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DIAPHRAGM APPARATUS

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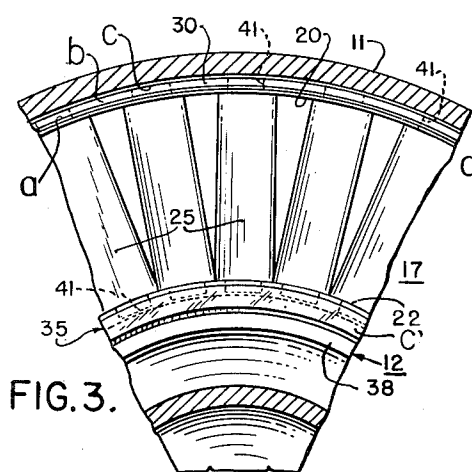
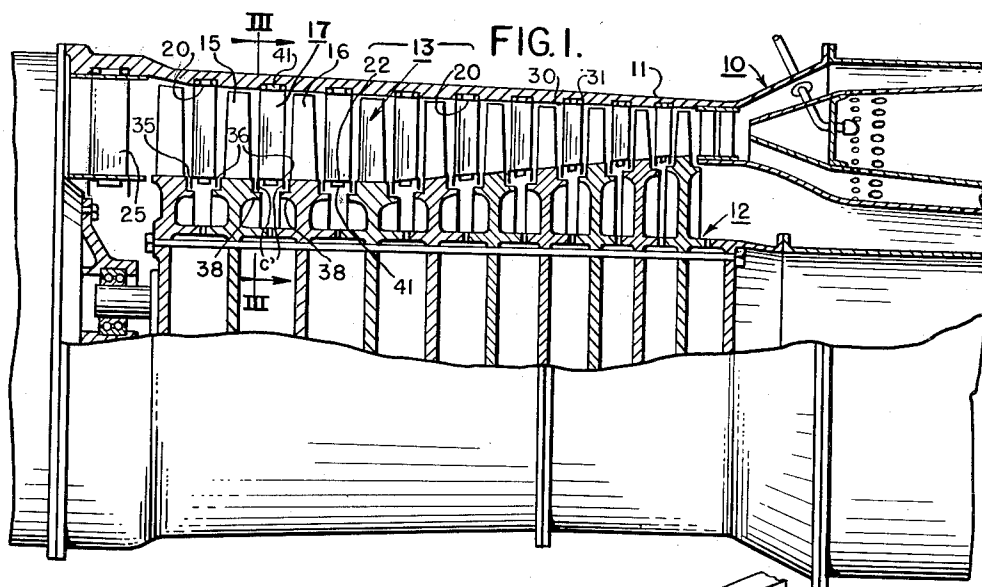


FIG. 3.

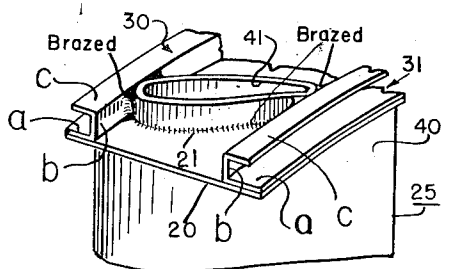


FIG. 4.

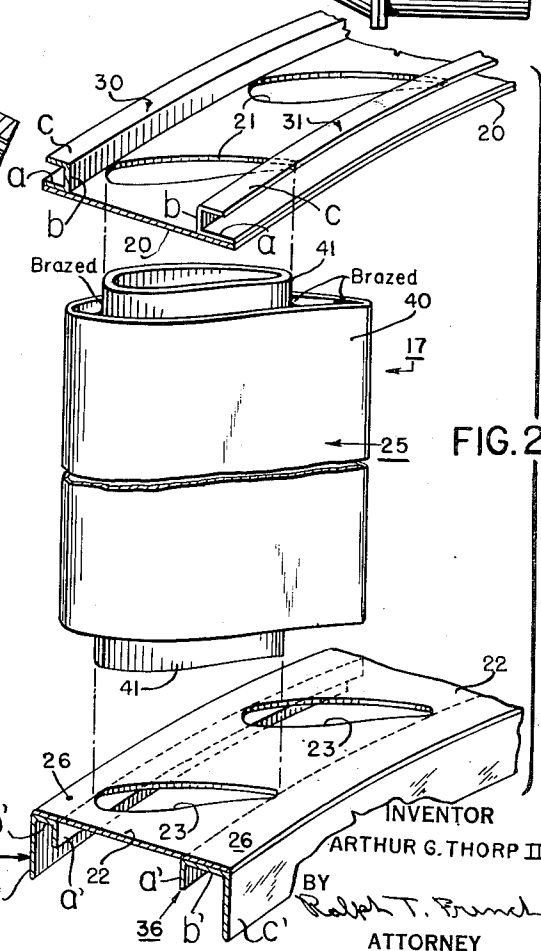


FIG. 2.

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5 Claims. (Cl. 253—78)

This invention relates to axial fluid flow rotary apparatus such as compressors, and more particularly to an axial flow compressor of the type employed in a gas turbine power plant.

One object of the invention is the provision of improved stationary diaphragm blade structure for apparatus of the foregoing class.

It has been proposed to construct aviation compressor diaphragms having cast or rolled solid vane sections, solid outer shrouds approximately one-eighth of an inch in thickness, and inner shrouds of similar weight with welded seal strips, or channel type inner shrouds rolled from material of about .049 inch thickness. It is recognized that much weight, as well as expense, might be saved by replacing such solid sections with sheet metal parts. Accordingly, another object of the invention is the provision of a compressor diaphragm constructed from sheet metal components.

Another object of the invention is the provision of an improved diaphragm assembly comprising hollow vanes and outer and inner shrouds formed of sheet metal.

It is a further object to provide a lightweight stationary diaphragm assembly in which radially arranged vanes having end portions are fitted into apertures formed in outer and inner sheet metal shrouds, the end portions of the vanes being brazed to adjacent surfaces of the respective shrouds and to channel strips carried thereby for affording adequate rigidity to the assembly.

Another object of the invention is to provide a diaphragm assembly of the foregoing type which may readily be constructed as an integral annular unit or in two or more arcuate segments, as desired.

It is also an object to provide an improved hollow vane unit comprising a sheet metal outer body wrapper having an airfoil shape and containing a central tubular core which projects from opposite open ends of the body wrapper.

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

Fig. 1 is a fragmentary longitudinal view, partly in section, of the compressor of a typical aviation gas turbine power plant, and embodying diaphragm assemblies constructed in accordance with the invention;

Fig. 2 is a fragmentary perspective view, enlarged in detail, showing the outer and inner shrouds and one of the vanes of a diaphragm structure embodying the invention as shown in Fig. 1;

Fig. 3 is a fragmentary, enlarged detail sectional view taken along the line III—III of Fig. 1; and

Fig. 4 is a fragmentary perspective view similar to Fig. 2 but showing the outer end of one of the vanes secured to the outer shroud component of the diaphragm.

As shown in Fig. 1, a gas turbine power plant, generally indicated at 10, may comprise a cylindrical casing structure 11 having journaled therein the rotor 12 of an axial flow compressor 13. The compressor rotor 12 com-

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prises a number of axially spaced stage rows of radially disposed rotary blades, including those indicated at 15 and 16. Suspended between the stages of rotary blades from the casing structure 11 are stationary diaphragm structures, including a diaphragm structure 17 which is selected for detailed illustration as representative of the others. Each diaphragm structure such as the diaphragm structure 17 may be formed as a complete annulus, or assembled from two semi-circular halves or a number of segmental portions. Generally, such a diaphragm structure may most conveniently be made in the form of two halves, the outer shroud portions thereof being secured in a suitable groove or recess in the casing structure 11.

According to the invention, as best shown in "exploded" form in Fig. 2 of the drawing, the diaphragm structure 17 comprises an outer arcuate sheet metal shroud strip or element 20 having circumferentially spaced slots 21, a concentrically disposed inner element or shroud strip 22 of sheet metal having corresponding slots 23, and a plurality of radially disposed vane units 25 mounted between the outer and inner shroud strips. It will be understood that the slots 21 and 23 are canted in the usual manner in accordance with the angle at which the vanes are set. Marginal areas, such as those indicated at 26 on the inner shroud strip 22, are formed laterally of the respective slots in both shroud strips. A pair of sheet metal reinforcing flange members or channel elements 30 and 31, having a substantially U-shaped cross-section with parallel sides *a* and *c*, joined by an intermediate wall *b*, are secured, as by seam welding or brazing, to the marginal surfaces of the outer shroud strip 20 outwardly of the slots 21. One side of each channel element engages the shroud strip 20, so that the end walls *b* of these channel elements are disposed normal to the outer shroud strip surface. Similarly, the marginal areas 26 of the inner shroud strip 22 are adapted to have brazed or secured thereto the intermediate walls *b'* of a pair of sheet metal channel elements 35 and 36. The innermost sides *a'* of these channel elements, respectively, are thus disposed normal to the inner shroud strip 23 and adjacent the opposite ends of the slots 23. The outer sides *c'* are elongated to constitute annular seal portions adapted to cooperate in the usual manner with annular shoulders 38 of the compressor rotor assembly, as shown in Fig. 1.

Further, in accordance with the invention, each of the vane units 25 comprises an outer airfoil envelope or wrapper 40 preferably formed of sheet metal, and an inner elongated central core element 41, the ends of which project beyond the edges of the wrapper. The core element 41 may be formed from seamless steel tubing, and the airfoil wrapper 40 may be attached thereto by brazing. The end of the core element 41 adjacent the outer shroud strip projects beyond the end of the wrapper 40 a sufficient distance to extend through the aligned slot 21 to an extent corresponding to the elevation of the walls *b* of channel elements 30 and 31. The opposite end of the core element 41 is likewise adapted to extend through a corresponding slot 23 in the inner shroud strip, and is engageable with inner sides *a'* of the channel elements 35 and 36.

The vane units 25 are firmly secured in place by brazing the ends thereof to both the apertured shroud strips and the channel elements. It is a feature of the invention to join the vanes to the reinforcing channel elements or flanges of the shrouds, in order to ensure with standing of the bending moment of the vanes without excessive deformation of the shrouds. By means of this construction of the diaphragm assembly, appreciable savings in weight of the compressor components may be effected. The improved diaphragm is readily adapted to construction in accordance with approved mass production tech-

niques, to afford economies in manufacture not always available with designs heretofore proposed. The improved construction may be employed in production of semi-circular diaphragm units, full ring diaphragms for stacked compressor assemblies, or multiple segments diaphragm units. The combination of shroud strips and channel elements may also be associated with solid vanes, as in construction of relatively small diaphragms.

While the invention has been shown in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof.

What I claim is:

1. In annular diaphragm structure, a shroud strip having circumferentially spaced slots formed between marginal portions thereof, a pair of channel elements secured in parallel relation to said marginal portions on the same face of said shroud strip, the innermost walls of said channel elements relative to the edges of the shroud strip being spaced apart and extending from the shroud strip in planes which are normal to the axis of the diaphragm structure and are adjacent corresponding ends of said slots, a plurality of radially disposed vanes having airfoil outer portions abutting said shroud strip, and core portions projecting from said airfoil outer portions of said vanes, each of said core portions extending through one of said slots to the same extent as that of said innermost walls of the channel elements, the juxtaposed surfaces of said shroud strip, channel elements and vanes being secured together.

2. Annular diaphragm structure of the class comprising outer circumferential shroud means, concentric inner shroud means, and a plurality of radial vanes mounted therebetween; said outer shroud means including a sheet metal strip element having circumferentially spaced slots formed intermediate parallel marginal portions thereof, a pair of spaced outer channel elements secured to the respective marginal portions of said strip element and having parallel surfaces extending outwardly normal to said strip element and adjacent the opposite ends of said slots; said inner shroud means including a sheet metal strip element having slots formed intermediate its marginal portions and spaced to correspond with the first-named slots, respectively, spaced channel elements secured to the marginal portions of the last-named strip element, said channel elements each having inner and outer parallel flange portions extending inwardly normal to the last-named strip element, said inner flanges having surfaces disposed adjacent the opposite ends of said inner shroud slots; and said vanes each including an inner core having opposite ends engaged in corresponding slots in the respective outer and inner shroud means and secured to the adjoining surfaces of said channel elements.

3. Annular diaphragm structure comprising a sheet metal outer shroud member having circumferentially spaced apertures, a pair of laterally spaced sheet metal flange members flanking said apertures in the outer shroud member, a sheet metal inner shroud member hav-

ing correspondingly spaced apertures, a pair of laterally spaced sheet metal flange members flanking the apertures in said inner shroud member, and a plurality of radially disposed vane units, each of said vane units including an outer sheet metal airfoil wrapper having ends abutting said outer and inner shroud members, respectively, and an inner tubular core having ends projecting beyond said wrapper, said ends of the core extending through corresponding apertures in said shroud members and being engaged with adjacent portions of the respective flange members carried thereby.

4. Annular diaphragm structure comprising an outer shroud strip formed of sheet metal and having circumferentially spaced apertures, a pair of laterally spaced circumferentially disposed reinforcing channel elements mounted on marginal portions of said outer shroud strip outwardly of said apertures, each of said channel elements having a substantially U-shaped cross section, with parallel sides and an end wall joining such sides, and being disposed with said end wall normal to said outer shroud strip; an inner shroud strip formed of sheet metal and having spaced apertures corresponding to the first-named apertures, a pair of U-shaped channel elements similar to the first-named channel elements having end walls secured to marginal portions of said inner shroud strip and parallel sides projecting radially inward relative to the diaphragm structure, and a plurality of radially disposed vane units each having a core portion projecting from one end into an aperture of said outer shroud strip and from the opposite end into an aperture of said inner shroud strip, said core portion of each vane being secured to engaging surfaces of the respective channel elements carried by said shroud strips for providing a rigid assembly.

5. Annular diaphragm structure comprising a sheet metal outer shroud member having circumferentially spaced apertures, a pair of laterally spaced sheet metal flange members flanking said apertures in the outer shroud member, a sheet metal inner shroud member having correspondingly spaced apertures, a pair of laterally spaced sheet metal flange members flanking the apertures in said inner shroud member, and a plurality of radially disposed tubular vanes, each of said vanes being formed of sheet metal and having opposite tubular end portions of reduced cross-sectional area, said end portions extending through corresponding apertures in said inner and outer shroud members and being engaged with and secured to adjacent portions of said shroud members and of the respective flange members carried thereby.

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