K. BAUMANN.

AXIAL FLOW STEAM TURBINE.

APPLICATION FILED MAR. 19, 1919.

1,322,222.

Patented Nov. 18, 1919.

3 SHEETS—SHEET 1.

Fig. 1.

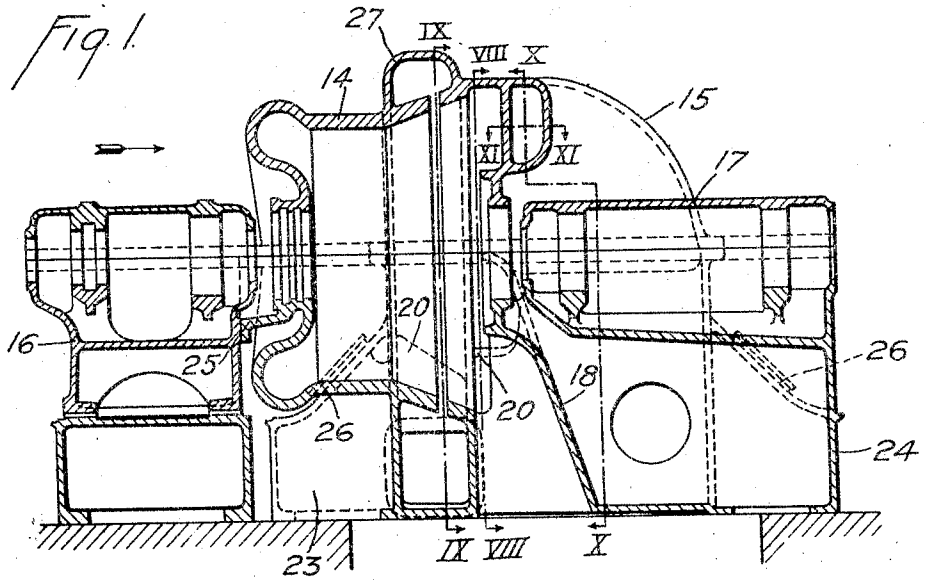
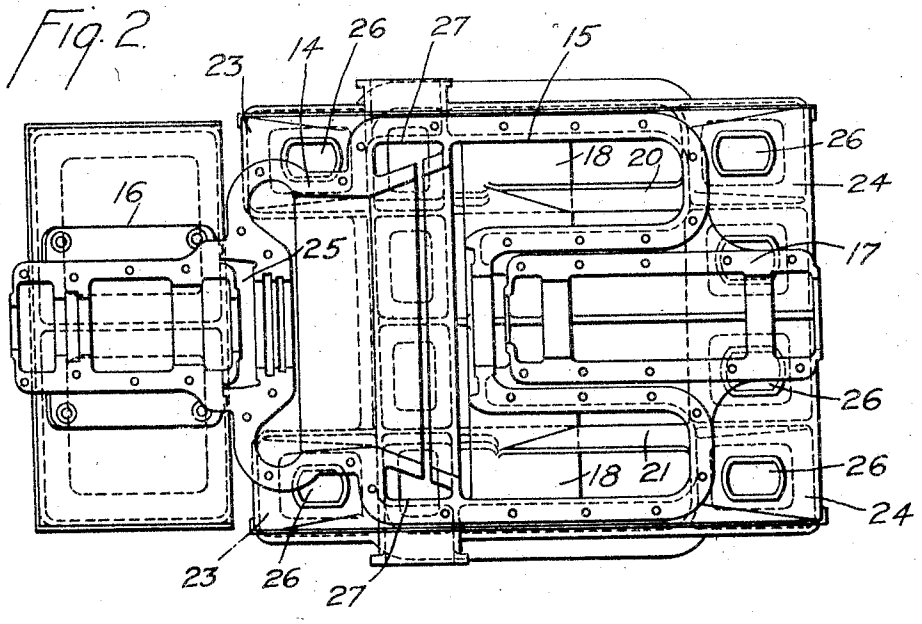


Fig. 2.



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3 SHEETS—SHEET 2

Fig. 3.

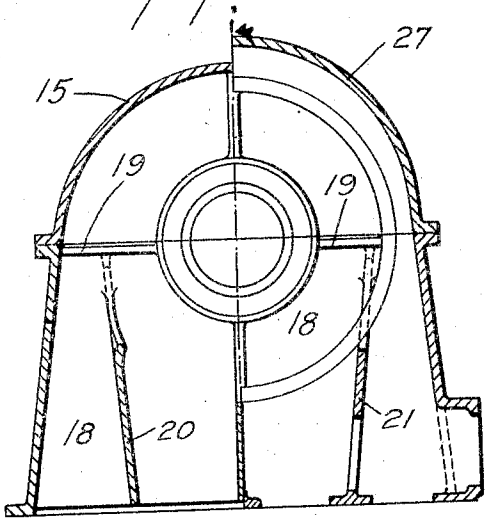


Fig. 4.

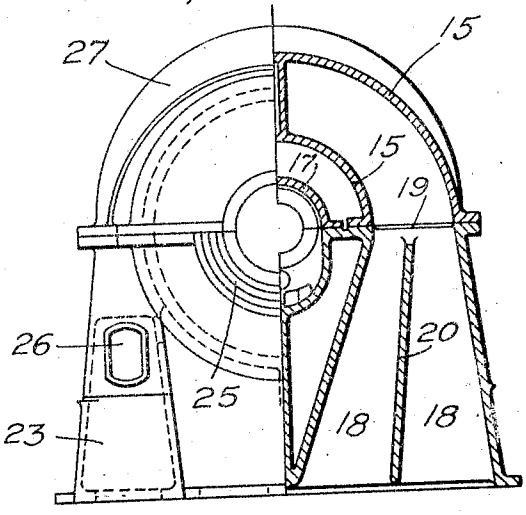


Fig. 5.



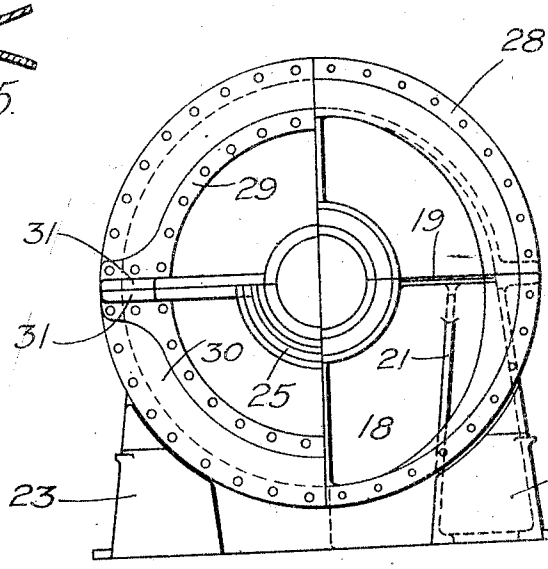


Fig. 8.

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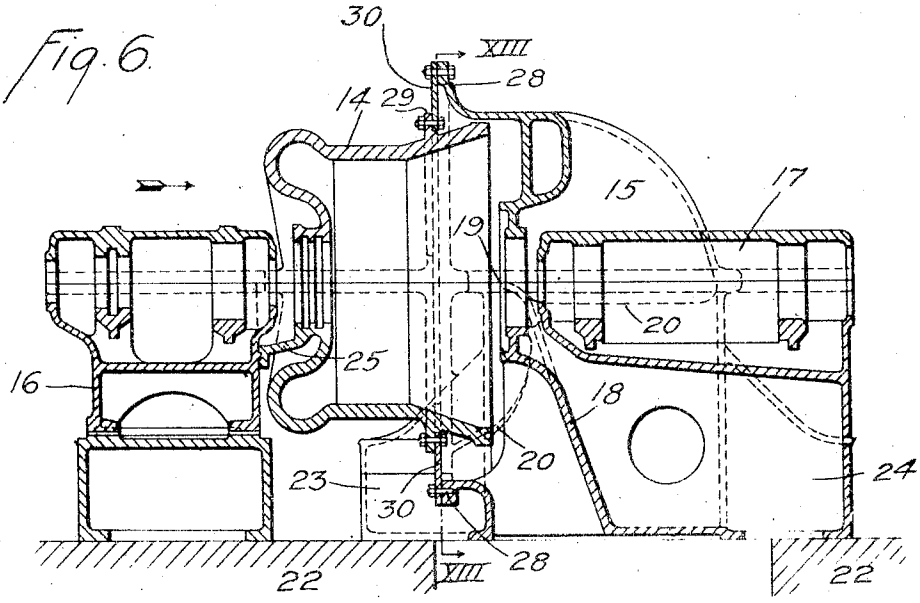
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3 SHEETS SHEET 3.

Fig. 6.



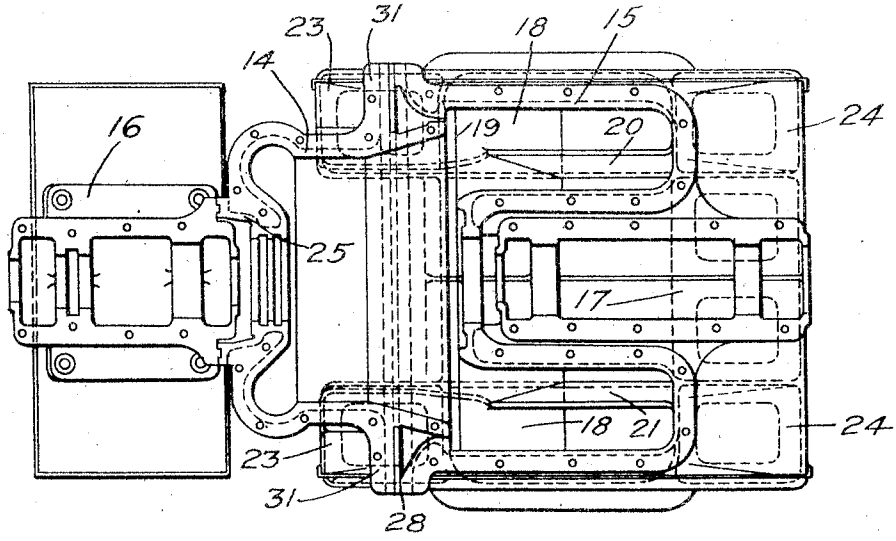


Fig. 7.

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UNITED STATES PATENT OFFICE.

KARL BAUMANN, OF URMSTON, ENGLAND, ASSIGNOR TO THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, LIMITED, A COMPANY OF GREAT BRITAIN.

AXIAL-FLOW STEAM-TURBINE.

1,322,222. Specification of Letters Patent. Patented Nov. 18, 1919.

Original application filed August 23, 1917, Serial No. 187,357. Divided and this application filed March 19, 1919. Serial No. 283,635.

To all whom it may concern:

Be it known that I, KARL BAUMANN, a citizen of the Confederation of Switzerland, and a resident of Urmston, in the county of Lancaster, England, have invented a new and useful Improvement in or Relating to Axial-Flow Steam-Turbines, of which the following is a specification.

This invention relates to steam turbines of the axial flow type in which the volume of steam leaving the exhaust blades is considerable and consequently the exhaust casings and outlets are of considerable size.

Where a turbine of this type is supported directly on its foundation from its exhaust casing and the vertical height of the supporting feet is considerable, the vertical expansion of the exhaust casing during the operation of the turbine may on occasions be such as would lift the high pressure end of the cylinder to which the feet are not directly attached to such an extent as to raise the bearing pedestal at the high pressure end of the turbine from its bed-plate. This will particularly be the case where the overhung portion of the cylinder is relatively short and rigid and is attached to the bearing pedestal. Where a turbine runs continuously at high vacuum the expansion referred to will usually not be sufficient to produce the undesirable effect described, but where the turbine has to be capable of running at times non-condensing this expansion may be great enough to give rise to the difficulty mentioned.

In order to overcome this difficulty the turbine is, according to this invention, provided with means for introducing a limited degree of flexibility between the overhung portion of the cylinder and the exhaust casing which is directly supported from the foundations.

In order that the invention may be clearly understood two constructional forms which it may assume will now be described with reference to the accompanying drawings in which Figure 1 is a central, longitudinal, vertical section and Fig. 2 a plan view of the lower portion of a turbine cylinder and exhaust casing constructed in accordance with this invention. Fig. 3 being, as to its left hand half a cross-section taken on the line VIII—VIII, and as to its right hand half on the line IX—IX of Fig. 1, and Fig. 4 being as to its left hand portion an end view looking in the direction of the arrow of Fig. 1, and as to its right hand portion a section on the line X—X of Fig. 1. Fig. 5 is a detail view on the line XI—XI of Fig. 1. Figs. 6 and 7 are views similar to Figs. 1 and 2 but showing an alternative construction, Fig. 8 as to its left hand portion being an end view looking in the direction of the arrow of Fig. 6, and as to its right hand portion a section on the line XIII—XIII of Fig. 6 with the turbine cylinder removed. The section indicating lines show the direction of view from which the various sectional views are taken and the same reference numerals are used to refer to like parts throughout the several figures of the drawings.

Referring now to Figs. 1 to 5, the turbine cylinder is indicated at 14 and the exhaust casing at 15. The bearing pedestal for the shaft bearing at the high pressure end of the turbine is indicated at 16, the shaft bearing 17 at the low pressure end being supported, as shown, from the lower half of the exhaust casing 15.

The exhaust casing is here shown as being provided with a diaphragm 18, the upper edge 19 of which extends across the exhaust casing near the final row of moving blades; and separates the steam flowing from the upper half of such blades through the exhaust casing from the steam flowing from the lower half of such blades through the exhaust casing. A diaphragm of this kind is well known and forms no part of the present invention.

The lower half the exhaust casing is provided with two internal webs 20, 21 extending, as shown, across the exhaust casing in a direction substantially parallel with the turbine shaft and the turbine is supported in position on its foundations 22 by feet 23, 24 located respectively at the high pressure and low pressure end of the exhaust casing 15.

The overhung portion of the cylinder is connected at the high pressure end by a semi-circular portion 25 with the pedestal 16 supporting the shaft bearing at this end. This connection is provided not for the purpose of supporting the overhung portion of the cylinder 14 but chiefly for the purpose of maintaining this part of the cyl-

inder in its proper position relative to the shaft so that the clearances between the stator and the rotor of the turbine may be made as fine as possible.

In the construction illustrated in the figures now being described the desired flexibility between the overhung portion of the cylinder and the exhaust casing is introduced by circumferentially dividing the turbine cylinder 14 near the exhaust casing 15 so that a portion of the cylinder 14 is separated from the exhaust casing, and by surrounding the circumferentially divided portion of the cylinder by an expansion belt 27 which connects the turbine cylinder 14 with the exhaust casing 15 and may be cast integral with the high pressure portion of the cylinder and the exhaust casing, or may be made separately and attached thereto as may be found most convenient. The webs 20 and 31 are, as shown in the right hand half of Fig. 3, continued through the lower portion of the expansion belt 27 and where they join the upper portion of the supporting feet 23 constitute a fixed point between the exhaust casing 15 and the overhung portion of the turbine cylinder 14. Such a fixed point is necessary in order to provide sufficient rigidity to prevent expansion on the turbine in an axial direction. All other points of the periphery of the cylinder 14 are, however, capable of a limited amount of movement and should the vertical expansion mentioned above take place the two divided portions of the cylinder surrounded by the expansion belt 27 at the upper half of the turbine will be caused to separate and at the bottom half to approach each other. In this way the exhaust casing 15 and its supporting feet 23 may expand in a vertical direction without causing the bearing pedestal 16 to be raised from its bed-plate.

The expansion belt 27 may also be utilized for conducing away steam from a low pressure portion of the turbine for heating or for other purposes or as an inlet for low pressure steam.

Although the circumferential division of the turbine cylinder 14 is shown in Figs. 1 to 4 as being between two portions of the turbine cylinder it is to be understood that this division may be made between the turbine cylinder and the exhaust casing. The aforementioned flexibility must, however, be introduced at a point between that portion of the exhaust casing rigidly supported by the feet and the overhung portion of the cylinder not directly supported from said feet.

In the alternative construction illustrated in Figs. 6 to 8 the requisite flexibility between the exhaust casing 15 and the overhung portion of the cylinder 14 is secured providing the exhaust casing 15 with a vertical facing 28 and forming a flange 29 around the cylinder 14 and connecting the facing 28 and flange 29 by a flexible annular diaphragm 30. With this construction, in order to secure sufficient rigidity in an axial direction, struts or the like may be provided between the cylinder 14 and the exhaust casing 15 and so connected therewith that while permitting of a relative tilting movement taking place between the parts connected by the annular diaphragm 30 they will resist any thrust in an axial direction. In the construction shown in Figs. 6 to 8, however, rigidity in an axial direction is secured by providing ribbed extensions 31 preferably near the horizontal joint on the flange 29. These extensions extend across the annular diaphragm 30 and are secured to said diaphragm and to the facing 28 on the exhaust casing.

The arrangement hereinabove described, two forms of which are illustrated by way of example in the figures of the accompanying drawings in which to secure flexibility an expansion belt or diaphragm is provided between divided portions of the cylinder or between the cylinder and the exhaust casing, is applicable to turbines having exhaust casings of various forms. For example, this arrangement may advantageously be employed with turbine exhaust casings of the kind set forth in my copending application, Serial No. 123,697, filed October 4, 1916, for steam turbines.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:

1. Turbine apparatus comprising in combination an exhaust casing and a turbine cylinder flexibly attached thereto.

2. Turbine apparatus comprising in combination, an exhaust casing and a turbine cylinder entirely supported thereby and flexibly connected therewith.

3. Turbine apparatus comprising in combination an exhaust casing and a turbine cylinder integrally joined therewith by a portion having greater flexibility than the body of the casing and cylinder.

4. Turbine apparatus comprising in combination a substantially rigid exhaust casing and a substantially rigid turbine element flexibly joined thereto by a flexible connection.

5. Turbine apparatus comprising in combination a substantially rigid exhaust casing having a portion of a turbine cylinder integral therewith and a turbine cylinder alined with the said portion and flexibly attached to the exhaust casing.

6. Turbine apparatus comprising in combination an exhaust casing, a circumferentially divided turbine cylinder supported thereby, and a flexible connecting element

joining the divisions of the cylinder and forming a steam passage in communication with the interior of the cylinder.

7. In turbine apparatus the combination with a rigidly mounted exhaust casing and a rigidly mounted rotor bearing of a turbine cylinder flexibly secured to the exhaust casing and alined with the said bearing.

8. In turbine apparatus, the combination with a rigidly mounted exhaust casing and a rigidly mounted rotor bearing, of a turbine cylinder rigidly attached to the bearing and flexibly connected to the exhaust casing.

9. In turbine apparatus, the combination with a rigidly mounted exhaust casing and a rigidly mounted rotor bearing, of a turbine cylinder attached at one end to the bearing and flexibly attached at the opposite end to the exhaust casing.

10. Turbine apparatus comprising in combination an exhaust casing, a turbine cylinder and a flexible diaphragm connecting the exhaust casing with the steam cylinder.

11. Turbine apparatus comprising in combination an exhaust casing, a turbine cylinder flexibly secured thereto so as to permit transverse displacement of the cylinder with respect to the exhaust casing, and means for preventing longitudinal displacement of the cylinder with respect to the said casing.

In testimony whereof I have hereunto subscribed my name this third day of January, 1919.

KARL BAUMANN.