April 26, 1960 R. M. WATSON ET AL 2,934,316

TURBINE CASING

Filed Nov. 18, 1955 2 Sheets-Sheet 1

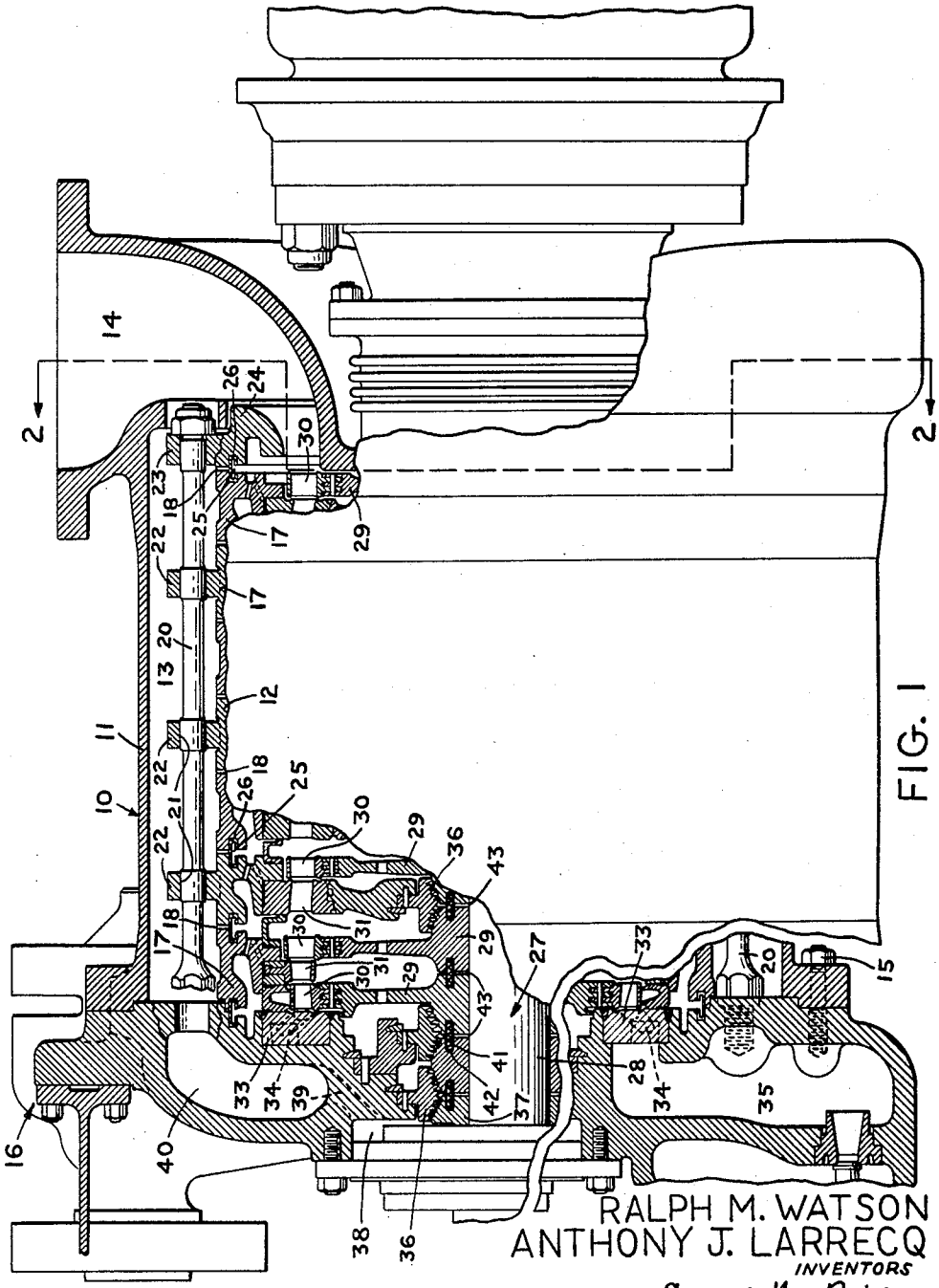


FIG. 1

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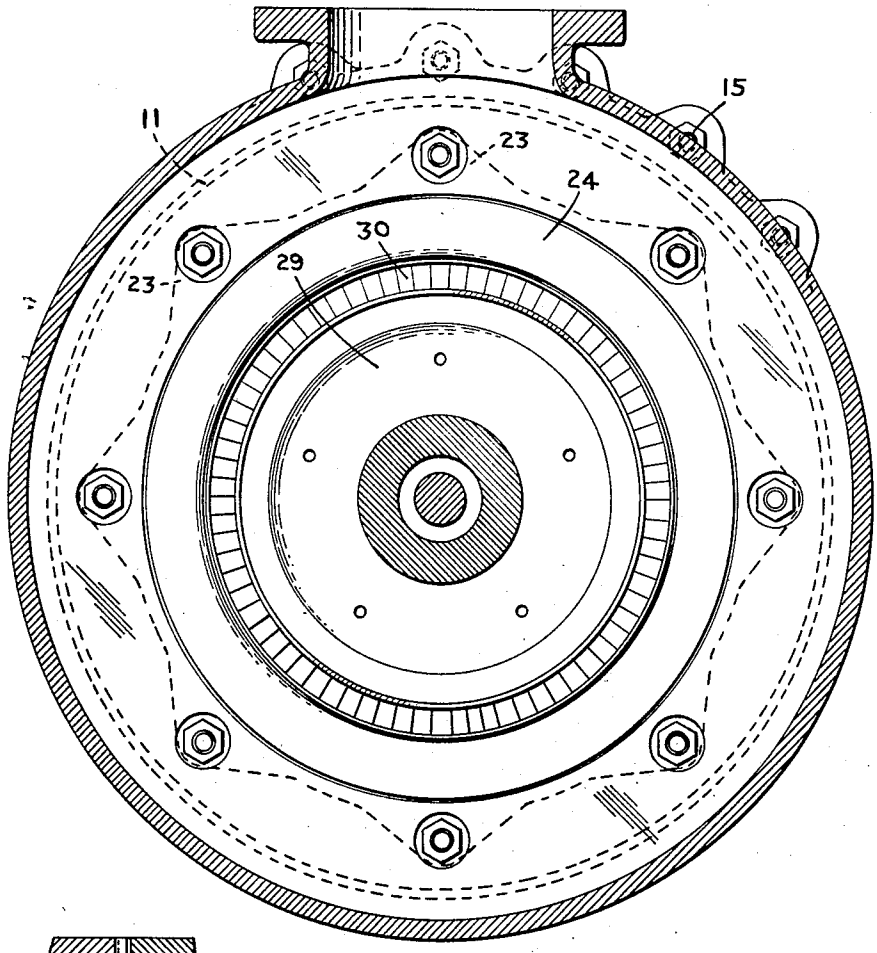


FIG. 2

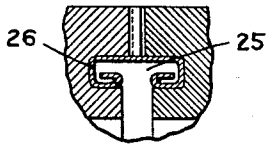


FIG. 3

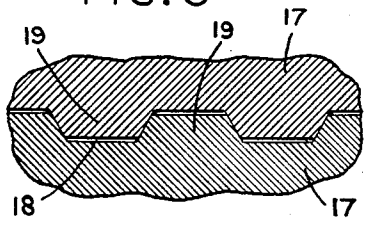


FIG. 5

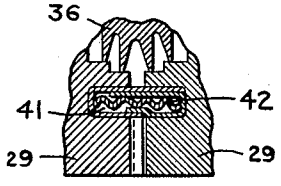


FIG. 4

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TURBINE CASING

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Application November 18, 1955, Serial No. 547,756

8 Claims. (Cl. 253—39)

The present invention relates generally to high temperature turbines and more particularly to a turbine casing comprising an outer casing of generally cylindrical form and an inner casing formed by a series of annular elements disposed within said outer casing in spaced relationship therewith.

In high temperature turbines, it is necessary to take extraordinary precautions, particularly during the starting up period to insure that uniform heating of the turbine casing takes place. It is standard practice with the starting of high temperature turbines to limit the temperature rise of the casing to about 100° F. per hour to avoid distortions which might cause the casing to crack or might cause failure of the turbine due to interference of the rotating and stationary elements therein.

The present invention overcomes this problem and allows the turbine to be started cold with full application of maximum steam pressure and temperature without undue distortion of the casing and without developing interference between the rotating and stationary elements in the turbine.

This is accomplished by a double casing for a turbine which includes a substantially cylindrical low pressure outer casing and a high pressure inner casing disposed within said outer casing and in spaced relationship therewith to form an annular chamber therebetween adapted to receive leakage steam. The inner casing is constructed so that the diaphragm of each turbine stage is mounted of its own independent annular inner casing element. Each of these casing elements is provided with face splines which maintain them in correct alignment with one another but permit radial expansion and contraction of the elements with one another while maintaining the diaphragms concentric with the axis of rotation of the turbine rotor.

The initial section of the first annular element of the inner casing in the steam chest which indirectly carries the journalled bearing establish the correct relation of the inner casing assembly with respect to the axis of rotation of the turbine.

A plurality of spaced tension rods attached to the steam chest at the inlet end thereof and to a free floating ring splined to the last annular element at the exhaust end of the turbine maintains the splined faces of the annular elements in contact with one another against the internal steam pressure of the turbine tending to separate them. The complete assembly of the inner casing elements and tension rods is contained within and completely independent of the low pressure outer casing. This novel arrangement of elements forming the inner casing permits these elements which are subject to high pressures in temperatures to expand freely of the structure forming the low pressure outer casing and thereby allows for the difference in temperatures between the inner and outer casing which may cause one to expand more than the other. This permits contraction and distortion of the casings without the inclusion of dangerous stresses or interferences which may occasion a failure of the turbine to operate.

The present invention further provides a seal for the prevention of steam leakage from the high pressure spaces bounded by the inner casing into the annular space formed between the inner casing and the outer casing.

The present invention further provides a double wall casing for a turbine having an annular space therebetween which communicates with the turbine exhaust outlet without external connection and which also communicates with points of high pressure steam leakage to collect said high pressure steam leakage therein and conduct it to the exhaust outlet to provide an area of intermediate temperature between the inner and outer casing of the turbine.

The present invention further provides an inner casing made of independent annular elements adapted to permit radial expansion thereof without danger of separation of rotation relative to one another.

The invention will be better understood from the following description when considered in connection with the accompanying drawings forming a part thereof and in which:

Figure 1 is a side elevation, partly broken away, of a turbine embodying the present invention.

Figure 2 is a transverse view of the turbine, take on line 2—2 of Figure 1.

Figure 3 is an enlarged sectional view of a seal ring embodied in the present invention.

Figure 4 is an enlarged sectional view of another seal ring embodied in the present invention.

Figure 5 is a transverse section taken through a spline joint embodied in the present invention.

Referring to the drawings, the reference numeral **10** designate a turbine provided with an outer cylindrical casing **11** and an inner casing **12** disposed inwardly of the outer casing **11** to form an annular space **13** therebetween. Outer casing **11** is provided with an exhaust conduit **14** on one end thereof and is connected by threaded fastenings **15** at the other end thereof to a steam chest **16**. Inner casing **12** comprises a plurality of annular rings or elements **17** having their side faces **18** disposed in abutting relationship with one another and provided with complementary teeth or splines **19** (see Fig. 5) which permit radial expansion and contraction of adjacent rings **17** with one another while maintaining them in correct alignment with each other. Rings **17** are mounted concentrically within outer casing **11** on longitudinally extending tension rods **20** extending through bores **21** provided in lugs **22** disposed on alternate rings **17**. Tension rods **20** are disposed in spaced relationship with one another circumferentially of the rings and have one end thereof threadably connected to the steam chest. An annular floating ring **24** is mounted on the other end of rods **20** in abutting relationship with the end ring **17** thereon. The side of ring **24** adjacent ring **17** is provided with complementary teeth or splines similar to those on ring **17**. The rods extend through lugs **23** formed on the floating ring, which lugs are similar to lugs **22**. Bolt means are disposed on rod **20** adjacent the floating ring **24** and maintain the floating ring in contact with the end ring **17** adjacent thereto and the opposite end ring **17** in contact with the side face of steam chest **16**. Continuous circumferential grooves or recesses **25** (see Fig. 3) are disposed in the side faces of rings **17** adjacent one another and float ring **24** for the insertion of sealing means therein. The sealing means comprise a ring **26** made of resilient material to prevent or restrict the leakage of high pressure steam from within the inner casing **12** between the rings and into the annular chamber **13**.

A rotor indicated generally as **27** is supported within

casing 12 by means of suitable bearings, not shown, and comprises a shaft 28 having a plurality of bucket wheels 29 fixed to the shaft by means not shown. Circumferentially spaced around bucket wheels 29 and secured thereto by any suitable means are a plurality of buckets 30. Stationary diaphragms 31 in the form of discs containing a plurality of blades forming nozzle passages are supported by individual rings 17 and are associated with the buckets 30 for directing the steam against the buckets. An annular nozzle block 33 is disposed in a steam chest 16 adjacent buckets 30 of the end or inlet bucket wheel 29. Block 33 is provided with a plurality of nozzle passages 34 therein for directing steam into said buckets. Nozzle passages 34 are in communication with an inlet steam chamber 35 disposed in the steam chest.

Labyrinth seals 36 are mounted on the steam chest 16 adjacent the inlet bucket wheel 29 and are adapted to prevent any substantial leakage of steam from nozzle passages 34 axially of the spacer elements 37 arranged on shaft 28. Any leakage of steam which by-passes the first stage of the turbine will be discharged between the labyrinth seals 36 and spacers 37 into a chamber 38 in the steam chest. A cored passage 39 in communication with annular space 38 at one end thereof and with a steam space 40 at the other end thereof in communication with the annular chamber 13 between the inner and outer casings of the turbine, permits high pressure leak-off steam to pass to the exhaust conduit 14. This reduces the pressure on the labyrinth carbon packing and also provides an area of intermediate temperature between the inner and outer casings, approaching the inner casing temperature, to permit rapid warm-up of the outer casing.

Referring to Figure 4, the hub portion of bucket wheels 29 and spacers 37 are provided with continuous circumferential recesses 41 disposed therein adjacent one another with annular resilient metallic elements 42 positioned therein to prevent leakage of high pressure steam from inner casing 12 axially along the rotor 28. The side faces 43 of spacers 37 and the hub portions of bucket wheels 29, are constructed similarly to the splined side faces of annular rings 17, as illustrated in Figure 5.

In the present invention, when steam is admitted to the steam chest 16 from a source, not shown, the steam will pass through nozzle passages 34 and into the buckets 30 and diaphragms 31 of the respective turbine stages after which the steam will be discharged through exhaust conduit 14. It will be noted that the present invention provides an inner casing 12 which is disposed within the outer low pressure casing 11 and is free to expand independently of the outer casing to permit contraction and distortion of the casings to occur without the inclusion of dangerous stresses or interferences which might occasion a failure of the turbine to operate.

In addition, the present invention provides an inner casing with a plurality of rings having splined side faces thereon which maintain adjacent rings in correct alignment with one another while permitting radial expansion and contraction with respect to one another. This permits the diaphragm of each turbine stage to be mounted on its own annular ring element so that the diaphragm remains concentric with respect to the axis of rotation of the bucket wheel.

The present invention further provides novel seal means for the prevention of steam leakage from the high pressure spaces bounded by the inner casing 12 into the low pressure space 13 adjacent the outer periphery of the inner casing.

The persent invention further provides means for passing steam leakage from the inlet or first stage of the turbine into an annular chamber between the inner and outer casings of the turbine and into the exhaust conduit

to provide an area of intermediate temperature between the casings which permits rapid warm-up of the outer casing.

It will be understood that the invention is not to be limited to the specific construction or arrangement of parts shown but that they may be widely modified within the invention defined by the claims.

What is claimed is:

1. A turbine comprising a casing having an inner casing disposed therein in spaced relation with the inner periphery of said outer casing to form an annular chamber therebetween, a steam chest at one end of said outer casing and in operative communication with said inner casing, an exhaust outlet at the other end of said outer casing and in operative communication with both said inner casing and said annular chamber, a shaft having rotors mounted thereon disposed in said inner casing, said inner casing comprising a plurality of annular elements having the side faces thereof disposed adjacent one another, said annular element adjacent said exhaust means comprising a floating ring, lug means on said annular elements, tension rods engaging said floating ring at one end and extending through said lug means on the other annular elements and detachably connected to said steam chest at the other end whereby said floating ring is caused to abut the annular element adjacent said floating ring to maintain all of the annular elements in abutting relationship with one another.

2. The turbine claim 1 wherein the side faces of said annular elements are provided with splines adapted to engage splines of adjacent elements.

3. The turbine of claim 1 wherein the side faces of said annular elements are provided with a continuous circumferential recess adjacent one another and resilient sealing means are disposed in each recess to prevent leakage of steam into said annular chamber.

4. The turbine claimed in claim 1 wherein said tension rods are disposed in spaced relationship with one another and circumferentially about the outer periphery of the annular elements.

5. A turbine comprising a casing having an inner casing disposed therein in spaced relation with the inner periphery of said outer casing to form an annular chamber therebetween, a steam chest at one end of said outer casing and in operative communication with said inner casing, an exhaust outlet at the other end of said outer casing and in operative communication with both said inner casing and said annular chamber, a shaft having rotors mounted thereon disposed in said inner casing, said inner casing comprising a plurality of annular elements having the side faces thereof disposed adjacent one another, said annular element adjacent said exhaust means comprising a floating ring, lug means on said annular elements, tension rods engaging said floating ring at one end and extending through said lug means on the other annular elements and detachably connected to said steam chest at the other end whereby said floating ring is caused to abut the annular element adjacent said floating ring to maintain all of the annular elements in abutting relationship with one another, seal means for the rotors mounted on the shaft to cause leakage fluid to pass axially along the shaft, and conduit means in said outer casing receiving said leakage fluid and passing said fluid to said annular chamber.

6. The turbine of claim 5 wherein the side faces of said annular elements are provided with splines adapted to engage splines of adjacent elements.

7. The turbine of claim 5 wherein the side faces of said annular elements are provided with a continuous circumferential recess adjacent one another and resilient sealing means are disposed in each recess to prevent leakage of steam into said annular chamber.

8. The turbine claimed in claim 5 wherein said tension rods are disposed in spaced relation with one another

and circumferentially about the outer periphery of the annular elements.

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