Feb. 23, 1960 R. HERTL 2,925,995

TURBINE APPARATUS

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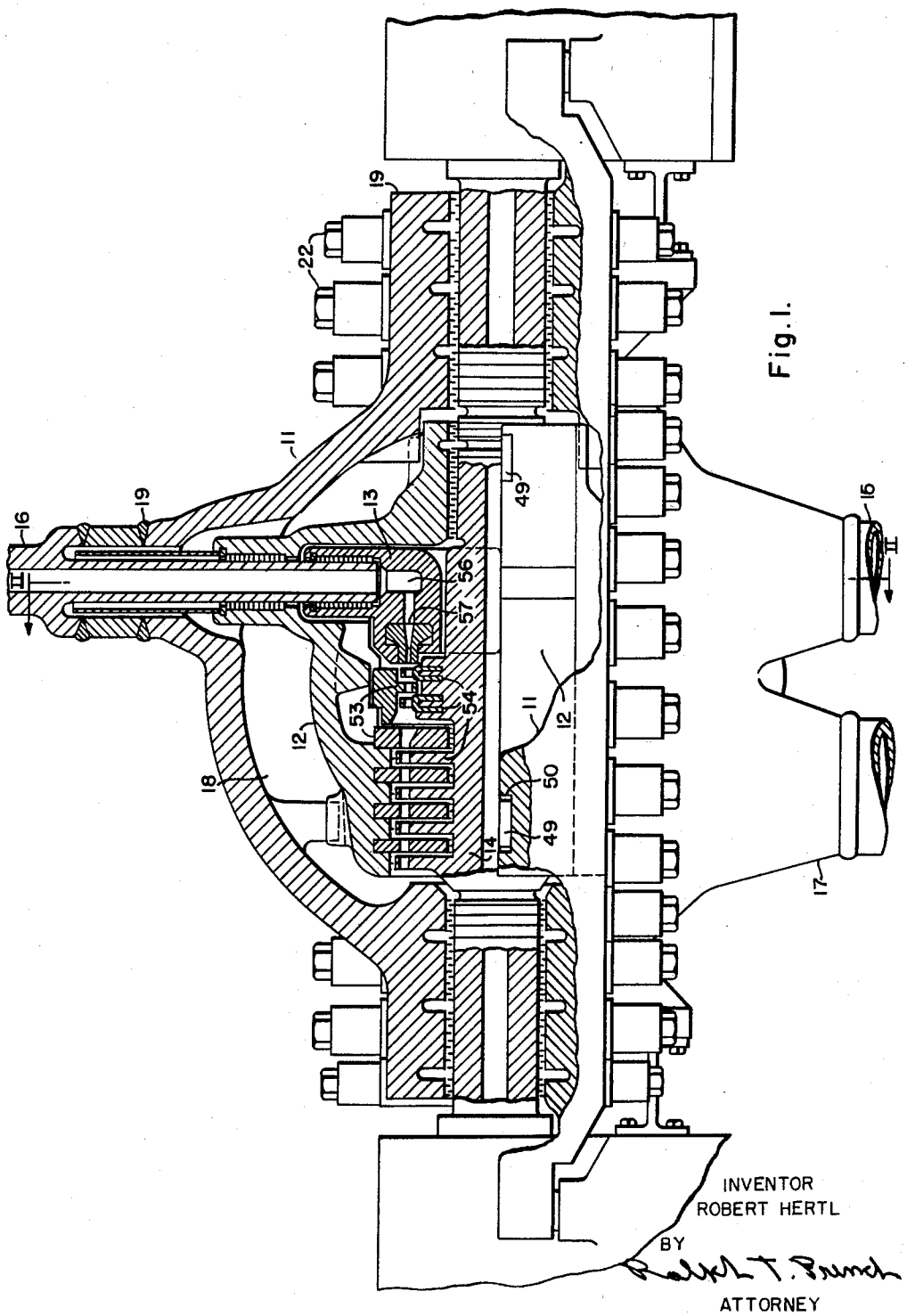


Fig. 1.

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Fig.2.

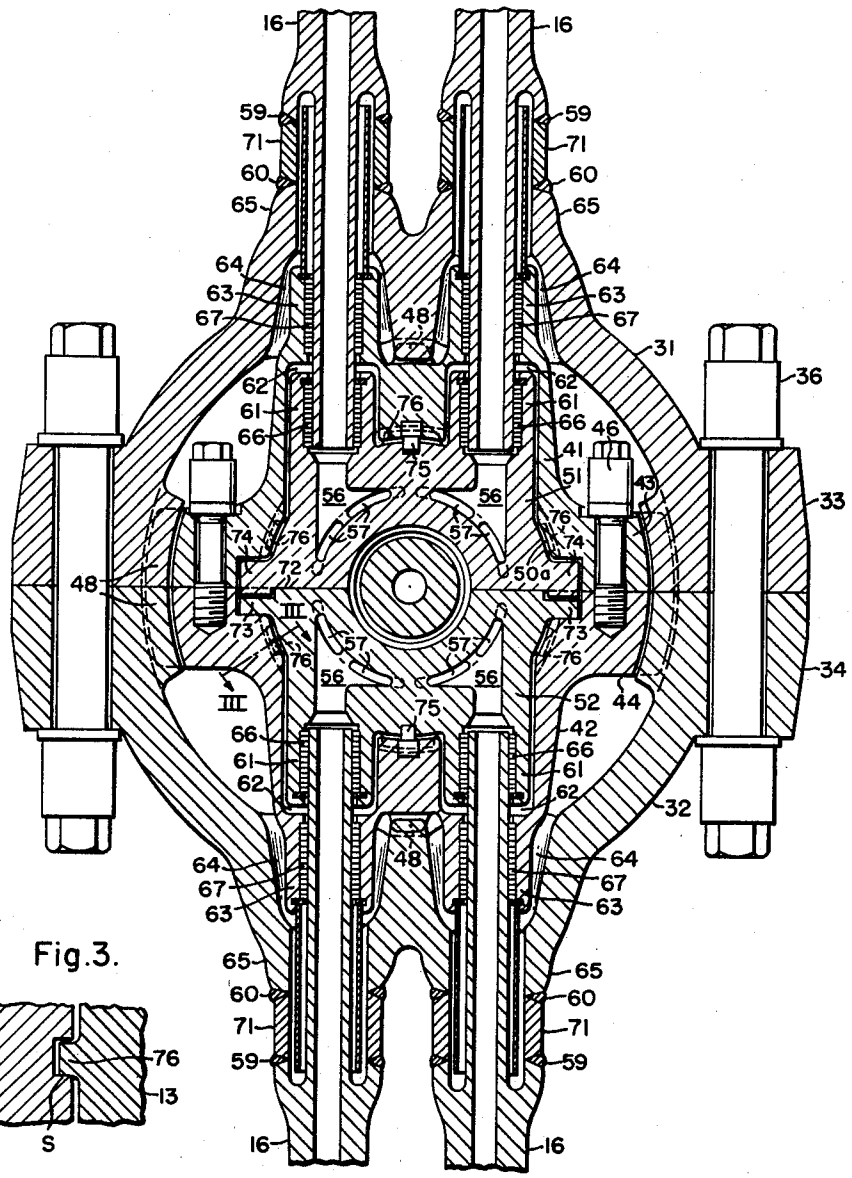


Fig.3.

WITNESSES

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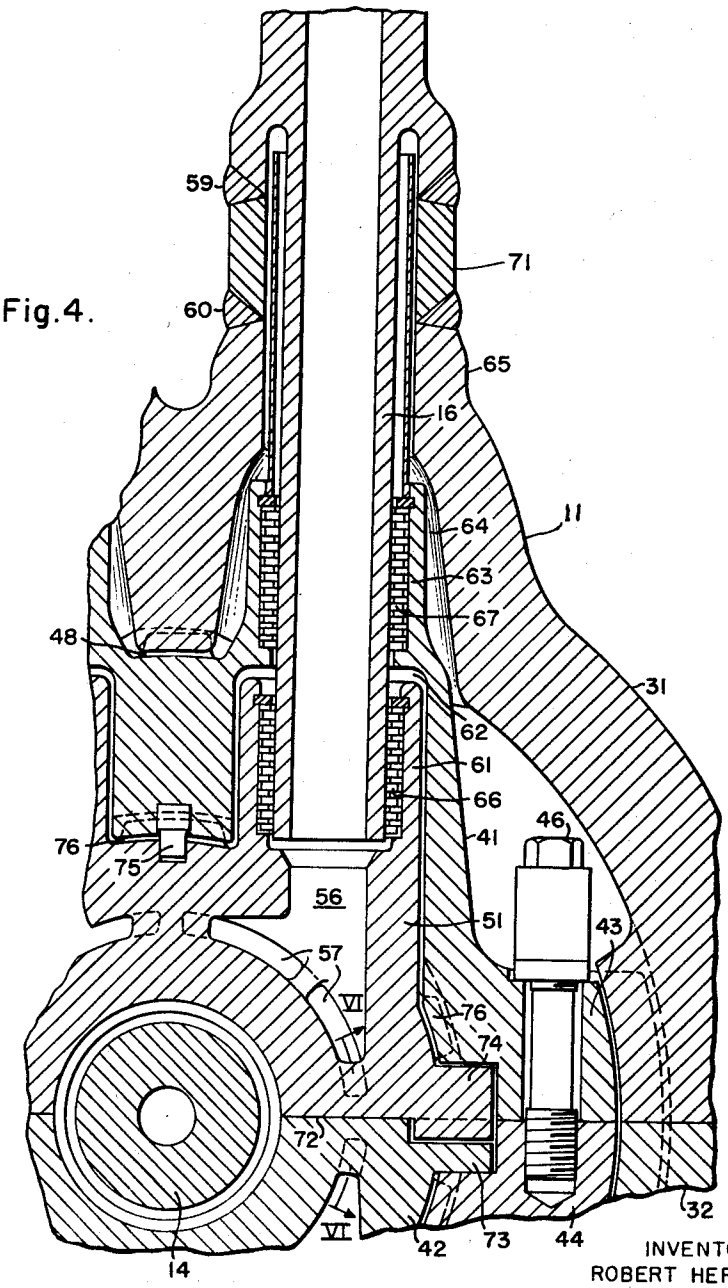
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Fig. 4.



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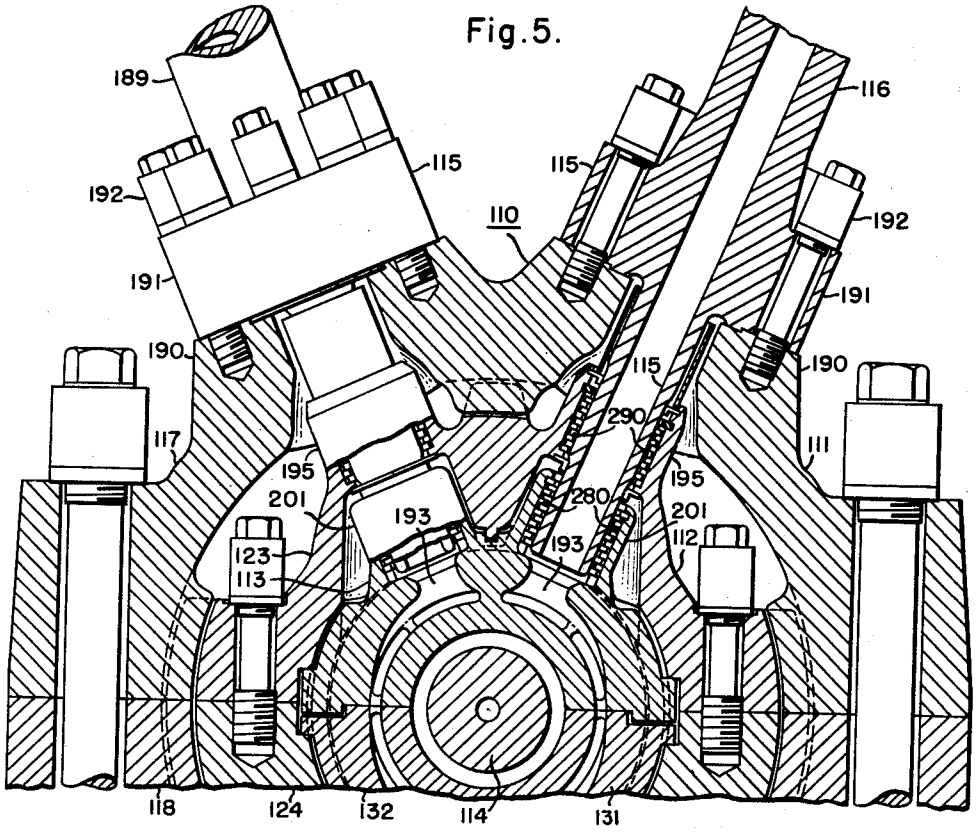
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Fig.5.



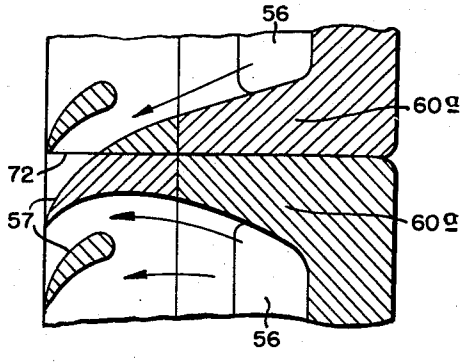


Fig.6.

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TURBINE APPARATUS

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Application August 16, 1956, Serial No. 604,462

4 Claims. (Cl. 253—39)

This invention relates to the inlet conduits and the nozzle casings of elastic-fluid turbines and particularly to the connections between the inlet conduits and the nozzle casings of high pressure, high temperature steam turbines.

Steam turbines employed fluid above the critical pressure are being designed with an inlet temperature about 1200° F. Because of material limitations, well known in the art, each part of the turbine exposed to temperatures of 1050° F. or above has been constructed of austenitic material with austenitic welds. Austenitic welds are very expensive and are also considered by some to be not as reliable as desired. The conventional means of constructing nozzle casings has required the use of austenitic welds. Therefore, it is an object of this invention to construct the nozzle casings without the use of any austenitic welds.

It is a further object of the invention to mount the nozzle casings without the use of any welds, thereby resulting in a more economically produced product, expediting manufacturing and facilitating inspection and repair.

Another object of the invention is to provide a separate and distinct nozzle casing which is free to expand and contract independently of the inner casing.

One embodiment of the present invention comprises a triple-casing turbine having an outer substantially fluid pressure tight casing, an inner casing and a nozzle casing. The nozzle casing is constructed so that it cooperates with the inner casing without the use of welds. A fluid chamber is provided in the nozzle casing which is in communication with the blade path and the inlet conduit. The inlet conduit is rigidly secured to the outer casing and extends through the outer and the inner casing and into the nozzle casing. The configuration of the inner casing where the inlet conduit passes through it and of the nozzle casing where the inlet conduit enters is such that provision is made for relative movement between the inner or the nozzle casing and the inlet conduit.

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

Fig. 1 is a view, partly in section and partly in elevation, showing a supercritical pressure steam turbine embodying the present invention;

Fig. 2 is a transverse sectional view taken along the line II—II of Fig. 1, looking in the direction indicated by the arrows;

Fig. 3 is an enlarged sectional view taken along the line III—III of Fig. 2 looking in the direction indicated by the arrows;

Fig. 4 is an enlarged transverse sectional view, similar to Fig. 2, showing one inlet conduit in detail;

Fig. 5 is a view similar to Fig. 2, but showing a modified conduit arrangement; and

Fig. 6 is a sectional view taken along line VI—VI of Fig. 4 looking in the direction of the arrows.

Referring to the drawings in detail, and in particular to Figs. 1 to 4, there is illustrated a supercritical pressure steam turbine comprising an outer substantially fluid pressure tight casing **11**, an inner casing **12**, a nozzle casing **13**, a rotor **14** and stationary blades **53** and rotating blades **54**. The turbine is provided with a plurality of fluid inlet conduits **16** and a suitable fluid exhaust **17**. The fluid conduits **16**, supplying fluid to the nozzle casing, extend through the outer casing **11** and the inner casing **12** and into the nozzle casing **13**, but are connected rigidly only to the outer casing **11**, as hereinafter described in detail. In addition, provision is made for relative movement between the fluid conduits and both the inner casing and the nozzle casing by a structure to be described in detail subsequently.

As is set forth in copending application, Serial No. 601,009 filed July 30, 1956 by the same applicant and assigned to the assignee of the present application, the outer and the inner casings are of substantially spherical shape and concentric with each other to withstand the high pressures and temperatures of steam to which they are subjected, in operation.

The fluid in the inlet conduits **16** has a temperature of approximately 1200° F. and the inlet conduits as required for this exposed temperature are constructed of austenitic material. After expansion of the working fluid in the blades **53** and **54** a portion of the fluid, which is now at a lower pressure and a temperature of about 1000° F., enters a chamber **18** between the inner and the outer casing. Hence, the outer casing is subjected only to exhaust temperature and is constructed of ferritic steel. The nozzle casing **13** and the inner casing **12** are of austenitic steel because the nozzle casing is subjected to inlet conditions and the inner casing to the temperature in the first blade stages, which is above 1050° F. Therefore, if a construction employing welds between the nozzle casing and the inner casing were used, the welds would have to be austenitic also. In the present invention the nozzle casing **13** is constructed so that no welds are needed between the nozzle casing and the inner casing.

Referring to Fig. 2, the outer casing **11** is axially divided into an upper half or cover **31** and a lower half or base **32** provided with flanges **33** and **34**, respectively, fastened together by a plurality of bolts **36**.

The outer casing **11** substantially completely encloses the inner casing **12**, which is axially divided into an upper half or cover **41** a lower half or base **42** provided with flanges **43** and **44**, respectively, fastened together by a plurality of studs **46**. The inner casing **12** is held against axial displacement relative to the outer casing by key connections **48**.

The inlet end of the inner casing **12** (the right-hand end as viewed in Fig. 1), encloses and supports the nozzle casing **13** in a manner subsequently to be described. As shown in Fig. 1, the inner casing is supported by the outer casing on a plurality of tongues or lugs **49** which extend from the inner casing **12** and which mate with grooves **50** provided on the outer casing **11**.

In addition to supporting the nozzle casing **13**, the inner casing **12** supports the stationary blades **53** which cooperate with a plurality of rotating blades **54** supported by the rotor.

As shown in Fig. 2, the nozzle casing **13** is divided into an upper half **51** and a lower half **52**. The nozzle casing has a plurality of chambers **56** in communication with the conduits **16**. Groups of nozzles **57** in communication with the chambers **56** direct elastic fluid to the blading.

The conduits **16** are rigidly connected to the outer

casing by annular welds 59 and extend inwardly through the inner casing 12 and through the nozzle casing 13 and are in communication with the nozzle chambers 56.

Where the conduits 16 enter the nozzle casing they are encompassed by and are in telescopic relation with a plurality of tubular necks 61 integral with the nozzle casing. A sealing means 66 is disposed between the tubular necks 61 and the inlet conduits as hereinafter described.

The inner casing is formed with tubular collars 63 providing recesses 62 that accommodate the tubular necks 61 of the nozzle casing. In addition, the conduits 16 extend through the inner casing by passing through the collars 63 which encompass the conduit and are in telescopic relation therewith.

Similarly, the outer casing is formed with tubular extensions 65 providing recesses 64 that accommodate the tubular collars 63.

Although the tubular necks 61 and the tubular collars 63 encompass the conduit 16 and are in telescopic relation therewith, they are constructed large enough to allow the nozzle casing 13 and the inner casing 12 to expand horizontally, vertically and radially outward. In addition, the recesses 62 and 64 are constructed large enough that they produce no restraint or stresses upon the neck 61 and the collars 63, leaving them free to expand and contract.

A sealing means 67 is provided between the tubular collars 63 and the inlet conduits, and, like the sealing means 66 provided between the tubular necks 61 and the inlet conduits, may be of the alternating seal ring type illustrated in the drawings, particularly Fig. 4. As illustrated, one set of alternate seal rings is in slidable sealing relation with the conduit 16, while another set of alternate seal rings is in slidable sealing relation with the nozzle casing or the inner casing. However, any sealing means constructed so as to permit relative movement between collars 63 and the inlet conduits and between necks 61 and the inlet conduits may be utilized.

From the foregoing it is seen that the conduits 16 extend inwardly through the inner casing at the tubular collars 63 and through the nozzle casing at the tubular necks 61 and are in communication with the nozzle chambers 56, so that the tubular necks 61, tubular collars 63, mating recesses 62 and 64, and conduits 16 are aligned relative to each other.

Because of the difference in material (as stated previously) between the outer casing and the fluid conduits, a transition collar 71 is welded at one end 59 to the inlet conduit 16 and at the other end 60 to the outer casing 11.

The upper and lower nozzle casing halves meet in a horizontal joint 72. The horizontal joint in the area of the nozzle chambers 56, as illustrated by Fig. 6, is comprised in part by the end walls 60*a* of the nozzle chambers and the vertical components of steam force in the inlet conduits exerted on the end walls tend to maintain the nozzle casing halves in contact along the horizontal joint 72.

A pair of lugs 73 on the lower half of the nozzle casing is disposed in suitable openings provided in the inner casing so as to support the lower half nozzle casing and thereby also the upper half. A pair of lugs 74 provided on the upper half, mate with suitable openings on the inner casing 12 and restrain any torque on the nozzle casing. The lugs are constructed to allow relative movement between the nozzle casing halves and between the nozzle casing and the inner casing along the plane of the horizontal joint.

Proper lateral location of the nozzle casing 13 relative to the inner casing is secured by a plurality of pins 75 located on the vertical centerline of the turbine and between the nozzle casing 13 and the inner casinng 12. These pins 75 permit relative vertical movement, provide a lateral fixation point, and also restrain, in conjunction with lugs 73 and 74, any torque on the nozzle casing.

In addition, tongue and groove connections 76 restrain the nozzle casing 13 against axial displacement relative to the inner casing 12. Reaction forces caused by steam ejecting from the nozzles 57 force the nozzle casing 13 to bear, in the direction toward the high pressure end, against the groove surface S of tongue and groove connections 76, as shown by Fig. 3, thereby providing an axial fixation point for the nozzle casing.

The foregoing construction provides a nozzle casing which is free to expand or contract horizontally, vertically and radially while remaining securely held in its proper working position within the inner casing without the use of welds. A third casing (a nozzle casing) has been provided, which is not welded to the inlet conduits nor to the outer or inner casing, and which is free to move relative to the inner casing and inlet conduits. In addition, the foregoing construction provides an inner casing which remains securely in its proper working position within the outer casing without the use of welds and which is capable of moving relative to the nozzle casing, inlet conduit and outer casing.

Referring to Fig. 5, there is shown a supercritical pressure turbine embodying a modification of the present invention. The turbine is constructed in a manner similar to that shown in Figs. 1 through 4 and 6 except that a plurality of inlet conduits 116 are here arranged radially.

Each conduit 116 is connected to the outer casing 111 by a flange 191 provided on each conduit and fastened by studs 192 to a flange 190 provided on the outer casing. Only the inlet conduits in the upper half of the turbine have been illustrated, but it is to be understood that similarly constructed conduits are disposed in the lower half of the unit. A portion of each inlet conduit 116 extends radially inward through the outer casing 111 and through the inner casing 112 and is in communication with a chamber 193 provided in the nozzle casing 113. Similar to the embodiment shown in Figs. 1 through 4, tubular necks 201, integral with the nozzle casing, and tubular collars 195 integral with the inner casing are provided which are aligned with each other and the inlet conduits 116. As in Figs. 1 through 4, the inlet conduits extend through the tubular necks and collars and are encompassed thereby. Sealing means 280 and 290 are provided between the inlet conduit and the necks and collars and so constructed as to permit relative movement therebetween.

By utilizing inlets which are radially arranged, rather than vertical as in the embodiment shown in Figs. 1 through 4, the space between inlets is increased, thereby allowing a flange and a bolted connection to be utilized between each conduit and the outer casing. A bolted connection at this point produces an inlet construction totally free of welds.

In addition, a radial arrangement of inlets may be found desirable in certain cases because the reaction forces of the steam passing through the inlets pass through the center of the turbine, thereby producing favorable conditions upon the nozzle casing.

In all other respects, the turbine shown in Fig. 5 is similar to that of the first embodiment shown in Figs. 1 through 4 and 6.

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. For use in an elastic-fluid turbine having an outer casing, an inner casing disposed within said outer casing, a rotor, and blading carried by said rotor and said inner casing; a fluid conducting system comprising a nozzle casing enclosed by said inner casing, said outer casing enclosing said inner casing in a substantially fluid pres-

sure tight manner, said nozzle casing including a chamber and a group of nozzles for supplying hot pressurized motive elastic fluid from said chamber to said blading, a tubular neck integral with said nozzle casing and communicating with said chamber, said neck extending into an opening formed in said inner casing and being spaced from said inner casing, a tubular collar integral with said inner casing and aligned with said tubular neck, said collar extending into an opening formed in said outer casing and being spaced from said outer casing, a conduit rigidly connected to said outer casing and aligned with said collar and said neck, said conduit extending through said collar and said neck and communicating with said chamber, said conduit being movable relative to said collar and said neck, and sealing means provided between said conduit and collar and between said conduit and said neck.

2. For use in an elastic-fluid turbine, having an outer casing including an upper half and a lower half, an inner casing including an upper half and a lower half disposed with said outer casing and supported thereby, a rotor disposed within said inner casing, and blading carried by said inner casing and by said rotor; a fluid conducting system comprising a nozzle casing enclosed by said inner casing, said outer casing enclosing said inner casing in a substantially fluid pressure tight manner, said nozzle casing including an upper half and a lower half, means for supporting said nozzle casing from said inner casing, means restraining rotational movement of said nozzle casing but permitting radial movement thereof relative to said inner casing, each nozzle casing half including a chamber and a plurality of nozzles for supplying hot pressurized motive elastic fluid from said chamber to said blading, tubular necks integral with the nozzle casing halves and extending outwardly into openings provided in said inner casing, tubular collars extending outwardly and being integral with said inner casing, said tubular collars being aligned with said tubular necks and extending into openings formed in said outer casing, inlet conduits fixedly secured to said outer casing and extending inwardly, said conduits being aligned with the respective tubular necks and collars and in telescopic relation therewith, said conduits providing passageways for elastic fluid to said chambers and being movable relative to said collars and said necks, and sealing means provided between said conduits and said collars and between said conduits and said necks.

3. For use in an elastic-fluid turbine having an outer casing including an upper half and a lower half, an inner casing including an upper half and a lower half disposed in said outer casing and supported thereby, a rotor disposed within said inner casing, blading carried by said inner casing and by said rotor; a fluid conducting system comprising a circumferential nozzle casing enclosed by said inner casing, in a substantially fluid pressure tight manner, said outer casing enclosing said inner casing in

a tubstantially fluid pressure tight manner, said nozzle casing including an upper half and a lower half, means for supporting said nozzle casing from said inner casing, means restraining rotational movement of said nozzle casing but permitting radial movement thereof relative to said inner casing, each nozzle casing half including a chamber and a plurality of nozzles for supplying hot pressurized motive elastic fluid from said chamber to said blading, tubular necks integral with the nozzle casing halves and extending outwardly into openings provided in said inner casing, tubular collars extending outwardly and being integral with said inner casing, said tubular collars being aligned with said tubular necks and extending into openings formed in said outer casing, inlet conduits fixedly secured to said outer casing and extending inwardly, said conduits being aligned with the respective tubular necks and collars and in telescopic relation therewith, said conduits providing passageways for the motive elastic fluid to said chambers and being movable relative to said collars and said necks, said conduits extending in radially outwardly direction with respect to the axis of rotation of said rotor, and sealing means provided between said conduits and said collars and between said conduits and said necks.

4. In combination, a substantially fluid pressure tight tubular outer casing, a tubular inner casing enclosed by said outer casing, a third tubular casing enclosed by said inner casing, mutually cooperating means provided in said third casing and said inner casing for supporting said third casing in said inner casing, means permitting relative movement between said third casing and said inner casing, a fluid conduit for the flow therethrough of hot pressurized fluid, said fluid conduit extending through and being fixedly connected to said outer casing, said fluid conduit having an inner end portion communicating with said third casing, a tubular neck integral with said third casing and extending outwardly into an opening provided in said inner casing, a tubular collar extending outwardly and being integral with said inner casing, said tubular collar being aligned with said tubular neck and extending into an opening formed in said outer casing, said fluid conduit being aligned with the tubular neck and collar and in telescopic relation therewith, said conduit extending in radially outwardly direction with respect to the longitudinal axis of said third casing, and sealing means provided between said conduit and said collar and between said conduit and said neck.

References Cited in the file of this patent

UNITED STATES PATENTS

2,414,788	Altorfer	Jan. 8, 1947
2,527,445	Pentheny	Oct. 24, 1950
2,527,446	Jenks et al.	Oct. 24, 1950

FOREIGN PATENTS

477,258	Great Britain	Dec. 24, 1937