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[54] **PLURAL SHELL AXIAL TURBINE FOR OPERATION WITH HIGH PRESSURE, HIGH TEMPERATURE STEAM**

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[58] **Field of Search**.... 415/108, 194 R, 138, 199 A, 415/198, 219 R, 4

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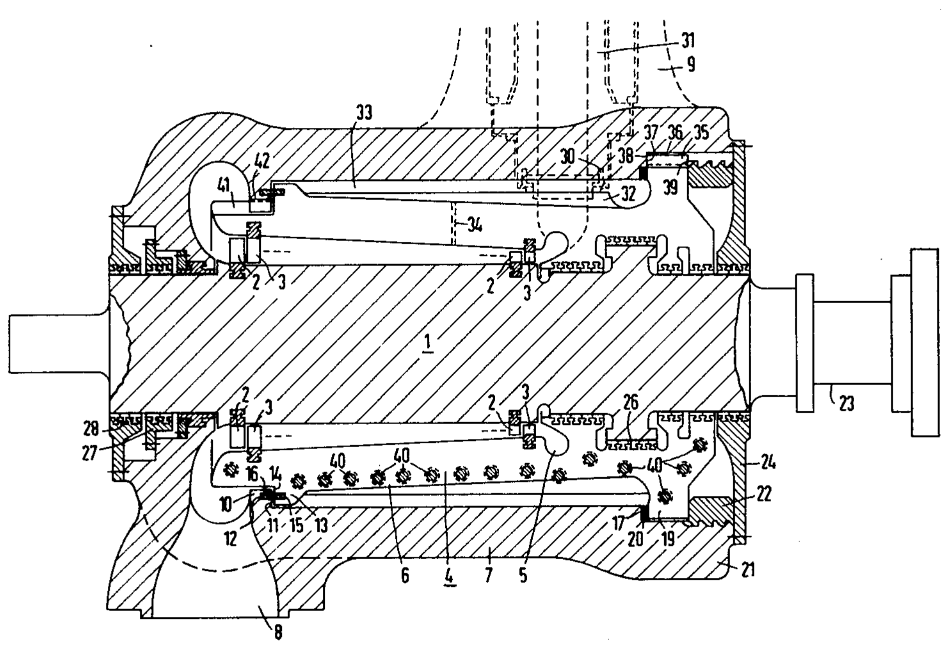
[57] **ABSTRACT**

In a plural shell axial turbine for operation with high pressure, high temperature steam and which has a pot-shaped housing as the outer shell and an inner shell divided in the plane of the axis, the guide vane component and the housing for the shaft packing at the inlet side are structurally combined to form an inner shell which is not divided in the direction of the axis. The inner shell is here designed so that it can be inserted into the pot-shaped housing which is also of integral construction, from the inlet side.

5 Claims, 1 Drawing Figure



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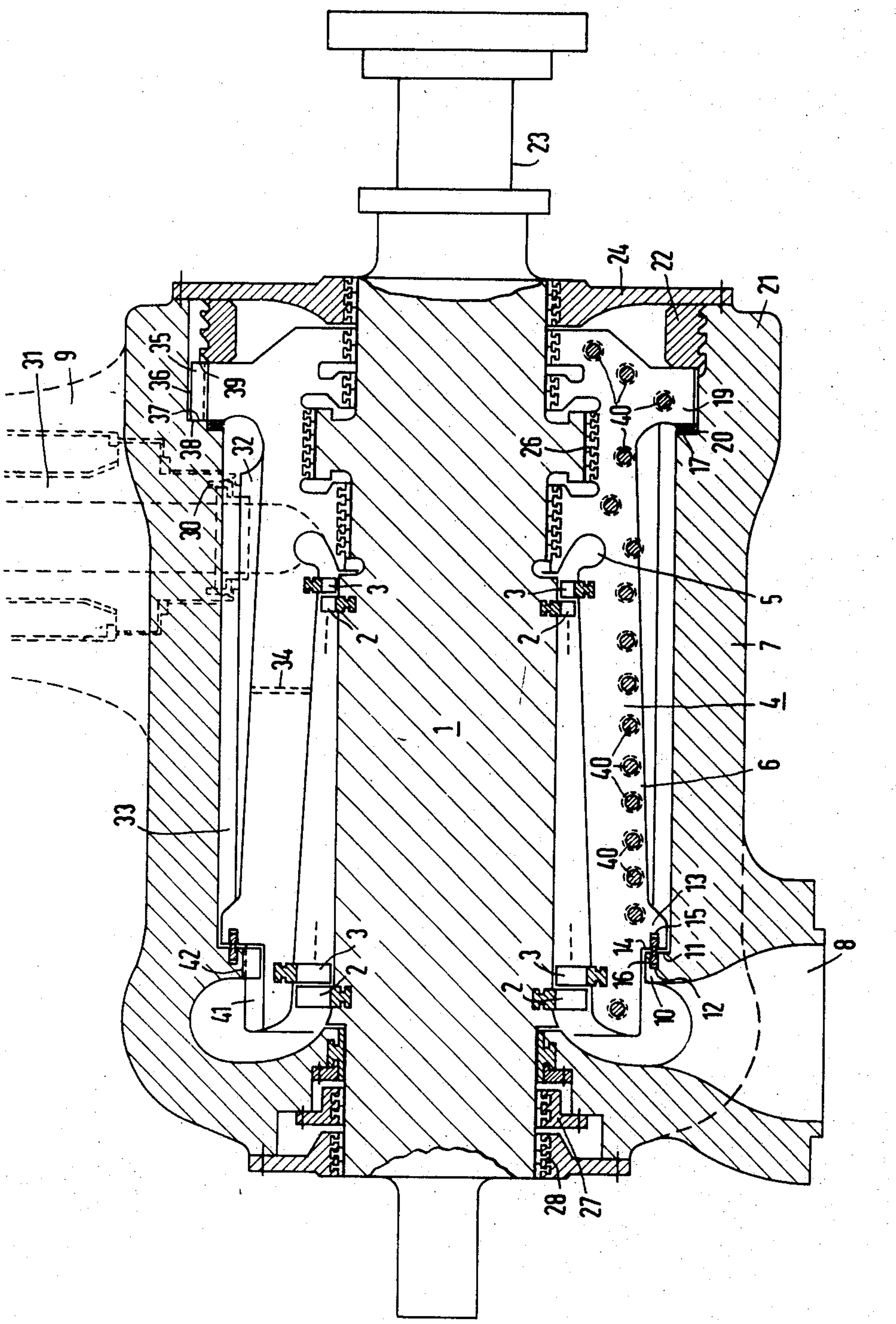

PLURAL SHELL AXIAL TURBINE FOR OPERATION WITH HIGH PRESSURE, HIGH TEMPERATURE STEAM

The invention relates to an axial turbine for operation with high pressure, high temperature steam and which has at least two shells, including a pot-shaped housing as an outer shell and an inner shell divided in the plane of the axis. Such a turbine usually is the high pressure section or stage of a plural section or stage turbine.

Conventional, high-pressure turbine sections are illustrated, for example, in (German Offenlegungsschrift Pat. No. 1,812,493) generally have at the outlet end of the outer shell a parting or dividing plane normal to the axis. There is thus provided, before the outlet end of the outer shell is assembled with the rest of the outer shell, an opening through which the housing for the shaft packing for the inlet side and the guide vane carrier, which is in the form of an inner housing, are inserted after being placed on the shaft. In such a design the thrust of the inner housing or the guide vane carrier and of the shaft packing housing at the inlet side that occurs must be countered separately, since the thrust of these respective structural parts acts in opposite directions. This thrust, which is generated by the large difference between the different steam spaces in the pot-shaped housing, is at times more than 6,000,000 kg. In order to be able to counter forces of this magnitude, supports are needed which are large axially and in the area of which large screws must be inserted in the inner housing to fasten together the axial halves thereof. Moreover, from a certain power rating on, the screw connection of the radial flange of the aforementioned radially divided pot-shaped housing, leads to difficulties, as while the dimensions of the steam connections increase with the power rating, the length of the high-pressure turbine section does not increase to the same extend and, therefore, not enough space is available for the flange.

It is, therefore, an object of the invention to provide a design for a pot-shaped axial turbine for high pressure, high temperature operation, in which a considerably smaller thrust from the pressure differences in the different steam spaces occurs and which can be manufactured and installed considerably more easily. Other objects and advantages of the invention will be apparent to one skilled in the art from the following description.

According to the invention, the guide vane component and the shaft packing housing for the inlet side are structurally combined to form an inner shell which is not divided in the plane of the axis. The inner shell is designed so that it can be inserted into the pot-shaped housing from the inlet side. The pot-shaped outer housing is also of integral construction rather than being radially divided into respective inlet and outlet parts. There is, thus, provided a construction in which only one support for the inner shell is necessary and a radial parting plane and a corresponding radial flange are eliminated for the pot-shaped housing.

The inner shell is supported at the outlet end in an axially movable manner against an inwardly projecting shoulder of the pot housing and is fixed axially and radially at the inlet end in the area of the shaft packing housing against corresponding shoulders of the pot housing by means of projections of the inner shell engaging with corresponding slots in the pot housing. The outlet end of the inner shell may be kept pressure-tight by means of a cylindrical I-ring which is inserted in respective circular, coaxial grooves in the shoulder of the pot-shaped housing and in the inner shell.

At the inlet end, the inner shell is fixed axially and radially by a thrust ring which is screwed into the open end of the outer shell and acts on the projections. For the purpose of sealing, an elastic U-ring seal is inserted at this side between the radial extension of the inner shell, carrying the projections, and a radial contact surface of the pot housing.

The dimensions of the supports for the axial thrust are relatively small, as the thrust from the pressure differences in the different steam spaces now does not exceed 2,000,000 kg. The combination and arrangement of the sealing rings herein is selected for use with the relatively small support surfaces. Beyond this, the axial fixation point of the inner shell can be so placed through the combination of the inner shell and the arrangement of the I-ring, that the thermal expansion of the rotor and the inner shell is in the same direction. Therefore, a smaller amount of axial play is required.

The end of the pot housing on the inlet side is merely closed off by a sealing cover put on in a steam-tight manner.

It is possible to design the inner shell either as the inner housing having steam inlets connected thereto in a pressure-tight fashion and to provide relief holes to the annular space between the outer and the inner housing or as a guide vane carrier construction in which the full input steam pressure is in the annular space.

The design and operation of an exemplary embodiment of the invention will be explained further with reference to a schematic drawing.

The drawing is a horizontal cross section through the turbine in the axial plane in which the inner shell is divided.

The shaft **1** of the illustrated high-pressure section of a turbine is equipped with axially spaced rotor blade rings **2** axially alternated with axially spaced guide vane rings **3**. The guide vane rings **3** are held by the axially divided inner shell **4** of the turbine. The illustrated embodiment is a throttle-controlled turbine, in which the steam flows to the high-pressure blades of the rings **2** from the annular recess **5**.

In the inner shell **4**, the guide vane carrier **6** containing the inlet plenum **5** is combined, according to the invention, with the inlet side shaft packing housing **26** to form a structural unit. The inner shell **4** and the outer shell or pot-shaped housing **7** of the turbine are designed in such a manner that the inner shell **4** can be inserted into the housing **7** from the inlet side of the housing **7**. It is thereby made possible to design also housing **7** integrally, so that a radial dividing plane, which has heretofore customary in the outlet region of the turbine, becomes unnecessary. The resulting one-piece housing **7** also includes a structural unit therewith the steam outlet connection **8** at the outlet part of the housing **7** and the live steam inlet connection **9** at the inlet part of the housing **7**.

The inner shell **4** is supported and secured in the housing **7** as follows. On the inlet side, the inner shell **4** has at the shaft packing housing **26** section thereof four projections **35** which are uniformly spaced around the circumference and which engage in corresponding axial slots **36** in the housing **7**. The radial contact surfaces **37** of the projections **35**, rest against the corresponding radial shoulders **38** of the housing **7**. The inner shell **4** is locked by means of a thrust ring **22**, which is screwed into the open inlet end **21** of the housing **7** and rests essentially against the outer end faces **39** of the projections **35**, braced against the housing **7**, and is thereby supported and secured axially and radially. In addition, an elastic, U-shaped ring seal **20** is inserted between the extension **19** carrying the projections **35** of the inner shell **4** and a further radial contact surface **17** of the housing **7**. At the outlet end, the housing **7** has a radially inwardly extending shoulder **10**, which is closer to the axis than the shoulders **38** on the inlet side. An annular slot **12** is machined into the radial contact surface **11** of the shoulder **10** facing the inlet side. The inner shell correspondingly has at its outer periphery a radial extension **13**, the radial contact surface **14** of which is likewise provided with an annular slot **15**. Into the two annular slots **12** and **15** a cylindrical, I-shaped seal ring **16** is inserted, which permits axial expansion of the inner shell in the direction of the exhaust steam connection and essentially performs the sealing of the outlet end of the annular space **33**. In addition, the inner shell **4** is held on the outlet side, as it is on the inlet side, by means of projections **41** on the radial extension **13** of the inner shell **4**, which engage with corresponding axial slots **42** in the housing shoulder **10**.

The mounting on the inlet side, therefore, constitutes the fixation point for the axial expansion of the inner shell **4**. As the shaft **1** has its point of fixation on the inlet side of the turbine at the annular recess **23**, at which a journal bearing is located, the inner shell **4** and the shaft **1**, therefore, expand in the same direction. Only a small amount of axial play between the two parts need, therefore, be considered in this design, which reduced the construction cost considerably.

The inner shell **4** can be inserted axially into the housing **7** from the inlet side. By combining the guide vane carrier **6** and the inlet shaft packing housing **26**, only one support for the inner shell **4** on the inlet side is necessary. The dimensions of this support are relatively small, as the thrust from the pressure differences in the different steam spaces does not exceed approximately 2,000,000 kg. The combination and arrangement of the sealing rings herein is selected for use with the relatively small support.

The end **21** of the housing **7**, which is open on the inlet side, is closed merely by a sealing cover **24** put on in a steam-tight manner. On the outlet side of the turbine, the shaft packing housing **27** and the sealing cover **28** are inserted from the outside into corresponding recesses of the housing **7**.

The illustrated embodiment is based on the premise that the live-steam inlets **31** (shown by dashed lines, as the inlets are not situated in the horizontal plane) are brought directly up to the inlet connections **32** of the inner shell by means of conventional, steam-tight angle ring connection **30**. Thereby, the inner shell fulfills the function of an inner housing, which may further have relief holes **34** to the annular space **33** between the housing **7** and the inner housing **4** for the purpose of pressure relief. At lower pressures (up to 220 kg/cm^2), however, it is also possible to construct the inner shell as a guide vane carrier, in which case a steam-tight connection between the steam inlet connection and the inner shell becomes unnecessary and the full pressure of the live steam is in the ring space **33**.

Through the use of an inner shell of this kind, which comprises the guide vane carrier section and the shaft packing housing for the inlet side and has supports and seals of small dimensions, and through the elimination of the radial flange on the outer housing, only relatively small wall thicknesses are necessary, which can be kept approximately the same everywhere. This has a beneficial effect on the rate of the temperature changes and, therefore, on the cost of the high-pressure section of the turbine. Due to the favorable location of the sealing rings **16** and **20** over the entire area of the inner housing **4**, the surfaces in the parting plane and the parting plane screws **40** can, furthermore, be kept small.

I claim:

1. Axial turbine for operation with high pressure, high temperature steam, comprising a pot-shaped housing having inlet and outlet means for the steam, the location of the steam inlet means in the axial direction of the housing being adjacent one side of the housing and the steam outlet means in the axial direction of the housing being adjacent the other side of the housing, a shaft, the shaft being mounted in the housing coaxially therewith for rotation therein, a packing housing for the shaft, said packing housing being mounted around the coaxially therewith in the pot-shaped housing adjacent the inlet side of the pot-shaped housing, and means for carrying guide vanes, said guide vane carrying means being integral with the packing housing and extending toward the other end of the pot-shaped housing, the guide vane carrying means and the packing housing forming an inner shell within the pot-shaped housing, said inner shell being integral in the axial direction of the housing and divided in a plane of the housing axis, a radially inwardly extending shoulder formed in the pot-shaped housing adjacent the steam outlet side thereof, said shoulder abutting and radially supporting the inner shell but permitting axial movement of the inner shell, radially outwardly extending projections formed adjacent the steam inlet side of the pot-shaped housing on the shaft packing housing portion of the inner shell, axial slots formed in the pot-shaped housing adjacent the projections, radially inwardly extending shoulders formed in the pot-shaped housing adjacent the slots, the projections being received in the slots and abutting against the shoulders, whereby the projections, shoulders and slots fix the inner shell adjacent the steam inlet side of the pot-shaped housing both radially and axially.

2. Axial turbine according to claim **1**, further comprising a radial surface formed on the inner shell facing a surface of the radially inwardly extending shoulder formed in the pot-shaped housing, formed in each of the facing surfaces a like circular slot coaxial with the housing, and a cylindrical I-ring received in the slots.

3. Axial turbine according to claim **1**, further comprising a thrust ring screwed into the housing at the steam inlet side thereof and abutting against the projections thereby locking the inner shell axially and radially.

4. Axial turbine according to claim **3**, further comprising a radially outward extension formed on the shaft packing housing portion of the inner shell adjacent the steam inlet side of the pot-shaped housing and defining a radial surface, the projections being carried by the extension formed in the pot-shaped housing a radial surface facing the radial surface of the projection, and an elastic U-ring seal inserted between the radial surface of the projection and the radial surface formed in the pot-shaped housing.

5. Axial turbine according to claim **3,** further comprising a sealing cover closing the steam inlet end of the pot-shaped housing, the sealing cover being mounted on the steam inlet end of the pot-shaped housing in a steam-tight manner.

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