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(54) **CONDUIT BUSHING WITH CELLULAR MATERIAL**

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(52) **U.S. Cl.**

CPC **F01D 25/04** (2013.01); **F01D 9/065** (2013.01); **F01D 25/30** (2013.01); **F16F 1/3835** (2013.01); **F16F 1/3842** (2013.01); **F05D 2230/642** (2013.01); **F05D 2250/40** (2013.01); **F05D 2260/31** (2013.01); **F05D 2260/96** (2013.01); **F16F 2224/0225** (2013.01)

(57) **ABSTRACT**

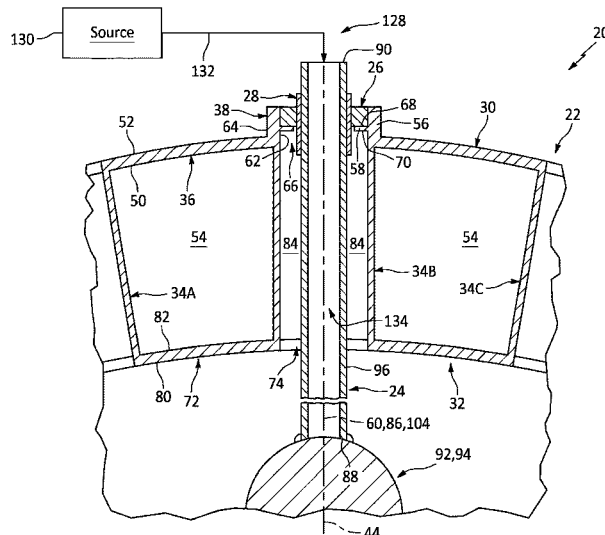
An assembly is provided for a gas turbine engine. This engine assembly includes a gas turbine engine case, a conduit and a bushing. The gas turbine engine case includes a case wall and a boss at a port through the case wall. The conduit extends longitudinally along a centerline through the port and into an interior of the gas turbine engine case. The bushing circumscribes the conduit and is arranged within the port. The bushing is engaged with and laterally between the conduit and the boss. The bushing is configured from or otherwise includes a cellular material. The cellular material may be or otherwise include a cellular metal material and/or a cellular composite material.

(58) **Field of Classification Search**

CPC F01D 9/065; F01D 25/04; F01D 25/30; F16F 1/3835; F16F 1/3842; F05D 2230/642; F05D 2250/40; F05D 2260/31; F05D 2260/96

See application file for complete search history.

17 Claims, 8 Drawing Sheets



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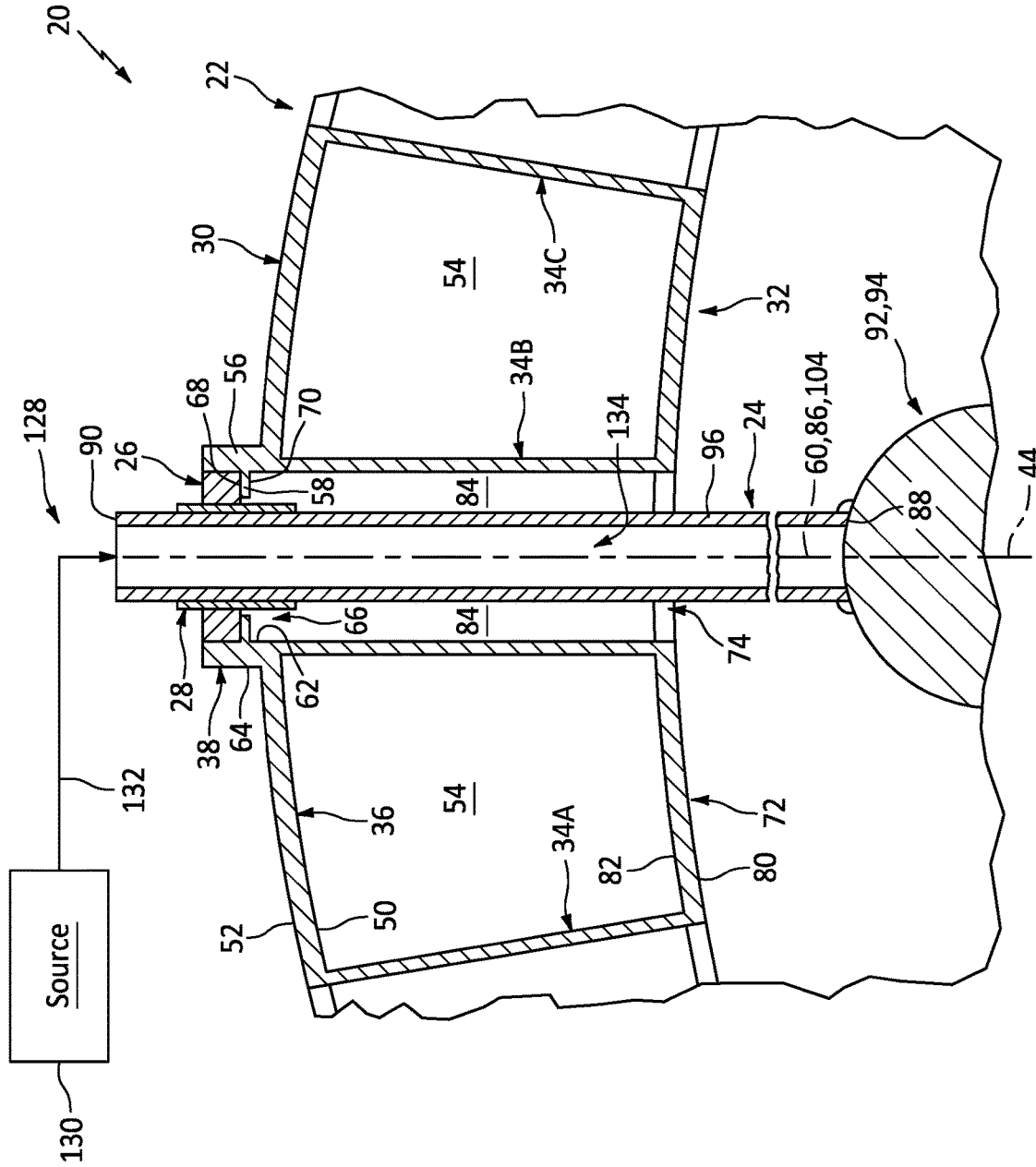


FIG. 1

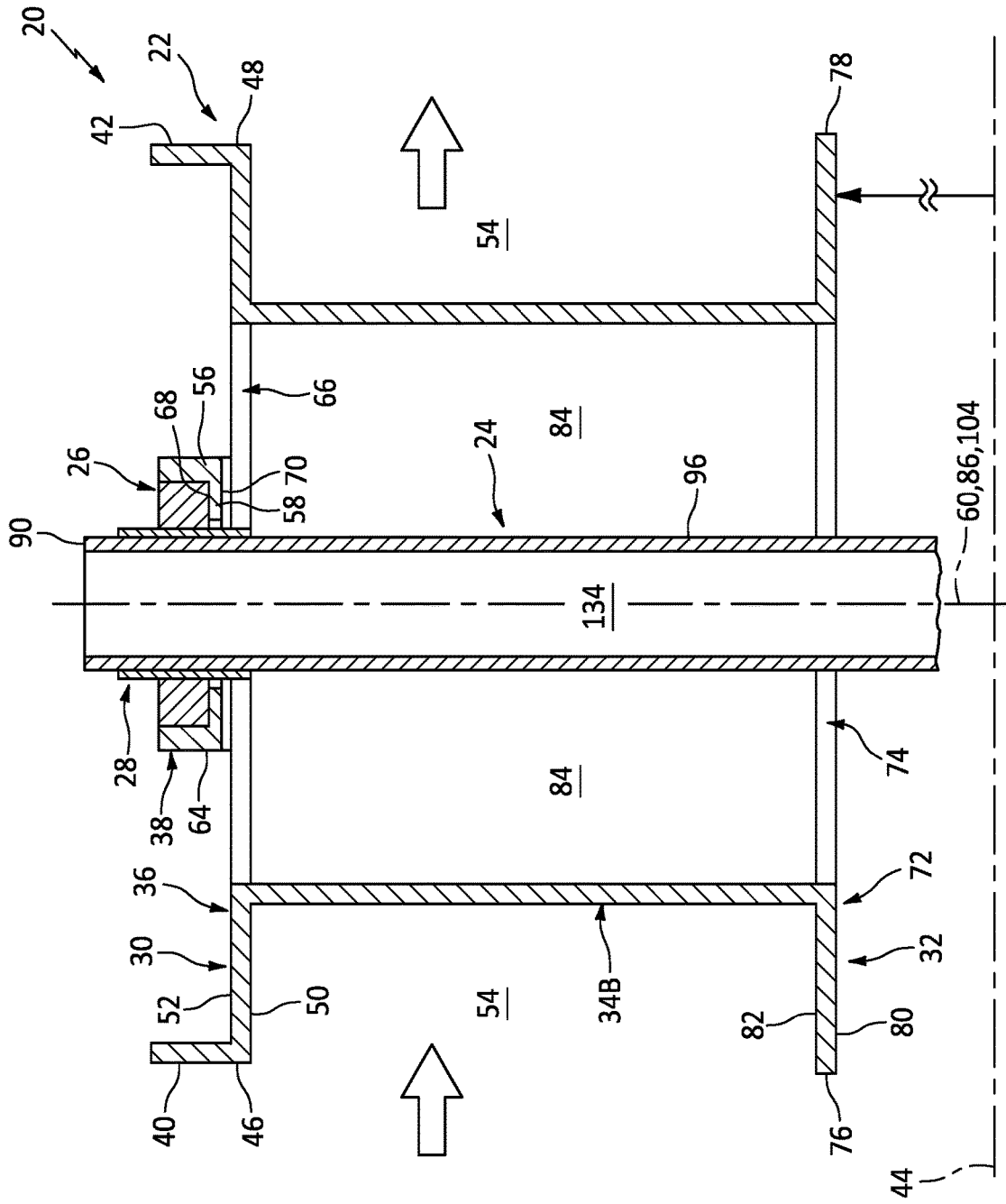


FIG. 2

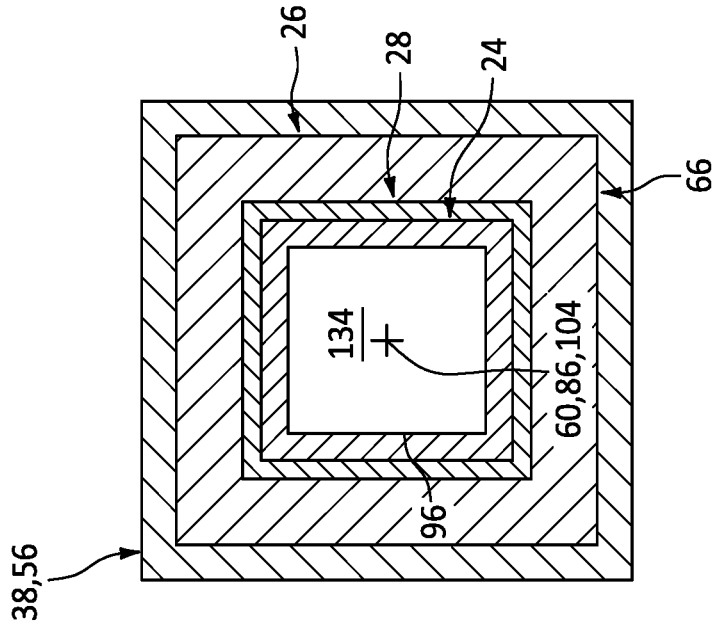


FIG. 3B

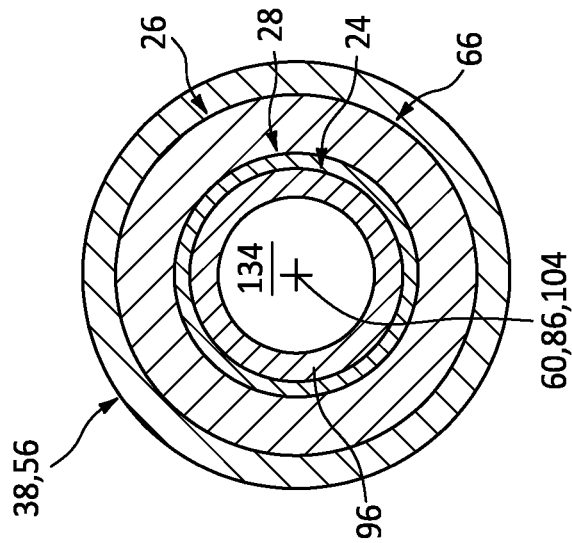


FIG. 3A

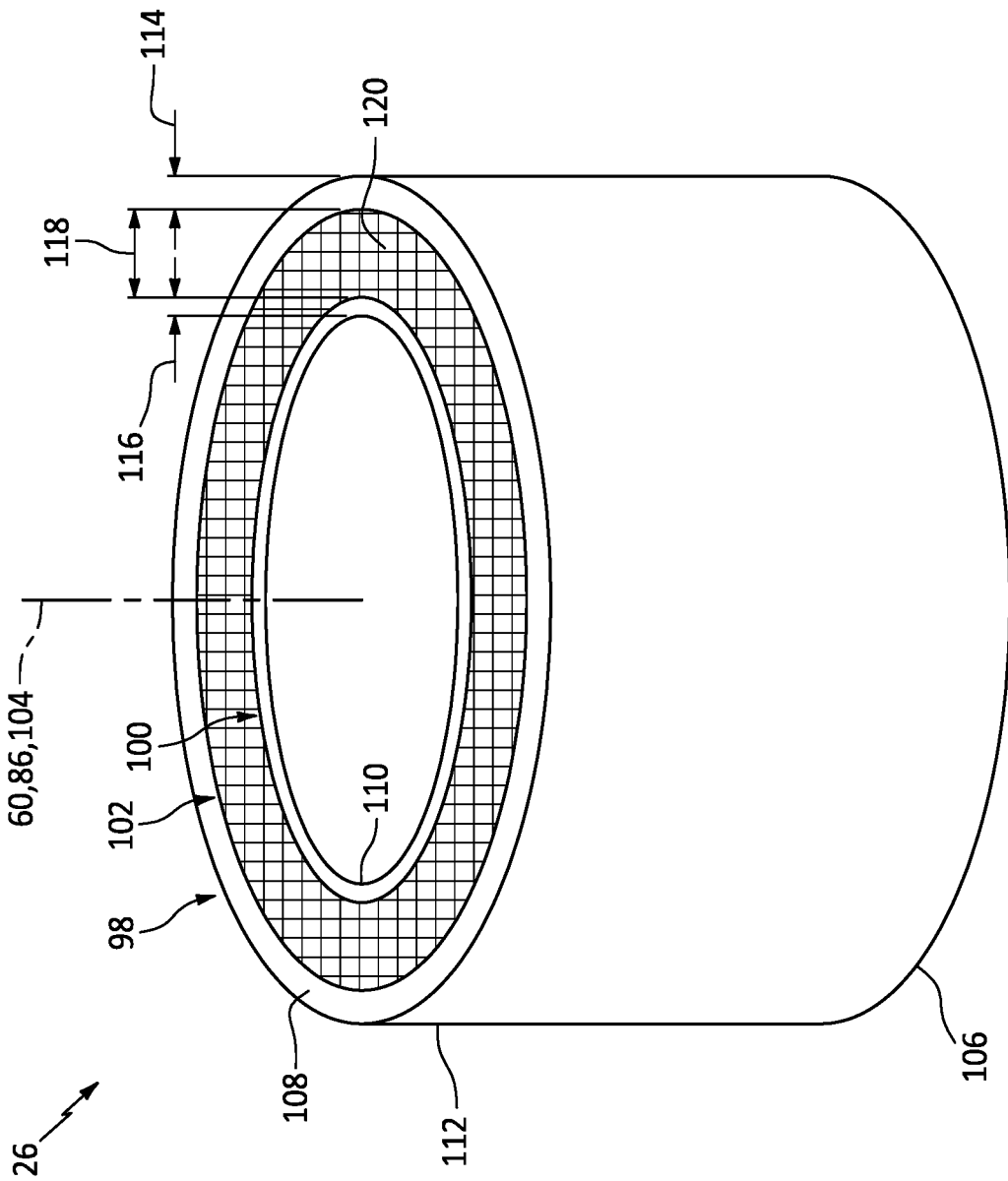


FIG. 4

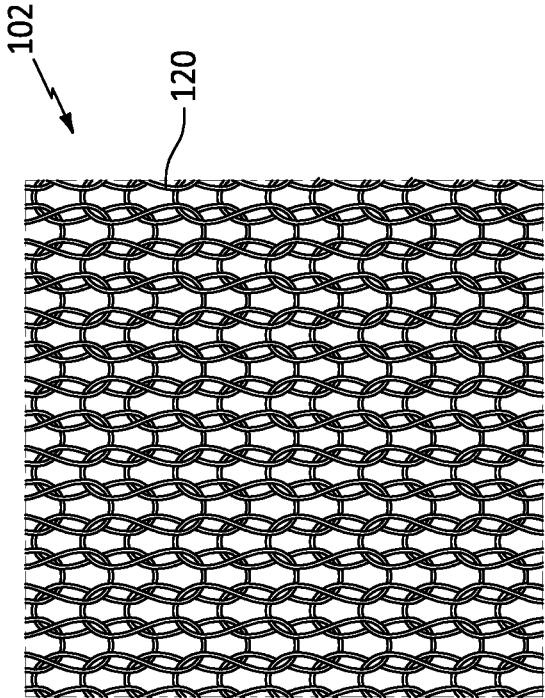


FIG. 5

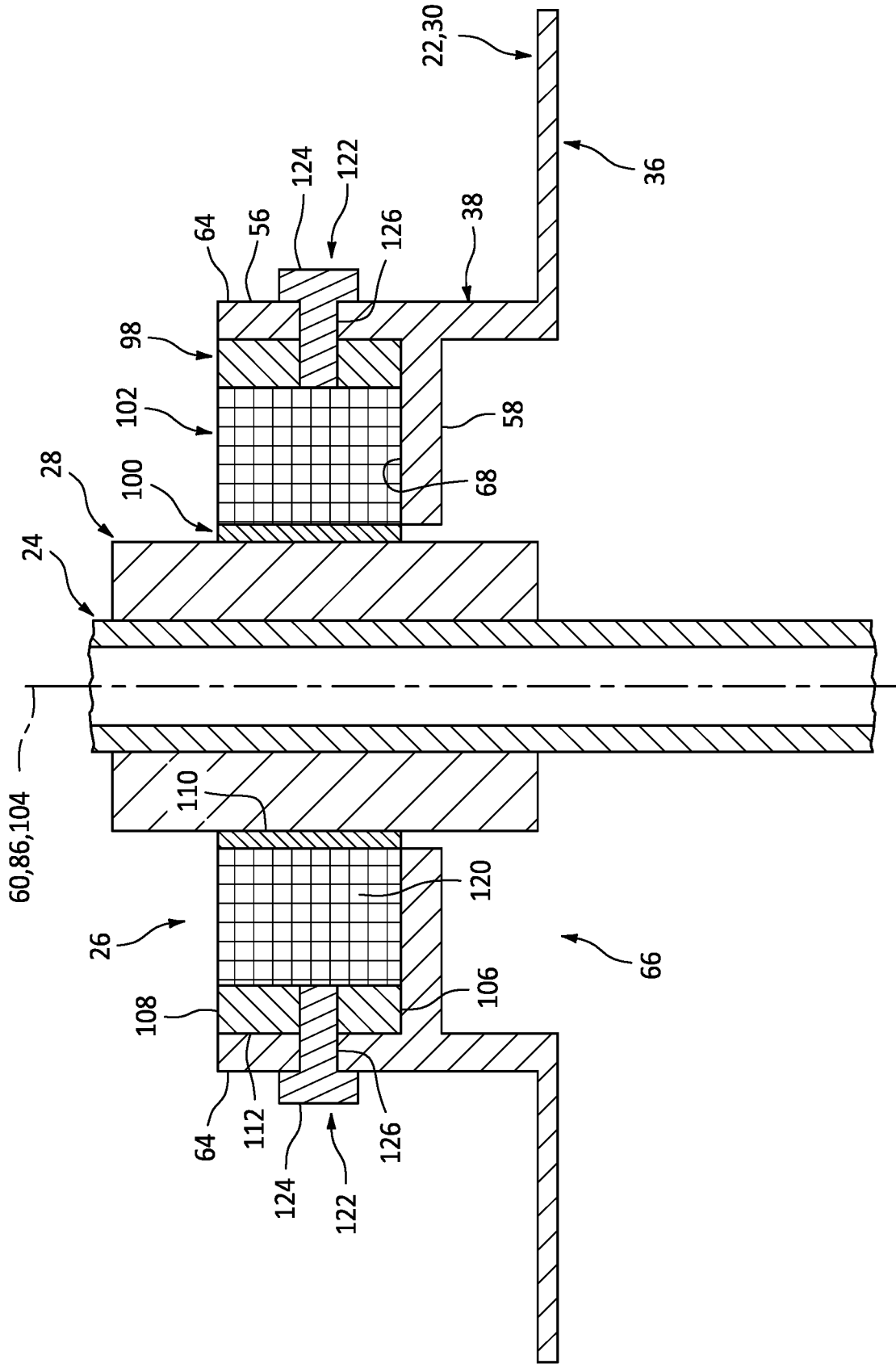


FIG. 6

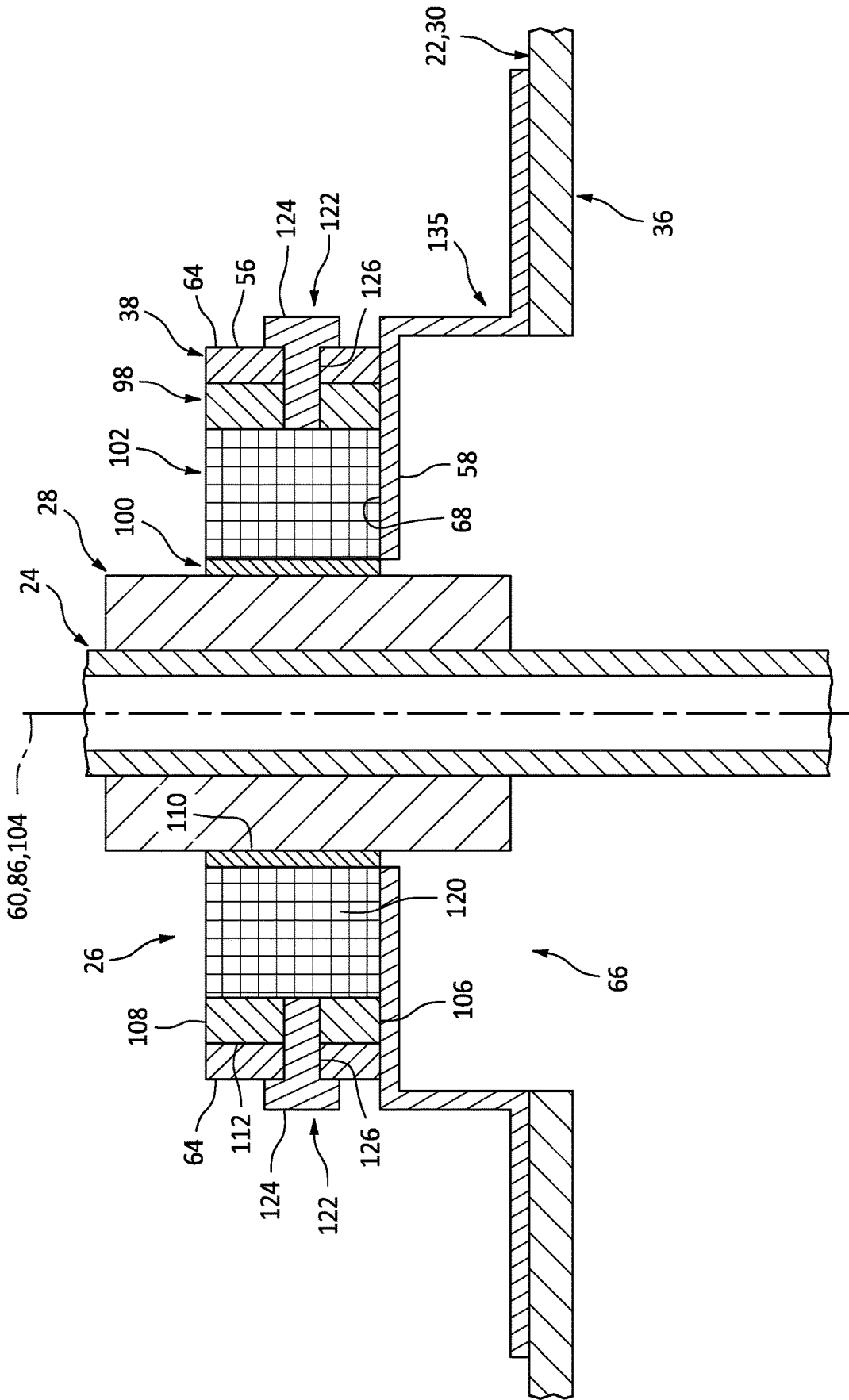


FIG. 7

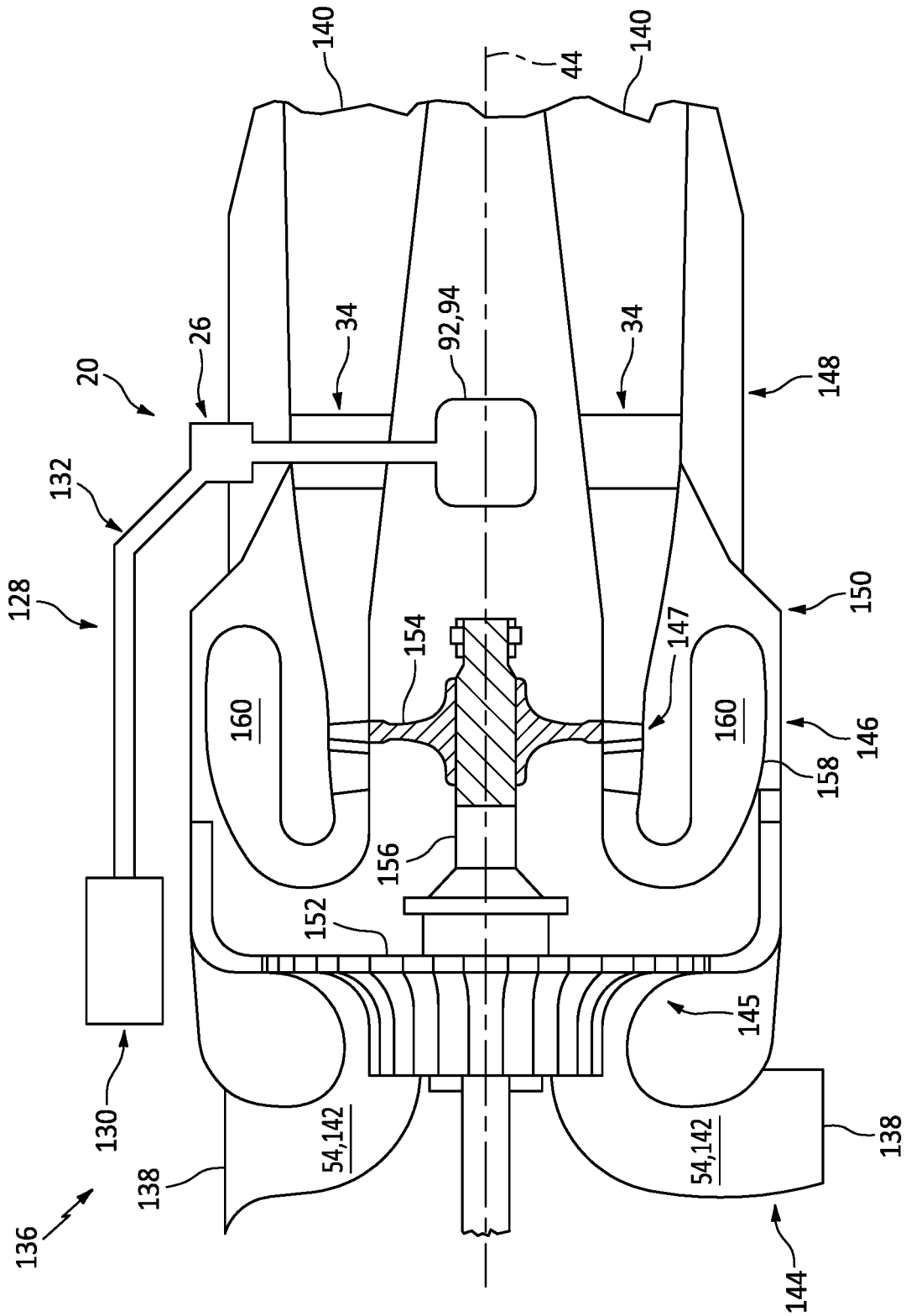


FIG. 8

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CONDUIT BUSHING WITH CELLULAR MATERIAL

TECHNICAL FIELD

This disclosure relates generally to a gas turbine engine and, more particularly, to arranging a conduit with a stationary structure of the gas turbine engine.

BACKGROUND INFORMATION

A gas turbine engine may include an exhaust case and a fluid conduit which passes radially through a port in the exhaust case from an exterior of the exhaust case to an interior of the exhaust case. The fluid conduit may float within the port such that the exhaust case may thermally shift relative to the fluid conduit. While such an arrangement has various benefits, there is still room in the art for improvement. There is a need in the art, in particular, to support the fluid conduit proximate the exhaust case while still permitting thermally induced shifting between the exhaust case and the fluid conduit.

SUMMARY

According to an aspect of the present disclosure, an assembly is provided for a gas turbine engine. This engine assembly includes a gas turbine engine case, a conduit and a bushing. The gas turbine engine case includes a case wall and a boss at a port through the case wall. The conduit extends longitudinally along a centerline through the port and into an interior of the gas turbine engine case. The bushing circumscribes the conduit and is arranged within the port. The bushing is engaged with and laterally between the conduit and the boss. The bushing is configured from or otherwise includes a cellular material.

According to another aspect of the present disclosure, another assembly is provided for a gas turbine engine. This engine assembly includes a stationary structure, a fluid system and a bushing. The stationary structure includes a boss forming a port. The fluid system includes a fluid source and a fluid conduit configured to receive a fluid from the fluid source. The fluid conduit projects longitudinally along a centerline through the port. The fluid may be configured as or otherwise includes lubricant and/or coolant. The bushing is engaged with and laterally between the fluid conduit and the boss. The bushing is configured from or otherwise includes a cellular material.

According to still another aspect of the present disclosure, another assembly is provided for a gas turbine engine. This engine assembly includes a stationary structure, a conduit and a bushing. The stationary structure includes a boss. The boss forms a port and includes an annular shelf. The conduit extends longitudinally along a centerline through the port. The bushing is seated within the port and abutted longitudinally against the annular shelf. The bushing is engaged with and laterally between the conduit and the boss. The bushing includes a cellular material circumscribing the conduit.

The cellular material may be or otherwise include a cellular metal material.

The cellular material may be or otherwise include a cellular composite material.

The bushing may be configured to damp longitudinal vibrations of the conduit.

The bushing may be configured to damp lateral vibrations of the conduit.

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The conduit may be configured to move longitudinally relative to the gas turbine engine case.

The conduit may be configured to move laterally relative to the gas turbine engine case.

5 The bushing may be configured to support the conduit within the boss.

The bushing may be fixed to the conduit.

The bushing may engage the conduit through a threaded connection.

10 The bushing may be fixed to the boss.

The assembly may also include a fastener extending through the boss and into the bushing. The fastener may mount the bushing to the boss.

The cellular material may be configured from or otherwise include metal mesh and/or composite mesh.

15 The cellular material may circumscribe the conduit.

The bushing may also include an inner wall circumscribing the conduit. The cellular material may also circumscribe and/or may be attached to the inner wall.

20 The bushing may also include an outer wall circumscribing and attached to the cellular material.

The bushing may be seated longitudinally against a shelf within the port.

The case wall may extend circumferentially about an axis. The axis may be angularly offset from the centerline.

25 The assembly may also include a sleeve mounted on the conduit. The bushing may engage the conduit through the sleeve.

The bushing may contact the conduit.

The gas turbine engine case may be configured as an exhaust case for the gas turbine engine.

30 The assembly may also include a gas turbine engine component within the gas turbine engine case. The conduit may be configured to supply fluid to the gas turbine engine component. The fluid may be or otherwise include lubricant and/or coolant.

35 The fluid may be or otherwise include a liquid and/or a gas.

The present disclosure may include any one or more of the individual features disclosed above and/or below alone or in any combination thereof.

40 The foregoing features and the operation of the invention will become more apparent in light of the following description and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial cross-sectional illustration of an assembly for a gas turbine engine.

FIG. 2 is a partial side sectional illustration of the engine assembly of FIG. 1.

45 FIGS. 3A and 3B are cross-sectional illustrations of a fluid conduit with various geometries at an interface with a conduit bushing and a conduit boss.

FIG. 4 is a perspective illustration of the conduit bushing.

50 FIG. 5 is an illustration of cellular metal material forming at least a portion of the conduit bushing.

FIG. 6 is an enlarged sectional illustration of a portion of the engine assembly of FIG. 1.

55 FIG. 7 is an enlarged sectional illustration of a portion of the engine assembly with a bracket attaching the conduit boss to an engine case.

FIG. 8 is a partial schematic side sectional illustration of a gas turbine engine.

DETAILED DESCRIPTION

65 FIG. 1 illustrates an assembly 20 for a gas turbine engine. This engine assembly 20 includes a stationary structure 22,

a fluid conduit **24** (e.g., a lubricant and/or coolant conduit) and a conduit bushing **26**. The engine assembly **20** of FIG. **1** also includes a conduit sleeve **28** for the fluid conduit **24**.

The stationary structure **22** may be any stationary (e.g., static) structure of the gas turbine engine. The stationary structure **22**, for example, may be configured as or otherwise include a turbine exhaust case (TEC). In another example, the stationary structure **22** may be configured as or otherwise include a turbine support structure (e.g., a mid-turbine frame or case) or a compressor support structure (e.g., a mid-compressor frame or case). In still another example, the stationary structure **22** may be configured as a simple case or wall (e.g., an exhaust case) of the gas turbine engine through which the fluid conduit **24** may pass. The present disclosure, of course, is not limited to the foregoing exemplary stationary structure configurations. The stationary structure **22** of FIG. **1** includes an outer turbine engine case **30** ("outer case"), an inner turbine engine case **32** ("inner case") and one or more turbine engine struts (e.g., **34A-C**; generally referred to as "**34**"); e.g., hollow frame struts.

The outer case **30** of FIG. **1** includes an outer case wall **36** and an annular conduit boss **38**. Referring to FIG. **2**, the outer case **30** may also include one or more mounts **40** and **42**; e.g., flanges or rims. The outer case **30** of FIGS. **1** and **2** may be configured as a turbine exhaust duct or case.

The outer case **30** of FIG. **1** and its outer case wall **36** extend circumferentially about (e.g., completely around) a centerline axis **44** of the stationary structure **22**, which may provide the outer case **30** and its outer case wall **36** with a full-hoop (e.g., tubular) geometry. Briefly, the centerline axis **44** may also be a rotational axis for one or more rotors within the gas turbine engine. Referring to FIG. **2**, the outer case **30** and its outer case wall **36** extend axially along the centerline axis **44** between and to a forward, upstream end **46** of the outer case wall **36** and an aft, downstream end **48** of the outer case wall **36**. The outer case wall **36** extends radially between and to an inner side **50** of the outer case **30** and an outer side **52** of the outer case wall **36**. The outer case inner side **50** of FIGS. **1** and **2** forms an outer peripheral boundary of a flowpath **54** through the stationary structure **22**.

The conduit boss **38** is disposed at (e.g., on, adjacent or proximate) the outer case wall outer side **52**. The conduit boss **38** of FIGS. **1** and **2**, for example, is connected to (e.g., formed integral with or otherwise attached to) the outer case wall **36**. This conduit boss **38** includes a boss wall **56** and a boss rim **58**. The conduit boss **38** and its boss wall **56** project longitudinally along a longitudinal centerline **60** of the conduit boss **38** (e.g., radially relative to the centerline axis **44**) out from the outer case wall outer side **52** to a distal end of the conduit boss **38**. Briefly, this longitudinal centerline **60** may be angularly offset from (e.g., but, coincident with) the centerline axis **44**; e.g., the longitudinal centerline **60** may be perpendicular to or acutely angled to the centerline axis **44**. The conduit boss **38** and its members **56** and **58** extend circumferentially about (e.g., completely around) the longitudinal centerline **60**, which may provide the conduit boss **38** and its members **56** and **58** with a full-hoop (e.g., tubular or annular) geometry. The boss wall **56** extends laterally (e.g., radially relative to the longitudinal centerline **60**) between and to an inner side **62** of the boss wall **56** and an outer side **64** of the conduit boss **38**. The boss wall inner side **62** at least partially or completely forms an outer peripheral boundary of an outer port **66** through the outer case **30** and its case members **36** and **38**. More particularly, the outer port **66** extends longitudinally along the longitudinal centerline **60** through the outer case **30** and its case

members **36** and **38** between and to the boss distal end and the outer case inner side **50**. The boss rim **58** projects laterally (e.g., radially relative to the longitudinal centerline **60**) inwards into the outer port **66** from the boss wall inner side **62**. The boss rim **58** extends longitudinally along the longitudinal centerline **60** between and to an (e.g., annular) outer shelf **68** of the boss rim **58** and an (e.g., annular) inner shelf **70** of the boss rim **58**. With this arrangement, the conduit boss **38** may be configured with one or more counterbores. The outer counterbore projects longitudinally along the longitudinal centerline **60** into the outer case wall **36** from the boss distal end to the internal boss outer shelf **68**. The inner counterbore projects longitudinally along the longitudinal centerline **60** into the outer case wall **36** from the outer case wall inner side **50** to the internal boss inner shelf **70**.

Referring to FIGS. **3A** and **3B**, the outer port **66** has a cross-sectional geometry when viewed in a reference plane, for example, perpendicular to the longitudinal centerline **60**. Referring to FIG. **3A**, the outer port geometry may be circular. Alternatively, referring to FIG. **3B**, the outer port geometry may be non-circular; e.g., polygonal such as square, rectangular, etc.

Referring to FIG. **2**, the forward, upstream mount **40** may be disposed at the outer case wall upstream end **46**. The aft, downstream mount **42** may be disposed at the outer case wall downstream end **48**. Each of these mounts **40**, **42** is connected to the outer case wall **36**. Each of the mounts **40**, **42** may project radially (relative to the centerline axis **44**) out from the outer case wall **36** to a respective distal end of the mount **40**, **42**. Each of these mounts **40**, **42** may be configured to facilitate mounting the outer case **30** and, more generally, the stationary structure **22** to another respective component of the gas turbine engine. The present disclosure, however, is not limited to such an exemplary mounting arrangement.

The inner case **32** of FIG. **1** includes an inner case wall **72** with an inner port **74** through the inner case **32**. The inner case **32** and its inner case wall **72** extend circumferentially about (e.g., completely around) the centerline axis **44**, which may provide the inner case **32** and its inner case wall **72** with a full-hoop (e.g., tubular) geometry. Referring to FIG. **2**, the inner case **32** and its inner case wall **72** extend axially along the centerline axis **44** between and to a forward, upstream end **76** of the inner case wall **72** and an aft, downstream end **78** of the inner case wall **72**. The inner case wall **72** extends radially between and to an inner side **80** of the inner case wall **72** and an outer side **82** of the inner case **32**. The inner case outer side **82** of FIGS. **1** and **2** forms an inner peripheral boundary of the flowpath **54** through the stationary structure **22**. The inner port **74** projects longitudinally along the longitudinal centerline **60** through the inner case **32** and its inner case wall **72** between and to the inner case wall inner side **80** and the inner case outer side **82**. A cross-sectional geometry of the inner port **74** may match (e.g., be the same as) or may be different than the outer port geometry.

The struts **34** of FIG. **1** are arranged circumferentially about the centerline axis **44** in a circular array. This array of the struts **34** is disposed radially between the outer case **30** and the inner case **32**. Each of the struts **34** of FIG. **1** extends radially between and is connected to the outer case wall **36** and the inner case wall **72**. Each of the struts **34** thereby extends radially across the flowpath **54** between the inner case **32** and the outer case **30**. Each of the struts **34** of FIG. **1** is hollow. Each of the struts **34** of FIG. **1**, for example, has a strut passage **84** (e.g., bore) which extends spanwise (e.g., longitudinally) through the respective struts **34**. The struts

passage **84** of a first of the struts **34B** ("first strut") is (e.g., axially and/or circumferentially) aligned with the outer port **66** and the inner port **74**. The first struts passage **84** is thereby radially between and fluidly coupled with (or forms) the outer port **66** and the inner port **74**.

The fluid conduit **24** extends longitudinally along a longitudinal centerline **86** of the fluid conduit **24** between and to an inner end **88** of the fluid conduit **24** and an outer end **90** of the fluid conduit **24**, which longitudinal centerline **86** may be coaxial with the longitudinal centerline **60**. The conduit inner end **88** of FIG. **1** is connected to an inner component **92** of the gas turbine engine (schematically shown). The conduit inner end **88**, for example, may be connected (e.g., welded, brazed and/or otherwise bonded) to and fluidly coupled with a bearing support structure **94**. The fluid conduit **24** projects longitudinally along the longitudinal centerline **60**, **86** out from its inner end **88**, sequentially through the apertures **74**, **84** and **66**, to conduit outer end **90**. The fluid conduit **24** may thereby pass (e.g., radially relative to the centerline axis **44**) from an exterior of the stationary structure **22** into an interior of the stationary structure **22**; thus, crossing the flowpath **54** without being exposed to/coming in contact with a fluid (e.g., relatively hot exhaust gas/combustion products) flowing through the flowpath **54**.

Referring to FIGS. **3A** and **3B**, a tubular sidewall **96** of the fluid conduit **24** has a cross-sectional geometry when viewed in the reference plane. Referring to FIG. **3A**, the fluid conduit geometry may be circular. Alternatively, referring to FIG. **3B**, the fluid conduit geometry may be non-circular; e.g., polygonal such as square, rectangular, etc. The fluid conduit geometry may be match with (e.g., the same as) the outer port geometry and/or the inner port geometry.

Referring to FIG. **4**, the conduit bushing **26** includes an outer bushing wall **98**, an inner bushing wall **100** and a cellular bushing core **102**. The conduit bushing **26** and its bushing members **98**, **100** and **102** extend circumferentially about a longitudinal centerline **104** of the conduit bushing **26**, which longitudinal centerline **104** may be coaxial with the longitudinal centerline **60**, **86**. The conduit bushing **26** and its bushing members **98**, **100** and **102** extend longitudinally along the longitudinal centerline **60**, **86**, **104** between and to a first (e.g., inner) end **106** of the conduit bushing **26** and a second (e.g., outer) end **108** of the conduit bushing **26**. The conduit bushing **26** extends laterally (e.g., radially relative to the longitudinal centerline **60**, **86**, **104**) between and to an inner side **110** of the conduit bushing **26** and an outer side **112** of the conduit bushing **26**. The outer bushing wall **98** is disposed at and may form the conduit bushing outer side **112**. The inner bushing wall **100** is disposed at and may form the conduit bushing inner side **110**. The cellular bushing core **102** extends laterally between and is connected (e.g., bonded, friction fit, etc.) to the outer bushing wall **98** and/or the inner bushing wall **100**. With this arrangement, the outer bushing wall **98** circumscribes the cellular bushing core **102** and the inner bushing wall **100**. The cellular bushing core **102** circumscribes the inner bushing wall **100**.

The outer bushing wall **98** has a lateral thickness **114**. The inner bushing wall **100** has a lateral thickness **116**. This inner bushing wall thickness **116** may be less than or equal to the outer bushing wall thickness **114**. The cellular bushing core **102** has a lateral thickness **118**. This cellular bushing core thickness **118** may be greater than the outer bushing wall thickness **114** and/or the inner bushing wall thickness **116**. The cellular bushing core thickness **118**, for example, may be at least two times (**2x**), five times (**5x**) or ten times (**10x**) the outer bushing wall thickness **114** and/or the inner bushing wall thickness **116**; e.g., between one and one-half times

(**1.5x**) and fifteen times (**15x**) the thickness **114**, **116**. The present disclosure, however, is not limited to such an exemplary relationship. The thicknesses **114**, **116** and **118** of the bushing members **98**, **100** and **102**, for example, may be selected to tune damping properties of the conduit bushing **26** based on the specific application.

Referring to FIGS. **3A** and **3B**, the conduit bushing **26** has a cross-sectional geometry when viewed in the reference plane. Referring to FIG. **3A**, the conduit bushing geometry may be circular. Alternatively, referring to FIG. **3B**, the conduit bushing geometry may be non-circular; e.g., polygonal such as square, rectangular, etc. The conduit bushing geometry may be match with (e.g., the same as) the outer port geometry, the inner port geometry and/or the fluid conduit geometry.

Referring to FIG. **4**, the outer bushing wall **98** may be formed as a tubular metal body. This outer bushing wall **98** may be solid (e.g., non-porous) and/or substantially uninterrupted. The inner bushing wall **100** may be formed as another tubular metal body. This inner bushing wall **100** may be solid and/or substantially uninterrupted. The metal forming the inner bushing wall **100** and the metal forming the outer bushing wall **98** may be a common (the same) metal, or may be different metals to provide the bushing sides with different properties. The cellular bushing core **102** may be formed as a tubular body of cellular metal material **120** (e.g., see FIG. **5**) such as, but not limited to, metal mesh, metal foam, metal honeycomb mesh or a metal lattice structure (e.g., a cellular metal material formed via additive manufacturing). The cellular metal material **120** of FIG. **5** is an apertured and/or otherwise porous material with a plurality of internal cells; e.g., pores, cavities, channels, through holes, etc. Referring again to FIG. **4**, the metal of the cellular metal material **120** and the metal of the bushing wall(s) may be a common metal, or may be different metals to further tailor properties of the conduit bushing **26**. Examples of the metal(s) include, but are not limited to, aluminum (Al) or an alloy thereof, titanium (Ti) or an alloy thereof, steel (e.g., stainless steel), nickel (Ni) or an alloy thereof (e.g., a high nickel alloy). The present disclosure, however, is not limited to such an exemplary arrangement or materials. For example, in other embodiments, it is contemplated the cellular bushing core **102** may be formed as a tubular body of (or including) cellular composite material. The cellular composite material may be or otherwise include a ceramic matrix composite, a metal matrix composite or any other composite (e.g., fiber-reinforced composite or non-fiber reinforced composite) capable to withstanding the environmental conditions at the conduit bushing location.

Referring to FIG. **6**, the conduit bushing **26** is mounted onto the fluid conduit **24**. The conduit bushing **26** of FIG. **6**, for example, is mounted onto the conduit sleeve **28** (e.g., a protective layer, another bushing, etc.), and the conduit sleeve **28** is mounted onto the fluid conduit **24**. The conduit sleeve **28** may be fixed to the fluid conduit **24** via an interference fit, bonding and/or otherwise. The conduit bushing **26** may be fixed to the conduit sleeve **28** via an interference fit, a threaded connection and/or otherwise. However, it is contemplated the conduit bushing **26** may alternatively be operable to translate (e.g., slightly) longitudinally along and/or rotate slightly about the conduit sleeve **28** in other embodiments.

The conduit bushing **26** is mounted to the conduit boss **38**. The conduit bushing **26** of FIG. **6**, for example, is seated within the outer port **66** and, more particularly, the outer counterbore, where the conduit bushing **26** may be abutted longitudinally against the boss rim **58** and its outer shelf **68**.

The conduit bushing **26** may be fixed to the outer case **30** and its conduit boss **38** via one or more fasteners **122**; e.g., bolts, set screws, etc. Each fastener **122** of FIG. **6**, for example, includes a head **124** and a shank **126**. The head **124** may be abutted against the conduit boss outer side **64**. The shank **126** may project out from the head **124**, through an aperture in the boss wall **56**, and may be abutted against or project into or through the conduit bushing **26** and its outer bushing wall **98**. The present disclosure, however, is not limited to such an exemplary attachment technique. The conduit bushing **26**, for example, may also or alternatively be fixed to the conduit bushing **26** via an interference fit, bonding and/or otherwise.

During gas turbine engine operation, the fluid conduit **24** may be subject to lateral and/or longitudinal vibrations. The lateral vibrations may describe vibrations which have a tendency to move the fluid conduit **24** laterally side-to-side (e.g., circumferentially about the centerline axis **44**; see FIG. **1**) and/or laterally back-and-forth (e.g., axially along the centerline axis **44**; see FIG. **2**). The longitudinal vibrations may describe vibrations which have a tendency to move the fluid conduit **24** longitudinally up-and-down (e.g., longitudinally along the longitudinal centerline **60**, **86**, **104**). The conduit bushing **26**, however, may damp some or all of these vibrations. The cellular metal material **120** (e.g., metal mesh) of the conduit bushing **26**, for example, may resiliently deform (e.g., compress, extend, twist, etc.) and thereby absorb vibrational energy from the fluid conduit **24**. This operability to resiliently deform may also facilitate relative movement between the fluid conduit **24** and the stationary structure **22** and its outer case **30**. The conduit bushing **26** and its cellular metal material **120** may thereby accommodate thermally induced movement (e.g., shifting) of the stationary structure **22** relative to the fluid conduit **24**. In this manner, the conduit bushing **26** and its cellular metal material **120** may support the fluid conduit **24** while also reducing internal stresses within the fluid conduit **24** as well as reducing or eliminating potential for rubbing between the stationary structure **22** and the fluid conduit **24**.

The conduit bushing **26** of FIG. **6** is engaged with and laterally between the conduit boss **38** and the fluid conduit **24**. The lateral engagement between the conduit bushing **26** and the fluid conduit **24** may be indirect engagement through, for example, the conduit sleeve **28**. However, in other embodiments, it is contemplated the conduit sleeve **28** may be omitted and the conduit bushing **26** may directly engage (e.g., contact) an exterior surface of the fluid conduit **24**.

Referring to FIG. **1**, the fluid conduit **24** may be included as part of a fluid system **128** for the gas turbine engine. The fluid system **128** of FIG. **1**, for example, includes a fluid source **130**, a fluid circuit **132** and the engine component **92**. The fluid circuit **132** includes an internal bore **134** through the fluid conduit **24**. This fluid circuit **132** is configured to direct fluid (e.g., lubricant and/or coolant) from the fluid source **130**, through the fluid conduit **24** and its internal bore **134**, to at least (or only) the engine component **92**.

In some embodiments, referring to FIG. **1**, the conduit boss **38** may be formed as an integral part of the outer case wall **36**. In other embodiments, referring to FIG. **7**, the conduit boss **38** may be attached to the outer case wall **36** by a bracket **135**; e.g., a channeled bracket. The bracket **135** may form the internal boss outer shelf **68**. The boss wall **56** may be connected to and project out from the bracket **135**.

FIG. **8** is a partial schematic side sectional illustration of a gas turbine engine **136**, which gas turbine engine **136** may include the engine assembly **20** described above. The gas

turbine engine **136** of FIG. **8** is configured as a single spool, radial-flow gas turbine engine. This gas turbine engine **136** may be included in an auxiliary power unit (APU) for an aircraft. Alternatively, the gas turbine engine **136** may be included in a propulsion system for the aircraft. Examples of the aircraft include, but are not limited to, an airplane, a drone (e.g., an unmanned aerial vehicle (UAV)), a helicopter or any other manned or unmanned aerial vehicle. The present disclosure, however, is not limited to such an exemplary single spool, radial-flow gas turbine engine nor to aircraft applications. For example, the gas turbine engine **136** may alternatively be configured as an industrial gas turbine engine within a land based power generation system.

The gas turbine engine **136** of FIG. **8** extends axially along the centerline axis **44** from a forward, upstream airflow inlet **138** into the gas turbine engine **136** to an aft, downstream combustion products exhaust **140** from the gas turbine engine **136**. The gas turbine engine **136** includes a core flowpath **142** (e.g., the flowpath **54**), an inlet section **144**, a (e.g., radial flow) compressor section **145**, a (e.g., reverse flow) combustor section **146**, a (e.g., axial flow) turbine section **147** and an exhaust section **148**. The gas turbine engine **136** also includes a housing structure **150** housing and/or at least partially forming one or more or all of the engine sections **144-148**.

The core flowpath **142** may extend within the gas turbine engine **136** from the airflow inlet **138** to the combustion products exhaust **140**. The core flowpath **142** of FIG. **8**, in particular, extends sequentially through the inlet section **144**, the compressor section **145**, the combustor section **146**, the turbine section **147** and the exhaust section **148**.

The compressor section **145** includes a bladed compressor rotor **152**; e.g., a compressor impeller. The turbine section **147** includes a bladed turbine rotor **154**. Each of these engine rotors **152**, **154** includes a plurality of rotor blades arranged circumferentially around and connected to at least one respective rotor disk or hub. The rotor blades, for example, may be formed integral with or mechanically fastened, welded, brazed, adhered and/or otherwise attached to the respective rotor disk or hub.

The compressor rotor **152** is connected to the turbine rotor **154** and an engine shaft **156**. This engine shaft **156** is rotatably supported by the housing structure **150** through a plurality of bearings; e.g., rolling element bearings, journal bearings, etc. At least the compressor rotor **152**, the turbine rotor **154** and the engine shaft **156** may form an engine rotating structure within the gas turbine engine **136**.

The combustor section **146** includes an annular combustor **158** with an annular combustion chamber **160**. The combustor **158** of FIG. **8** is configured as a reverse flow combustor. Inlets ports/flow tubes into the combustion chamber **160**, for example, may be arranged at (e.g., on, adjacent or proximate) and/or towards an aft bulkhead wall of the combustor **158**. An outlet from the combustor **158** may be arranged axially aft of an inlet to the turbine section **147**. The combustor **158** may also be arranged radially outboard of and/or axially overlap at least a (e.g., aft) portion of the turbine section **147**. With this arrangement, the core flowpath **142** of FIG. **8** reverses direction (e.g., from a forward-to-aft direction to an aft-to-forward direction) a first time as the core flowpath **142** extends from a diffuser plenum surrounding the combustor **158** into the combustion chamber **160**. The core flowpath **142** of FIG. **8** then reverses direction (e.g., from the aft-to-forward direction to the forward-to-aft direction) a second time as the core flowpath **142** extends from the combustion chamber **160** into the turbine section **147**.

During operation, air enters the gas turbine engine 136 through the inlet section 144 and its airflow inlet 138. The inlet section 144 directs the air from the airflow inlet 138 into the core flowpath 142 and the compressor section 145. The air entering the core flowpath 142 may be referred to as core air. This core air is compressed by the compressor rotor 152. The compressed core air is directed through a diffuser and its plenum into the combustion chamber 160. Fuel is injected and mixed with the compressed core air to provide a fuel-air mixture. This fuel-air mixture is ignited within the combustion chamber 160, and combustion products thereof flow through the turbine section 147 and cause the turbine rotor 154 to rotate. The rotation of the turbine rotor 154 drives rotation of the compressor rotor 152 and, thus, compression of the air received from the airflow inlet 138. The exhaust section 148 receives the combustion products from the turbine section 147. The exhaust section 148 directs these combustion products out of the gas turbine engine 136 through the combustion products exhaust 140.

The engine assembly 20 may be included in various gas turbine engines other than the one described above. The engine assembly 20, for example, may be included in a geared gas turbine engine where a gear train connects one or more shafts to one or more rotors in a fan section, a compressor section and/or any other engine section. Alternatively, the engine assembly 20 may be included in a direct drive gas turbine engine configured without a gear train. The engine assembly 20 may be included in a gas turbine engine configured with a single spool, with two spools, or with more than two spools. The present disclosure therefore is not limited to any particular types or configurations of gas turbine engines. It is also contemplated the engine assembly 20 may be included in a gas turbine hybrid electric engine or any turbine hybrid engine.

While various embodiments of the present disclosure have been described, it will be apparent to those of ordinary skill in the art that many more embodiments and implementations are possible within the scope of the disclosure. For example, the present disclosure as described herein includes several aspects and embodiments that include particular features. Although these features may be described individually, it is within the scope of the present disclosure that some or all of these features may be combined with any one of the aspects and remain within the scope of the disclosure. Accordingly, the present disclosure is not to be restricted except in light of the attached claims and their equivalents.

What is claimed is:

1. An assembly for a gas turbine engine, comprising:
 - a gas turbine engine case including a case wall and a boss at a port through the case wall;
 - a conduit extending longitudinally along a centerline through the port and into an interior of the gas turbine engine case;
 - a bushing circumscribing the conduit and arranged within the port, the bushing engaged with and laterally between the conduit and the boss, and the bushing comprising a cellular material; and
 - a sleeve mounted on the conduit, the bushing engaging the conduit through the sleeve.
2. The assembly of claim 1, wherein the bushing is configured to damp longitudinal vibrations of the conduit.
3. The assembly of claim 1, wherein the bushing is configured to damp lateral vibrations of the conduit.
4. The assembly of claim 1, wherein the conduit is configured to move longitudinally relative to the gas turbine engine case.

5. The assembly of claim 1, wherein the conduit is configured to move laterally relative to the gas turbine engine case.

6. The assembly of claim 1, wherein the bushing is configured to support the conduit within the boss.

7. The assembly of claim 1, wherein the bushing is fixed to the conduit.

8. The assembly of claim 1, wherein the bushing is fixed to the boss.

9. The assembly of claim 1, wherein the cellular material comprises at least one of metal mesh or composite mesh.

10. The assembly of claim 1, wherein the cellular material circumscribes the conduit.

11. The assembly of claim 10, wherein the bushing further comprises an outer wall circumscribing and attached to the cellular material.

12. The assembly of claim 1, wherein the bushing is seated longitudinally against a shelf within the port.

13. The assembly of claim 1, wherein the case wall extends circumferentially about an axis; and the axis is angularly offset from the centerline.

14. The assembly of claim 1, wherein the gas turbine engine case is configured as an exhaust case for the gas turbine engine.

15. An assembly for a gas turbine engine, comprising:

- a gas turbine engine case including a case wall and a boss at a port through the case wall;
- a conduit extending longitudinally along a centerline through the port and into an interior of the gas turbine engine case; and
- a bushing circumscribing the conduit and arranged within the port, the bushing engaged with and laterally between the conduit and the boss, and the bushing comprising a cellular material; wherein the bushing engages the conduit through a threaded connection.

16. An assembly for a gas turbine engine, comprising:

- a gas turbine engine case including a case wall and a boss at a port through the case wall;
- a conduit extending longitudinally along a centerline through the port and into an interior of the gas turbine engine case;
- a bushing circumscribing the conduit and arranged within the port, the bushing engaged with and laterally between the conduit and the boss, and the bushing comprising a cellular material; and
- a fastener extending through the boss and into the bushing;

 the fastener mounting the bushing to the boss.

17. An assembly for a gas turbine engine, comprising:

- a gas turbine engine case including a case wall and a boss at a port through the case wall;
- a conduit extending longitudinally along a centerline through the port and into an interior of the gas turbine engine case; and
- a bushing circumscribing the conduit and arranged within the port, the bushing engaged with and laterally between the conduit and the boss, and the bushing comprising a cellular material;

 wherein the cellular material circumscribes the conduit; wherein the bushing further comprises an inner wall circumscribing the conduit; and wherein the cellular material further circumscribes and is attached to the inner wall.