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(54) **SPLIT COMPRESSOR TURBINE ENGINE**

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F02C 3/14	(2006.01)
F02C 7/04	(2006.01)

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

CPC ***F02C 3/107*** (2013.01); ***F02C 3/145*** (2013.01); ***F02C 7/04*** (2013.01); *F05D 2240/40* (2013.01)

(58) **Field of Classification Search**

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See application file for complete search history.

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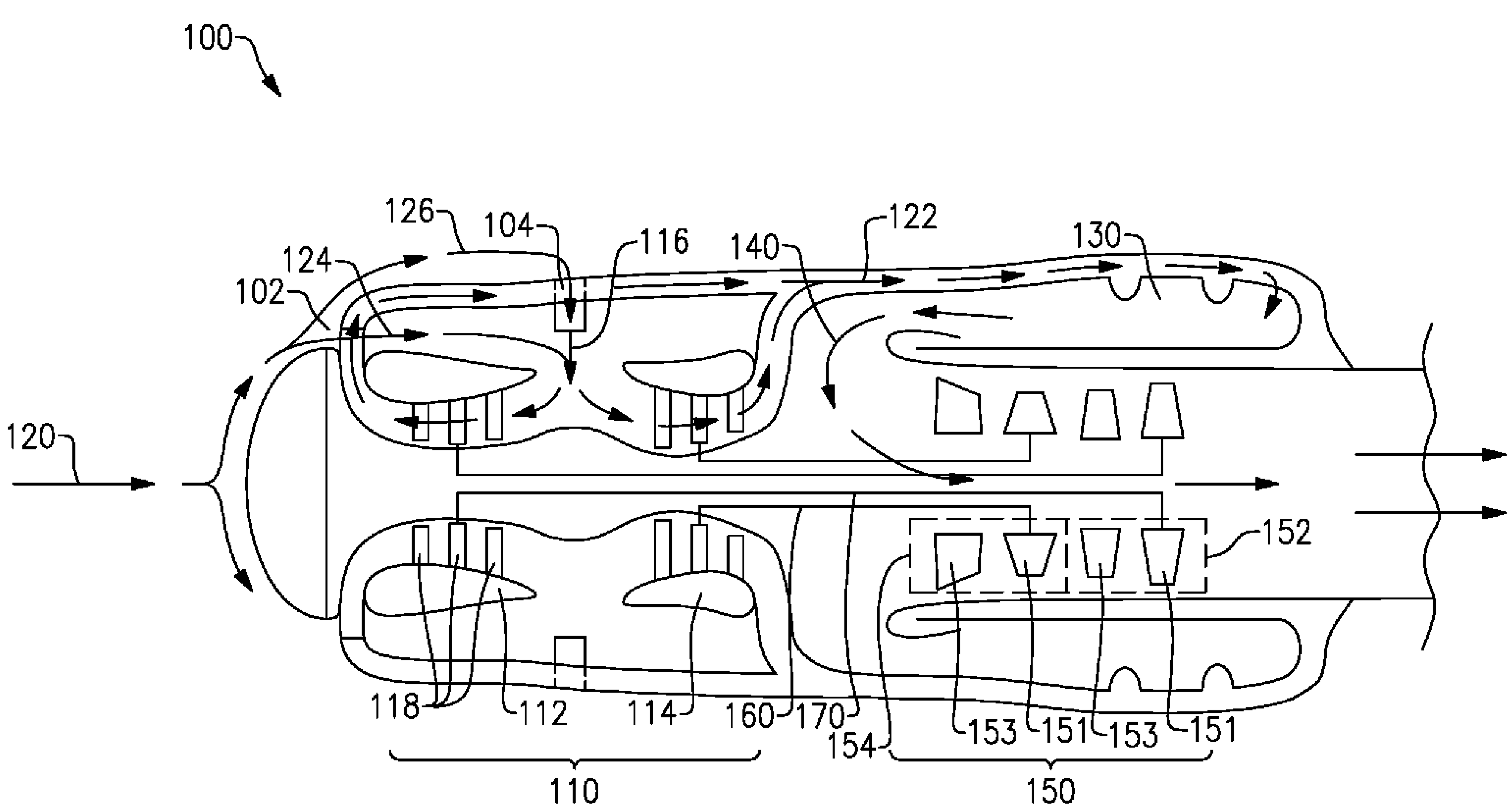
(57) **ABSTRACT**

A turbine engine includes a first compressor and a second compressor fluidly parallel to the first compressor. A reverse flow combustor is fluidly connected to the first compressor and the second compressor. A first turbine and a second turbine are fluidly connected in series, and fluidly connected to an output of the reverse flow combustor.

21 Claims, 3 Drawing Sheets



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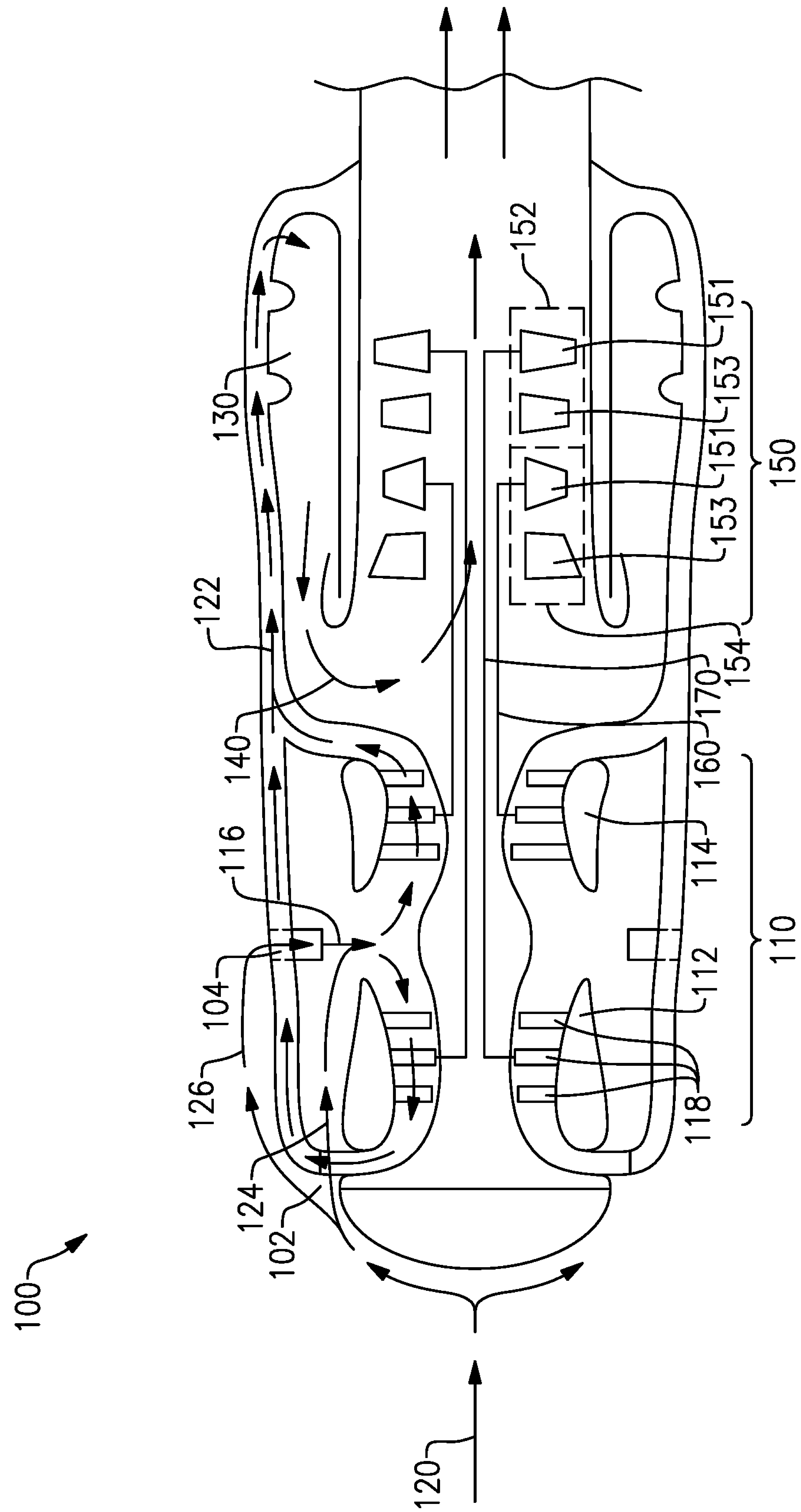
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FIG.1

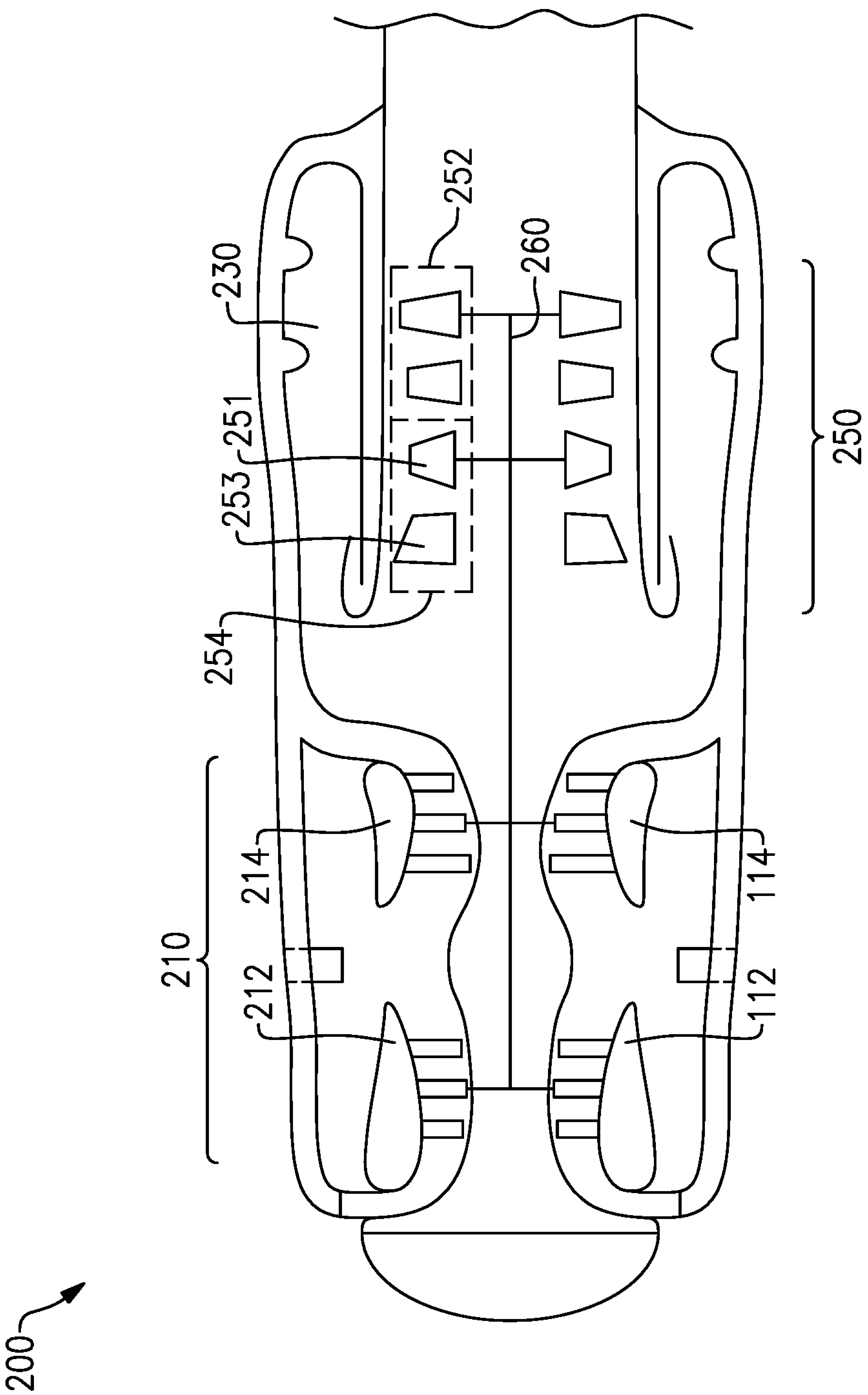

FIG.2

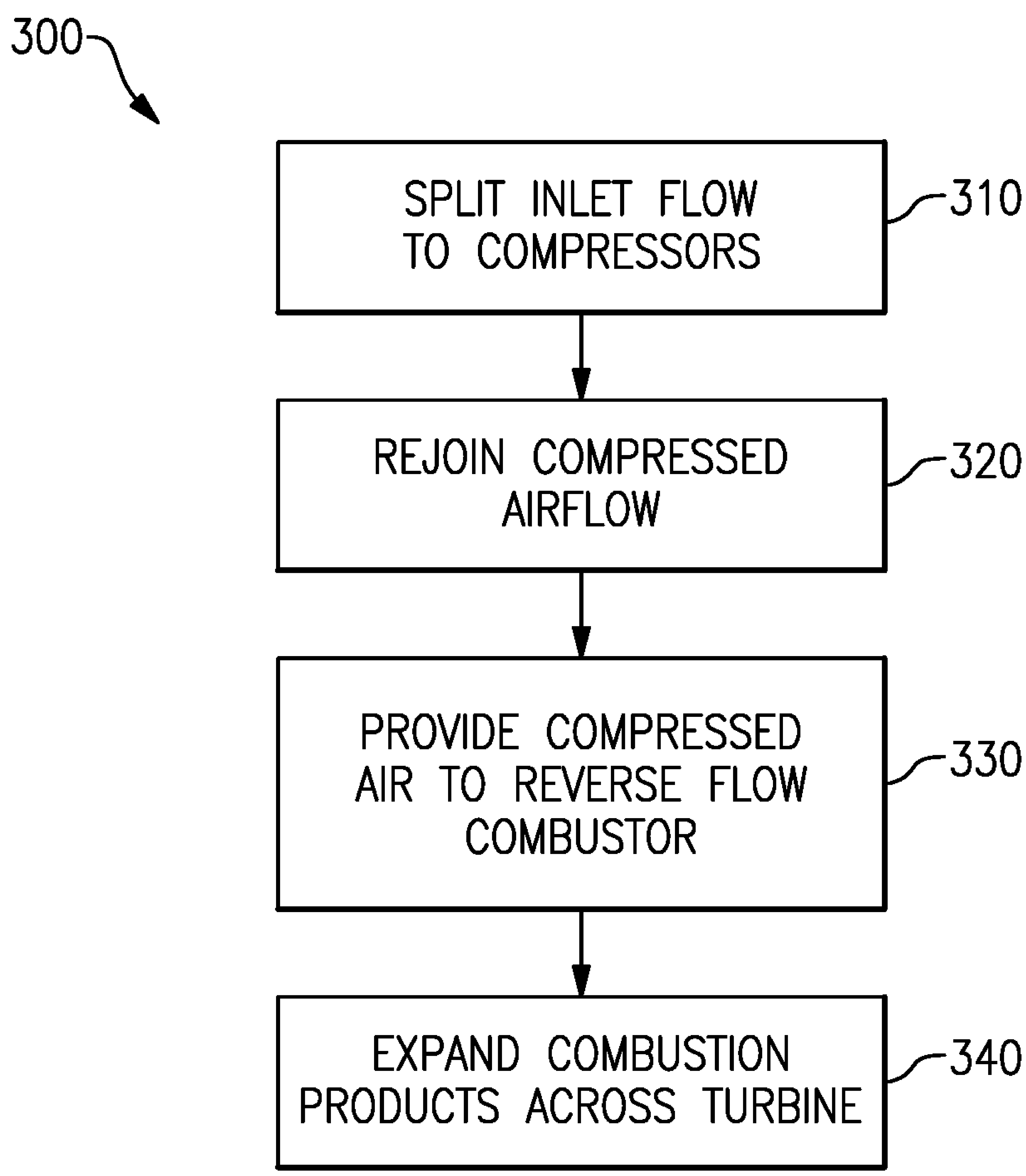
300
SPLIT INLET FLOW TO COMPRESSORS
310
REJOIN COMPRESSED AIRFLOW
320
PROVIDE COMPRESSED AIR TO REVERSE FLOW COMBUSTOR
330
EXPAND COMBUSTION PRODUCTS ACROSS TURBINE
340

FIG.3

SPLIT COMPRESSOR TURBINE ENGINE

TECHNICAL FIELD

The present disclosure relates generally to turbine engines, and more specifically to a split compressor turbine engine.

BACKGROUND

Turbine engines generally compress air in a compressor section, and provide the compressed air to a combustor. The compressed air is mixed with a fuel, and ignited within the combustor. The resultant combustion products are passed to a turbine section, and are expanded across the turbine section. The expansion of the combustion products drives rotation of the turbine section. The turbine section is connected to the compressor section via one or more shafts, and the rotation of the turbine section, in turn, drives rotation of the compressor section.

In a typical example, the compressor section and the turbine section each include multiple compressors and turbines, respectively. The first compressor, referred to as a low pressure compressor, compresses ambient air, and provides the compressed air to the second compressor, referred to as the high pressure compressor. This arrangement is referred to as the compressors being in series, and provides compressed air to the combustor section from a single output source in the compressor section.

SUMMARY OF THE INVENTION

In one exemplary embodiment a turbine engine includes a first compressor and a second compressor fluidly parallel to the first compressor, a reverse flow combustor fluidly connected to the first compressor and the second compressor, and a first turbine and a second turbine fluidly in series, and fluidly connected to an output of the reverse flow combustor.

In another example of the above described turbine engine a fluid inlet of the first compressor and a fluid inlet of the second compressor are approximately equal sized, such that fluid flow into each of the first compressor and the second compressor is approximately equal.

In another example of any of the above described turbine engines at least one of the first turbine and the second turbine is a single stage turbine.

In another example of any of the above described turbine engines each of the first turbine and the second turbine is a single stage turbine.

In another example of any of the above described turbine engines the first compressor and the first turbine are connected to a first spool, and wherein the second compressor and the second turbine are connected to a second spool.

In another example of any of the above described turbine engines the first spool and the second spool are collinear.

In another example of any of the above described turbine engines the first compressor, the second compressor, the first turbine and the second turbine are connected to a single spool.

In another example of any of the above described turbine engines at least one of the first compressor and the second compressor is a direct drive compressor.

In another example of any of the above described turbine engines the first compressor and the second compressor are counter-rotating compressors.

In another example of any of the above described turbine engines the first compressor and the second compressor are co-rotating.

In another example of any of the above described turbine engines at least one of the first compressor and the second compressor is comprised of multiple rotors, each of the rotors being constructed of a lightweight high strength ceramic.

In another example of any of the above described turbine engines the lightweight high strength ceramic is a silicon based structural ceramic material.

In another example of any of the above described turbine engines the lightweight high strength ceramic comprises one of silicon nitride, silicon carbide, silicon carbide fiber reinforced ceramic composite, and carbon fiber reinforced silicon carbide composite.

An exemplary method for driving a turbine engine includes splitting an inlet flow between a first compressor and a second compressor, providing an output flow of each of the first compressor and the second compressor to a reverse flow combustor, and driving a first turbine and a second turbine to rotate by expanding combustion products generated in the reverse flow combustor across the first turbine and the second turbine.

In another example of the above described method for driving a turbine engine splitting an inlet flow between the first compressor and the second compressor, comprises splitting the inlet flow approximately evenly.

In another example of any of the above described methods for driving a turbine engine expanding the combustion products across the first turbine and the second turbine comprises expanding an output of the first turbine across the second turbine.

Another example of any of the above described methods for driving a turbine engine further includes driving rotation of the first compressor via a shaft connecting the first compressor to the first turbine, and driving rotation of the second compressor via a shaft connecting the second compressor to the second turbine.

Another example of any of the above described methods for driving a turbine engine further includes driving rotation of the first compressor and the second compressor via a shaft connecting the first compressor and the second compressor to the first turbine and the second turbine.

In one exemplary embodiment a turbine engine includes a first compressor and a second compressor fluidly parallel to the first compressor, a combustor fluidly connected to the first compressor and the second compressor, and a turbine section comprising a first turbine and a second turbine downstream of the first turbine, the turbine section being fluidly connected to an output of the combustor.

In another example of the above described turbine engine each of the first turbine and the second turbine are single stage turbines.

These and other features of the present invention can be best understood from the following specification and drawings, the following of which is a brief description.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** schematically illustrates a split compressor turbine engine architecture according to a first example.

FIG. **2** schematically illustrates a split compressor turbine engine architecture according to a second example.

FIG. 3 illustrates a method for operating a gas turbine engine according to either of the examples of FIGS. 1 and 2.

DETAILED DESCRIPTION OF AN EMBODIMENT

FIG. 1 schematically illustrates an exemplary split compressor turbine engine architecture 100. The engine includes a pair of split compressors 112, 114 within a compressor section 110. The compressors 112, 114 share an inlet 116, and operate in fluid parallel, with the compressed air output being merged into a single compressed airflow 122 downstream of both compressors 112, 114. The inlet 116 draws ambient air from a surrounding atmosphere through a first inlet 102 on a forward end of the engine 100 and through a second inlet 104, on a radially outward surface of the engine 100.

Airflow into the engine follows flowpath 120, and branches into the first inlet 102 along a first branch 124 and into the second inlet 104 along a second branch 126. The first and second branch 124, 126 merge at the compressor section 110 inlet 116, and the flow is then split again between inlets of the first compressor 112 and the second compressor 114. In some examples, the split is approximately 50%, with each compressor 112, 114 receiving approximately the same volume of air along its respective flowpath as the other compressor 112, 114. Such an example can be achieved by providing each of the compressors 112, 114 approximately equal sized inlets, thereby ensure that an approximately equal volume of air will enter the compressors 112, 114. In alternative examples, the compressors can be sized such that different volumes of air are received at their inlets, or a controlled or passive metering device can be incorporated at the inlet 116.

Each compressor 112, 114 includes multiple compressor stages 118 that sequentially compress the air resulting in a higher pressure at the compressor outlet than at the compressor inlet 116. Each stage includes a compressor rotor and a corresponding compressor stator, with the rotors being shaped to drive air along the compressor as the rotors rotate. In some examples, the compressor rotors are constructed of lightweight, high strength materials, such as a lightweight high strength ceramic material. In further examples, the light weight high strength ceramic material is a silicon based structural material, such as silicon nitride, silicon carbide, silicon carbide reinforced ceramic composite, or carbon fiber reinforced silicon carbide composite.

The compressed airflow 122 is passed to a reverse flow combustor 130, where the compressed air is mixed with a fuel and ignited according to known combustor techniques. The resultant combustion products are passed along a combustion product flowpath 140 into a turbine section 150.

Within the turbine section 150 are two single stage turbines 152, 154 arranged in fluid series. Each of the single stage turbines 152, 154 includes a single rotor 151, and a single stator vane 153. In alternative examples, either or both of the turbines 152, 154 within the turbine section 150 can include multiple turbine stages, instead of the illustrated single stage turbines 152, 154.

Each rotor 151 is connected to a corresponding shaft 160, 170. The shafts 160, 170 are alternately referred to as spools. Each shaft 160, 170 connects the turbine rotor 151 to a corresponding one of the compressors 112, 114, and drives the rotation of the corresponding compressor 112, 114. In the example of FIG. 1, the shafts 160, 170 are collinear, with the shaft 160 that is connected to the forward turbine 154 being radially outward of the shaft 170 that is connected to the aft turbine 152. While illustrated in FIG. 1 utilizing direct drive connections to the shafts 160, 170, one of skill in the art could adapt the engine architecture 100 to utilize a geared connection, and drive one or both of the compressors 112, 114 via a geared connection.

Further, in the example of FIG. 1, the turbines 152, 154 are sized such that rotation of the forward turbine 154, and rotation of the aft turbine 152, drive rotation of their corresponding compressors 112, 114 at the same, or approximately the same, speed at any given time.

In some examples, each of the compressors 112, 114 are driven to rotate in the same direction about an engine centerline axis, and are referred to as co-rotating compressors 112, 114. In alternative examples, the compressors 112, 114 rotate in opposite directions about the centerline axis, and are referred to as counter-rotating compressors 112, 114. In either example, the turbine 152, 154 corresponding to a given compressor 112, 114 rotates in the same direction as the compressor 112, 114.

With continued reference to FIG. 1, and with like numerals indicating like elements, FIG. 2 schematically illustrates an alternate configuration split compressor turbine engine architecture 200. As with the first example, the architecture 200 includes two compressors 212, 214 arranged in parallel with an inlet flow to a compressor section 210 being split between the compressors 212, 214.

The output of the compressor section 210 is provided to a reverse flow combustor 230, where the compressed air from the compressor section 210 is mixed with a fuel and ignited. The resultant combustion products are provided from the reverse flow combustor 230 to a turbine section 250 including a first turbine 254 and a second turbine 252. Each of the turbines 252, 254 includes a single stage having a stator 253 and a rotor 251. In alternative examples, the turbines 252, 254 can include multiple stages and operate in a similar fashion.

Each of the turbines 252, 254 is connected to a single shaft 260. The shaft 260 is, in turn, connected to both of the compressors 212, 214 in either a direct drive (as illustrated) or a geared connection. The shaft 260 translates rotation from the turbines 252, 254 to the compressors 212, 214, thereby allowing the turbines 252, 254 to drive rotation of the compressors 212, 214.

Aside from the alternate utilization of a single shaft 260, in place of the two shaft 260, 270 arrangement of FIG. 1, the engine architecture 200 of FIG. 2 operates, and is configured, in fundamentally the same manner as the engine architecture of FIG. 1. One of skill in the art, having the benefit of this disclosure will understand the necessary adjustments required to configure the engine architecture for a single shaft, as opposed to the two shaft example described above in greater detail.

With continued reference to FIGS. 1 and 2, FIG. 3 illustrates a method 300 for operating a split compressor turbine engine, such as the engine architectures 100, 200 of FIGS. 1 and 2. Initially, an airflow is provided to a split inlet, and is divided between two parallel operating compressors within a compressor section in a "Split Inlet Flow to Compressors" step 310.

The compressors operate in parallel to compress the air, and provide an output of compressed air. The compressed air output from each compressor is rejoined into a single compressed airflow in a "Rejoin Compressed Airflow" step 320.

The rejoined compressed air is provided to a reverse flow combustor and mixed with a fuel in the reverse flow combustor in a "Provide Compressed Air to Reverse Flow Combustor" step **330**. The fuel/air mixture is ignited and the resultant combustion products are expelled from the reverse flow combustor according to known reverse flow combustor techniques.

The resultant combustion products are provided to a turbine section and expanded across multiple turbines within the turbine section in an "Expand Combustion Products Across Turbine" step **340**. The expansion of the combustion products drives the turbines to rotate, and the rotation of the turbines is utilized to drive rotation of at least one corresponding compressor via a shaft connection.

It is further understood that any of the above described concepts can be used alone or in combination with any or all of the other above described concepts. Although an embodiment of this invention has been disclosed, a worker of ordinary skill in this art would recognize that certain modifications would come within the scope of this invention. For that reason, the following claims should be studied to determine the true scope and content of this invention.

The invention claimed is:

1. A turbine engine comprising:

a first compressor and a second compressor in fluid parallel with the first compressor, each of the first compressor and the second compressor including multiple compressor stages;

a reverse flow combustor fluidly connected to said first compressor and said second compressor; and

a first turbine and a second turbine in fluid series, and fluidly connected to an output of the reverse flow combustor.

2. The turbine engine of claim **1**, wherein a fluid inlet of the first compressor and a fluid inlet of the second compressor are equal sized, such that fluid flow into each of the first compressor and the second compressor is equal.

3. The turbine engine of claim **1**, wherein at least one of said first turbine and said second turbine is a single stage turbine.

4. The turbine engine of claim **3**, wherein each of said first turbine and said second turbine is a single stage turbine.

5. The turbine engine of claim **1**, wherein said first compressor and said first turbine are connected to a first spool, and wherein said second compressor and said second turbine are connected to a second spool.

6. The turbine engine of claim **5**, wherein said first spool and said second spool are collinear.

7. The turbine engine of claim **1**, wherein said first compressor, said second compressor, said first turbine and said second turbine are connected to a single spool.

8. The turbine engine of claim **1**, wherein at least one of said first compressor and said second compressor is a direct drive compressor.

9. The turbine engine of claim **1**, wherein said first compressor and said second compressor are counter-rotating compressors, relative to each other.

10. The turbine engine of claim **1**, wherein said first compressor and said second compressor are co-rotating.

11. The turbine engine of claim **1**, wherein at least one of said first compressor and said second compressor is comprised of multiple rotors, each of said rotors being constructed of a lightweight high strength ceramic.

12. The turbine engine of claim **11**, wherein the lightweight high strength ceramic is a silicon based structural ceramic material.

13. The turbine engine of claim **12**, wherein the lightweight high strength ceramic comprises one of silicon nitride, silicon carbide, silicon carbide fiber reinforced ceramic composite, and carbon fiber reinforced silicon carbide composite.

14. A method for driving a turbine engine comprising:

splitting an inlet flow between a first compressor and a second compressor such that the second compressor is in fluid parallel with the first compressor, each of the first compressor and the second compressor including multiple compressor stages;

providing an output flow of each of said first compressor and said second compressor to a reverse flow combustor; and

driving a first turbine and a second turbine to rotate by expanding combustion products generated in said reverse flow combustor across the first turbine and the second turbine.

15. The method of claim **14**, wherein splitting an inlet flow between the first compressor and the second compressor, comprises splitting the inlet flow evenly.

16. The method of claim **14**, wherein expanding the combustion products across the first turbine and the second turbine comprises expanding an output of the first turbine across the second turbine.

17. The method of claim **14**, further comprising driving rotation of the first compressor via a shaft connecting the first compressor to the first turbine, and driving rotation of the second compressor via a shaft connecting the second compressor to the second turbine.

18. The method of claim **14**, further comprising driving rotation of the first compressor and the second compressor via a shaft connecting the first compressor and the second compressor to the first turbine and the second turbine.

19. A turbine engine comprising:

a first compressor and a second compressor in fluid parallel with the first compressor, each of the first compressor and the second compressor including multiple compressor stages;

a combustor fluidly connected to said first compressor and said second compressor; and

a turbine section comprising a first turbine and a second turbine downstream of the first turbine, the turbine section being fluidly connected to an output of the combustor.

20. The turbine engine of claim **19**, wherein each of said first turbine and said second turbine are single stage turbines.

21. The turbine engine of claim **1**, wherein the first turbine and the second turbine are sized such that the first compressor and the second compressor are driven to rotate at the same speed.

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