a rotor comprising a shaft portion and a disc-like portion, said rotor having a plurality of circumferentially spaced openings therein providing communication between axially opposite sides of the rotor, a casing, means providing a central admission chamber for motive fluid situated within the casing axially to one side of said rotor in a plane transverse to the axis of rotation and having a circumferentially extending outlet in communication with said openings, and means providing one or more channels for conducting motive fluid inwardly of the casing to said chamber, said means comprising stationary fluid guiding surface arranged to cause rotational flow in the same direction of all of the motive fluid admitted to the chamber and said chamber being of diminishing cross-sectional area in the direction of said flow.

13. In a radial flow elastic fluid turbine, a rotor comprising a shaft portion and a disc-like portion, said rotor having a plurality of circumferentially spaced openings therein providing communication between axially opposite sides of the rotor, a casing, means providing a central admission chamber for motive fluid situated within the casing axially to one side of said rotor in a plane transverse to the axis of rotation and having an outlet in communication with said openings, and means providing one or more channels for conducting motive fluid inwardly of the casing to said chamber, said means comprising stationary fluid guiding surface arranged to cause rotational flow in the same direction of all of the motive fluid admitted to the chamber, said openings flaring outwardly at the ends communicating with said chamber.

14. In a radial flow elastic fluid turbine, a rotor comprising a shaft portion and a disc-like portion, said disc-like portion having a plurality of circumferentially spaced, axially extending openings therein providing communication between the axially opposite sides of the rotor, a casing, means providing a central admission chamber for motive fluid situated within the casing axially to one side of said rotor and in a plane transverse to the axis of rotation, said chamber having an outlet in communication with said openings, means providing one or more channels for conducting motive fluid inwardly of the casing to said chamber said means comprising stationary fluid guiding surface arranged to cause rotational flow of motive fluid in the chamber, and curved means on said rotor at the discharge ends of said openings for directing the motive fluid radially outwardly to the blade system of the turbine.

15. In a radial flow elastic fluid turbine, a rotor comprising a shaft portion and a disc-like portion, said rotor having a plurality of openings therein providing communication between axially opposite sides of the rotor, a casing, means providing a central admission chamber for motive fluid situated within the casing axially to one side of said rotor in a plane transverse to the axis of rotation and a channel for conducting motive fluid from the exterior of the casing inwardly to said admission chamber, said chamber having an outlet in communication with the openings in said rotor, and said means including stationary fluid guiding surface arranged to gradually alter the direction of flow of motive fluid in its path of flow through said means to said outlet so as to produce a rotational component of flow in said plane at said outlet.

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