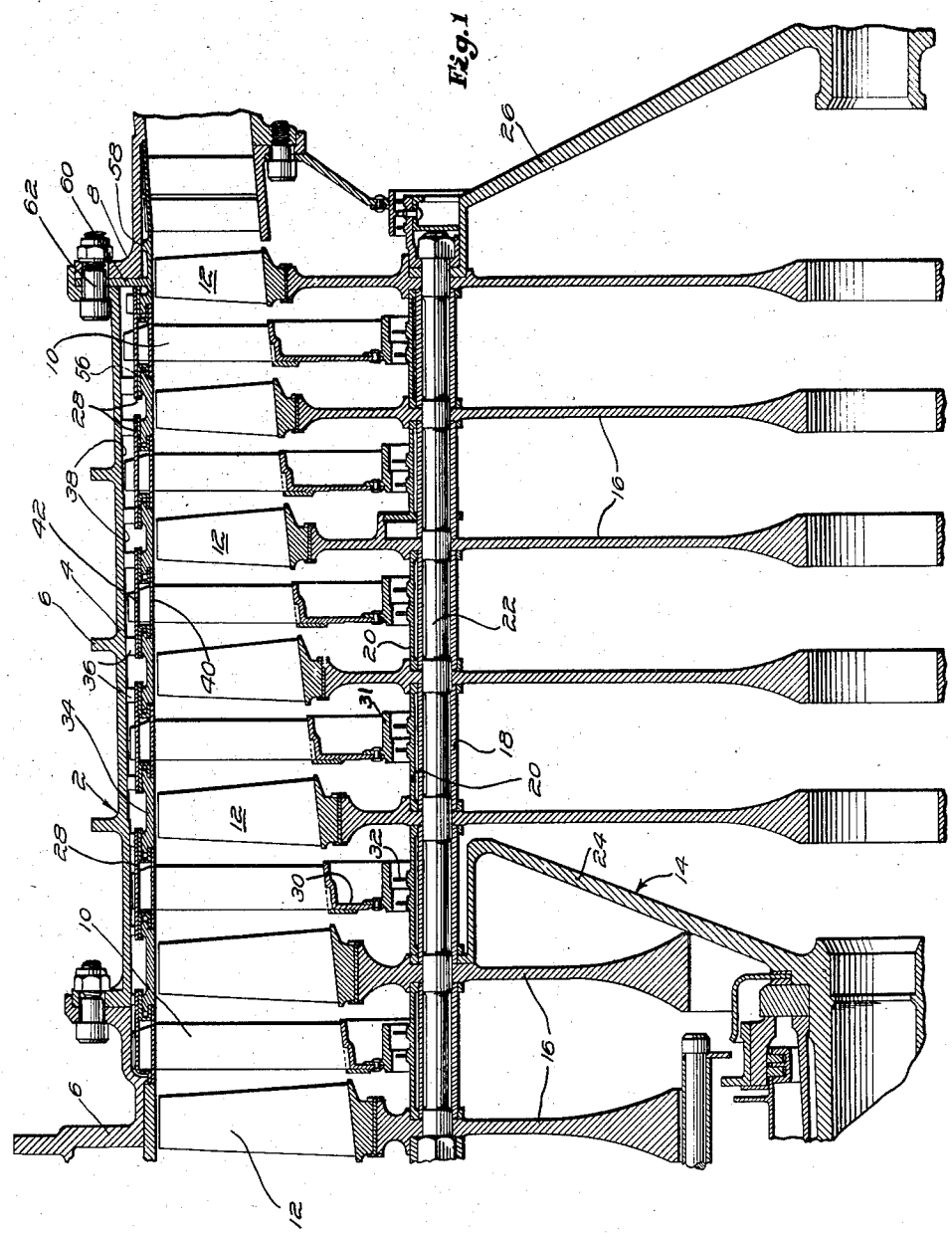
May 12, 1959 B. H. SHINN 2,885,768

STATOR CONSTRUCTION FOR COMPRESSORS

Original Filed Feb. 27, 1951 2 Sheets-Sheet 1

Fig. 1



Inventor
Byron H. Shinn
by Charles Warren
Attorney

May 12, 1959 B. H. SHINN 2,885,768

STATOR CONSTRUCTION FOR COMPRESSORS

Original Filed Feb. 27, 1951 2 Sheets-Sheet 2

Fig. 2.

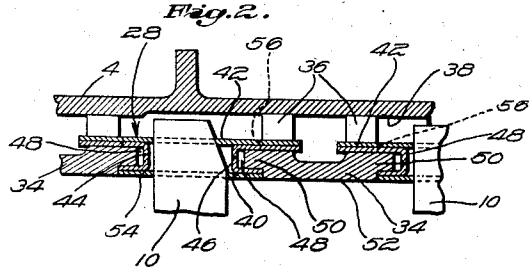


Fig. 3.

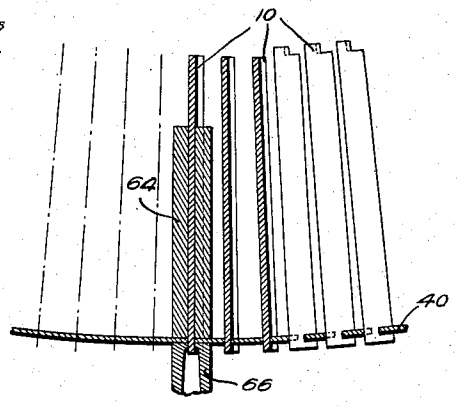


Fig. 4.

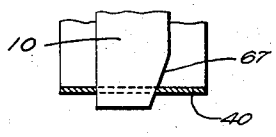


Fig. 5.

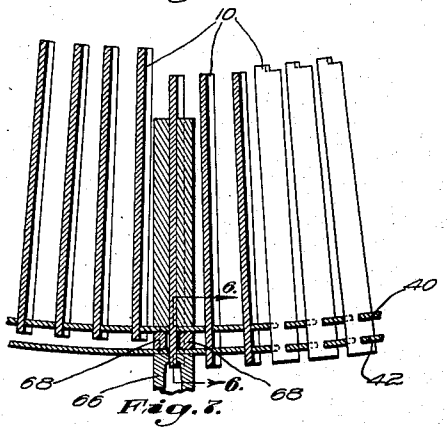


Fig. 6.

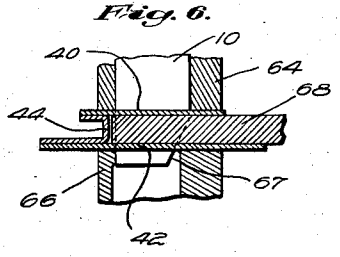


Fig. 7.

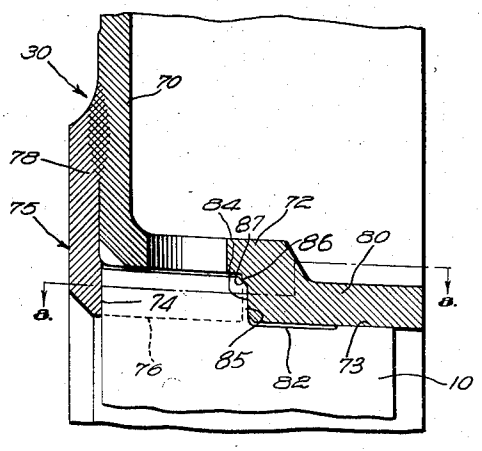
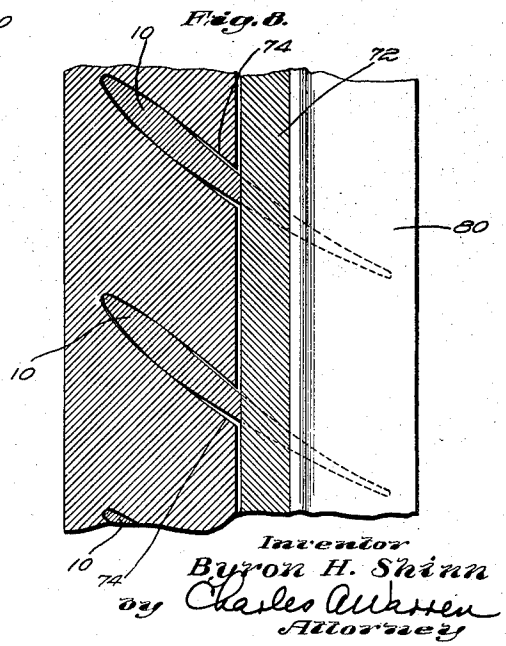


Fig. 8.



Inventor
Byron H. Shinn
by Charles Allen Warren
Attorney

United States Patent Office 2,885,768
Patented May 12, 1959

2,885,768

STATOR CONSTRUCTION FOR COMPRESSORS

Byron H. Shinn, Bolton, Conn., assignor to United Aircraft Corporation, East Hartford, Conn., a corporation of Delaware

Original application Serial No. 212,974, February 27, 1951. Divided and this application February 26, 1953, Serial No. 339,089

7 Claims. (Cl. 29—156.4)

The present invention relates to axial flow compressors and particularly to an arrangement for supporting the stator vanes in position. This application is a division of application Serial No. 212,974, filed February 27, 1951, now Patent No. 2,749,026, for Stator Construction For Compressors.

It has been customary to provide openings through the supporting shroud for the vanes in which the vanes are positioned in assembly. Such openings are frequently provided by a punching operation. For a secure fit of the vane within the opening in the shroud it is necessary that the punch conform almost exactly to the shape of the vane. Even then, however, the tolerances and variations in shape of both punch and vane may result in openings which will not receive the vane, or which will not securely hold the vane without some looseness. A feature of this invention is the perforation of the shroud by the use of the vane itself as the punch. The vane remains in position after the punching operation such that the resulting opening in the supporting shroud must of necessity conform exactly to the shape of the vane.

Where the shroud is box-shaped, as above mentioned, alignment of the pre-punched vane receiving openings in the inner and outer rings of the shroud presents a problem since a slight misalignment of the openings would result in serious misalignment of the inner ends of the vanes. A further feature of the invention is the elimination of the alignment problems by the punching and assembly of the vanes and shrouds in a single operation.

Other objects and advantages will be apparent from the specification and claims, and from the accompanying drawings which illustrate an embodiment of the invention.

Fig. 1 is a longitudinal sectional view through a multistage axial flow compressor with the vanes held by a box-type shroud.

Fig. 2 is a fragmentary sectional view on a larger scale showing the supporting shroud for one row of vanes and the adjacent spacer ring.

Fig. 3 is a fragmentary sectional view showing a part of the shroud ring with some of the vanes partially assembled.

Fig. 4 is a fragmentary sectional view at right angles to Fig. 3.

Fig. 5 is a view similar to Fig. 3, showing a further step.

Fig. 6 is a fragmentary sectional view similar to Fig. 4 with the outer shroud ring assembled.

Fig. 7 is a fragmentary sectional view on a larger scale than Fig. 1, showing the diaphragm construction.

Fig. 8 is a fragmentary sectional view along line 8—8 of Fig. 7.

With reference first to Fig. 1 the invention is shown in a multistage axial flow compressor in which a housing 2 is made up of a central substantially cylindrical element 4 having stiffening ribs 6 thereon and end rings 6 and 8 bolted to the central element. The housing

supports rows of axially spaced stator vanes 10 projecting inwardly from the housing and alternating with rows of blades 12 on the rotor 14.

The rotor construction is not a part of the present invention. The particular rotor construction shown comprises a number of axially spaced discs 16 each having one row of blades 12 mounted on its periphery, the discs being spaced apart by suitable spacer tubes 18 arranged in a ring around the axis of the rotor. A surrounding cylinder 20 overlies the ring of spacer tubes as shown. A number of through bolts 22 extending through the series of discs and through the spacer tubes from one end of the rotor to the other secure the discs together in predetermined spaced relation and also secure the end bells 24 and 26 which support the rotor in bearings, not shown.

Each of the rows of vanes 10 is supported at its outer end by a box shroud 28 and carries at its inner end a diaphragm 30, the inner end of which supports a sleeve 31 cooperating with sealing fins 32 on the outer surfaces of the cylinders 20 on the rotor. The box shrouds of successive vane rows are spaced apart by spacers 34 which function not only to hold the box shrouds in predetermined spaced axial relation to each other but also have projecting lugs 36 which pilot the spacer rings and box shrouds within the outer housing. It will be noted that the element 4 of the outer housing has its inner surface formed as a succession of stepped cylindrical surfaces 38 gradually increasing in diameter toward one end of the housing to provide for assembly of the housing over a built up assembly of stator rings and spacers.

As best shown in Fig. 2 each box shroud is made up of an inner substantially flat ring 40 and an outer similar flat ring 42 through both of which the vanes 10 extend. The rings are spaced apart radially and are held in predetermined spaced relation by spacers 44 and 46 welded or otherwise securely attached to the opposite edges of the rings 40 and 42. The spacers 44 and 46 are preferably U-shaped, as indicated, to provide laterally open grooves 48 to receive cooperating tongues 50 on the spacer rings 34.

Each of the spacer rings 34 has an inner surface 52 so spaced in reference to the tongues 50 that when the spacer rings and box shrouds are assembled the surface 52 on the spacer ring will form a continuation of the inner surfaces 54 of the adjacent box shrouds to provide a smooth surface for the flow of the fluid being compressed.

The outer ring 42 and the adjacent portion of the spacers 44 and 46 are notched as at 56 to receive the projecting lugs 36 on the spacer rings thereby holding the box shrouds and spacer rings against relative rotation. It will be apparent that the lugs 36 are so dimensioned that they will provide a close fit with the cooperating cylindrical surface 38 of the outer housing thereby functioning to pilot the spacer rings and also the box shrouds accurately within the housing. It may be noted in connection with Fig. 1 that the endmost spacer ring 58 has a projecting radial flange 60 which is engaged by the same bolts 62 that hold the main element 4 and end section 8 of the outer housing together thereby supporting this spacer ring in such a manner that it cannot rotate.

In the assembly of the stator vanes in the box shroud the entire row of vanes are first punched through the inner ring 40, as best shown in Fig. 4. In performing this punching operation the outer end of the blade itself acts as the punch and the device is so set up that a suitable clamp 64 engages each blade and drives it through the ring 40, the latter being backed up by a die 66 of conventional construction. It may be advantage-

ous to cut back the trailing edge of the vane as shown at 67, to improve the punching action.

The vanes having been punched through the inner ring 40, one of the spacers 44 or 46 is attached to the ring 40 and the outer ring 42 is attached to the spacer thereby leaving the opposite edges of the rings 40 and 42 open to permit the insertion of fingers 68 which space the inner and outer rings and also support the inner ring while each vane is being forced through the outer ring 42. Obviously during the punching of the outer ring the latter is backed up by a die such as the die 66 or a similar die which will support the material of the ring while the vane is forced through it. The row of vanes having been punched through the outer ring the other spacer 46 is secured in position and the outer shroud ring assembly with the vanes is completed.

With this arrangement, the holes in the rings 40 and 42 are inevitably in precise radial alignment and of necessity accurately fit the vane, having been punched by the vane itself. Since the vanes remain in position in the shroud rings after the punching operation, they are securely held and supported by each of the inner and outer rings such that there is no looseness and the only deflection that will occur when the row of vanes is loaded is the deflection resulting from the load itself applied to the vanes rather than any deflection resulting from looseness between the parts.

At their inner ends, the vanes are supported in alignment with each other by the diaphragm 30 which, to permit ease of assembly over the inner ends of the vanes, is made up in two parts. One part 70 is in the form of a ring consisting of a disc or radial flange having at its outer periphery a cylindrical or axially projecting flange 72. This flange is offset at a point spaced from the disc by a dimension approximately half of the axial dimension of the vane to form a shoulder 85 engaging laterally with a radial surface 84 on the vane, as shown. The flange 72 also has an outer surface 73 engaging endwise with the vanes adjacent to their trailing edges (it will be understood that the row of vanes may be notched at their inner ends after assembly in the outer shroud to provide the precision surfaces engaged by surfaces 73 and 85). The second part 75 of the diaphragm consists of a cylindrical portion or ring 76 and a radial flange 78. The ring 76 has a row of notches 74, Fig. 8, corresponding approximately in shape to the upstream half of the compressor vanes and is fitted over the inner ends of the vanes as best shown in Fig. 8. The radial flange 78 abuts the surface of the radial flange on the part 70.

As shown, each vane 10 has a notch 82 which substantially corresponds in shape to the surface of the flange 72 and is engaged thereby in the assembly of the parts. The notch 82 is preferably cut back adjacent to the corner of the notch to provide two distinct surfaces for engagement respectively with the surfaces 73 and 85 on the flange 72. The vanes and the outer surface of the flange 72 have cooperating angled surfaces 86 and 87 to provide a wedging action when the parts 70 and 75 are assembled.

The second part 75 having been assembled in position it may be welded or otherwise secured to the disc 70. The inner end of radial flange 70 may have attached thereto a sleeve 31 which cooperates with the sealing fins 32.

The stator ring has been described with the sleeves and spacers for the outer shroud forming, when welded together, a shoud ring segment which is a circumferentially unsplit part. It will be understood that the same part may be made up of two or more ring segments each forming only a part of a complete circle but together forming a complete shroud ring.

In the assembly of the compressor, it has been found desirous in certain instances to assemble the rotor as a complete unit prior to its assembly within the stationary parts of the compressor. In this event, it is necessary that the stator vane rings be split for positioning over the rotor, and with the stator construction above described, it has been found desirable to split the stator rings after the complete assembly of the stator vanes in the box shrouds in order to maintain concentricity. Thus in assembly of the compressor the rotor is supported with its axis vertical and with the downstream end of the rotor at the bottom. The split halves of the stator rings are then placed successively in position. The spacer rings 34 are not split and function to hold the stator rings in predetermined relation around the rotor in such a manner that the entire series of stator vanes and box shrouds with the alternating spacer rings may be assembled around the rotor before the outer housing is placed in position. Subsequently the housing is placed in position and the several parts fastened together.

It is to be understood that the invention is not limited to the specific embodiment herein illustrated and described, but may be used in other ways without departure from its spirit as defined by the following claims.

I claim:

1. In the assembly of stator vanes in a supporting shroud, each vane being of substantially constant cross-sectional shape and dimension for the length received in the shroud, the shroud consisting of inner and outer members in overlapping spaced relation, and spacer means secured to said members for holding said members in fixed spaced relation, the steps of driving each vane through the spaced members to remove a section of shroud material to form the openings which receive the vane, supporting the members in said spaced relation while the vanes are punched through the second of the two shrouds, and leaving each vane in the members.

2. In the assembly of stator vanes in an outer supporting shroud, each vane being of substantially constant cross-sectional shape and dimension for the length received in the shroud, the shroud consisting of inner and outer members in overlapping spaced relation, and spacer means secured to said members for holding said members in fixed spaced relation, the steps of driving each vane through the spaced members to form the openings which receive the vane, supporting the members in said spaced relation while the vanes are punched through the second of the two shrouds, leaving each vane in the members and subsequently securing the inner ends of the vanes together.

3. In the assembly of stator vanes in the outer supporting shroud, each vane being of substantially constant cross-sectional shape and dimension for the length received in the shroud, the shroud comprising inner and outer ring members in spaced concentric relation to each other, the steps of driving each vane successively through the inner and outer members such that each vane forms the openings which receive the vane, supporting the members in said spaced relation while the vanes are punched through the second of the two shrouds, leaving each vane in the members, securing the members together to prevent relative axial movement and subsequently securing the inner ends of the vanes together.

4. In the assembly of a number of closely spaced stator vanes in a substantially cylindrical supporting shroud, the cross-sectional shape and dimension of each vane being substantially constant for the portion of the vane received in the shroud, said shroud comprising inner and outer cylindrical members in overlapping and radially spaced relation to each other, with the vanes extending in a radial direction with respect to the shroud, the steps of driving each vane successively through one of said members such that the vane ends will punch through said one of said members and project beyond the surface of said one of said members, subsequently supporting the members in predetermined spaced relation to each other and driving each vane successively in a radial direction through the other of said members

while said members are supported in spaced relation such that the vane end will punch through the other of said members and project beyond the surface of said other of said members in the direction of the punching, and leaving each vane in the openings thus formed in the inner and outer members.

5. In the assembly of a number of closely spaced stator vanes in a substantially cylindrical supporting shroud the cross-sectional shape and dimension of each vane being substantially constant for the portion of the vane received in the shroud, said shroud comprising inner and outer cylindrical members in overlapping and radially spaced relation to each other, with the vanes extending in a radial direction with respect to the shroud, the steps of driving each vane successively through one of said members such that the vane ends will punch though said one of said members and project beyond the surface of said one of said members, subsequently supporting the members in predetermined spaced relation to each other and driving each vane successively in a radial direction through the other of said members while said members are supported in spaced relation such that the vane end will punch through the other of said members and project beyond the surface of said other of said members in the direction of the punching, leaving each vane in the openings thus formed in the inner and outer members and subsequently securing the inner ends of the vanes together.

6. In the assembly of a number of closely spaced stator vanes in a substantially cylindrical supporting shroud the cross-sectional shape and dimension of each vane being substantially constant for the portion of the vane received in the shroud, said shroud comprising inner and outer cylindrical members in overlapping and radially spaced relation to each other, with the vanes extending in a radial direction with respect to the shroud, the steps of punching an end of each vane through one of the members, supporting the members in predetermined spaced radial relation and punching the same end of each vane through the other member, said vane at the same time moving radially through said first member, leaving said vanes in said shroud members and securing said members in fixed spaced relation to prevent relative axial movement.

7. In the assembly of a number of closely spaced stator vanes in a substantially cylindrical supporting shroud the cross-sectional shape and dimension of each vane being substantially constant for the portion of the vane received in the shroud, said shroud comprising inner and outer cylindrical members in overlapping and radially spaced relation to each other, with the vanes extending in a radial direction with respect to the shroud, the steps of punching an end of each vane through one of the members, supporting the members in predetermined spaced radial relation and punching the same end of each vane through the other member, said vane at the same time moving radially through said first member, leaving said vanes in said shroud members and securing said members in fixed spaced relation to prevent relative axial movement and subsequently connecting the other ends of the vanes together.

References Cited in the file of this patent

UNITED STATES PATENTS

1,158,755	Weaver	Nov. 2, 1915
2,120,711	Phillips	June 14, 1938
2,278,040	Allen	Mar. 31, 1942
2,505,820	Zeidler	May 2, 1950
2,593,506	Wales	Apr. 22, 1952
2,640,319	Wislicenus	June 2, 1953
2,658,719	Johanson	Nov. 10, 1953
2,663,270	Friedly	Dec. 22, 1953
2,722,048	Gier	Nov. 1, 1955