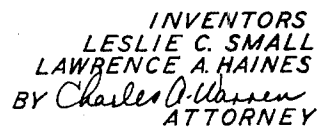


L. C. SMALL, JR., ET AL

STATOR CONSTRUCTION

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2,932,485

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2 Sheets-Sheet 2

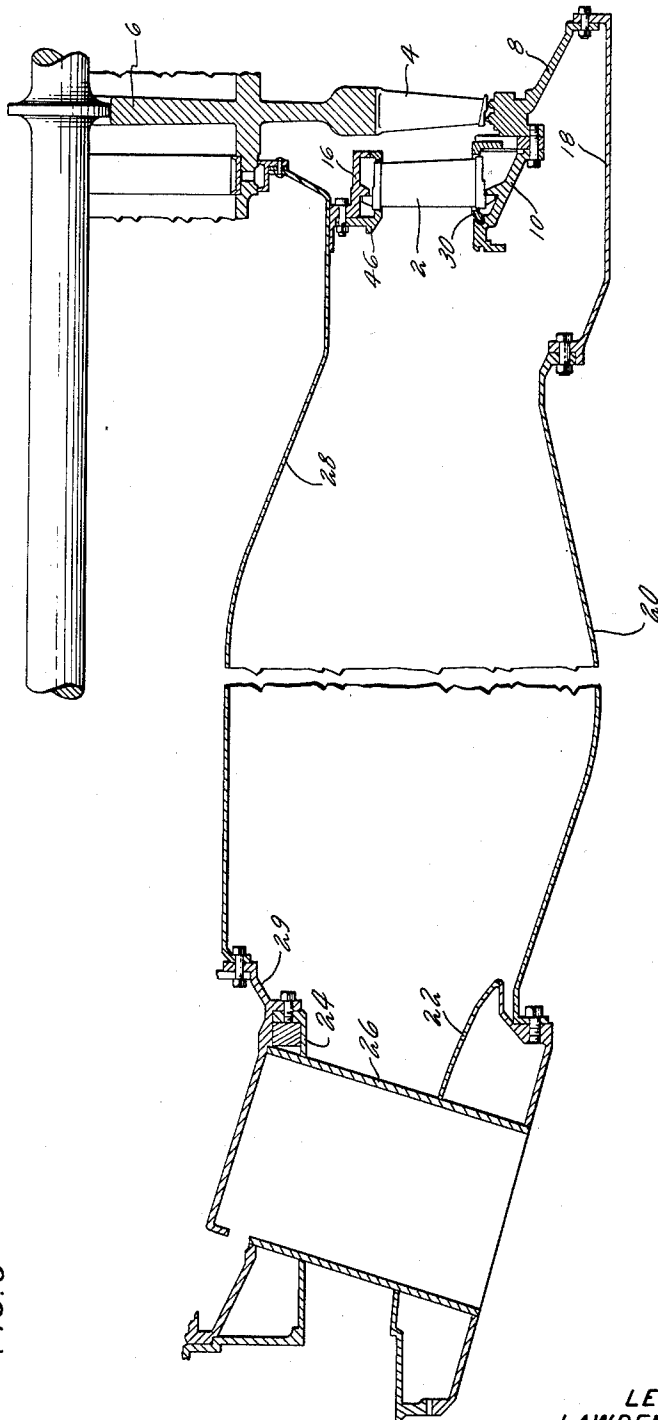


FIG. 3

INVENTORS
LESLIE C. SMALL
LAWRENCE A. HAINES
BY *Charles D. Warren*
ATTORNEY

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STATOR CONSTRUCTION

Leslie C. Small, Jr., South Glastonbury, and Lawrence A. Haines, Hartford, Conn., assignors to United Aircraft Corporation, East Hartford, Conn., a corporation of Delaware

Application October 1, 1954, Serial No. 459,639

10 Claims. (Cl. 253—78)

This invention relates to nozzle vanes for a turbine and particularly to the mounting of the vanes in a supporting structure.

The nozzles have been supported in inner and outer shroud rings which have openings to receive the vanes and which carry both the axial thrust on the vanes due to the pressure drop through the nozzle and also the circumferential thrust from the torque applied to the vanes. The loading of the shroud rings has been found to be so high, especially at the operating temperatures of the nozzles vanes and shroud rings, that the shrouds have been subject to severe cracking, frequently to such an extent as to cause failure. A feature of the invention is an arrangement by which to relieve the shroud rings of a substantial part of the load acting on these rings.

Another feature is the transfer of the thrust loading on the vanes directly from the vanes to a support structure without transmitting this thrust through the shrouds. One feature of the invention is an arrangement by which to permit expansion and contraction of the shroud without affecting the nozzle vanes and without interfering with the device by which the thrust loading on the vanes is absorbed.

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 turbine.

Fig. 2 is a fragmentary sectional view substantially on the line 2—2 of Fig. 1.

Fig. 3 is a longitudinal sectional view through a part of a turbine engine.

The invention is shown in conjunction with a turbine having nozzle vanes 2 directly upstream of a row of turbine blades 4 carried by a rotor 6. The rotor is supported centrally of a casing 8 by suitable bearings supported from the casing, as shown, for example, in the Willgoos Patent 2,639,579. The casing 8 is made up of support rings 10 and 12 attached together in axial alignment as by bolts 14 and these rings carry the outer ends of the turbine vanes. The support ring 10 is shown as providing support for the outer ends of the row of vanes 2. The inner ends of the vanes 2 are supported by an inner ring 16.

The rings 10 and 16 are so mounted that they are held in concentric relation with respect to each other and are prevented from moving axially with respect to each other. This may be done, for example, by the attachment of the outer casing 8 to a surrounding supporting ring 18 which in turn is secured to the outer annular wall 20 of the combustion chamber of the engine. The wall 20 at its forward end is connected to the outer wall 22 of the diffuser section into which a compressor, not shown, discharges. The inner wall 24 of the diffuser is held in predetermined relation to the outer wall by radial struts 26.

The inner casing ring 16 is attached to a sleeve 28 forming the inner wall of the combustion chamber and extending forwardly for attachment to the inner wall 24 of the diffuser as by a ring 29. With this arrangement it

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will be clear that the rings 10 and 16 are supported so that they are held in predetermined radial and axial relation to each other and can have axial loads applied thereto without detrimentally affecting the arrangement of the parts.

Associated with the outer casing ring 10 is a shroud ring 30 having openings 32 therein through which the outer ends of the vanes 2 extend. As shown each vane has an enlarged head 34 at the outer end which fits within the opening 32 and the latter is made large enough so that the vane can move freely therein, permitting the vane to move radially with respect to the shroud ring.

Any axial pressure loads applied to the vane 2 are transmitted through projecting lugs 36 on each vane which engage with an inwardly extending rib 38 on the casing ring 10. As shown, the radial dimensions of the rib and lugs are such that radial movement of the vane is not interfered with. That is to say, there is radial clearance provided between the casing rib and the vane and between the lug and the casing. The rib 38 may be continuous or may be interrupted to form a plurality of projecting lugs with which the vane lugs engage.

As shown, the cooperating surfaces on the rib 38 and lugs 36 are in a plane substantially at right angles to the axis of the nozzle such that relative circumferential movement of any of the lugs with respect to rib 36 is permissible except as the circumferential movement of each vane is limited by the shroud ring. That is to say, the axial load only is transmitted directly from the vane through the lugs 36 to the casing and the circumferential loading on the vane is through the shroud to the casing thereby relieving the shroud of any axial loads.

The shroud ring 30 has a number of radially extending projections 40 at its downstream edge which fit within radially extending grooves 42 in a ring 44 attached to the casing 10 by the bolts above mentioned. With this arrangement the shroud ring is prevented from turning within the casing ring but is free to move radially so that thermal expansion of the shroud ring with respect to the casing ring 10 is not restricted. It will be apparent that the essential contact between the shroud ring and the outer supporting structure is the interengagement of the projections 40 with the ring 44 and the radial overlapping of the ring 44 with the shroud, as shown at 45, Fig. 2, by which to limit rearward axial movement of the shroud ring. This overlap, which results from the tongues 43 defined between the grooves 42 extending radially inward beyond the outer surface 35 of the ring 30, is best shown in Fig. 2. The forward axial movement of the shroud ring 34 is limited by engagement of the forward edge of the ring in a notch 47 in the casing ring 10. It will be apparent that the outer end of each vane 2 is free to move in a circumferential direction except as limited by slot 32 so that the torque loading on the vanes is transmitted directly to the shroud ring. Nevertheless, a substantial part of the load, that is to say, the axial thrust loading on the vanes, is not imparted in any way to the shroud ring but is transferred directly from the vane to the casing ring. The upstream end of the shroud may be positioned in a notch 45 in casing ring 10 but not in contact with the ring as shown.

A similar arrangement is utilized at the inner ends of the vane 2. In this arrangement the inner casing ring 16 carries, in spaced relation thereto, a shroud ring 46 having openings 48 to receive the enlarged inner ends 50 of the vanes 2. Because the thermal expansion problem is not as severe at the inner ends of the vanes the upstream end of the shroud ring 46 may be bolted directly to the casing ring 16 without providing for relative thermal expansion. As at the outer ends of the vanes, each vane has a projecting lug 52 which engages with a circumferential rib 54 on the casing ring 16 so that the

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axial thrust loading on each vane is transmitted directly to the ring 16 without being transferred through the shroud ring. It will be understood that the lugs 36 extend outwardly from the outer vane end whereas the lugs 52 extend inwardly from the inner vane end. Also as at the outer ends of the vanes the torque loading on each vane is transmitted to the shroud ring since the circumferential movement of the vanes is limited only by the opening in the shroud ring through which the vanes extend.

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.

We claim:

1. In a turbine nozzle construction, a casing ring, a shroud ring attached to and having a portion thereof spaced radially from said casing ring, a row of vanes extending radially from said shroud ring, said shroud ring having a row of openings in said radially spaced portion receiving the ends of said vanes slidably therein, and interengaging cooperating means on said casing ring and on said vanes to limit the movement of said vanes axially of said rings in one direction, said cooperating means having radial clearance to permit radial movement between the vanes and the casing.

2. In a turbine nozzle ring, an outer casing ring, an inner casing ring substantially concentric to and positioned within the outer ring, an outer shroud ring mounted on the inner side of said outer casing ring and having a portion thereof located in radially spaced relation thereto, an inner shroud ring mounted on the outer side of said inner ring and having a portion thereof located in radially spaced relation to said inner ring, each of said shroud rings having a row of openings in said radially spaced portions, a number of vanes extending between said shroud rings and having their ends axially slidably positioned in said openings, and interengaging cooperating lugs in axial engagement on one of said casing rings and on the adjacent ends of the vanes by which to limit axial movement of said vanes with respect to said casing ring, said one of said casing rings having means engaging with the adjacent shroud ring to prevent relative angular movement.

3. In a turbine nozzle construction, a casing ring, a shroud ring adjacent to and having a portion thereof radially spaced from said casing ring, a row of vanes extending radially through the spaced portion of said shroud ring and axially movable relative thereto, said portion of the shroud ring having a row of openings receiving said vanes axially slidably therein, limiting means provided by said casing ring and vanes in axial engagement with each other for limiting their relative axial movement, and interengaging radially extending guide means on the shroud and casing rings to permit thermal expansion of the shroud ring with respect to the casing ring and restrain relative rotation thereof.

4. In a turbine nozzle construction, a casing ring, a shroud ring adjacent to and having a portion thereof radially spaced from said casing ring, a row of vanes extending radially through the spaced portion of said shroud ring, said portion of the shroud ring having a row of openings receiving said vanes axially slidably therein, limiting means provided by said rings for limiting the relative axial movement of said rings and including interengaging radially extending guide means on the shroud and casing rings to permit thermal expansion of the shroud ring with respect to the casing ring, a projection on the end of each vane, and a projecting rib on the casing ring and located between said casing and shroud rings, said rib having a radially extending surface engaging with the projections on the vanes.

5. In a turbine nozzle construction, a casing ring, a shroud ring adjacent to and having a portion thereof radially spaced from said casing ring, a row of vanes having their ends extending radially through the spaced portion.

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of said shroud ring, said portion of the shroud ring having a row of openings receiving said vanes axially slidably therein, limiting means provided by said casing ring and vanes and in axial engagement for limiting their relative axial movement, and interengaging radially extending guide means on the shroud and casing rings to permit thermal expansion of the shroud ring with respect to the casing ring, said interengaging radially extending guide means being so arranged as to prevent relative turning motion between the rings.

6. In a turbine nozzle construction, an outer casing ring, an inner casing ring substantially concentric to and positioned within said outer ring, means connected to said rings for supporting said rings in predetermined axial relation to each other, a shroud ring adjacent to one of said casing rings and located between the casing rings, limiting means provided by the shroud ring and the adjacent casing ring for limited relative axial movement therebetween said shroud ring being spaced from the adjacent casing ring and having a row of openings therein, a row of vanes extending between said casing rings and having their ends projecting through and freely movable radially and axially in the row of openings in said shroud ring, and interengaging means on said vanes and on the casing ring and in axial engagement to which the shroud ring is adjacent for limiting the axial movement of said vanes with respect to the last mentioned casing ring.

7. In a turbine nozzle construction, an outer casing ring, an inner casing ring substantially concentric to and positioned within said outer ring, means connected to said rings for supporting said rings in predetermined axial relation to each other, a shroud ring adjacent to the outer casing ring and located between the casing rings, limiting means provided by the shroud ring and the adjacent casing ring for limited relative axial movement therebetween, said shroud ring being spaced radially from the adjacent casing ring and having a row of openings therein, a row of vanes extending between said casing rings and having their outer ends projecting through and freely movable radially and axially in the row of openings in said shroud ring, and cooperating means on said vanes and on the outer casing ring and in axial engagement for limiting the axial movement of said vanes with respect to said outer casing ring.

8. In a turbine nozzle construction, an outer casing ring, an inner casing ring substantially concentric to and positioned within said outer ring, means connected to said rings for supporting said rings in predetermined axial relation to each other, a shroud ring adjacent to one of said casing rings and located between the casing rings, said shroud ring being radially spaced from the adjacent casing ring and having a row of openings therein, a row of vanes extending between said casing rings and projecting through and radially slidable in the row of openings in said shroud ring, cooperating means on said vanes and on the casing ring to which the shroud ring is adjacent for limiting the axial movement of said vanes with respect to the last mentioned casing ring, and interengaging cooperating means on the shroud ring and the casing ring adjacent thereto to hold the shroud against turning movement within the casing and to permit thermal expansion of the shroud ring radially with respect to the adjacent casing ring.

9. In a turbine nozzle construction, a casing ring, a shroud ring within and radially spaced from said casing ring, said shroud ring having a row of openings therein and having an axially slidable connection with the casing ring so as to be relatively movable axially with respect to said casing ring, a row of nozzle vanes having their outer ends slidable radially and axially in said row of openings, and means including at least one lug on the outer end of each vane and a cooperating circumferential rib on said casing to absorb directly in the casing any axial load on the vane.

10. In a turbine nozzle construction, a casing ring, a shroud ring within and radially spaced from said casing

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ring, said shroud ring having a row of openings therein and being relatively movable axially with respect to said casing ring, cooperating interengaging means provided by said casing ring and shroud ring for preventing circumferential movement of the shroud ring within the casing ring, a row of nozzle vanes having their outer ends slidable radially and axially in said row of openings, and means including at least one lug on the outer end of each vane and a cooperating circumferential rib on said casing to absorb directly in the casing any axial load on the vane.

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CERTIFICATE OF CORRECTION

Patent No. 2,932,485

April 12, 1960

Leslie C. Small, Jr., et al.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 48, strike out "and axially movable relative thereto" and insert the same after "ring" and before the comma in line 46, same column.

Signed and sealed this 11th day of October 1960.

(SEAL)

Attest:

KARL H. AXLINE

Attesting Officer

ROBERT C. WATSON
Commissioner of Patents