(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
3 July 2014 (03.07.2014)

WIPO | PCT

(10) International Publication Number
WO 2014/105668 A1

(51) International Patent Classification:
F02C 7/20 (2006.01) *F01D 25/24* (2006.01)
F02C 7/00 (2006.01)

(21) International Application Number:
PCT/US2013/076790

(22) International Filing Date:
20 December 2013 (20.12.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/746,775 28 December 2012 (28.12.2012) US

(71) Applicant: **UNITED TECHNOLOGIES CORPORATION** [US/US]; One Financial Plaza, Hartford, CT 06101 (US).

(72) Inventor: **LITTLE, Jonathan, D.**; 51 Belknap Road, West Hartford, CT 06117 (US).

(74) Agents: **KOMAREC, Stephen, M.** et al.; Kinney & Lange, P.A., 312 South Third Street, Minneapolis, MN 55415 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

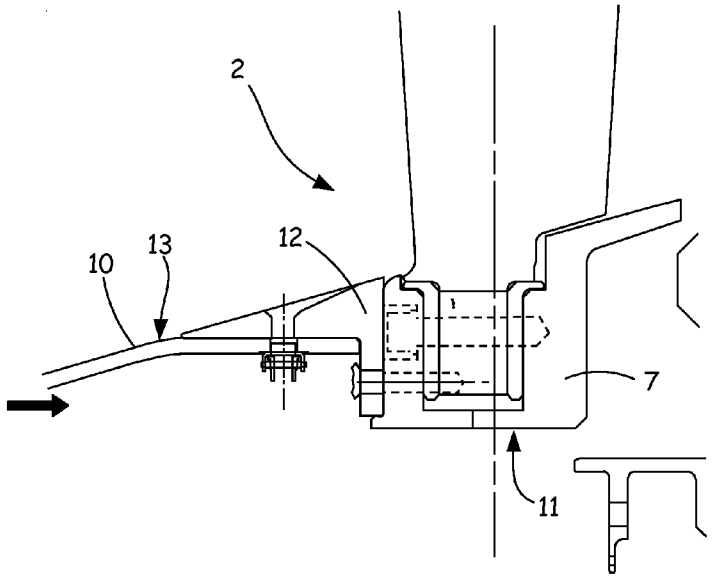
— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

[Continued on next page]

(54) Title: GAS TURBINE ENGINE NOSECONE ATTACHMENT STRUCTURE



(57) Abstract: A single piece nosecone with support ring and fastening method providing smooth aerodynamic flow into a gas turbine engine is disclosed. The support ring may include a rim having a curved upper surface, the curvature following a curve of the nosecone and having a hole extending radially therethrough to connect to the nosecone. The support ring may also include a flange having a first portion with a wall resting on top of a platform of the nosecone, the first portion having a hole aligned with the hole in the rim to connect to the nosecone and a second portion extending substantially radially from the first portion and having a hole extending therethrough, the second portion being employed to connect to the gas turbine engine.

WO 2014/105668 A1

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

GAS TURBINE ENGINE NOSECONE ATTACHMENT STRUCTURE

BACKGROUND

The present disclosure relates generally to gas turbine engines and, more particularly, to nosecones for gas turbine engines.

A gas turbine engine is a type of power plant commonly used for generating thrust for aircrafts, power for land or sea based operations, or other applications. A typical gas turbine engine includes an inlet section for drawing in a large mass of air, a compressor section for receiving and compressing the large mass of air to provide high-pressure air, a combustion section for mixing and combusting air and fuel, and a turbine section for receiving combustion gases and causing turbine blades to rotate to generate the aforementioned thrust or power.

The inlet section of the gas turbine engine may employ a nosecone assembly attached to a support structure, such as a support structure attached to a rotor. The nosecone assembly is generally constructed of multiple pieces of a very specific shape which are manufactured and assembled to tight tolerances to provide aerodynamic flow of air into the gas turbine engine. The nosecone assembly often includes a nosecone and a separate end cap attached to the nosecone. A support structure is provided to allow the cap to be bolted thereto. Due to the nosecone being constructed of a thin metal sheet, it is difficult to attach the nosecone to the support structure and the cap to the nosecone without warping or breaking the nosecone. Furthermore, conventional support structures can disrupt the aerodynamic flow of air around the nosecone. Such support structures can be relatively bulky, heavy, and expensive.

SUMMARY

According to the present invention, a method includes connecting an inboard extending portion of a flange of a support ring to a gas turbine engine and sliding a nosecone into the support ring until a tip of a rim of the support ring hits a step at one end of a platform of the nosecone. The rim of the support ring is connected to the platform of the nosecone.

Another embodiment is a support ring for connecting a nosecone to a gas turbine engine. The support ring includes a rim and a flange. The rim has a conical surface that follows a curve of the nosecone. The rim has a hole extending radially therethrough to connect to the nosecone. The flange has a first portion with a wall

resting on top of a platform of the nosecone. The first portion has a hole aligned with the hole in the rim to connect to the nosecone. The second portion extends substantially radially from the first portion and has a hole extending therethrough.

Another embodiment is a gas turbine engine including a nosecone, a gas turbine engine static support structure, and a support ring. The nosecone has a platform having a step on one end thereof. The support ring connects the nosecone to the gas turbine engine static support structure. The support ring has a rim having a curved surface following a curvature of the nosecone and a flange having an inboard extending portion. The rim is employed to connect to the nosecone. The inboard extending portion is employed to connect to the gas turbine engine static support structure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view of a gas turbine engine.

FIG. 2 is a partial sectional view showing a nosecone attached to an inlet guide vane (IGV) inner shroud of a gas turbine engine via a support ring, in accordance with at least some embodiments of the present disclosure.

FIG. 3 shows a portion of FIG. 2 in an enlarged form.

FIGS. 4-6 show various steps of attaching the support ring of FIG. 2 to the nosecone and the IGV inner shroud.

FIG. 7 shows a perspective view of a portion of the nosecone and the support ring connected to the nosecone, in accordance with one embodiment of the present disclosure.

FIG. 8 shows a perspective view of a second embodiment of the nosecone and a sectional view of the support ring connected to the nosecone.

FIG. 9 shows a perspective view of the second embodiment of the nosecone with removal tools inserted through tool holes.

FIG. 10 shows a perspective view of the second embodiment of the nosecone after it has been removed from the support ring.

DETAILED DESCRIPTION

Referring now to the drawings, and with specific reference to FIG. 1, a gas turbine engine is generally referred to by reference numeral 2. As depicted and described herein, gas turbine engine 2 may be an industrial gas turbine engine such as those used in land-based power generation or the like. As shown herein, gas turbine engine 2 may generally include compressor section 3A mounted to central shaft 4A. Downstream of compressor section 3A is an annular combustion chamber 5.

Downstream of combustion chamber 5 is turbine section 6A also mounted to central shaft 4A.

In the illustrated embodiment, gas turbine engine 2 also includes compressor section 3B and turbine section 6B connected by shaft 4B. Compressor section 3A can be a low pressure compressor section, compressor section 3B can be a high pressure compressor section, turbine section 6B can be a high pressure turbine section, and turbine section 6A can be a low pressure turbine section. Shafts 4A and 4B are concentric and can rotate about centerline axis C_L. Turbine section 6C is a power turbine section rotating independently from and positioned downstream of turbine sections 6A and 6B. Turbine section 6C may, for example, drive an electrical generator, pump, or gearbox (not shown).

Accordingly, it can be seen that, generally speaking, gas turbine engine 2 works by having compressor sections 3A and 3B draw in ambient air and compressing the same. That compressed air is then delivered to combustion chamber 5 where it is ignited, with the resulting hot combustion gases then being delivered to turbine sections 6A, 6B, and 6C. The hot expanding combustion gases cause the blades of turbine section 6A to rotate, and as they are mounted on the same shaft 4A as the blades of compressor section 3A, compressor section 3A rotates as well to create a self-sustaining cycle. Similarly, the hot expanding combustion gases cause the blades of turbine section 6B to rotate, and as they are mounted on the same shaft 4B as the blades of compressor section 3B, compressor section 3B rotates as well to create a self-sustaining cycle. The hot expanding combustion gases then flow downstream to cause the blades of turbine section 6C to rotate, driving the connected electrical generator, pump, gearbox, or other load.

Referring to FIGS. 2 and 3, a partial sectional view of gas turbine engine 2 is shown, in accordance with at least some embodiments of the present disclosure. As shown, gas turbine engine 2 may include inlet guide vane (IGV) inner shroud 7 and IGV vane 8. IGV vane 8 may be connected on one (radially inner) end to IGV inner shroud 7 and surrounded by compressor case 9 on the other (radially outer) end. IGV inner shroud 7, IGV vane 8, and compressor case 9 combine to form IGV assembly 11. IGV assembly 11 can be part of compressor 3A (shown in FIG. 1). Compressor case 9 can include or act as an outer shroud for IGV vane 8. IGV inner shroud 7 and compressor case 9 are static support structures in gas turbine engine 2. IGV vane 8 is a variable

stator vane, pivotably connected to and extending between IGV inner shroud 7 and compressor case 9.

Gas turbine engine 2 may also include nosecone 10 connected to IGV inner shroud 7 via support ring 12, the details of which are shown more clearly in FIG. 3 and described further below in FIGS. 4-6. Nosecone 10 combines with support ring 12 to form nosecone assembly 13. Nosecone 10 has a substantially conical shape with a curved profile from a closed nosecone tip 10A, extending rearward toward to an open nosecone aft end 10B. Nosecone 10 may be formed of aluminum or any other suitable material commonly employed in the design of gas turbine engines. Additionally, nosecone 10 may be formed as unitary piece extending along the curved profile from nosecone tip 10A to nosecone aft end 10B. It will be understood that only those components that are required for a proper understanding of the present disclosure have been shown and described herein. Nevertheless, several other components that are present in a typical gas turbine engine or used in conjunction or combination therewith are contemplated and considered within the scope of the present disclosure.

Turning now to FIGS. 4-6 and referring to those in conjunction with FIGS. 3 and 7, the steps of attachment of nosecone 10 to IGV inner shroud 7 via support ring 12 are shown, in accordance with at least some embodiments of the present disclosure. With respect to support ring 12 in particular, in at least some embodiments and as shown, it may be cylindrical or substantially cylindrical in shape having rim 14 and flange 16 extending inboard from rim 14. As visible more clearly in FIGS. 3 and 7, rim 14 may have a somewhat curved and sloping profile following the curved profile from point 18 of nosecone 10. Support ring 12 may also include first portion 20 having a substantially triangular profile to support rim 14, as well as to facilitate the continuous sloping profile of nosecone 10 and rim 14. First portion 20 may include cylindrical wall 22 which may rest on platform 24 at nosecone aft end 10B of nosecone 10. Specifically, first portion 20 may be designed such that upon assembly, support ring 12 is flush with top surface 18 of nosecone 10. Furthermore, flange 16 may be designed such that wall 22 has a length substantially the same as that of platform 24.

As will be described below, rim 14 and first portion 20 of flange 16 may be employed for connecting to nosecone 10 and second portion 28 of flange 16 may be employed for connecting to IGV inner shroud 7. Furthermore, second portion 28 of flange 16 may extend in an inboard direction from edge 30 of first portion 20, as shown in FIG. 4 or alternatively, as shown in FIG. 7, flange 16 may extend in an inboard

direction slightly away from edge 30. Similar to nosecone 10, support ring 12 may be formed of aluminum or any other suitable material commonly employed in the design of gas turbine engines. Additionally, rim 14 and flange 16 may be formed as a unitary piece or separate pieces connected together in operational association.

To facilitate the connection of nosecone 10 and support ring 12, rim 14 and first portion 20 of flange 16 may be formed with holes 32 at short intervals throughout the circumference of support ring 12, with each hole extending radially from rim 14 through wall 22 of the first portion for receiving a screw or bolt that connects rim 14 to nosecone 10, in a manner described below. (The terms screw and bolt will be used interchangeably herein, with either term being used to refer to both screws and bolts.) Similarly, second portion 28 of flange 16 may also be formed with holes 34 throughout its circumference at short intervals, with each hole facilitating connection of support ring 12 to IGV inner shroud 7, as also described below.

Support ring 12 may be positioned between and connected to nosecone 10, as well as IGV inner shroud 7. As shown in FIG. 4, support ring 12 may be first connected to IGV shroud 7. Specifically, second portion 28 of flange 16 of support ring 12 may be slid in a direction shown by arrow 36 until it is adjacent to and hits wall 38 of IGV inner shroud 7 and rests against rim 40 thereof. Wall 38 of IGV inner shroud 7 may have holes 42 at short intervals throughout the circumference of wall 38 and each hole may align with one of holes 34 of second portion 28 when flange 16 is abutted against wall 38. Second portion 28 of flange 16 may be designed such that it has a height similar to that of wall 38 above rim 40. Bolt 44 may be inserted substantially axially through each of holes 34 of flange 16 and into the aligning hole 42 of wall 38 of IGV inner shroud 7 to secure support ring 12 to IGV inner shroud 7, as shown in FIG. 5. It will be understood that only one of holes 34 and one of holes 42 receiving bolt 44 is shown in FIGS. 4-6. Nevertheless, holes 34 and 42 are formed through the entire circumference of both IGV inner shroud 7 and flange 16, as described above, with each of the corresponding holes receiving one of bolts 44 or other fastening mechanism.

After connecting support ring 12 to IGV inner shroud 7, nosecone 10 may be secured to support ring 12. In order to facilitate the connection of nosecone 10 and support ring 12, nosecone platform 24 may be formed with small step 46 (see FIG. 7) at point 18 thereof. As shown in FIG. 5, nosecone 10 may be slid towards support ring 12 in a direction indicated by arrow 48 until step 46 hits tip 50 of rim 14 or wall 22 of flange 16 rests snugly on platform 24 of nosecone 10. Platform 24 may be designed with

holes 52 that may align with holes 32 on rim 14 and first portion 20 after support ring 12 is abutted against step 46 of nosecone 10. Inner wall 54 of platform 24 may also have nut plate 56 riveted or attached in another manner thereto to facilitate connection of nosecone 10 to support ring 12.

Specifically, as shown in FIG. 6, nosecone 10 may be clamped in between nut plate 56 on inner wall 54 of platform 24 and support ring 12 on an outer wall 58 of platform 24. Screws 60 or other fastener may be inserted in a direction shown by arrow 62 into each of aligning holes 32 and 52 and secured to nut plate 56. Each of screws 60 may be a flush head screw and countersunk into support ring 12 such that the head of the screw remains flush with the top surface of rim 14 upon installation. Furthermore, to provide anti-rotation capability to screw 60, such that screw 60 does not disengage and get sucked in into IGV inner shroud 7, the head of screw 60 may be peened. Specifically, the edges of screw 60 head may be locally deformed into holes 32 of rim 14 to prevent rotation of screw 60 within holes 32 and 52. Screw 60 may also be formed with at least one locking thread to further prevent rotation of screw 60 within holes 32 and 52 and disengagement from rim 14. Nosecone 10 is connected to IGV inner shroud 7 via support ring 12 as shown in FIG. 3.

By virtue of utilizing a flush head screw 60 to connect nosecone 10 to support ring 12, a flush surface at the intersection of nosecone 10 and support ring 12 may be achieved and the disruption to the flow of inlet air around nosecone 10 may be minimized, thereby substantially preserving the aerodynamic flow of air into IGV inner shroud 7. Notwithstanding the fact that in the present embodiment, a flush head screw (e.g., screw 60) with anti-rotation capabilities has been employed for connecting nosecone 10 to support ring 12, in at least some embodiments, other types of screw or fastening mechanisms that may provide a flush surface with rim 14 and have anti-rotational capabilities may be employed as well. Furthermore, flexibility for thermal growth between the stiffer support ring 12 and nosecone 10 can be provided by scallops or tabs 62 as shown in FIG. 8.

Referring now to FIG. 8, a second embodiment of nosecone 10' is shown, in accordance with at least some embodiments of the present disclosure. To the extent that nosecone 10' of FIG. 8 is substantially similar to nosecone 10 of FIG. 7 (which shows one embodiment of the nosecone), only the differences between the two embodiments will be described herein. Specifically, platform 24 of nosecone 10' may be designed with nosecone tabs 62 extending axially aft from the platform. Each of

nosecone tabs 62 may be provided with hole 64 that aligns with holes 32 on first portion 20 of flange 16 of support ring 12 when support ring 12 is slid against platform 24 of nosecone 10'. The assembly of nosecone 10' is similar to that of nosecone 10 described above with screw 60 being inserted radially inward into holes 32 and 64. Nosecone tabs 62 provide easy removal of nosecone 10' from support ring 12 and IGV inner shroud 7. Specifically, to remove nosecone 10', it may be slid away from support ring 12 (after removing screws 60) in a direction indicated by arrow 66.

In the embodiment shown in FIG. 8, nosecone 10' includes holes 68 and 70. Holes 68 and 70 are tool holes that extend through nosecone 10'. In the illustrated embodiment, holes 68 and 70 extend substantially radially inward through nosecone 10'. Holes 68 and 70 can be structurally reinforced such that nosecone 10' is stronger adjacent holes 68 and 70 than at least some other portions of nosecone 10'. Structurally reinforcing nosecone 10' allows nosecone 10' to be removed from support ring 12 via a pulling force applied to holes 68 and 70.

In the embodiment illustrated in FIG. 8, holes 68 and 70 are structurally reinforced via grommets 72 and 74 attached to nosecone 10' at holes 68 and 70, respectively. In alternative embodiments, holes 68 and 70 can be structurally reinforced via a hard anodized coating applied to nosecone 10' at holes 68 and 70. In further alternative embodiments, holes 68 and 70 can be structurally reinforced via other structure suitable for the application. By structurally reinforcing holes 68 and 70, holes 68 and 70 can be strengthened to allow nosecone 10' to be removed from support ring 12 without damaging nosecone 10'.

Holes 68 and 70 are positioned nearer nosecone tip 10A than nosecone aft end 10B. In the illustrated embodiment, holes 68 and 70 are positioned about one-third of the way from nosecone tip 10A to nosecone aft end 10B. By positioning holes 68 and 70 away from nosecone aft end 10B, holes 68 and 70 can be spaced from IGV assembly 11 to reduce the effect of holes 68 and 70 on air flowing through IGV assembly 11. Hole 68 is positioned substantially circumferentially opposite hole 70. In alternative embodiments, holes 68 and 70 can be positioned elsewhere on nosecone 10' suitable for the application. In further alternative embodiments, nosecone 10' can include fewer or more than two holes 68 and 70. For example, in one alternative embodiment, a single hole (not shown) could be positioned at nosecone tip 10A. Although holes 68 and 70 are shown on nosecone 10', holes 68 and 70 can also be included on nosecone 10 (shown in FIGS. 2, 3, 5, 6, and 7) or another nosecone suitable for the application.

FIG. 9 is a perspective view of nosecone 10' and removal tools 76 and 78. Removal tools 76 and 78 can be used to remove nosecone 10' from support ring 12. First, removal tools 76 and 78 are inserted in holes 68 and 70, respectively. Removal tools 76 and 78 can be inserted into holes 68 and 70 in a substantially radial direction. Second, a pulling force is applied to nosecone 10' via removal tools 76 and 78 so as to pull nosecone 10' away from support ring 12. In this manner, nosecone 10' can be removed from support ring 12 without having to heat and expand support ring 12. Thus, nosecone 10' and support ring 12 can be at a substantially same temperature while nosecone 10' is pulled away from support ring 12. In one embodiment, nosecone 10' and support ring 12 can be at a substantially ambient temperature while nosecone 10' is pulled away from support ring 12.

Even though support ring 12 is positioned radially outward of and in friction contact with nosecone 10', removal tools 76 and 78 can pull nosecone 10' away from support ring 12 without heating support ring 12 and without damaging nosecone 10'. In one embodiment, removal tools 76 and 78 can be rigid tools configured specifically for use with nosecone 10'. In other embodiments, removal tools 76 and 78 can be other tools suitable for the application.

In the illustrated embodiment, two removal tools 76 and 78 are inserted into two holes 68 and 70. In alternative embodiments, fewer or more than two removal tools 76 and 78 can be inserted into fewer or more than two holes 68 and 70. For example, in one alternative embodiment, removal tool 76 can be lengthened and can be inserted first into hole 68 and then into hole 70 so as to apply a pulling force to both holes 68 and 70. In another alternative embodiment, hole 68 can be positioned at nosecone tip 10A, hole 70 can be omitted, and removal tool 76 can be inserted into hole 68 for applying a pulling force to nosecone 10' at nosecone tip 10A. In further alternative embodiments, three or more removal tools 76 and 78 can be inserted into three or more holes 68 and 70.

FIG. 10 is a perspective view of nosecone 10' after it has been removed from support ring 12. Removal of nosecone 10' can allow access to various components of gas turbine engine 2 (shown in FIG. 1) such as shaft 4A (shown in FIG. 1), IGV assembly 11, and nosecone assembly 13. Maintenance personnel can then perform maintenance on and/or repair such components as necessary. After maintenance has been completed, nosecone assembly 13 can be re-attached in the manner described above with respect to FIGS. 2-6.

It will be understood that while the connection between nosecone 10 (or 10') and support ring 12 has been described as following a certain order of steps (e.g., first connecting the support ring to the IGV inner shroud and then connecting the nosecone to the support ring), this order is merely exemplary.

The foregoing disclosure stands in contrast to prior art designs employing multiple pieces to form the nosecone and in so doing making assembly and disassembly more difficult, time-consuming and prone to damage. In addition, the single piece construction of the nosecone of the present disclosure eliminates welding and allows the nosecone to be formed from sheet stock material by spinning or pressing process, resulting in lower cost components. The nosecone assembly of the present disclosure can have relatively few gaps and recesses improving aerodynamic flow. Further, the nosecone assembly can be attached to an inner shroud of an inlet guide vane without an intervening structural support. Omitting a separate structural support can reduce cost, reduce weight, and improve aerodynamics of an industrial gas turbine engine. The nosecone assembly of the present disclosure can also facilitate relatively easy and efficient assembly and disassembly while reducing risk of damage.

While the invention has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed, but that the invention will include all embodiments falling within the scope of the appended claims.

Discussion of Possible Embodiments

The following are non-exclusive descriptions of possible embodiments of the present invention.

A method for connecting a nosecone to a gas turbine engine can include providing a nosecone having a platform and a step at one end of the platform and providing a support ring having a rim and a flange having an inboard extending portion. The inboard extending portion of the flange can be connected to the gas turbine engine. The platform of the nosecone can be slid until a tip of the rim hits the step of the nosecone. The rim of the support ring can be connected to the platform of the nosecone.

A method can include connecting an inboard extending portion of a flange of a support ring to a gas turbine engine and sliding a nosecone into the support ring until a tip of a rim of the support ring hits a step at one end of a platform of the nosecone. The rim of the support ring can be connected to the platform of the nosecone.

The method of the preceding paragraph can optionally include, additionally and/or alternatively any, one or more of the following features, configurations and/or additional steps:

at least one hole in the inboard extending portion of the flange can be aligned with at least one hole in a wall of an inlet guide vane inner shroud and inserting a fastener therethrough;

connecting the rim of the support ring to the platform of the nosecone can include attaching a nutplate on a inner wall of the platform around a hole in the platform, aligning a hole in the rim of the support ring with the hole in the platform, and inserting a fastener through the hole in the rim and the hole in the platform;

a flush-head anti-rotational screw can be employed to fasten the rim to the platform;

the screw can be peened to provide further anti-rotation capability;

the rim can have a curved profile such that upon assembly, the rim follows the curved profile of the nosecone;

the platform of the nosecone can include a plurality of tabs, each of the plurality of tabs capable of connecting to the rim of the support ring; and/or

the support ring continues the smooth aerodynamic flow of air around the nosecone.

A support ring for connecting a nosecone to a gas turbine engine can include a rim and a flange. The rim can have a conical surface that follows a curve of the nosecone. The rim can have a hole extending radially therethrough to connect to the nosecone. The flange can have a first portion with a wall resting on top of a platform of the nosecone. The first portion can have a hole aligned with the hole in the rim to connect to the nosecone. The second portion can extend substantially radially from the first portion and can have a hole extending therethrough.

The support ring of the preceding paragraph can optionally include, additionally and/or alternatively any, one or more of the following features, configurations and/or additional components:

the first portion can have a substantially triangular section configuration;

the rim and the flange can be constructed as a single piece;

the support ring can provide support to the nosecone without high attachment stresses; and/or

the support ring can continue the aerodynamic flow of air around the nosecone.

A gas turbine engine can include a nosecone, a gas turbine engine static support structure, and a support ring. The nosecone can have a platform having a step on one end thereof. The support ring can connect the nosecone to the gas turbine engine static support structure. The support ring can have a rim having a curved surface following a curvature of the nosecone and a flange having an inboard extending portion. The rim can be employed to connect to the nosecone. The inboard extending portion can be employed to connect to the gas turbine engine static support structure.

The gas turbine engine of the preceding paragraph can optionally include, additionally and/or alternatively any, one or more of the following features, configurations and/or additional components:

the platform can include a plurality of tabs, the tabs being connected to the support ring;

the nosecone can be connected in between a nut plate on a bottom surface of the platform and the support ring on a top surface of the platform;

the rim can include a plurality of holes capable of being aligned with a plurality of holes on the platform when the support ring is slid against the nosecone;

the plurality of holes on the platform can be aligned with the plurality of holes on the rim when the platform step is slid against and up to the rim;

the rim and the flange of the support ring can be constructed as a single piece; and/or

the nosecone can be connected to the support ring using flush head screws having anti-rotational capability.

CLAIMS:

1. A method comprising:

connecting an inboard extending portion of a flange of a support ring to a gas turbine engine;

sliding a nosecone into the support ring until a tip of a rim of the support ring hits a step at one end of a platform of the nosecone; and

connecting the rim of the support ring to the platform of the nosecone.

2. The method of claim 1, wherein connecting the inboard extending portion of the flange of the support ring to the gas turbine engine comprises:

aligning at least one hole in the inboard extending portion of the flange with at least one hole in a wall of an inlet guide vane inner shroud and inserting a fastener therethrough.

3. The method of claim 1, wherein connecting the rim of the support ring to the platform of the nosecone comprises:

attaching a nutplate on a inner wall of the platform around a hole in the platform;

aligning a hole in the rim of the support ring with the hole in the platform; and

inserting a fastener through the hole in the rim and the hole in the platform.

4. The method of claim 3, wherein a flush-head anti-rotational screw is employed to fasten the rim to the platform.

5. The method of claim 4, wherein the screw is peened to provide further anti-rotation capability.

6. The method of claim 1, wherein the rim has a curved profile such that upon assembly, the rim follows the curved profile of the nosecone.

7. The method of claim 1, wherein the platform of the nosecone includes a plurality of tabs, each of the plurality of tabs capable of connecting to the rim of the support ring.

8. The method of claim 1, wherein the support ring continues the smooth aerodynamic flow of air around the nosecone.

9. A support ring for connecting a nosecone to a gas turbine engine, the support ring comprising:

a rim having a conical surface, the conical surface following a curve of the nosecone, the rim having a hole extending radially therethrough to connect to the nosecone; and

a flange having a first portion with a wall resting on top of a platform of the nosecone, the first portion having a hole aligned with the hole in the rim to connect to the nosecone; and a second portion extending substantially radially from the first portion and having a hole extending therethrough.

10. The support ring of claim 9, wherein the first portion has a substantially triangular section configuration.

11. The support ring of claim 9, wherein the rim and the flange are constructed as a single piece.

12. The support ring of claim 9, wherein the support ring provides support to the nosecone without high attachment stresses.

13. The support ring of claim 9, wherein the support ring continues the aerodynamic flow of air around the nosecone.

14. A gas turbine engine, comprising:

a nosecone having a platform, the platform having a step on one end thereof;

a gas turbine engine static support structure; and

a support ring connecting the nosecone to the gas turbine engine static support structure, the support ring having a rim having a curved surface, the curved surface following a curvature of the nosecone, the rim being employed to connect to the nosecone; and a flange having a inboard extending portion, the inboard extending portion being employed to connect to the gas turbine engine static support structure.

15. The gas turbine engine of claim 14, wherein the platform comprises a plurality of tabs, the tabs being connected to the support ring.

16. The gas turbine engine of claim 14, wherein the nosecone is connected in between a nut plate on a bottom surface of the platform and the support ring on a top surface of the platform.

17. The gas turbine engine of claim 14, wherein the rim includes a plurality of holes and the platform includes a plurality of holes, the plurality of holes on the rim

capable of being aligned with the plurality of holes on the platform when the support ring is slid against the nosecone.

18. The gas turbine engine of claim 17, wherein the plurality of holes on the platform are aligned with the plurality of holes on the rim when the platform step is slid against and up to the rim.

19. The gas turbine engine of claim 14, wherein the rim and the flange of the support ring are constructed as a single piece.

20. The gas turbine engine of claim 14, wherein the nosecone is connected to the support ring using flush head screws having anti-rotational capability.

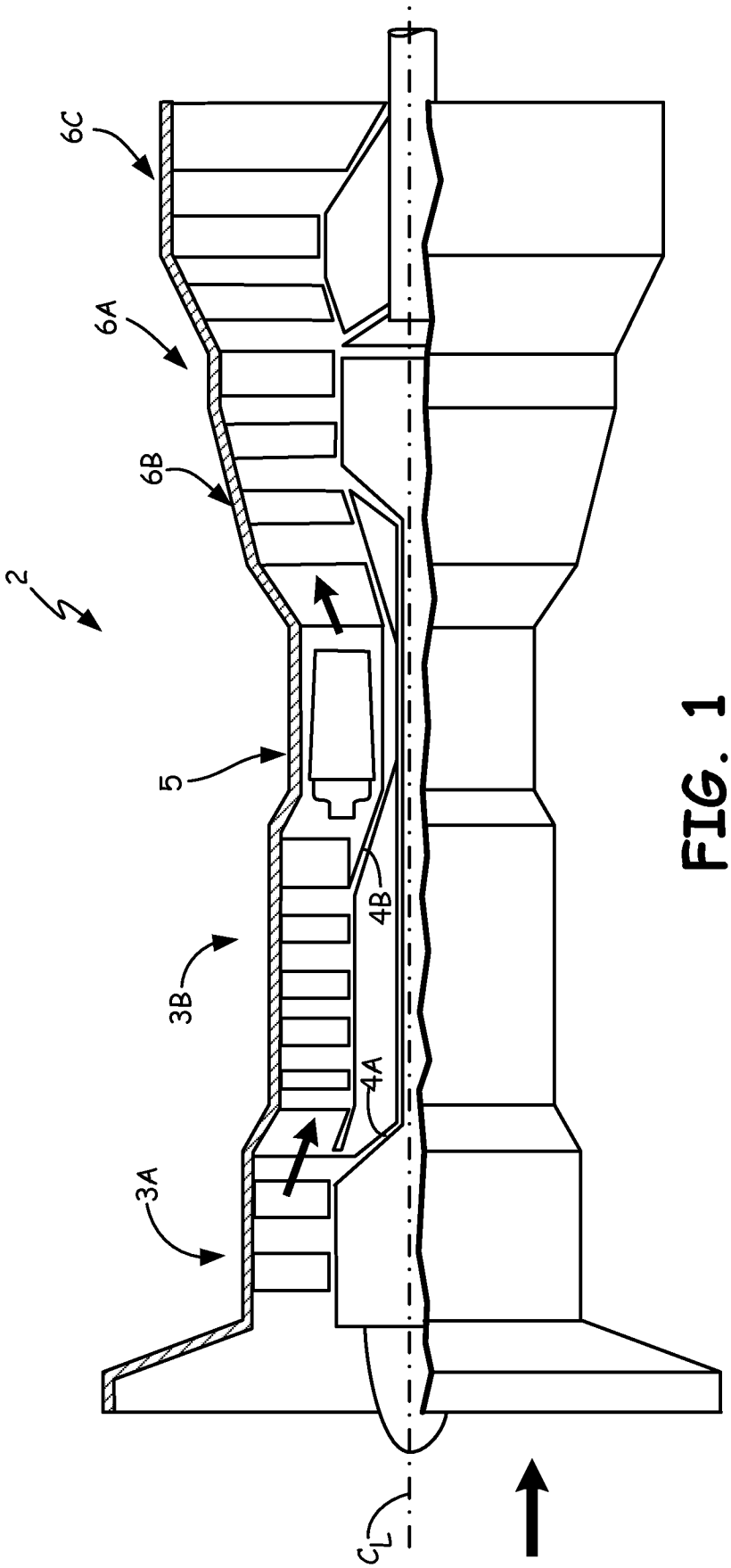


FIG. 1

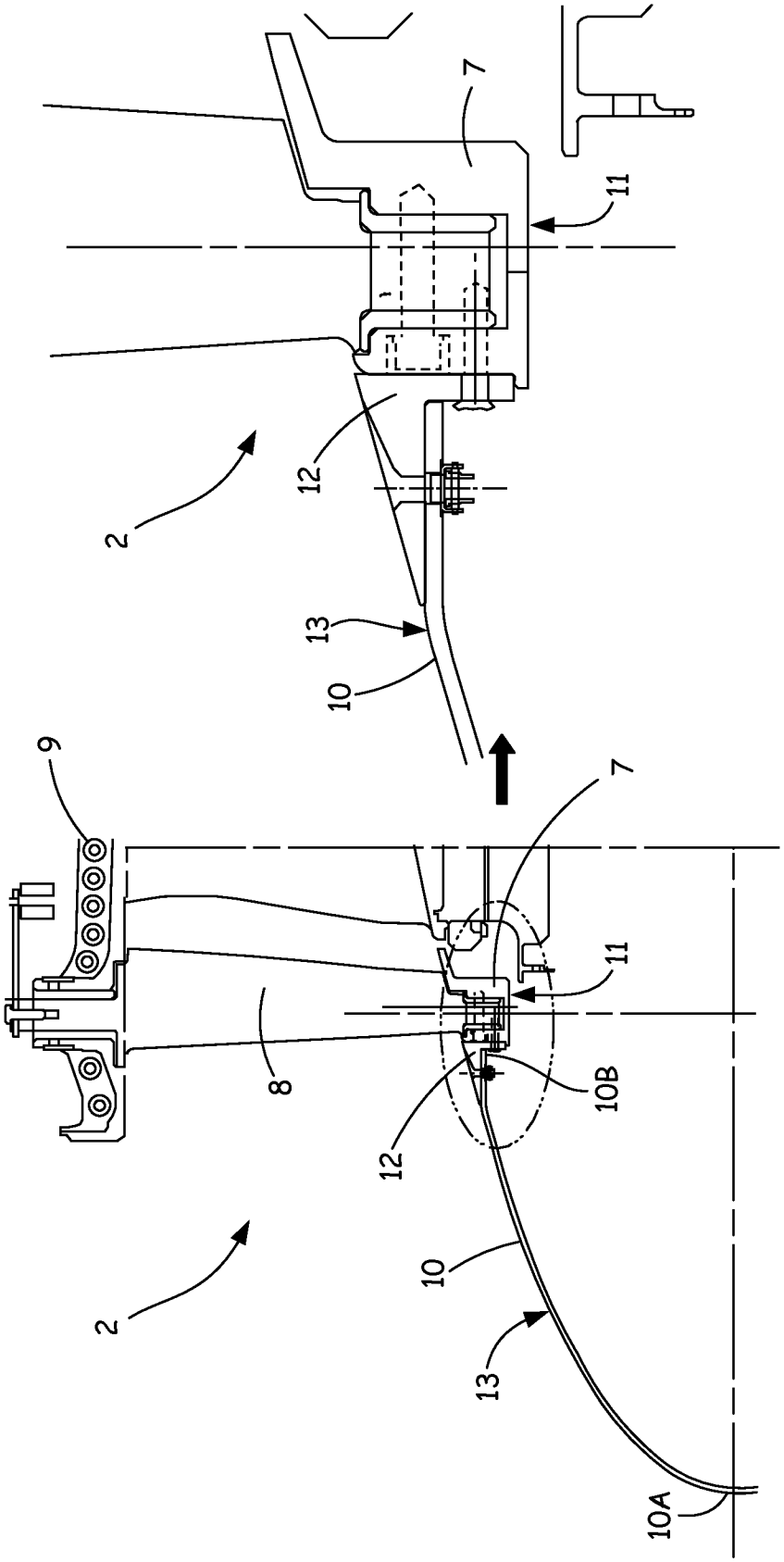


FIG. 3

FIG. 2

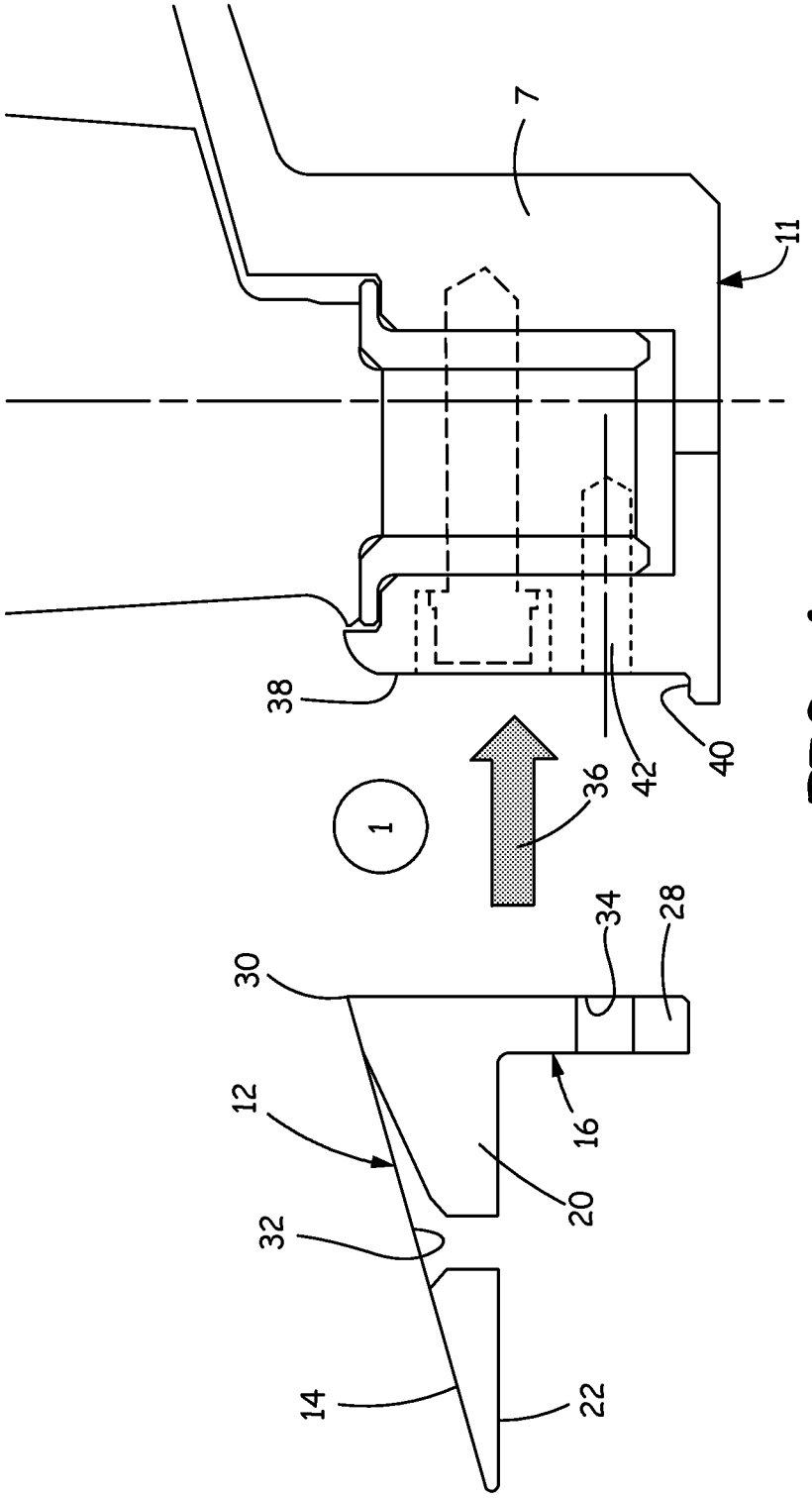


FIG. 4

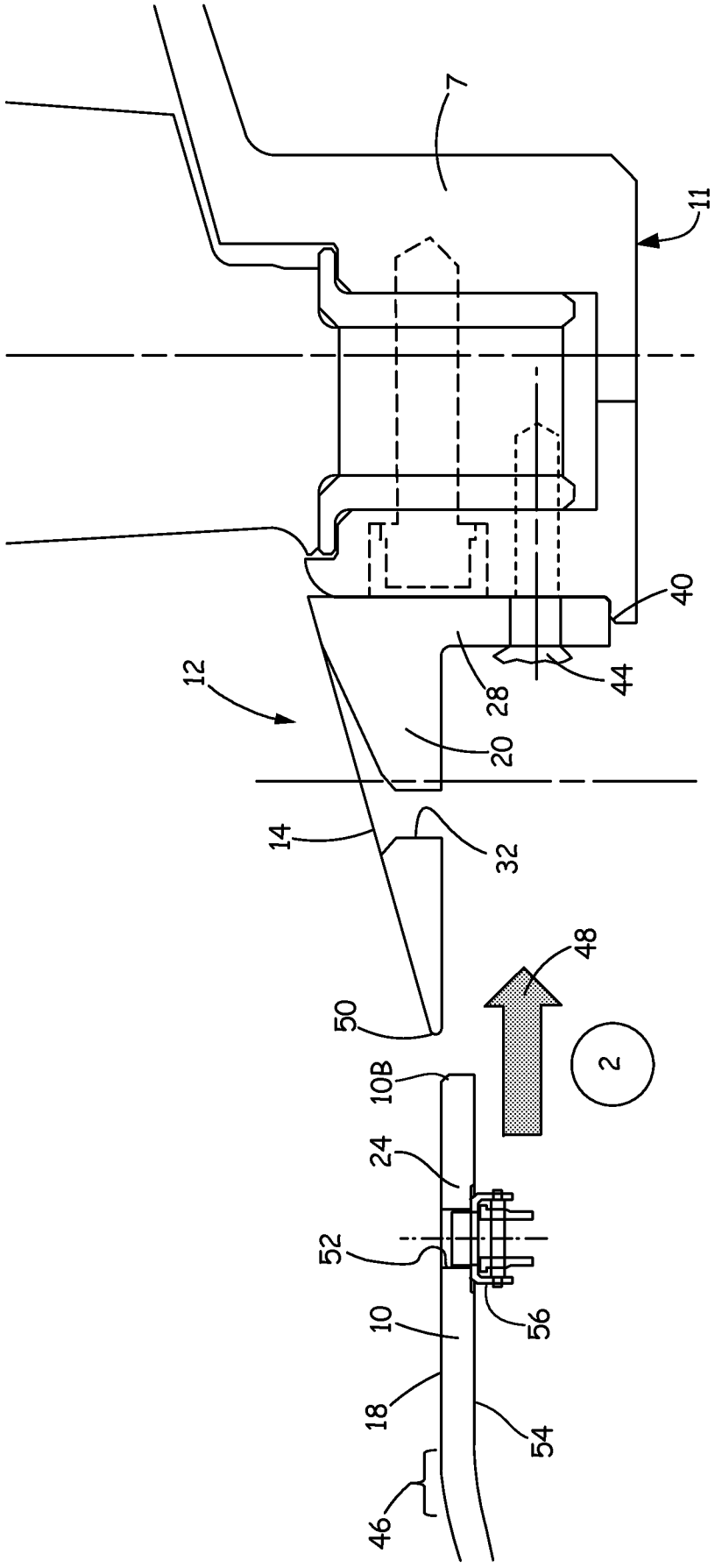


FIG. 5

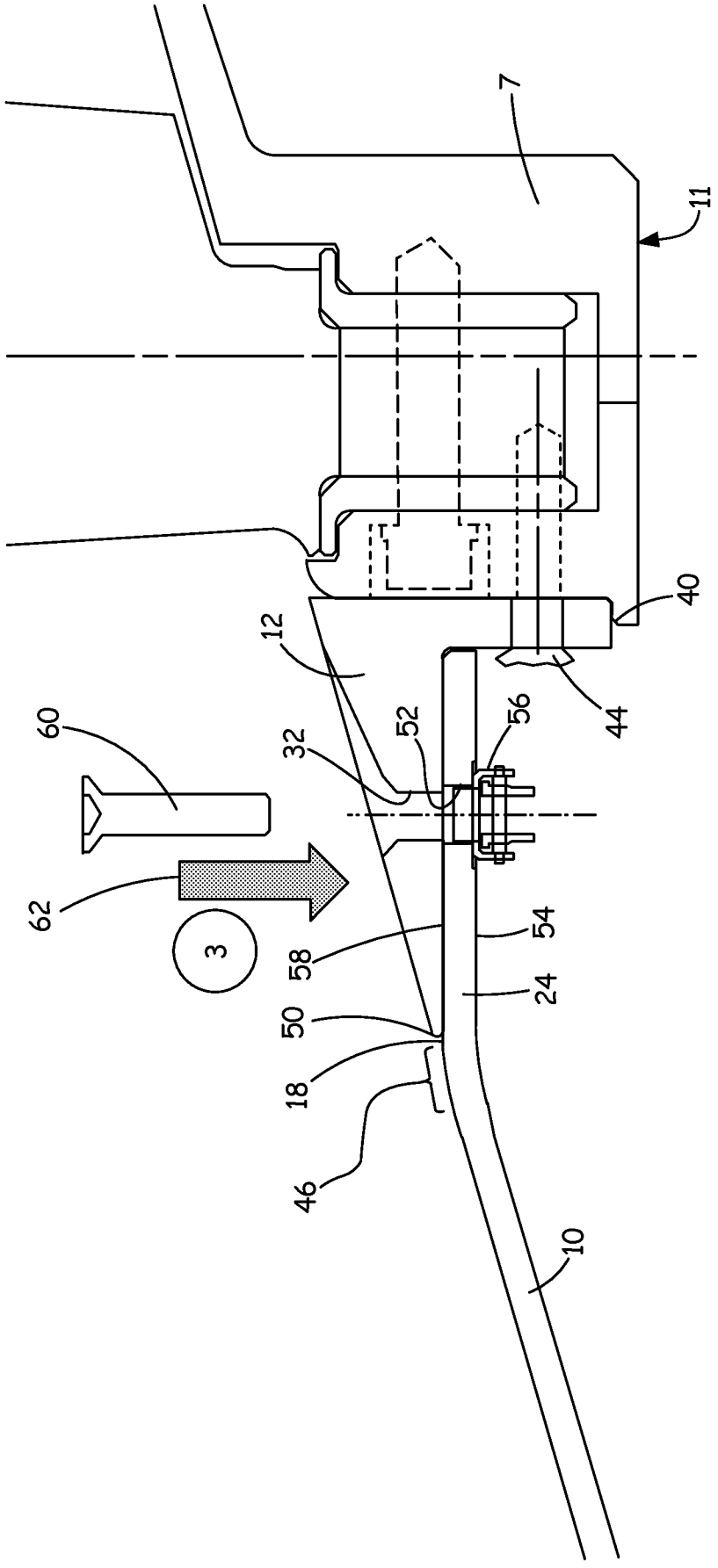


FIG. 6

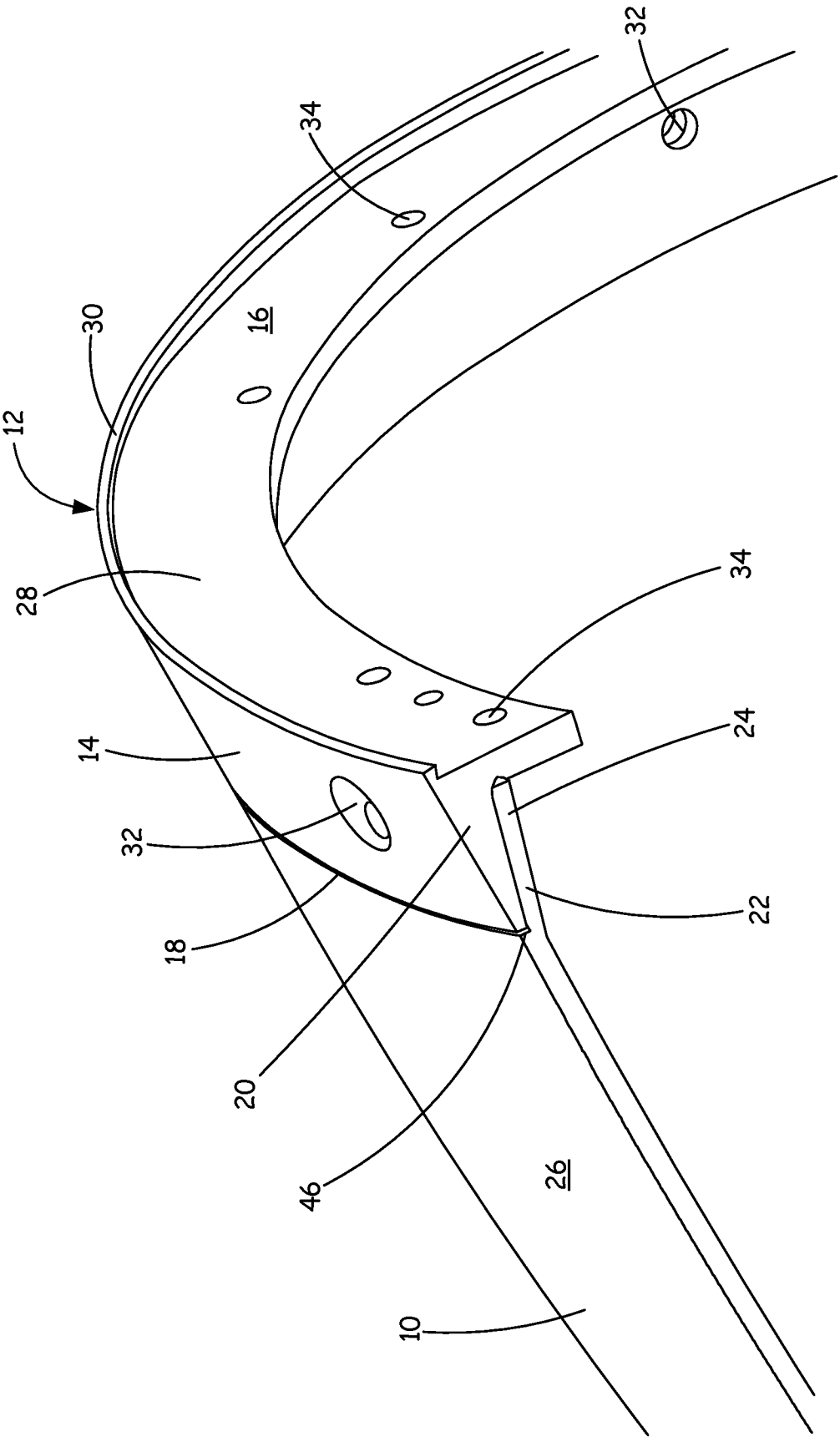


FIG. 7

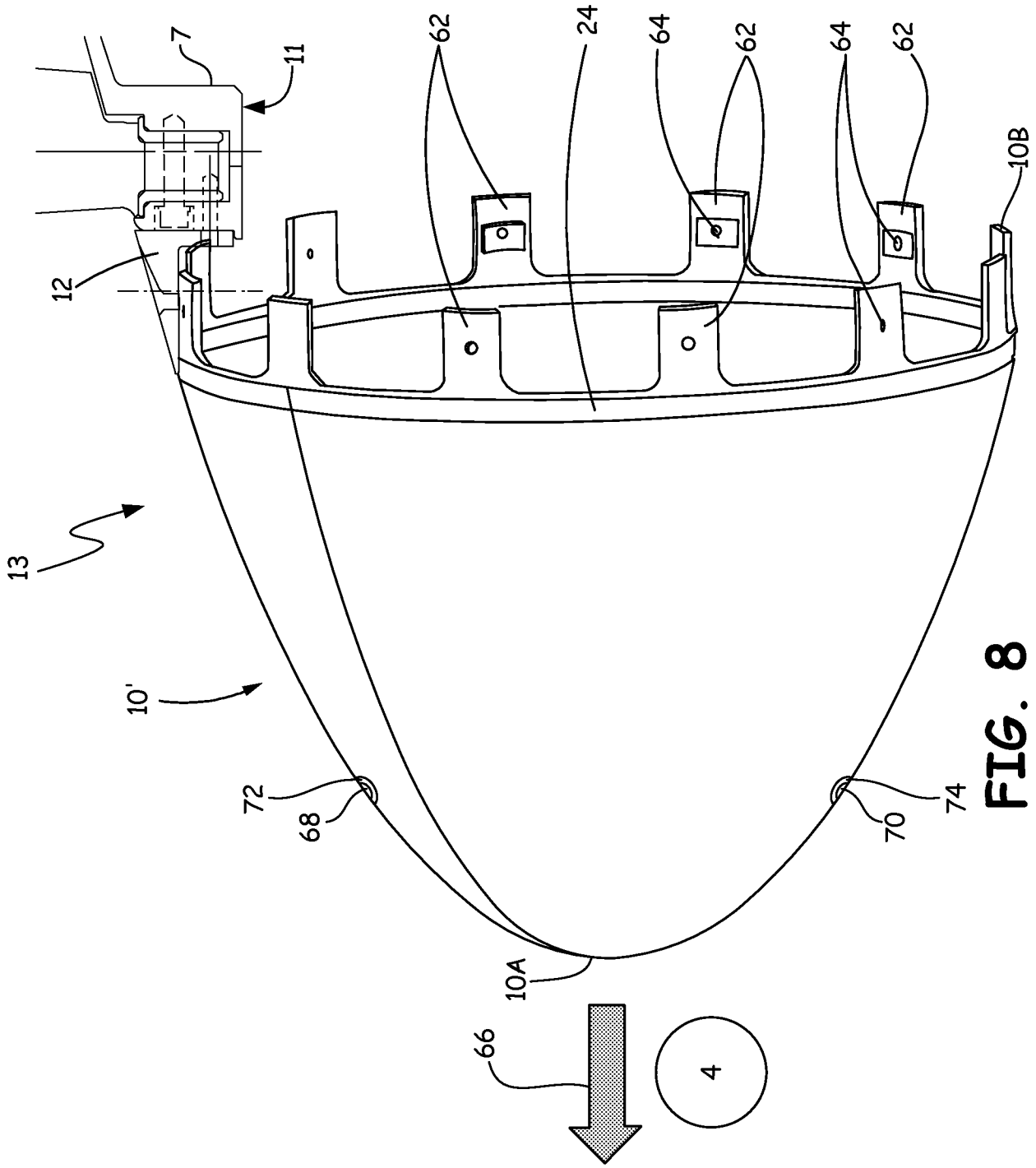


FIG. 8

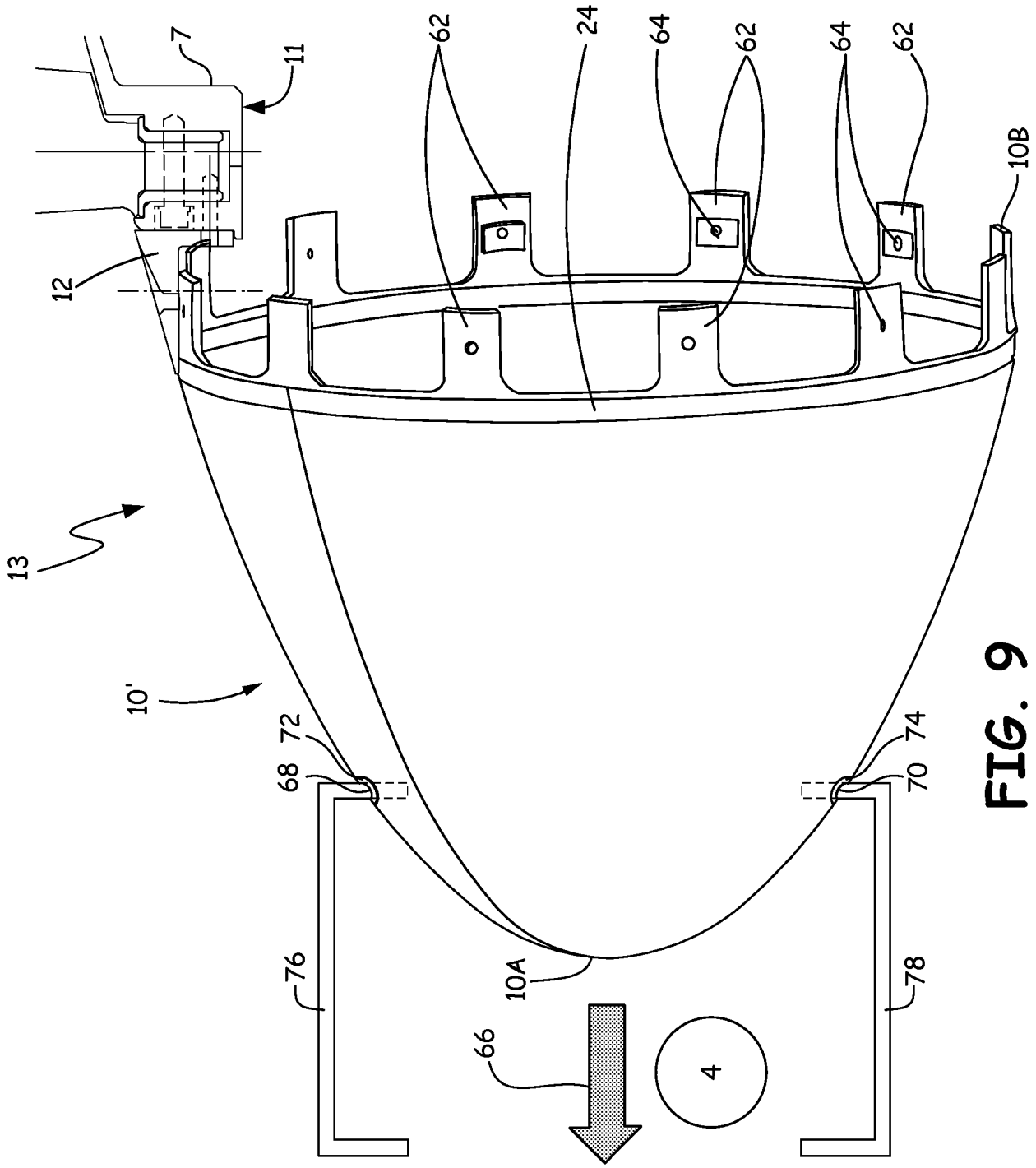


FIG. 9

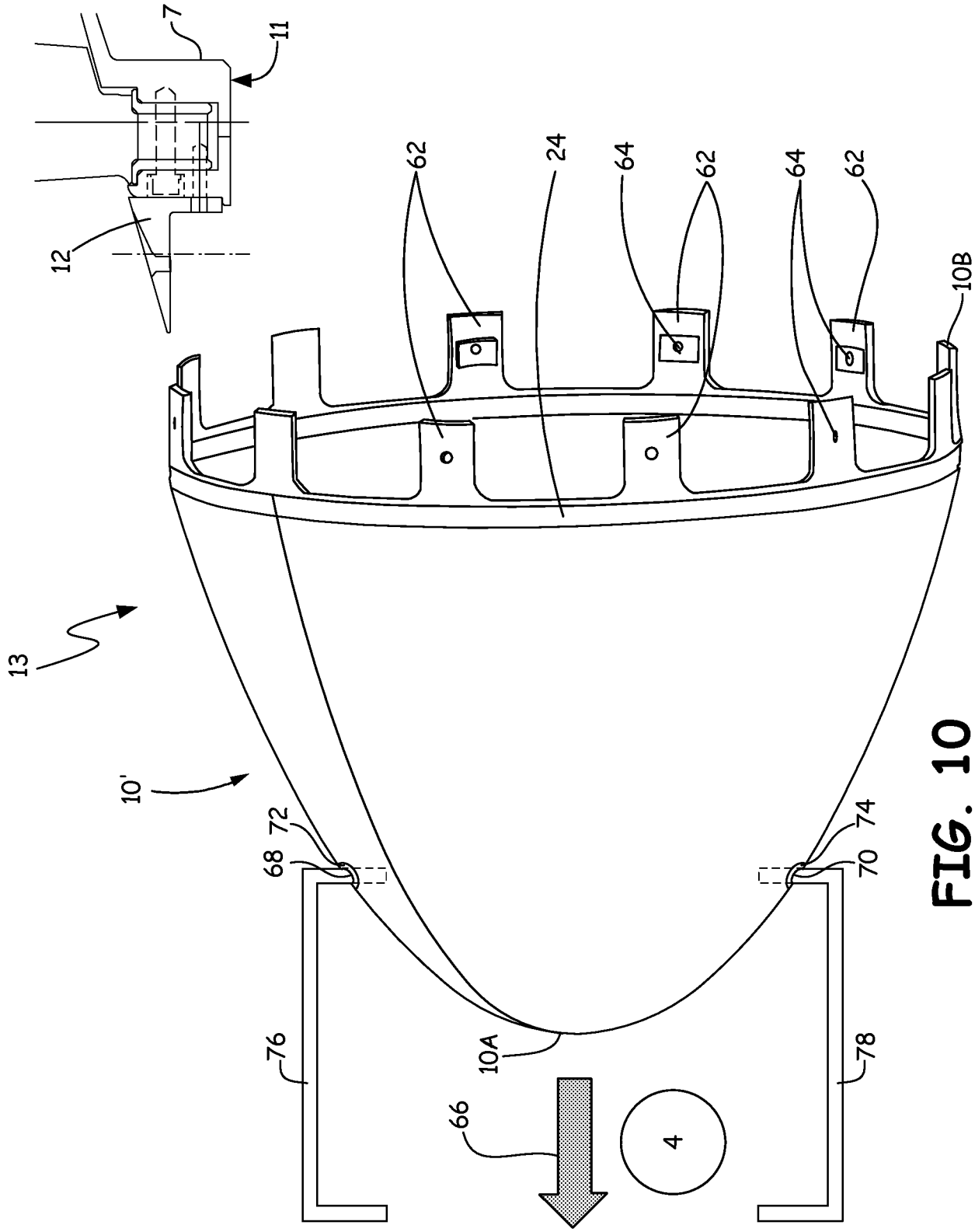


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/076790

A. CLASSIFICATION OF SUBJECT MATTER

F02C 7/20(2006.01)i, F02C 7/00(2006.01)i, F01D 25/24(2006.01)i

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)
F02C 7/20; F01D 25/00; B23P 11/00; F01D 5/00; F01D 5/02; B21K 25/00; F02C 7/00; F01D 25/24

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & keywords: gas turbine engine, nose cone, support ring, rim, flange, tip, step, platform, and hole

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2002-0102160 A1 (BREAKWELL, IAN S.) 01 August 2002 See paragraphs [0019]-[0021] and figure 2.	1-20
A	US 2009-0214354 A1 (BAGNALL, ADAM MACGREGOR) 27 August 2009 See paragraphs [0035]-[0041] and figures 2-3.	1-20
A	US 2011-0085914 A1 (BREAKWELL, IAN S.) 14 April 2011 See paragraphs [0027]-[0035] and figures 2-3.	1-20
A	US 2010-0043228 A1 (DANIELS, JAMES LLOYD) 25 February 2010 See paragraph [0025] and figures 2-3.	1-20
A	US 2010-0226786 A1 (MAHAN, VANCE A.) 09 September 2010 See paragraphs [0025]-[0026], [0032] and figures 3, 5.	1-20

☐ Further documents are listed in the continuation of Box C.

☒ See patent family 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 application or patent 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

Date of the actual completion of the international search	Date of mailing of the international search report
29 April 2014 (29.04.2014)	**02 May 2014 (02.05.2014)**

Name and mailing address of the ISA/KR
International Application Division
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701,
Republic of Korea
Facsimile No. +82-42-472-7140

Authorized officer
LEE, Jong Kyung
Telephone No. +82-42-481-3360

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2013/076790

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2002-0102160 A1	01/08/2002	DE 60200255 D1	22/04/2004
		DE 60200255 T2	05/08/2004
		EP 1227036 A2	31/07/2002
		EP 1227036 A3	22/01/2003
		EP 1227036 B1	17/03/2004
		GB 0102169 D0	14/03/2001
		US 6561763 B2	13/05/2003
US 2009-0214354 A1	27/08/2009	EP 2096029 A2	02/09/2009
		EP 2096029 A3	23/05/2012
		US 8529204 B2	10/09/2013
US 2011-0085914 A1	14/04/2011	GB 0917955 D0	25/11/2009
		GB 2474449 A	20/04/2011
		GB 2474449 B	22/02/2012
US 2010-0043228 A1	25/02/2010	CA 2647758 A1	28/06/2009
		EP 2075420 A2	01/07/2009
		EP 2075420 A3	29/07/2009
		EP 2075420 B1	15/08/2012
		JP 2009-185805 A	20/08/2009
US 2010-0226786 A1	09/09/2010	US 8616854 B2	31/12/2013