United States Patent

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[73] Assignee **Siemens Aktiengesellschaft**
Berlin, Germany

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[33] **Germany**
[31] **P 18 12 490.18**

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[54] DEVICE FOR AXIALLY FIXEDLY AND RADIALLY DISPLACEABLY MOUNTING TURBINE CASING PARTS

7 Claims, 6 Drawing Figs.

[52] U.S. Cl. 415/136, 415/108
[51] Int. Cl. F01d 25/26
[50] Field of Search 415/136, 134, 135, 13, 108

[56] **References Cited**

UNITED STATES PATENTS

2,297,852	10/1942	Zetterquist	415/136
3,141,651	7/1964	Moyer	415/136
3,498,727	3/1970	Martin, Jr. et al.	415/136

FOREIGN PATENTS

222,283	10/1924	Great Britain	415/136
773,430	4/1957	Great Britain	415/136

Primary Examiner—Henry F. Raduazo
Attorneys—Curt M. Avery, Arthur E. Wilfond, Herbert L. Lerner and Daniel J. Tick

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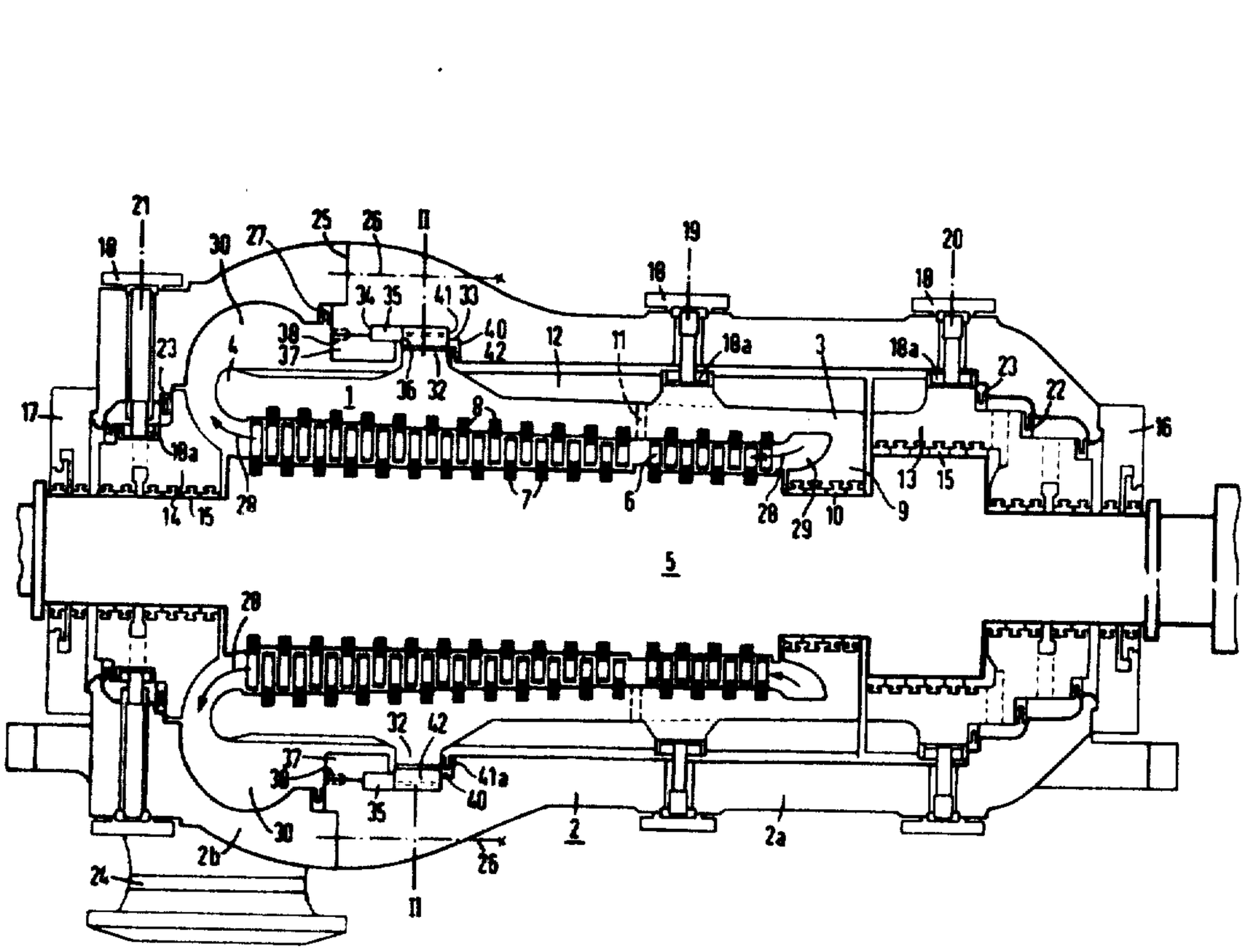
ABSTRACT: Device for mounting the inner casing shell of a turbomachine of multishell construction so that it is axially fixed and radially displaceable and is centered with respect to the outer casing of the turbomachine includes an annular collar located on an annular shoulder formed at the inner periphery of the outer casing for holding the inner shell radially displaceably centered and steamtight, a ring member slidable over the outer periphery of the inner shell from one side of the annular collar facing the steam exhaust side of the turbomachine so as to axially fix the annular collar against displacement by steam pressure from the other side of the annular collar which faces the steam inlet side of the turbomachine, the ring member being anchored to the outer casing, the inner periphery of the outer casing being formed with an annular groove axially adjacent the one side of the annular collar, a closed holder ring having a plurality of axially extending divisions therein and comprising a plurality of ring parts radially insertable in the annular groove and form-lockingly assemblable into the closed holder ring so that a face area thereof abuts the annular collar and fixes the inner shell against axial displacement, and a support ring at least partly overlapping the inner periphery of the holder ring for fixing the latter against radial displacement.



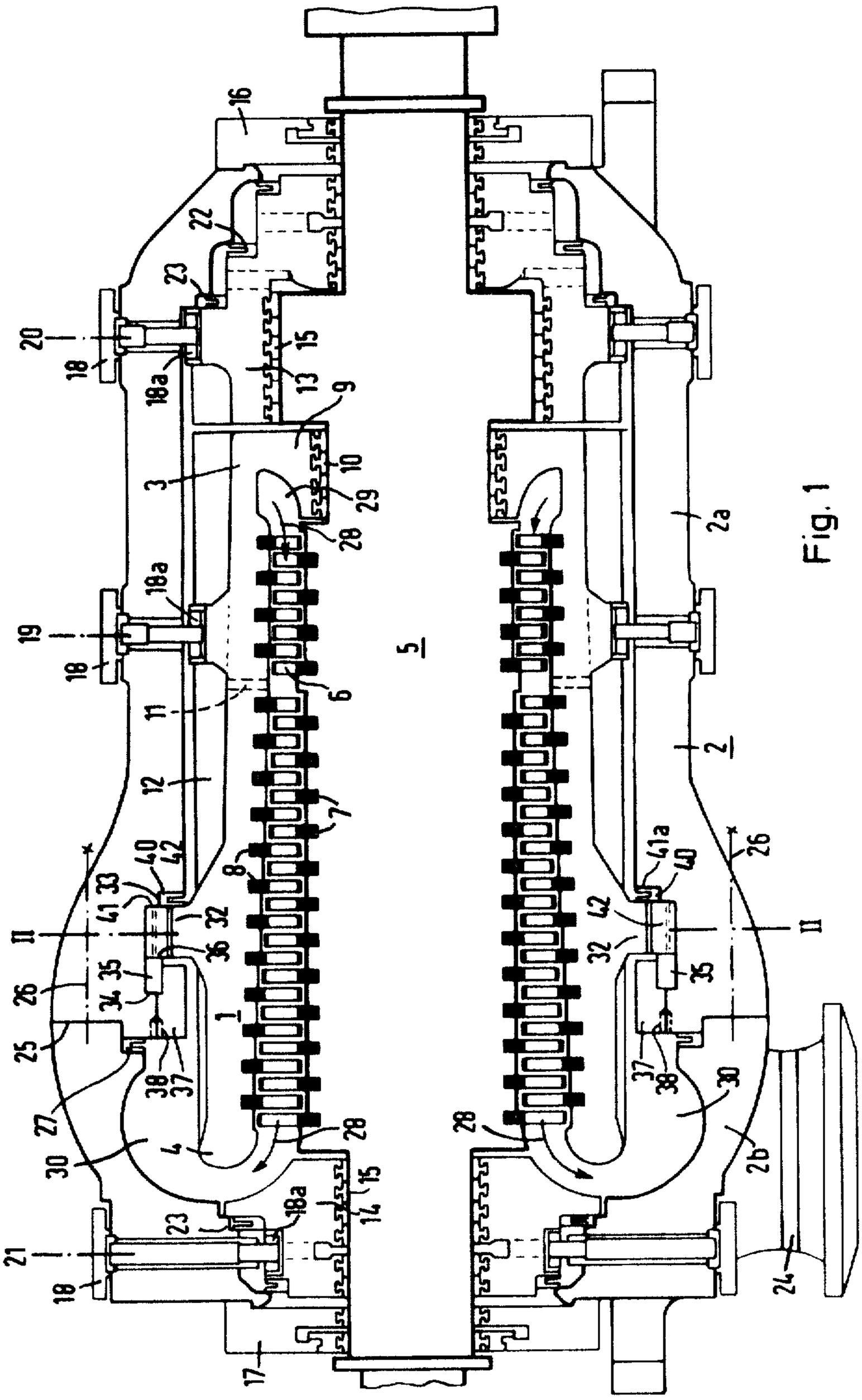

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Fig. 1

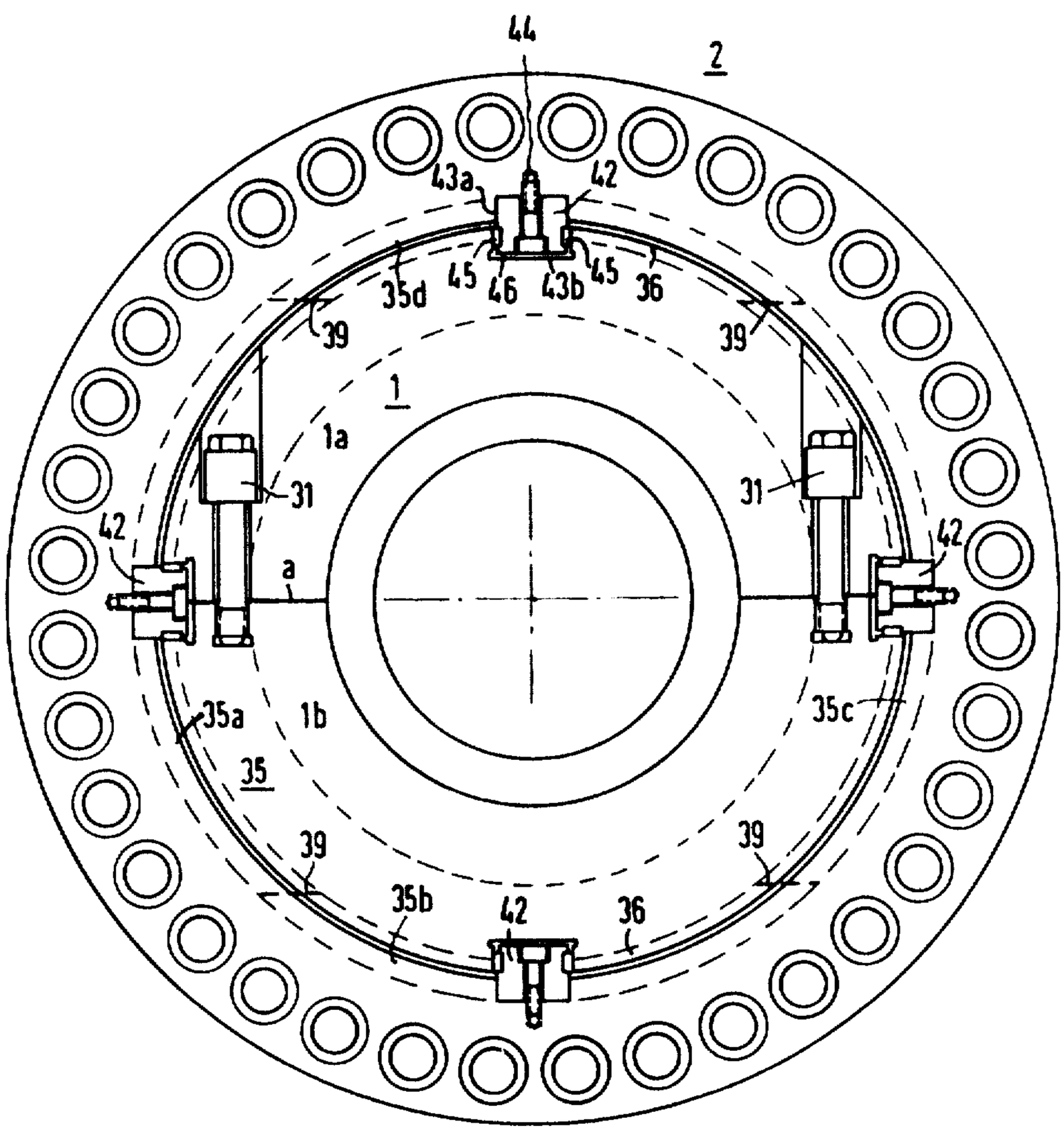
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Fig. 2

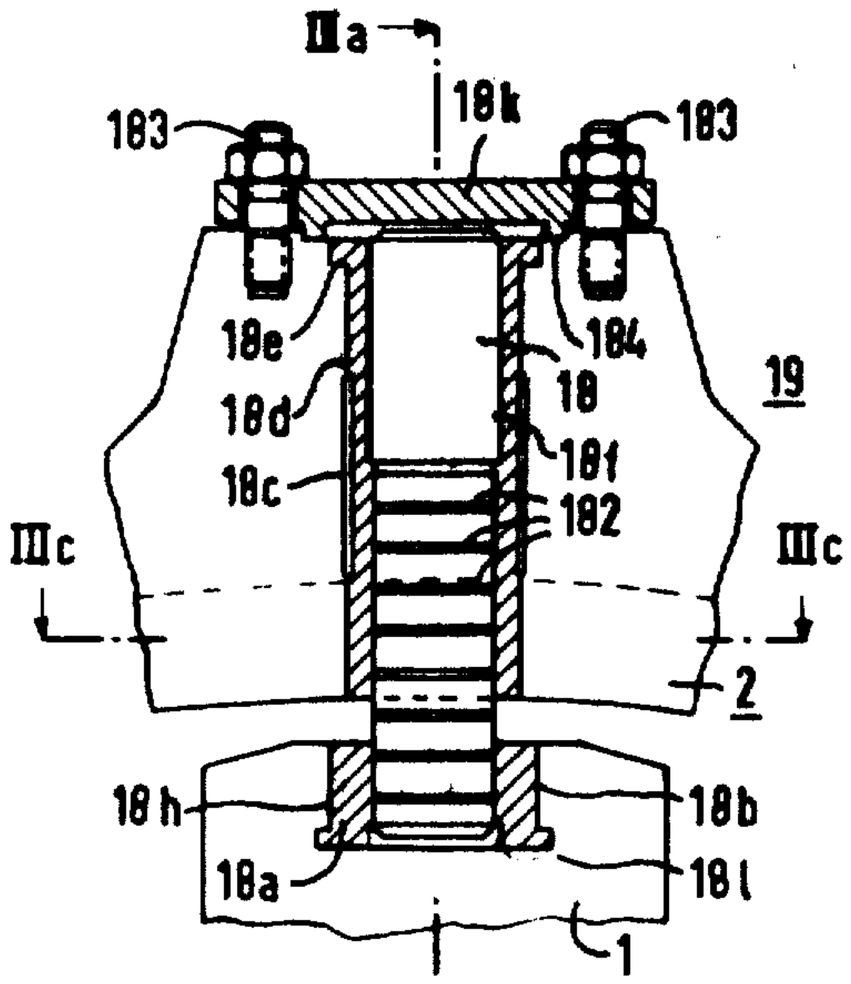

Fig.3b

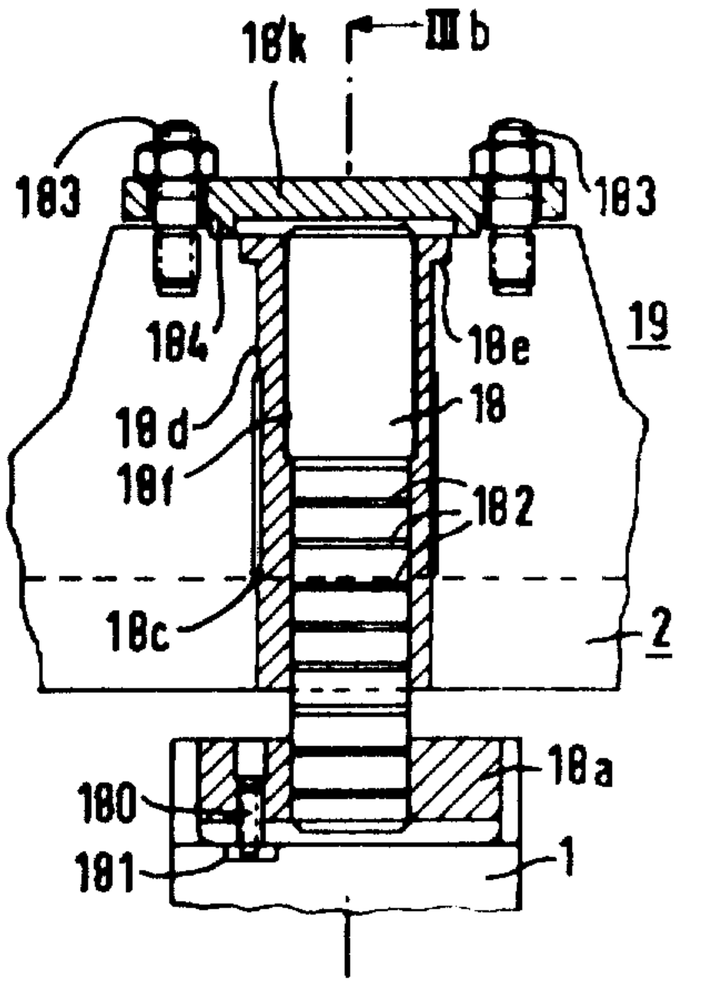

Fig.3a

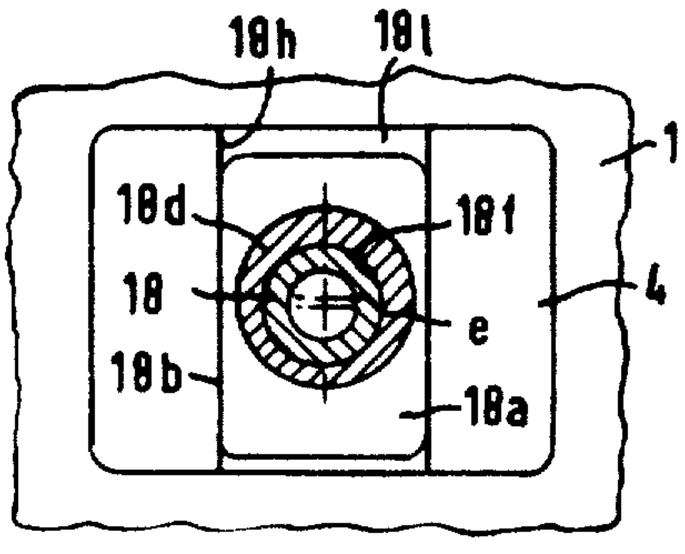

Fig. 3c

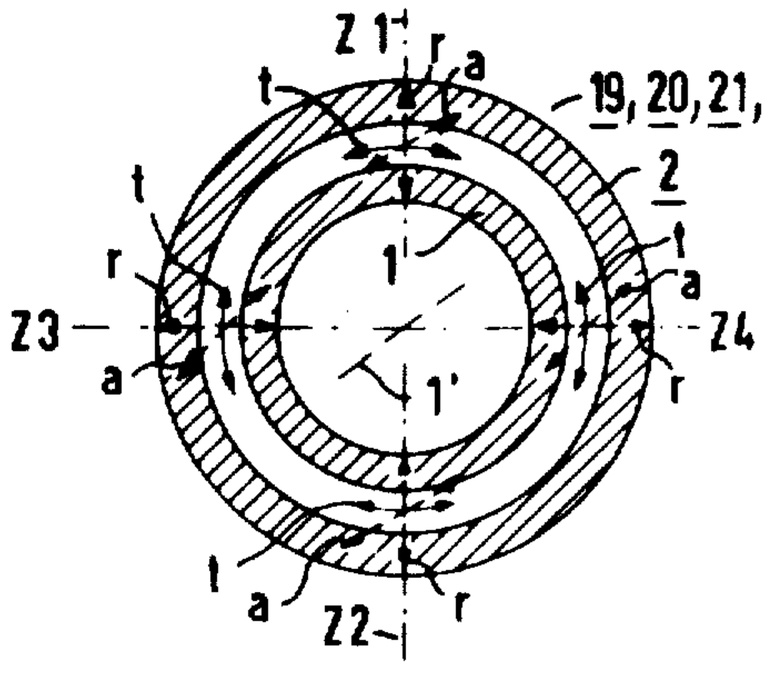

Fig. 3d

DEVICE FOR AXIALLY FIXEDLY AND RADIALLY DISPLACEABLY MOUNTING TURBINE CASING PARTS

Our invention relates to device for axially fixedly and radially displaceably mounting turbine casing parts. More particularly, our invention relates to such device for centering the inner casing shell (interior casing, guide vane carrier) with respect to the exterior casing in turbomachines of the multishell type of construction, preferably axial steam turbines with a pot-shaped casing which includes an interior shell divided in axial plane and an exterior casing, the interior shell being held radially displaceably centered and steamtightly by an annular collar located on an annular shoulder formed at the inner periphery of the exterior casing, the annular collar being axially fixed against steam pressure exerted at the side of the annular collar, namely at the steam inlet side of the turbine, by ring members slid over the outer periphery of the interior shell from the other side of the annular collar, namely the steam exhaust side of the turbine, and anchored to the exterior casing.

Such a device is known from the German Pat. No. DBP 1,140,947 wherein the ring members holding the interior shell against an annular shoulder formed at the inner periphery of the pot-shaped exterior casing are provided with a bayonet ring; such bayonet ring is slid, in a direction from the steam exhaust end of the interior shell, over the latter until it reaches an outer toothed collar located behind a toothed collar at the inner periphery of the exterior casing and then, by being suitably rotated, engages the teeth of the toothed collar on the exterior casing and is thereby fixed against displacement in axial direction.

It is an object of our invention to provide device for axially fixedly and radially displaceably mounting turbine casing parts which is of improved and relatively simplified construction to avoid any necessity for rotating ring members so as to effect a threadlike or bayonetlike meshing of ring members with projections from the exterior casing.

With the foregoing and other objects in view, we provide in accordance with our invention, device for mounting the inner casing shell of a turbomachine of multishell construction so that it is axially fixed and radially displaceable and is centered with respect to the outer casing of the turbomachine comprising an annular collar located on an annular shoulder formed at the inner periphery of the outer casing for holding the inner shell radially displaceably centered and steamtight, a ring member slideable over the outer periphery of the inner shell from one side of the annular collar facing the steam exhaust side of the turbomachine so as to axially fix the annular collar against displacement by steam pressure from the other side of the annular collar which faces the steam inlet side of the turbomachine, the ring member being anchored to the outer casing, the inner periphery of the outer casing being formed with an annular groove axially adjacent the one side of the annular collar, a closed holder ring having a plurality of axially extending divisions therein and comprising a plurality of ring parts radially insertable in the annular groove and form-lockingly assemblable into the closed holder ring so that a face area thereof abuts the annular collar and fixes the inner shell against axial displacement, and a support ring at least partly overlapping the inner periphery of the holder ring for fixing the latter against radial displacement.

The advantages attainable by the invention are primarily that a convenient form-locking insertability of the holder ring is provided whereby the holder ring absorbs all forces in axial direction and the support ring is virtually free of axial forces so that it is only required to protect the holder ring from falling out of its position. Because of this insertability of the holder ring, a simple fastening element can be used as support ring.

In accordance with another feature of our invention, the holder ring is formed of four ring parts whose joints extend in planes parallel to an axial plane of the turbomachine, pairs of the ring parts being of similar construction. Thus, one of the pairs of holder ring parts is initially insertable in the annular groove, and the other pair is then insertable in radial direction

i.e. in the same direction in which the joints of the rings extend. Thereby the number of holder ring parts is kept at a minimum.

In accordance with a further feature of our invention, the inner shell has an axial joint, and one of the pairs of holder ring parts covers and is disposed symmetrically opposite the axial joint of the inner shell overlapping substantially two-thirds of the periphery of the inner shell.

Other features which are considered as characteristic for the invention are set forth in the appended claims.

Although the invention is illustrated and described herein as embodied in device for axially fixedly and radially displaceably mounting turbine casing parts, it is nevertheless not intended to be limited to the details shown, since various modifications and structural changes may be made therein without departing from the spirit of the invention and within the scope and range of equivalents of the claims.

The construction and method of operation of the invention, however, together with additional objects and advantages thereof will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a longitudinal sectional view of a high-pressure turbine of axial superpressure construction type and with multishell casing structure having the mounting and centering device of our invention;

FIG. 2 is a cross-sectional view of FIG. 1 taken along the line II–II, showing the inner casing annular collar and the joint flange of the outer casing;

FIG. 3*a* is a fragmentary much-enlarged view of FIG. 1 showing one of the centering pin devices;

FIG. 3*b* is a sectional view of FIG. 3*a* taken along the line III*b*–III*b* in the direction of the arrows;

FIG. 3*c* is a cross-sectional view of FIG. 3*b* taken along the line III*c*–III*c* in the direction of the arrows; and

FIG. 3*d* is a schematic view illustrating the principle of the centering pin device in a radial centering plane perpendicular to the axis of the turbine shaft, wherein centering pins are provided above and below (as viewed in FIGS. 1 and 2) as well as left and right of the turbine shaft.

In the figures, like members and features are identified by the same reference numerals.

Referring now to the drawings, and particularly to FIGS. 1 and 2 thereof, there is shown the device of our invention for axially fixedly and radially displaceably mounting and centering an inner casing shell 1, having shell halves 1*a* and 1*b*, with respect to an outer casing 2 of an axial reaction turbine. The turbine has a multishell type of construction with a tank or potlike casing, a casing part 2*a* of the outer tank being at the steam delivery end 3 of the turbine, and a casing part 2*b* of the outer tank being at the steam exhaust end 4 of the turbine. The inner shell 1 is formed as a combined guide vane carrier inner casing with the steam delivery end 3 and the steam exhaust end 4 of the turbine, a stepped space or blading channel 6 being located between the turbine shaft 5 and the inner casing shell 1. Runner blade rings 7 are fastened in axial succession to the shaft 5, and guide vane rings 8 are fastened in axial succession to the inner periphery of the inner casing shell 1. The latter has a sealing shell 9 at the steam delivery end 3 that is provided at the inner periphery thereof with an axial labyrinth seal 10 and is additionally formed with pressure-relieving channels 11 interconnecting the blading channel 6 with a space 12 located between the inner casing shell 1 and the outer casing part 2*a* so that the space 12 is subjected to a pressure intermediate the delivered steam pressure at 3 and the exhaust steam pressure at 4. Shaft seals 13 and 14 in the form of sealing shells are provided at the ends of the outer casing 2 located respectively, at the steam delivery end 3 and the steam exhaust end 4 of the turbine. The shaft seals 13 and 14 are provided at the inner periphery thereof with axial labyrinth seals 15. Sealing covers 16 and 17 likewise serving as shaft seals are sealingly fastened to suitable flanges on the ends of the outer casing 2 located at the steam delivery and exhaust

ends 3 and 4, respectively, of the turbine. Also provided are hereinafter further described radial pins or bolts 18, received in eccentric bushings and having slide blocks or rings 18*a* at the free ends thereof, for adjustably mounting the inner shell 1 in a radial plane 19 or the sealing shells 13 and 14 in radial planes 20 and 21, respectively, so as to be axially and radially centrally heat displaceable. Elastic, U-shaped sealing rings 22 are disposed between the sealing shells 13 and 14, on the one hand, and adjacent engagement shoulders 23 formed in the outer housing casing 2. Exhaust steam is discharged through an exhaust pipe 24 which can be connected to a succeeding turbine stage or an intermediate superheater. The outer casing parts 2*a* and 2*b* are connected at radially extending flanged joint 25 secured by flange bolts diagrammatically represented by the dot-dash lines 26, the flanged joint 25 being also provided with a U-shaped elastic sealing ring 27. The steam flows in the direction of the arrows 28 from fresh steam inlets (not shown), connected steamtightly and heat transferably to the inner shell 1, into the inflow chamber or steam chest 29 wherefrom it travels through the blading channel 6 expending power and dropping in pressure until it reaches the exhaust chamber 30 wherefrom it is discharged through the exhaust pipe 24.

In the vicinity of the cutting plane II–II, the inner shell 1, which, as shown in FIG. 2, is formed with an axial joint *a* at which nonillustrated flanges are clamped together by means of flange bolts 31, is held radially displaceably centered and steamtight with an annular collar 32 (FIG. 1) at an annular shoulder 33 formed on the inner periphery of the outer casing 2. By means of ring members, which are anchored to the outer housing 2 and are slipped over the outer periphery of the inner shell 1 from the end thereof located adjacent the steam exhaust end 4 of the turbine, the annular collar 32 is axially fixed against displacement by the steam pressure prevalent at the steam inflow end 3 of the turbine. According to our invention, axially adjacent to the side of the annular collar 32 facing toward the exhaust end 4 of the turbine there is located at the inner periphery of the outer housing 2 an annular groove 34. A holder ring 35 divided several times in axial direction is provided. Ring parts or segments 35*a*, 35*b*, 35*c* and 35*d* (FIG. 2) which, with an inner sheil 1 inserted in the outer casing 2 and its annular collar 32 abutting the annular shoulder 33, are insertable radially in the annular groove 34 and are assemblable form-lockingly into the closed holder ring 35. The holder ring 35, with the face area 36 thereof covering the annular collar 32, fixes the inner shell 1 in axial direction, and is fixed in turn, in radial direction by a support ring 37 at least partly overlapping the inner periphery thereof which prevents the ring parts 35*a* to 35*d* thereof from slipping out and prevents them from turning about due to axial forces. The support ring 37, in turn, is not stressed in axial direction by steam forces, and requires, therefore, only to be secured in axial direction by small pin screws 38 or similar fastening members. Advantageously the holder ring 35 is composed of the aforementioned four ring parts 35*a* to 35*d*, whose joints 39 extend in planes parallel to the axial joint *a* of the inner shell 1, pairs of the ring parts, as shown in FIG. 2, namely the ring parts 35*a* and 35*c*, on the one hand, and 35*b* and 35*d*, on the other hand, having the same construction. The axial joint *a* of the inner shell 1 can coincide with a horizontal plane extending through the center of the shaft 5, but can also lie, however, in a vertical axial plane, as viewed in FIG. 2. As shown, the pair of ring parts 35*a* and 35*c* covering the axial joint *a* of the inner shell 1 extends over about two-thirds the periphery of the inner shell 1; furthermore, the ring parts 35*a* to 35*d* are disposed symmetrically with respect to the joint *a* as well as to the axial plane perpendicular thereto, the assembly and manufacture being facilitated because of the similar structural components.

Advantageously, the annular collar 32 of the inner shell 1 is held by the holder ring 35 against an elastic U-shaped sealing ring 40 which is inserted in an annular groove 41 located axially adjacent the annular collar 32 at the side thereof facing the steam inflow end 3. The base of the U-shaped sealing ring

40, as shown in FIG. 1, abuts the base of the groove 41, and the legs of the U-shaped ring 40 abuts the annular collar 32 or the groove sides 41*a* in the outer casing 2 which are located opposite the annular collar 32.

Centering blocks 42 (FIG. 2) are located between the annular collar 32 and the outer casing 2 and are inserted in corresponding casing pockets 43*a* and 43*b*, respectively, at the outer casing 2 and the inner shell 1. The centering blocks 42 are drawn against the outer casing 2 by screw bolts 44 and are provided at the lateral sides thereof extending in axial direction with slide keys 45 on which the inner shell 1 can slide in radial direction. Correspondingly, radial gaps 46 are provided between the inner shell 1 and the centering blocks 42 or between the inner shell 1 and the outer casing 2. The centering blocks 42 are disposed in the form of a cross symmetrical to the axis of the shaft 5. Due to the thickness of the slide keys 45 an accurate adjustment can also be made in the plane 19 (FIG. 1) perpendicular to the axis of the shaft 5 with respect to the centering in that plane.

Assembly is effected relatively easily by means of the mounting and centering device of our invention. The vertical position of the shaft 5 provided with the inner shell 1 and the shaft seal 13 can be lowered somewhat into the outer casing part 2*a* when inserting the elastic sealing rings shells 23, the elastic sealing ring 40 having been previously placed in the groove 41 therefor, and the sealing blocks 42 having been previously fastened to the outer casing 2. Centering can then be effected in the planes 19, 20 and II–II, whereupon the ring parts 35*b* and 35*d* of the holder ring 35 are initially inserted and, thereafter, the ring parts 35*a* and 35*c*. The support ring 37 is then inserted and axially fixed. The casing part 2*b* with the sealing shell 14 can thereafter be mounted.

In FIG. 3*d* there is illustrated the principle of radial pin centering in a schematic and perspective view between a generally identified inner shell 1 and a generally identified outer casing 2. The rotary axis of the turbine is identified by the reference character 1'. As indicated, four suspension or centering points Z1, Z2, Z3 and Z4 are provided per centering plane, each of the centering points being afforded a relative displacement of both housing parts 1 and 2 with respect to one another in the peripheral direction as indicated by the double-headed arrows *t*, in the radial direction as indicated by the double-headed arrows *r* and in the axial direction as indicated by the double-headed arrows *a*. Of the just-mentioned arrows, the arrows *t* are shown respectively extended to imply that they relate to an adjustment in the peripheral direction at assembly, which is a fixed adjustment, while the broken arrows *a* and *r* are meant to imply that a radially central heat movable relative displacement, due to dissimilar thermal expansions between the inner casing 1 on the one hand and the outer casing 2 on the other hand is possible in axial and radial direction during the operation of the turbine. The use of the reference characters 19, 20, 21 is meant to bring out that the aforedescribed centering principle is applicable for the centering pin devices in the radial centering planes 19, 20, 21 of FIG. 1. Accordingly, the hereinafter following description of FIGS. 3*a* to 3*c* is applicable for all of the aforementioned centering pin devices.

As is shown in FIGS. 3*a* to 3*c* in detail, the outer casing 2 is formed with a radial bore 18*c* wherein a cylindrical bushing 18*d* formed with a flange 18*e* is inserted. The bushing 18*d* is provided with an eccentric bore 18*f* whose eccentricity *e* is clearly shown in FIG. 3*c*. The hollow cylindrical centering pin or bolt 18 is inserted in this eccentric bore 18*f*, and the lower end of the eccentric pin 18 is fitted in a sliding block or ring or an adjusting spring 18*a*. The sliding ring 18*a* is slidingly guided in the axial direction of the turbine with sliding surfaces 18*b* thereof extending in the axial direction of the turbine against corresponding opposing surfaces 23*h* of longitudinal grooves 23*l* formed in the inner shell 1. In order that the slide blocks or rings 18*a* be prevented from slipping within the sliding surfaces 18*h* of the inner shell 1 when the respective centering pin device is installed, they are secured with a set screw 180

(FIG. 3*a*) within a recess **181** formed in the inner casing **1** so that, as shown, adequate clearance for movement of the respective slide blocks or rings **18***a* in the axial direction is provided. The radial pins or bolts **18** are provided at their outer periphery with grooves **182** through which a possible wear or binding between the parts **18** and **18***d* which are radially displaceable relative to one another can be suppressed. A cover **18***k* is tightly fastened by bolts **183** from the outside on the outer casing **2** to seal the casing bore **18***c* and is pressed by an annular bead **184** formed thereon against corresponding opposing surfaces formed on the outer casing **2**. As shown in FIGS. **3***a* and **3***b*, relative motion in the radial direction between the radial pins **18** and bushings **18***d* as well as between the pins **18** and the sliding blocks or rings **18***a* in radial direction is afforded as represented by the arrow *r* of FIG. **3***d*. Furthermore, relative motion in axial direction between the sliding blocks or rings **18***a* and the respective opposing surfaces **18***h* at the inner casing **2** is afforded in direction of the arrow *a*, as shown in FIG. **3***d*. The adjustment, i.e. the centering, of the inner shell **1** with respect to the outer casing **2** is effected, with the covers **18***k* removed, by turning the respective bushings **18***d* in their bore **18***c*. When the foregoing measures are carried out in all four centering points Z1 to Z4 of a centering plane (FIG. **3***d*), all desired relative positions of the inner shell **1** with respect to the outer casing **2** can then be attained within the desired adjustment limits, i.e. a raising or lowering or a lateral displacement or a rotation in the peripheral direction of the inner shell **1** relative to the outer casing **2**.

We claim:

1. Device for mounting the inner casing shell of a turbomachine of multishell construction so that it is axially fixed and radially displaceable and is centered with respect to the outer casing of the turbomachine comprises an annular collar located on an annular shoulder formed at the inner periphery of the outer casing for holding the inner shell radially displaceably centered and steamtight, a ring member slidable over the outer periphery of the inner shell from one side of said annular collar facing the steam exhaust side of the turbomachine so as to axially fix said annular collar against displacement by steam pressure from the other side of said annular collar which faces the steam inlet side of the turbomachine, said ring member being anchored to the outer casing, the inner periphery of the outer casing being formed with an annular groove axially adjacent said one side of said annular collar, a closed holder ring having a plurality of axially extending divisions therein and comprising a plurality of ring parts radially insertable in said annular groove and form-lockingly assemblable into said closed holder ring so that a face area thereof abuts said annular collar and fixes the inner shell against axial displacement, and a support ring at least partly overlapping the inner periphery of said holder ring for fixing the latter against radial displacement.

2. Mounting device according to claim **1** wherein said holder ring comprises four ring parts having joints extending in planes parallel to an axial plane of the turbomachine, pairs of said ring parts being of similar structure.

3. Mounting device according to claim **2** wherein the inner casing shell has an axial joint, and one of said pairs of holder ring parts covers and is disposed symmetrically opposite the axial joint of the inner shell, said one pair of holder ring parts extending over substantially two-thirds of the periphery of the inner shell.

4. Mounting device according to claim **1** wherein an annular groove is formed in the outer casing axially adjacent said annular collar at said other side thereof facing the stem inlet side, said annular collar being held by said holder ring against an elastic U-shaped sealing ring received in said annular groove, the base of said U-shaped sealing ring abutting the base of said groove and the legs of said U-shaped sealing ring respectively abutting said annular collar and a side of said groove located opposite said annular collar.

5. Mounting device according to claim **1** including casing pockets located between said annular collar and the outer casing, centering blocks respectively received in said casing pockets, said holder ring simultaneously fixing said centering blocks in addition to the inner shell, against axial displacement, said centering blocks being disposed in the form of a cross symmetrical to the turbomachine axis, said centering blocks being actuable for mounting the inner shell radially centrally heat transferably and for adjusting the inner shell in respective radial planes at assembly thereof.

6. Mounting device according to claim **1**, including fastening means extending in axial direction for fixing said support ring to the outer casing against axial displacement, said fastening means being received in bores having axes disposed in an annular joint between said support ring and the outer casing.

7. Mounting device according to claim **6** wherein said fastening means are set screws.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,592,557 **Dated** July 13, 1971

Inventor(s) Horst Haas and Axel Remberg

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the heading, page 1, column 1 - the German priority number should read -- P 18 12 490.8 --

Signed and sealed this 23rd day of November 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Patents