(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 437 977 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **90314368.3**

(22) Date of filing: **28.12.90**

(51) Int. Cl.5: **F01D 5/26**, F01D 5/02, F01D 11/00

(30) Priority: **18.01.90 US 466795**

(43) Date of publication of application: **24.07.91 Bulletin 91/30**

(84) Designated Contracting States: **DE FR GB**

(71) Applicant: **UNITED TECHNOLOGIES CORPORATION**
United Technologies Building 1, Financial Plaza
Hartford, CT 06101(US)

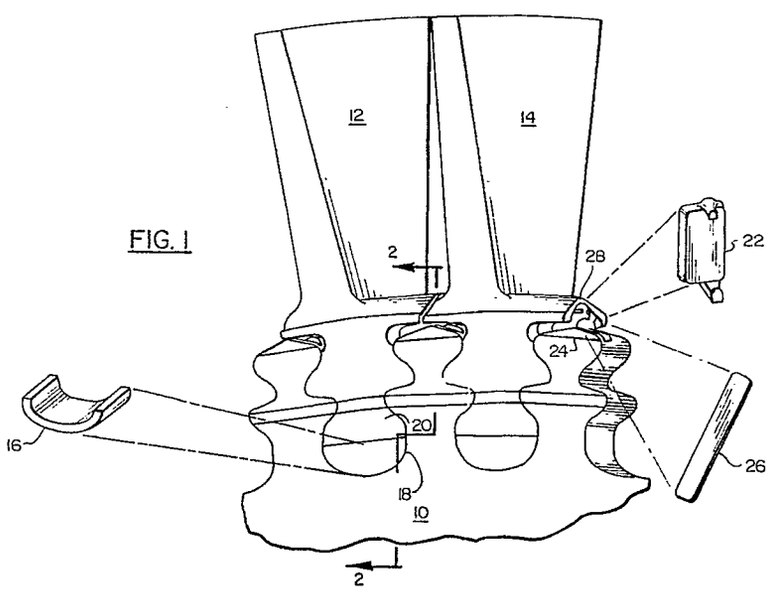
(72) Inventor: **Brown, Wesley D.**
825 Center Street, Apt. 40A
Jupiter, FL 33458(US)
Inventor: **McCracken, James R.**
3877 Biscayne Drive
Winter Springs, FL 32708(US)
Inventor: **Vercellone, Peter T.**
7933 Oakmount Drive
Lake Worth, FL 33467(US)

(74) Representative: **Tomlinson, Kerry John et al**
Frank B. Dehn & Co. European Patent Attorneys Imperial House 15-19 Kingsway
London WC2B 6UZ(GB)

(54) Turbine rim configuration.

(57) A turbine rotor rim construction which provides for individual blade (12,14) installation and removal, blade-to-blade damping through the use of readily installed damper weights (22) located between adjacent blades and which permit blades to slide into position thereover, under blade balance weights (16) which can be readily installed, removed or changed by temporarily removing a blade, and seals (26) which can be readily installed under the platforms of adjacent blades.

FIG. 1



EP 0 437 977 A1

TURBINE RIM CONFIGURATION

This invention relates to gas turbine engine rotors and more particularly to a rim configuration for high pressure turbine rotors.

It is important to provide sealing between adjacent blades in a turbine rotor to minimize the escape of gases from the flow path in a gas turbine engine. Seals of thin flat rectangular plates have been used to bridge the longitudinal gap between adjacent blade platforms. Seals of this type are shown in our U.S. Patents Nos. 3,752,598, 4,422,827 and 4,505,642.

In addition to the provision of platform sealing in the turbine rotor structure, it is desirable to provide for blade damping and blade balance.

An object of the invention is to provide a turbine rotor construction which brings together sealing, damping and balance features into a single-stage turbine rim configuration.

Another object of the invention is to provide a single-stage turbine configuration having a combination of features covering a broad range of requirements for balancing, minimum weight/complexity, leakage control and assembly.

A further object of the invention is to provide a turbine rim configuration which provides for individual blade installation and removal, blade-to-blade damping, under-blade balance weights and platform sealing.

Viewed from one aspect, the invention provides a turbine rotor rim construction for a gas turbine engine including a rotor disk, said disk having a plurality of slots equally spaced around its perimeter, turbine blades positioned within said slots, each blade having a root portion fitting within a disk slot, an airfoil portion extending outwardly from said disk perimeter and a platform portion between said root and said airfoil portions and adjacent said disk perimeter, sealing means installed under the platform portion of adjacent blades for controlling leakage between said blades, characterised by damper means installed on the perimeter of said disk between adjacent blades and under said blade platform portions, and balance weights installed as necessary for any blade between said blade root and said disk slot.

Viewed from another aspect, the invention provides a method of assembling a turbine rotor, comprising taking a rotor disk having a plurality of slots equally spaced around its perimeter, installing damper means in positions on the perimeter of the disk between the slots, installing turbine blades in the slots, installing sealing means between adjacent blades and under adjacent blade platforms, installing blade retention means, and balancing the rotor by removing the retention means, removing an individual blade from its slot, installing a balance weight to be positioned between the blade root and the disk slot, and replacing the blade and retention means.

According to the invention, the feature of individual blade installation and removal permits under-blade weight balancing, replacing conventional riveted-on saddle weights. The rim design does not rely on heavy, life-limited rim sideplates to control cross flow rim leakage, leakage control being maintained through tight clearances between the blade and disk attachment profiles and a blade platform/platform seal. Further, each damper is retained in proper orientation through the use of two cast posts which may be of different size or shape to provide foolproofing during the assembly process. The dampers, when positioned close to the disk dead rim surface, allow sufficient clearance to permit the turbine blades to slide into position over the damper.

The foregoing and other objects, features and advantages of the invention will become more apparent in the light of the following detailed description of the preferred embodiment thereof as shown in the accompanying drawings, which is given by way of example only.

Brief Description of the Drawings

Fig. 1 is an exploded view of a single-stage turbine rotor showing the features of the construction.

Fig. 2 is a side view of the rim construction, generally along line 2-2 in Fig. 1, showing a portion of a turbine blade root and rotor disk rim in accordance with the invention.

Fig. 3 is a sectional view along line 3-3 of Fig. 2.

Fig. 4 is a sectional view along line 4-4 of Fig. 2.

In the exploded view of Fig. 1, a portion of turbine rotor disk 10 is shown with turbine blades 12 and 14 in assembled position thereon. The figure shows schematically arcuate shaped balance weight 16 and its position within blade slot 18 and under blade root 20, damper 22 and its location between turbine blades and with respect to disk dead rim surface 24, and interplatform seal 26 between and under adjacent blade platforms such as platform 28. It is to be understood that there will be a damper and a seal between each adjacent pair of blades on the turbine disk and a balance weight under blades as necessary to achieve dynamic balance of the turbine rotor stage.

Turbine blade 12 shown in Fig. 2 includes airfoil 30, root 20 and platform 32. The blade is mounted on rotor disk 10 and retained in position on the rim of the disk by snap ring 34. Balance weight 16 is shown in position between the underside of root 20 and slot 18 in the disk, the ends of the balance weight fitting within groove 36 in the blade root.

Damper 38 of the same construction as damper 22 includes posts 40 and 42 located at each end of the damper to retain the damper in proper orientation. The posts while shown of different size may be of the same size or of different shape. Smaller post 40 engages shallow pocket 44 and larger post 42 engages shallow pocket 46, the pockets being on the dead. rim area of the rotor disk. When initially placed in position on the disk rim, damper 38 will lie against rim flat surface 48 with posts 40 and 42 being deep in pockets 44 and 46, respectively. This provides sufficient clearance to permit blade 12 and adjacent blade 14 to slide into position over the damper. Centrifugal force throws the damper radially outward until it contacts friction damper support pad 50 on the underside of blade 12.

Interplatform seal 52, which is of stamped metal and like seal 26, is trapped in position by seal finger 54 and the upper side of damper support 50. The finger and damper support are integral cast portions of blade 12. Rear buttress 56 of the blade is designed to allow the seal to be installed from the rear of rotor disk 10, to the right in Fig. 2, after all of the blades have been assembled into the disk. When installed, approximately 0.15 inches (3.8mm) of the seal protrudes from the disk and blade buttresses providing a visible check on seal installation. Deformation of the seal into the narrow channel along the underside of the adjacent blade platforms provides retention of the seal prior to engine operation. Engine operation molds the thin seal to the contour of the underside of the blade platforms to provide even greater retention and sealing.

Fig. 3 is a view of the underside of adjacent blades 12 and 14 along line 3-3 in Fig. 2. Cast seal finger 54 and damper support 50 on blade 12 and cast seal finger 58 and damper support 60 on blade 14 can be seen with interplatform seal 52 in place. Damper 38 also is shown in its position opposite the damper supports.

Fig. 4, which is a section along line 4-4 in Fig. 2, shows damper 38 and seal 52 in engine operation position. The top surface of the damper is against the lower side or face of damper support pad 50 on blade 12 and damper support pad 60 on blade 14. The top surface of the seal is against the underside of platform 32 on blade 12 and the underside of platform 62 on blade 14.

The arrangement of dampers, interplatform seals and under-blade balance weight capability is assembled as follows:

1. All dampers are installed in the disk. The dampers are waxed into position until trapped by a blade.
2. All blades are then installed in the disk.
3. Interplatform seals are installed by inserting them between blade platforms at the rear buttress of the blades. About 0.15 (3.8mm) of the seal will be visible from the rear of the disk when properly installed.
4. The snap ring is installed in place at the rear of the blades and disk.
5. The assembled rotor is then spin balanced. To the extent that balance weights are needed, the interplatform seals on either side of the selected blade are temporarily removed, the snap ring is removed, the blade is retracted and a weight is trapped in position under the blade root.
6. The blade is pushed forward to assembled position, the interplatform seals are reinstalled and the snap ring is reinstalled.

It should be understood that the invention is not limited to the particular embodiment shown and described herein, but that various changes and modifications may be made without departing from the scope of the concept as defined by the following claims.

Claims

1. A turbine rotor rim construction for a gas turbine engine including a rotor disk, said disk having a plurality of slots equally spaced around its perimeter, turbine blades positioned within said slots, each blade having a root portion fitting within a disk slot, an airfoil portion extending outwardly from said disk perimeter and a platform portion between said root and said airfoil portions and adjacent said disk perimeter, sealing means installed under the platform portion of adjacent blades for controlling leakage between said blades, characterised by damper means installed on the perimeter of said disk between adjacent blades and under said blade platform portions, and balance weights installed as necessary for any blade between said blade root and said disk slot.

2. A turbine rotor rim construction in accordance with claim 1 in which each damper means includes a post at each end, and the perimeter of the disk has pockets in the disk area between adjacent blade slots for receiving said damper posts when said damper means is

installed on said disk.

3. A turbine rotor rim construction in accordance with claim 2 in which the damper posts are of different size and the disk pockets are sized accordingly.

4. A turbine rotor rim construction in accordance with claim 1, 2 or 3 in which the perimeter area of said disk between said slots has a recessed area to receive said damper means and permit said blades to be positioned within said slots during assembly.

5. A turbine rotor rim construction in accordance with claim 1, 2, 3 or 4 in which the turbine blades have damper pads formed integrally therewith and located beneath the underside of the platform portions for contact by said damper means during operation of the turbine rotor.

6. A turbine rotor rim construction in accordance with claim 5 in which the damper pads also serve to retain the sealing means in place against the underside of said platform portions.

7. A turbine rotor rim construction in accordance with any preceding claim in which the balance weights are arcuate in shape and conform to the shape of the disk slot.

8. A turbine rotor rim construction in accordance with any preceding claim in which each blade root portion is grooved to receive a portion of a balance weight.

9. A turbine rotor rim construction in accordance with claim 1 which is assembled as follows:
   1. All damper means are installed in position on the perimeter of the disk;
   2. All blades are installed in the disk;
   3. All sealing means are installed between adjacent blades and under adjacent blade platforms.
   4. Blade retention means is installed.
   5. Balance weights are installed between a blade root and disk slot as may be necessary to achieve rotor balance.

10. A method of assembling a turbine rotor, comprising taking a rotor disk having a plurality of slots equally spaced around its perimeter, installing damper means in positions on the perimeter of the disk between the slots, installing turbine blades in the slots, installing sealing means between adjacent blades and under adjacent blade platforms, installing blade retention means, and balancing the rotor by removing the retention means, removing an individual blade from its slot, installing a balance weight to be positioned between the blade root and the disk slot, and replacing the blade and retention means.

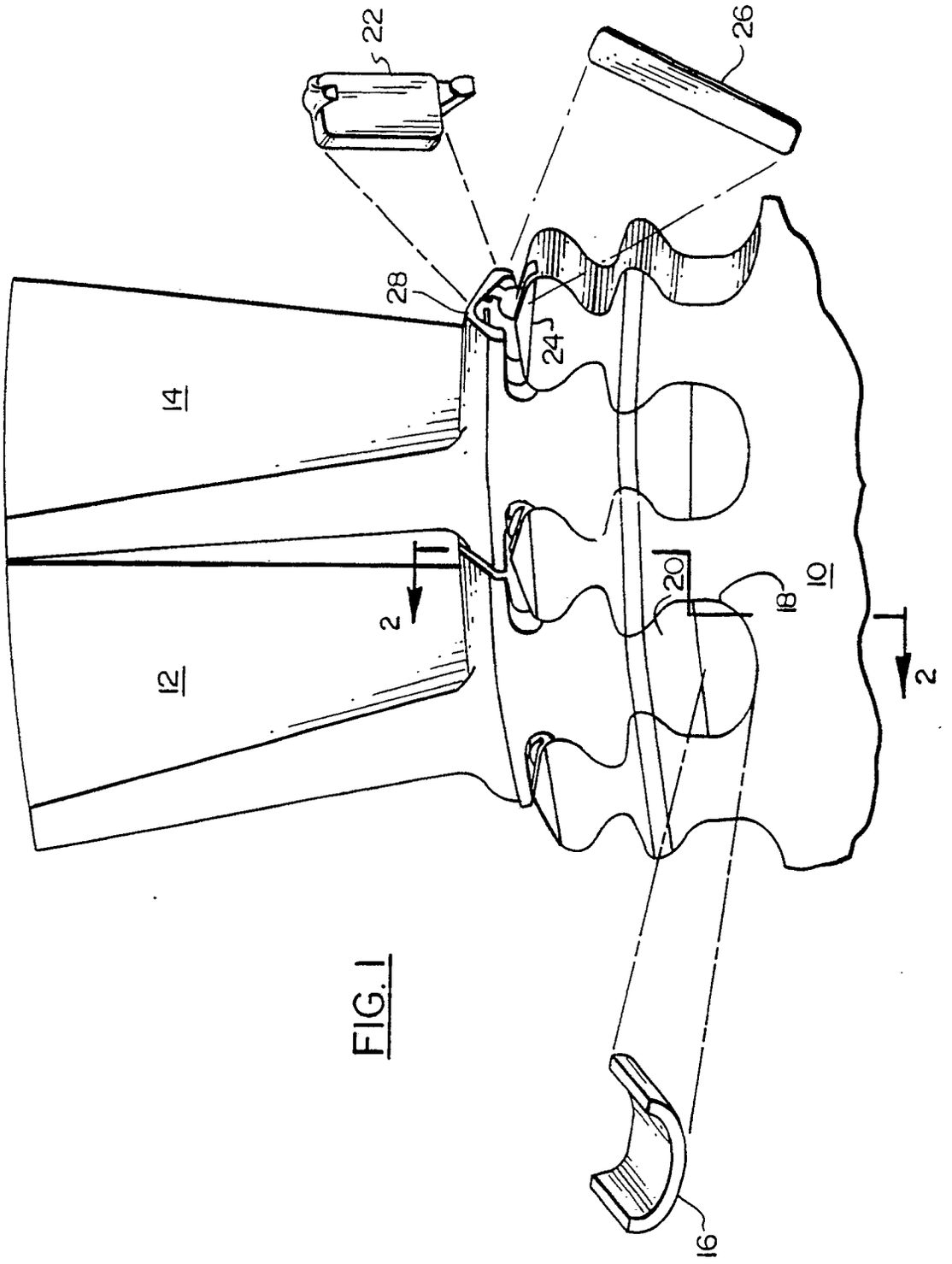


FIG. 1

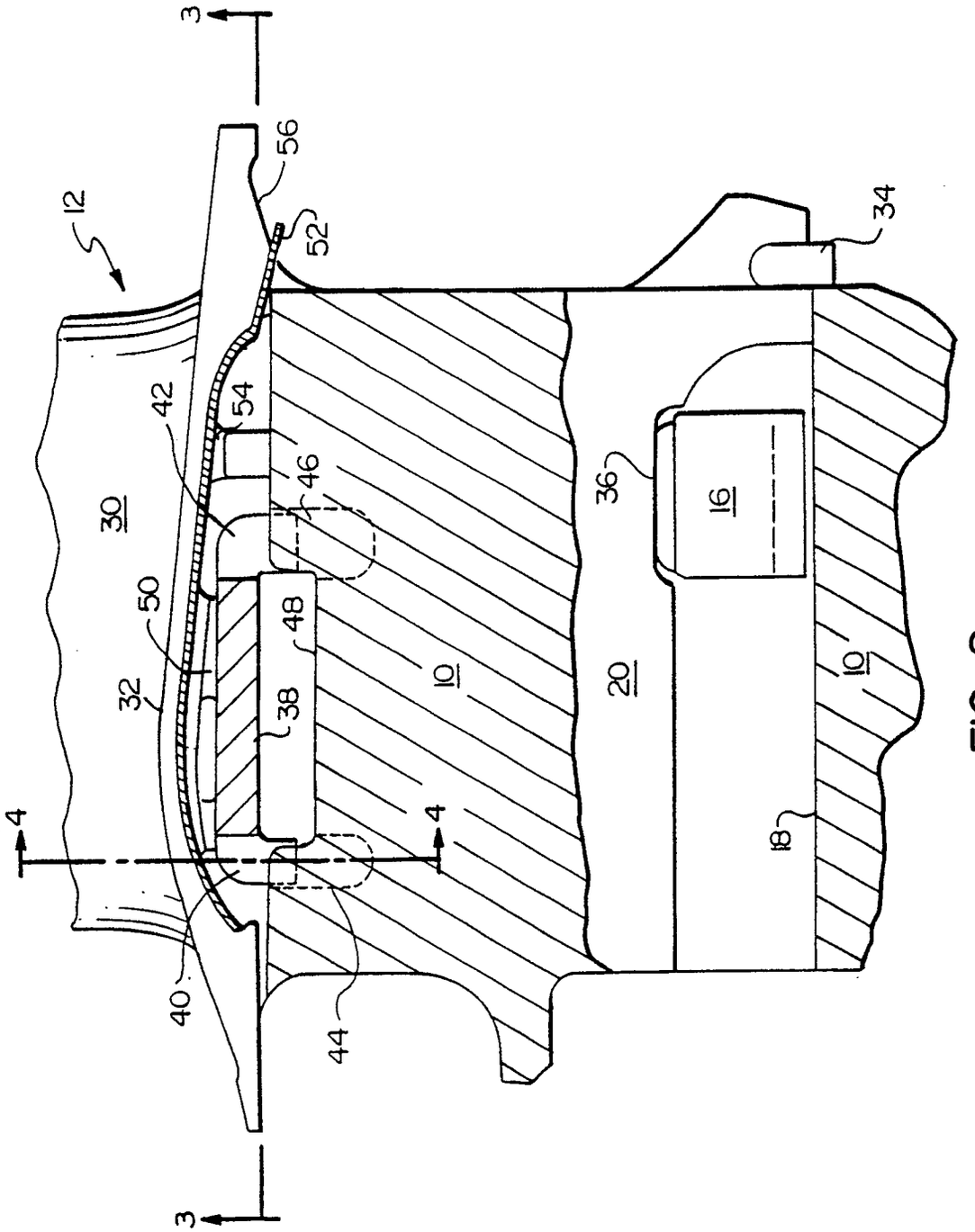


FIG. 2

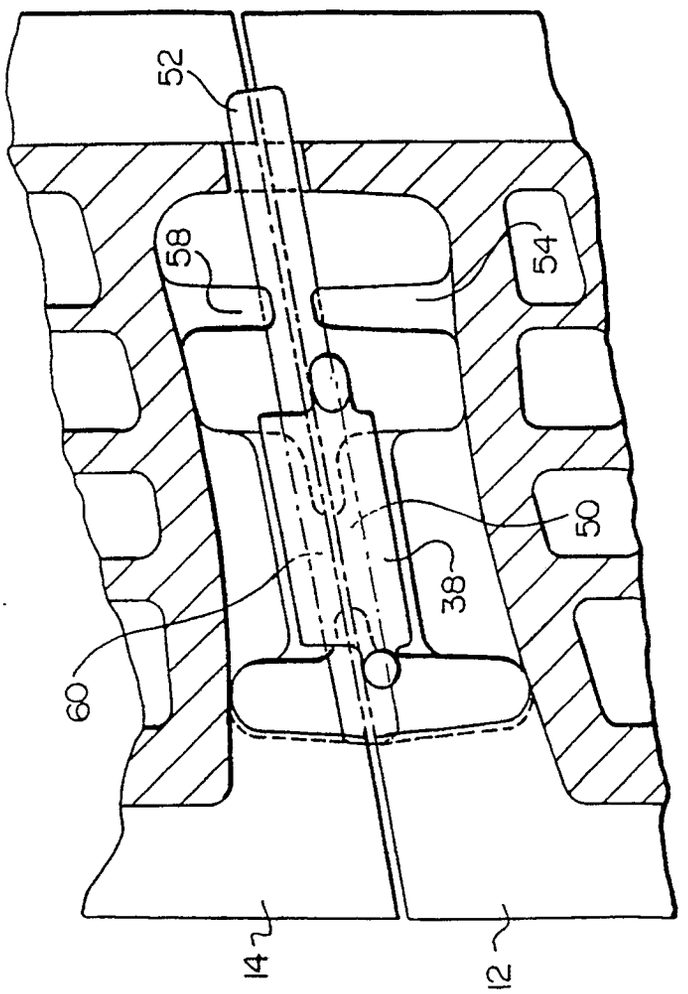


FIG. 3

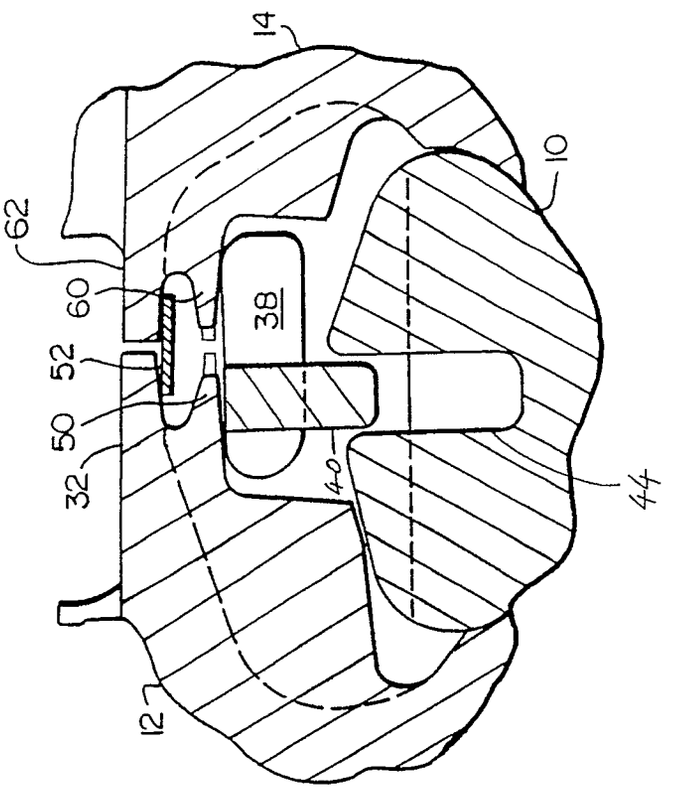


FIG. 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 31 4368

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	US-A-4 872 810 (W.D. BROWN) * Column 1, line 65 - column 2, line 35; column 3, line 7 - column 4, line 63; figures 1-5 *	1,5,7,8	F 01 D 5/26 F 01 D 5/02 F 01 D 11/00
A		9,10	
Y	EP-A-0 314 606 (UNITED TECHNOLOGIES) * Column 1, lines 56-60; column 2, line 53 - column 3, line 10; column 3, lines 29-56; figures 1-4 *	1,5,7,8	
A		9,10	
A	GB-A-2 111 130 (UNITED TECHNOLOGIES) * Page 1, line 119 - page 2, line 47; figures 1-3 *	1,5,6	
A	DE-A-2 743 563 (GENERAL ELECTRIC) * Page 11, line 23 - page 12, line 13; figure 4 *	1,2	
A	US-A-3 037 741 (TUFT) * Claim 1; figures 1-3,6-8 *	1,2,3,4	
A	US-A-2 843 356 (HULL)		TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A,D	US-A-4 505 642 (HILL)		F 01 D
A,D	US-A-4 422 827 (BUXE)		

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	10 April 91	SERRANO GALARRAGA J.

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
Y: particularly relevant if combined with another document of the same catagory
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention

E: earlier patent document, but published on, or after the filing date
D: document cited in the application
L: document cited for other reasons

&: member of the same patent family, corresponding document