Jan. 1, 1963 W. S. BROFFITT 3,071,346

TURBINE NOZZLE

Original Filed Dec. 22, 1952

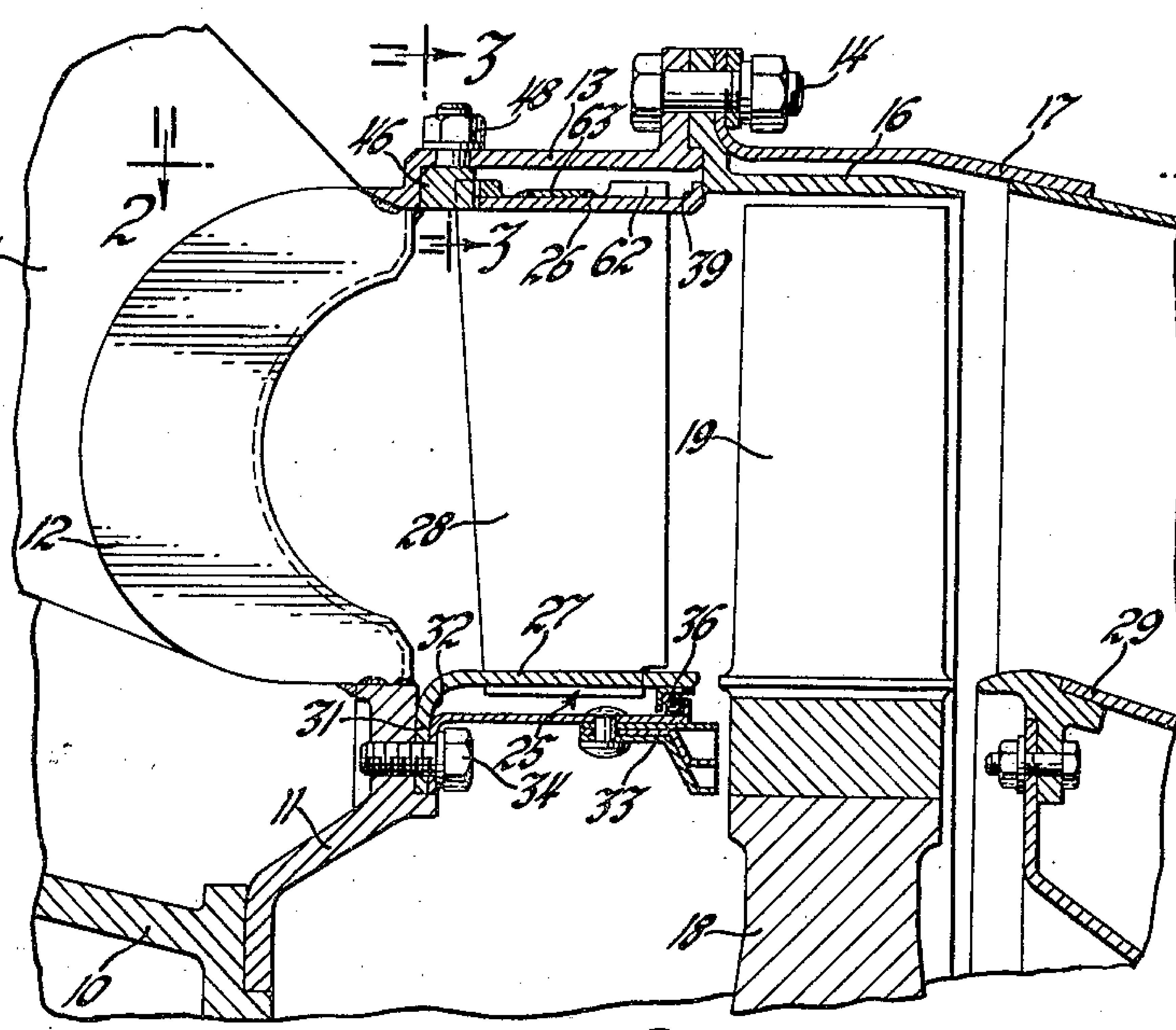

Fig. 1

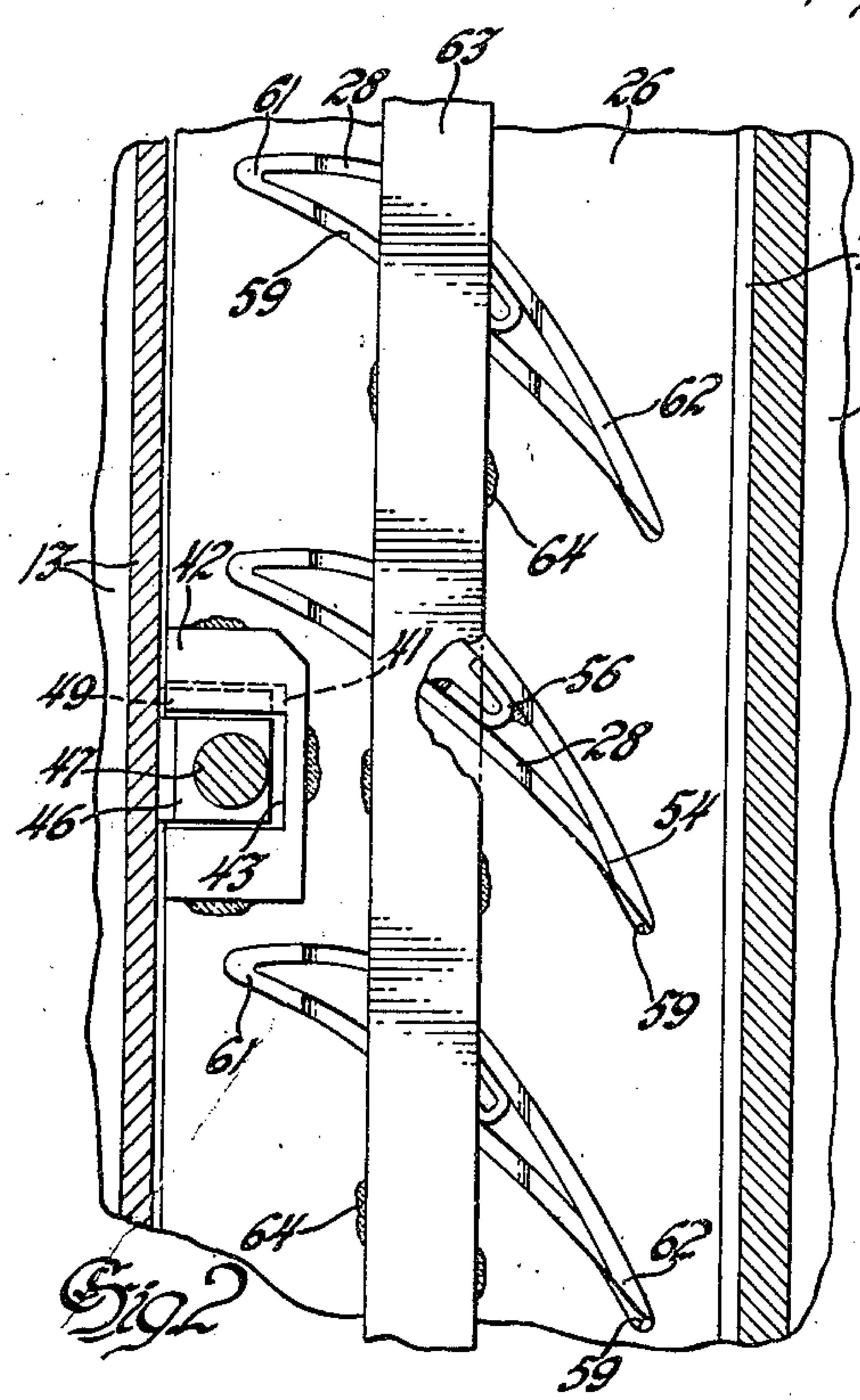

Fig. 2

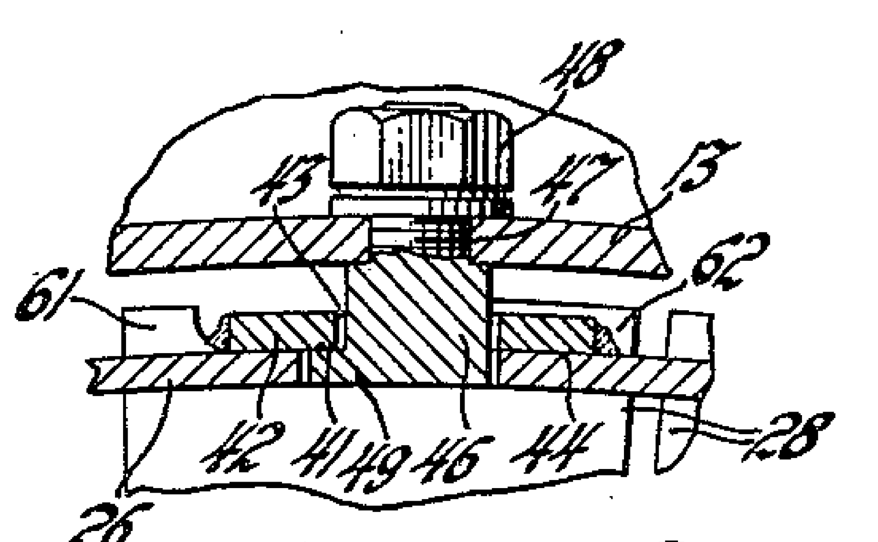

Fig. 3

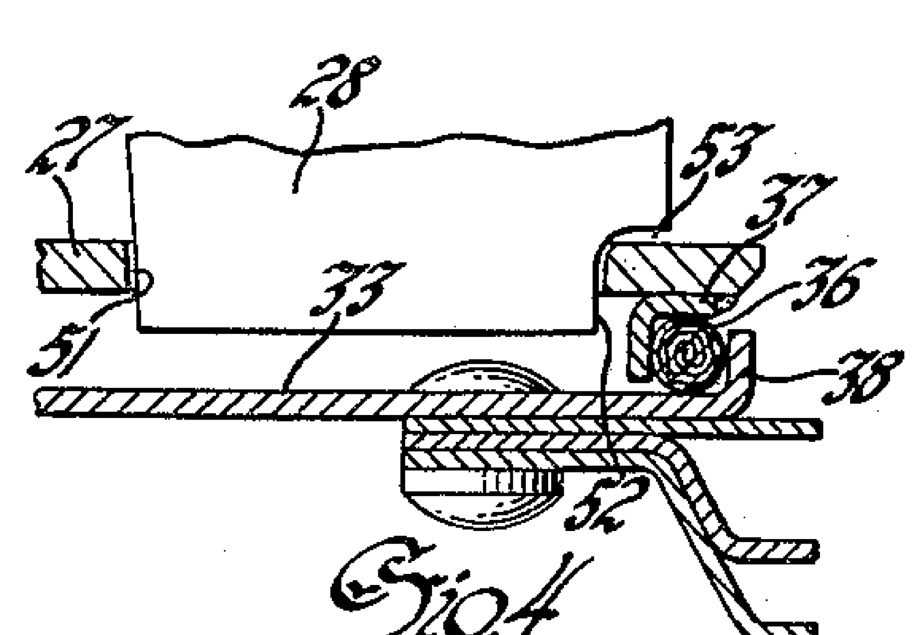

Fig. 4

Inventor

Wilgus S. Broffitt

By Willits, Helwig & Baillio

Attorneys

United States Patent Office 3,071,346
Patented Jan. 1, 1963

3,071,346
TURBINE NOZZLE

Wilgus S. Broffitt, 3858 N. New Jersey, Indianapolis, Ind.
Continuation of application Ser. No. 327,353, Dec. 22, 1952. This application June 21, 1960, Ser. No. 37,804
5 Claims. (Cl. 253—78)

My invention relates to turbine nozzles and the like and, more particularly, to a turbine nozzle structure particularly adapted to gas turbine installations. It will be understood, however, that the principles of the invention may be applied to analogous installations. It will also be understood that within the term "nozzle" may be embraced not only the first stage nozzle but intermediate stage nozzles or diaphragms of multistage turbines. This application is a continuation of my application, Serial No. 327,353, filed December 22, 1952, now abandoned.

The principal object of the invention is to provide a structure of this sort better adapted to withstand the extremely rigorous conditions of aircraft gas turbine service than nozzle arrangements previously known. It this connection, it is well known that the temperatures employed in such engines are extremely high and are highest at the turbine nozzle. It is also known that the engines are quickly started and stopped and sometimes are subject to flame-outs and to over-temperature conditions in service, all of which give rise to rapid temperature changes and high stresses due to expansion of the hot parts of the nozzle.

A turbine nozzle for an axial flow turbine ordinarily comprises an outer shroud ring and an inner shroud ring, these defining the boundaries of the motive fluid path, and a large number of vanes extending generally radially between the shroud rings. It has been found impracticable to make this entire assembly a single rigid lattice with continuous inner and outer shroud rings and vanes fixed at both ends to both shroud rings, because stresses occasioned by thermal expansions and accompanied by gas loading have resulted in distortion and destruction of nozzle structures.

The conventional approach to this problem has been to form one or both of the shroud rings as a plurality of segments to provide expansion gaps in the shroud rings.

In principle, my invention involves employing continuous shroud rings and providing a loose connection between the vanes and the shroud rings. It may also involve provision for radial expansion of the shroud rings with respect to other parts of the turbine on which they are mounted, where such provision is desirable.

This invention is related to that disclosed and claimed in my copending application for "Turbine Nozzle," Serial No. 327,352, filed December 22, 1952 (Patent No. 2,801,-075).

The principles of the invention and the advantages thereof will be more clearly apparent to those skilled in the art from the succeeding detailed description and the accompanying drawings, in which:

FIG. 1 is a fragmentary sectional view of a gas turbine engine of one type incorporating the nozzle structure of the invention, the section being taken on a plane containing the axis of the turbine;

FIG. 2 is a partial plan view of the nozzle projected on the plane indicated by line 2—2 in FIG. 1;

FIG. 3 is a detail sectional view taken on the plane indicated by line 3—3 in FIG. 1; and

FIG. 4 is an enlarged detail view corresponding to a fragment of FIG. 1.

The invention is illustrated herein as applied to a known engine (a turbojet engine of the J33 series). The engine is illustrated only sufficiently to make clear the structure pertinent to the invention, since the general

structure and operation of the engine are widely known and understood. The view of FIG. 1 shows principally the turbine nozzle, the rim of the turbine wheel including the blades, and the structure defining the motive fluid path adjacent the turbine, which is of the single stage type.

Referring first to FIG. 1, the frame member 10, which is the principal structural member of the engine interconnecting the turbine and compressor and supporting the main shaft of the engine, has fixed thereon an annular support 11 joined by a number of radially extending gusset plates 12 to a turbine nozzle casing 13. The gussets 12 are welded to the ring 11 and casing 13 and thus the members 11 and 12 define a support for the casing from the engine frame 10. Fixed on the turbine nozzle casing 13 by bolts 14 are a turbine shroud 16 and an outer wall of the exhaust duct 17. A turbine wheel 18 on which are mounted blades 19 rotates within the shroud 16. Motive fluid is delivered to the turbine by a number of combustion chambers 21, only the discharge ends of which are illustrated, which are mounted between the ring 11 and casing 13 and extend circumferentially between the gusset plates 12. The motive fluid discharged from the combustion chambers flows directly to a full-admission turbine nozzle indicated generally as 25 and comprising an outer shroud ring 26, an inner shroud ring 27, and nozzle vanes or blades 28 extending generally radially between the shroud rings. The vanes 28 direct motive fluid to the turbine blades 19 from which it is exhausted into the exhaust duct defined by the wall 17 and an inner duct wall or tailcone 29.

The inner shroud ring 27 is mounted on the support 11 and the outer shroud ring 26 on the casing 13; and the vanes 28 are slidably mounted in both shroud rings. As a result of this structure, the nozzle is adequately supported but, because of the freedom for movement between the parts of the nozzle, undesirable stresses due to heating are not set up. Moreover, the construction and assembly of the shroud are greatly facilitated by the elimination of welds or other rigid connections between the vanes and the shrouds.

The inner shroud ring 27 is formed with an inwardly directed flange 31 at its forward edge, there being a rather large radius or fillet 32 between the cylindrical portion of the shroud and the radial part of the flange 31. The shroud 27 and a labyrinth seal ring assembly 33 are mounted on the support ring 11 by a number of cap screws 34 threaded into the support ring. The seal ring 33 cooperates with the forward face of the turbine wheel in known manner. A wire braid seal 36 (see particularly FIG. 4) is mounted in the annular space defined by a small angle iron 37 on the shroud 27 and a flange 38 on the seal ring 33.

The outer shroud ring 26 is generally cylindrical with an outwardly directed flange 39 at the trailing edge. The leading edge of the shroud ring 26 is provided with rectangular slots 41 at a number of places, preferably sixteen equally spaced points around the shroud. A small plate 42 is welded to the shroud ring over each of the openings 41, the plate 42 defining a rectangular opening 43 slightly smaller than the opening 41 in the shroud ring 26. The plate 42 thus defines an abutment 44 on the inner surface thereof, and is an integral part of the shroud ring 26. Mounted in the casing and engaging the nozzle at each of the slots 41 is a key 46 having a stem 47 extending through the casing 13 and threaded to receive a nut 48 which retains the key in the casing. The key extends with slight clearance through the slot 43 in the plate 42 and has a ledge or head 49 which extends under the abutment 44 so that the shroud ring 26 is supported at a number of points by the ledges 49 of the keys 46 engaging the abutments 44, and restraining the shroud ring against movement inwardly from the casing beyond a desired amount. As will be apparent, the keys 46 also restrain the shroud ring 26 against rotation and thus the keys 46 and the abutment 39 which engages the flange 16 determine the position of the outer shroud ring in the casing.

The vanes 28 are slidably mounted in mating openings in both of the shroud rings. In the inner shroud ring (see particularly FIG. 4) the opening 51 for the vane is shorter than the chord of the vane and the vane is notched or cut away as indicated at 52 at the trailing edge to provide a shoulder or abutment 53 which may engage the radially outer surface of the shroud ring 27. The opening 51 is so dimensioned as to receive the blade readily, but no excess clearance is desired.

The vanes 28, although they may be solid, are preferably of a folded sheet metal construction, as will be most clearly seen in FIG. 2. The vanes are formed by folding sheet metal at the leading edge of the vane and the trailing edges are scarfed off and welded or high temperature brazed at 54. The vanes may be additionally stiffened and strengthened against vibration by channel strips 56 welded or blazed between the walls of the blade.

The outer end of each vane extends through an opening 59 in the outer shroud ring 26, which opening is dimensioned to receive the vane with sufficient clearance for sliding movement for assembly and to accommodate expansion in service. The portions of the vane adjacent the leading and trailing edge are slightly longer than the remainder of the blade to provide portions 61 and 62 which extend for some distance through the outer shroud. The central portion of the chord of the blade preferably lies approximately flush with the outer surface of the outer shroud ring or, if additional clearance is desired for expansion, it may not extend quite as far as the surface of the outer shroud ring. The vanes are retained in place in the shrouds by yieldable means comprising a flexible strap or band 63 extending over the central part of the chord of the vane, which strap is spot-welded as indicated at 64 or otherwise fixed to the outer shroud at a number of points around the circumference of the shroud. Thus, the entire nozzle assembly 25, comprising the inner and outer shroud rings and the vanes, may be assembled simply by fitting the parts together and then tack-welding the strap 63 in place.

This nozzle assembly is, of course, somewhat loose; but, when properly supported in the engine according to the invention, is entirely adequate to withstand the gas loads, and the looseness prevents the setting up of undesirable stresses and distortion which might otherwise result from the conditions of great heat, rapid temperature changes, and buffeting by gases which are to be expected in gas turbines.

In the assembly of the nozzle, the outer shroud ring is fitted into place in the keys 46 and the inner shroud ring is held by the cap screws 34. When the turbine shroud 16 is mounted on the casing 13, it holds the outer shroud from backing off the keys 46.

Some clearance is provided between the outer shroud 26 and the casing to accommodate the greater expansion of the shroud than the casing in service. Under hot running conditions, the plates 42 and flange 39 of the outer shroud ring may engage or nearly engage the casing.

In the event of damage to one of the nozzle vanes, it will be apparent that replacement thereof is very easy.

The invention is not to be regarded as limited in any way by the detailed description herein of the preferred embodiment thereof for the purpose of explaining the invention. It will be apparent that many modifications may be made by the exercise of skill in the art within the scope of the principles of the invention.

The term "continuous one-piece" as used in the claims to define the outer shroud ring is employed to distinguish from a shroud ring composed of relatively movable parts and to define a shroud ring which is a continuous rigid ring. This term does not exclude a ring composed of two or more parts rigidly fixed together to provide a continuous unitary ring.

I claim:

1. A turbine nozzle assembly comprising, in combination, a turbine nozzle casing, a turbine nozzle including a continuous outer shroud ring spaced radially from the casing, an inner shroud ring, and vanes extending between and supported by the shroud rings, the shroud rings defining boundaries of the motive fluid path through the nozzle, and means for supporting the outer shroud ring in the casing with freedom for relative radial expansion of the casing and the outer ring comprising keys extending inwardly from the casing, the outer shroud ring having openings receiving the keys, and the keys having shoulders thereon engageable with the radially inner surface of the outer shroud ring.

2. A turbine nozzle assembly comprising, in combination, a turbine nozzle casing, a turbine nozzle including a continuous outer shroud ring, an inner shroud ring, and vanes extending between and supported by the shroud rings, the shroud rings defining boundaries of the motive fluid path through the nozzle, and means for supporting the outer shroud ring in the casing with freedom for relative radial expansion of the casing and the outer ring comprising keys extending inwardly from the casing, the outer shroud ring having openings receiving the keys, and the keys having heads thereon engageable with the radially inner surface of the outer shroud ring, the outer shroud ring being radially spaced from the casing and slidable radially to a limited extent on each key.

3. A turbine nozzle assembly comprising, in combination, a turbine nozzle casing, a turbine nozzle including a continuous outer shroud ring spaced radially from the casing, an inner shroud ring, and vanes extending between and supported by the shroud rings, the shroud rings defining boundaries of the motive fluid path through the nozzle, and means for supporting the outer shroud ring in the casing with freedom for relative radial expansion of the casing and the outer ring comprising keys extending inwardly from the casing, the outer shroud ring having slots in the leading edge thereof receiving the keys, and the keys having shoulders thereon engageable with the radially inner surface of the outer shroud ring, and means on the casing and the outer shroud ring providing an abutment between the outer shroud ring and the casing to hold the shroud ring against movement axially of the shroud ring off the keys.

4. A turbine nozzle comprising an annular casing; an annular support radially within the casing; means structurally interconnecting the casing and support; a continuous inner nozzle shroud ring mounted on the support; a continuous one-piece outer nozzle shroud ring mounted in the casing, the shroud rings defining boundaries of the motive fluid path through the nozzle; means connecting the casing and the outer shroud ring mounting the outer shroud ring in the casing including abutments between the casing and the outer shroud ring providing a range of relative radial movement therebetween limited in both radial directions, means connecting the casing and the outer shroud ring providing an abutment against relative rotation thereof, and means connecting the casing and the outer shroud ring providing an abutment against axial displacement of the shroud ring; and nozzle vanes extending from one shroud ring to the other and loosely mounted in both shroud rings, the vanes extending through openings in the shroud rings; the opening in one shroud ring being smaller than the vane and the vane defining an abutment engageable with the said one shroud ring; and means engageable with the vanes limiting movement of the vane abutment away from the said one shroud ring comprising a flexible strap extending around the perimeter of the other shroud ring adjacent the ends of the vanes, the strap being fixed at spaced points to the shroud ring.

5. A turbine nozzle as recited in claim 4 in which the

ends of the vanes extending through the said other shroud rings are formed with projections extending from the shroud ring on each side of the strap.

References Cited in the file of this patent

UNITED STATES PATENTS

2,479,573	Howard	Aug. 23, 1949
2,622,843	Williams	Dec. 23, 1952
2,625,013	Howard et al.	Jan. 13, 1953
2,625,367	Rainbow et al.	Jan. 13, 1953
2,625,793	Mierley et al.	Jan. 20, 1953
2,640,319	Wisclenus	June 2, 1953
2,643,086	Thomas et al.	June 23, 1953
2,654,566	Boyd	Oct. 6, 1953
2,702,688	Ericson	Feb. 22, 1955

FOREIGN PATENTS

823,442	France	Oct. 18, 1937

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,071,346 January 1, 1963

Wilgus S. Broffitt

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

In the grant, lines 1 to 3, for "Wilgus S. Broffitt, of Indianapolis, Indiana," read -- Wilgus S. Broffitt, of Indianapolis, Indiana, assignor to General Motors Corporation, of Detroit, Michigan, a corporation of Delaware --; line 12, for "Wilgus S. Broffitt, his heirs" read -- General Motors Corporation, it successors --; in the heading to the printed specification, line 3, for "Wilgus S. Broffitt, 3858 N. New Jersey, Indianapolis, Ind." read -- Wilgus S. Broffitt, Indianapolis, Ind., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware --; column 3, line 23, for "blazed" read -- brazed --.

Signed and sealed this 30th day of July 1963.

(SEAL)
Attest:
ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents