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ROTOR FOR MULTISTAGE TURBINES AND COMPRESSORS

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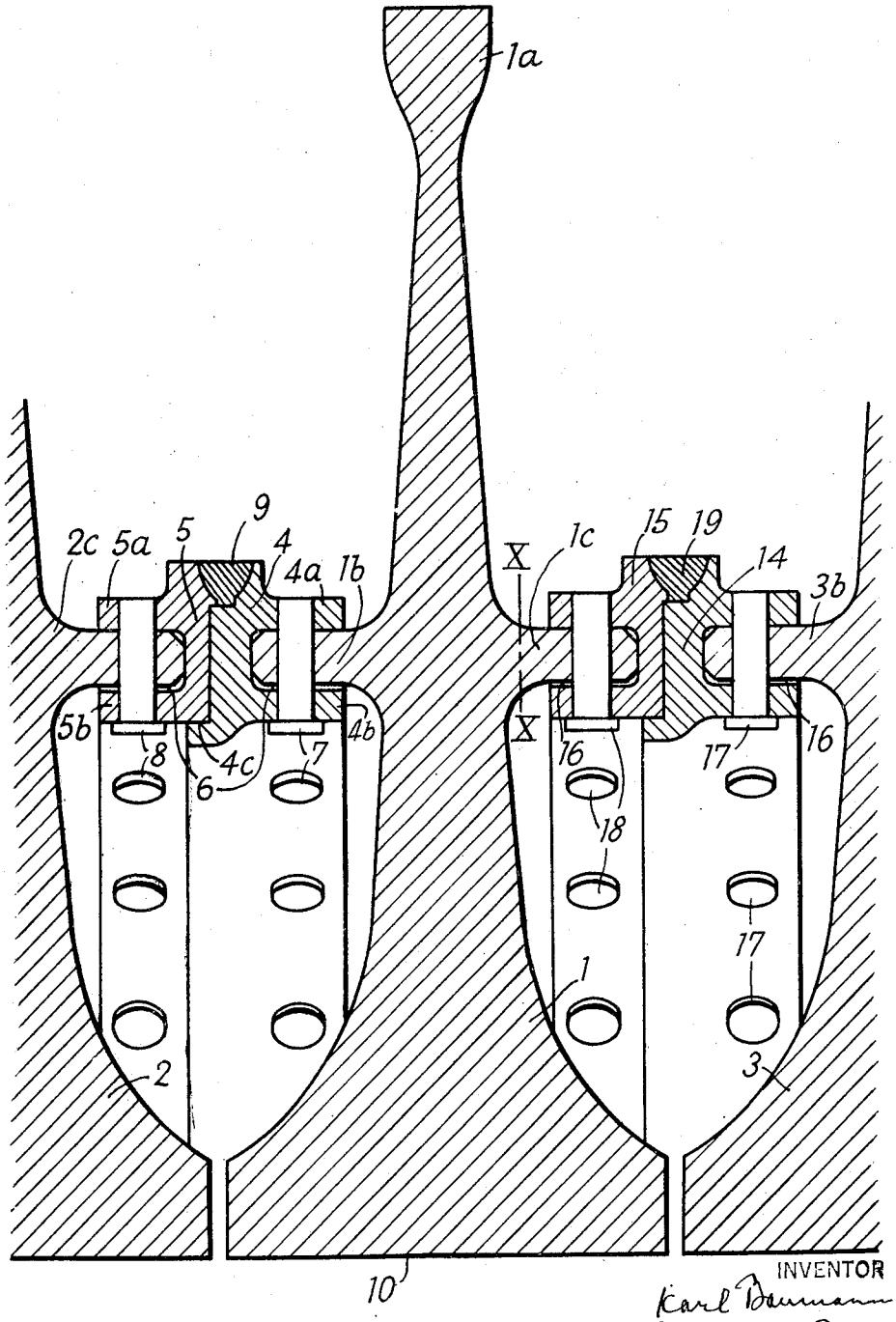

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ROTOR FOR MULTISTAGE TURBINES AND COMPRESSORS

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This invention relates to a rotor for multi-stage turbines and compressors, and in particular to bladed rotors therefor.

In the design of rotors having several rows of blades for use in high-speed multi-stage turbines or compressors, there are, as the number and diameter of the blading stages increase, serious limitations to the use of rotor constructions of the drum type and also of the type involving separate discs mounted upon a shaft, these limitations being accentuated in circumstances where minimisation of overall weight is specially important as, for example, is the case with the rotors of turbines or compressors intended for use on aircraft; more particularly, in the case of a rotor of the drum type, the hoop stress is liable to become excessive with increased diameter or blading speed, whilst in the case of a rotor of the multi-disc type, the diameter of the shaft must be increased correspondingly with increase in the number, and overall length, of stages in order that the critical speed shall be maintained within reasonable limits, and with such increased shaft diameter the hoop stress at the bores is liable to become excessive and to cause loss in shrinkage fit between the discs and shaft and in consequence result in the setting up of vibrations.

In order to overcome the limitations referred to, resource has been made to the use of a rotor construction involving a plurality of discs tightly abutting together at projections formed solid with the discs at a diameter considerably greater than that of the usual bores. With such construction a rigid structure having relatively high critical speed is formed in which the discs are held together at spigoted locations of contact by means of a bolt passing through relatively small holes in the hubs, or alternatively by welded unions between the projections on the discs; this latter method is, however, unsatisfactory inasmuch as, with the welding applied to a part of the disc proper, local stresses are liable to be introduced into the disc, and since the latter is a highly stressed member, such local stresses are eminently undesirable.

With the above and other considerations in view, the present invention provides an improved rotor construction comprising a plurality of separate discs, each carrying, or adapted to carry, at its periphery one or more rows of blades and held in side-by-side and abutting relationship so as to form a rigid structure of high critical speed, said discs being formed each with an integral projection, or several circularly-distributed projections, facing and in axial alignment with

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a similar projection or projections on the adjacent disc, and the projection or projections on one disc being secured by pinning or riveting or bolting to an annular member which is rigidly attached, by welding, to an annular member secured by pinning or riveting or bolting to the projection or projections on the adjacent disc.

Inasmuch as such welding as is utilised in effecting attachment between the discs is not applied directly to a disc proper, but on the contrary to a member which is secured to the disc by being pinned, riveted or bolted to the disc projection(s), the possibility of introduction of local stresses into the disc proper is minimised.

Advantageously provision should be made for clearance between the projection, or projections, on a disc and the annular member which is secured thereto by pinning or riveting or bolting, so that during application of welding to said annular member (for attaching it to the annular member which is secured by pinning or riveting or bolting to the projection or projections of the adjacent disc) said annular member can expand freely and with but minimum application of stress to the disc due to engagement of said annular member with said projection or projections of the disc.

In carrying out the invention it is preferable for the annular member secured to the projection or projections on one disc to be spigoted with respect to the annular member secured to the projection or projections on the adjacent disc; advantageously the annular member for one disc may be machined on a radial face remote from the disc so as to register with a spigot on to a corresponding face of the annular member for the adjacent disc.

Conveniently the annular members for adjacent discs may be formed at the radially outer edges of their contiguous radial end faces in such manner as jointly to form a recess for receiving weld metal rigidly to attach the rings one to the other.

In practising the invention, the projection or projections on the discs may be of any suitable form but it is preferred to use a single continuous projection of cylindrical shape. The radial position of the projection or projections will preferably be chosen so that during rotation at normal working speed there will be little or no sheer stress at the radial plane between the projection or projections of a disc and the face of the disc proper.

With the projection or projections on a disc formed cylindrically and adapted to fit into the

annular space formed between a radially inner flange and a radially outer flange on the annular member to which said projection or projections will be secured by pinning or riveting or bolting as aforesaid, the said annular member will be constructed with said flanges spaced apart in the radial direction by a distance at least equal to the depth of the projection in the radial direction together with an amount corresponding to the distances by which the radially outer face of the inner flange and the radially inner face of the outer flange can be expected to move in the radial direction whilst the welding operation is being effected upon said annular member; also, the depth in the axial direction of the annular space formed between said radially inner and outer flanges will be such that, with the projection fitted properly in position between said flanges for pinning or riveting or bolting thereto, the opposing radial surfaces of the annular member and the projection within said space, are separated by an amount at least equal to the distance in the axial direction by which said radial surface of the annular member can be expected to move during the welding operation.

In a preferred construction, the annular members are secured each to the appertaining disc by means of radial pins inserted at the radially inner end of a series of radial holes formed in the annular members and the projection or projections of the disc, the contiguous annular members being secured together by welding effected whilst the discs are temporarily held tightly together and in coaxial relationship with each other.

For some applications the discs may be formed without central bores, the two end discs in the assembly being attached, in similar manner to that described, to members forming stub shafts for the bearings. By the omission of central bores in the discs the overall length of the rotor to accommodate a given number of stages may be reduced since the disc hubs will be more lightly stressed and may therefore be made narrower than is possible in the case where the discs are formed with central bores.

To enable the invention to be fully understood reference is made to the accompanying drawing, the sole figure of which is a half axial sectional view of a portion of a turbine or compressor bladed rotor constructed in accordance with the invention.

The rotor shown comprises a rigid assembly of discs 1, 2, 3 which are formed separately and secured together in side-by-side and coaxial relationship in a manner presently to be described. It will be appreciated that the discs will be shaped at the outer periphery as indicated for disc 1 at 1*a* so as to form a base for attachment thereto of one or more rows of blades (not shown).

For the attachment of the disc 1 to discs 2, 3, said disc 1 is formed on opposite end faces with integral cylindrical projections 1*b* and 1*c* respectively; said projections are preferably located at such radial distance from the axis of the disc that under the normal speed of rotation about said axis there will be little or no sheer stress in the neighbourhood of the plane indicated at X—X. Discs 2 and 3 are formed with similar projections 2*c*, 3*b* respectively facing, and at the same radial distance from the axis as, the projections 1*b*, 1*c* for disc 1.

The attachment of disc 1 to disc 2 is effected

through the intermediary of two ring members 4 and 5 respectively. Ring 4 is formed with flanges 4*a* and 4*b* to provide a recess into which the disc projection 1*b* fits with radial clearance 6. Likewise ring 5 is formed with flanges 5*a* and 5*b* providing a recess for receiving disc projection 2*c* also with radial clearance 6. After entry of the disc projection 1*b* into position between ring flanges 4*a*, 4*b*, the ring is rigidly secured to the projection by headed pins 7 inserted in corresponding radial holes in the ring inner flange 4*b* and extending through corresponding holes in the disc projection 1*b* into holes in the ring outer flange 4*a*. Similarly, ring 5 is rigidly secured to disc projection 2*c* by pins 8 passing through holes in the ring flanges 5*a*, 5*b* and the disc projection 2*c*.

With ring 4 secured as described to disc 1, its radial end face remote from the disc registers with spigot 4*c* on to the corresponding radial end face of ring 5 attached to disc 2. On their outer periphery the rings 4 and 5 are shaped jointly to provide a circumferential recess for the reception of weld metal 9 for rigidly attaching together the rings 4 and 5 and therewith the discs 1 and 2. It will be appreciated that the welding operation will be effected while the discs 1 and 2 are temporarily held tightly together and in coaxial relationship with each other so that the rings 4 and 5 will be firmly held together with their facing radial end surfaces closely engaged.

In similar manner to that just described in respect of the attachment of discs 1 and 2, the discs 1 and 3 are rigidly attached together by means of rings 14 and 15 fitting over the disc projections 3*b* and 1*c* respectively with radial clearance 16, which rings after being secured to said disc projections by pins 17 and 18 respectively are subsequently welded together at 19.

With the construction shown and described and subject to the clearance 6, 16 being suitably dimensioned, the discs 1, 2 and 3 can be rigidly connected together without introduction of local stresses into the discs during the welding operation.

In the construction specifically shown and described the discs 1, 2 and 3 are formed with a central bore 10 for assembly on a shaft. In an alternative construction the discs may be formed without central bores and the outer faces of the two end discs of the rotor are formed each with a projection or projections to which a member may be secured in the manner described above, which members form stub shafts for the bearings. In this construction the disc hubs will be more lightly stressed and may therefore be made narrower than is indicated in the drawing, thus enabling the overall length of the rotor to be reduced.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A rotor for a multi-stage turbine or compressor, comprising a plurality of discs having projections integral therewith and directed from the opposing sides of adjacent discs, annular members mounted on said projections, and a weld securing said members together, said annular members being formed with two axially directed radially spaced annular flanges which receive the projections with clearance between the projections and the radially inner flanges of the respective annular members, and fastening means extending radially through the flanges of the annular members and the respective pro-

jections and securing the annular members to the respective discs.

2. A rotor for a multi-stage turbine or compressor, comprising a plurality of discs having annular projections integral with the respective discs and directed toward one another from the opposing side faces of adjacent discs, annular members mounted on the projections on the respective discs, and a weld securing said members together, each of said annular members being formed with two axially directed radially spaced annular flanges which receive the annular projection on the respective disc with clearance between the projection and the radially inner flange of the respective annular member, and fastening means extending radially through the flanges of each annular member and the respective projection and securing the annular members to the respective discs.

3. A rotor for a multi-stage turbine or compressor, comprising a plurality of discs each having an annular projection on a side face thereof and integral therewith and directed axially toward the opposing side face of an adjacent disc, an annular member mounted on the projection on one disc, an annular member mounted on the projection on an adjacent disc, and a weld securing the annular members together, each of said annular members being formed with two axially directed annular flanges spaced radially to receive the axially directed annular projection on the respective disc with clearance between the radially inner flange of the annular member and the respective projection, and the annular members being formed on their meeting faces one with a surface and the other with a cooperating flange to locate said members concentrically with the discs for welding together.

4. A rotor for a multi-stage turbine or compressor, comprising at least two coaxially arranged discs each having a plurality of projections integral therewith and extending axially therefrom toward the adjacent disc, an annular member secured on the projections on each disc and having two axially directed flanges forming a housing for the respective projections with clearance between each projection and the radially inner of said two flanges of the respective annular member, said annular members being formed on their meeting faces one with a surface and the other with a flange which cooperate to locate said members and the discs secured thereto concentrically for welding together.

5. A rotor for a multi-stage turbine or compressor, comprising at least two coaxially arranged discs, each of the discs having on the surface thereof which faces the other disc an annular axially directed projection arranged concentrically with the rotor axis and intermediately between said axis and the periphery of the disc, an annular member mounted on each of said projections and having radially inner and radially outer axially projecting flanges forming a space for receiving the respective projection with clearance between the radially inner flange and the projection, and fastening means extending radially through said flanges of each annular member and the respective projection, the meeting surfaces of the annular members of the two discs being provided with cooperating parts which locate said members and the discs secured thereto concentrically with the axis of the rotor, and the radially outer edges of said members adjacent to their meeting surfaces being shaped to provide a recess for receiving weld metal.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,399,816	Spiers	Dec. 13, 1921
2,369,051	Huber	Feb. 6, 1945

FOREIGN PATENTS

Number	Country	Date
341,892	Germany	Oct. 1921