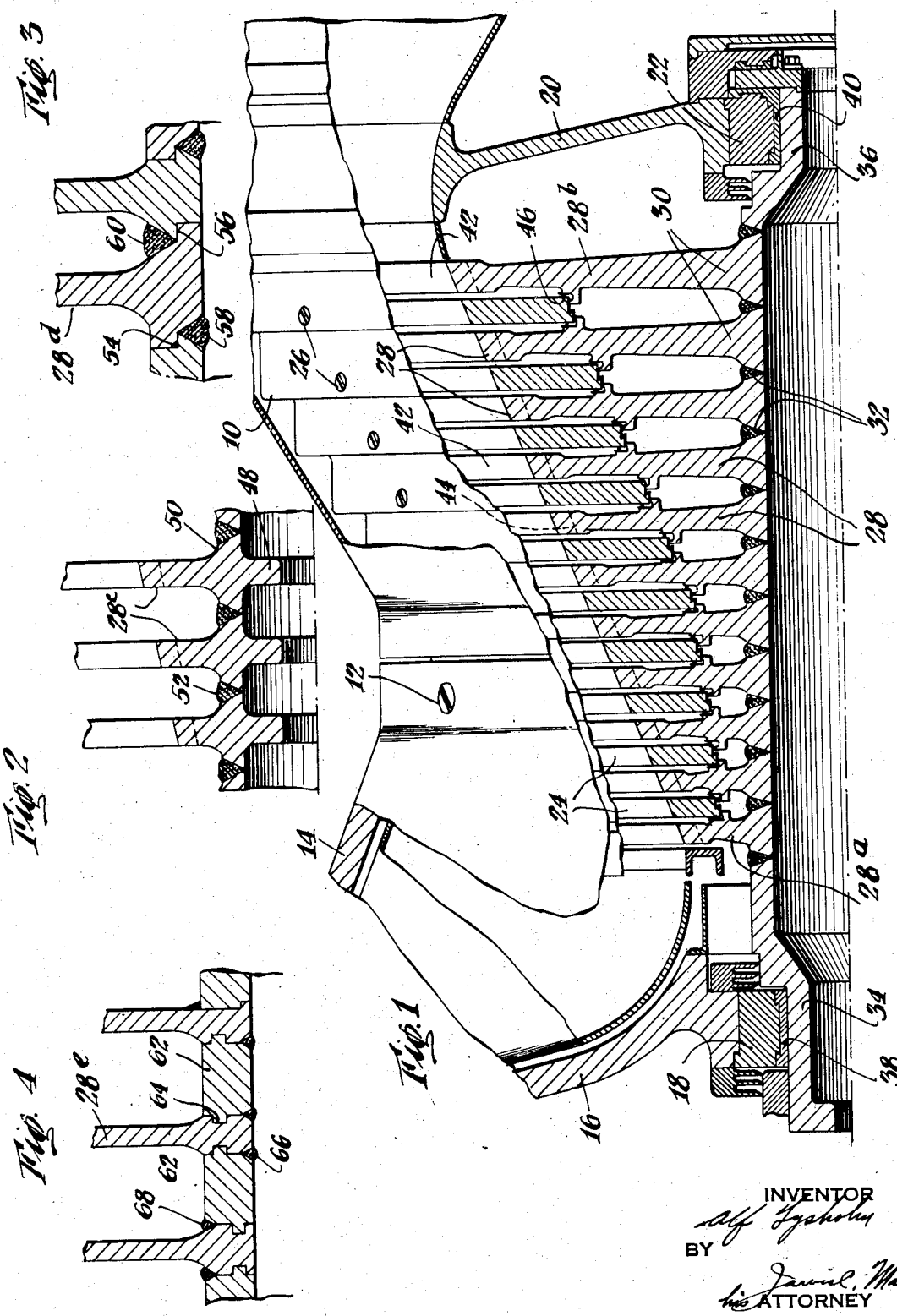
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TURBINE

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TURBINE

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This application is a continuation in part with respect to my copending application Serial No. 710,465, filed February 9, 1934.

The present invention relates to turbines and has particular reference to turbines intended to be operated with motive fluid of relatively very high temperature. Still more particularly the invention relates to turbines adapted to be operated as parts of gas turbine systems and to which motive fluid is admitted at an initial temperature of at least approximately 800° C. absolute.

When motive fluid is used which has an initial temperature of the above noted or higher value, difficulties are encountered in maintaining proper clearances within the turbine and also in maintaining the parts of the turbine rotors as heretofore constructed in rigidly connected relationship throughout the normal life of the turbine. Such difficulties are largely traceable to the phenomenon commonly referred to as "creep" which occurs in the metals usually employed in turbine construction, when they are subjected to the combination of mechanical stresses and extremes of temperature which obtain in high temperature turbines, particularly gas turbines.

The general object of the present invention is to provide improved turbine rotor construction of built-up form which will eliminate or substantially diminish the difficulties heretofore encountered in the construction and operation of turbines of the character under consideration.

In accordance with the invention, the turbine rotor is built up of a number of separate parts including a series of turbine discs to which the turbine blades are attached. The discs are annular in form and the parts of the rotor are welded together at or near the inner periphery of the annular discs so as to provide a hollow central shaft portion for the rotor, which shaft portion includes as an integral part thereof the hub portions of the discs.

The discs at the ends of the welded group forming the main part of the rotor are welded to suitable end pieces to provide the necessary bearing support for the rotor. It will be understood, of course, that the construction with respect to end pieces for bearings will vary depending upon the type of rotor for which the turbine is intended. Such pieces may be at the ends of the rotor in the case of the usual type of axial flow rotor having bearings at its ends for its support. Other types of constructions having different bearing arrangements are, however, contemplated within the scope of the invention.

The invention may be carried into effect with different specific forms of construction, and its more detailed nature and the advantages to be derived from its use may best be understood from a consideration of the ensuing portion of this specification and the accompanying drawing in which are described and illustrated by way of example, suitable forms of rotor construction for carrying the invention into effect.

In the drawing:

Fig. 1 is a longitudinal central half section, partly in elevation, of a turbine having a rotor embodying the invention in which the hub portions of the rotor discs are welded directly together to form the shaft portion of the rotor;

Fig. 2 is a fragmentary longitudinal central section of rotor discs directly welded together but of other form;

Fig. 3 is a view similar to Fig. 2 but showing still another form of rotor discs welded directly together; and

Fig. 4 is a view similar to Fig. 2 illustrating still another form of construction embodying the invention.

Referring now to Fig. 1, the turbine illustrated is of the axial flow multiple stage reaction type, the particular embodiment illustrated being suitable for use as a gas turbine adapted to operate at the very high temperatures at which such turbines usually run.

The outer turbine casing 10 is of generally conical form and in the embodiment illustrated, is attached by means of a series of radial pins 12 to an annular supporting member 14 which is in turn secured to a second supporting member 16, the latter providing support for the rotor bearing 18 at the inlet end of the turbine. An end member 20 attached to the rear end of the casing 10 provides support for the second rotor bearing 22.

Casing 10 supports a series of stationary blade rings 24, suitably spaced in axial direction to permit the rings of rotor blades to be inserted therebetween. The stationary blade rings may advantageously be secured to the casing 10 by means of radial pins 26, but the particular mode of mounting the stationary blades is not pertinent to the present invention or to an understanding thereof.

The rotor comprises a series of annular blade carrying discs 28 which at their bases are thickened laterally as at 30. The base portions 30 of the discs are permanently secured together by means of welds indicated at 32, and the end discs 28a and 28b are welded respectively to the annular end members 34 and 36 providing the

journals 38 and 40 which are supported by bearings 18 and 22, respectively.

As will be evident from the drawing, the thickened base portions 30, when welded together, form a continuous hollow rotor shaft from which the discs 28 project. This form of shaft not only produces a relatively light rotor structure, but avoids the possibility of parts becoming loosened due to creep of the metal during the life of the turbine. The hollow shaft construction also permits the ready admission of motive fluid to the interior of the shaft to aid in obtaining uniform heating and expansion of the rotor when the turbine is started from cold state.

At the perimeters of the several discs 28 the moving turbine blades 42 are attached. The specific mode of attachment may vary within the scope of the invention but the blades are preferably secured by welding, to provide a completely integral rotor structure. The joints may be dovetailed as well as welded and as will be appreciated by those skilled in the art, the specific form of the joint may be in accordance with numerous known methods of attachment.

For purposes of illustration, a dove-tail or socket joint combined with welding is diagrammatically indicated at 44.

In the drawing the usual tightening strips are indicated at 46, these strips serving to minimize leakage between the moving blade discs of the rotor and the stationary blade rings which project radially inwardly between the rotating discs.

In the form shown in Fig. 2, the construction is the same as in Fig. 1 in so far as the general assembly of the rotor is concerned. In the present instance, however, the discs 28c are provided with inwardly projecting flange portions 48 which project radially inwardly from the thickened portions 50 that are welded together as at 52 to form the shaft of the rotor. The inwardly projecting flanges 48 serve to reduce the stresses set up in the discs due to centrifugal force and are also useful in aligning the separate discs in a jig or the like prior to welding the parts together.

Instead of making full butt welds of the kind shown in Fig. 2, the hubs of the discs in certain instances may advantageously be shouldered as shown at 54 in Fig. 3 to provide interfitting sockets, the cylindrical portions of the sockets serving to provide radial alignment of the discs before they are welded and the axially abutting ends at 56 serving to accurately determine the axial spacing of the discs 28*d*.

The discs may be welded either at the inner periphery of the hub portions as indicated at 58, or externally at the hub portions as indicated at 60, the position of the weld depending upon the size and spacing of the turbine discs which in some cases may make a weld 60 relatively inaccessible.

In Fig. 4 another form of construction is illustrated in which the discs 28*e* are not thickened sufficiently to permit their being welded directly to each other, in which case the hubs of the discs have interposed between them a series of spacing rings 62 arranged so that the spacing rings and the hub portions of the discs together form the central hollow shaft portion of the rotor.

For ease and accuracy of assembly and welding, the hubs of the discs and the spacing rings are advantageously flanged as indicated at 64 and the welds may be made either externally or internally of the rings as indicated at 66 and 68.

In the construction shown in Fig. 4 the rotor may be very readily and comparatively cheaply constructed of rolled plate material, which when of the kind of steel usually required for high temperature rotors, is much less expensive in sheet form than in the form of special forgings.

From the foregoing it will be evident that within the scope of the invention the specific designs hereinbefore described by way of example may be varied and the invention is to be understood as embracing all forms of construction falling within the scope of the appended claims.

What I claim is:

1. For use in elastic fluid turbines, a build-up integral hollow rotor comprising a plurality of turbine discs having different blade root diameters and a central hollow shaft portion, said discs being generally symmetrical axially with respect to the respective central planes of the discs, said shaft portion being formed by axially abutting parts including the hub portions of said discs and said parts being united by welding, said shaft portion constituting the sole means for retaining the discs in axially assembled relation and the radially outer portions of said discs being in axially spaced relation.

2. For use in elastic fluid turbines, a build-up integral hollow rotor comprising a plurality of turbine discs of progressively greater blade root diameter from the inlet to the outlet end of the rotor for carrying blades providing a generally conical path of flow for expansion of motive fluid, and a central hollow shaft portion of substantially uniform diameter, said discs being generally symmetrical axially with respect to the respective central planes of the discs, said shaft portion being formed by axially abutting parts including the hub portions of said discs and said parts being united by welding, said shaft portion constituting the sole means for retaining the rotor parts in axially assembled relation and the radially outer portions of said discs being in axially spaced relation.

3. For use in elastic fluid turbines, a build-up integral hollow rotor comprising a plurality of turbine discs of different blade root diameter having hub portions thickened axially on each side of the respective central planes of the discs, to provide discs substantially symmetrical with respect to said planes, and a central hollow shaft portion, said shaft portion being formed by the axially abutting hub portions of the discs and welds uniting the abutting hub portions, said shaft portion constituting the sole means for maintaining the discs in axially assembled relation and the radially outer portions of said discs being in axially spaced relation.

4. For use in elastic fluid turbines, a built-up integral hollow rotor comprising a plurality of turbine discs having different blade root diameters and hub portions thickened in axial direction at each side of the respective central planes of the discs, to provide discs substantially symmetrical with respect to said planes, said hubs having shoulders at their axially opposite sides to center them with respect to axially adjacent hubs and said abutting hubs being united by welds to form a central hollow shaft portion, said shaft portion constituting the sole means for maintaining the discs in axially assembled relation and the radially outer portions of said discs being in axially spaced relation.

5. For use in elastic fluid turbines, a built-up hollow rotor including a plurality of annular discs having inner portions thickened axially on each side of the respective central planes of the

discs, to provide discs substantially symmetrical with respect to said planes, welds connecting said thickened portions to form a central shaft portion of the rotor, and flange portions projecting inwardly from the thickened portions of the discs, the flange portion and the radially outer portion of respective discs being substantially symmetrically located with respect to the central plane of the disc and the flange portion and the radially outer portion of respective discs being axially spaced from the corresponding portions of adjacent discs.

6. For use in elastic fluid turbines, a built-up integral hollow rotor including a plurality of annular discs of increasing diameter axially of the rotor, said discs having hub portions of substantially the same diameter thickened axially on each side of the respective central planes of the discs, to provide discs substantially symmetrical with respect to said planes, welds connecting said thickened portions to form a central hollow shaft portion of substantially uniform diameter axially of the rotor from which the outer parts of said discs project radially in axially spaced relation, said central shaft portion providing the sole means for holding said discs in axially assembled relation, and flange portions on said discs projecting inwardly from the thickened portions thereof.

7. For use in elastic fluid turbines, a built-up hollow rotor having a plurality of annular turbine discs, said discs being generally symmetrical axially with respect to the respective central planes of the discs, and a plurality of annular spacing rings interposed between said discs and welded to the inner portions of the discs, the inner portions of the discs and said spacing rings providing a central hollow shaft portion for the rotor from which the discs project and the portions of the discs radially outside said shaft portion being in axially spaced relation.

8. For use in elastic fluid turbines, a built-up hollow rotor having a plurality of annular turbine discs, said discs being generally symmetrical axially with respect to the respective central planes of the discs, and a plurality of annular spacing rings interposed between said discs, the radially inner portions of said discs and the ends of said spacing rings being provided with cooperating shoulder portions for centering the discs and rings with respect to each other and welds for connecting the discs and rings together, the inner portions of the discs and the rings providing a hollow central shaft portion for the rotor from which the discs project and the portions of the discs radially outside said shaft portion being in axially spaced relation.

9. For use in elastic fluid turbines, a built-up integral hollow rotor comprising a plurality of annular turbine discs having different blade root diameters and hub portions of substantially the same diameter thickened in axial direction at each side of the central planes of the discs, to provide discs substantially symmetrical with respect to said planes, said hubs having shoulders at their axially opposite sides to center them with respect to axially adjacent hubs and said hubs being united by internal and external welds to form a central hollow shaft portion of substantially uniform diameter, said shaft portion constituting the sole means for maintaining the discs in axially assembled relation and the portions of said discs outside said hub portions being in axially spaced relation.

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