# United States Patent [19]

**Corey et al.**

[11] **3,880,550**

[45] **Apr. 29, 1975**


[54] **OUTER SEAL FOR FIRST STAGE TURBINE**


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[22] Filed: **Feb. 22, 1974**

[21] Appl. No.: **445,047**

[52] **U.S. Cl.** ..... **415/174**; 277/96

[51] **Int. Cl.** ..... **F01d 11/00**

[58] **Field of Search** ..... 415/174; 277/96



[56] **References Cited**

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[57] **ABSTRACT**

An outer air seal for the first stage turbine of an engine having the seal segments made of a high strength base material with a highly oxidation-corrosion resistant abradable alloy layer bonded to the surface thereof on the side adjacent the rotor blade. Another embodiment having an abrasive layer bonded to the high strength base material with the abradable layer being bonded to the abrasive layer.


**4 Claims, 3 Drawing Figures**

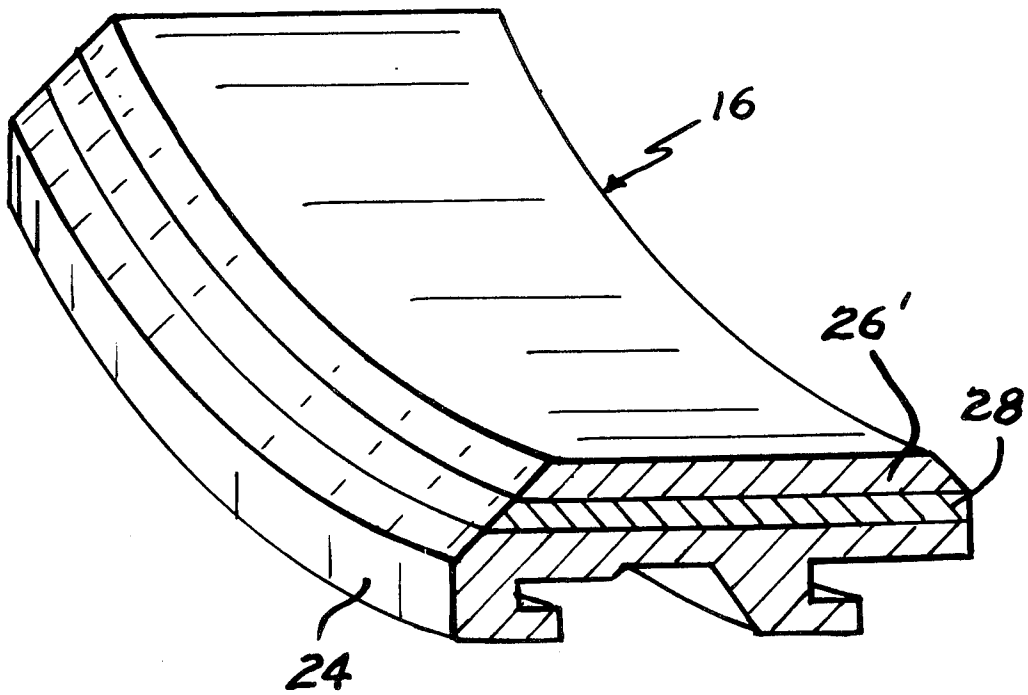


Fig-1

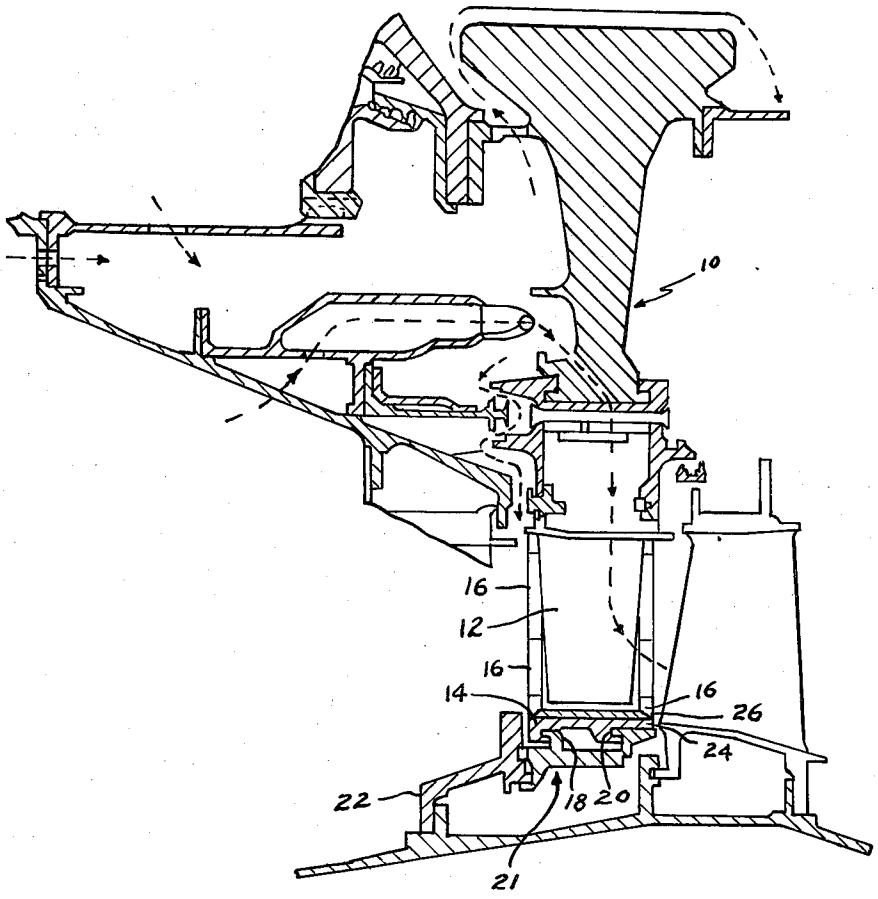



Fig-2

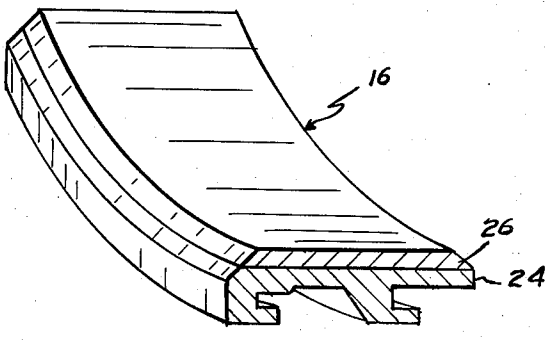
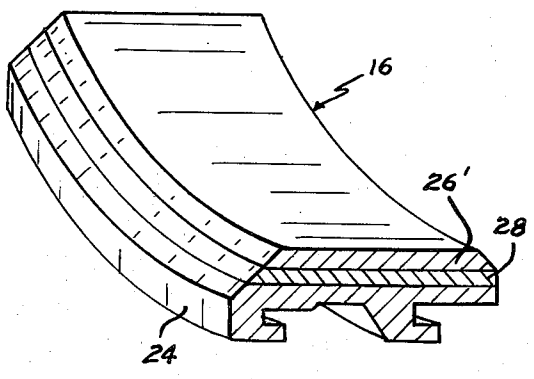



Fig-3



# OUTER SEAL FOR FIRST STAGE TURBINE

## RIGHTS OF THE GOVERNMENT

The invention described herein may be manufactured and used by or for the Government of the United States for all governmental purposes without the payment of any royalty.

## BACKGROUND OF THE INVENTION

The outer air seals for the first stage turbine of the TF30 engine and the JT9D engine use a single material for the seal segments. The material is selected with a compromise between strength and corrosion resistance. In the past, abradable surfaces on the seals have been used but these have been unsuccessful since a compound of sufficient abradability without undesirable side effects, such as corrosion, had not been found. Thus, abradable surfaces were eliminated and the design returned to single material seal segments.

## BRIEF SUMMARY OF THE INVENTION

According to this invention, seal segments are provided for the outer seal of the first stage turbine wherein a highly oxidation-corrosion resistant abradable alloy is bonded to a strong high temperature alloy, thus eliminating the property compromise necessitated by the use of a single alloy. In another embodiment, an abrasive material is bonded to the high strength material with the highly oxidation-corrosion resistant layer being bonded to the abrasive material.

## IN THE DRAWING

FIG. **1** is a partially schematic cut away sectional view of the first stage turbine of an engine with the outer air seal of the invention.

FIG. **2** is an elongated sectional view of an outer air seal of the device of FIG. **1.**

FIG. **3** is an enlarged sectional view of an outer air seal for the device of FIG. **1** according to another embodiment of the invention.

## DETAILED DESCRIPTION OF THE INVENTION

Reference is now made to FIG. **1** of the drawing which shows the first stage rotor assembly **10** having rotor blades **12,** one of which is shown, positioned adjacent the outer air seal **14.** The outer air seal **14** has a plurality of segments **16** positioned around the rotor assembly. The segments **16** are supported on support elements **18** and **20** on a support member **21** which are supported on the outer case **22.** All of this structure is prior art structure except the seal **14.**



The seal segments **16,** one of which is shown in FIG. **2,** have a base member **24** of a material PWA 647 or PWA 663 with highly oxidation-corrosion resistant abradable layer **26** of PWA 1045 NiCrAlY diffusion bonded to the base material by heating for 1 hour to between 1,300° and 1,400°F in a vacuum at a pressure between 145 and 275 meganewtons per square meter and then postheating two hours to between 1,900° and 2,150°F at a pressure of about 15 meganewtons per square meter. Before bonding the surfaces are cleaned by sanding and then either chemical polishing or electropolishing. The material PWA 662, PWA 647 and PWA 1045 will be described in greater detail below.

A modification of the device of FIGS. **1** and **2** is shown in FIG. **3.** In this device, the seal segments **16** have a layer **28** of abrasive material WS-6 bonded to the base member with the abradable layer **26'** of PWA 1045 being bonded to the abrasive layer **28.** This will allow incrusion of the moving rotor blade tip into the abradable layer until it reaches the abrasive layer whereupon some machining of the blade tip by the abrasive layer would occur.

The composition of the materials PWA 1045, PWA 663, PWA 647 and WS-6 are given in the following table wherein the parts by weight given are of 100 total parts.

| | PWA 1045 | PWA 663 | PWA 647 | WS-6 |
|---|---|---|---|---|
| Aluminum | 5.5 | 6.0 | — | — |
| Bismuth | — | 0.5 PPM max | — | — |
| Boron | 0.003 max | 0.015 | 0.01 max | — |
| Carbon | 0.05 | 0.11 | 0.6 | 0.9 |
| Chromium | 16.00 | 8.0 | 23.4 | 25.0 |
| Cobalt | — | 10.0 | Remainder | Remainder |
| Columbium | — | 0.10 max | — | 1.0 |
| Iron | 0.75 max | 0.35 max | 1.50 max | 1.0 |
| Lead | — | 10 PPM max | — | — |
| Manganese | 0.50 max | 0.20 max | 0.10 max | — |
| Molybdenum | — | 6.0 | — | — |
| Nickel | Remainder | Remainder | 10.0 | 15.0 |
| Phosphorous | 0.015 max | — | — | — |
| Silicon | 0.40 max | 0.25 max | 0.40 max | — |
| Sulfur | 0.015 max | 0.015 max | 0.015 max | — |
| Tantalum | — | 4.25 | 3.5 | 2.75 |
| Titanium | — | 1.0 | 0.2 | 0.9 |
| Tungsten | — | 0.10 max | 7.0 | 7.75 |
| Yttrium | 0.2 | — | — | — |
| Zirconium | — | 0.075 | 0.45 | 0.4 |

The terms PWA 1045, PWA 663, PWA 647 and WS-6 as used in the specification and claims will indicate the composition as given in this table.

In some applications, other alloys than those given may be used for the base member **24.**

There is thus provided an improved outer air seal of the first stage of a turbine engine.

We claim:

**1.** An outer seal for the first stage of a turbine engine, comprising an annular seal segment support member surrounding the blades of the first stage of the turbine engine; a plurality of seal segments supported on the seal segment support member; said seal segments having a layer of PWA 1045 sheet material bonded to a high strength Nickel-Chrominum alloy base material.

**2.** The device as recited in claim **1** wherein the high strength base material is PWA 663.

**3.** The device as recited in claim **1** wherein the high strength base material is **PWA** 647.

**4.** The device as recited in claim **1** wherein an abrasive layer of WS-6 is bonded to the high strength base material between the base material and the sheet of PWA 1045.

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