Oct. 22, 1963 L. E. VARADI ETAL 3,107,897

GAS TURBINE NOZZLE AND VANE ASSEMBLY

Filed Aug. 24, 1961

Fig 1

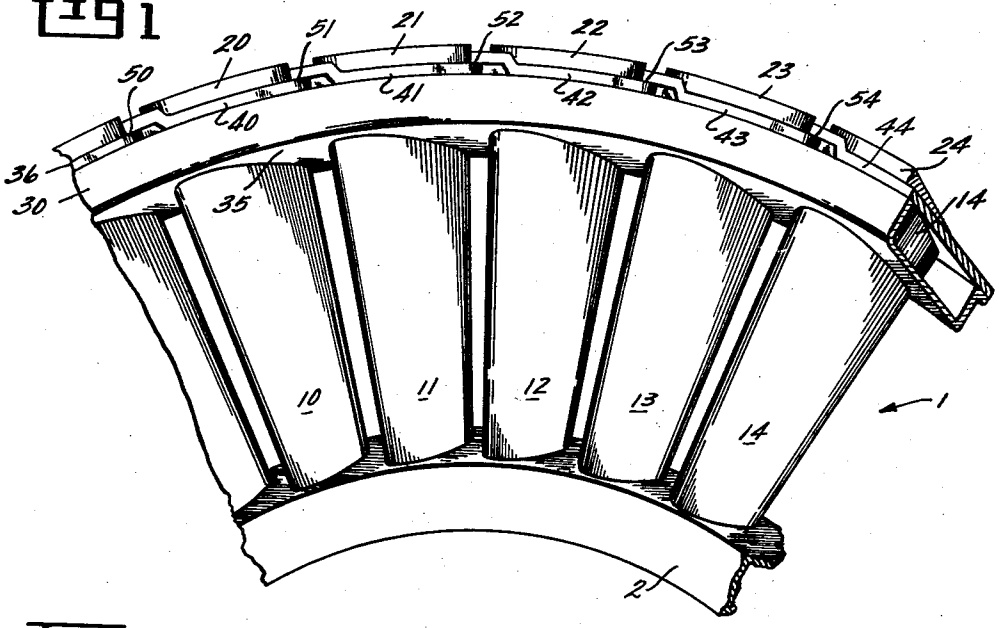


Fig 2

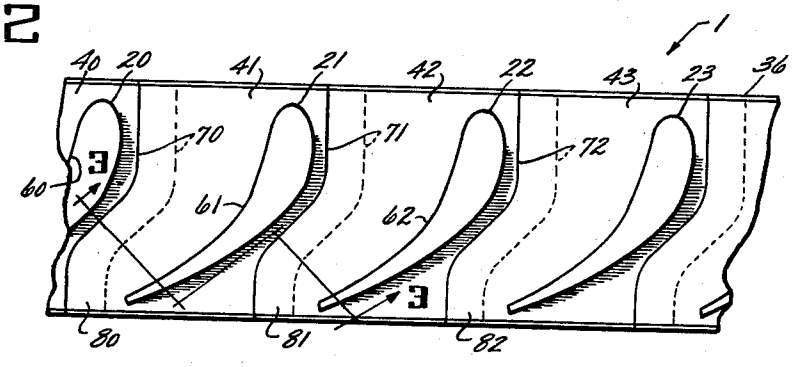
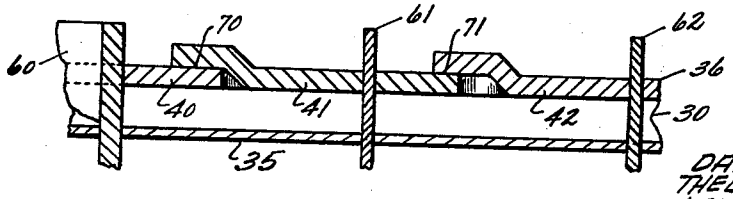


Fig 3



INVENTORS.
DANIEL M. JUDGE
THEODORE E. BOURQUE
LOUIS E. VARADI
BY- Lawrence G. Norris
ATTORNEY—

United States Patent Office 3,107,897
Patented Oct. 22, 1963

3,107,897

GAS TURBINE NOZZLE AND VANE ASSEMBLY

Louis E. Varadi, Danvers, Mass., Theodore E. Bourque, Norwalk, Conn., and Daniel M. Judge, Saugus, Mass., assignors to General Electric Company, a corporation of New York

Filed Aug. 24, 1961, Ser. No. 133,640
6 Claims. (Cl. 253—78)

Our invention relates to gas turbine engines and in particular to nozzle and vane assemblies, such as turbine diaphragm and compressor stator vane assemblies, for such engines.

As is well known to those skilled in the art, gas turbine engines typically include a number of nozzle and vane assemblies, such as turbine diaphragm and compressor stator vane assemblies, for directing the air and gas flow within the engine through the rotating compressor and turbine stages. In the axial flow type of engine, such assemblies are generally made up of a series of circumferentially spaced stator vanes or nozzle partitions extending radially between inner and outer shrouds which define an annular flow path through the engine.

In the case of the turbine diaphragm, it has been a relatively common practice in the design of such structures to form the outer shroud from two or more concentric bands such that in cross section the shroud has a rectangular box-like shape. In such designs both the inner and outer bands are provided with a series of profiled slots shaped to conform to the contour of the nozzle partitions and through which the nozzle partitions are inserted at assembly and then brazed or otherwise secured in place.

Now it will be appreciated that given a construction along the foregoing lines in which two concentric bands are provided with profiled slots which must be aligned at assembly to receive the radially extending nozzle partitions, the slots must either be contoured and positioned with a high degree of accuracy if the necessary alignment relationship is to be provided to receive and properly position the nozzle partitions, or if looser tolerances are allowed, then one set of slots must be made substantially oversize in order to allow the necessary relative freedom of movement for alignment purposes at assembly. The requirement for very close tolerances greatly increases the manufacturing expense involved and that approach is generally therefore not used. On the other hand, where the slots are made oversize, the portions of the slots not occupied by the nozzle partitions when the assembly is put together must be filled in with a suitable filler material once the assembly has been completed and the desired alignment relationship obtained. Because the amount of filler material which must be used in some cases becomes quite substantial, this approach has a tendency to adversely affect the structural rigidity and integrity of the assembly which would otherwise be available if the parent metals of the nozzle partitions and the band could be directly joined along the entire peripheries of the slots.

In view of the foregoing, it is accordingly one object of our invention to provide a new and improved nozzle and vane assembly for gas turbine engines which will facilitate low cost manufacture and at the same time provide a higher degree of structural rigidity than has hitherto been available.

It is another object of our invention to provide an improved nozzle and vane assembly for gas turbine engines which will permit maintaining critical alignment tolerances between the vanes and nozzles while at the same time permitting the use of low cost and relatively simple manufacturing techniques.

We accomplish these and other objects of our invention in one embodiment thereof as applied to a turbine diaphragm construction, in which the outer shroud is formed

of a pair of concentric bands, by forming the outer shroud band of a number of separate segments, each segment being adapted separately to receive one or more nozzle partitions through profiled slots formed in the segments. Upon assembly of the diaphragm, the outer shroud band segments may be moved circumferentially relative to each other into correct alignment. For reasons which will later be explained in greater detail, we prefer to provide for a circumferential overlap between the adjacent segments of the outer shroud band. One advantage of this approach is that the overlapped portions, when joined together, provide stiffening ribs in the outer band which contribute to the overall structural integrity of the assembly. The segmented outer band permits the profiled slots in the segments to be formed so as to very closely conform to the contour of the nozzle partitions, thereby greatly reducing the amount of filler material required and permitting the joint strength to approach that of the parent metals.

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which may be regarded as the invention, the organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings in which:

FIG. 1 is a fragmentary view of an annular diaphragm having use in an axial flow compressor or turbine assembly and embodying our invention;

FIG. 2 is a fragmentary view of the segmented outer band of the annular diaphragm;

FIG. 3 is a sectional view of the outer band of FIG. 2 along the line 3—3 of FIG. 2 showing one form of circumferentially joining the outer band segments with varying degrees of segment overlap therebetween.

Referring to the drawing, and particularly to FIG. 1, an annular diaphragm 1 is shown in fragmentary view having use in an axial flow compressor or turbine assembly not shown. The annular diaphragm 1 has an inner shroud 2 having a plurality of radially extending stator vanes such as those shown at 10–14. The stator vanes 10–14 are circumferentially positioned on the outer surface of the inner shroud 2. The stator vanes 10–14 have positioned thereon at a point adjacent the stator vane ends shown at 20–24 an outer shroud 30 which has an inner concentric band 35 and an outer concentric band 36. In accordance with the invention, the outer band 36 is formed by circumferentially joining a plurality of circumjacent outer band segments such as shown at 40–44 to each other to form an integral outer band structure 36. The inner band 35 is formed to a suitable configuration so as to form a generally rectangular cross section in association with the outer band 36. It will be noted that the outer band 36 is formed of outer band segments 40–44 which develop overlap areas such as those shown at 50–54 when circumferentially joined to each other to form the integral outer band 36.

As shown by FIG. 2, the individual outer band segments 40–42 have apertures 60–62 positioned through selective segments 40–42. The apertures 60–62 may be formed by any of several machining operations; for example, a punch operation or a cutting operation. The respective apertures 60–62 in the selected outer band segments 40–42 receive the stator vane ends 20–22 therethrough in a closely joining relationship since the apertures 60–62 have walls formed to critically conform to the contour of the vane ends 20–22 respectively received therein. The individual outer band segments 40–42 are circumferentially joined to each other by a brazing operation after they have been aligned circumferentially to correctly position the radially extending stator vanes 10–

14. The alignment may provide varying segment overlap 70–72 as more clearly shown by FIG. 3.

A cross-sectional view of the outer band 36 along the line 3—3 of FIG. 2 is shown by FIG. 3 where the segment overlaps 70—71 of the adjacent outer band segments 40–42 varies with the necessary alignment required prior to the brazing operation. In place of the segment overlap 70—71, the circumferentially positioned outer band segments 40–44 circumjacent to the inner band 35 may be joined by butt welding or by a secondary means such as rivets or bolts inserted through the adjacent outer band segments.

Another desirable advantage of the present invention is shown by FIG. 2 where the segment overlap 70–72 provides stiffening ribs 80–82 along a non-axial or serpentine line which generally follows the curvature of the vane ends 20–22 in cross section. Such stiffening ribs 80–82 provide a substantially more rigid outer band 36.

In accordance with the present invention, other forms of circumferentially segmenting the outer band 36 will be apparent to one skilled in the art. For example, the respective outer band segments 40–44 may have one or more apertures positioned therethrough to selectively receive the stator vane ends 20–24. Thus, it is not critical that a single outer band segment have a single aperture therethrough. Further, certain outer band segments may possibly be formed without apertures to provide spacer elements between related outer band segments which do have apertures therein. Similarly, the stiffening ribs 80–82 need not be along a serpentine line as shown since it is considered within the scope of the present invention to provide such stiffening ribs with any suitable contour as may be desired and believed necessary by one having skill in the art.

It will be observed from the foregoing that we have provided an improved diaphragm construction for axial flow turbines and compressors in which the outer shroud is to be formed of two or more concentric bands. Our construction allows the slots or apertures in the outer band to be formed to conform closely to the contour of the vanes or partitions, thereby providing for superior bonding of the vanes to the band segments, while at the same time allowing low cost manufacturing methods to be used without sacrificing alignment accuracy. In addition, our invention in its preferred form provides additional stiffening ribs on the outer band which even further enhance the structural integrity of the system.

As will be evidenced from the foregoing description, certain aspects of the invention are not limited to the particular details of construction illustrated, and it is contemplated that other modifications and applications will occur to those skilled in the art. It is, therefore, intended that the appended claims shall cover such modifications and applications that do not depart from the true spirit and scope of the invention.

Having described the invention, what is claimed is:

1. An annular diaphragm for use in an axial flow compressor or turbine assembly comprising in combination:
(*a*) an inner shroud,
(*b*) an outer shroud having an inner annular band and an outer annular band,
(*c*) a plurality of vanes radially extending from said inner shroud through said inner band,
(*d*) a plurality of segments circumjacent said inner band comprising said outer band,
(*e*) selected ones of said segments having at least one aperture therein,
(*f*) respective ones of said vanes being received in respective ones of said apertures, said segments thereby being circumferentially positioned relative to each other by said vanes,
(*g*) portions of each of said relatively positioned segments overlapping the adjacent segments,
(*h*) and means to circumferentially joint the overlapping portions of said relatively positioned segments to each other to integrally form the outer annular band.

2. An annular diaphragm for use in an axial flow compressor or turbine assembly comprising in combination:
(*a*) an inner shroud,
(*b*) an outer shroud having an inner annular band and an outer annular band,
(*c*) a plurality of vanes radially extending from said inner shroud through said inner band,
(*d*) a plurality of segments circumjacent said inner band comprising said outer band,
(*e*) selected ones of said segments having at least one aperture therein,
(*f*) respective ones of said vanes being received in respective ones of said apertures, said segments thereby being circumferentially positioned relative to each other by said vanes,
(*g*) portions of each of said relatively positioned segments overlapping the adjacent segments,
(*h*) and means to circumferentially join the overlapping portions of said relatively positioned segments to each other along a serpentine line to integrally form the outer annular band.

3. An annular diaphragm for use in an axial flow compressor or turbine assembly comprising in combination:
(*a*) an inner shroud,
(*b*) an outer shroud having an inner annular band and an outer annular band,
(*c*) said inner band having a plurality of apertures therein,
(*d*) a plurality of vanes radially extending from said inner shroud, each of said vanes extending through a respective one of said apertures in said inner band,
(*e*) a plurality of segments circumjacent said inner band comprising said outer band,
(*f*) selected ones of said segments having at least one aperture therein,
(*g*) respective ones of said vanes being received in respective ones of said apertures in said segments, said segments thereby being circumferentially positioned relative to each other by said vanes,
(*h*) portions of said relatively positioned segments overlapping the adjacent segments,
(*i*) and means to circumferentially join the overlapping portions of said relatively positioned segments to each other to integrally form the outer annular band.

4. An annular diaphragm for use in an axial flow compressor or turbine assembly comprising in combination:
(*a*) an inner shroud,
(*b*) an outer shroud having an inner annular band and an outer annular band,
(*c*) said inner band having a plurality of apertures therein,
(*d*) a plurality of vanes radially extending from said inner shroud, each of said vanes extending through a respective one of said apertures in said inner band,
(*e*) a plurality of segments circumjacent said inner band comprising said outer band,
(*f*) selected ones of said segments having at least one aperture therein,
(*g*) respective ones of said vanes being received in respective ones of said apertures in said segments, said segments thereby being circumferentially positioned relative to each other by said vanes,
(*h*) portions of said relatively positioned segments overlapping the adjacent segments,
(*i*) and means to circumferentially join the overlapping portions of said relatively positioned segments to each other along a serpentine line to integrally form the outer annular band.

5. An annular diaphragm for use in an axial flow compressor or turbine assembly comprising in combination:
(*a*) an inner shroud,

(*b*) an outer shroud comprising a first annular band and a second annular band concentric with and radially spaced from said first band,

(*c*) a plurality of vanes radially extending from said inner shroud through said outer shroud,

(*d*) a circumferential portion of said first band comprising a single arcuate member and having a plurality of apertures therethrough for receiving said vanes,

(*e*) a corresponding circumferential portion of said second band having a plurality of segments, selected ones of said segments each having an aperture therethrough shaped to conform to the contour of said vanes for receiving a corresponding one of said vanes, said segments thereby being circumferentially positioned relative to each other by said vanes and,

(*f*) means to circumferentially join the relatively positioned segments to each other to integrally form said second band.

6. An annular diaphragm as defined in claim 5 wherein said segments are joined along a serpentine line.

References Cited in the file of this patent

UNITED STATES PATENTS

875,644	Barth	Dec. 31, 1907
2,632,396	Koskinen	Mar. 24, 1953
2,632,397	Jandasek	Mar. 24, 1953
2,685,405	Stalker	Aug. 3, 1954
2,741,455	Hunter	Apr. 10, 1956
2,834,573	Stalker	May 13, 1958
2,894,681	Lunde et al.	July 14, 1959
2,935,297	Stalker	May 3, 1960
2,937,805	Warnken	May 24, 1960
2,945,673	Hockert	July 19, 1960
2,963,272	Welsh	Dec. 6, 1960
2,980,396	Movsesian	Apr. 18, 1961
2,996,281	Creek	Aug. 15, 1961

FOREIGN PATENTS

12,347	Great Britain	1901