STATOR FOR AXIAL COMPRESSORS

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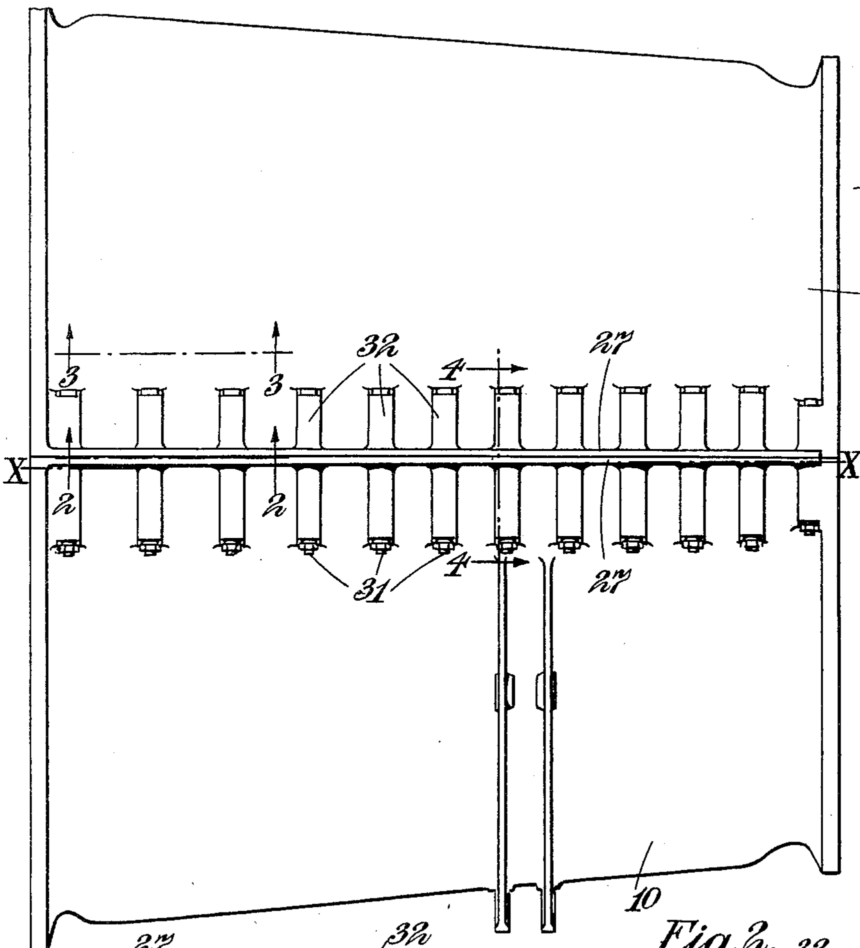

Fig.1.

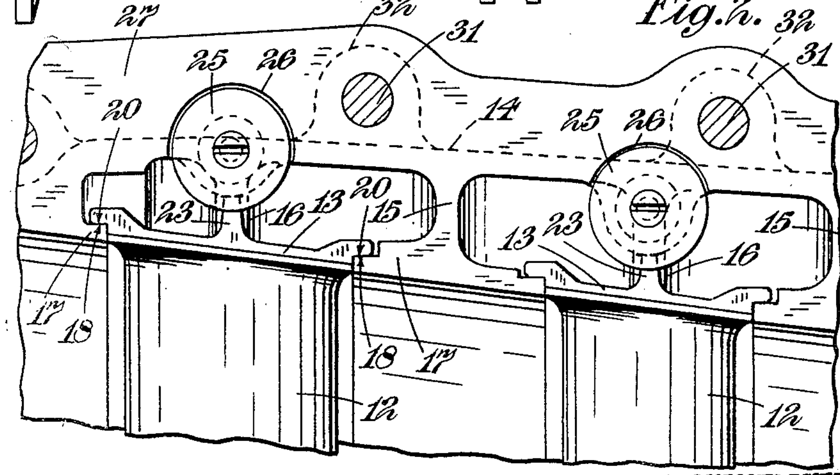

Fig.2.

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Fig.3.

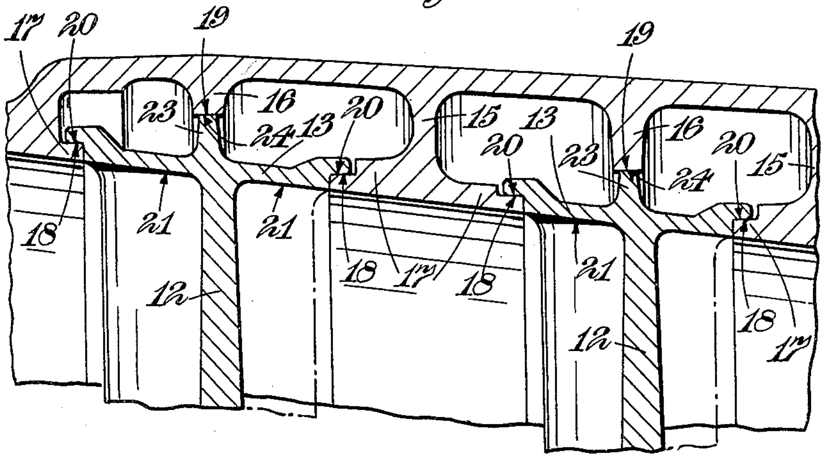


Fig.4.

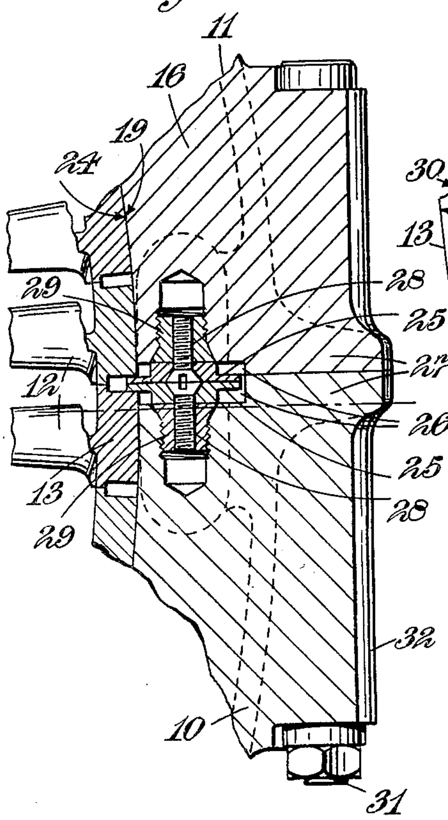
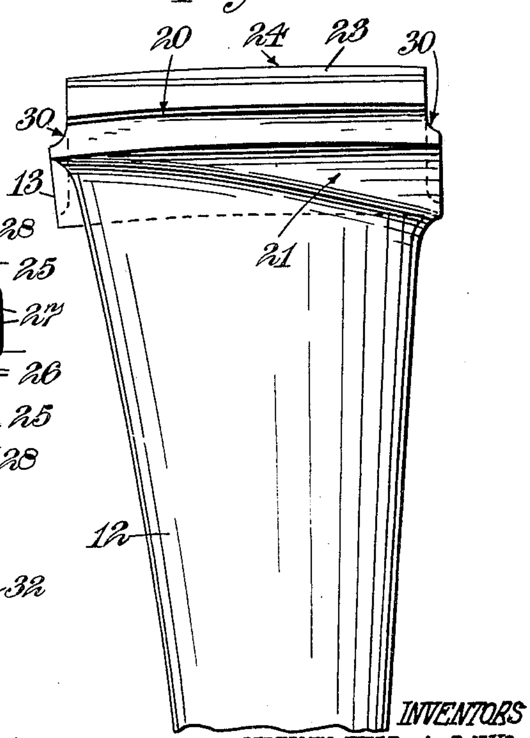


Fig.5.



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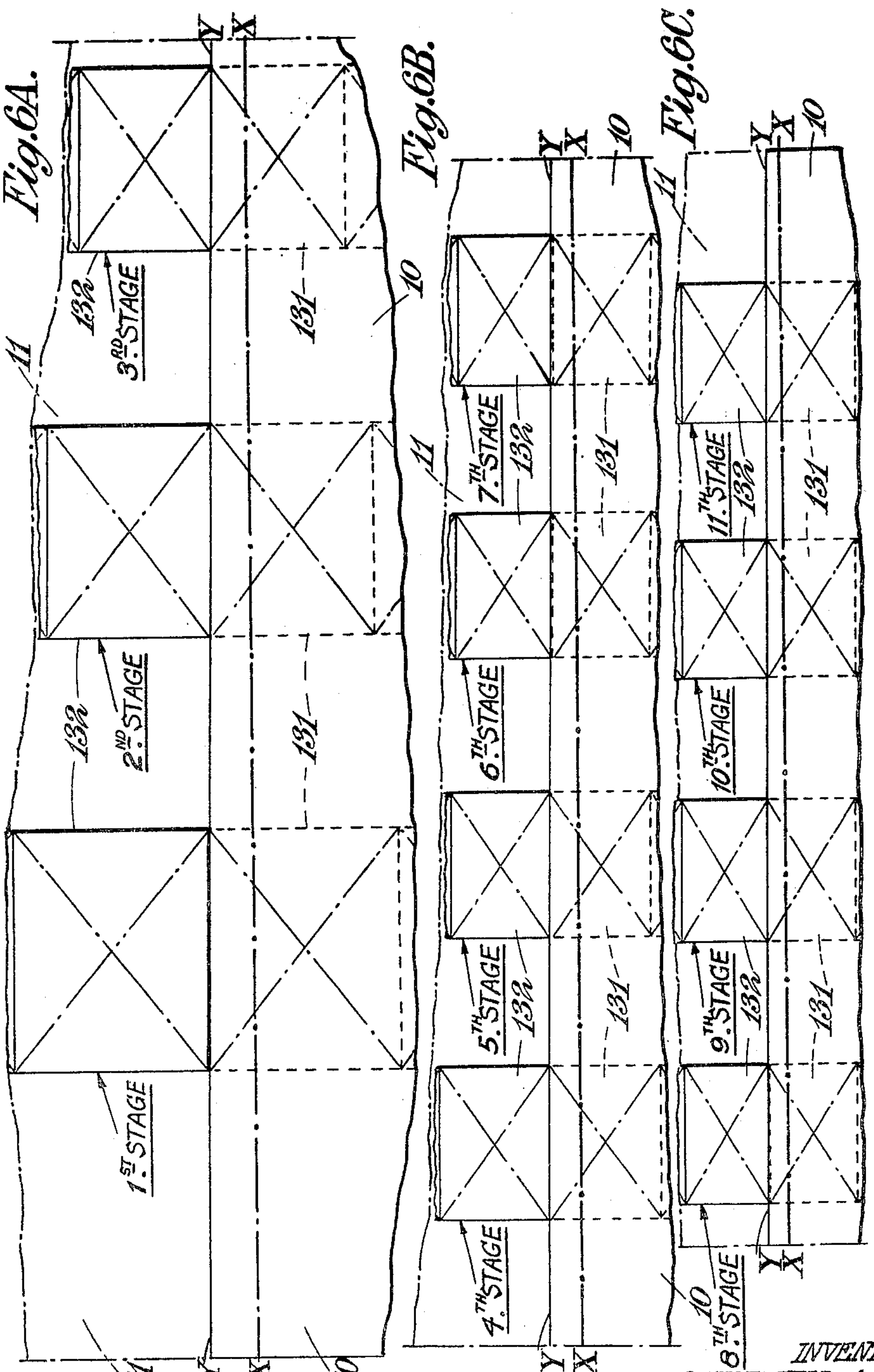

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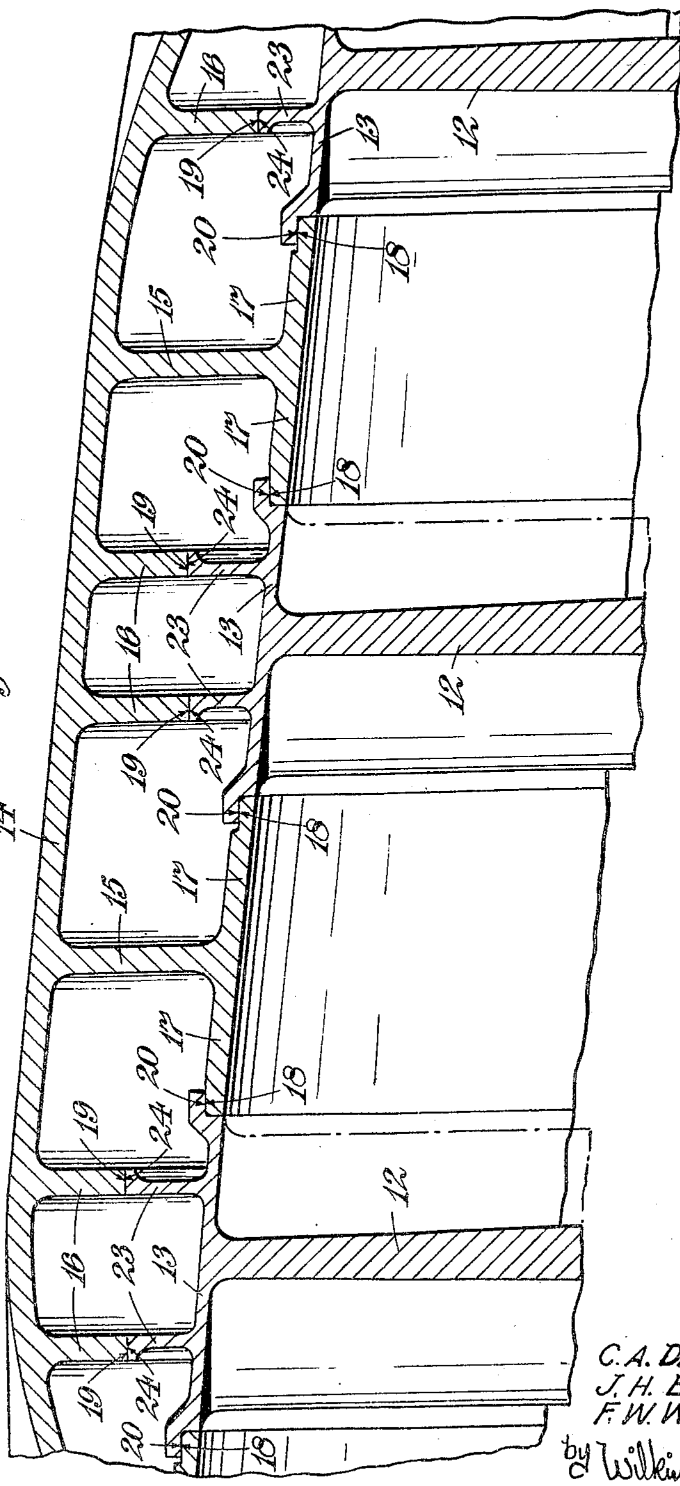
Fig. 7.



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Patented Feb. 27, 1951 2,543,355

UNITED STATES PATENT OFFICE

2,543,355

STATOR FOR AXIAL COMPRESSORS

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Application February 10, 1948, Serial No. 7,488
In Great Britain February 17, 1947

9 Claims. (Cl. 230—133)

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This invention relates to axial compressors, such as are for example used in gas-turbine engines, and has for an object to provide an improved construction of stator blade and stator casing for axial compressors which have advantages from the point of view of lightness, which is important in compressors used in aircraft power plants, and of ease of manufacture and assembly.

According to this invention an axial-flow compressor stator assembly comprises a stator casing having a relatively thin wall, a plurality of axially-spaced main internal reinforcing webs each main web extending circumferentially around and projecting radially inwardly from the wall and each main web being formed with axially-spaced outwardly facing abutment surfaces curved about the axis of said casing, and a plurality of intermediate internal reinforcing webs there being at least one intermediate web between each pair of said main webs, each said intermediate web extending circumferentially around and projecting radially inwardly from said wall and being formed with an inwardly facing abutment surface curved about the axis of said casing; and a plurality of stages of stator blading, each stage of stator blading comprising a plurality of blades in circumferential assembly supported and located by a pair of main webs and at least one intermediate web, the blades being formed with axially and circumferentially extending blade root platforms, which platforms are formed each with inwardly-facing abutment surfaces at its axially-spaced edges to abut said outwardly-facing abutment surfaces of the associated pair of main webs, and each with at least one outwardly facing abutment surface so arranged to cooperate with the inwardly-facing abutment surface of the intermediate web between said pair of main webs as to maintain the blade root platform in contact with the abutment surfaces on the main webs and to locate the blade against radial and rocking movement.

Preferably the outwardly-facing abutment surfaces of the blade platforms are formed on ribs projecting radially outwardly from the outer surfaces of the platforms and having an axial dimension less than the axial dimension of the platforms.

Moreover it is preferred that the main webs be formed with axially and circumferentially extending flanges having outwardly-facing abutment surfaces of the main webs formed at their axially-spaced edges, and that the inner surfaces of the main webs and platforms be arranged to provide a smooth continuous surface for the outer wall of the working fluid passage through the compressor.

It will be appreciated that the invention by

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reducing the contact area between the blade platforms and the casing, facilitates accuracy in machining of the parts and also simplifies assembly.

By providing strengthening webs on the inner surface of the casing, the webs and wall are at substantially the same temperature so that circumferential thermal stresses due to the provision of reinforcing webs are avoided. Further since the wall of the casing is thin and the reinforcing webs also provide the means for retaining the blades, the overall weight can be reduced as compared with a casing having external strengthening webs. Furthermore, the external surface can be substantially smooth which is an advantage from the point of view of cleanliness and appearance.

There will now be described by way of example of this invention an axial compressor suitable for use with a gas-turbine-engine. For the sake of clarity only the compressor stator is illustrated, the compressor rotor being omitted. The description has reference to the accompanying diagrammatic drawings in which

Figure 1 is an external view of the compressor casing,

Figure 2 is a section on the line **2—2** of Figure 1 on a larger scale,

Figure 3 is a section on the line **3—3** of Figure 1 on the same scale as Figure 2,

Figure 4 is a section on the line **4—4** of Figure 1 on the same scale as Figure 2,

Figure 5 is a view of the root end of a stator-blade, and Figures 6A, 6B, 6C are a diagrammatic illustration of the junction between the parts of the compressor casing.

Figure 7 is a view corresponding to Figure 3 of an alternative arrangement.

Referring to the drawings, the compressor stator comprises a stator-casing formed in two parts **10** and **11** and a number of stages of compressor stator-blades **12** which are secured in the casing by their root-platforms **13**.

The platform **13** of each blade is of substantially rectangular form and is located at the outer end of the blade so that the latter projects radially inwards from the compressor casing.

The wall **14** of the compressor casing is of relatively thin section and is provided internally with continuous, circumferential, radially-projecting strengthening webs **15**, **16** so that the external surface of the casing is substantially free from projections and presents a clean appearance. The webs **15** which alternate with webs **16**, have a greater radial extent than the webs **16** and terminate at their inner ends in axially-directed flanges **17** so that the webs **15** have a T-section. There are thus formed by each pair of webs **15** a groove to receive the blades platforms **13** with a web **16** projecting inwardly from the base of the groove. In use the webs 15, 16 and wall 14 will be at substantially the same temperature whereby thermal stresses due to the presence of external webs are avoided.

The outward-facing surfaces 18 of the flanges 17 are machined to be curved about the axis X—X (Figure 1) of the casing and the inwardly facing surfaces 19 of the webs 16 are machined to be similarly curved.

The platform 13 of each blade has its axially spaced edges machined to provide inwardly-facing surfaces 20 which are curved about the casing axis X—X, the edges being recessed in the thickness of the platform so that the surfaces 20 are set back from the front face 21 of the platform and so that the faces 21 of the blades, when the latter are assembled in the casing, conform to the inner surface 22 of the flanges 17 to provide a smooth internal surface to the compressor casing. The surface of the platform remote from the blade is formed intermediate the axially spaced edges with a rib 23 the outwardly facing surface 24 of which is machined to be curved about the casing axis X—X. The radial extent of the rib 23 is such that when the blade is assembled in a groove between the webs 15 with the curved surfaces 20 in blade-retaining abutment with the surfaces 17, the surfaces 24 will cooperate with the surfaces 19 on the webs 16. The curved surfaces 18, 24 will be clearly seen in the axial end view of the blade illustrated in Figure 5.

The blades 12 are mounted in the casing by sliding them around the grooves from the division between the parts 10, 11 with the surfaces 20 in engagement with the surfaces 18 and the surfaces 24 in engagement with the surfaces 19. It will be appreciated that the blades will thereby be retained accurately in position with the blade radial to the casing axis, whilst accuracy of machining is facilitated owing to the small area of the co-operating surfaces.

The platforms 13 of the blades 12 of each stage will abut through their circumferentially spaced edges so as to form a substantially continuous ring.

It will be seen that a clearance or space is left between the wall 14 and the blade platforms 13, and these spaces provide circumferential passages which can be used for effecting tapping from the compressor at appropriate stages, for example for anti-surge bleed purposes or for extracting cooling air.

To retain the blades in position in the parts of the casing prior to jointing of the parts 10, 11 together, there are provided washers 25 (Figures 2 and 4) which are accommodated in recesses 26 in the jointing flanges 27 formed on the parts, 10, 11, and which engage the circumferentially-spaced edges of the platforms 13 of the end blades in the parts. The washers 25 are held in position by bolts 28 which thread into bushes 29 secured in the casing parts. The edges of the blades with which the washers engage are cut back as illustrated at 30 in Figure 5 to receive the washers.

The parts 10, 11 are secured together by bolts 31 extending through bosses 32 formed on the exterior of the casing.

It will be seen from Figure 1, that the plane of division between the parts 10, 11 of the casing does not coincide with the diametral plane through the axis X—X of the casing, but is slightly inclined thereto. This is done so that the edges of the end blade platforms received in each stage of the parts are substantially flush with the joint face, whereby damage to the platforms in assembly is avoided and assembly is facilitated.

The arrangement is more clearly illustrated in Figures 6A, 6B, 6C which are continuations one of the other in order, and illustrate the disposition of the end platforms of the stator blades in each of the 11 stages of the compressor. It will be appreciated that since the number of blades in each stage increases from the first stage of the compressor to the eleventh stage and since the diameter of the casing decreases, the chordal dimension of the platforms decreases from stage to stage. Moreover since there are normally an odd number of blades in each stage, the number of blades accommodated in say the part 10 is one greater than in the part 11, so that the platforms 131 of the end blades in casing part 10 project at each stage by amount approximately equal to one quarter of the chordal dimension beyond the diametral line XX and the platforms 132 of the end blades in each stage of other part 11 are set back by approximately one quarter of the chordal dimension from the diametral line.

The joint between the parts 10, 11 indicated in Figures 6A, 6B, 6C is therefore made to lie in a plane which is inclined to the diametral plane and which substantially contains the end surfaces of the end blades of each stage. The line of division Y—Y between the parts 10 and 11 is thus displaced from the diametral line X—X at each stage by an amount substantially equal to the amount by which the blade platform 131 at that stage extends beyond the diametral line. Thus in the arrangement illustrated, the end surfaces of blades 131 of stages 2, 3, 4, 5, 9, 10 and 11 lie in the plane of division, that of the first stage lies slightly beyond the plane, and those of the remaining stages lie slightly below the plane of division. The extent by which the end surfaces project or are set back from the plane of division can however be limited to a maximum of say ±0.025 inch.

It will be appreciated from the foregoing description that this invention provides a construction of stator-blade and stator-casing whereby manufacture and assembly of the compressor stator is simplified, and further that the compressor stator is of a strong but light construction and clean external appearance.

The invention is not limited to the construction above set forth. For example if desired the blade platform may be provided as illustrated in Figure 7 in which the same references as previously used are employed to indicate corresponding parts, with a pair of outwardly-directed, axially-spaced, curved surfaces 24 intermediate the axially-spaced edges thereof, for example by being provided with a pair of radially extending ribs 23, to co-operate with corresponding inwardly-directed curved surfaces 19 formed internally of the wall 14 of the casing, for example by providing thereon a pair of webs such as webs 16 between each pair of webs 15.

We claim:

1. An axial-flow compressor stator assembly comprising a stator casing having a relatively thin wall, a plurality of axially-spaced main internal reinforcing webs each main web extending circumferentially around and projecting radially inwardly from the wall and each main web being formed with axially-spaced

outwardly facing abutment surfaces curved about the axis of said casing, and a plurality of intermediate internal reinforcing webs there being at least one intermediate web between each pair of said main webs, each said intermediate web extending circumferentially around and projecting radially inwardly from said wall and being formed with an inwardly-facing abutment surface curved about the axis of said casing; and a plurality of stages of stator blading, each stage of stator blading comprising a plurality of blades in circumferential assembly supported and located by a pair of main webs and at least one intermediate web, the blades being formed with axially and circumferentially extending blade root platforms, which platforms are formed each with inwardly-facing abutment surfaces at its axially-spaced edges to abut said outwardly-facing abutment surfaces of the associated pair of main webs, and each with at least one outwardly-facing abutment surface so arranged to cooperate with the inwardly-facing abutment surface of the intermediate web between said pair of main webs as to maintain the blade root platform in contact with the abutment surfaces on the main webs and to locate the blade against radial and rocking movement.

2. An axial-flow compressor stator assembly as claimed in claim 1 in which said blade root platforms are formed each on the side thereof remote from the blade with at least one circumferentially and radially extending rib having an axial dimension less than the axial dimension of the blade root platform, and having at its radially outer end the outwardly-facing abutment surface which cooperates with the inwardly-facing abutment surface on the intermediate web.

3. An axial-flow compressor stator assembly as claimed in claim 1, in which said main reinforcing webs are formed each with axially and circumferentially extending flanges at their inward ends; said flanges being formed at their axially spaced edges with the outwardly-facing abutment surfaces of the main webs, said abutment surfaces having an axial dimension less than the axial dimension of said flanges.

4. An axial-flow compressor stator assembly as claimed in claim 1, wherein said intermediate reinforcing webs alternate with said main reinforcing webs.

5. An axial-flow compressor stator assembly comprising a stator casing having a relatively thin wall, a plurality of axially-spaced main internal reinforcing webs, each main web extending circumferentially around and projecting radially inwardly from the wall and each main web being formed with axially-spaced outwardly-facing abutment surfaces curved about the axis of said casing and being formed additionally with inwardly-facing surfaces curved about the axis of the casing to constitute portions of the outer wall of the working fluid passage through the stator casing, and a plurality of intermediate internal reinforcing webs, there being at least one intermediate web between each pair of said main webs, each said intermediate web extending circumferentially around and projecting radially inwardly from said wall and being formed with inwardly-facing abutment surface curved about the axis of said casing; and a plurality of stages of stator blading, each stage of stator blading comprising a plurality of blades supported and located in circumferential assembly by a pair of main webs and at least one intermediate web, the blades comprising axially and circumferentially extending root platforms arranged to provide with said inwardly-facing surfaces of said main webs a substantially smooth outer wall of the working fluid passage through the stator casing, said root platforms having each a pair of inwardly-facing abutment surfaces at its axially-spaced edges arranged to cooperate with said outwardly-facing abutment surfaces of adjacent main webs and said blade root platforms having each at least one outwardly-facing abutment surface to abut the inwardly-facing abutment surface of an intermediate web to maintain said main webs and said blade root platform in contact thereby to locate the blade against radial and rocking movement, the number of outwardly-facing abutment surfaces on each root platform corresponding to the number of intermediate webs between its associated pair of main webs.

6. An axial-flow compressor stator assembly as claimed in claim 5 in which said blade root platforms are formed each on the side remote from the blade with a circumferentially and radially extending rib having an axial dimension less than the axial dimension of the blade root platform and having at its radially outer end the outwardly-facing abutment surface arranged to abut the inwardly-facing abutment surface of an intermediate web between said adjacent main webs to maintain said main webs in contact with said blade root platform and thereby to locate the blade against radial and rocking movement.

7. An axial-flow compressor assembly as claimed in claim 5, wherein said subsidiary reinforcing webs alternate with said main internal reinforcing webs.

8. An axial-flow compressor stator assembly as claimed in claim 5, in which the main reinforcing webs are formed with axially and circumferentially extending flanges at their inward ends, said flanges being formed at their axially-spaced edges with the outwardly-facing abutment surfaces curved about the axis of said casing, said abutment surfaces having an axial dimension less than the axial dimension of said flanges.

9. An axial-flow compressor stator assembly as claimed in claim 8, wherein the pair of axially-spaced outwardly-facing abutment surfaces are constituted as circumferential recesses in the thickness of said flanges and wherein the pair of inwardly-facing axially-spaced abutment surfaces of said blade platforms are constituted as recesses in the thickness of said platforms whereby when the blade is mounted in the casing the surface of the platform facing towards the axis of the casing forms with the inwardly-facing surfaces of the adjacent main webs a substantially smooth outer wall of the working fluid passage through the stator casing.

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