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Meylan et al.

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[54] **CASING OF A FLUID FLOW MACHINE**

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[52] **U.S. Cl.** **415/219,** 248/19

[51] **Int. Cl.** **F01d 25/26,** F01d 25/28

[58] **Field of Search** .... 415/108, 136, 138, 219 R; 248/2, 19

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[57] **ABSTRACT**

A fluid flow machine of the double shell type, particularly a steam turbine, in which the inner casing having mounted therein a guide blade carrier and a bladed rotor is secured to the foundation, and the outer casing which surrounds and is spaced from the inner casing includes a frame therefor supported on the foundation by means of friction plates and being free to expand in any horizontal direction. Pairs of upper and lower straps are located around the frame for pivotal movement in horizontal planes, the upper and lower straps of each pair being pivotally connected at one end to upper and lower pivot points which are fixed in relation to the foundation, and being pivotally connected at the opposite ends thereof to the frame, thereby to guide the frame and outer casing in its horizontal movement on the foundation.

6 Claims, 3 Drawing Figures

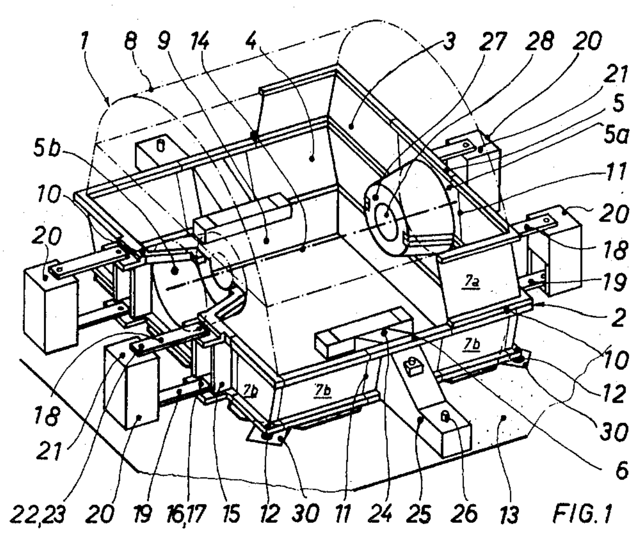

FIG. 1

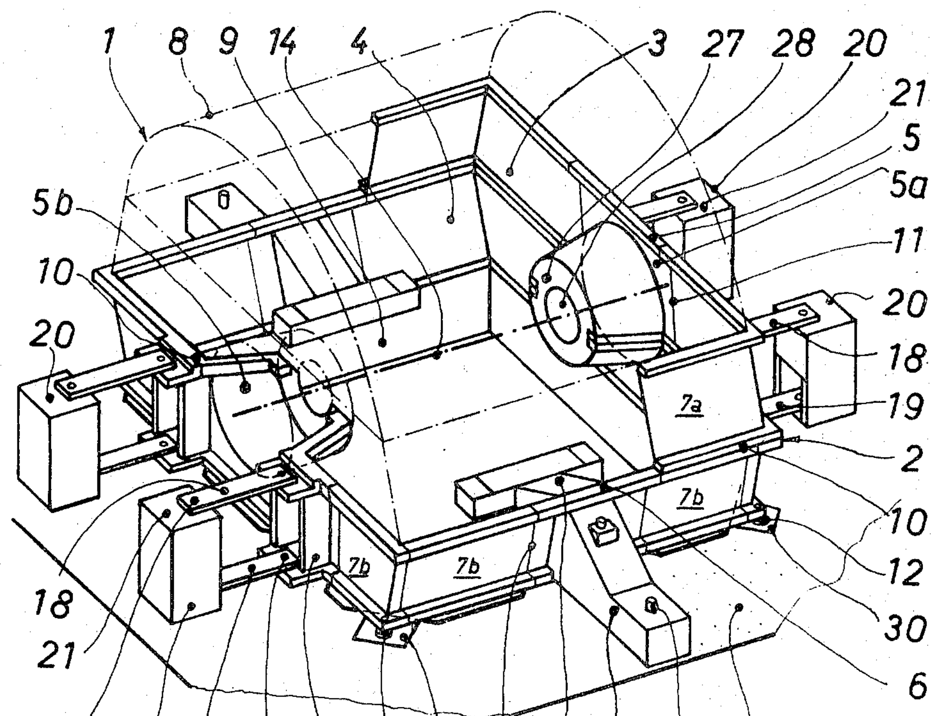
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FIG. 1

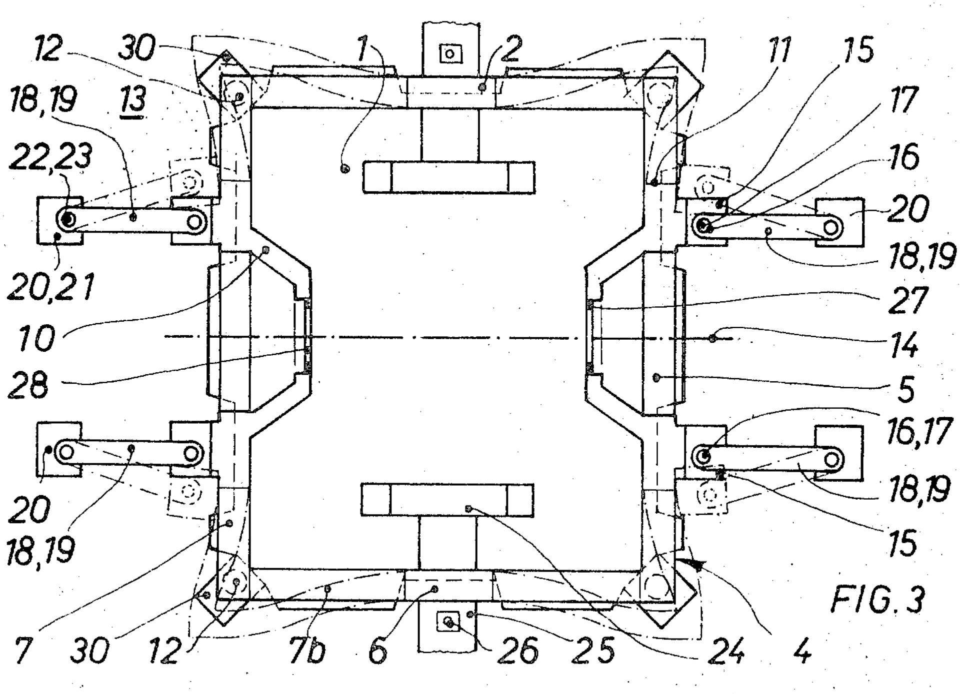
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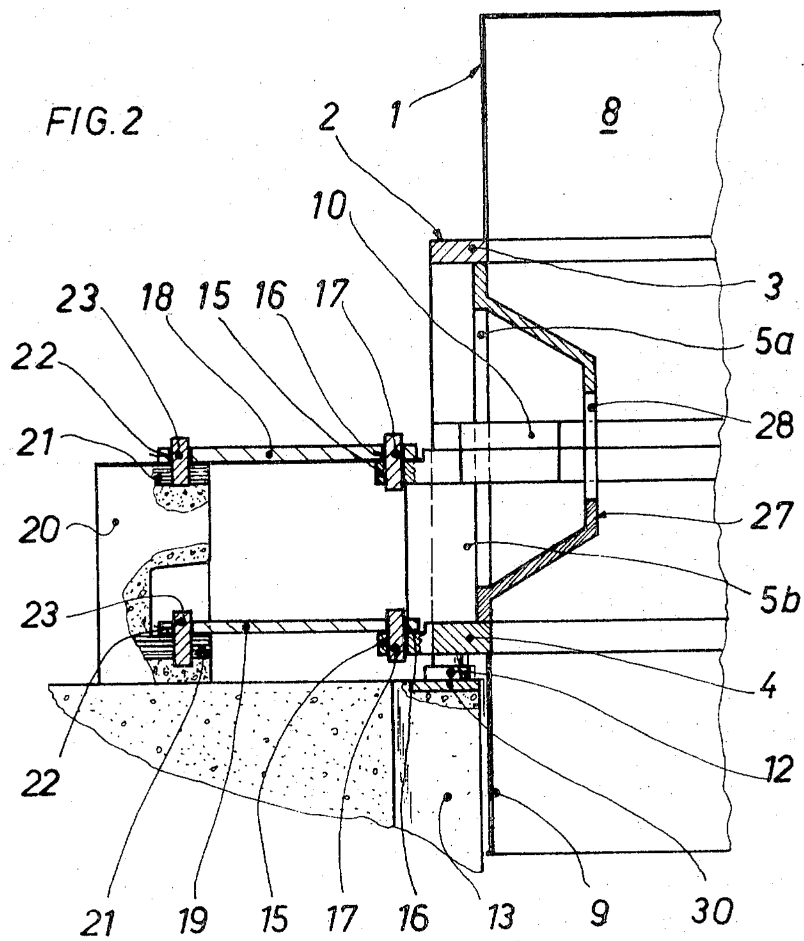
FIG. 3

FIG. 2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CASING OF A FLUID FLOW MACHINE

The present invention concerns a casing of a fluid flow machine of double-shell construction, in particular a steam turbine, the outer casing of which is provided with a frame which carries the inherent weight of the outer casing and within which the inner casing is supported. The frame which is supported on the foundation by way of friction plates and is free to expand in the horizontal plane comprises an upper frame part and a lower frame part to which, respectively, a steam enclosure and an exhaust steam connection is fixed.

Welded low-pressure casings for steam turbines are known which comprise a base frame connected with steamtight joints to a self-supporting steam enclosure and exhaust steam flange, the casing being split at the base frame on a horizontal axial plane of the turbine, the lower part of the frame being supported directly on the turbine foundation and the base frame incorporating shaft lead-throughs which form the fixed points of the casing. It is also known that the base frame of such casings can be made in a number of separate parts which are subsequently joined together at the site of installation.

With constructions of this kind, the enclosing walls, such as the outer shell and the exhaust steam flange, must be provided with bracing members in the form of longitudinal, transverse, corner and/or diagonal struts in order to support the enclosing walls which are stressed by the external atmosphere and the internal vacuum. These have the effect of impairing flow conditions within the casing.

Furthermore, for both constructional and functional reasons, the bracing members cannot always be located where they are most effective, because account must be taken of the planes of division of the base frame, the shaft and the inner shell. It can then happen that the forces of reaction give rise to a statically indeterminate system.

In addition, the bracing members required for strength purposes transmit thrust forces to parts of the casing which should be subjected to forces as little as possible, since otherwise the correct functioning of other components of the casing will be impaired. The packing boxes at the shaft leadthrough are an example of this.

The principal object of this invention is thus to provide a low-pressure casing having improved flow conditions in the exhaust steam space.

This object is achieved in that the base frame of the low-pressure casing is provided with lugs having eyes to which straps hinged in one axis are attached in a horizontal plane, and by way of further linkages with one degree of freedom these straps engage lugs on columns rigidly fixed to the foundation, the straps being arranged in pairs approximately in parallel planes to one another.

This improved construction presents the advantage that, in addition to the simple and elegant construction of the casing, the casing components are still able to respond to heat between the fixed points, i.e. the casing is rigidly fixed to the foundation at the shaft leadthroughs and at the support of the guide blade carrier. On the other hand, the other parts of the wall of the outer casing are free to expand in any direction, the base frame being guided in a horizontal plane principally by means of friction plates at the corners of the casing.

Moreover, savings in material and hence also in weight are achieved, thus greatly facilitating manufacture and transport even though the unit capacities of the turbo-sets exceed, or are at least equal to, those of existing machines.

The fact that the casing contains no struts to disturb flow within the steam space presents a real opportunity for a modular system of construction, particularly series manufacture of individual parts of the base frame, but also of the other casing components. The straps attached to the casing and linked to the foundation represent a further advantage. This resides in the fact that the casing no longer has to withstand the stresses created by inherent weight, vacuum and atmospheric pressure by virtue of its own stiffness, i.e. internal struts located between the walls, but instead, by bracing the casing externally by means of the straps, these forces are transferred directly to the foundation.

One embodiment of the invention will now be explained in more detail with reference to the accompanying drawings, in which:

FIG. **1** is a perspective view of a low-pressure casing of a steam turbine,

FIG. **2** shows a section through the casing at one of the shaft lead-throughs, and

FIG. **3** shows another section at the horizontal plane of division of the casing.

With reference now to FIG. **1** the low-pressure casing is illustrated with certain parts of the casing removed, their outline being indicated by the chain dotted line. The casing **1** consists essentially of a frame **2** to which the outer shell **8** and exhaust steam connection **9** are fixed. The frame **2** comprises an upper frame part **3** and lower frame part **4.** The frame **2** incorporates a shaft sealing gland assembly **5,** an inner casing bar **6** and connecting wells **7** joined together at vertical planes **11.** The joints between these parts can be separable, i.e. by means of bolts, but a permanent joint is also conceivable, by welding, for example. In the same way as frame **2,** gland assemblies **5,** inner casing bars **6** and connecting walls **7** are divided into upper and lower parts, these being indicated in the drawing by indices *a* or *b*.

The connecting walls **7** are free to respond to thermal forces acting in a horizontal direction, but remain rigid to forces acting in the vertical direction. In other words, their moment of inertia in the vertical direction is a multiple of that in the horizontal direction.

The shaft gland assemblies **5** and inner casing bars **6** are specified as the fixed points of casing **1,** and are rigid in every direction. The two halves of the casing formed along the plane of division are freely fixed together by means of the flanges **10** provided on upper frame part **3,** and lower frame part **4,** the flanges being secured together by means of bolts, for example.

The outer shell **8** and exhaust steam connection **9** are formed from simple metal sheet and permanently welded to frame **2.** These sheets constitute a simple enclosing membrane which adapts itself to the operating condition of the turbine at any given time.

The exhaust steam passes by way of the exhaust steam flange **9** to a condenser, not shown. The lower frame part **4** is supported on the foundation **13.** For this purpose, friction plates **12,** which take up the vertical forces, are arranged round the lower frame part on the contact surface facing the foundation **13.** These are provided principally on the connecting walls **7** of the lower frame part **4** because the fixed points of the casing 1 are determined by the inner casing support 6 and shaft gland assembly 5. Lugs 15, with eyes 16, are mounted on the shaft gland assembly 5 on both sides of the turbine axis and in parallel planes. An upper strap 18 and a lower strap 19 are pivoted at each of these eyes by means of hinge pins 17. The straps 18 and 19 are attached at their other ends to lugs 21, which similarly have eyes 22, by means of hinge pins 23. The lugs 21 are mounted on columns 20 which are rigidly fixed in the foundation 13. The columns 20 could, however, also be of reinforced concrete, forming an integral part of foundation 13.

The inner casing bar 6 comprises essentially an arm 25 and a cantilever bracket 24. The arm 25 is rigidly fixed to the foundation 13 with anchor bolts 26. The inner casing of the steam turbine which contains the rotor and guide blading, which for reasons of clarity is not shown, is supported on the cantilever brackets 24 which extend into the steam space of casing 1. The gland components, which form the shaft lead-throughs 28, are mounted on ring plates 27 incorporated in shaft gland assembly 5.

FIG. 2 shows a section through the casing 1 of a steam turbine at one of the shaft lead-throughs 28. The casing 1 consists of a frame 2, outer shell 8 and exhaust steam connection 9. Casing 1 can be split, the plane of division passing through frame 2 which is composed of upper frame part 3 and lower frame part 4. Upper frame part 3 and lower frame part 4 are provided with a flange 10 at the plane of division which is held together with bolts, not shown, to provide a steamtight joint. Outer shell 8 and exhaust steam connection 9 are fixed to their respective frame parts 3 and 4 by welding.

The shaft lead-through 28 is located in the gland assembly 5 of frame 2, the ring plates 27, which support the gland components, also being split.

Each column 20, on which the lugs 21 are mounted, is set rigidly in the foundation 13. Pins 23 allowing a single-axis hinged connection between the column 20 and upper strap 18 and lower strap 19 are fitted in the eyes 22 of lugs 21. Upper strap 18 and lower strap 19 are attached to the rigid gland assembly 5 by means of hinge pins 17 located in eye 16 of lug 15.

Friction plates 12, which rest on plates 30 set in foundation 13, are provided at the sides of gland assembly 5 and lower frame part 4 which faces the foundation 13. The casing 1 is thus positioned in the vertical direction, and movable horizontally. The relatively small expansion of lower frame part 3 in the vertical direction is taken up by the play in the hinged joints formed by straps 18 and 19 and pins 17 and 23.

Through bracing of the frame 2 of casing 1 of the steam turbine on the columns 20, by means of the pivoted upper straps 18 and lower straps 19, the resultant force of reaction forces acting on the casing can assume any direction without the case of a statically indeterminate system ever arising.

FIG. 3 shows a plan view of the casing of a steam turbine, with the upper part of the casing and upper frame part 3 removed. The lower frame part 4 comprises the gland assembly 5, inner casing bar 6 and the connecting walls 7 located between these. The planes of division 11 are indicated by broken lines at the flange 10 of the lower frame. The connecting walls 7 are supported on friction plates 12 which rest upon plates 30 set in the foundation 13. When the casing temperature rises, the straps 18 and 19 are deflected from their normal position. The bearing and gland clearances are scarecely affected by the minimal component of deflection in the axial direction. On the other hand, radial expansion of the gland assembly 5 and inner casing support 6 relative to the shaft axis can take place freely without reaction forces being applied to casing 1.

The chain dotted lines in FIG. 3 show, in an exaggerated manner the expansion of the lower frame part 4 and of the entire frame 2. It is to be noted that only parts which do not influence operation, such as the connecting walls 7, are subjected to deformation as a result of heat. On the other hand, the position and also the shape of the gland assembly 5 and the inner casing bar 6, which respectively support the shaft lead-throughs 28 and the inner casing, are retained.

Thus it is apparent that the straps 18 and 19, acting as external bracing for casing 1 and frame 2 on foundation 13, transmit to the rigid foundation 13 any buckling forces caused by vacuum, atmospheric pressure or inherent weight. In the region of the shaft lead-throughs 28 the lower frame part 3 is provided on the foundation 13 with an axially extending guideway, not shown, which ensures symmetrical expansion and maintains the central position of the shaft lead-throughs 28 relative to the shaft.

It lies within the scope of the invention that the inner casing bar 6 should be supported on the foundation 13 by straps in the same way as the gland assembly 5. External bracing by means of straps could also be applied to other parts of the casing, the exhaust steam flange for example, instead of to the lower frame part 4. Furthermore, external bracing could also be used in its essentials on the casings of other types of fluid flow machines, provided these do not have a self-supporting outer shell, without detracting from the advantages of the subject of the invention.

The straps 18, 19 can be located also in planes intersecting at any point, instead of in parallel planes. In addition, cables can be used in place of straps as the pivotal linkage means.

We claim:

1. In a fluid flow machine of the double shell type and which is anchored to a foundation, the machine comprising an inner casing having mounted therein a guide blade carrier and a bladed rotor, and an outer casing surrounding and spaced from said inner casing, the improvement wherein said outer casing includes a frame therefor supported on the foundation by means of friction plates and being free to expand in any horizontal direction, and pairs of upper and lower strap means located around said frame for movement in horizontal planes, the upper and lower strap means of each said pair being pivotally connected at one end to upper and lower pivot points which are fixed in relation to the foundation and being pivotally connected at the opposite ends thereof to said frame thereby to guide said frame and outer casing in its horizontal movement.

2. A fluid flow machine as defined in claim 1 wherein said pairs of upper and lower strap means are connected at the said opposite ends thereof to shaft gland assemblies secured to opposite ends of the frame.

3. A fluid flow machine as defined in claim 1 wherein said pairs of upper and lower strap means are formed by cables or rods.

4. A fluid flow machine as defined in claim 1 wherein the pivot points for the ends of said strap means which

are fixed in relation to the foundation are provided on columns upstanding from the foundation.

5. A fluid flow machine as defined in claim **4** wherein said columns form integral parts of the foundation.

6. A fluid flow machine as defined in claim **4** wherein said columns are constituted by separate structural parts secured to the foundation.

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