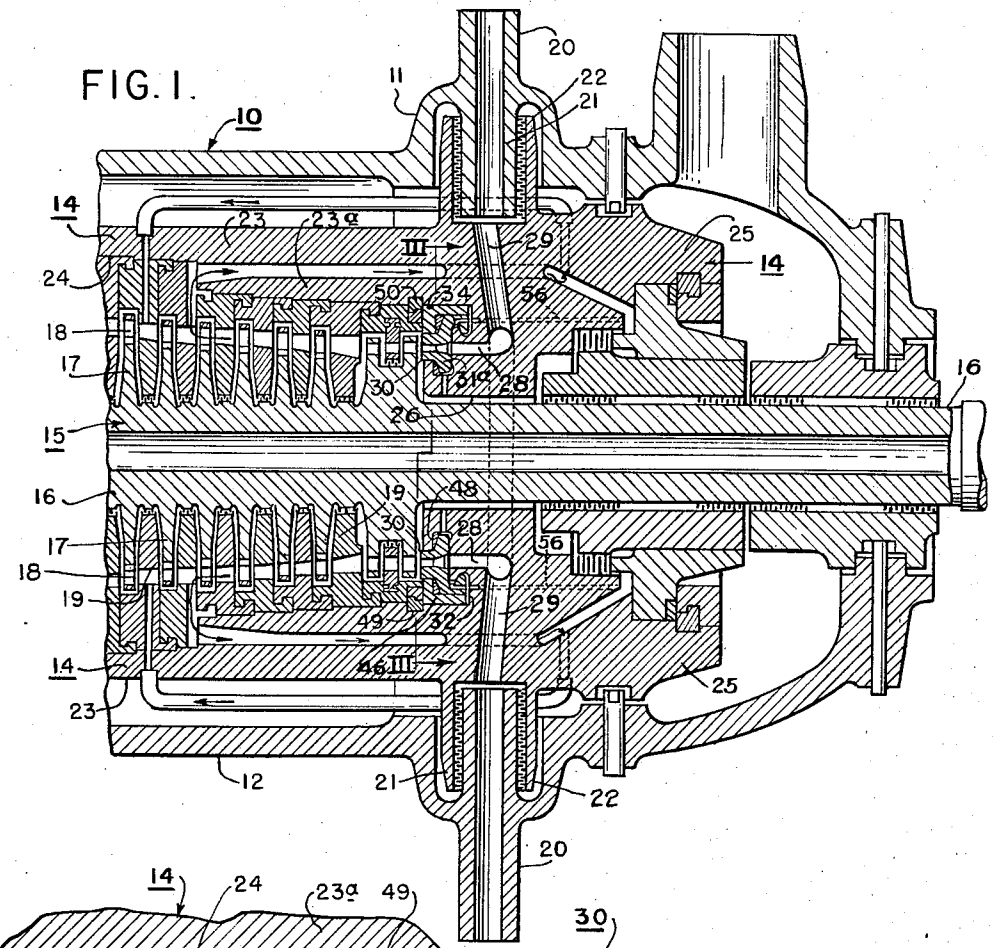
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TURBINE APPARATUS

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FIG. 1.



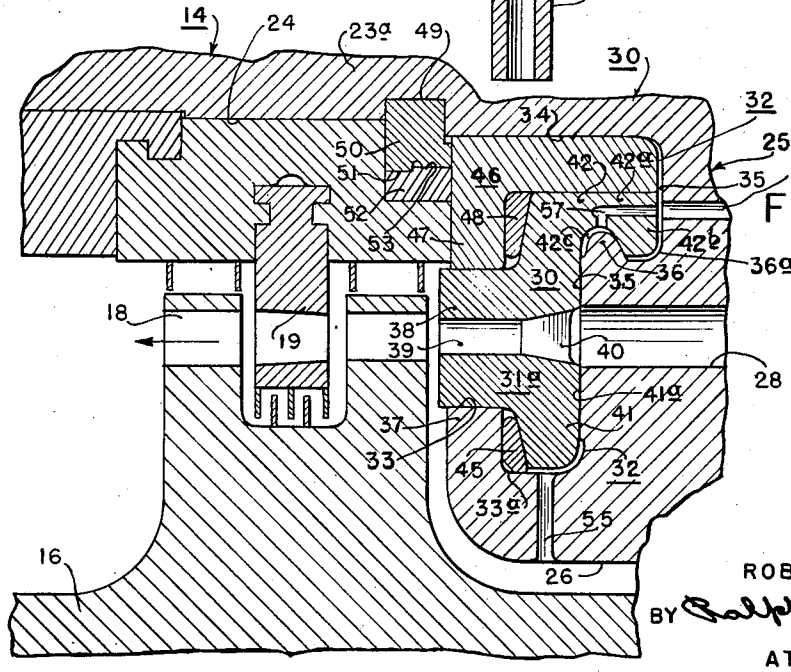


FIG. 2.

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TURBINE APPARATUS

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FIG. 3.

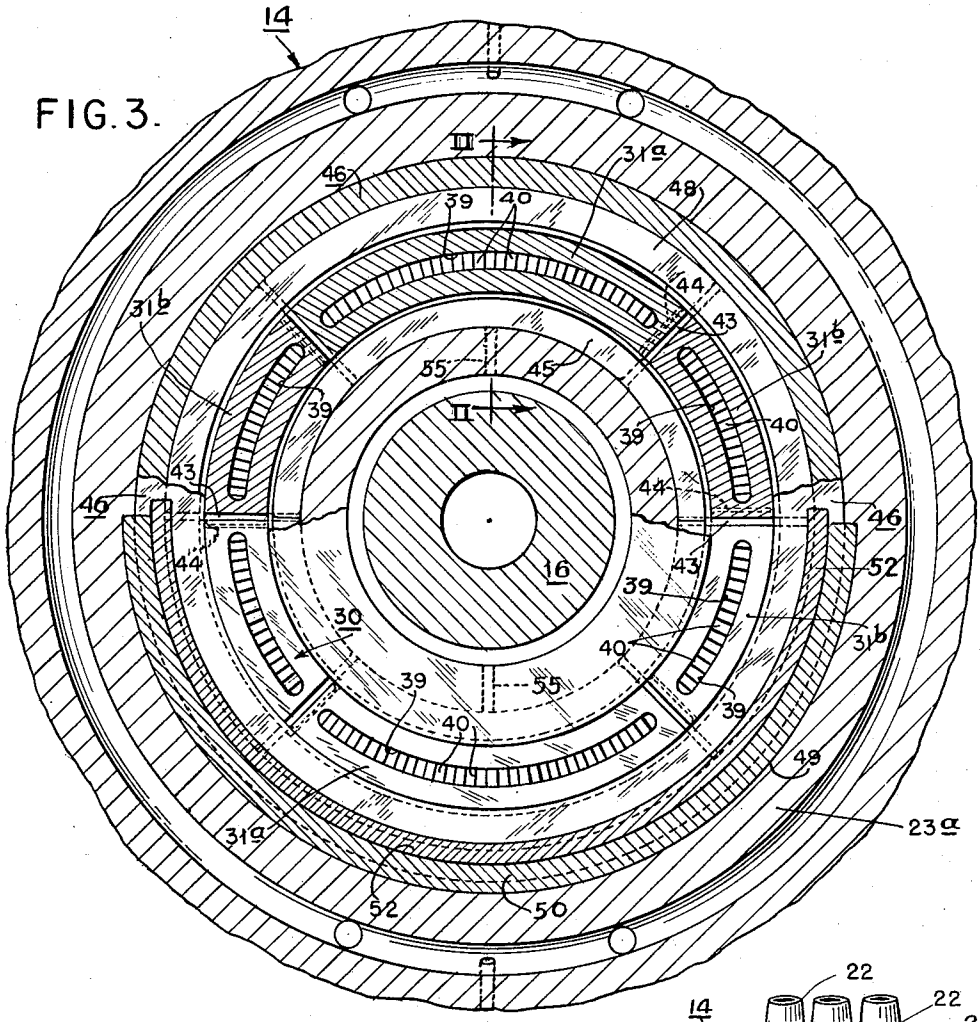
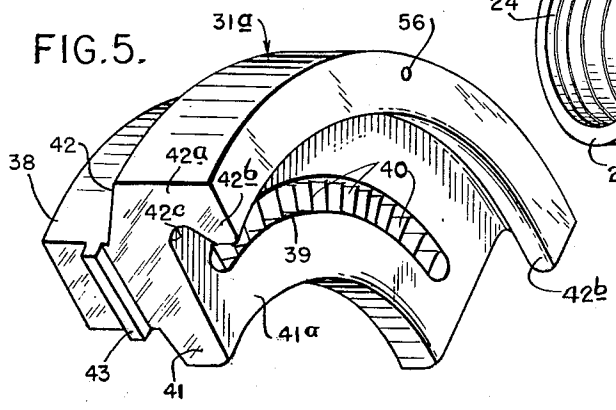


FIG. 5.



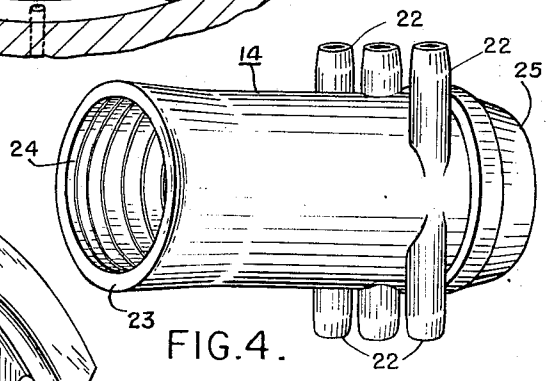


FIG. 4.

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TURBINE APPARATUS

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FIG. 6.

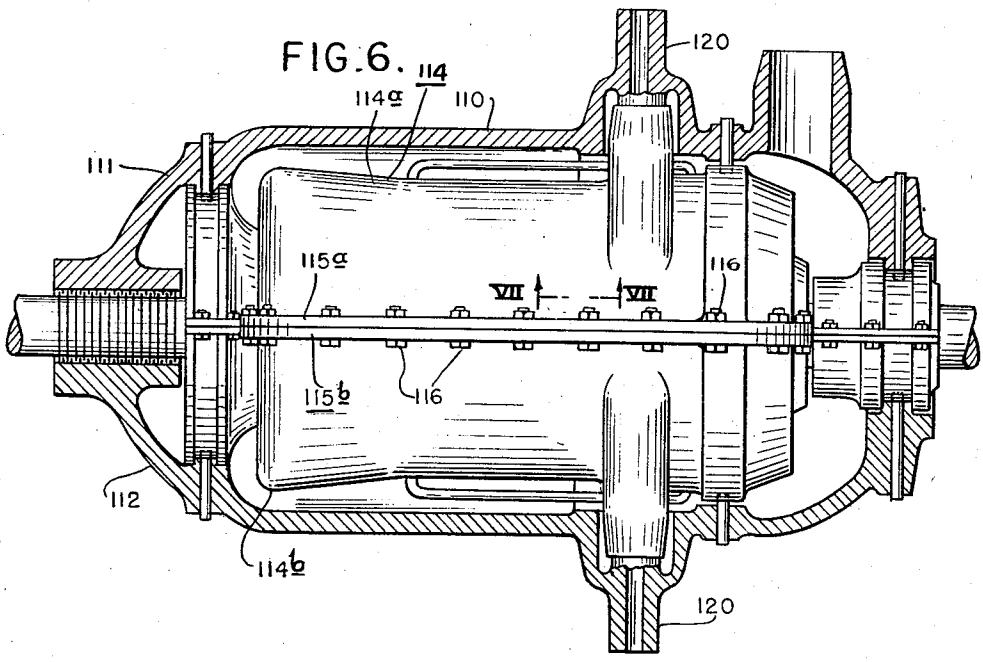


FIG. 8.

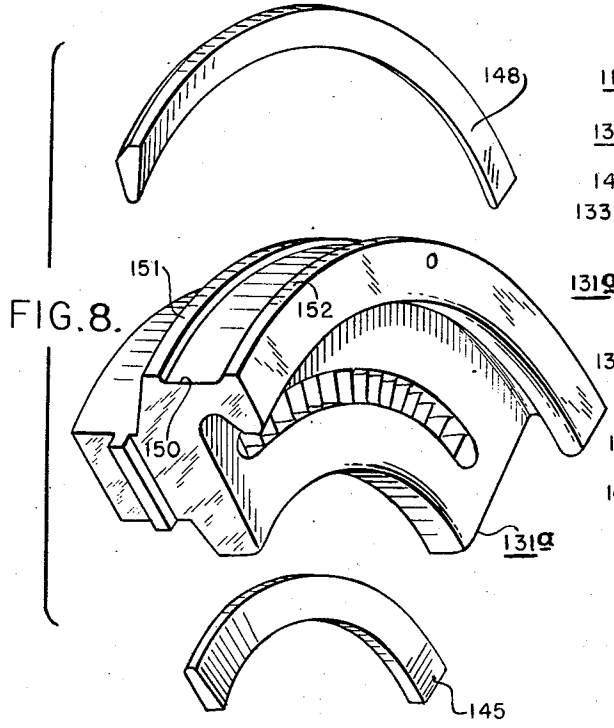
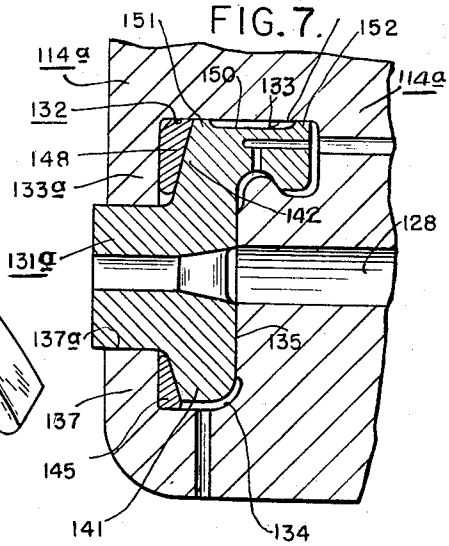


FIG. 7.



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United States Patent Office 2,905,434 Patented Sept. 22, 1959

2,905,434

TURBINE APPARATUS

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Application July 8, 1954, Serial No. 442,019

5 Claims. (Cl. 253—78)

This invention relates to an elastic fluid turbine, more particularly to an arrangement for securing the nozzle block structure in the casing of such a turbine and has for an object to provide an improved arrangement for securing the nozzle block structure in the casing without bolts or fastening means of a similar nature.

In prior art arrangements, the nozzle block is usually secured to the casing of a steam turbine by a substantial number of bolts. Although such nozzle block bolting arrangements are adequate for most steam turbine applications, the size and number of the bolts required increases as the pressure and temperature values of the motive steam is increased until, at steam values on the order of 5000 p.s.i.a. and 1150° F. for example, the required bolts are so large and numerous that the design problem of locating, properly spacing and securely locking them becomes quite difficult. Aside from the design problems involved, they are subject to creep and relaxation, causing loose joints and leakage, possible bolt failure, damage and shutdown of the turbine for repair and undesirable outage of the unit. The cost of the bolts is quite high and the repair and replacement expenses are considerable.

In view of the above, it is a further object to provide an improved boltless nozzle block securing arrangement which lends itself to ease of manufacture, is reliable in performance and relatively inexpensive.

In applicant's Patent No. 2,796,231, issued June 18, 1957 and assigned to the same assignee, there is disclosed a high pressure, high temperature steam turbine of the double casing type in which the inner casing is an integral tubular member devoid of the usual horizontal joint. Accordingly, it is another object to provide an arrangement for securing a nozzle block formed in arcuate segments to an integral or one-piece steam turbine casing of the above type in such a manner that a good steam tight seal is attained between the nozzle block and the casing without bolts.

A more specific object is to provide a boltless nozzle block structure for a one-piece steam turbine casing in which the nozzle block may be easily dismantled when desired without damage thereto.

These and other objects are effected by the invention as will be apparent from the following description taken in connection with the accompanying drawings, forming a part of this application, in which:

Fig. 1 is a fragmentary axial sectional view of a steam turbine illustrating one embodiment of the invention;

Fig. 2 is an enlarged fragmentary sectional view taken on line II—II of Fig. 3;

Fig. 3 is a sectional view taken on line III—III of Fig. 1;

Fig. 4 is a perspective view, taken on a smaller scale, of the inner turbine casing;

Fig. 5 is a perspective view of one form of the nozzle block segments;

Fig. 6 is an axial sectional view, with parts in elevation, of a steam turbine incorporating another embodiment of the invention;

Fig. 7 is an enlarged fragmentary sectional view taken on line VII—VII of Fig. 6; and

Fig. 8 is an exploded perspective view, taken on the same scale as Fig. 7, showing another form of the nozzle block segments and associated wedges.

Referring to the drawings in detail, especially Fig. 1, there is shown a portion of a steam turbine which may be generally similar to the turbine more fully shown and described in applicant's Patent No. 2,796,231 mentioned above. Fig. 1 shows only those portions which are thought to be essential for proper comprehension of the invention. The steam turbine has an outer casing **10** including an upper half **11** and a lower half **12** bolted to each other, an inner casing **14** of generally tubular shape disposed within the outer casing halves **11** and **12** and in spaced relation therewith, and a bladed rotor aggregate **15** coaxially aligned with the inner casing **14** and extending through the outer casing **10**.

The rotor **15** is provided with a spindle **16** having a plurality of spaced disc portions **17** integrally formed thereon, and a plurality of annular rows of blades **18** attached to the peripheries thereof. As well understood in the art, the blades **18** cooperate with a plurality of stationary diaphragm blade rows **19**, as shown in Fig. 1, to provide a plurality of stages in which energy is extracted from the steam by expansion. The rotor aggregate **15** and the diaphragms **19** may be made and assembled in any suitable manner.

The outer casing **10** is provided with a plurality of steam inlet connections **20** having inward extending sleeves **21** cooperating with a plurality of outwardly extending tubular portions **22**, integrally formed with the inner casing **14**, and disposed in telescopic slidable engagement therewith. With this arrangement, as well known in the art, free thermal expansion of the integral components **20** and **21** and tubular portions **22** is permitted without thermal stressing of the inner and outer casings.

The inner casing **14**, as best shown in Figs. 1 and 4, is provided with a continuous tubular outer wall **23** open at one end and, in accordance with applicant's previously mentioned Patent No. 2,796,231 may be further provided with an inner continuous wall **23***a*. The radially innermost surface of the wall **23***a* and the portion of the radially innermost surface of the wall **23** which is disposed to the left of the wall **23***a*, as viewed in Fig. 1, jointly define a large axial passageway **24** within which is accommodated the rotor and stationary blading **18** and **19**, respectively. The casing **14** is further provided with a radial wall **25** closing the other end and having a smaller axial passageway **26** through which the shaft of the spindle **16** extends.

The radial casing wall **25** is provided with an annular nozzle chamber or steam inlet passage **28** having a plurality of outwardly extending passages **29** communicating with the steam inlets **20**, and a nozzle block structure generally designated **30** is disposed in the inner casing **14** in registry with the nozzle chamber **28** so that, in operation, steam is fed from the nozzle chamber through the nozzle block structure **30** to the succeeding stages of turbine heretofore described.

In accordance with the invention, the nozzle block structure **30** is of the boltless type and, as best shown in Figs. 2 and 3, includes a set of arcuate nozzle block segments **31***a* and **31***b* arranged in end-to-end relation and forming a ring. The nozzle block segments **31***a* and **31***b* are received in a continuous annular recess **32** provided in the radial wall **25**. The recess **32** is provided with inner and outer walls **33** and **34**, respectively, spaced radially from each other and an end wall **35**,

The end wall 35 has a radially outwardly-extending annular flange or retrorse portion 36, which may also be termed a lip portion, defining an annular groove 36*a* while the inner wall 33 is provided with a radially outwardly-extending flange or lip portion 37 providing an annular groove 33*a*. As best shown in Figs. 1 and 2, the annular lip portion 36 is disposed radially outwardly of the nozzle chamber 28, while the lip portion 37 is disposed radially inwardly of the nozzle chamber.

The nozzle block segments 31*a* and 31*b* may be similar in shape, differing only in arcuate length (Fig. 3); hence, only one need be described. The segment 31*a* (Fig. 5) is provided with a central portion 38 of arcuate shape and having an arcuate passage 39 extending therethrough. Within the passage 39 there are provided a series of stationary blades or nozzles 40 spaced from each other and extending radially from one side of the passage to the other. Inner and outer flanges 41 and 42, respectively, extend radially from the central portion 38 and the outer flange 42 is further provided with an axially extending portion 42*a* and a radially inwardly extending or retrorse portion 42*b* defining a groove 42*c*. The flange 41 and the central portion 38 form a smooth sealing surface 41*a* which engages the recess wall 35 to prevent diversion of steam.

The segments 31*a* and 31*b* may be provided at their ends with mating tongues and grooves 43 and 44, respectively, and are received in the recess 32 and maintained in tightly seated positions therein by a set of arcuate wedging members 45 preferably of tapered cross section disposed between the flange 37 of the recess and the flanges 41 of the nozzle block segments. In addition thereto, a continuous retainer ring 46 having a radially inwardly-extending flange portion 47 is snugly received within the space in the recess remaining between the nozzle block flanges 42 and the wall 34. To maintain pressure against the nozzle block segments, a ring wedging member 48 preferably of tapered cross section is interposed between the retainer ring flange 47 and the segment flanges 42.

The inner surface of the wall 23*a* of the casing 14 is provided with an annular groove 49 within which are received a set of arcuate keying members 50. The keying members 50 have a stepped inner wall 51 and a locking ring 52 is shrink fitted in place to retain the keying members 50 in position. The locking ring 52 is also formed with a stepped outer wall 53 cooperating with the stepped wall 51.

The nozzle block structure 30 is assembled in the casing 14 prior to assembly of the rotor 15 and the diaphragm blading 19. Since the casing 14 is a one piece member, all of the components disposed within the casing 14 are inserted through the open end of the tubular wall 23. The sequence of assembly is as follows: The set of arcuate wedging members 45 are first positioned in the groove 33*a*, whereupon the nozzle block segments 31*a* and 31*b* are inserted with the flange 41 disposed in the groove 33*a* and the flange portion 42*b* disposed within the groove 36*a* of the recess. The wedging ring 48 is then applied, whereupon by heating the casing 14 to expand the tubular wall 23*a* the retainer ring 46 may be shrink fitted. The set of keying members 50 are then inserted in the groove 49 and, while the casing is still in a heated state, the locking ring 52 is shrink fitted into position. The co-relation of the above components is such that upon assembly thereof in the manner described above, the nozzle block segments 31*a* and 31*b* are in a state of compressive pressure, such pressure being effective to bring only the smooth faces 41*a* of the nozzle block segments into sealing engagement with the smooth face of the recess wall 35. Although the sealing engagement may be adequate to prevent diversion of steam around the nozzle block segments, further precautions may be taken to direct any such diverted steam through the inner casing 14, thereby avoiding excessive build-up

in pressure within the nozzle block structure. For example, a series of bleed off passages 55 may be provided in the radial wall 25 extending from the groove 33*a* to the axial passageway 26. Similarly, a series of passages 56 may be provided in the radial wall 25 and communicating with the flanges 42*b* of the nozzle block segments.

Should it be desired to insure against build-up of steam within the grooves 42*c* of the nozzle block segments, the latter may be provided with a series of passages 57 extending through the flange portions 42*a* and 42*b* thereof and communicating with passages 56.

With the above arrangement, the nozzle block segments are firmly secured in the recess 32 and all forces of the steam tending to drive the segments out of their position are resisted in a positive manner. It will be noted that such forces exerted upon the nozzle block segments place the flanges 37 and 36 of the casing and flanges 41 and 42*b* of the nozzle block segments in bending and shear, so that the segments cannot be loosened from their position except by rupture of these flanges. By properly designing these flanges to provide adequate cross sectional thickness, relatively low stresses may be obtained, and failure due to stressing may be substantially eliminated. It will be noted that all parts are well confined and retained so that should any part chip, the chips will not damage the turbine blades.

In addition to the above, it will be noted that the retainer ring 46 serves two functions. The first function is to insure that the nozzle block segments are properly seated in radially inward direction. The second function is to insure that should any deviation occur in manufacture preventing positive sealing between the segment faces 41*a* and the face of the recess wall 35, such minor variation is taken up by the forces exerted by the retainer ring flange 47 through the wedging ring 48. Movement of the retainer ring 46 is prevented in a positive manner by the locking ring 52.

Should it be desired to remove the nozzle block segments in service, such removal may be effected in a simple and expedient manner by cutting away the relatively inexpensive locking ring 52. Upon removal of this ring, the keying members 50 may be readily removed, whereupon the retaining ring 46 may be removed by heating the inner casing 14. Upon removal of the retainer ring, the wedging ring 48 is freed, whereupon the nozzle block segments may be lifted out and, if desired, the arcuate wedging members 45 may be removed for inspection and/or replacement if so indicated. Since the nozzle block segments are made of the highest quality steel suitable for the purpose and since they are quite expensive to manufacture, salvage of the nozzle block segments in an undamaged state is a highly desirable feature of the invention.

Referring to Figs. 6, 7 and 8, especially Fig. 6, a second embodiment of the invention is shown incorporated in a steam turbine which is generally similar to that shown in Fig. 1 in connection with the first embodiment and provided with an outer casing 110 including an upper half 111 and a lower half 112 bolted to each other and having an inner casing 114 disposed within the outer casing halves 111 and 112 in spaced relation therewith. Steam is admitted to the turbine by a plurality of steam inlets 120 communicating with the nozzle chamber 128. However, in this embodiment the inner casing 114 is of the generally well known two-part type having an upper half portion 114*a* and a lower half portion 114*b* provided with horizontal flanges 115*a* and 115*b*, respectively, disposed in a plane parallel to the axis of the casing and bolted to each other by means of a series of nuts and bolts 116. Since this turbine may be similar to that shown in connection with the first embodiment, only those portions wherein the two differ have been shown and will be described.

Referring to Fig. 7 in which a fragmentary portion of the upper casing 114*a* has been shown, it will be noted

that there is provided a recess **132** of arcuate shape and having inner and outer walls **133** and **134** spaced radially from each other and an end wall **135**. The recess **132** is in communication with nozzle chamber **128** and its general cross-sectional shape is similar to that of recess **32** (shown in connection with the first embodiment) but is further provided with a radially inwardly extending arcuate flange portion **133***a* which cooperates with the radially outwardly extending arcuate flange or lip portion **137** to define a restricted passageway **137***a*.

The lower casing **115***a* is provided with an identical arcuate recess **132**, so that when the two casings are bolted to each other, the recesses are continuous and describe a circle.

A set of arcuate nozzle block segments **131***a* are received in the recess **132**. The nozzle block segments **131***a* are somewhat similar to the nozzle blocks **31***a* described in connection with the first embodiment but are further provided with an outer groove **150** partly defining a pair of spaced peripheral ribs **151** and **152**. The nozzle block segments **131***a* are maintained in tightly seated position within the recess **132** by a set of arcuate wedging segments **145** of tapered cross section disposed between the flange **137** of the recess and the flanges **141** of the nozzle block segments. In addition thereto, a similar set of arcuate wedging segments **148** of tapered cross section are interposed between the flange **133***a* and the flanges **142** of the nozzle block segments.

The nozzle block segments are assembled in the upper casing half **114***a* and in the lower casing half **114***b* while the two casing halves are separated from each other, so that the recess **132** in each casing half is accessible from one of its ends. The nozzle block segments may be slidably inserted into the recess **132** by an arcuate motion generally known in the art as "rolling in place." After the nozzle block segments are in position, the wedging segments **145** are driven into position, whereupon the wedging segments **148** may be driven in position to tighten the asssembly.

After the lower casing half **114***b* is fitted with the nozzle block segments **131***a* in the same manner as described in connection with the upper casing half **114***a*, the two casing halves may be joined to each other as shown in Fig. 6.

Referring to Fig. 7, it will be noted that the ribs **151** and **152** of the nozzle block segments are in snug contact with the wall **133** of the recess. In operation, should the component parts expand by heating thereof, stressing between the nozzle block segments and the inner casing **114** is localized to the zones adjacent the ribs **151** and **152**, thereby causing the latter to crush only the adjacent contact surfaces of the wall **133**, increasing the sealing pressure in these zones and obviating damage to the entire casing **114**.

It will now be seen that the invention is advantageous when utilized either in conjunction with a casing having an inner casing of the one-piece type or of the two-piece type and that in either case the nozzle blocks are firmly and positively held in the inner casing without the use of bolts or other screw fastening means. It will also be noted that in both embodiments the nozzle block locking portions and wedging members are confined within the recesses so that should any chipping occur, the chips are confined therein, thereby avoiding possible damage to the rotating parts of the turbine disposed downstream of the nozzle block.

While the invention has been shown in several forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications without departing from the spirit thereof.

What is claimed is:

1. A casing for an elastic fluid turbine having an integral tubular wall and a radial wall connected therewith, said radial wall having an annular fluid inlet passage communicating with an annular recess of larger radial width than said passage and disposed adjacent the junction of said radial wall and said tubular wall, said recess being defined by inner and outer walls and an end wall, said end wall having a radially outwardly extending annular lip portion disposed radially outwardly of said fluid inlet passage, a plurality of arcuate nozzle block segments received in said recess, said nozzle block segments having radially inwardly extending lip portions engaging said end wall lip portion, and wedging means received in said recess for maintaining said nozzle block segments in firm abutment with the end wall of said recess.

2. An elastic fluid turbine having a casing provided with an annular fluid inlet passage in registry with an annular recess of larger radial width than said passage, said recess being defined by inner and outer walls and an end wall, said end wall having a retrorse portion encompassing said inlet passage, a plurality of arcuate nozzle block segments disposed in said recess, said nozzle block segments being of lesser radial width than said recess and having a retrorse portion in engagement with the retrorse portion of said end wall, a retainer ring received in said recess and encompassing said nozzle block segments, and a wedging ring interposed between said retainer ring and said nozzle block segments for urging said segments against the end wall of said recess.

3. A casing for an elastic fluid turbine having a radial wall, said radial wall having an annular fluid inlet passage communicating with an annular recess of larger radial width than said passage, said recess being defined by integral tubular inner and outer walls and an end wall, said end wall having a radially outwardly extending annular lip portion disposed radially outwardly of said inlet passage, a plurality of arcuate nozzle block segments received in said recess, said nozzle block segments having radially inwardly extending lip portions engaging said end wall lip portion, and wedging means received in said recess for maintaining said nozzle block segments in firm abutment with the end wall of said recess.

4. A casing for an elastic fluid turbine having an integral continuous tubular wall and a radial wall connected therewith, said radial wall having an annular fluid inlet passage communicating with an annular recess of larger radial width than said passage and disposed adjacent the junction of said radial wall and said tubular wall, said recess being defined by inner and outer walls and an end wall, said end wall having a radially outwardly extending annular lip portion disposed radially outwardly of said inlet passage, a plurality of arcuate nozzle block segments received in said recess, said nozzle block segments having radially inwardly extending lip portions engaging said end wall lip portion, wedging means received in said recess for maintaining said nozzle block segments in firm abutment with the end wall of said recess, said inner wall of said annular recess being provided with a radially outwardly extending annular lip portion disposed radially inwardly of said inlet passage and jointly with said end wall forming an annular groove, said nozzle block segments being provided with radially inwardly extending flange portions received in said groove, and said wedging means further including a plurality of arcuate wedging members interposed between said nozzle segment flange portions and said inner wall lip portion.

5. A casing for an elastic fluid turbine having a tubular wall and a radial wall integral therewith, said radial wall having an annular fluid inlet passage communicating with an annular recess of larger radial width than said passage and disposed adjacent the junction of said radial wall and said tubular wall, said recess being defined by inner and outer walls and an end wall, said end wall having a radially outwardly extending annular lip portion disposed radially outwardly of said passage, a plurality of arcuate nozzle block segments received in said recess, said nozzle block segments having a plurality of radially extending blades and provided with radially inwardly extending lip

portions disposed radially outwardly of said blades, said lip portions engaging said end wall lip portion, wedging means received in said recess for maintaining said nozzle block segments in firm abutment with the end wall of said recess, said tubular wall being integral and continuous, a tightly fitting retainer ring received in said recess, said retainer ring being provided with a radially inwardly extending annular flange disposed in abutment with said wedging means and urging the same in axial direction against said nozzle block segments, and further comprising means including a keying ring secured in said tubular wall for preventing slipping of said retainer ring.

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