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Inventor(s)	Hanrahan; Paul R. et al.

Powerplant with multiple integrated gas turbine engines

Abstract

A powerplant is provided that includes a first gas turbine engine, a second gas turbine engine, a second engine bypass flowpath and a flow control system. The first gas turbine engine includes a first core flowpath fluidly coupled with a first inlet and a first exhaust. The first core flowpath extends sequentially through a first compressor section, a first combustor section and a first turbine section. The second gas turbine engine a second core flowpath fluidly coupled with a second inlet and a second exhaust. The second core flowpath extends sequentially through a second compressor section, a second combustor section and a second turbine section. The flow control system fluidly couples the first inlet and the first exhaust to the second core flowpath during a first mode. The flow control system fluidly couples the first inlet and the first exhaust to the second engine bypass flowpath during a second mode.

Inventors: **Hanrahan; Paul R. (Sedona, AZ), Kupratis; Daniel B. (Wallingford, CT)**

Applicant: **RTX Corporation** (Farmington, CT)

Family ID: **1000008762950**

Assignee: **RTX CORPORATION (Farmington, CT)**

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Primary Examiner: Meade; Lorne E

Assistant Examiner: Amar; Marc

Attorney, Agent or Firm: Getz Balich LLC

Background/Summary

(1) This application claims priority to U.S. Provisional Patent Application No. 63/422,488 filed Nov. 4, 2022, which is hereby incorporated herein by reference in its entirety.

BACKGROUND OF THE DISCLOSURE

1. Technical Field

(1) This disclosure relates generally to a powerplant and, more particularly, to a gas turbine engine powerplant.

2. Background Information

(2) Various types and configurations of powerplants are known in the art for an aircraft. While these known aircraft powerplants have various benefits, there is still room in the art for improvement. There is a need in the art, in particular, for an improved multi-engine aircraft powerplant.

SUMMARY OF THE DISCLOSURE

(3) According to an aspect of the present disclosure, a powerplant is provided that includes a first gas turbine engine, a second gas turbine engine, a second engine bypass flowpath and a flow control system. The first gas turbine engine includes a first inlet, a first exhaust, a first compressor section, a first combustor section, a first turbine section and a first core flowpath. The first core flowpath is fluidly coupled with and between the first inlet and the first exhaust. The first core flowpath extends sequentially through the first compressor section, the first combustor section and the first turbine section. The second gas turbine engine includes a second inlet, a second exhaust, a second compressor section, a second combustor section, a second turbine section and a second core flowpath. The second core flowpath is fluidly coupled with and between the second inlet and the second exhaust. The second core flowpath extends sequentially through the second compressor section, the second combustor section and the second turbine section. The second engine bypass flowpath bypasses the second core flowpath. The flow control system is configured to fluidly couple the first inlet and the first exhaust to the second core flowpath during a first mode. The flow control system is configured to fluidly couple the first inlet and the first exhaust to the second engine bypass flowpath during a second mode.

(4) According to another aspect of the present disclosure, another powerplant is provided that includes a first gas turbine engine, a second gas turbine engine and a first engine bypass flowpath. The first gas turbine engine includes a first fan section, a first compressor section, a first combustor section, a first turbine section and a first core flowpath. The first core flowpath extends sequentially through the first compressor section, the first combustor section and the first turbine section. The second gas turbine engine includes a second fan section, a second compressor section, a second combustor section, a second turbine section and a second core flowpath. The second core flowpath extends sequentially through the second compressor section, the second combustor section and the second turbine section. The first engine bypass flowpath is outboard of the first core flowpath and extends sequentially through the first fan section and the second fan section.

(5) According to still another aspect of the present disclosure, another powerplant is provided that includes a first gas turbine engine and a second gas turbine engine. The first gas turbine engine includes a first inlet, a first exhaust, a first compressor section, a first combustor section, a first turbine section and a first core flowpath. The first core flowpath is fluidly coupled with and between the first inlet and the first exhaust. The first core flowpath extends sequentially in a first direction along a centerline through the first compressor section, the first combustor section and the first turbine section. The first core flowpath extends circumferentially about the centerline. The second gas turbine engine includes a second inlet, a second exhaust, a second compressor section, a second combustor section, a second turbine section and a second core flowpath. The second core

flowpath is fluidly coupled with and between the second inlet and the second exhaust. The second core flowpath extends sequentially in a second direction along the centerline through the second compressor section, the second combustor section and the second turbine section. The second core flowpath extends circumferentially about the centerline. The second direction is opposite the first direction along the centerline.

(6) The powerplant may also include a second engine bypass flowpath outboard of the second core flowpath. The second core flowpath and the second engine bypass flowpath may be independently fluidly coupled with and downstream of the first engine bypass flowpath.

(7) The powerplant may also include a flow control system configured to fluidly couple a first inlet and a first exhaust to the second core flowpath during a first mode. The flow control system may be configured to fluidly couple the first inlet and the first exhaust to the second engine bypass flowpath during a second mode. The first core flowpath may extend sequentially through the first compressor section, the first combustor section and the first turbine section between the first inlet and the first exhaust.

(8) The first gas turbine engine may be forward of the second gas turbine engine along a centerline.

(9) The flow control system may be configured to: fluidly decouple the first inlet and the first exhaust from the second engine bypass flowpath during the first mode; and/or fluidly decouple the first inlet and the first exhaust from the second core flowpath during the second mode.

(10) The second combustor section may include a combustor. The first inlet and the first exhaust may each be fluidly coupled to the second core flowpath upstream of the combustor during the first mode.

(11) The first inlet may be fluidly coupled to the second core flowpath along the second compressor section during the first mode.

(12) The first inlet may be fluidly coupled to the second core flowpath downstream of the second compressor section during the first mode.

(13) The first inlet may be fluidly coupled to the second core flowpath at a diffuser of the second gas turbine engine during the first mode.

(14) The first core flowpath may extend in a first direction along a centerline within at least one of the first compressor section, the first combustor section or the first turbine section towards the first exhaust. The second core flowpath may extend in a second direction along the centerline within at least one of the second compressor section, the second combustor section or the second turbine section towards the second exhaust. The second direction may be opposite the first direction.

(15) The first gas turbine engine may also include a first rotating structure rotatable about a centerline. The first rotating structure may include a first compressor rotor within the first compressor section and a first turbine rotor within the first turbine section. The second gas turbine engine may also include a second rotating structure rotatable about the centerline. The second rotating structure may include a second compressor rotor within the second compressor section and a second turbine rotor within the second turbine section.

(16) The first rotating structure may be offset from the second rotating structure along the centerline.

(17) The first gas turbine engine may also include a first fan rotor and a first turbine rotor within the first turbine section and configured to drive rotation of the first fan rotor. The second gas turbine engine may also include a second fan rotor and a second turbine rotor within the second turbine section and configured to drive rotation of the second fan rotor.

(18) The first fan rotor may be upstream of the second fan rotor.

(19) The powerplant may also include a first engine bypass flowpath outboard of the first core flowpath. The first fan rotor and the second fan rotor may be within the first engine bypass flowpath.

(20) The second core flowpath and the second engine bypass flowpath may be fluidly coupled in parallel with and downstream of the first engine bypass flowpath.

(21) The first gas turbine engine may also include a first compressor rotor within the first compressor section. The first turbine rotor may be configured to drive rotation of the first compressor rotor. The first turbine rotor may be arranged between the first fan rotor and the first compressor rotor along a centerline.
(22) The second gas turbine engine may also include a second compressor rotor within the second compressor section. The second turbine rotor may be configured to drive rotation of the second compressor rotor. The second compressor rotor may be arranged between the second fan rotor and the second turbine rotor along a centerline.
(23) The powerplant may include a starter configured to drive rotation of a compressor rotor in the second compressor section during the first mode to facilitate startup of the second gas turbine engine.
(24) The present disclosure may include any one or more of the individual features disclosed above and/or below alone or in any combination thereof.
(25) 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
(1) FIG. **1** is a schematic side illustration of a multi-engine powerplant for an aircraft propulsion system.
(2) FIG. **2** is a schematic side illustration of a portion of the powerplant of FIG. **1** with a first gas turbine engine.
(3) FIG. **3** is a schematic side illustration of a portion of the powerplant of FIG. **1** with a second gas turbine engine.
(4) FIG. **4** is a graph depicting a first gas turbine engine pressure ratio during various modes of operation.
(5) FIGS. **5**A and **5**B are schematic illustrations of alternative passage arrangements between flowpaths of the powerplant of FIG. **1**.
(6) FIGS. **6**A and **6**B are illustrations of a section of a vane array during various modes of operation.
DETAILED DESCRIPTION
(7) FIG. **1** is a schematic side illustration of a multi-engine powerplant **20** for an aircraft propulsion system. This powerplant **20** extends axially along an axial centerline **22** of the powerplant **20** from a forward, upstream airflow inlet **24** into the powerplant **20** to an aft, downstream exhaust **26** from the powerplant **20**. The powerplant **20** includes a plurality of gas turbine engines **28** and **30** arranged within a common engine housing **32**. The powerplant **20** of FIG. **1** also includes an inter-engine flow control system **34**.
(8) The gas turbine engines **28** and **30** may be axially offset from (e.g., spaced from, not axially overlap, etc.) one another along the axial centerline **22**. The first gas turbine engine **28** of FIG. **1**, for example, is arranged (e.g., completely) forward of the second gas turbine engine **30** along the axial centerline **22**. With this arrangement, the first gas turbine engine **28** is arranged axially between the powerplant inlet **24** and the second gas turbine engine **30** along the axial centerline **22**. The second gas turbine engine **30** is arranged axially between the powerplant exhaust **26** and the first gas turbine engine **28** along the axial centerline **22**. Furthermore, the first gas turbine engine **28** may be arranged at the powerplant inlet **24** and/or the second gas turbine engine **30** may be arranged at the powerplant exhaust **26**.
(9) Referring to FIG. **2**, the first gas turbine engine **28** includes a first fan section **36**, a first compressor section **37**, a first combustor section **38** and a first turbine section **39**. These first engine

sections **36**, **39**, **38** and **37** may be arranged sequentially along an axial centerline **42** of the first gas turbine engine **28**. This axial centerline **42** may be parallel (e.g., coaxial) with the axial centerline **22**. The axial centerline **42** may also be a rotational axis for one or more rotors within the first gas turbine engine **28**. The first gas turbine engine **28** may also include and/or otherwise be associated with a first core flowpath **44** and a first engine bypass flowpath **46** (referred to below as "first bypass flowpath").

(10) The first fan section **36**, the first compressor section **37** and the first turbine section **39** each include a respective bladed rotor **48-50**. Each of these bladed rotors **48-50** 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, adhered and/or otherwise attached to the respective rotor disk(s).

(11) The first fan rotor **48** is connected to and driven by the first turbine rotor **50** through a first fan shaft **51**. The first compressor rotor **49** is connected to and driven by the first turbine rotor **50** through a first compressor shaft **52**. The first fan shaft **51** and the first compressor shaft **52** may be integral with one another providing a common first engine shaft. Alternatively, the first fan shaft **51** may be discrete from the first compressor shaft **52**; e.g., the shafts **51** and **52** may be independently connected to the first turbine rotor **50**. In either case, the first turbine rotor **50** may be arranged axially between the first fan rotor **48** and the first compressor rotor **49** along the axial centerline **22**, **42**. At least (or only) the first fan rotor **48**, the first compressor rotor **49**, the first turbine rotor **50**, the first fan shaft **51** and the first compressor shaft **52** may form a first engine rotating structure **54**. This first engine rotating structure **54** is rotatable about the axial centerline **22**, **42** and is supported by one or more first engine bearings **56**; e.g., rolling element and/or thrust bearings. Each of these first engine bearings **56** is connected to the engine housing **32** by at least one stationary structure such as, for example, an annular support strut.

(12) The first core flowpath **44** includes an inlet **58** to the first core flowpath **44** and an exhaust **60** from the first core flowpath **44**. The first core flowpath **44** of FIG. **2** extends from the first core flowpath inlet **58**, sequentially through the first compressor section **37**, the first combustor section **38** and the first turbine section **39**, to the first core flowpath exhaust **60**. As the first core flowpath **44** extends towards the first core flowpath exhaust **60**, the first core flowpath **44** may extend within and/or through any one or more or all of the first engine sections **37-39** in a first direction along the axial centerline **22**, **42**, which first direction of FIG. **2** is an axial forward direction. The first core flowpath **44** may also extend circumferentially about (e.g., completely around) the axial centerline **22**, **42**; e.g., the first core flowpath **44** may be an annular flowpath.

(13) The first bypass flowpath **46** may at least partially or completely bypass a core **62** of the first gas turbine engine **28**; e.g., the first engine sections **37-39**. The first bypass flowpath **46** of FIG. **2**, for example, is disposed radially outside of and extends axially along the first engine core **62**. The first bypass flowpath **46** may be formed radially by and between the engine housing **32** and a stationary structure **64** (e.g., a case, a nacelle inner fixed structure, etc.) of the first gas turbine engine **28**, where the engine housing **32** may form an outer peripheral boundary of the first bypass flowpath **46**, and where the first engine stationary structure **64** may form an inner peripheral boundary of the first bypass flowpath **46**.

(14) The first bypass flowpath **46** includes an inlet **66** to the first bypass flowpath **46** and an exhaust **68** from the first bypass flowpath **46**, which first bypass flowpath inlet **66** may be the same as the powerplant inlet **24**. The first bypass flowpath **46** of FIG. **2** extends from the first bypass flowpath inlet **66**, sequentially through the first fan section **36** and a second fan section **70** of the second gas turbine engine **30**, to the first bypass flowpath exhaust **68**. As the first bypass flowpath **46** extends towards the first bypass flowpath exhaust **68**, the first bypass flowpath **46** may extend within and/or through any one or more or all of the fan sections **36** and **70** in a second direction along the axial centerline **22**, **42**, which second direction of FIG. **2** is an axial aft direction. The first bypass flowpath **46** may also extend circumferentially about (e.g., completely around) the axial

centerline **22**, **42**; e.g., the first bypass flowpath **46** may be an annular flowpath and circumscribe the first engine core **62**.

(15) During first gas turbine engine operation, first core gas (e.g., air) enters the first core flowpath **44** through the first core flowpath inlet **58**. This first core gas is compressed by the first compressor rotor **49** and directed into a first combustion chamber **72** (e.g., an annular first combustion chamber) of a first combustor **74** (e.g., an annular first combustor) within the first combustor section **38**. Fuel is injected into the first combustion chamber **72** by one or more first fuel injectors and mixed with the compressed first core gas to provide a first core fuel-air mixture. This first core fuel-air mixture is ignited by one or more first ignitors and combustion products thereof flow through and cause the first turbine rotor **50** to rotate. The rotation of the first turbine rotor **50** drives rotation of the first compressor rotor **49** and, thus, compression of the gas received from the first core flowpath inlet **58**. The rotation of the first turbine rotor **50** also drives rotation of the first fan rotor **48**, which propels first bypass air (air received from the powerplant inlet **24**) through the first bypass flowpath **46**.

(16) Referring to FIG. **3**, the second gas turbine engine **30** includes the second fan section **70**, a second compressor section **76**, a second combustor section **77** and a second turbine section **78**. These second engine sections **70**, **76**, **77** and **78** may be arranged sequentially along an axial centerline **80** of the second gas turbine engine **30**. This axial centerline **80** may be parallel (e.g., coaxial) with the axial centerline **22**, **42**. The axial centerline **80** may also be a rotational axis for one or more rotors within the second gas turbine engine **30**. The second gas turbine engine **30** may also include and/or otherwise be associated with a second core flowpath **82** and a second engine bypass flowpath **84** (referred to below as “second bypass flowpath”).

(17) The second fan section **70**, the second compressor section **76** and the second turbine section **78** each include a respective bladed rotor **86-88**. Each of these bladed rotors **86-88** 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, adhered and/or otherwise attached to the respective rotor disk(s).

(18) The second fan rotor **86** and the second compressor rotor **87** are connected to and driven by the second turbine rotor **88** through a second engine shaft **89**. The second compressor rotor **87** may be arranged axially between the second fan rotor **86** and the second turbine rotor **88** along the axial centerline **22**, **42**, **80**. At least (or only) the second fan rotor **86**, the second compressor rotor **87**, the second turbine rotor **88** and the second engine shaft **89** may form a second engine rotating structure **90**. This second engine rotating structure **90** is rotatable about the axial centerline **22**, **42**, **80** and is supported by one or more second engine bearings **92**; e.g., rolling element and/or thrust bearings. Each of these second engine bearings **92** is connected to the engine housing **32** by at least one stationary structure such as, for example, an annular support strut.

(19) The second core flowpath **82** includes an inlet **94** to the second core flowpath **82** and an exhaust **96** from the second core flowpath **82**. The second core flowpath inlet **94** is downstream of and fluidly coupled with the first bypass flowpath **46** and its exhaust **68**. The second core flowpath exhaust **96** is upstream of and fluidly coupled with an exhaust flowpath **98**, which exhaust flowpath **98** may extend axially within the powerplant **20** to the powerplant exhaust **26**. The second core flowpath **82** of FIG. **3** extends from the second core flowpath inlet **94**, sequentially through the second compressor section **76**, the second combustor section **77** and the second turbine section **78**, to the second core flowpath exhaust **96**. As the second core flowpath **82** extends towards the second core flowpath exhaust **96**, the second core flowpath **82** may extend within and/or through any one or more or all of the second engine sections **76-78** in the second direction along the axial centerline **22**, **42**, **80**. The second core flowpath **82** may also extend circumferentially about (e.g., completely around) the axial centerline **22**, **42**, **80**; e.g., the second core flowpath **82** may be an annular flowpath.

(20) The second bypass flowpath **84** may at least partially or completely bypass a core **100** of the

second gas turbine engine **30**; e.g., the second engine sections **76-78**. The second bypass flowpath **84** of FIG. **3**, for example, is disposed radially outside of and extends axially along the second engine core **100**. The second bypass flowpath **84** may be formed radially by and between the engine housing **32** and a stationary structure **102** (e.g., a case, a nacelle inner fixed structure, etc.) of the second gas turbine engine **30**, where the engine housing **32** may form an outer peripheral boundary of the second bypass flowpath **84**, and where the second engine stationary structure **102** may form an inner peripheral boundary of the second bypass flowpath **84**. In the embodiment of FIG. **3**, the second engine stationary structure **102** is axially separated from the first engine stationary structure **64** by at least (or only) the second core flowpath inlet **94**. Of course, in other embodiments, one or more other intermediate structures (e.g., cases, nacelle structures, etc.) may be arranged between the second engine stationary structure **102** and the first engine stationary structure **64**.

(21) The second bypass flowpath **84** includes an inlet **104** to the second bypass flowpath **84** and an exhaust **106** from the second bypass flowpath **84**. The second bypass flowpath inlet **104** is downstream of and fluidly coupled with the first bypass flowpath **46** and its exhaust **68**. With such an arrangement, the second bypass flowpath inlet **104** and the second core flowpath inlet **94** of FIG. **3** may be (e.g., independently) fluidly coupled with the first bypass flowpath **46** in parallel. The second bypass flowpath exhaust **106** is upstream of and fluidly coupled with the exhaust flowpath **98**. With such an arrangement, the second bypass flowpath exhaust **106** and the second core flowpath exhaust **96** of FIG. **3** may be (e.g., independently) fluidly coupled with the exhaust flowpath **98** in parallel. The second bypass flowpath **84** of FIG. **3** extends from the second bypass flowpath inlet **104** to the second bypass flowpath exhaust **106**. As the second bypass flowpath **84** extends towards the second bypass flowpath exhaust **106**, the second bypass flowpath **84** may extend in the second direction along the axial centerline **22**, **42**, **80**. The second bypass flowpath **84** may also extend circumferentially about (e.g., completely around) the axial centerline **22**, **42**, **80**; e.g., the second bypass flowpath **84** may be an annular flowpath and circumscribe the second engine core **100**.

(22) During second gas turbine engine operation, second core gas (e.g., air from the first bypass flowpath **46**) enters the second core flowpath **82** through the second core flowpath inlet **94**. This second core gas is compressed by the second compressor rotor **87** and directed into a second combustion chamber **108** (e.g., an annular second combustion chamber) of a second combustor **110** (e.g., an annular second combustor) within the second combustor section **77**. Fuel is injected into the second combustion chamber **108** by one or more second fuel injectors and mixed with the compressed second core gas to provide a second core fuel-air mixture. This second core fuel-air mixture is ignited by one or more second ignitors and combustion products thereof flow through and cause the second turbine rotor **88** to rotate. The rotation of the second turbine rotor **88** drives rotation of the second compressor rotor **87** and, thus, compression of the gas received from the second core flowpath inlet **94**. The rotation of the second turbine rotor **88** also drives rotation of the second fan rotor **86**, which further propels the first bypass air (downstream of the first fan rotor **48**) through the first bypass flowpath **46**. Some of this first bypass air is directed into the second core flowpath inlet **94** to provide the second core gas. Some of the first bypass air is directed into and through the second bypass flowpath **84** as second bypass air. This second bypass air may be exhausted from the powerplant **20** with the second core gas through the exhaust flowpath **98** to provide forward thrust.

(23) Referring to FIG. **1**, the flow control system **34** is configured to selectively integrate and/or manage operation of the first gas turbine engine **28** with operation of the second gas turbine engine **30**. The flow control system **34**, for example, may fluidly couple the first core flowpath **44** with the second core flowpath **82** during a first mode of operation (e.g., a series and/or boost mode) and/or may fluidly couple the first core flowpath **44** with the second bypass flowpath **84** during a second mode of operation (e.g., a parallel and/or dash mode). The flow control system **34** may operate in

the first mode during, for example, subsonic aircraft flight where the air entering the powerplant inlet **24** is relatively cool. The flow control system **34** may operate in the second mode during, for example, supersonic aircraft flight where the air entering the powerplant **20** is relatively warm; e.g., due to ram air compression of the incoming air. The flow control system **34** of FIG. **1** includes one or more inlets **112**A and **112**B (generally referred to as "**112**"), one or more outlets **114**A and **114**B (generally referred to as "**114**") and one or more flow regulators **116**A and **116**B (generally referred to as "**116**"), **118**A and **118**B (generally referred to as "**118**"); e.g., valves, etc.
(24) The first system inlet **112**A is fluidly coupled with the second core flowpath **82**. This first system inlet **112**A is configured to receive (e.g., bleed) the second core gas from the second core flowpath **82**, for example upstream of the second combustor **110** within the second combustor section **77**. The first system inlet **112**A of FIG. **1**, for example, is formed by and/or in a component (e.g., a case, vane array, etc.) of the second gas turbine engine **30**. The first system inlet **112**A may be located in/along the second compressor section **76**. Alternatively, the first system inlet **112**A may be located in/along the second combustor section **77**. For example, the first system inlet **112**A may be located at (e.g., on, adjacent or proximate) a diffuser between the second compressor section **76** and a plenum surrounding the second combustor **110**. The first system inlet **112**A is selectively fluidly coupled to (or decoupled from) the first core flowpath inlet **58** through the first system inlet regulator **116**A. This first system inlet regulator **116**A is configured to regulate the flow of the second core gas diverted out of the second core flowpath **82** to the first gas turbine engine **28** and its first core flowpath **44**.
(25) The first system outlet **114**A is fluidly coupled with the second core flowpath **82**. This first system outlet **114**A is configured to direct the combustion products from the first gas turbine engine **28** into the second core flowpath **82**, for example upstream of the second combustor **110** and/or downstream of the first system inlet **112**A. The first system outlet **114**A of FIG. **1**, for example, is formed by and/or in another component (e.g., a case, vane array, etc.) or the component of the second gas turbine engine **30**. The first system outlet **114**A may be located in/along the second combustor section **77**. For example, the first system outlet **114**A may be located at (e.g., on, adjacent or proximate) the diffuser. The first system outlet **114**A is selectively fluidly coupled to (or decoupled from) the first core flowpath exhaust **60** through the first system outlet regulator **118**A. This first system outlet regulator **118**A is configured to regulate the flow of the combustion products exhausted from the first core flowpath **44** and directed into the second gas turbine engine **30** and its second core flowpath **82**.
(26) The second system inlet **112**B is fluidly coupled with the second bypass flowpath **84**. This second system inlet **112**B is configured to receive (e.g., bleed) the second bypass air from the second bypass flowpath **84**. The second system inlet **112**B of FIG. **1**, for example, is formed by and/or in a component (e.g., a case, vane array, etc.) of the engine housing **32** and/or the second gas turbine engine **30**. The second system inlet **112**B may be located in/along the second bypass flowpath **84**. The second system inlet **112**B is selectively fluidly coupled to (or decoupled from) the first core flowpath inlet **58** through the second system inlet regulator **116**B. This second system inlet regulator **116**B is configured to regulate the flow of the second bypass air diverted out of the second bypass flowpath **84** to the first gas turbine engine **28** and its first core flowpath **44**. In the embodiment of FIG. **1**, the second system inlet regulator **116**B forms the second system inlet **112**B. However, in other embodiments, the second system inlet regulator **116**B may be discrete from and downstream of the second system inlet **112**B.
(27) The second system outlet **114**B is fluidly coupled with the second bypass flowpath **84**. This second system outlet **114**B is configured to direct the combustion products from the first gas turbine engine **28** into the second bypass flowpath **84**. The second system outlet **114**B of FIG. **1**, for example, is formed by and/or in another component (e.g., a case, vane array, etc.) or the component of the engine housing **32** and/or the second gas turbine engine **30**. The second system outlet **114**B may be located in/along the second bypass flowpath **84**. The second system outlet **114**B is

selectively fluidly coupled to (or decoupled from) the first core flowpath exhaust **60** through the second system outlet regulator **118**B. This second system outlet regulator **118**B is configured to regulate the flow of the combustion products exhausted from the first core flowpath **44** and directed into the second bypass flowpath **84**. In the embodiment of FIG. **1**, the second system outlet regulator **118**B forms the second system outlet **114**B. However, in other embodiments, the second system outlet regulator **118**B may be discrete from and upstream of the second system outlet **114**B.
(28) During the first mode of operation, the flow control system **34** fluidly couples the first core flowpath **44** with the second core flowpath **82**. The first system inlet regulator **116**A, for example, opens and fluidly couples the first system inlet **112**A to the first core flowpath inlet **58**. A quantity (e.g., between fifty and ninety percent (50-90%)) of the second core gas may thereby be bled from the second core flowpath **82** and directed into the first core flowpath **44** as the first core gas. The first system outlet regulator **118**A also opens and fluidly couples the first system outlet **114**A to the first core flowpath exhaust **60**. The combustion products exiting the first turbine section **39** may thereby be exhausted from the first core flowpath **44** and directed into the second core flowpath **82** as additional second core gas. The powerplant **20** may be configured such that a pressure of the second core gas bled from the second core flowpath **82** may be exactly or approximately (e.g., within +/−5%) a pressure of the combustion products directed into the second core flowpath **82**. For example, where one of the gas flows has a lower total pressure than the other gas flow, the lower pressure gas flow may flow slower than the other gas flow as the gas flows combine to raise static pressure until the gas flows are in balance. The combustion products of the first turbine section **39**, being hotter than the air in the second core flowpath **82**, raise the combined temperature of gas entering the second combustion chamber **108**, such that a reduced amount of fuel can be added to provide a certain inlet temperature to the second turbine section **78**. With the foregoing arrangement, the gas received by the first compressor section **37** is pre-charged by the second compressor section **76**; e.g., the second compressor section **76** may function as a low pressure compressor section for the first engine core **62**. The first gas turbine engine **28** may thereby have a relatively large overall pressure ratio (OPR); e.g., first engine OPR=first fan section pressure ratio×second fan second pressure ratio×second compressor section pressure ratio/losses through the flow control system **34**×first compressor section pressure ratio. This first mode of operation may thereby provide relatively fuel efficient powerplant operation at, for example, subsonic aircraft speeds.
(29) During the first mode of operation, the flow control system **34** may also fluidly decouple the first core flowpath **44** from the second bypass flowpath **84**. The second system inlet regulator **116**B and/or the second system outlet regulator **118**B, for example, may be closed. However, it is contemplated in other embodiments, the flow control system **34** may fluidly couple the first core flowpath **44** to both the second core flowpath **82** and the second bypass flowpath **84**, for example, during a transition from the second mode of operation to the first mode of operation, etc.
(30) During the second mode of operation, the flow control system **34** fluidly couples the first core flowpath **44** with the second bypass flowpath **84**. The second system inlet regulator **116**B, for example, opens and fluidly couples the second system inlet **112**B to the first core flowpath inlet **58**. A quantity (e.g., notionally the same as the quantity that was bled from the second core in the first mode of operation) of gas may thereby be bled from the second bypass flowpath **84** and directed into the first core flowpath **44** as the first core gas. The second system outlet regulator **118**B also opens and fluidly couples the second system outlet **114**B to the first core flowpath exhaust **60**. The combustion products exiting the first turbine section **39** may thereby be exhausted from the first core flowpath **44** and directed into the second bypass flowpath **84** as additional second bypass gas. The powerplant **20** may be configured such that a pressure of the second bypass air bled from the second bypass flowpath **84** may be exactly or approximately (e.g., within +/−5%) a pressure of the combustion products directed into the second bypass flowpath **84**. With the foregoing arrangement, the gas received by the first compressor section **37** is not pre-charged by the second compressor

section **76**. The first gas turbine engine **28** may thereby have a relatively low overall pressure ratio (OPR); e.g., first engine OPR=first fan section pressure ratio×second fan second pressure ratio/losses through the flow control system **34**×first compressor section pressure ratio. Here, the combustion products exhausted from the first core flowpath **44** may be relatively low temperature since the second core gas is bled from the second bypass flowpath **84** rather than the second core flowpath **82**. The powerplant **20** may therefore accommodate higher temperature inlet air through the powerplant inlet **24** at, for example, supersonic aircraft speeds. Reducing the first core gas inlet temperature may also facilitate an increase in fuel-to-air ratio (FAR) to increase first gas turbine power.

(31) Furthermore, reducing first core gas inlet temperature and pressure into the first core flowpath **44** may compel a reduction in first gas turbine engine power and subsequently in first fan rotor speed. Reducing first core gas inlet temperature may reduce the mechanical-to-corrected speed parameter of the first compressor rotor **49** such that to maintain a similar corrected speed in both modes, it mechanically rotates slower in this second mode. The first fan rotor **48**, which has not been reduced in mechanical-to-corrected speed, and which rotates in a common speed through shaft **51**, may then rotate at a reduced corrected speed (e.g., see FIG. **4**).

(32) Continuing to look at FIG. **4**, it is considered that a reduction in fan speed warrants reductions in both fan inlet flow and fan pressure ratio, and that a balance exists where reductions in inlet flow and pressure ratio together may maintain a constant exit flow. It is contemplated that an increase in first gas turbine engine power from a higher FAR facilitated in the second mode can balance the reduction in first gas turbine engine power compelled by a reduction in first core gas inlet temperature and pressure, and the reduction in speed of the fan rotor **48**, such that the amount of exit flow from the first fan section **36** through the first bypass flowpath **46** to the second fan section **70** can remain notionally the same in both modes.

(33) During the second mode of operation, the flow control system **34** may also fluidly decouple the first core flowpath **44** from the second core flowpath **82**. The first system inlet regulator **116**A and/or the first system outlet regulator **118**A, for example, may be closed. However, it is contemplated in other embodiments, the flow control system **34** may fluidly couple the first core flowpath **44** to both the second core flowpath **82** and the second bypass flowpath **84**, for example, during a transition from the first mode of operation to the second mode of operation, etc.

(34) During the second mode of operation, the second turbine engine **30** may not receive the combustion products of first turbine **39** into flowpath **82** to preheat the air entering combustor **108**, so more fuel may be added to achieve a certain second turbine inlet temperature than in the first mode of operation.

(35) In some embodiments, referring to FIG. **3**, the flow control system **34** may operate in the first mode during startup of the powerplant **20**; e.g., when neither gas turbine engine **28**, **30** is operating. This powerplant startup may describe an initial startup of the powerplant **20** when the aircraft is on ground and stationary. The powerplant startup may also or alternatively describe a restart of the powerplant **20** during aircraft flight. During such powerplant startup, a starter **119** may drive rotation of the second compressor rotor **87** to provide the compressed air to the second combustor section **77** to facilitate startup of the second gas turbine engine **30**. Here, the second gas turbine engine **30** may be started prior to (or concurrently with) starting of the first gas turbine engine **28**. To reduce a load of the second compressor rotor **87** on the starter **119**, the flow control system **34** may open the flow regulators **116**A and **118**A to bleed off at least some of the air from the second compressor section **76**/the second core flowpath **82**. By reducing the load of the second compressor rotor **87** on the starter **119**, a power output of the starter **119** may be reduced. Examples of the starter **119** include, but are not limited to, an electric machine (e.g., a dedicated starter motor or a motor-generator) or another drive device (e.g., a pneumatic motor, etc.).

(36) In some embodiments, referring to FIG. **1**, the flow control system **34** may include a single first system inlet **112**A, a single first system outlet **114**A, a single second system inlet **112**B and a

single second system outlet **114**B. In other embodiments, referring to FIGS. **5**A and **5**B, the flow control system element **112**, **114** may be one of a plurality of the elements **112**, **114**. For example, the flow control system **34** of FIG. **5**A includes two or more of the system inlets **112** for bleeding the gas from the respective second flowpath **82**, **84** for the first core flowpath **44**. In another example, the flow control system **34** of FIG. **5**B includes two or more of the system outlets **114** for exhausting the combustion products from the first core flowpath **44** to the respective second flowpath **82**, **84**.
(37) In some embodiments, referring to FIGS. **6**A and **6**B, a respective set of the system inlet(s) **112** and the system outlet(s) **114** may be arranged in a vane array **120** (or strut array). The vane array **120** of FIGS. **6**A and **6**B, for example, includes a plurality of vanes **122** (or struts) which extend across the respective flowpath **82**, **84**. Each set of the system inlet(s) **112** and the system outlet(s) **114** may be disposed with a respective one of the vanes **122**. Each system inlet **112** may be on one side of the respective vane **122**, while a respective system outlet **114** may be on another side of the respective vane **122**. Referring to FIG. **6**A, when the corresponding regulators **116**, **118** (see FIG. **1**) are open, the vane array **120** may be configured to facilitate a quantity of blowby through the vane array **120**. This blowby may serve to separate the gas flowing into the system inlet(s) **112** and the gas flowing out of the system outlet(s) **114**. Referring to FIG. **6**B, when the corresponding regulators **116**, **118** (see FIG. **1**) are closed, the gas at the system inlet(s) **112** and the system outlet(s) **114** may stagnate and most if not all of the gas may flow through/axially across the vane array **120**.
(38) Each engine core **62**, **100** may have various configurations other than those described above. Each engine core **62**, **100**, for example, may be configured with a single spool (see FIG. **1**), with two spools, or with more than two spools. Each engine core **62**, **100** may be configured with one or more axial flow compressor sections, one or more radial flow compressor sections, one or more axial flow turbine sections and/or one or more radial flow turbine sections. Each engine core **62**, **100** may be configured with any type or configuration of annular, tubular (e.g., CAN), axial flow and/or reverser flow combustor. The present disclosure therefore is not limited to any particular types or configurations of gas turbine engine cores. Furthermore, while the powerplant **20** is described above for an aircraft propulsion system, the powerplant **20** of the present disclosure is not limited to such an exemplary application.
(39) 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. A powerplant, comprising: a first gas turbine engine including a first inlet, a first exhaust, a first compressor section, a first combustor section, a first turbine section and a first core flowpath fluidly coupled with and between the first inlet and the first exhaust, the first core flowpath extending sequentially through the first compressor section, the first combustor section and the first turbine section; a second gas turbine engine including a second inlet, a second exhaust, a second compressor section, a second combustor section, a second turbine section and a second core flowpath fluidly coupled with and between the second inlet and the second exhaust, the second core flowpath extending sequentially through the second compressor section, the second combustor section and the second turbine section; a second engine bypass flowpath bypassing the second core

flowpath; and a flow control system configured to fluidly couple the first inlet and the first exhaust to the second core flowpath during a first mode, and the flow control system configured to fluidly couple the first inlet and the first exhaust to the second engine bypass flowpath during a second mode.

2. The powerplant of claim 1, wherein the flow control system is configured to fluidly decouple the first inlet and the first exhaust from the second engine bypass flowpath during the first mode; and fluidly decouple the first inlet and the first exhaust from the second core flowpath during the second mode.

3. The powerplant of claim 1, wherein the second combustor section comprises a combustor; and the first inlet and the first exhaust are each fluidly coupled to the second core flowpath upstream of the combustor during the first mode.

4. The powerplant of claim 1, wherein the first inlet is fluidly coupled to the second core flowpath along the second compressor section during the first mode.

5. The powerplant of claim 1, wherein the first inlet is fluidly coupled to the second core flowpath downstream of the second compressor section during the first mode.

6. The powerplant of claim 1, wherein the first inlet is fluidly coupled to the second core flowpath at a diffuser of the second gas turbine engine during the first mode.

7. The powerplant of claim 1, wherein the first core flowpath extends in a first direction along a centerline within at least one of the first compressor section, the first combustor section or the first turbine section towards the first exhaust; the second core flowpath extends in a second direction along the centerline within at least one of the second compressor section, the second combustor section or the second turbine section towards the second exhaust; and the second direction is opposite the first direction.

8. The powerplant of claim 1, wherein the first gas turbine engine further includes a first rotating structure rotatable about a centerline, the first rotating structure includes a first compressor rotor within the first compressor section and a first turbine rotor within the first turbine section; and the second gas turbine engine further includes a second rotating structure rotatable about the centerline, the second rotating structure includes a second compressor rotor within the second compressor section and a second turbine rotor within the second turbine section.

9. The powerplant of claim 8, wherein the first rotating structure is offset from the second rotating structure along the centerline.

10. The powerplant of claim 1, wherein the first gas turbine engine further includes a first fan rotor and a first turbine rotor within the first turbine section and configured to drive rotation of the first fan rotor; and the second gas turbine engine further includes a second fan rotor and a second turbine rotor within the second turbine section and configured to drive rotation of the second fan rotor.

11. The powerplant of claim 10, wherein the first fan rotor is upstream of the second fan rotor.

12. The powerplant of claim 10, further comprising: a first engine bypass flowpath outboard of the first core flowpath; the first fan rotor and the second fan rotor within the first engine bypass flowpath.

13. The powerplant of claim 12, wherein the second core flowpath and the second engine bypass flowpath are fluidly coupled in parallel with and downstream of the first engine bypass flowpath.

14. The powerplant of claim 10, wherein the first gas turbine engine further includes a first compressor rotor within the first compressor section; the first turbine rotor is configured to drive rotation of the first compressor rotor; and the first turbine rotor is arranged between the first fan rotor and the first compressor rotor along a centerline.

15. The powerplant of claim 10, wherein the second gas turbine engine further includes a second compressor rotor within the second compressor section; the second turbine rotor is configured to drive rotation of the second compressor rotor; and the second compressor rotor is arranged between the second fan rotor and the second turbine rotor along a centerline.

16. The powerplant of claim 10, further comprising a starter configured to drive rotation of a compressor rotor in the second compressor section during the first mode to facilitate startup of the second gas turbine engine.

17. A powerplant, comprising: a first gas turbine engine including a first fan section, a first compressor section, a first combustor section, a first turbine section and a first core flowpath extending sequentially through the first compressor section, the first combustor section and the first turbine section; a second gas turbine engine including a second fan section, a second compressor section, a second combustor section, a second turbine section and a second core flowpath extending sequentially through the second compressor section, the second combustor section and the second turbine section; a first engine bypass flowpath outboard of the first core flowpath and extending sequentially through the first fan section and the second fan section; the first gas turbine engine arranged forward of the second gas turbine engine along a common axial centerline; a second engine bypass flowpath outboard of the second core flowpath, the second core flowpath and the second engine bypass flowpath independently fluidly coupled with and downstream of the first engine bypass flowpath; and a flow control system configured to fluidly couple a first inlet and a first exhaust to the second core flowpath during a first mode, the flow control system configured to fluidly couple the first inlet and the first exhaust to the second engine bypass flowpath during a second mode, and the first core flowpath extending sequentially through the first compressor section, the first combustor section and the first turbine section between the first inlet and the first exhaust.