PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :		(11) International Publication Number:
F16J 15/40	**A1**	**WO 98/23886**
		(43) International Publication Date: 4 June 1998 (04.06.98)

(21) International Application Number: PCT/US97/21575

(22) International Filing Date: 25 November 1997 (25.11.97)

(30) Priority Data:
08/774,327 27 November 1996 (27.11.96) US

(71) Applicant: ALLIEDSIGNAL, INC. [US/US]; 101 Columbia Road, P.O. Box 2245, Morristown, NJ 07962–2245 (US).

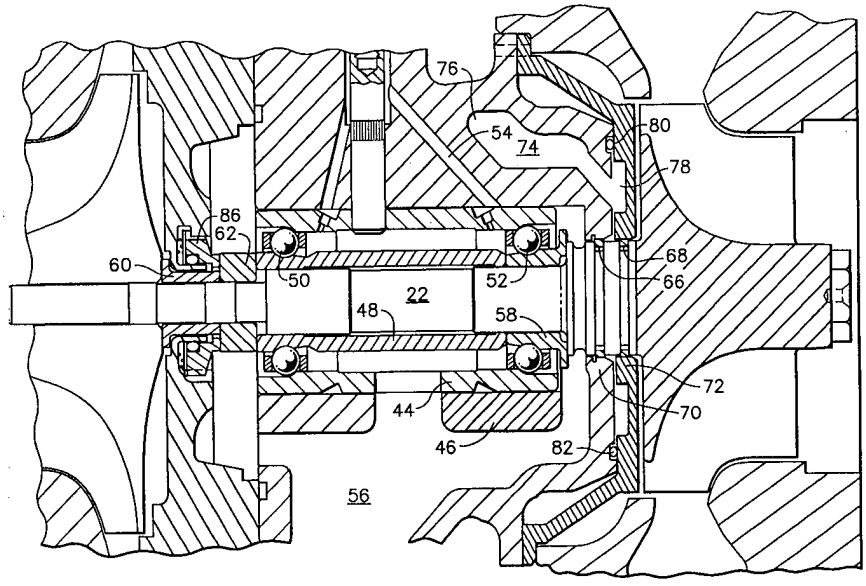
(72) Inventor: ADEFF, George, A.; 7516 Ogelsby Avenue, Los Angeles, CA 90045 (US).

(74) Agent: CRISS, Roger, H.; AlliedSignal Inc. (Law Dept., E. Iannarone), 101 Columbia Road, P.O. Box 2245, Morristown, NJ 07962–2245 (US).

(81) Designated States: AL, AU, BA, BB, BG, BR, CA, CN, CU, CZ, EE, GE, GH, HU, ID, IL, IS, JP, KP, KR, LK, LR, LS, LT, LV, MG, MK, MN, MW, MX, NZ, PL, RO, RU, SD, SG, SI, SK, SL, TR, TT, UA, UZ, VN, YU, ZW, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: PRESSURE BALANCED TURBOCHARGER ROTATING SEAL



(57) Abstract

A pressure balanced turbocharger rotating seal is provided by two piston rings (66, 68) mounted on the shaft (22) of the turbocharger, one of the rings (66, 68) engaging a circumferential surface of the shaft bore in the center housing and the second ring (68) engaging a circumferential surface of the shaft bore (30) in the turbine wheel (25) shroud, with a passage (74) for introducing pressurizing gas intermediate the two rings (66, 68), the passage (74) including a circumferential channel (78) in the inner face of the turbine wheel shroud, and a compression seal (82) engaged between the center housing and turbine wheel shroud outboard of the channel.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	**ES**	Spain	**LS**	Lesotho	**SI**	Slovenia
AM	Armenia	**FI**	Finland	**LT**	Lithuania	**SK**	Slovakia
AT	Austria	**FR**	France	**LU**	Luxembourg	**SN**	Senegal
AU	Australia	**GA**	Gabon	**LV**	Latvia	**SZ**	Swaziland
AZ	Azerbaijan	**GB**	United Kingdom	**MC**	Monaco	**TD**	Chad
BA	Bosnia and Herzegovina	**GE**	Georgia	**MD**	Republic of Moldova	**TG**	Togo
BB	Barbados	**GH**	Ghana	**MG**	Madagascar	**TJ**	Tajikistan
BE	Belgium	**GN**	Guinea	**MK**	The former Yugoslav Republic of Macedonia	**TM**	Turkmenistan
BF	Burkina Faso	**GR**	Greece			**TR**	Turkey
BG	Bulgaria	**HU**	Hungary	**ML**	Mali	**TT**	Trinidad and Tobago
BJ	Benin	**IE**	Ireland	**MN**	Mongolia	**UA**	Ukraine
BR	Brazil	**IL**	Israel	**MR**	Mauritania	**UG**	Uganda
BY	Belarus	**IS**	Iceland	**MW**	Malawi	**US**	United States of America
CA	Canada	**IT**	Italy	**MX**	Mexico	**UZ**	Uzbekistan
CF	Central African Republic	**JP**	Japan	**NE**	Niger	**VN**	Viet Nam
CG	Congo	**KE**	Kenya	**NL**	Netherlands	**YU**	Yugoslavia
CH	Switzerland	**KG**	Kyrgyzstan	**NO**	Norway	**ZW**	Zimbabwe
CI	Côte d'Ivoire	**KP**	Democratic People's Republic of Korea	**NZ**	New Zealand		
CM	Cameroon			**PL**	Poland		
CN	China	**KR**	Republic of Korea	**PT**	Portugal		
CU	Cuba	**KZ**	Kazakstan	**RO**	Romania		
CZ	Czech Republic	**LC**	Saint Lucia	**RU**	Russian Federation		
DE	Germany	**LI**	Liechtenstein	**SD**	Sudan		
DK	Denmark	**LK**	Sri Lanka	**SE**	Sweden		
EE	Estonia	**LR**	Liberia	**SG**	Singapore		

PRESSURE BALANCED TURBOCHARGER ROTATING SEAL

BACKGROUND OF THE INVENTION

Field of the Invention:

This invention relates generally to turbocharger shaft seal arrangements. More particularly, a pressure balanced dual piston ring configuration on the shaft in combination with a compression seal engaged between the center housing and turbine wheel shroud provides an effective turbine end seal for avoiding contamination by condensates and vapor in the exhaust gas driving the turbine.

Description of the Related Art:

Turbochargers are being employed in numerous applications including conventional internal combustion engine charge air boosting and new concepts for turbopumping of exhaust gases and pressurizing reactants for power generation systems such as fuel cells. In most turbochargers operational requirements dictate the need for relatively leak-free seals between the shaft bearings within the center housing, and the rotating turbine and compressor wheels. This is particularly true at the turbine end of the shaft, since the turbine typically operates in a relatively high temperature environment. Accordingly, it is desirable to prevent leakage of bearing lubricant into the turbine housing to prevent gumming or coking of the lubricant in high temperature applications, which can detrimentally affect the turbine performance and further to prevent partial ignition of the lubricant within the turbine housing or blow through of the lubricant, either of which creates adverse effects on the level of pollutants discharged by the system. Similarly, avoiding contamination of the inlet compression gas stream by lubricant from the center housing is important.

In many applications, the requirement exists for significantly reduced contamination of the compression gas stream over the available art and avoiding contamination of the turbocharger lubricating oil by water vapor, condensates or other corrosive effluents in the exhaust gas stream driving the turbine of the turbocharger. The prior art typically employs one or more sealing rings on the turbine shaft in a labyrinth arrangement for preventing leakage on one or both the turbine and compressor sides of the shaft. Additionally, venting the compressor end seal within the center housing to allow lubricant contacting the seal to drain and slinger arrangements

on the shaft for pumping excess lubricant radially away from the seal rings are employed for increasing efficiency of the overall seal configuration. These prior art configurations, singly and in various combinations have not demonstrated sufficient sealing capability for new high efficiency sealing requirements.

The present invention provides increased sealing effectiveness over the prior art by combining plural sealing elements with an integral pressure balancing cavity receiving pressurizing gas from the compressed gas stream or an external source.

SUMMARY OF THE INVENTION

The present invention provides a seal for a turbine shaft wheel employed in a turbocharger comprising first and second piston rings mounted on the shaft, the first ring sealingly engaging a circumferential surface of the shaft bore in the center housing casting and the second ring sealingly engaging a circumferential surface of the shaft bore in the turbine wheel shroud. A passage having a portion integral to the center housing for introducing a pressurizing gas, communicates with the shaft bore intermediate the first and second piston rings, with a second portion of the passage including a circumferential channel in the inner face of the turbine wheel shroud. An O-ring seal engaged between the center housing and turbine wheel shroud outboard of the channel completes the seal on the turbine end of the shaft.

A positive face seal on the compressor end of the shaft, in combination with the pressure balanced twin seal ring and compression seal arrangement of the turbine end provides efficacious seals for preventing contamination of the compression gas stream and avoiding contamination of the lubricant respectively.

In alternative embodiments requiring higher temperature capability for the turbine, the O-ring seal is replaced with an appropriate high temperature compression seal.

BRIEF DESCRIPTION OF THE DRAWINGS

The details and features of the present invention will be more clearly understood with respect to the detailed description and drawings in which:

FIG. 1 is a side section view of a turbocharger employing the present invention;

FIG. 2 is a detailed section view of the center housing of the turbocharger of FIG. 1 showing the elements of the present invention in a current embodiment; and

FIG. 3 is a detailed top section view of the turbocharger center housing of FIG1 showing the pressure port a schematic representation of the pressurizing gas sources.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings, FIG. 1 shows a turbocharger embodiment employing the present invention which includes a center housing 10, a compressor housing 12 connected to the center housing by bolts 14 or other conventional means, and a turbine housing 16 connected to the center housing with bolts 18. A bearing assembly, generally designated 20, is carried within the center housing and a shaft 22 is engaged by a center bore of the bearing. A compressor wheel 24 is mounted on one end of the shaft which extends through a first bore 26 in the compressor end of the center housing concentric with the center bore. A turbine wheel 28 is mounted on the second end of the shaft which extends through a second bore 30, also concentric with the center bore, in the turbine end of the center housing and a third bore 32, also concentric with the center bore, in a turbine wheel shroud 34. The turbine wheel shroud (defined in alternative embodiments as a turbine backface or heat shield) is mounted to the center housing or constrained between the center housing and turbine housing for the embodiment shown in the drawings. The first, second and third bores and the center bore of the bearing collectively comprise a shaft bore for the turbocharger.

The turbocharger operates conventionally with expansion gas provided through a volute 36 in the turbine housing to aerodynamically drive the turbine, exhausting through outlet 38 in the turbine housing. Rotation of the turbine is carried through the shaft to rotate the compressor wheel, drawing compression gas through the inlet 40 in

the compressor housing with compressed gas exiting the compressor into volute 42 for communication to an engine inlet manifold or other compressed gas user.

For the embodiment shown in the drawings, the bearing system includes a bearing outer ring 44 received within a bearing carrier 46. A bearing inner ring 48 which is mounted for rotation with the shaft, is supported by axially separated sets of roller bearing elements 50 and 52. Lubricating oil injection channels, generally designated 54 and a collection sump 56 constitute the lubrication system for the bearings and shaft. Compressive loads are carried by a collar 58 on the turbine end of the shaft and collar 60 and ring 62 on the compressor end of the shaft. For the embodiment shown in the drawings, thrust loads are carried by the roller bearing elements. In alternative embodiments of the present invention, journal bearings and associated thrust bearings are employed as the bearing system for the shaft. Contouring of the turbine end of the shaft, generally designated 64 provides a slinger effect for oil collection.

First and second piston rings 66 and 68 mounted on the shaft, provide a labyrinth seal with the first ring sealingly engaging a circumferential surface 70 of the second bore 30 in the center housing and the second ring sealingly engaging a circumferential surface 72 of the third bore 32 in the turbine wheel shroud. A passage 74 having a first portion 76 integral to the center housing for introducing a pressurizing gas, communicates with the shaft bore intermediate the first and second piston rings, with a second portion of the passage including a circumferential channel 78 in the inner face 80 of the turbine wheel shroud. An O-ring seal 82 engaged between the center housing and turbine wheel shroud outboard of the channel completes the seal on the turbine end of the shaft.

Pressurizing gas is provided to passage 74 through port 84, as shown in FIG. 3, which is connected to an external source such as compressed brake air tank in a vehicle application, independent pressurized gas tanks or fed from the compressor volute of the turbocharger, or further downstream in the gas supply system. Each of these alternatives is shown schematically in FIGs.1 and 3. The first portion 76 of passage 74 is integrally cast in the center housing for the embodiment shown in the drawings, and extends to the turbine end face of the center housing. The circumferential channel 78 carries the pressurizing gas for equal distribution around the shaft between the seal rings through the clearance gap between the end face and turbine wheel shroud. The

pressurizing gas at a higher absolute pressure than the expansion gas in the turbine provides a pressure gradient across the outer seal ring precluding transmission of contaminants such as water vapor, corrosive condensates or other potential contaminants from the expansion gas to the lubricating system for the turbocharger. Similarly, the pressure established between the seals provides a gradient across the inner seal ring assisting the labyrinth configuration of the structure of the seal in precluding leakage of lubricating oil into the turbine housing.

A positive face seal 86 is provided on the compressor end of the shaft, which in combination with the pressure balanced twin seal ring and compression seal arrangement of the turbine end provides an efficacious seal for preventing contamination of the compression gas stream. An exemplary seal for use on the compressor end of the shaft is a carbon face seal such as that disclosed in U.S. Patent 4,420,160 entitled "Face Seal System" issued December 13,1983 to Herman C. Laham and having a common assignee with the present application.

In alternative embodiments requiring higher temperature capability for the turbine, the O-ring seal is replaced with an appropriate high temperature compression seal such as a compressible metal ring.

Having now described the invention in detail as required by the patent statutes, those skilled in the art will recognize modifications and substitutions to the specific embodiments disclosed herein. Such modifications and substitutions are within the scope and intent of the present invention as defined in the following claims.

WHAT IS CLAIMED IS:

1. A seal for a turbine wheel shaft employed in a turbocharger comprising:

a shaft supporting a turbine wheel and a compressor wheel, said shaft rotatably retained within a shaft bore extending through a center housing and a turbine wheel shroud;

first and second piston rings mounted on the shaft proximate the turbine wheel, the first ring sealingly engaging a circumferential surface of the shaft bore in the center housing and the second ring sealingly engaging a circumferential surface of the shaft bore in the turbine wheel shroud;

a passage for introducing a pressurizing gas, the passage communicating with the shaft bore intermediate the first and second piston rings;

means for supplying pressurizing gas to the passage; and

a compression seal engaged between the center housing and turbine wheel shroud outboard of the channel.

2. A seal as defined in claim 1 wherein the passage includes a first portion integral with the center housing and a second portion comprising a circumferential channel in the inner face of the turbine wheel shroud.

3. A seal as defined in claim 1 wherein the compression seal comprises an O-ring.

4. A seal as defined in claim 1 wherein the compression seal comprises a deformable metallic ring.

5. A seal as defined in claim 2 wherein the center housing is a casting and the first portion of the passage is integrally cast with the center housing.

6. A seal as defined in claim 2 wherein the means for supplying pressurizing gas comprises a port in the center housing operably interconnected to the first portion of the passage and a pressurized gas source.

7. A seal as defined in claim 6 wherein the pressurized gas source comprises a pressure take-off from a volute receiving compressed gas from the compressor wheel.

8. A seal as defined in claim 6 wherein the pressurized gas source comprises a compressed gas tank.

9. A seal system for a turbine wheel and compressor wheel shaft employed in a turbocharger comprising:

a shaft supporting a turbine wheel and a compressor wheel, said shaft rotatably retained within a shaft bore extending through a center housing and a turbine wheel shroud;

first and second piston rings mounted on the shaft proximate the turbine wheel, the first ring sealingly engaging a circumferential surface of the shaft bore in the center housing and the second ring sealingly engaging a circumferential surface of the shaft bore in the turbine wheel shroud;

a passage for introducing a pressurizing gas, the passage communicating with the shaft bore intermediate the first and second piston rings;

means for supplying pressurizing gas to the passage;

a compression seal engaged between the center housing and turbine wheel shroud outboard of the channel; and

a positive face seal operatively engaging the shaft proximate the compressor wheel.

10. A seal system as defined in claim 9 wherein the passage includes a first portion integral with the center housing and a second portion comprising a circumferential channel in the inner face of the turbine wheel shroud.

11. A seal as defined in claim 10 wherein the center housing is a casting and the first portion of the passage is integrally cast with the center housing.

12. A seal as defined in claim 10 wherein the means for supplying pressurizing gas comprises a port in the center housing operably interconnected to the first portion of the passage and a pressurized gas source.

13. A seal as defined in claim 12 wherein the pressurized gas source comprises a pressure take-off from a volute receiving compressed gas from the compressor wheel.

14. A seal as defined in claim 12 wherein the pressurized gas source comprises a compressed gas tank.

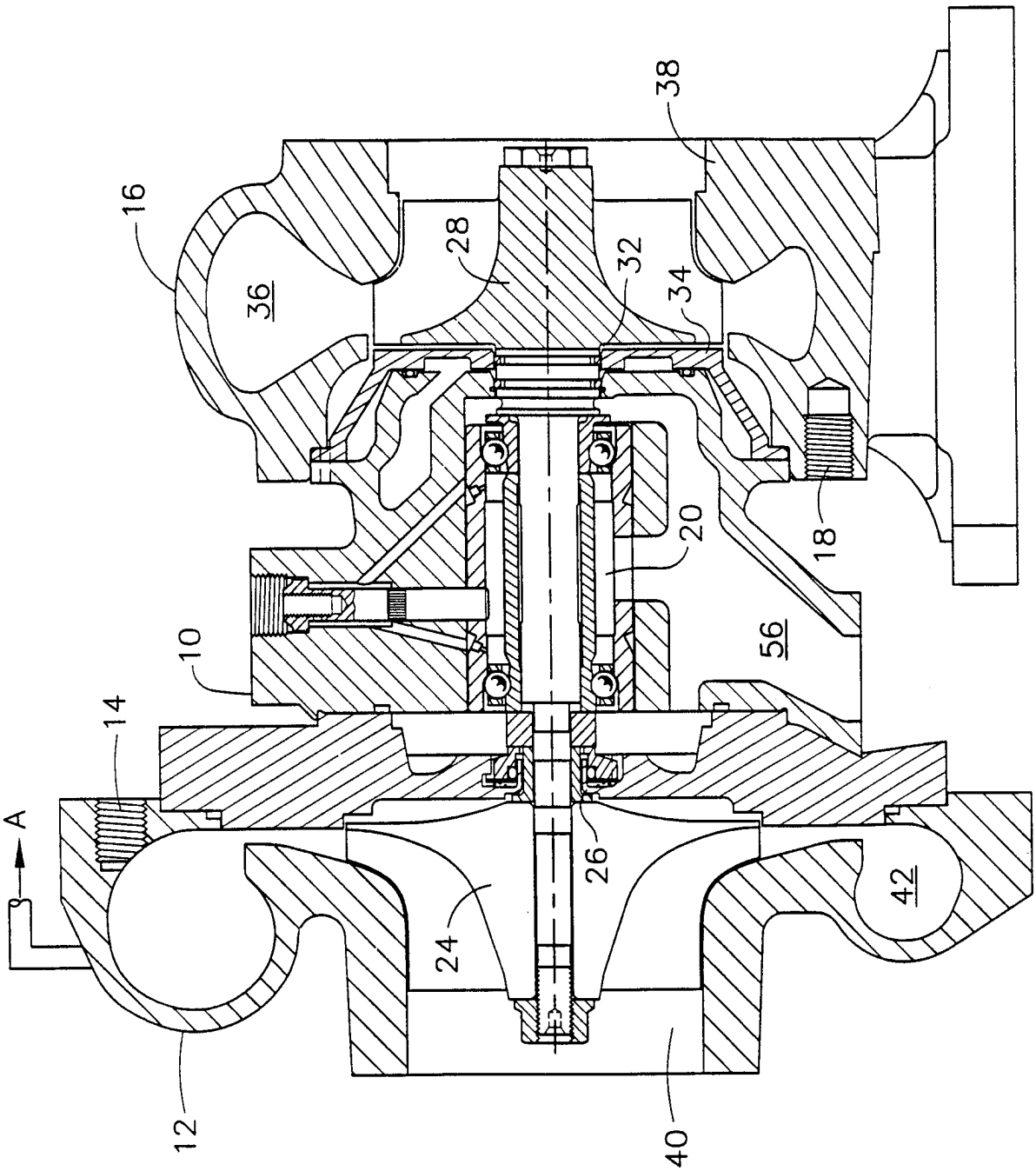


FIG. 1

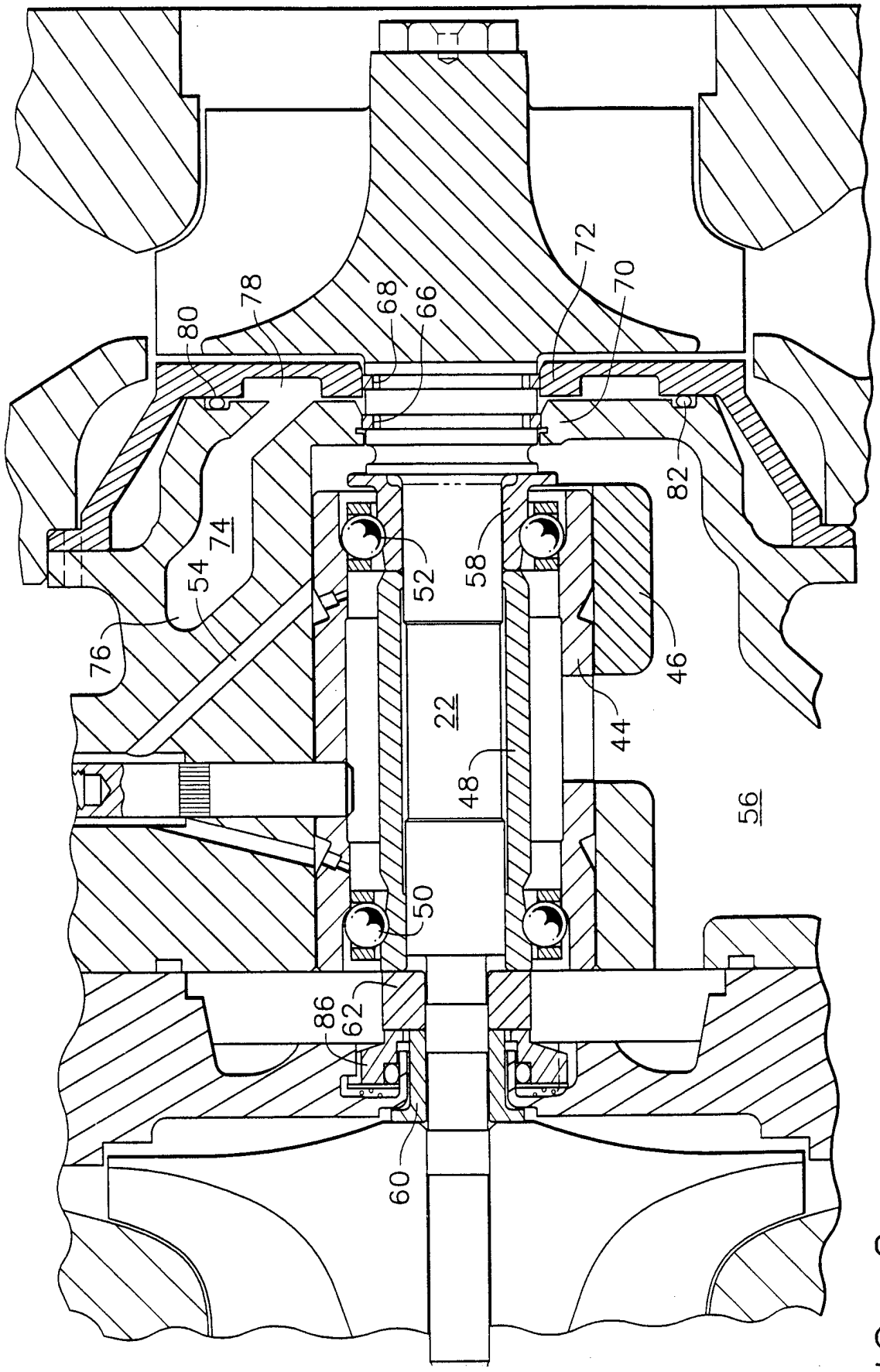


FIG. 2

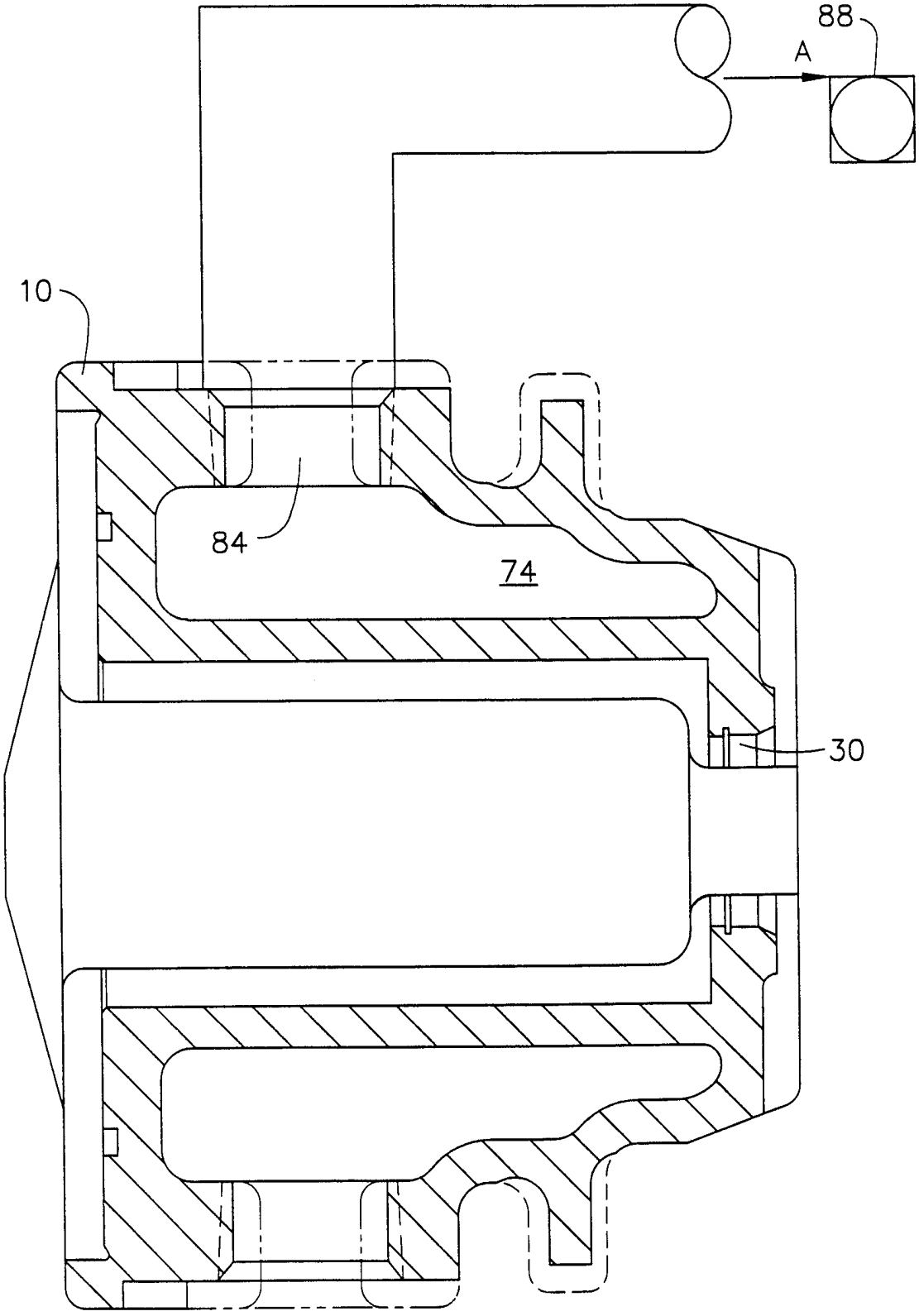


FIG. 3

INTERNATIONAL SEARCH REPORT

national Application No
PCT/US 97/21575

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F16J15/40

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F16J F04D F01D F02C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 357 246 A (NISSAN MOTOR) 7 March 1990 see the whole document ---	1,6,7,9, 12
A	US 4 377 290 A (NETZEL JAMES P) 22 March 1983 see figure 1 ---	3
A	DE 22 57 188 A (SCHLECHT KARL) 6 June 1974 see claim 1; figure 1 ---	8,14
A	EP 0 374 713 A (KLEIN SCHANZLIN & BECKER AG) 27 June 1990 ---	
A	EP 0 035 891 A (GARRETT CORP) 16 September 1981 --- -/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

2

Date of the actual completion of the international search	Date of mailing of the international search report
16 April 1998	27. 04. 98
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Hoffmann, M

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

In ational Application No
PCT/US 97/21575

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 1 124 203 A (CHICAGO PNEUMATIC TOOL COMPANY) 21 August 1968 ---	
A	DE 37 37 932 A (MOTOREN TURBINEN UNION) 18 May 1989 -----	

2

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

In: itional Application No
PCT/US 97/21575

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0357246 A	07-03-90	JP 2045616 A	15-02-90
		JP 2623736 B	25-06-97
		DE 68924512 D	16-11-95
		DE 68924512 T	04-04-96
		US 5076765 A	31-12-91
US 4377290 A	22-03-83	CA 1235434 A	19-04-88
		GB 2117064 A,B	05-10-83
DE 2257188 A	06-06-74	GB 1399035 A	25-06-75
EP 0374713 A	27-06-90	DE 3843429 A	28-06-90
EP 0035891 A	16-09-81	BR 8101288 A	15-09-81
		CA 1148188 A	14-06-83
		JP 1024944 B	15-05-89
		JP 1552568 C	23-03-90
		JP 56134669 A	21-10-81
		US 4420160 A	13-12-83
GB 1124203 A		NONE	
DE 3737932 A	18-05-89	CH 676379 A	15-01-91
		JP 1142203 A	05-06-89
		JP 1886557 C	22-11-94
		JP 6008614 B	02-02-94
		US 4865332 A	12-09-89