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EXHAUST DUCT MOUNTING STRUCTURE FOR HYBRID AIRCRAFT POWERPLANT

Abstract

An assembly is provided for an aircraft propulsion system. This assembly includes an electric machine, an exhaust duct and a mounting structure. The electric machine extends axially along an axis. The exhaust duct includes an annular first section and a non-annular second section fluidly coupled with and downstream of the annular first section. The annular first section extends circumferentially around the axis. The non-annular second section axially overlaps the electric machine and extends partially circumferentially about the electric machine. The mounting structure connects the electric machine to the exhaust duct. The mounting structure includes a duct mount, a machine mount and a framework. The duct mount is connected to the annular first section. The machine mount is connected to the electric machine. The framework extends axially between and is connected to the duct mount and the machine mount. The framework includes a plurality of struts arranged in a truss.

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Background/Summary

TECHNICAL FIELD

[0001] This disclosure relates generally to an aircraft and, more particularly, to a hybrid powerplant for the aircraft.

BACKGROUND INFORMATION

[0002] A hybrid powerplant for an aircraft may include a gas turbine engine and an electric motor. The gas turbine engine and the electric motor may be operatively connected in parallel through a gearbox or inline through a shaft and/or another coupling. Various types and configurations of hybrid powerplants are known in the art. While these known hybrid powerplants have various benefits, there is still room in the art for improvement.

SUMMARY

[0003] According to an aspect of the present disclosure, an assembly is provided for an aircraft propulsion system. This assembly includes an electric machine, an exhaust duct and a mounting structure. The electric machine extends axially along an axis. The exhaust duct includes an annular first section and a non-annular second section fluidly coupled with and downstream of the annular first section. The annular first section extends circumferentially around the axis. The non-annular second section axially overlaps the electric machine and extends partially circumferentially about the electric machine. The mounting structure connects the electric machine to the exhaust duct. The mounting structure includes a duct mount, a machine mount and a framework. The duct mount is connected to the annular first section. The machine mount is connected to the electric machine. The framework extends axially between and is connected to the duct mount and the machine mount. The framework includes a plurality of struts arranged in a truss.

[0004] According to another aspect of the present disclosure, another assembly is provided for an aircraft propulsion system. This assembly includes a gas turbine engine, an electric machine, a duct mount, a machine mount and a framework. The gas turbine engine includes a rotating assembly and an engine case housing the rotating assembly. The rotating assembly is rotatable about an axis. The electric machine includes a machine rotor and a machine case housing the machine rotor. The machine rotor is operatively coupled to the rotating assembly rotatable by a drivetrain. The duct mount is connected to the engine case and circumscribes the drivetrain. The machine mount is connected to the machine case and circumscribes the drivetrain. The framework extends axially between and is connected to the duct mount and the machine mount. The framework includes a plurality of struts arranged in a truss.

[0005] According to still another aspect of the present disclosure, another assembly is provided for an aircraft propulsion system. This assembly includes an electric machine, an exhaust duct and a mounting structure. The electric machine extends axially along an axis. The exhaust duct includes an annular first section and a non-annular second section fluidly coupled with and downstream of the annular first section. The annular first section circumscribes the axis. The non-annular second section axially overlaps the electric machine and wraps partially circumferentially about the electric machine. The mounting structure connects the electric machine to the exhaust duct. The mounting structure includes a plurality of struts arranged in a truss. An outer portion of the truss wraps partially circumferentially about the annular first section. An inner portion of the truss projects radially into a pocket in the non-annular second section towards the electric machine.

[0006] The gas turbine engine may also include an exhaust duct with a pocket. The truss may wrap partially circumferentially around the exhaust duct and project radially into the pocket.

[0007] The duct mount may include an annular mounting flange that extends circumferentially around the axis.

[0008] The duct mount may include a plurality of mounting flanges arranged circumferentially

about the axis.
[0009] The exhaust duct may be bonded to the duct mount.
[0010] The exhaust duct may be mechanically fastened to the duct mount.
[0011] The machine mount may extend circumferentially around and may be mechanically fastened to the electric machine.
[0012] The machine mount may include a mounting ring and a triangular frame. The mounting ring may be connected to the electric machine. The triangular frame may project out from the mounting ring and may be connected to the framework.
[0013] The machine mount may include a mounting ring, a first arm and a second arm.
[0014] The mounting ring may be connected to the electric machine. The first arm may project out from the mounting ring and may be connected to a first set of the struts at a first node. The second arm may project out from the mounting ring and may be connected to a second set of the struts at a second node.
[0015] The exhaust duct may extend partially circumferentially about the mounting ring between a first circumferential side and a second circumferential side. The first arm may radially overlap the first circumferential side. The first node may be disposed radially outboard of the exhaust duct. The second arm may radially overlap the second circumferential side. The second node may be disposed radially outboard of the exhaust duct.
[0016] The machine mount may also include a third arm circumferentially between the first arm and the second arm. The third arm may project out from the mounting ring and may be connected to a third set of the struts at a third node.
[0017] A fourth set of the struts may be connected to the mounting ring at a fourth node that is diametrically opposite the third node.
[0018] A third set of the strut may be connected to the mounting ring circumferentially between and equispaced from the first node and the second node.
[0019] The struts may include a first strut, a second strut and a third strut. The first strut and the second strut may be connected to the duct mount at a first duct mount node. The second strut and the third strut may be connected to the machine mount at a first machine mount node. The third strut may be connected to the duct mount at a second duct mount node.
[0020] The struts may also include a fourth strut. The fourth strut may be connected to the second strut at a location between the first duct mount node and the second duct mount node. The fourth strut may be connected to the machine mount at a second machine mount node.
[0021] The struts may also include a fourth strut. The fourth strut may be connected to the second strut at a location between the first duct mount node and the second duct mount node. The fourth strut may be connected to the duct mount at a third duct mount node.
[0022] The assembly may also include a gas turbine engine and a drivetrain. The gas turbine engine may include the exhaust duct, an engine case and a rotating assembly. The engine case may house the rotating assembly. The electric machine may be mounted to the engine case through the mounting structure. The drivetrain may project through a bore of the annular first section and may operably couple a rotor in the electric machine to the rotating assembly.
[0023] The electric machine may be configurable an electric motor and/or an electric generator.
[0024] The present disclosure may include any one or more of the individual features disclosed above and/or below alone or in any combination thereof.
[0025] The foregoing features and the operation of the invention will become more apparent in light of the following description and the accompanying drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] FIG. **1** is a partial schematic sectional illustration of an aircraft system.

[0027] FIG. **2** is a schematic illustration of an electric machine arranged with a power source.

[0028] FIG. **3** is a schematic illustration of a gas turbine engine.

[0029] FIG. **4** is a perspective illustration of a portion of a powerplant at the electric machine and an exhaust duct of the gas turbine engine.

[0030] FIG. **5** is a sectional illustration of a portion of the powerplant at the electric machine (schematically shown) and the exhaust duct.

[0031] FIG. **6** is a cross-sectional illustration of an inlet section of the exhaust duct.

[0032] FIG. **7** is a cross-sectional illustration of an outlet section of the exhaust duct with the electric machine (schematically shown).

[0033] FIG. **8** is a sectional illustration of a bolted connection between an engine case, the exhaust duct and an electric machine mounting structure.

[0034] FIG. **9** is a perspective illustration of a machine mount.

[0035] FIG. **10** is a perspective illustration of the exhaust duct and the mounting structure with a segmented duct mount.

[0036] FIG. **11** is a sectional illustration of the bolted connection between the engine case, the exhaust duct and the segmented duct mount.

DETAILED DESCRIPTION

[0037] FIG. **1** illustrates a system **20** for an aircraft. The aircraft may be an airplane, a helicopter, a drone (e.g., an unmanned aerial vehicle (UAV)) or any other manned or unmanned aerial vehicle or system. The aircraft system **20** may be configured as or otherwise include a propulsion system for the aircraft. The aircraft system **20** of FIG. **1**, for example, includes a propulsor rotor **22** and a hybrid powerplant **24**. The aircraft system **20** of FIG. **1** also includes a drivetrain **26** operatively connecting the powerplant **24** to the propulsor rotor **22**.

[0038] The propulsor rotor **22** may be configured as or otherwise include a bladed rotor. This propulsor rotor **22** may be an open rotor (e.g., an un-ducted rotor) such as a propeller rotor **28** for a propeller propulsion system; e.g., a hybrid turboprop engine. Other examples of the open rotor include a propulsor rotor for a propfan propulsion system or a propulsor rotor for a pusher fan propulsion system. The present disclosure, however, is not limited to such exemplary open rotors nor to open rotor propulsion systems. The propulsor rotor **22**, for example, may alternatively be a ducted rotor such as a fan rotor (e.g., a fan) for a turbofan propulsion system; e.g., a hybrid turbofan engine. It is further contemplated the propulsor rotor **22** may be configured as another type of air mover. However, for ease of description, the propulsor rotor **22** may be described and/or referred to herein as the propeller rotor **28** for the propeller propulsion system.

[0039] The powerplant **24** includes an electric machine **30** and a gas turbine engine **32**. The powerplant **24** is configured to drive rotation of the propulsor rotor **22**, using the electric machine **30** and/or the gas turbine engine **32**, through the drivetrain **26**. This drivetrain **26** may be configured as a geared drivetrain. The drivetrain **26** of FIG. **1**, for example, includes a geartrain **34** (e.g., a reduction gear system) and a shaft **36** and/or another power transmission device coupling an output of the geartrain **34** to the propulsor rotor **22**. The present disclosure, however, is not limited to such an exemplary geared drivetrain arrangement. Furthermore, in other embodiments, the geartrain **34** may be omitted from the drivetrain **26** to provide a direct drive drivetrain between the powerplant **24** and the propulsor rotor **22**.

[0040] Referring to FIG. **2**, the electric machine **30** may be configurable as an electric motor and/or an electric generator; e.g., a motor-generator. For example, during a motor mode of operation, the electric machine **30** may operate as the electric motor to convert electricity received from a power source **38** into mechanical power. This mechanical power may be utilized for various purposes within the aircraft system **20** of FIG. **1** such as, for example, rotating the propulsor rotor **22** and/or rotating a low speed rotating structure **40** (or another rotating structure) within the gas turbine engine **32** during engine startup. During a generator mode of operation, the electric machine **30** may operate as the electric generator to convert mechanical power received from, for example, the gas turbine engine **32** and its low speed rotating structure **40** into electricity. This electricity may be utilized for various purposes within the aircraft system **20** such as, for example, electrically powering one or more electric components of the aircraft system **20** and/or charging the power source **38** (see FIG. **2**). The electricity may also or alternatively be utilized for various purposes outside of the aircraft system **20** such as, for example, electrically powering one or more electric components in the aircraft. Of course, in other embodiments, the electric machine **30** may alternatively be configured as a dedicated electric motor (e.g., without the electric generator functionality) or a dedicated electric generator (e.g., without the electric motor functionality).

[0041] The electric machine **30** of FIG. **2** includes an electric machine rotor **42** and an (e.g., annular) electric machine stator **44**. The machine stator **44** may be radially outboard of and circumscribe the machine rotor **42**. The electric machine **30**, however, is not limited to such an exemplary rotor-stator configuration. The machine rotor **42**, for example, may alternatively be axially next to or radially outboard of and circumscribe the machine stator **44**. The machine rotor **42** of FIG. **2** is rotatable about a rotational axis **46** of the machine rotor **42**, which rotational axis **46** may also be an axial centerline of the electric machine **30**. The electric machine **30** also includes an electric machine case **48** that at least partially or completely houses the machine rotor **42** and the machine stator **44**.

[0042] The power source **38** is electrically coupled with the electric machine **30** through one or more electrical leads **50**; e.g., high voltage lines. The power source **38** is configured to store electricity. The power source **38** is also configured to provide the stored electricity to the electric machine **30** and/or receive electricity from the electric machine **30**; e.g., during power source recharging. The power source **38**, for example, may be configured as or otherwise include one or more batteries **52** and/or one or more other electric storage devices.

[0043] Referring to FIG. **3**, the gas turbine engine **32** includes a compressor section **60**, a combustor section **61**, a turbine section **62** and an (e.g., axisymmetric) exhaust duct **64**. The turbine section **62** may include a high pressure turbine (HPT) section **62**A and a low pressure turbine (LPT) section **62**B; e.g., a power turbine section. The gas turbine engine **32** also includes an engine case **66** housing the engine sections **60-62**B; e.g., a core **68** of the gas turbine engine **32**.

[0044] The compressor section **60**, the combustor section **61**, the HPT section **62**A, the LPT section **62**B and the exhaust duct **64** are arranged sequentially along a core flowpath **70** within the gas turbine engine **32**. This flowpath **70** extends within the gas turbine engine **32** from an upstream airflow inlet **72** into the gas turbine engine **32** to a downstream combustion products exhaust **74** from the gas turbine engine **32**.

[0045] Each of the engine sections **60**, **62**A and **62**B includes a respective bladed rotor **76-78**. Each of these bladed rotors **76-78** includes a plurality of rotor blades arranged circumferentially around and connected to one or more respective rotor disks. The rotor blades, for example, may be formed integral with or mechanically fastened, welded, brazed and/or otherwise attached to the respective rotor disk(s). The compressor rotor **76** is connected to the HPT rotor **77** through a high speed shaft **80**. At least (or only) the compressor rotor **76**, the HPT rotor **77** and the high speed shaft **80** may collectively form a high speed rotating structure **82** of the gas turbine engine **32**. The LPT rotor **78** is connected to a low speed shaft **84**, which low speed shaft **84** may extend axially through a bore of the high speed rotating structure **82** and its high speed shaft **80**. At least (or only) the LPT rotor **78** and the low speed shaft **84** may collectively form the low speed rotating structure **40**. This low speed rotating structure **40** may be coupled to and rotatable with the propulsor rotor **22** of FIG. **1** through the drivetrain **26** and its member(s) **34** and/or **36**. The low speed rotating structure **40** of FIG. **1** may also be coupled to and rotatable with the machine rotor **42** through an electric machine drivetrain **86**; e.g., a power coupling shaft and/or another power transmission device. With such an arrangement, the machine rotor **42** of FIG. **1** is coupled to the propulsor rotor **22** through the low speed rotating structure **40**, and more particularly sequentially through the drivetrain **86**, the low speed rotating structure **40** and the drivetrain **26** of FIG. **1**. The present disclosure, however, is not limited to such an exemplary operative connection between the electric machine **30** and the propulsor rotor **22**.

[0046] The rotating structures **82** and **40** and their shafts **80** and **84** of FIG. **3** are supported by a plurality of bearings. Each of these bearings is connected to the engine case **66** by one or more support structures; e.g., struts, frames, etc. With this arrangement, each of the rotating structures **82** and **40** of FIG. **3** is rotatable about a common (or respective) rotational axis **88**, which rotational axis **88** may also be an axial centerline of the respective rotating structure **82**, **40**. In some embodiments, referring to FIG. **1**, the rotational axis **88** may be coaxial with or at least substantially parallel with (e.g., within +/−2° or 5° of) the rotational axis **46** of the machine rotor **42**. The electric machine **30** of FIG. **1** may thereby be (e.g., completely or substantially) radially aligned with, but aft and/or downstream of the engine core **68**. Here, the exhaust duct **64** is aft and/or downstream of the engine core **68**.

[0047] Referring again to FIG. **3**, during gas turbine engine operation, air enters the flowpath **70** through the airflow inlet **72** and is directed into the compressor section **60**. The air within the flowpath **70** may be referred to as “core air”. This core air is compressed by the compressor rotor **76** and directed into a combustion chamber **90** (e.g., an annular chamber) of a combustor within the combustor section **61**. The fuel is injected into the combustion chamber **90** by one or more fuel injectors and mixed with the compressed air to provide a fuel-air mixture. This fuel-air mixture is ignited and combustion products thereof flow through and sequentially drive rotation of the HPT rotor **77** and the LPT rotor **78**. The rotation of the HPT rotor **77** drives rotation of the compressor rotor **76** and, thus, compression of the air received from the airflow inlet **72**. The rotation of the LPT rotor **78** and, more generally, the low speed rotating structure **40** provides mechanical power for driving (e.g., rotating) the propulsor rotor **22** of FIG. **1**. The present disclosure, however, is not limited to such an exemplary gas turbine engine configuration. For example, in other embodiments, the low speed rotating structure **40** may also include a compressor rotor. In still other embodiments, the low speed rotating structure **40** may be omitted and the high speed rotating structure **82** may be configured for providing the mechanical power for driving the propulsor rotor **22** of FIG. **1**. In such embodiments, the electric machine **30** and its machine rotor **42** may be coupled to the propulsor rotor **22** through the high speed rotating structure **82**. Referring again to FIG. **3**, after flowing through the turbine section **62**, the combustion products flow through the exhaust duct **64** and are exhausted from the powerplant **24** through the combustion products exhaust **74** into an environment **92** external to the aircraft system **20**; see also FIG. **1**.

[0048] Referring to FIGS. **4** and **5**, the exhaust duct **64** is located at an aft and/or downstream end of the gas turbine engine **32**. The exhaust duct **64** of FIGS. **4** and **5**, for example, extends longitudinally along a longitudinal centerline **94** between and to an inlet **96** to the exhaust duct **64** (see FIG. **5**) and an outlet **98** from the exhaust duct **64**, which longitudinal centerline **94** may be coaxial with one or more of the rotational axes **46**, **88**; see also FIG. **1**. The exhaust duct **64** is connected to the engine case **66**. The exhaust duct **64** of FIG. **5**, for example, is mechanically fastened to an aft and/or downstream portion **100** of the engine case **66** housing the turbine section **62** at the duct inlet **96**. The duct outlet **98** forms the combustion products exhaust **74**. The exhaust duct **64** thereby projects longitudinally out from the turbine section portion **100** of the engine case **66** to the combustion products exhaust **74**. The exhaust duct **64** includes an annular inlet section **102**, a non-annular outlet section **103** and a transition section **104**.

[0049] Referring to FIG. **5**, the inlet section **102** forms the duct inlet **96**. The inlet section **102** of FIG. **5** is disposed longitudinally between (a) the turbine section **62**/the engine case **66** and (b) the electric machine **30** along the longitudinal centerline **94**. Referring to FIG. **6**, the inlet section **102** has an annular cross-sectional geometry (“annular geometry”) when viewed, for example, in a reference plane perpendicular to the longitudinal centerline **94** and/or the flowpath **70** at a point of interest along the inlet section **102**. The annular geometry of FIG. **6** has a circular shape. This annular geometry may be uniform along a longitudinal length of the inlet section **102**. Alternatively, the annular geometry may (e.g., slightly) change along at least a portion of the longitudinal length of the inlet section **102**. The present disclosure, however, is not limited to such an exemplary annular shape.

[0050] Referring to FIG. **5**, the outlet section **103** forms the duct outlet **98** and the combustion products exhaust **74**. The outlet section **103** longitudinally overlaps the electric machine **30** along the longitudinal centerline **94**. The outlet section **103** of FIG. **5**, for example, extends longitudinally along the electric machine **30** to the combustion products exhaust **74**. Referring to FIG. **7**, the outlet section **103** has a non-annular cross-sectional geometry ("non-annular geometry") when viewed, for example, in a reference plane perpendicular to the longitudinal centerline **94** and/or the flowpath **70** at a point of interest along the outlet section **103**. The non-annular geometry of FIG. **7** is an arcuate geometry with, for example, a U-shape or a crescent shape. This non-annular geometry may be uniform along a longitudinal length of the outlet section **103**. Alternatively, the non-annular geometry may (e.g., slightly) change along at least a portion of the longitudinal length of the outlet section **103**. The present disclosure, however, is not limited to such an exemplary non-annular geometry. For example, in other embodiments, the non-annular geometry of the outlet section **103** may have a circular segment shape or a polygonal shape.

[0051] Referring to FIGS. **4** and **5**, the transition section **104** connects the outlet section **103** to the inlet section **102**. The transition section **104** of FIGS. **4** and **5**, for example, extends longitudinally between and to the inlet section **102** and the outlet section **103**. The transition section **104** may (or may not) longitudinally overlap the electric machine **30** along the longitudinal centerline **94**. An aft and/or downstream portion of the transition section **104** of FIG. **5**, for example, extends longitudinally along the electric machine **30** to the outlet section **103**. A forward and/or upstream portion of the transition section **104** of FIG. **5**, on the other hand, may be disposed longitudinally between (a) the inlet section **102** and (b) the electric machine **30** along the longitudinal centerline **94**. The transition section **104** has a non-annular cross-sectional geometry ("non-annular geometry") when viewed, for example, in a reference plane perpendicular to the longitudinal centerline **94** and/or the flowpath **70** at a point of interest along the transition section **104**. The non-annular geometry is an arcuate geometry; see also FIG. **4**. This non-annular geometry of the transition section **104** changes along at least a portion or an entirety of a longitudinal length of the transition section **104** to provide a (e.g., gradual) transition between the annular geometry of the inlet section **102** and the non-annular geometry of the outlet section **103**.

[0052] The exhaust sections **103** and **104** of FIGS. **4** and **5** are configured to provide the exhaust duct **64** with a side pocket **106**; e.g., a groove, an indentation, a recession, a channel, etc. This side pocket **106** is outside of the flowpath **70** and, more particularly, separated from the flowpath **70** by an exterior sidewall **108** of the exhaust duct **64**. The side pocket **106** is thereby disposed next to the exhaust duct **64** and its sidewall **108**. The side pocket **106** of FIGS. **4** and **5**, for example, extends longitudinally into the exhaust duct **64** from an end at the duct outlet **98** to the inlet section **102** and its internal bore **109**; see also FIG. **6**. The side pocket **106** projects radially into (in a radial outward direction relative to the longitudinal centerline **94**) the exhaust duct **64** and its exhaust sections **103** and **104**. The side pocket **106** extends laterally within the exhaust duct **64** and its exhaust sections **103** and **104**.

[0053] The electric machine **30** may be arranged at least partially within the side pocket **106**. One or more of the duct sections **103** and/or **104** may each extend axially along (e.g., overlap) the electric machine **30**. One or more of the duct sections **103** and/or **104** may each extend (e.g., wrap) circumferentially about the electric machine **30** (and the longitudinal centerline **94**) between opposing circumferential sides **110**A and **110**B (generally referred to as "**110**") of the exhaust duct **64**; see FIG. **7**. With this arrangement, the electric machine **30** may be aligned with the gas turbine engine **32**; e.g., the rotational axes **46**, **88** may be at least substantially coaxial. The electric machine **30** may also project (e.g., vertically and/or laterally) out of the side pocket **106** and away from the exhaust duct **64** such that at least a portion of an exterior of the electric machine **30** and its machine case **48** is exposed to air (e.g., relatively cool air, ambient air, etc.) outside of and away from the exhaust duct **64**. Such an arrangement may (e.g., significantly) reduce cooling requirements for the electric machine **30**. Insulation may also (or may not) be provided along an exterior surface of the exhaust duct **64** and its sidewall **108** within the side pocket **106** to provide further heat protection for the electric machine **30**.

[0054] The electric machine **30** of FIGS. **4** and **5** is mounted to the gas turbine engine **32** and its engine case **66** and/or its exhaust duct **64** through a mounting structure **112**. This mounting structure **112** is configured to fixedly locate the electric machine **30** relative to the gas turbine engine **32**. The mounting structure **112** is also configured to facilitate airflow to and around the electric machine **30** and/or access to the electric machine **30** and/or the drivetrain **86** during aircraft system assembly. The mounting structure **112** of FIGS. **4** and **5**, for example, includes a duct mount **114**, a machine mount **116** and an open framework **118**.

[0055] Referring to FIG. **4**, the duct mount **114** may be configured as or otherwise include an annular mounting flange. The duct mount **114** of FIG. **4**, for example, extends circumferentially around the longitudinal centerline **94**/the axes **46**, **88** providing the duct mount **114** with a full-hoop body. Referring to FIG. **8**, the duct mount **114** extends radially from a radial inner end **120** of the duct mount **114** to a radial outer end **122** of the duct mount **114**. This duct mount **114** may be connected to the exhaust duct **64** and/or the engine case **66**. The sidewall **108** of the exhaust duct **64** of FIG. **8**, for example, is abutted axially against the duct mount **114** at its duct mount inner end **120**. The exhaust duct **64** and its sidewall **108** of FIG. **8** are also bonded (e.g., welded) to the duct mount **114**. The engine case **66** of FIG. **8** may also be abutted axially against or otherwise engaged with the duct mount **114**. Here, the duct mount **114** is positioned axially between the engine case **66** and the exhaust duct **64**. The engine case **66** of FIG. **8** is also mechanically fastened to the duct mount **114** with a plurality of fasteners **124** (e.g., bolts) at a bolted flange connection. The duct mount **114** may thereby connect the exhaust duct **64** to the engine case **66** as well as connect the mounting structure **112** to each of the elements **64** and **66**.

[0056] Referring to FIG. **9**, the machine mount **116** includes a mounting ring **126** and a (e.g., triangular) mounting frame **128** connected to (e.g., formed integral with) the mounting ring **126**. The mounting ring **126** extends circumferentially around the longitudinal centerline **94**/the axes **46**, **88** providing the mounting ring **126** with a full-hoop geometry. The mounting ring **126** extends radially from a radial inner end **130** of the machine mount **116** and its mounting ring **126** to a radial outer end **132** of the mounting ring **126**. The mounting frame **128** projects radially out from the mounting ring **126** at its outer end **132**. The mounting frame **128** of FIG. **9**, for example, includes one or more mounting arms **134**A, **134**B and **136**; e.g., projections, tabs, etc. The central mounting arm **136** is arranged laterally between the side mounting arms **134**A and **134**B (generally referred to as "**134**"). Each of these mounting arms projects **134**A, **134**B, **136** out from the mounting ring **126** to a distal end **138**A, **138**B, **140** of the respective mounting arm **134**A, **134**B, **136**. These mounting arm ends **138**A, **138**B, **140** may be arranged to provide the mounting frame **128** with a substantially triangular shape, where each of the mounting arm ends **138**A, **138**B, **140** forms a respective peak **142**A, **142**B, **144** of the triangular shape. An angle **146** between the side mounting arm peaks **142**A and **142**B (generally referred to as "**142**") about the central mounting arm peak **144** may be an obtuse angle; e.g., between one-hundred degrees (100°) and one-hundred and forty degrees (140°). An angle **148**A between the central mounting arm peak **144** and the second side mounting arm peak **142**B about the first side mounting arm peak **142**A may be an acute angle; e.g., between fifteen degrees (15°) and forty-five degrees (45°). An angle **148**B between the central mounting arm peak **144** and the first side mounting arm peak **142**A about the second side mounting arm peak **142**B may be an acute angle; e.g., between fifteen degrees (15°) and forty-five degrees

(45°). The present disclosure, however, is not limited to such exemplary values.

[0057] Referring to FIG. **5**, the machine mount **116** and its mounting ring **126** are connected to the electric machine **30** and its machine case **48**. The mounting ring **126** of FIG. **5**, for example, is seated on a rim of the machine case **48**. With this arrangement, the machine mount **116** and its mounting ring **126** extend circumferentially about (e.g., circumscribe) and axially engage (e.g., are abutted against) the electric machine **30** and its machine case **48**. The mounting ring **126** is mechanically fastened to the machine case **48** with a plurality of fasteners (e.g., bolts) at a bolted connection (not shown for ease of illustration). The machine mount **116** thereby connects the mounting structure **112** to the electric machine **30** and its machine case **48**.

[0058] Referring to FIGS. **4** and **5**, the framework **118** extends axially between and connects the duct mount **114** to the machine mount **116**. The framework **118** of FIGS. **4** and **5** (see also FIG. **10**) includes a plurality of struts **150**A and **150**B, **151**A and **151**B, **152**A and **152**B, **153**A and **153**B, **154**A and **154**B (respectively generally referred to as "**150**", "**151**", "**152**", "**153**", "**154**") (e.g., fixed length links, rods, beams, etc.) arranged in a truss **156**; e.g., a modified Warren truss. This truss **156** may be laterally symmetric and vertically asymmetric. Therefore, for ease of description, a lateral first side **158**A of the truss **156** is described below with the understanding that the other lateral second side **158**B of the truss **156** may be a mirror image of the first side **158**A of the truss **156**.

[0059] To the first side **158**A of the truss **156** of FIG. **4**, each of the mount-to-mount (MM) struts **150**A, **151**A and **152**A extends between and is connected to the duct mount **114** and the machine mount **116**. The first MM strut **150**A of FIG. **4**, for example, is connected to the duct mount **114** at a bottom duct mount node through a fitting **160**A, which fitting **160**A may be bonded to the first MM strut **150**A and mechanically fastened (e.g., bolted) to the duct mount **114**. The second MM strut **151**A and the third MM strut **152**A are connected to the duct mount **114** at a side duct mount node through a fitting **162**A, which fitting **162**A may be bonded to the second and the third MM struts **151**A and **152**A and mechanically fastened (e.g., bolted) to the duct mount **114**. The first MM strut **150**A and the second MM strut **151**A are connected to the machine mount **116** and its first side mounting arm **134**A at a side machine mount node through a fitting **164**A, which fitting **164**A may be bonded to the first and the second MM struts **150**A and **151**A and mechanically fastened (e.g., bolted) to the machine mount **116**. The third MM strut **152**A from the first side **158**A of the truss **156** and the third MM strut **152**B from the second side **158**B of the truss **156** are connected to the machine mount **116** and its central mounting arm **136** at a central machine mount node through a fitting **166**, which fitting **166** may be bonded to the third MM struts **152**A and **152**B and mechanically fastened (e.g., bolted) to the machine mount **116**.

[0060] The duct mount-to-strut (DMS) strut **153**A extends between and is connected to the duct mount **114** and the third MM strut **152**A. The DMS strut **153**A from the first side **158**A of the truss **156** and the DMS strut **153**B from the second side **158**B of the truss **156** of FIG. **4**, for example, are connected to the duct mount **114** at a central duct mount node through a fitting **168**, which fitting **168** may be bonded to the DMS struts **153** and mechanically fastened (e.g., bolted) to the duct mount **114**. The DMS strut **153**A is connected to the third MM strut **152**A at an intermediate strut node disposed along a length of the third MM strut **152**A between the nodes at the fittings **162**A and **166**.

[0061] Referring to FIG. **5**, the machine mount-to-strut (MMS) strut **154**B on the second side **158**B extends between and is connected to the machine mount **116** and the third MM strut **152**B. The MMS strut **154**B of FIG. **5**, for example, is connected to the machine mount **116** at a bottom machine mount node through a fitting **170**B, which fitting **170**B may be bonded to the MMS strut **154**B and mechanically fastened (e.g., bolted) to the machine mount **116**. This bottom machine mount node may be diametrically opposite the central machine mount node. The MMS strut **154**B of FIG. **4** is connected to the third MM strut **152**B at the intermediate strut node with the DMS strut **153**B.

[0062] With the foregoing arrangement, referring to FIG. **4**, the mounting ring **126** is disposed in the side pocket **106**. Each side mounting arm **134** projects out of the side pocket **106** and radially overlaps a respective circumferential side **110** of the exhaust duct **64**. An outer peripheral portion of the truss **156** and its struts **150**, **151**, **152** and **153** wrap partially circumferentially around the exhaust duct **64** and circumferentially and axially overlaps a portion of the side pocket **106** between the inlet section **102** and the electric machine **30**. In addition, an inner portion of the truss **156** and its struts **154** project radially into the side pocket **106**; see also FIG. **5**. The mounting frame **128** and its truss **156** thereby wrap around each circumferential end **110** of the exhaust duct **64** and its transition section **104**.
[0063] In some embodiments, referring to FIGS. **4** and **5**, the duct mount **114** may be configured as a single monolithic body. In other embodiments, referring to FIG. **10**, the duct mount **114** may include a plurality of discrete mounting flanges **172**A and **174** (note, a mirror image of flange **172**A is not visible in the view of FIG. **10**) arranged circumferentially about the longitudinal centerline **94**/the axes **46**, **88**. With such an arrangement, the duct mount **114** may be arranged with (e.g., mounted to) the gas turbine engine **32** following assembly of the exhaust duct **64** to the engine case **66**. Referring to FIG. **11**, each mounting flange (e.g., **174**) may be mechanically fastened to the exhaust duct **64** and the engine case **66** with a plurality of fasteners (e.g., bolts) at a bolted flange connection. Here, the exhaust duct **64** includes a mounting flange **176** arranged between and engaged with (e.g., axially abutted against) the engine case **66** and the duct mount **114**.
[0064] 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.

Claims

1. An assembly for an aircraft propulsion system, comprising: an electric machine extending axially along an axis; an exhaust duct including an annular first section and a non-annular second section fluidly coupled with and downstream of the annular first section, the annular first section extending circumferentially around the axis, and the non-annular second section axially overlapping the electric machine and extending partially circumferentially about the electric machine; and a mounting structure connecting the electric machine to the exhaust duct, the mounting structure including a duct mount, a machine mount and a framework; the duct mount connected to the annular first section; the machine mount connected to the electric machine; and the framework extending axially between and connected to the duct mount and the machine mount, the framework comprising a plurality of struts arranged in a truss.
2. The assembly of claim 1, wherein the duct mount comprises an annular mounting flange that extends circumferentially around the axis.
3. The assembly of claim 1, wherein the duct mount includes a plurality of mounting flanges arranged circumferentially about the axis.
4. The assembly of claim 1, wherein the exhaust duct is bonded to the duct mount.
5. The assembly of claim 1, wherein the exhaust duct is mechanically fastened to the duct mount.
6. The assembly of claim 1, wherein the machine mount extends circumferentially around and is mechanically fastened to the electric machine.
7. The assembly of claim 1, wherein the machine mount includes a mounting ring connected to the electric machine; and a triangular frame projecting out from the mounting ring and connected to the

framework.

8. The assembly of claim 1, wherein the machine mount includes a mounting ring connected to the electric machine; a first arm projecting out from the mounting ring and connected to a first set of the plurality of struts at a first node; and a second arm projecting out from the mounting ring and connected to a second set of the plurality of struts at a second node.

9. The assembly of claim 8, wherein the exhaust duct extends partially circumferentially about the mounting ring between a first circumferential side and a second circumferential side; the first arm radially overlaps the first circumferential side, and the first node is disposed radially outboard of the exhaust duct; and the second arm radially overlaps the second circumferential side, and the second node is disposed radially outboard of the exhaust duct.

10. The assembly of claim 8, wherein the machine mount further includes a third arm circumferentially between the first arm and the second arm; the third arm projects out from the mounting ring and is connected to a third set of the plurality of struts at a third node.

11. The assembly of claim 10, wherein a fourth set of the plurality of struts are connected to the mounting ring at a fourth node that is diametrically opposite the third node.

12. The assembly of claim 8, wherein a third set of the plurality of strut are connected to the mounting ring circumferentially between and equispaced from the first node and the second node.

13. The assembly of claim 1, wherein the plurality of struts include a first strut, a second strut and a third strut; the first strut and the second strut are connected to the duct mount at a first duct mount node; the second strut and the third strut are connected to the machine mount at a first machine mount node; and the third strut is connected to the duct mount at a second duct mount node.

14. The assembly of claim 13, wherein the plurality of struts further include a fourth strut; the fourth strut is connected to the second strut at a location between the first duct mount node and the second duct mount node; and the fourth strut is connected to the machine mount at a second machine mount node.

15. The assembly of claim 13, wherein the plurality of struts further include a fourth strut; the fourth strut is connected to the second strut at a location between the first duct mount node and the second duct mount node; and the fourth strut is connected to the duct mount at a third duct mount node.

16. The assembly of claim 1, wherein the annular first section is axially spaced from the electric machine.

17. The assembly of claim 1, further comprising: a gas turbine engine comprising the exhaust duct, an engine case and a rotating assembly, the engine case housing the rotating assembly, the electric machine mounted to the engine case through the mounting structure; and a drivetrain projecting through a bore of the annular first section and operably coupling a rotor in the electric machine to the rotating assembly.

18. An assembly for an aircraft propulsion system, comprising: a gas turbine engine including a rotating assembly and an engine case housing the rotating assembly, the rotating assembly rotatable about an axis; an electric machine including a machine rotor and a machine case housing the machine rotor, the machine rotor operatively coupled to the rotating assembly rotatable by a drivetrain; and a duct mount connected to the engine case and circumscribing the drivetrain; a machine mount connected to the machine case and circumscribing the drivetrain; and a framework extending axially between and connected to the duct mount and the machine mount, the framework comprising a plurality of struts arranged in a truss.

19. The assembly of claim 18, wherein the gas turbine engine further includes an exhaust duct with a pocket; the truss wraps partially circumferentially around the exhaust duct and projects radially into the pocket.

20. An assembly for an aircraft propulsion system, comprising: an electric machine extending axially along an axis; an exhaust duct including an annular first section and a non-annular second section fluidly coupled with and downstream of the annular first section, the annular first section circumscribing the axis, and the non-annular second section axially overlapping the electric machine and wrapping partially circumferentially about the electric machine; and a mounting structure connecting the electric machine to the exhaust duct, the mounting structure including a plurality of struts arranged in a truss, an outer portion of the truss wrapping partially circumferentially about the annular first section, and an inner portion of the truss projecting radially into a pocket in the non-annular second section towards the electric machine.