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(54) **ROLLING ELEMENT CAGE FOR GEARED TURBOFAN**

WÄLZKÖRPERKÄFIG FÜR GETRIEBETURBOLÜFTER

CAGE À CORPS DE ROULEMENT POUR TURBORÉACTEUR À ENGRENAGE

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Description

of an embodiment of the gear system.

BACKGROUND

[0001] A gas turbine engine typically includes a fan section, a compressor section, a combustor section and a turbine section. Air entering the compressor section is compressed and delivered into the combustion section where it is mixed with fuel and ignited to generate a high-speed exhaust gas flow. The high-speed exhaust gas flow expands through the turbine section to drive the compressor and the fan section. The compressor section typically includes low and high pressure compressors, and the turbine section includes low and high pressure turbines.

[0002] A speed reduction device such as an epicyclical gear system may be utilized to drive the fan section such that the fan section may rotate at a speed different than the turbine section so as to increase the overall propulsive efficiency of the engine. The high rotational speeds encountered by such gear systems require provisions for lubrication during all operating conditions to provide desired operation and durability.

[0003] EP 2 559 914 A1 discloses a gear system for a turbofan engine assembly as set forth in the preamble of claim 1.

SUMMARY

[0004] According to the invention, there is provided a gear system for a turbofan engine assembly, as set forth in claim 1.

[0005] The invention also provides a geared turbofan engine as set forth in claim 10.

[0006] Features of embodiments of the invention are set forth in the dependent claims.

[0007] Although the different examples have the specific components shown in the illustrations, embodiments of this disclosure are not limited to those particular combinations. It is possible to use some of the components or features from one of the examples in combination with features or components from another one of the examples.

[0008] These and other features disclosed herein can be best understood from the following specification and drawings, the following of which is a brief description.

BRIEF DESCRIPTION OF THE DRAWINGS**[0009]**

Figure 1 schematically shows an embodiment of a gas turbine engine.

Figure 2 schematically shows an embodiment of gear system for a gas turbine engine.

Figure 3 schematically shows a section of an embodiment of the gear system.

Figure 4 schematically shows an enlarged section

DETAILED DESCRIPTION

[0010] Figure 1 schematically illustrates an example gas turbine engine 20 that includes a fan section 22 and a core engine section 25. The core engine section 25 includes a compressor section 24, a combustor section 26 and a turbine section 28. Alternative engines might include an augmentor section (not shown) among other systems or features. The fan section 22 drives air along a bypass flow path B while the compressor section 24 draws air in along a core flow path C where air is compressed and communicated to a combustor section 26. In the combustor section 26, air is mixed with fuel and ignited to generate a high pressure exhaust gas stream that expands through the turbine section 28 where energy is extracted and utilized to drive the fan section 22 and the compressor section 24.

[0011] Although the disclosed non-limiting embodiment depicts a two-spool turbofan gas turbine engine, it should be understood that the concepts described herein are not limited to use with two-spool turbofans as the teachings may be applied to other types of turbine engines; for example a turbine engine including a three-spool architecture in which three spools concentrically rotate about a common axis and where a low spool enables a low pressure turbine to drive a fan via a gearbox, an intermediate spool that enables an intermediate pressure turbine to drive a first compressor of the compressor section, and a high spool that enables a high pressure turbine to drive a high pressure compressor of the compressor section.

[0012] The example engine 20 generally includes a low speed spool 30 and a high speed spool 32 mounted for rotation about an engine central longitudinal axis A relative to an engine static structure 36 via several bearing systems 38. It should be understood that various bearing systems 38 at various locations may alternatively or additionally be provided.

[0013] The low speed spool 30 generally includes an inner shaft 40 that connects a fan 42 and a low pressure (or first) compressor section 44 to a low pressure (or first) turbine section 46. The inner shaft 40 drives the fan 42 through a speed change device, such as a gear system 48, to drive the fan 42 at a lower speed than the low speed spool 30. The high-speed spool 32 includes an outer shaft 50 that interconnects a high pressure (or second) compressor section 52 and a high pressure (or second) turbine section 54. The inner shaft 40 and the outer shaft 50 are concentric and rotate via the bearing systems 38 about the engine central longitudinal axis A.

[0014] A combustor 56 is arranged between the high pressure compressor 52 and the high pressure turbine 54. In one example, the high pressure turbine 54 includes at least two stages to provide a double stage high pressure turbine 54. In another example, the high pressure turbine 54 includes only a single stage. As used herein,

a "high pressure" compressor or turbine experiences a higher pressure than a corresponding "low pressure" compressor or turbine.

[0015] The example low pressure turbine 46 has a pressure ratio that is greater than about 5. The pressure ratio of the example low pressure turbine 46 is measured prior to an inlet of the low pressure turbine 46 as related to the pressure measured at the outlet of the low pressure turbine 46 prior to an exhaust nozzle.

[0016] A mid-turbine frame 58 of the engine static structure 36 is arranged generally between the high pressure turbine 54 and the low pressure turbine 46. The mid-turbine frame 58 further supports bearing systems 38 in the turbine section 28 as well as setting airflow entering the low pressure turbine 46. Although the example engine embodiment includes a mid-turbine frame 58, it is within the contemplation of this disclosure to include a turbine section 28 without a mid-turbine frame 58.

[0017] Airflow through the core airflow path C is compressed by the low pressure compressor 44 then by the high pressure compressor 52 mixed with fuel and ignited in the combustor 56 to produce high speed exhaust gases that are then expanded through the high pressure turbine 54 and low pressure turbine 46. The mid-turbine frame 58 includes vanes 60, which are in the core airflow path and function as an inlet guide vane for the low pressure turbine 46. Utilizing the vane 60 of the mid-turbine frame 58 as the inlet guide vane for low pressure turbine 46 decreases the length of the low pressure turbine 46 without increasing the axial length of the mid-turbine frame 58. Reducing or eliminating the number of vane rows or states in the low pressure turbine 46 shortens the axial length of the turbine section 28. Thus, the compactness of the gas turbine engine 20 is increased and a higher power density may be achieved.

[0018] The disclosed gas turbine engine 20 in one example is a high-bypass geared aircraft engine. In a further example, the gas turbine engine 20 includes a bypass ratio greater than about six (6), with an example embodiment being greater than about ten (10). The example gear system 48 is an epicyclical gear train, such as a planetary gear system, star gear system or other known gear system, with a gear reduction ratio of greater than about 3:1.

[0019] In one disclosed embodiment, the gas turbine engine 20 includes a bypass ratio greater than about ten (10:1) and the fan diameter is significantly larger than an outer diameter of the low pressure compressor 44. It should be understood, however, that the above parameters are only exemplary of one embodiment of a gas turbine engine including a geared architecture and that the present disclosure is applicable to other gas turbine engines.

[0020] A significant amount of thrust is provided by the bypass flow B due to the high bypass ratio. The fan section 22 of the engine 20 is designed for a particular flight condition -- typically cruise at about 0.8 Mach and about 35,000 feet (10668 m). The flight condition of 0.8 Mach

and 35,000 ft. (10668 m), with the engine at its best fuel consumption - also known as "bucket cruise Thrust Specific Fuel Consumption ('TSFC')" - is the industry standard parameter of pound-mass (lbm) of fuel per hour being burned divided by pound-force (lbf) of thrust the engine produces at that minimum point.

[0021] Fan pressure ratio is the pressure ratio across the fan blade alone, without a Fan Exit Guide Vane ("FEGV") system. The low fan pressure ratio as disclosed herein according to one non-limiting embodiment is less than about 1.50. In another non-limiting embodiment the low fan pressure ratio is less than about 1.45.

[0022] Corrected fan tip speed is the actual fan tip speed in ft/sec divided by an industry standard temperature correction of $[(T_{\text{ram}} / 518.7) / (R)]^{0.5}$ (where $R = K \times 9/5$). The corrected fan tip speed, as disclosed herein according to one non-limiting embodiment, is less than about 1150 ft/second (350.5 m/s). The low fan pressure ratio and fan tip speed are applicable throughout all operational phases of the gas turbine engine and at least at the bucket cruise thrust specific fuel consumption operating conditions.

[0023] The example gas turbine engine includes the fan 42 that comprises in one non-limiting embodiment less than about twenty-six (26) fan blades. In another non-limiting embodiment, the fan section 22 includes less than about twenty (20) fan blades. Moreover, in one disclosed embodiment the low pressure turbine 46 includes no more than about six (6) turbine rotors schematically indicated at 34. In another non-limiting example embodiment the low pressure turbine 46 includes about three (3) turbine rotors. A ratio between the number of fan blades 42 and the number of low pressure turbine rotors is between about 3.3 and about 8.6. The example low pressure turbine 46 provides the driving power to rotate the fan section 22 and therefore the relationship between the number of turbine rotors 34 in the low pressure turbine 46 and the number of blades 42 in the fan section 22 disclose an example gas turbine engine 20 with increased power transfer efficiency.

[0024] Referring to Figure 2, with continued reference to Figure 1, a disclosed embodiment of the gear system 48 includes a sun gear 62 rotatable about the engine axis A by the inner shaft 40. The sun gear 62 drives a plurality of planet gears 64 circumscribed by a fixed ring gear 68. The planet gears 64 are supported in a carrier 66 that rotates about the engine axis A. Each of the planet gears 64 rotate about separate axes 70.

[0025] Referring to Figure 3 with continued reference to Figure 2, each of the planet gears 64 is supported on rolling element bearing assemblies 120. Because the carrier 66 is rotating, the bearing assemblies 120 experience gear loads, schematically shown at arrow G, and centrifugal loads, schematically shown as arrow C, of the rotating gear mass. The gear load G and centrifugal load C are added by vector summation and are applied to the bearing assemblies as a total load. The example gear system 48, with the rotating carrier, rotates more than

2500 rpm. Such speeds can generate total loads much higher than those typically encountered by rolling element bearing assemblies.

[0026] Referring to Figures 3 and 4, a disclosed gear system embodiment 48 includes the carrier 66 that supports the planet gears 64 and drives a fan shaft 74. The ring gear 68 is fixed to the static engine structure 36 through a flex mount 82. The sun gear 62, planet gears 64 and ring gear 68 are all centered along a gear centerline 72 to provide a single stage gear system 48.

[0027] The disclosed carrier 66 includes a forward plate 76 that is attached to an aft plate 78 by fasteners 80. An inner scoop 96 receives lubricant (such as oil) from a fixed inner lubricant jet 98. An outer scoop 88 receives lubricant from an outer lubricant jet 94. The inner lubricant scoop 96 communicates lubricant through passages 100 within the carrier 66 to a spray bar 102. The spray bar 102 sprays lubricant, via radial passages 105, into a gear interface 84 between the planet gears 64 and/or the ring gear 68 and a gear interface 86 between the planet gears 64 and the sun gear 62.

[0028] The planet gear 64 includes an inner cavity 106 disposed about the axis 70. Lubricant is communicated into the internal cavity 106 through the outer scoop 88. The outer scoop 88 catches lubricant directed from an outer fixed lubricant jet 94. Lubricant from the fixed lubricant jet 94 is caught and accumulated within an accumulator portion 90 of the outer scoop 88. In the accumulator portion 90, lubricant gathers until it reaches a level that enables flow into a passage 92 that leads to the inner cavity 106.

[0029] The disclosed bearing assembly 120 includes rolling bearing elements 112 supported between an outer race 114 and an inner race 116. The rolling bearing elements 112 can be a ball, roller, tapered roller spherical roller element. Moreover, other bearing configurations and shapes as are known for use in a rolling element bearing assembly are within the contemplation of this disclosure. The rolling bearing elements 112 are spaced apart by a cage 118 disposed between the inner race 116 and the outer race 114. The inner race 116 includes guide rails 122 with a surface 124. The cage 118 moves along the surface 124 of the guide rails 122 during operation.

[0030] Lubricant is directed radially outward into a first passage 108 defined within the planet gear 64 and a second passage 110 defined in the inner race 116.

[0031] Lubricant is directed radially outward into a first passage 108 defined within the planet gear 64 and a second passage 110 defined in the inner race 116. Lubrication is communicated to the rolling bearing elements 112 through a third passage 104 between the internal cavity 106 and an outer radial surface of the planet gear 64. The third passage 104 is angled to direct lubricant onto the rolling bearing element 112.

[0032] Lubricant within the inner cavity 106 is driven radially outward by centrifugal forces into the first lubricant passage 108 through the planet gear 64 and in turn

to the second lubricant passage 110 defined within the inner race 116. The second passage 110 extends through the guides 122 to the surface 124 interface with the cage 118. Lubricant works its way into a gap between the cage 118 and the surface 124. This gap closes under centrifugal load and acts like a journal bearing supporting the cage 118 under high load. Lubricant communicated to this interface prevents substantial wear at high loads.

[0033] Since the cage 118 is under high G load, the lubricant reduces frictional forces that may otherwise reduce operational life. The example cage 118 may be made from high durability materials including high-strength steels coated with silver, gold or nickel plate to further protect against wear. The guide rails 122 may also be coated with hard materials such as Titanium Nitride, Tungsten Carbide, Chrome or Chrome Carbide. Moreover, in one disclosed embodiment the surface 124 of the guide rails 122 may be formed to include a smooth finish of 16 micro-inches (0.4064 micrometer) or better. It should be understood that other materials and coatings that provide a desired durability and wear resistance are within the contemplation of this disclosure for any portion of the bearing assembly 120.

Claims

1. A gear system (48) for a turbofan engine assembly comprising:

- a sun gear (62) rotatable about an engine centerline (70);
- a non-rotatable ring gear (68);
- a rotating carrier (66) that drives a fan;
- a plurality of planet gears (64) intermeshed between the sun gear (62) and the ring gear (68);
- a rolling element bearing assembly (120) supporting rotation of the planet gears (64) on the carrier (66), the rolling element bearing assembly (120) including a rolling element (112);
- a first passage (108) for communicating lubricant through the planet gear (64); and
- a second passage (110) in communication with the first passage (108); wherein
- the rolling element (112) is between an inner race (116) and an outer race (114) separated by a cage (118); and
- the inner race (116) includes guide rails (122) with a surface (124);

characterised in that:

- the second passage (110) extends through the guide rails (122) of the inner race (116) to an interface between the surface (124) of the guide rails (122) and the cage (118);
- each of the plurality of planet gears (64) includes an inner cavity (106) disposed about an axis of

- rotation (70) of the respective planet gear (64);
and
the carrier (66) includes an outer scoop (88) that receives lubricant from an outer fixed lubricant jet (94) and feeds lubricant into the inner cavity (106) along the axis (70). 5
2. The gear system as recited in claim 1, wherein the first passage (108) is in communication with the inner cavity (106) and the planet gear (64) further includes a third passage (104) through the planet gear (64) that directs lubricant toward the rolling element bearing (112). 10
3. The gear system as recited in claim 2, wherein the outer scoop (88) feeds lubricant through the first lubricant passage (108), the second passage (110) and the third passage (104) to provide lubricant to the roller element bearing assembly (120). 15
4. The gear system as recited in claim 3, wherein the carrier (66) includes an inner scoop (96) that receives lubricant from an inner fixed lubricant jet (98) and feeds lubricant through the carrier (66) to a spray bar (102), the spray bar (102) spraying lubricant into at least one of the gear interfaces between the planet gear (64), the sun gear (62) and the ring gear (68). 20
5. The gear system as recited in any preceding claim, wherein the rolling element bearing (120) is one of a ball, roller, tapered roller and spherical roller element. 25
6. The gear system as recited in any preceding claim, wherein the cage (118) comprises at least one of a steel and a steel alloy. 30
7. The gear system as recited in any preceding claim, wherein the cage (118) is plated within at least one of silver, nickel and gold. 35
8. The gear system as recited in any preceding claim, wherein the guide rails (122) are coated with at least one of Tungsten Carbide, Titanium Nitride, Chrome and Chrome Carbide alloy. 40
9. The gear system as recited in any preceding claim, wherein the interface between the surface (124) of the guide rails (122) and the cage (118) includes a machine surface finish of at least 16 micro-inches (0.4064 micrometer). 45
10. A geared turbofan engine (20) comprising:
- a fan (42) configured to drive air along a bypass flow path; 50
- a compressor section (24) configured to communicate compressed air to a combustor sec-

tion (26) for generating a high energy gas flow for driving a turbine section (28) where energy is extracted and utilized to drive the compressor section (24) and the fan (42); and
a gear system (48) driven by the turbine section (28) for driving the fan (42), the gear system being a gear system as recited in any preceding claim, the rotating carrier (66) driving the fan (42).

Patentansprüche

1. Zahnradsystem (48) für eine Turbofan-Triebwerksanordnung, umfassend:

ein Sonnenrad (62), das um eine Triebwerksmittellinie (70) drehbar ist;
ein nicht drehbares Hohlrad (68);
einen rotierenden Träger (66), der einen Fan antreibt;
eine Vielzahl von Planetenrädern (64), die zwischen dem Sonnenrad (62) und dem Hohlrad (68) kämmen;
eine Wälzkörperlageranordnung (120), die die Rotation der Planetenräder (64) an dem Träger (66) unterstützt; wobei die Wälzkörperlageranordnung (120) einen Wälzkörper (112) beinhaltet;
einen ersten Kanal (108) zum Leiten eines Schmiermittels durch das Planetenrad (64); und
einen zweiten Kanal (110) in Kommunikation mit dem ersten Kanal (108); wobei
der Wälzkörper (112) zwischen einem inneren Laufring (116) und einem äußeren Laufring (114) liegt, die durch einen Käfig (118) getrennt sind; und
der innere Laufring (116) Führungsschienen (122) mit einer Oberfläche (124) beinhaltet; **dadurch gekennzeichnet, dass:**

sich der zweite Kanal (110) durch die Führungsschienen (122) des inneren Laufrings (116) zu einer Grenzfläche zwischen der Oberfläche (124) der Führungsschienen (122) und dem Käfig (118) erstreckt;
jedes aus der Vielzahl von Planetenrädern (64) einen inneren Hohlraum (106) beinhaltet, der um eine Rotationsachse (70) des jeweiligen Planetenrads (64) angeordnet ist; und
der Träger (66) eine äußere Mulde (88) beinhaltet, die Schmiermittel von einer äußeren feststehenden Schmiermitteldüse (94) aufnimmt und Schmiermittel dem inneren Hohlraum (106) entlang der Achse (70) zuführt.

2. Zahnradsystem nach Anspruch 1, wobei der erste Kanal (108) in Kommunikation mit dem inneren Hohlraum (106) steht und das Planetenrad (64) ferner einen dritten Kanal (104) durch das Planetenrad (64) beinhaltet, der Schmiermittel zum Wälzkörperlager (112) leitet. 5
3. Zahnradsystem nach Anspruch 2, wobei die äußere Mulde (88) Schmiermittel durch den ersten Schmiermittelkanal (108), den zweiten Kanal (110) und den dritten Kanal (104) zuführt, um Schmiermittel zu der Wälzkörperlageranordnung (120) zu liefern. 10
4. Zahnradsystem nach Anspruch 3, wobei der Träger (66) eine innere Mulde (96) beinhaltet, die Schmiermittel von einer inneren feststehenden Schmiermitteldüse (98) aufnimmt und Schmiermittel durch den Träger (66) einem Spritzbalken (102) zuführt, wobei der Spritzbalken (102) Schmiermittel in mindestens eine aus den Zahnradgrenzflächen zwischen dem Planetenrad (64), dem Sonnenrad (62) und dem Hohlrad (68) spritzt. 20
5. Zahnradsystem nach einem der vorstehenden Ansprüche, wobei das Wälzkörperlager (120) eines aus einer Kugel, einer Walze, einer Kegelrolle, und einem Pendelrollenkörper ist. 25
6. Zahnradsystem nach einem der vorstehenden Ansprüche, wobei der Käfig (118) mindestens eines aus einem Stahl und einer Stahllegierung umfasst. 30
7. Zahnradsystem nach einem der vorstehenden Ansprüche, wobei der Käfig (118) mit mindestens einem aus Silber, Nickel und Gold plattiert ist. 35
8. Zahnradsystem nach einem der vorstehenden Ansprüche, wobei die Führungsschienen (122) mit mindestens einer aus Wolframcarbid-, Titannitrid-, Chrom- und Chromcarbidlegierung beschichtet ist. 40
9. Zahnradsystem nach einem der vorstehenden Ansprüche, wobei die Grenzfläche zwischen der Oberfläche (124) der Führungsschienen (122) und dem Käfig (118) eine Maschinenoberflächenglätte von mindestens 16 Mikrozoll (0,4064 Mikrometer) beinhaltet. 45
10. Getriebe-Turbofan-Triebwerk (20), umfassend: 50
 - einen Fan (42), der so konfiguriert ist, dass er Luft entlang eines Nebenstromströmungswegs treibt;
 - einen Verdichterabschnitt (24), der so konfiguriert ist, dass er verdichtete Luft zu einem Brennkammerabschnitt (26) zum Erzeugen eines Hochenergiegasstroms zum Antreiben eines Turbinenabschnitts (28) leitet, wo Energie ent-

zogen und verwendet wird, um den Verdichterabschnitt (24) und den Fan (42) anzutreiben; und
 ein Zahnradsystem (48), das von dem Turbinenabschnitt (28) zum Antreiben des Fans (42) angetrieben wird, wobei das Zahnradsystem ein Zahnradsystem nach einem der vorstehenden Ansprüche ist, wobei der rotierende Träger (66) den Fan (42) antreibt.

Revendications

1. Système d'engrenage (48) pour un ensemble turbo-réacteur comprenant :
 - une roue solaire (62) pouvant tourner autour d'un axe central de moteur (70) ;
 - une roue dentée (68) non rotative ;
 - un support rotatif (66) qui entraîne une soufflante ;
 - une pluralité d'engrenages planétaires (64) engrenés entre la roue solaire (62) et la roue dentée (68) ;
 - un ensemble palier à corps de roulement (120) supportant la rotation des engrenages planétaires (64) sur le support (66), l'ensemble palier à corps de roulement (120) comportant un corps de roulement (112) ;
 - un premier passage (108) pour faire communiquer le lubrifiant à travers l'engrenage planétaire (64) ; et
 - un deuxième passage (110) en communication avec le premier passage (108) ; dans lequel le corps de roulement (112) est situé entre une bague intérieure (116) et une bague extérieure (114) séparées par une cage (118) ; et la bague intérieure (116) comporte des rails de guidage (122) avec une surface (124) ; **caractérisé en ce que** :
 - le deuxième passage (110) s'étend à travers les rails de guidage (122) de la bague intérieure (116) jusqu'à une interface entre la surface (124) des rails de guidage (122) et la cage (118) ;
 - chacun de la pluralité d'engrenages planétaires (64) comporte une cavité interne (106) disposée autour d'un axe de rotation (70) de l'engrenage planétaire respectif (64) ; et
 - le support (66) comporte une buse externe (88) qui reçoit le lubrifiant d'un jet de lubrifiant externe fixe (94) et alimente en lubrifiant la cavité interne (106) le long de l'axe (70) .
2. Système d'engrenage selon la revendication 1, dans

- lequel le premier passage (108) est en communication avec la cavité interne (106) et l'engrenage planétaire (64) comporte en outre un troisième passage (104) à travers l'engrenage planétaire (64) qui dirige le lubrifiant vers le palier à corps de roulement (112) . 5
3. Système d'engrenage selon la revendication 2, dans lequel la buse externe (88) alimente en lubrifiant à travers le premier passage de lubrifiant (108), le deuxième passage (110) et le troisième passage (104) pour fournir du lubrifiant à l'ensemble palier à corps de roulement (120). 10
4. Système d'engrenage selon la revendication 3, dans lequel le support (66) comporte une buse interne (96) qui reçoit le lubrifiant d'un jet de lubrifiant fixe intérieur (98) et alimente en lubrifiant à travers le support (66) une barre de pulvérisation (102), la barre de pulvérisation (102) pulvérisant du lubrifiant dans au moins l'une des interfaces d'engrenage entre l'engrenage planétaire (64), la roue solaire (62) et la couronne dentée (68). 15 20
5. Système d'engrenage selon une quelconque revendication précédente, dans lequel le palier à corps de roulement (120) est l'un d'un corps à billes, à rouleaux, à rouleaux coniques et à rouleaux sphériques. 25
6. Système d'engrenage selon une quelconque revendication précédente, dans lequel la cage (118) comprend au moins l'un d'un acier et d'un alliage d'acier. 30
7. Système d'engrenage selon une quelconque revendication précédente, dans lequel la cage (118) est plaquée avec au moins l'un de l'argent, du nickel et de l'or. 35
8. Système d'engrenage selon une quelconque revendication précédente, dans lequel les rails de guidage (122) sont revêtus d'au moins l'un parmi le carbure de tungstène, le nitrure de titane, le chrome et l'alliage de carbure de chrome. 40
9. Système d'engrenage selon une quelconque revendication précédente, dans lequel l'interface entre la surface (124) des rails de guidage (122) et la cage (118) comporte une finition de surface de machine d'au moins 16 micropouces (0,4064 micromètre). 45
10. Turboréacteur à engrenage (20) comprenant : 50
- une soufflante (42) conçue pour entraîner l'air le long d'un chemin d'écoulement de dérivation ;
une section de compresseur (24) conçue pour communiquer de l'air comprimé à une section de chambre de combustion (26) pour générer un flux de gaz à haute énergie afin d'entraîner une section de turbine (28) où l'énergie est ex-

traite et utilisée pour entraîner la section de compresseur (24) et la soufflante (42) ; et un système d'engrenage (48) entraîné par la section de turbine (28) pour entraîner la soufflante (42), le système d'engrenage étant un système d'engrenage selon une quelconque revendication précédente, le support rotatif (66) entraînant la soufflante (42).

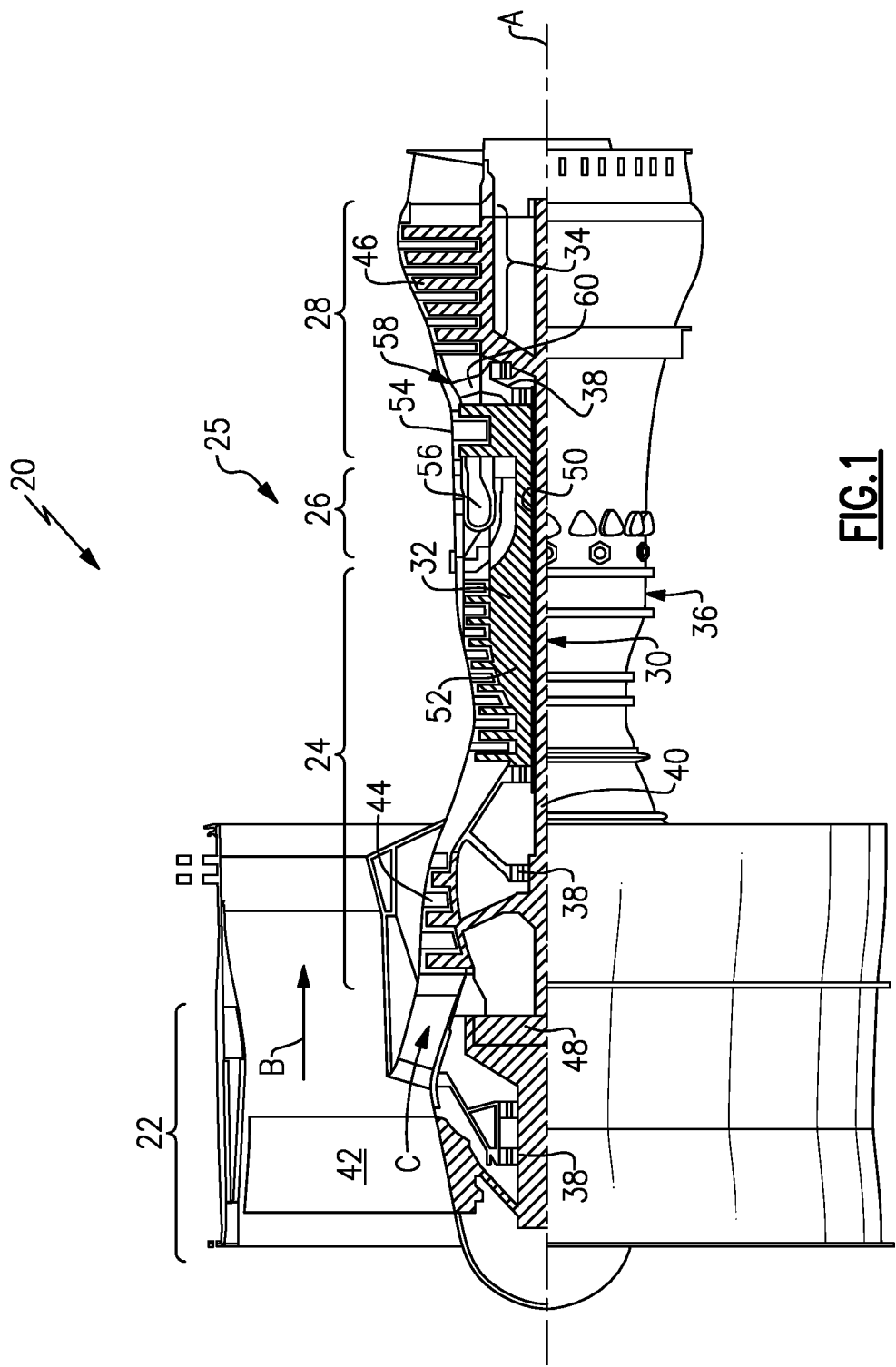


FIG.1

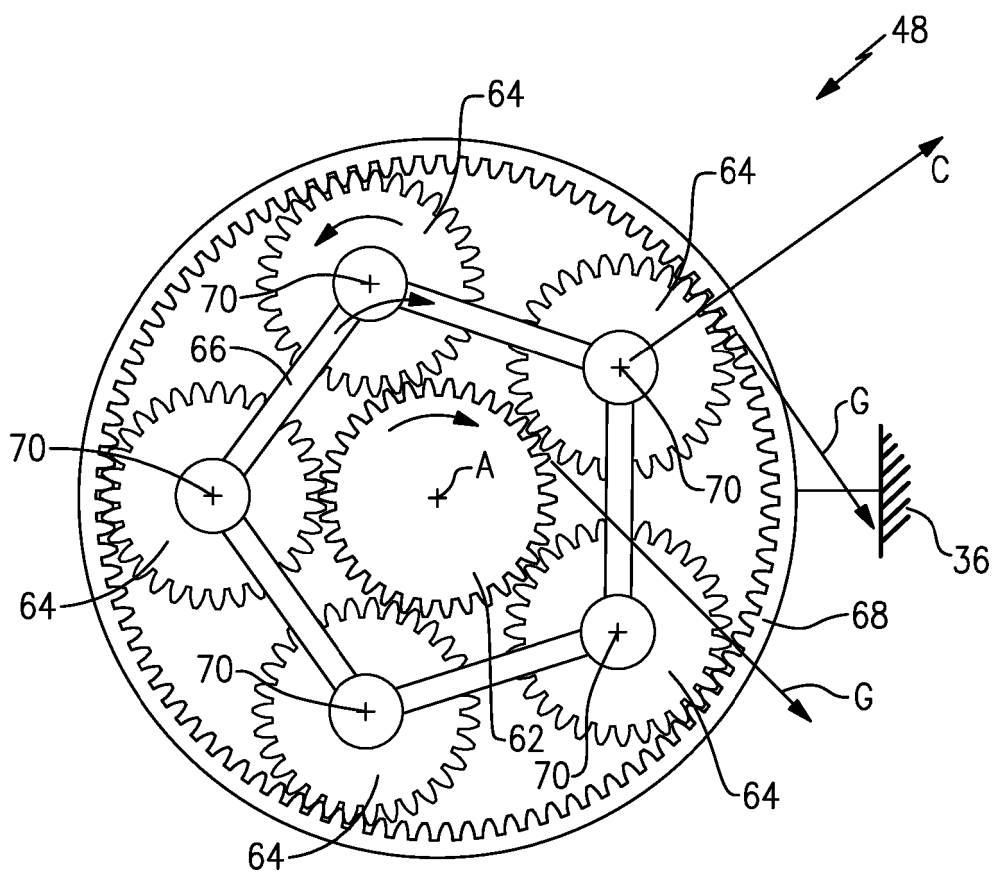


FIG.2

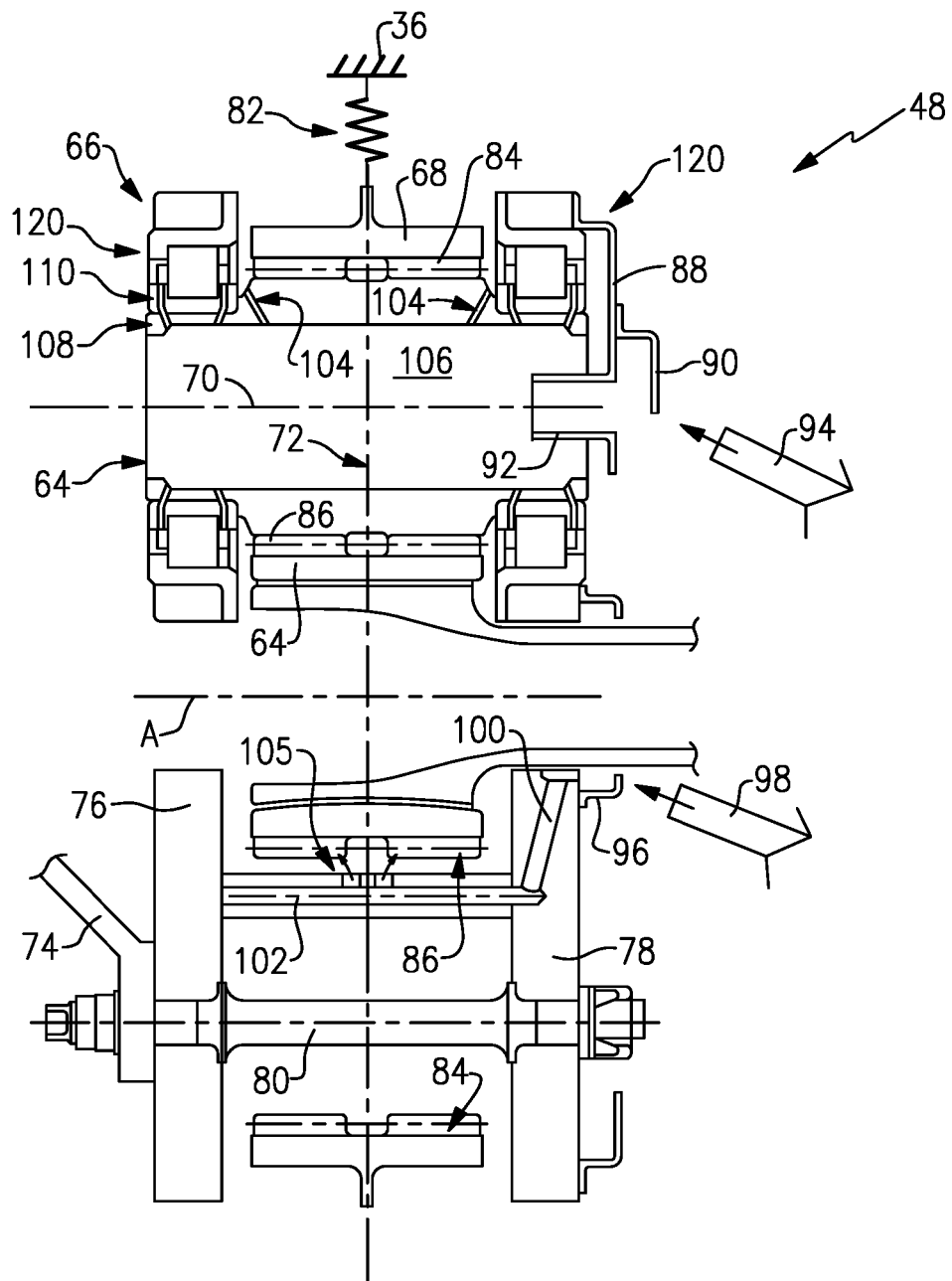


FIG.3

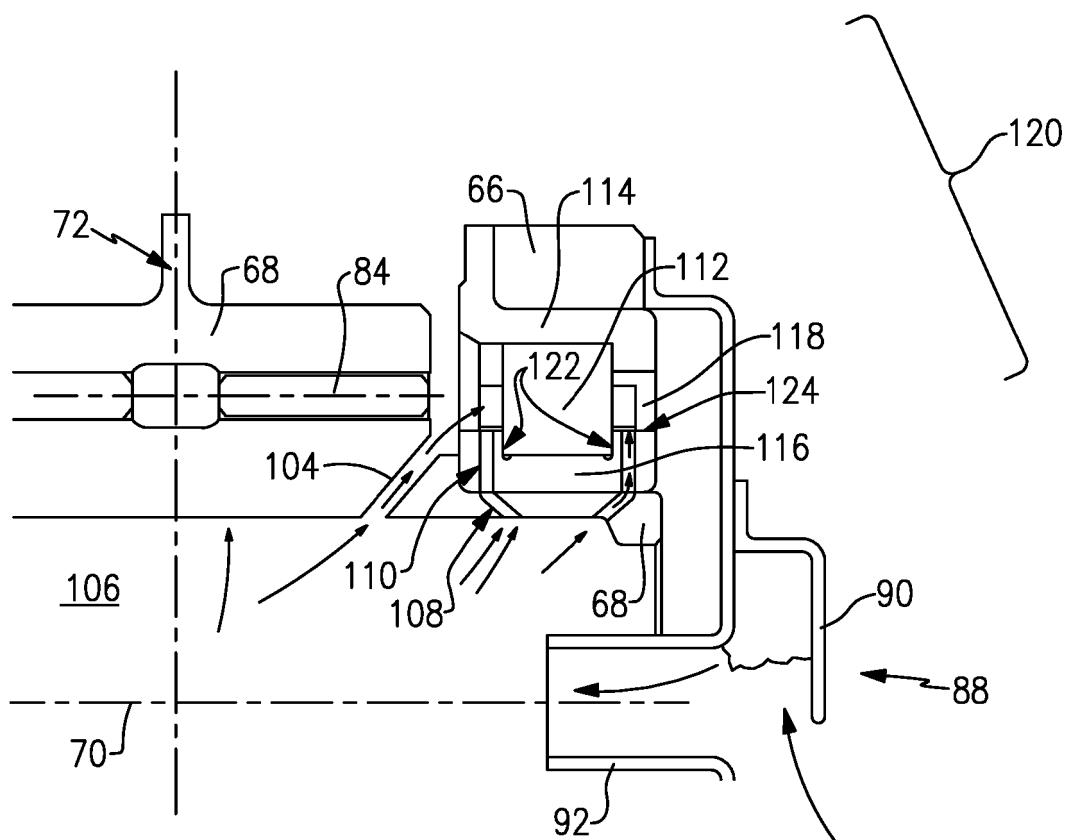


FIG.4

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 2559914 A1 [0003]