# United States Patent

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[54] **TURBINE CASING WITH RAISED HORIZONTAL JOINT**
**4 Claims, 4 Drawing Figs.**


[52] **U.S. Cl.** ..... **415/219,** 415/199
[51] **Int. Cl.** ..... **F01d 1/00**
[50] **Field of Search** ..... 415/138, 139, 140, 199, 219, 108, 168



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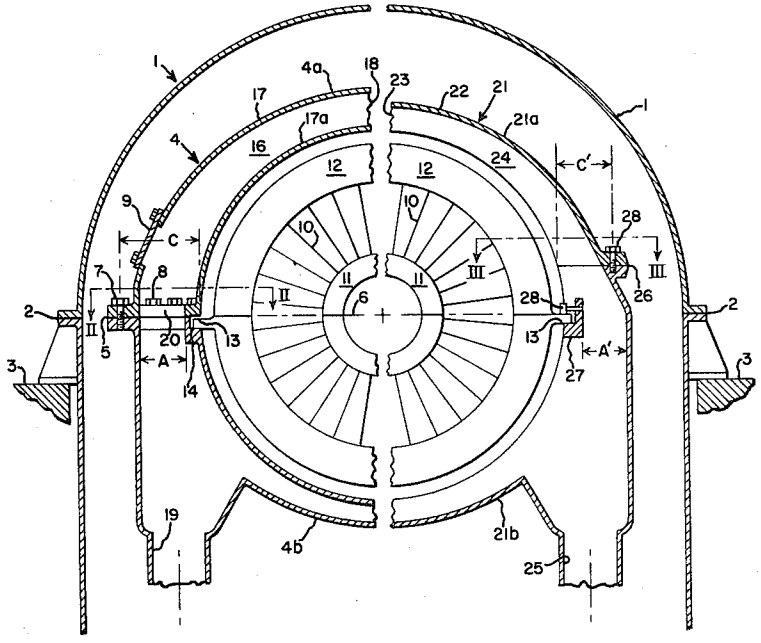
**ABSTRACT:** The inner casing of a low-pressure steam turbine has top and bottom sections which are connected along a horizontal joint disposed substantially higher than the horizontal centerline of the machine. The connectors at the joint can thus be located outside the inner casing because of the smaller sealing surface area at the raised joint.

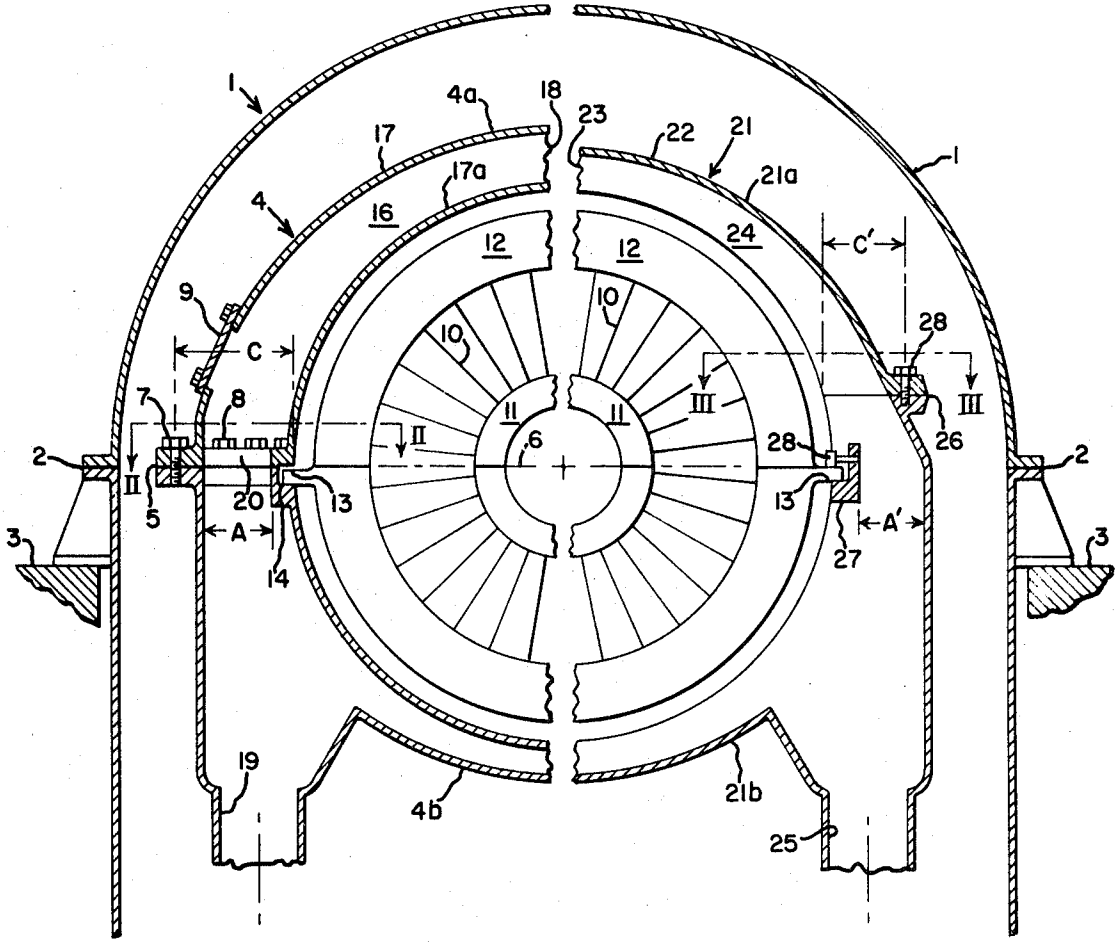



FIG. 1a
(PRIOR ART)

FIG. 1b

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FIG. 3

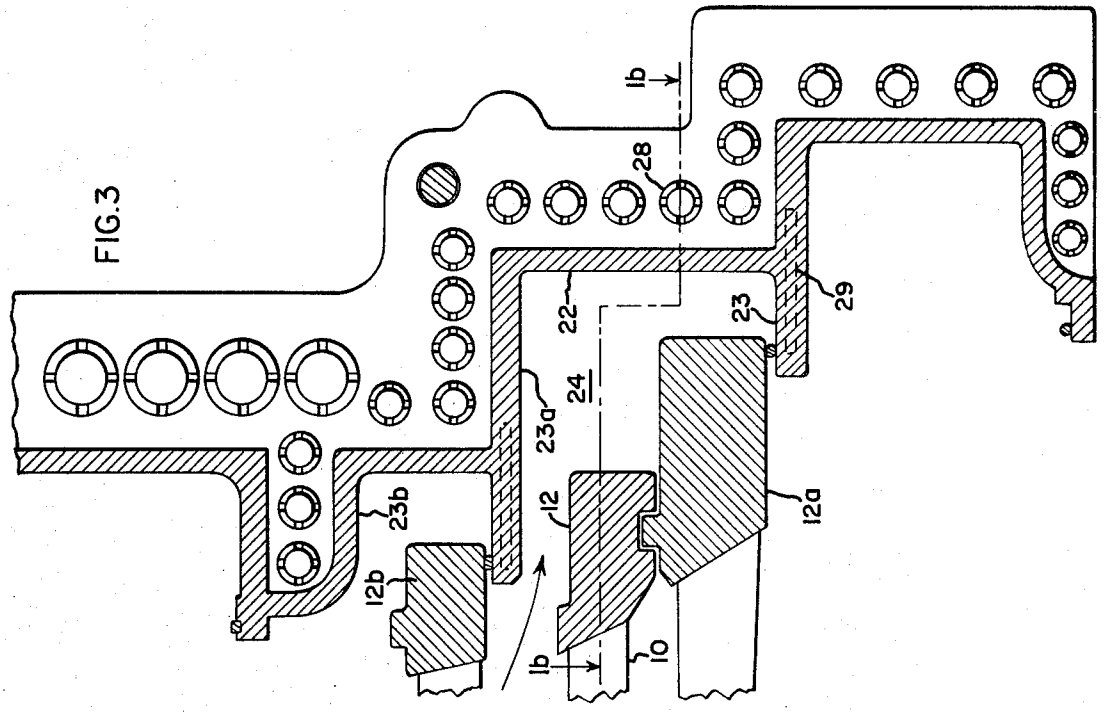
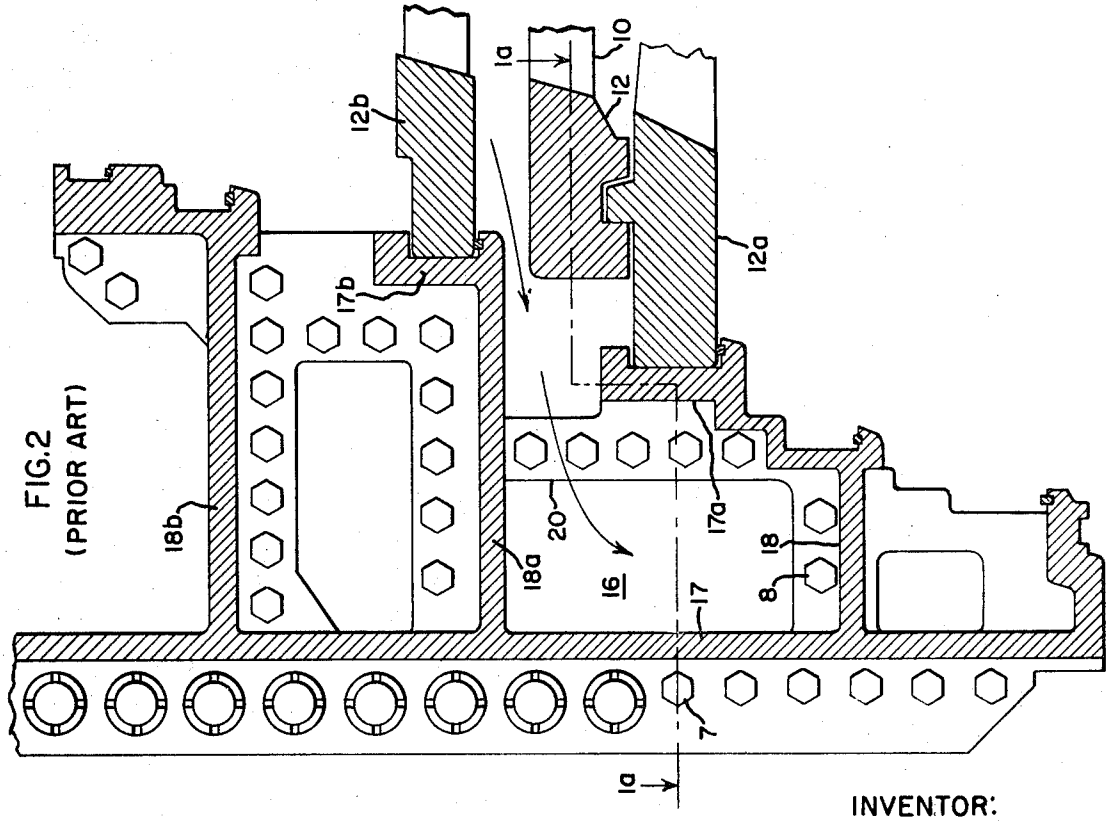



FIG. 2
(PRIOR ART)

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# TURBINE CASING WITH RAISED HORIZONTAL JOINT

## BACKGROUND OF THE INVENTION

This invention relates to elastic fluid turbines and particularly to an improvement in the inner casing construction of a low-pressure steam turbine.

The low-pressure units of large steam turbines are often arranged so that the lowest pressure turbine sections are disposed in an inner casing which is located in an outer casing or exhaust hood leading to the condenser. Thus the space between the inner and outer casings is at a vacuum corresponding roughly to exhaust or condenser pressure, while the steam pressure inside the inner casing varies as it is expanded from one stage of buckets and nozzle diaphragms to the next.

Low-pressure turbines are also generally constructed to provide for extraction of steam at various points along the low-pressure turbine sections in order to supply various feedwater heaters. Thus passages within the inner casing must be provided to lead the extracted steam from selected turbine stages and to remove it through pipes leading from the outer casing or exhaust hood. These extraction passages are generally formed between longitudinally spaced radial walls and the wrapper walls of the inner casing.

As is known to those skilled in the art, the inner casing must be split into two or more sections to allow for removal of the stationary nozzle diaphragms separating the turbine stages, and also for removal of the rotor itself. In the past, the inner casing upper and lower sections have been divided along a horizontal joint which is located roughly at the horizontal centerline of the machine, and the upper and lower halves of the nozzle diaphragms have also been supported substantially at the horizontal centerline. Because of the fact that the space between the outer casing and inner casing is at a vacuum, a tight seal must be maintained at this horizontal joint between the upper and lower inner casing halves. Furthermore, because of the fact that the passages for extraction of steam inside the inner casing are so large at the centerline, it has been necessary to provide additional connecting bolts inside the wrapper of the inner casing in order to provide an adequate seal. These internal connecting bolts can only be reached by providing access holes in the wrapper.

It is undesirable, both in terms of time requirements and safety of personnel, to require them to remove bolts which are inside the wrapper. Furthermore, the number of connectors and flanges necessary to accomplish sealing at the horizontal centerline joint, obstruct the steam flow both in the extraction passages and in the space between the inner and outer casings.

Accordingly, one object of the present invention is to provide an improved inner casing construction for a low-pressure steam turbine, wherein the connecting means for sealing the upper and lower inner casing halves may all be disposed on the outside of the inner casing.

Another object of the invention is to provide an improved inner casing construction for a low-pressure steam turbine, wherein the connecting means for joining the casing halves is arranged to minimize obstructions in the steam flow paths.

## SUMMARY OF THE INVENTION

Briefly stated, the invention is practiced by locating the horizontal joint of the inner casing substantially above the turbine horizontal centerline and at a location of smaller sealing area around the extraction passages, and locating the connecting members on the outside of the inner casing.

## DRAWING

The invention, both as to organization and method of practice, together with further objects and advantages thereof, will best be understood by reference to the following description, taken in connection with the accompanying drawings, in which:

FIG. 1*a* is a transverse cross section through one-half of a low-pressure steam turbine illustrating the prior art,



FIG. 1*b* is a similar cross section through the other half and illustrating the present invention,

FIG. 2 is a horizontal cross section taken along lines II—II of FIG. 1*a* illustrating the prior art, and

FIG. 3 is a horizontal cross section taken along lines III—III of FIG. 1*b*, illustrating the invention.

## DESCRIPTION OF A PRIOR ART CONSTRUCTION

Referring to FIG. 1*a* of the drawing, an outer casing **1**, which in this case is the exhaust hood, is arranged in upper and lower halves connected at a horizontal joint **2** and supported on a foundation **3**. At its lower end, the outer casing **1** communicates with the condenser (not shown). Disposed inside the outer casing is an inner casing **4** comprising an upper section **4***a* and a lower section **4***b*. Sections **4***a* and **4***b* are connected along a horizontal joint **5** disposed substantially along the horizontal centerline **6** of the turbine rotor (not shown). Joint **5** is sealed by external connecting bolts **7** and internal connecting bolts **8**. Access to internal bolts **8** is provided by a removable cover **9**.

The steam flows longitudinally along the turbine through nozzle partition blades **10** which are supported between inner and outer semicircular ring portions **11**, **12** respectively. Members **10**, **11** and **12** together make up a stationary nozzle diaphragm which is supported substantially at the horizontal centerline **6** by means of a lug **13** supported in a suitable recess **14** in the lower casing half. Extraction passages **16** are formed inside the inner casing **4** by an outer wrapper wall **17** and a number of spaced dial dividing walls **18**. The wrapper and radial walls are arranged so that the cross-sectional flow area of extraction passages **16** increase gradually from the top of the inner casing around the unit until they finally empty into an extraction steam removal pipe **19** toward the lower part of the inner casing.

Reference to FIG. 2 of the drawing, which also illustrates the prior art, shows a horizontal cross section of a portion of the turbine, looking downward just above the horizontal joint. It will be seen that the configuration of the wall sections of the inner casing **4** is rather complex in order to provide the various extraction passages such as **16**, as well as to accommodate the varying sizes of the outer diaphragm rings such as **12**, **12***a* and **12***b* along the steam flow path. It will be observed that additional radial wall portions **18***a*, **18***b* are longitudinally spaced along the unit, these being joined to additional circumferential well portions **17***a*, **17***b* which in turn cooperate with the outer diaphragm rings. These members together seal off regions of fluid pressure leading into extraction conduit **16**.

Due to the substantial distance between the outer wrapper wall **17** and the various diaphragm rings at the horizontal centerline, a substantial sealing area is required at the joint. This requires internal horizontal sealing flanges **20** which tend to obstruct the flow of extraction steam. Furthermore, extensive internal bolting **8** is necessary to provide an adequate seal.

The foregoing description is illustrative of an inner casing construction of the prior art, although it will be understood that many variations have been suggested in the prior art.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGS. 1*b* and 3 relate to the improved construction of the present invention. The outer casing **1** is arranged as before, as are the members **10**, **11** and **12** making up the diaphragm.

The improvement of the present invention relates to the inner casing shown as **21**, constructed with a top section **21***a* and a bottom section **21***b*. A wrapper wall **22** and a group of radial wall portions **23**, together with the diaphragm outer rings **12** define, as before, extraction passages **24**. Passages **24** gradually increase in cross-sectional area from the top toward the lower part of casing **21** and are led from the casing through extraction pipes **25**.

According to the present invention, the upper and lower casing sections are connected at a horizontal joint **26**. Joint **26** is disposed substantially higher than the centerline **6** of the

unit, perhaps on the order of 2 feet in a large low-pressure turbine. Since the radius of the inner casing will vary from 4 feet to 8 feet or more, the joint is thus raised on the order of one-quarter to one-half of the inner casing radius. Mounting pads **27** arranged on selected radial walls **23** support the diaphragm lugs **13** substantially at the horizontal centerline as before, and removable square-headed pins **28** hold the lugs **13** in position.

Means for connecting the upper and lower sections at horizontal joint **26** include bolts **28**. These bolts are all located and accessible from the outside of inner casing **21**.

Reference to FIG. **3** of the drawing shows a horizontal cross section taken just above horizontal joint **26**. FIG. **3** shows the inner casing to include additional diaphragm rings **12**, **12***b* and additional radial wall portions **23***a*, , **23***b* as before, together defining extraction passages such as **24**. Passages **24** become smaller in cross-sectional area as the top of the inner casing is approached. Hence the total area for sealing the raised horizontal joint is substantially smaller than in FIG. **2** for a comparable unit and the lengths of the radial walls are also shorter. This enables a sufficient seal at the joint to be obtained by the use of bolts **28** which are all external to the inner casing. Sealing keys **29** at the horizontal joint may be employed if desired to give additional sealing capability.

## OPERATION

The operation of the invention is as follows. Referring to FIGS. **1***a* and **1***b* of the prior art and the present invention respectively, it will be noted that the cross-sectional areas of the extraction conduits **16**, **24** respectively decrease from the top of the inner casings toward the horizontal centerline. However, in FIG. **1***a*, because of the inner circumferential walls **17***a* and the large sealing flanges **20** at the horizontal centerline, the outer dimension of the wrapper **17** is necessarily greater than it is in FIG. **1***b*, in order to provide the same flow areas at the centerline, these areas being indicated by letters A and A′ respectively.

By raising the horizontal joint **26** to the location indicated, where the cross-sectional flow area is smaller in passage **24**, a much smaller area for sealing is required. In other words, the horizontal distance C′ on which the bolts **28** must exert sealing force is much smaller in dimension than the comparable horizontal distance C in the left-hand FIG.

Since dimension C was so great with the prior art construction, insufficient force could be obtained with bolts **7**, thus requiring internal bolts **8** and the accompanying flanges **20**. The internal bolts and flanges compounded the casing construction difficulties, as well as bringing about the aforesaid enlargement of inner casing wrapper diameter in order to accommodate the required extraction flow area. Also the support block with recess **14** blocked the extraction passage **16**, thereby causing an additional increase in dimension C.

It will be noted in the improved construction that, since the distance between the inner and outer casings becomes greater as the horizontal joint is raised, more space becomes available for the external bolting flanges carrying bolts **28** and hence the flow area of steam to the condenser between the inner and outer casings is less obstructed with e improved design.

When removing the upper section of the inner casing in FIG. **1***b*, it is only necessary to remove bolts **28** without requiring entry into the inner casing wrapper as in the old construction. Removal of the square-headed pins **28** then allow the diaphragm sections to be raised in the usual manner.

Thus it will be seen that the foregoing improvement to inner casing design in a low-pressure steam turbine of a raised horizontal joint as indicated offers substantial improvements over the prior art. Removal of the inner casing upper section is greatly facilitated and improved steam flow passages result without increase of the outer casing overall dimensions.

Although the invention has been shown as specifically applied to a large low-pressure steam turbine, the construction is equally applicable to other types of elastic fluid turbines of a two-casing construction. While there has been shown herein what is considered to be the preferred embodiment of the invention, other modifications may be made by those skilled in the art, and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

**1**. In an elastic fluid turbine having a rotor with a plurality of bucket wheels and a plurality of stationary nozzle diaphragms separating said wheels and having outer ring portions dividing regions of gradually decreasing fluid pressure, the improvement comprising:

an outer casing communicating at its bottom side with a region of fluid pressure lower than that in said diaphragm regions,

an inner casing disposed thin said outer casing and having a wrapper wall and a plurality of spaced radial wall portions, said wall portions and said outer diaphragm ring portions cooperating to define extraction conduits from said diaphragm pressure regions, said conduits gradually increasing in cross-sectional area from the top of the inner casing to the horizontal centerline of the rotor,

said inner casing being divided into upper and lower sections along a horizontal joint disposed substantially higher than said centerline, whereby the sealing surface at the joint is smaller than it would be if located at the centerline, and

bolting means sealingly connecting said upper and lower sections and accessible from the outside of said inner casing.

**2**. The combination according to claim **1**, wherein said nozzle diaphragms are supported substantially at the horizontal centerline on pads attached to said radial wall portions in the lower casing section, and further including removable pins holding said diaphragms in place.

**3**. The combination according to claim **1**, wherein said horizontal joint is disposed a distance above said horizontal centerline on the order of one-quarter to one-half of the inner casing radius.

**4**. The combination according to claim **1**, wherein said radial wall portions include sealing keys disposed at the horizontal joint.

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