No. 868,134. PATENTED OCT. 15, 1907.

R. SCHULZ.

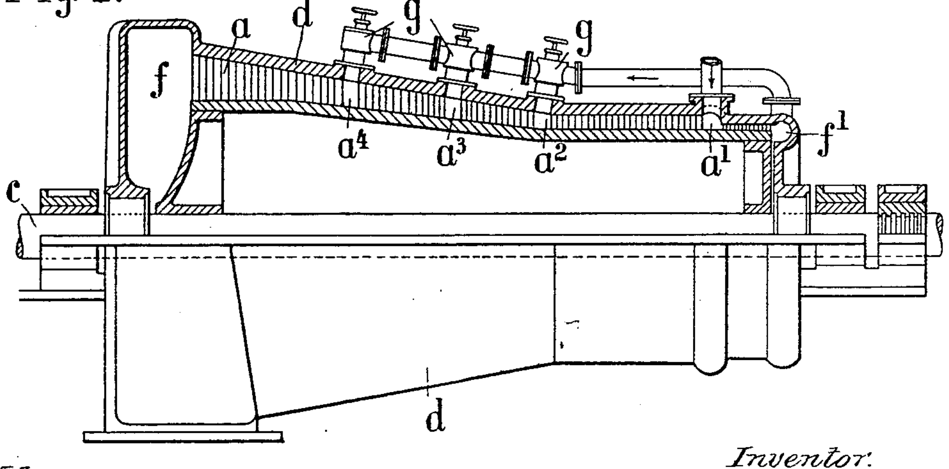
STEAM TURBINE.

APPLICATION FILED NOV. 27, 1905.

3 SHEETS—SHEET 1.

To relieve axial thrust.

Fig. 1.



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3 SHEETS—SHEET 2.

Fig. 2.

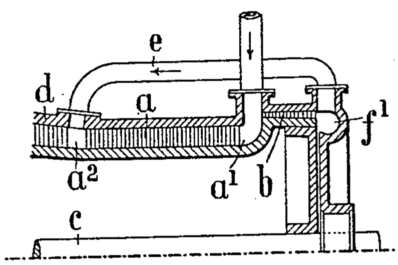


Fig. 3.

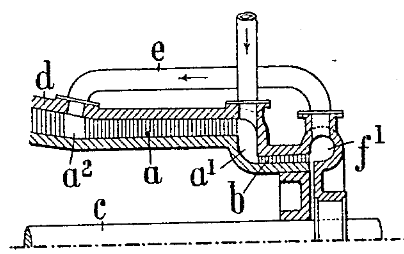
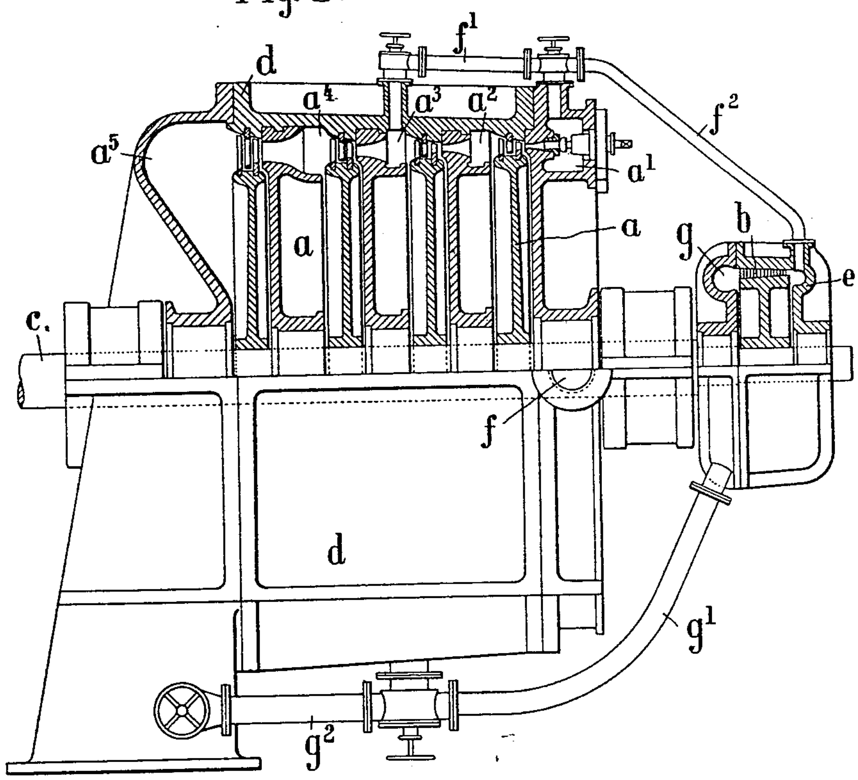


Fig. 8.



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253. MOTORS-FLUID

d-58

No. 868,134.

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APPLICATION FILED NOV. 27, 1905.

3 SHEETS—SHEET 3.

Fig. 4.

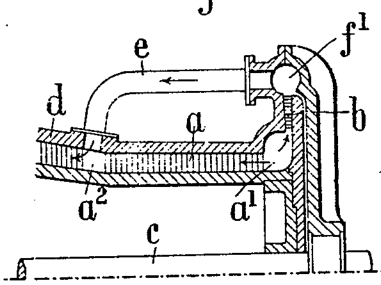


Fig. 5.

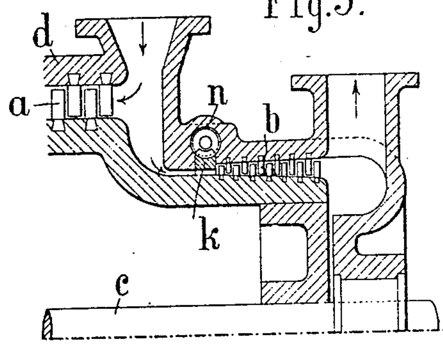


Fig. 6.

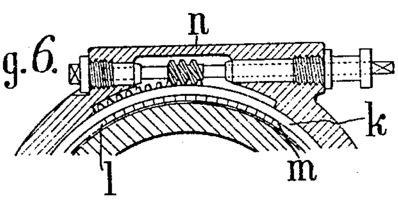
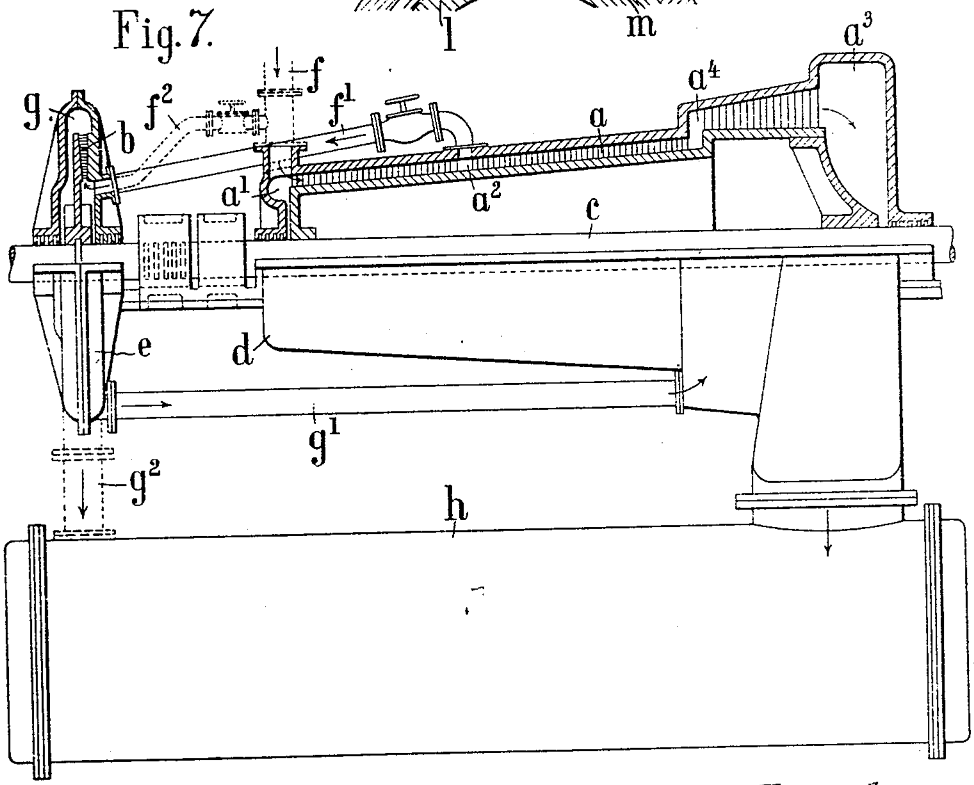


Fig. 7.



Witnesses
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UNITED STATES PATENT OFFICE.

RICHARD SCHULZ, OF BERLIN, GERMANY.

STEAM-TURBINE.

No. 868,134. Specification of Letters Patent. Patented Oct. 15, 1907.

Application filed November 27, 1905. Serial No. 289,270.

To all whom it may concern:

Be it known that I, Richard Schulz, engineer, a subject of the King of Prussia, and residing at Berlin, in the Kingdom of Prussia, in the Empire of Germany, have invented certain new and useful Improvements in Devices for Relieving Axial Thrust in Axial Steam-Turbines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters or figures of reference marked thereon, which form a part of this specification.

My invention relates to and has for its object, a device for relieving the axial thrust in axial steam turbines by means of thrust relieving rings of guide blades and of moving blades, which replace the well known counter-pressure disks, or thrust bearings, which have many closely fitting surfaces.

One of the great objections to existing devices to relieve axial turbines from axial thrust, is that the quantity of steam used for the production of the pressure for relieving the thrust is not just sufficing and solely for this purpose. It is well known that, in order to relieve axial turbines from axial thrust, two turbines which are equal in all their measurements are symmetrically arranged one with the other on one and the same shaft, so that both the separate thrusts acting in the direction of their axes, reciprocally balance one another. Also in compound steam turbines, the high pressure turbine is so arranged with regard to the low pressure turbine, that their axial thrusts act in opposite directions. Further it is well known, that an axial steam turbine can be so joined to a radial turbine, that both turbines experience an axial thrust in the same direction which may be entirely or partly balanced by the action of steam at the back of the radial turbine. In this case also, as in the former cases, each turbine is not fed by itself and not with such small quantity of steam just necessary for relieving the axial thrust. Another objection, especially in the case of counter-pressure disks which are firmly fixed to the shaft, and which are most commonly used, is that such thrust bearings or the like are steam-tight only in a limited degree. Their more or less tight fitting results from, and is obtained by means of, many closely fitting surfaces, and the escaping steam does no useful work.

One of the important objects of my present invention, in which indeed I also make use of counter-pressure bodies or disks is to replace the many closely fitting surfaces by a system of thrust relieving rings of guide blades and of moving blades, so that the leakage steam is compelled to be usefully employed in doing work. The rings of guide blades and of moving blades formed for the relief of the axial thrust, however, act with only a steam consumption which approximates to that of the usual counter-pressure disks with many closely fitting surfaces.

Another important object of my invention therefore, is, that the quantity of steam used for the production of the pressure for relieving the thrust, is just sufficient for this purpose.

In the construction of a device of this kind, both turbine and relieving rings of blades are arranged in the same case or shell and have a common steam admission chamber, but on the contrary, they have separate passages for exhaust. In a second mode of construction of a device of this kind, the rings of blades for relieving the axial thrust are provided with a separate case or shell, with short steam passages.

Another object of my invention is to regulate the supply of steam which is used for the production of the pressure for relieving the axial thrust.

The different constructional forms of such a device are illustrated in the accompanying drawings in which:

Figures 1, 2, 3, and 4 are longitudinal sections (partly in side view) showing the first of the above named examples. Fig. 5 and 6 show a longitudinal section and cross-section respectively of the regulating means for the steam admission to the thrust relieving device. Figs. 7 and 8 are longitudinal sections (in part a side view is shown) showing the second of the above named examples.

Similar letters of reference refer to similar parts in all views.

As shown in Figs. 1, 2, and 3 I arrange close to the axially arranged turbine *a*, an axially arranged thrust-relieving device *b*, which has the smallest possible measurements and steam passages as short as possible. Only one case or shell *d* and only one shaft *c* is provided for both turbine and relieving device. Both receive steam out of a common steam admission chamber *a′*, but exhaust into separate chambers *f* and *f′* respectively. In the example shown in Fig. 1 the diameter of the device *b* is approximately equal to that of the first turbine wheel of the turbine *b*, while in the example shown in Fig. 2 the mean diameter of the device *b* is greater than the mean diameter of the first turbine wheel of turbine *a*, and in the example shown in Fig. 3 the former is smaller than the latter. The axial thrust of the turbine *a* is quite or partly overcome by the opposed adjusted axial thrust of the device *b*, and the resulting axial thrust is directed in opposition to that of the turbine *a*. To ascertain the strength of the axial thrust, the pressure in the exhaust chamber *f* of the turbine *a* and *f′* of the device *b*, on the outer surfaces of the rings of blades respectively, must be taken into consideration. In spite of its greater diameter the turbine a maintains only slight opposition pressure on account of the very low steam pressure in the exhaust chambers f. By considerable raising of the end pressure of the turbine a, the axial thrust would be indeed reduced, but then the steam would be only badly utilized in the turbine a. The device b, on the contrary, may be worked with high end pressure, without disadvantage with regard to efficiency, and indeed this may be best done by not allowing the steam from the device b to discharge immediately into the exhaust chamber f of the turbine a, but instead letting it do more work in this device. For this purpose the steam exhaust pipe of the thrust-relieving device b is in connection with either several annular chambers a^2, a^3, a^4, which are able to be closed by means of the valves q, Fig. 1., or with only one annular chamber a^2 (Figs. 2 and 3) of the turbine a. As the steam is conducted out of the deviee b to the annular chambers a^2, a^3, a^4, a high medium or low exhaust pressure is obtained for the device b and in this manner the strength of the axial thrust may be regulated.

As shown in Fig. 4, I erect an axial turbine a in connection with a radially arranged thrust-relieving device b. Both turbine and relieving device have a common steam admission chamber a'. Here also the steam exhaust chamber f' of the device b is in connection with an annular chamber a^2 of the turbine a by means of a pipe e, and the steam of the device b exercises an axial thrust which is directed in opposition to that of the turbine a. Also the axial thrust of the turbine a may be entirely or partly balanced by taking proper dimensions for the thrust-relieving device b and a resulting axial thrust obtained which is directly against the same.

Means for fractional supply attached to the device b, such for example as shown in Figs. 5 and 6, serve for the further regulation of the resulting axial thrust and at the same time for the raising of the normal load of the turbine a. To the shell d, I add a ring-shaped projecting piece n in front of the sliding ring k, and in the projecting piece n are one or more grooves of a certain length l m (Fig. 6) for the admission of the steam through the thrust-relieving device b. The sliding-ring k likewise has channels on a part of its circumference of equal length. Thus by turning the sliding ring, the steam admission to the device b can be regulated according to requirements. But the regulation of the device may also be effected in other well known ways.

The thrust-relieving device with means for fractional supply is a new and very serviceable means for supplying more or less steam to, and simultaneously decidedly raising the capacity of both turbine and relieving device, suddenly. The steam which is employed in this way for raising the efficiency of the turbine which is to be relieved of axial thrust is, as is easily seen, better utilized than in the case of former arrangements, in the case of which boiler steam was supplied directly through a so-called secondary valve to one or also to several places in a turbine with many high, mean and low pressure parts. It was necessary to throttle the steam down to a lower pressure and also it was badly utilized. One had to be content with obtaining from a relatively small turbine, consuming a very large quantity of steam, a very high efficiency. If however the steam determined for raising the efficiency of the turbine is in advance led through a thrust-relieving device, which as in Figs. 5 and 6 has one or more systems of blades which can be regulated, the steam performs considerable work in the thrust-relieving device, in the case of full or nearly full steam passage, before it enters into the turbine at a lower pressure. By a suitable choice of the end pressure in the thrust-relieving device, quite a considerable part of the expansive power of the steam, corresponding to the difference between the admission and exhaust pressure in the thrust-relieving device, can be converted into useful work.

In both examples shown in Figs. 7 and 8 the thrust-relieving device b on the shaft c of the turbine a, which is to be relieved of the thrust, is provided with a special case or shell e.

As shown in Fig. 7, the boiler steam flows through the conducting pipe f into the admission chamber a' at the front end of the shell d of the turbine a which is to be relieved of its thrust. The exhaust steam of the latter goes out of the annular chamber a^3 at the back of the shell d into the condenser k. The device b receives its steam either out of the pipe f by means of a pipe f^2, which is shown in dotted lines, or out of an annular chamber a^2 of the turbine a through a pipe f', and indeed in the latter case, at a less pressure than in the former, because the steam on the way to the annular chamber a^2 has already performed work in the turbine a. The device b, as shown in Fig. 7, is, by way of example arranged radially. Steam having done work in the same, can be conducted out of the chamber g through a pipe g^2 either into the condenser k, or into the open air, or into a turbine which works with low pressure steam. But also, as in the above described supposed construction, the steam from the device b may be conducted by means of a pipe g', into a special annular chamber a^4 of the turbine a arranged at a little distance from the exhaust chamber a^3, so that the steam may perform still further work in the turbine.

In the example shown in Fig. 8 a multiple impact turbine a is shown on the same shaft c with a thrust-relieving device b. As the multiple turbine, as is well known, only experiences a very little axial thrust on account of the pressure of the steam on itself, in this case the thrust relieving device serves chiefly to relieve the axial thrust which is produced outside the turbine a, for example: in the case of ships, the thrust of the propeller; in the case of hoisting-engines with transmission of power by means of a worm to a worm-wheel, the thrust on the bearing of the worm-wheel shaft; and likewise in the case of one-side-working centrifugal pumps, and the like the thrust on the shaft bearing. In the construction shown in Fig. 8, the boiler steam flows through the pipe f to the first chamber a' of the multiple impact turbine a which is provided with further chambers a^2, a^3, a^4, and nozzles out of the same which conducts the steam to separate rotary wheels on the shaft c. The steam flowing through the turbine a goes at the back end of the shell d and by means of the annular chamber a^5 into the condenser. The thrust-relieving device b is here also arranged on the shaft c with a special shell e, and, as represented by way of example is arranged axially. The remaining arrangement is analogous to that described with regard to Fig. 7. Piping f', f^2 (Fig. 8) with two valves, is in connection with the admission chamber of the device b, the one valve enables the steam passage from the chamber a' to be cut off, the other the steam passage from the chamber a^3. The device b therefore, can be supplied with steam of higher pressure, or with steam of lower pressure, from the turbine a according to requirements. On the other hand piping g', g^2 with two valves, likewise by way of example, is in connection with the exhaust chamber of the device b; of these two valves, the one permits the exhaust steam of the device b to be cut off from the annular chamber a^3 and the other from the exhaust pipe of the turbine a which leads to the condenser. Here also the axial thrust regulation can be accomplished under different conditions and the steam which is used in the thrust-relieving device b may be conducted to the turbine a so that it may still further do useful work.

In order to raise the working efficiency of the turbine a and to be able to employ the high pressure steam in the device b advantageously, I provide in the latter at least one adjustable system of guide blades. The device b requires then to have only one single blade-wheel.

Without limiting myself to the exact construction and arrangements of parts herein shown and described, what I claim and desire to secure by Letters Patent is:—

1. The combination with a high pressure parallel flow turbine of means to dynamically balance the axial thrust of the turbine, said means supplied by high pressure steam and means to utilize the steam therefrom at an intermediate stage in the turbine.

2. The combination with a high pressure parallel flow turbine of a device to dynamically balance the axial thrust of the turbine, said means supplied by high pressure steam and means for augmenting the supply of steam at an intermediate stage by the exhaust steam from said means.

3. The combination with a high pressure parallel flow steam turbine of means to dynamically balance the axial thrust of the turbine, a steam admission common to both the turbine and balancing means, and means to return the exhaust from the balancing means to an intermediate stage of the turbine.

4. In a turbine, means to supply high pressure motive fluid to the turbine, means to supply motive fluid of a pressure lower than the initial pressure to any one of a plurality of lower pressure stages and means to control the passage of lower pressure motive fluid to the desired stage.

5. The combination with a high pressure turbine, of means to dynamically balance the axial thrust thereof, a steam supply common to both and means to admit exhaust steam from the balancing means to any one or several intermediate stages of the turbine.

6. The combination with a high pressure parallel flow turbine of means to dynamically balance the axial thrust of the turbine said means using high pressure steam and included between the high pressure stage and an intermediate pressure stage.

7. The combination with a high pressure turbine, of means to dynamically balance the axial thrust thereof, a steam inlet common to the turbine and thrust relieving device and means to conduct the exhaust steam from the balancing means to an intermediate stage of the turbine.

8. In a steam turbine, means to supply steam thereto, means to continually supply steam of a pressure lower than the initial pressure to an intermediate stage of the turbine and augment the normal supply of steam at that stage, and means to control the supply of the lower pressure steam.

9. In a turbine, a plurality of high pressure stages through which steam flows simultaneously and a lower pressure stage into which said high pressure stages simultaneously discharge.

10. In a turbine, a plurality of high pressure stages through which the steam simultaneously flows in different parallel directions, and a lower pressure stage into which said high pressure stages discharge.

11. In a parallel flow turbine, a plurality of high pressure stages through which the steam simultaneously flows in different parallel directions, a plurality of lower pressure stages in the same turbine into which said high pressure stages discharge, one or more of said low pressure stages utilizing the combined quantities of steam.

12. In a turbine, two high pressure parallel flow stages through which steam passes simultaneously in opposite parallel directions, and a lower pressure stage into which both of the high pressure stages simultaneously discharge.

13. A dummyless marine turbine of the aforesaid class comprising at one end two oppositely bladed parts adapted to receive steam in opposite directions immediately from the steam inlet of the turbine and another bladed part adapted to receive steam from the aforesaid parts for the purpose set forth.

14. A dummyless marine turbine of the aforesaid class comprising two oppositely bladed parts adapted to receive steam in opposite directions immediately from the steam inlet of the turbine and another bladed part adapted to receive steam from the aforesaid parts, the drum at one part of the self-balance being of larger diameter than at the other part for the purpose set forth.

In testimony that I claim the foregoing as my invention, I have signed my name in presence of two subscribing witnesses.

RICHARD SCHULZ.

Witnesses:

WOLDEMAR HAUPT,
JOHANNES HEIN.