July 12, 1966 C. A. SERRIADES 3,260,046

JET ENGINE

Filed Sept. 9, 1963 2 Sheets-Sheet 2

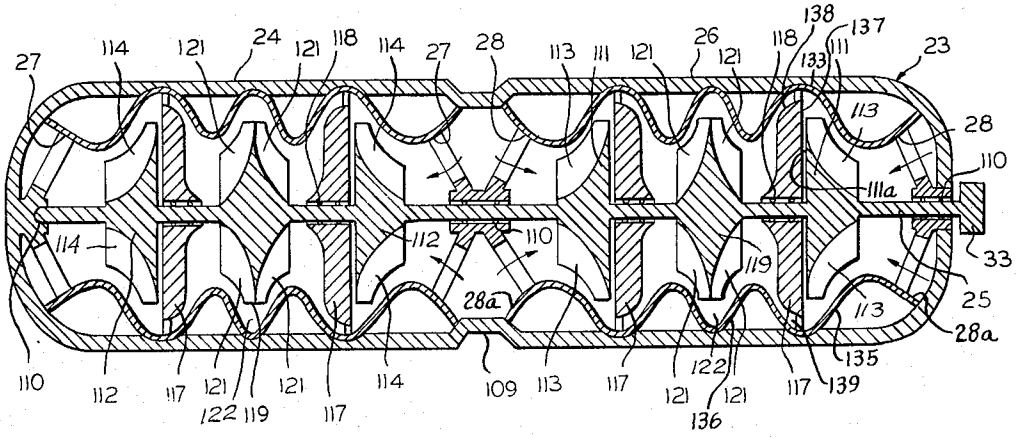


FIG. 2

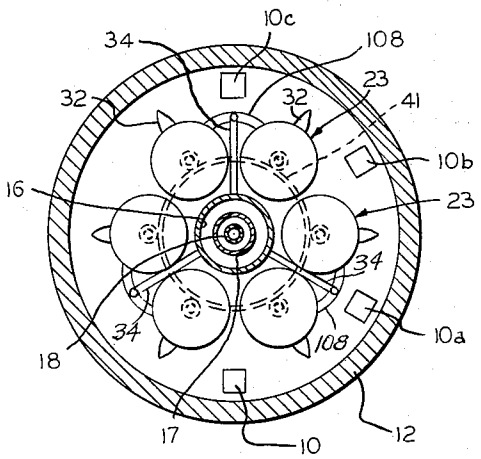


FIG. 3

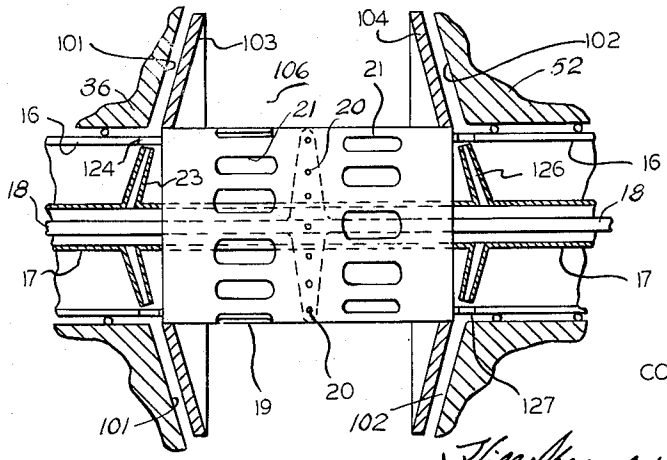


FIG. 4

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United States Patent Office

3,260,046
Patented July 12, 1966

3,260,046

JET ENGINE

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Filed Sept. 9, 1963, Ser. No. 307,471
10 Claims. (Cl. 60—35.6)

This invention generally relates to a jet engine and more particularly relates to an improved high altitude supersonic engine.

Present jet engines are plagued with many problems which prevent them from operating efficiently at high altitutes. The engines have inadequate cooling and means that are inadequate to supply sufficient compressed air for efficient operation of the jet engine. The present invention provides a jet engine having a pluarity of tandem compressors, cooperating with a turbine and afterburners to supply the propulsion forces for the jet engine. Also, the jet engine of the present invention has means for cooling the turbine as well as the afterburners.

Therefore, it is an object of the present invention to provide an improved jet engine.

It is another object of the present invention to provide a jet engine utilizing at least one pair of tandem compressors.

It is another object of the present invention to provide a jet engine having a turbine and annular baffle means, forming a combustion chamber for the turbine, spaced from the walls of the turbine and means to supply a coolant between the walls of the baffle and the walls of the turbine to cool the turbine and the gases flowing into the turbine.

It is another object of the present invention to provide an improved jet engine having at least one tandem compressor delivering compressed air to at least one afterburner.

It is another object of the present invention to provide a jet engine having a second-stage tandem radial compressor in the forward portion of the jet engine, a second-stage tandem radial compressor in the rear portion of the jet engine, and first-stage compressors and turbine in the central portion of the jet engine between the forward and rear second-stage tandem compressors.

It is another object of the present invention to provide a tandem radial compressor having inlets at both ends of each compressor in the tandem relationship and a central outlet in each compressor between the inlets.

It is another object of the present invention to provide an improved jet engine utilizing tandem radial compressors having four end inlets, and two top central outlets.

Other features and objects of the present invention will become apparent to those skilled in the art after a careful consideration of the following detailed description when considered in conjunction with the accompanying drawings wherein like reference numerals and characters refer to like and corresponding parts throughout the several views.

On the drawings:

FIGURE 1 is a longitudinal cross-sectional view with parts in elevation of a jet engine constructed in accordance to the principles of the present invention;

FIGURE 2 is an enlarged longitudinal cross-sectional view with parts in elevation of a tandem compressor constructed in accordance to the principles of the present invention;

FIGURE 3 is a transverse cross-sectional view with parts in elevation taken along the lines III—III of FIGURE 1; and

FIGURE 4 is an enlarged partial longitudinal cross-sectional view with parts in elevation of a turbine combustion chamber constructed in accordance to the principles of the present invention.

As shown on the drawings:

The jet engine of the present invention has cylindrical outer shell with forward and rear portions. The front portion of the jet engine has spider supports to provide an intake for air and midway along the jet engine there is provided intake scoop means for air. The air is directed to a secondary pair of axially spaced first-stage compressors. From one of the first-stage compressors, compressed air is directed into a plurality of circumferentially spaced forward tandem radial compressors and from the other first-stage compressor, compressed air is directed into a plurality of circumferentially spaced rear tandem radial compressors. The forward second-stage tandem compressors deliver compressed air to a central combustion chamber from both axial ends thereof. The combustion chamber is spaced from a turbine, positioned adjacent the combustion chamber to receive gas therefrom, by a pair of annular baffles extending from a perforated cylindrical passage means.

Fuel and compressed air are mixed in the combustion chamber and ignited. The ignited gases are expanded to rotate the contrarotating turbine blades. The gases exhausted from the turbine are directed through exhaust nozzles to the atmosphere to provide part of the propulsion forces for the jet engine. The rotor blades of the first-stage compressors are connected to the turbine as are a plurality of shafts which are utilized to rotate the forward and rear second-stage compressors. The rear tandem compressors direct compressed air to a plurality of circumferentially spaced afterburners. The compressed air is mixed with fuel in the afterburners and ignited to provide a part of the propulsion forces for the jet engine. Fuel, liquid coolant, and compressed air pipes concentrically extend along the axial center of the jet engine. The fuel and coolant pipes have a first group of branch pipes extending therefrom to direct water between the baffle walls and the turbine walls and to supply fuel to the combustion chamber, and a second group of branch pipes to direct water to cool the afterburners and fuel into the afterburners to be ignited therein.

The jet engine of the present invention provides an improved jet engine which has efficient operating conditions and may be effectively utilized at high altitudes. The jet engine provides means for adequately compressing atmospheric air as well as providing auxiliary cooling means for the jet engine and the afterburners thereof. My invention substantially reduces the hazard caused by extreme heat generated in jet engines which cause parts in the engines to prematurely rupture.

Referring to FIGURE 1, there is illustrated a jet engine **11** constructed in accordance to the principles of the present invention. The jet engine **11** has a generally cylindrical shell **12** having at its forward end a plurality of radially inwardly extending spider supports **13** forming an air intake for the jet engine. The rear portion of the shell has a circular support plate **14** connected to the inner circumference thereof.

A plurality of circumferentially spaced afterburners

adjacent outlets **76**, and a conduit connecting adjacent outlets **74**.

The conduits **108** interconnecting the outlets **29** have conduits **34** extending therefrom connected to a forward portion of the conduit **16** to deliver compressed air along the conduit **16** towards the rear of the jet engine (FIGURE 1). The conduits **108** interconnecting the outlets **31** have conduit **79** connected thereto which connects to the conduit **16** adjacent a deflector **81** that direct compressed air along the conduit **16** towards the front portion thereof.

The conduits **108** (FIGURE 3) interconnecting the outlets **74** and **76** of adjacent tandem compressors are interconnected by a conduit **94** leading to an afterburner **84** through a throat **96** (FIGURE 1). Therefore, a jet engine utilizing six rear tandem compressors **68** with adjacent pairs of the rear tandem compressors having their outlets interconnected by a conduit that feeds into an afterburner, would require only three afterburners.

It is of course understood that more or less tandem compressors may be utilized as well as more or less afterburners may be utilized. Also, the ratio of rear tandem compressors to afterburners may be increased or decreased depending upon what is desired. For example, there may be an afterburner for every rear tandem compressor or even two afterburners for every tandem compressor. The number of afterburners and compressors being dependent upon the use of the jet engine. However, at least two forward tandem compressors and at least two rear tandem compressors appears to be preferable for the jet engine of the present invention.

Referring to FIGURE 2 there is illustrated a forward tandem compressor **23** constructed in accordance to the principles of the present invention. It is of course, understood that the rear tandem compressor **68** is identical to the forward tandem compressor **23** and is constructed in a similar manner. Therefore, although the description of FIGURE 2 will refer to the tandem compressor **23** it is also meant to describe the tandem compressors **68**. The tandem compressor **23** has first and second radial compressors **24** and **26** interconnected by a cylindrical housing **109**. The shaft **25** extends through both compressors with one end being journaled thereto and the other end extending through the compressor and having fixed thereto a gear wheel **33**. The shaft is rotatably connected to the tandem compressor by suitable bearings **110**.

Attached to the shaft **25** adjacent each end of the compressor **26** is a rotor radial compressor impeller blade **111** and adjacent each end of the compressor **24** a rotor radial compressor impeller blade **112**. The impellers **111** and **112** have vanes **113**, **114** respectively connected thereto. The vanes direct air from the inlets **27** and **28** to a plurality of stationary diffuser members **117** fixed at one end to the interior compressor housing and at its other end forming a suitable journal with the shaft by bearing means **118** each of the diffusers **117** has a radially extending wall **137** facing an axially inwardly facing side **111***a* of its corresponding impeller **111** and a peripheral wall **138** extending from the periphery of the radially extending wall **137** axially and radially inwardly with respect to the shaft **33** to provide one surface of a diffuser section **139**. Therefore, there is an impeller-diffuser compressor set adjacent each inlet in the tandem compressor. Between the two diffusers **117** is attached to the shaft a central double entry centrifugal impeller **119**. The impeller has on each side face thereof vanes **121** to receive air from the diffusers and direct the air radially outwardly into a central annular passage **122** which communicates with the compressor outlets **29** and **31**. A hollow substantially cylindrical unitary sheet form structure **133** completely surrounds the shaft **33**, the impellers **111** and **119**, and the diffuser **117**, and extends axially substantially the length of the said shaft. The sheet form structure **133** comprises a pair of inlet portions **28***a* which are situated respectively axially outwardly of the single entry impellers **111** to provide air inlets **28** thereto, and which slope respectively axially and radially inwardly toward their corresponding single entry impellers **111**. The structure **133** is further characterized as comprising a pair of first portions **135** which extend axially inwardly from the inlet portions **28***a*, respectively, and which then slope axially inwardly and radially outwardly and then axially and radially inwardly to surround their respective impellers **111** and their corresponding diffusers **117**, and to form with the peripheral walls **138** of the diffusers **117** a pair of diffuser sections **139** for receiving the air from the impellers **111**. The structure **133** further comprises a pair of second portions **136** which extend axially inwardly from the first portions **135**, respectively, and which slope axially inwardly and radially outwardly to join each other in spaced surrounding relation about said double entry impeller **119**.

In this manner air is brought into both tends of the radial compressors **24** and **26**, compressed, and exited through a top central outlet.

Referring to FIGURE 4 there is illustrated a portion of the turbine **40** of the present invention. As is illustrated, the turbine **40** has an entrance adjacent to the exit of the combustion chamber **106** which is formed by the baffles **103** and **104**. The cooling fluid, water or any other suitable cooling fluid, is delivered to the pipe **17**. The water flows along the pipe **17** from the front end of the jet engine towards the rear end. The pipe **17** has a first set of a plurality of branch conduits **123** and **126** extending therefrom and through openings **124** and **127** formed in the conduit **16**. The branch pipes **123** and **126** deliver coolant fluid to the area between the baffles and the turbine rotor walls **101** and **102**. The water injected between the combustion chamber walls and the walls of the turbine insulate and protect the turbine walls from the heat generated in the combustion chamber. The water vaporizes and mixes with the combustion gases to lower the temperature of the combustion gases and then passes through the turbine blades.

The fuel conduit **18** is interconnected with the fuel nozzles **20** by a plurality of branch pipes (not shown) in order to deliver fuel to the combustion chamber **106**.

A second set of branch pipes **92** connect the water pipe **17** to the afterburners hollow shell to supply water coolant thereto and a second set of branch pipes **93** are connected to the fuel pipe **18** to deliver fuel to the afterburner nozzles **89**.

The auxiliary compressed air annular tanks **48** and **63** are utilized to store compressed air for starting the jet engine. The annular tank **48** has a conduit **128** connecting the interior of the tank to the conduits **34** to supply compressed air thereto and to the combustion chamber **106**. The tank **63** has a plurality of conduits **129** connected to the conduits **79** to supply compressed air thereto and to the combustion chamber **106**. The conduits **128** and **129** have valve means (not shown) that are controlled by a remote control signal to open and close the valves as desired to start the engine. Also, the compressed air tanks **48** and **63** have a plurality of inlets **131** and **132** respectively which are connected to a high pressure auxiliary compression (not shown). It is of course understood that the inlets **131** and **132** are provided with valve means (not shown) that automatically closes the inlets once the desired pressure in the tanks **48** and **63** is obtained.

In operation, atmospheric air is drawn through the spider supports **13** and the scoops **97** and delivered to the first-stage compressors **45** and **59**. The first-stage compressed air is directed to a plurality of forward tandem radial-flow compressors and a plurality of rear tandem radial-flow compressors. The forward second-stage tandem compressors receive the compressed air from the ends thereof and exit the second-stage compressed air from two sets of central outlets. One set of central outlets is connected to a compressed air conduit to flow compressed air towards the rear of the jet engine and the other set of outlets is connected to a compressed air conduit to axially flow compressed air towards the front of the jet engine.

The rear and front flow of compressed air meet and are radially directed into a combustion chamber where they are mixed with fuel and ignited. The combustion chamber is cooled by water flowing between the combustion chamber and turbine walls. The ignited fuel and compressed air is combined with vaporized water and directed into the contrarotating turbine blades 43 and 58 and exited through exhaust nozzles to give propulsion to the jet engine. Meanwhile, the rear tandem radial-flow compressors 68 supply compressed air to a plurality of afterburners 84 which are regeneratively cooled by a cooling liquid such as water. The compressed air is mixed with fuel in the afterburners and ignited therein. The gases are exhausted through the afterburners to provide propulsion for the jet engine.

Therefore, it is seen where I have provided an improved jet engine which will provide supersonic air craft with a superior operating engine especially at high altitude where it is desirous to have a high degree of compression where the atmospheric air content is sparse.

It will be understood that the above embodiment of my invention has been used for illustrative purposes only and that other modifications and variations in the present invention may be effected without departing from the spirit and scope of the invention as set forth in the herein appended claims.

I claim as my invention:

1. A jet engine comprising:

a jet engine body formed by a shell having a forward and a rear end,

said jet engine body having mounted therein

a plurality of circumferentially spaced afterburners having their nozzle exhaust extending beyond the rear end of the jet engine body,

said afterburners having hollow shell bodies,

a compressed air conduit means extending from the forward end of the jet engine body towards the rear end,

said compressed air conduit being mounted along the axial centerline of the jet engine body,

an enlarged housing portion on said compressed air conduit being approximately at the center of the jet engine body,

said enlarged housing portion having a plurality of compressed air apertures therein and a plurality of fuel nozzle apertures therein,

a water conduit being concentric with the compressed air conduit and extending therethrough for substantially the length of the jet engine,

a fuel conduit being concentric with the compressed air conduit and extending through the water conduit and extending substantially the length of the jet engine,

a turbine radially outwardly spaced from the enlarged central housing,

said turbine having contrarotating turbine blades connected to a pair of contrarotating turbine rotors,

one of the contrarotating turbine rotors being rotatably connected adjacent the forward end of the enlarged housing and the other contrarotating turbine rotor being rotatably connected adjacent the rear end of the enlarged housing,

said contrarotating turbine rotors being rotatable about said compressed air conduit and having axially extending turbine blades connected thereto,

two spaced circular baffles extending from the compressed air conduit to form an annular turbine combustion chamber therebetween above the compressed air and fuel apertures in the enlarged housing,

said turbine combustion chamber leading into the turbine,

a first plurality of branch water pipes connected to the water conduit and being mounted to spray water in the spaces between the baffles and the walls of the turbine rotors,

forward first-stage axially extending compressor rotor blades connected to the one turbine rotor to rotate therewith,

a forward annular auxiliary compressed air tank mounted adjacent the one rotor,

forward first-stage axially extending compressor stator blades connected to said forward compressed air tank to cooperate with the forward first-stage compressor rotor blades,

rear first-stage axially extending compressor rotor blades connected to the other turbine rotor to rotate therewith,

a rear annular auxiliary compressed air tank mounted adjacent the other rotor,

rear first-stage axially extending compressor stator blades connected to said rear compressed air tank to cooperate with the rear first-stage compressor rotor blades,

said compressed air conduit being connected to the compressed air apertures in the enlarged housing to deliver compressed air therethrough and into the turbine combustion chamber,

first fuel conduit means for communicating the fuel conduit with the fuel apertures in the enlarged housing to deliver fuel therethrough into the turbine combustion chamber,

second water pipe means connected to the water conduit and the afterburners to deliver water to the hollow afterburner shells,

second fuel pipe means connected to the fuel conduit and the afterburners to deliver fuel to the afterburners,

a plurality of circumferentially spaced forward tandem compressors,

a plurality of circumferentially spaced rear tandem compressors,

each of said forward and rear tandem compressors having

a first and second interconnected radial compressor having a common rotor shaft extending therethrough,

said first and second compressors each having a forward end inlet and a rear end inlet and a central outlet,

each of said first and second compressors having an impeller-diffuser set adjacent each inlet to compress air entering the inlets and direct air towards the center of the first and second compressors,

a central centrifugal impeller located in the center of both the first and second compressors,

each centrifugal impeller having directing vanes on each side thereof to receive compressed air from both ends of each of the first and second compressors and impel the compressed air upwards towards the central outlets of the first and second compressors,

first and second pipe means respectively interconnecting the outlets of the first and second compressors of two adjacent forward and rear tandem compressors,

first delivery pipe means connecting the first pipes of the forward tandem compressors with the compressed air conduit at a point before the enlarged housing to flow compressed air towards the rear of the jet engine and towards the enlarged housing,

second delivery pipe means connecting the second pipes of the forward tandem compressors with

the compressed air conduit at a predetermined distance beyond the enlarged housing to flow compressed air towards the forward end of the jet engine and towards the enlarged housing,

third delivery pipe means connecting the first and second pipes of the rear tandem compressors to the afterburners to deliver compressed air thereto,

a forward and rear centrifugal type impeller vane connected respectively to the forward and rear turbine rotors to receive compressed air from the forward and rear first-stage compressors,

a manifold hood means connected to each forward and rear tandem compressors to deliver air to the end inlets of the first and second compressors thereof,

forward and rear conduit means connected to the forward and rear centrifugal type impeller and the forward and rear compressor manifold hoods to deliver compressed air from the first stage compressors to the tandom compressors,

gear wheel means connected to the turbine to rotate therewith the rotor shaft of the forward and rear tandem compressors,

means connected to the forward and rear auxiliary compressor tanks to deliver pressurized air stored in the tanks to the compressed air conduit in response to a signal received,

means connected to the forward and rear auxiliary compressor tanks to refill the tanks with pressurized air after the jet engine is started, and

conduit means connected to the turbine to deliver gases therefrom to exhaust nozzles to form a portion of the propulsion force of the jet engine.

2. A jet engine comprising:

a jet engine body formed by a shell having a forward and a rear end,

said jet engine body having mounted therein

a plurality of circumferentially spaced afterburners mounted at the rear end of the jet engine body,

said afterburners having hollow shell bodies,

a compressed air conduit means extending from the forward end of the jet engine body towards the rear end,

said compressed air conduit being mounted along the axial centerline of the jet engine body,

an enlarged housing portion on said compressed air conduit being approximately at the center of the jet engine body,

said enlarged housing portion having a plurality of compressed air apertures therein and a plurality of fuel nozzle apertures therein,

a water conduit being concentric with the compressed air conduit and extending therethrough for substantially the length of the jet engine,

a fuel conduit being concentric with the compressed air conduit and extending through the water conduit and extending substantially the length of the jet engine,

a turbine radially outwardly spaced from the enlarged central housing,

said turbine having contrarotating turbine blades rotating about the axis of the jet engine,

two spaced circular baffles extending from the enlarged housing to form an annular turbine combustion chamber therebetween above the enlarged housing compressed air and fuel apertures,

said turbine combustion chamber leading into the turbine,

a first plurality of branch water pipes connected to the water conduit and being mounted to spray water in the spaces between the baffles and the walls of the turbine,

forward first-stage axially extending compressor blades connected to the turbine to rotate therewith,

a forward annular auxiliary compressed air tank mounted adjacent the turbine,

forward first-stage axially extending compressor stator blades connected to said forward compressed air tank to cooperate with the forward first-stage compressor rotor blades,

rear first-stage axially extending compressor rotor blades connected to the turbine to rotate therewith,

a rear annular auxiliary compressed air tank mounted adjacent the turbine,

rear first-stage axially extending compressor stator blades connected to said rear compressed air tank to cooperate with the rear first-stage compressor rotor blades,

said compressed air conduit being connected to the compressed air apertures in the enlarged housing to deliver compressed air therethrough and into the turbine combustion chamber,

first fuel conduit means for communicating the fuel conduit with the fuel apertures in the enlarged housing to deliver fuel therethrough into the turbine combustion chamber,

second water pipe means connected to the water conduit and the afterburners to deliver water to the hollow afterburner shells,

second fuel pipe means connected to the fuel conduit and the afterburners to deliver fuel to the afterburners,

a plurality of circumferentially spaced forward tandem compressors,

a plurality of circumferentially spaced rear tandem compressors,

each of said forward and rear tandem compressors having

a first and second interconnected radial compressor having a common rotor shaft extending therethrough,

said first and second compressors each having a forward end inlet and a rear end inlet and a central outlet,

each of said first and second compressors having an impeller-diffuser set adjacent each inlet to compress air entering the inlets and direct air towards the center of the first and second compressors,

a central centrifugal impeller located in the center of both the first and second compressors,

each centrifugal impeller having directing vanes on each side thereof to receive compressed air from both ends of each of the first and second compressors and impel the compressed air upwards towards the central outlets of the first and second compressors,

first delivery pipe means connecting the outlets of the first compressors of the forward tandem compressors with the compressed air conduit at a point before the enlarged housing to flow compressed air towards the rear of the jet engine and towards the enlarged housing,

second delivery pipe means connecting the outlets of the second compressors of the forward tandem compressors with the compressed air conduit at a predetermined distance beyond the enlarged housing to flow compressed air towards the forward end of the jet engine and towards the enlarged housing,

third delivery pipe means connecting the outlets

of the rear tandem compressors to the afterburners to deliver compressed air thereto,

a forward and rear centrifugal type impeller vane connected to the turbine to receive compressed air from the forward and rear first-stage compressors,

a manifold hood means connected to each forward and rear tandem compressors and to the forward and rear centrifugal-type turbine impellers to deliver first-stage compressed air to the end inlets of the first and second compressors thereof,

means connected to the turbine to rotate the rotor shaft of the forward and rear tandem compressors, and conduit means connected to the turbine to deliver gases therefrom to exhaust nozzles to form a portion of the propulsion force of the jet engine.

3. A jet engine comprising:

a jet engine body formed by a shell having a forward and a rear end,

said jet engine body having mounted therein

a plurality of circumferentially spaced afterburners mounted at the rear end of the jet engine body,

a compressed air conduit means extending from the forward end of the jet engine body towards the rear end,

said compressed air conduit being mounted along the axial centerline of the jet engine body,

an enlarged housing portion on said compressed air conduit being approximately at the center of the jet engine body,

said enlarged housing portion having a plurality of compressed air apertures therein and a plurality of fuel nozzle apertures therein,

a water conduit being concentric with the compressed air conduit and extending therethrough for substantially the length of the jet engine,

a fuel conduit being concentric with the compressed air conduit and extending through the water conduit and extending substantially the length of the jet engine,

a turbine radially outwardly spaced from the enlarged central housing,

said turbine having contrarotating turbine blades rotating about the axis of the jet engine,

two spaced circular baffles extending from the enlarged housing to form an annular turbine combustion chamber therebetween above the enlarged housing compressed air and fuel apertures,

said turbine combustion chamber leading into the turbine,

a first plurality of branch water pipes connected to the water conduit and being mounted to spray water in the spaces between the baffles and the walls of the turbine,

forward first-stage axially extending compressor rotor blades connected to the turbine to rotate therewith,

a forward annular auxiliary compressed air tank mounted adjacent the turbine,

forward first-stage axially extending compressor stator blades connected to said forward compressed air tank to cooperate with the forward first-stage compressor rotor blades,

rear first-stage axially extending compressor rotor blades connected to the turbine to rotate therewith,

a rear annular auxiliary compressed air tank mounted adjacent the turbine,

rear first-stage axially extending compressor stator blades connected to said rear compressed air

tank to cooperate with the rear first-stage compressor rotor blades,

said compressed air conduit being connected to the compressed air apertures in the enlarged housing to deliver compressed air therethrough and into the turbine combustion chamber,

first fuel conduit means for communicating the fuel conduit with the fuel apertures in the enlarged housing to deliver fuel therethrough into the turbine combustion chamber,

second water pipe means connected to the water conduit and the afterburners to deliver water to cool the afterburners,

second fuel pipe means connected to the fuel conduit and the afterburners to deliver fuel to the afterburners,

a plurality of circumferentially spaced forward tandem compressors,

a plurality of circumferentially spaced rear tandem compressors,

each of said forward and rear tandem compressors having

a first and second interconnected radial compressor having a common rotor shaft extending therethrough,

said first and second compressors each having a forward end inlet and a rear end inlet and a central outlet,

each of said first and second compressors having an impeller-diffuser set adjacent each inlet to compress air entering the inlets and direct air towards the center of the first and second compressors,

a central centrifugal impeller located in the center of both the first and second compressors,

each centrifugal impeller having directing vanes on each side thereof to receive compressed air from both ends of each of the first and second compressors and impel the compressed air upwards towards the central outlets of the first and second compressors,

first delivery pipe means connecting the outlets of the first compressors of the forward tandem compressors with the compressed air conduit at a point before the enlarged housing to flow compressed air towards the rear of the jet engine and towards the enlarged housing,

second delivery pipe means connecting the outlets of the second compressors of the forward tandem compressors with the compressed air conduit at a predetermined distance beyond the enlarged housing to flow compressed air towards the forward end of the jet engine and towards the enlarged housing,

third delivery pipe means connecting the outlets of the rear tandem compressors to the afterburners to deliver compressed air thereto,

a forward and rear centrifugal type impeller vane connected to the turbine to receive compressed air from the forward and rear first-stage compressors,

a manifold means connected to each forward and rear tandem compressors and to the forward and rear centrifugal type turbine impellers to deliver first-stage compressed air to the end inlets of the first and second compressors thereof,

gear means connected to the turbine to rotate the rotor shaft of the forward and rear tandem compressors, and

conduit means connected to the turbine to deliver gases therefrom to exhaust nozzles to form a portion of the propulsion force of the jet engine.

4. A jet engine comprising:
a jet engine body formed by a shell having a forward and a rear end,
said jet engine body having mounted therein
a plurality of circumferentially spaced afterburners mounted at the rear end of the jet engine body,
an enlarged housing being mounted approximately at the center of the jet engine body,
said enlarged housing having a plurality of compressed air apertures therein and a plurality of fuel nozzle apertures therein,
a water conduit extending for substantially the length of the jet engine,
a fuel conduit being concentric with the water conduit and extending through the water conduit for substantially the length of the jet engine,
a turbine radially outwardly spaced from the enlarged central housing,
said turbine having contrarotating turbine blades rotating about the axis of the jet engine,
two spaced circular baffles extending from the enlarged housing to form an annular turbine combustion chamber therebetween above the enlarged housing compressed air and fuel apertures,
said turbine combustion chamber leading into the turbine.
a first plurality of branch water pipes connected to the water conduit and being mounted to spray water in the spaces between the baffles and the walls of the turbine,
forward first-stage axially extending compressor rotor blades connected to the turbine to rotate therewith,
a forward annular auxiliary compressed air tank mounted adjacent the turbine,
forward first-stage axially extending compressor stator blades connected to said forward compressed air tank to cooperate with the forward first-stage compressor rotor blades,
rear first-stage axially extending compressor rotor blades connected to the turbine to rotate therewith,
a rear annular auxiliary compressed air tank mounted adjacent the turbine,
rear first-stage axially extending compressor stator blades connected to said rear compressed air tank to cooperate with the rear first stage compressor rotor blades,
means connected to the compressed air apertures in the enlarged housing to deliver compressed air therethrough and into the turbine combustion chamber,
first fuel conduit means for communicating the fuel conduit with the fuel apertures in the enlarged housing to deliver fuel therethrough into the turbine combustion chamber,
second water pipe means connected to the water conduit and the afterburners to deliver water to cool the afterburners,
second fuel pipe means connected to the fuel conduit and the afterburners to deliver fuel to the afterburners,
a plurality of circumferentially spaced forward tandem compressors,
a plurality of circumferentially spaced rear tandem compressors,
each of said forward and rear tandem compressors having
a first and second interconnected radial compressor having a common rotor shaft extending therethrough,
said first and second compressors each having a forward end inlet and a rear end inlet and a central outlet,
each of said first and second compressors having an impeller-diffuser set adjacent each inlet to compress air entering the inlets and direct air towards the center of the first and second compressors,
a central centrifugal impeller located in the center of both the first and second compressors,
each centrifugal impeller having directing vanes on each side thereof to receive compressed air from both ends of each of the first and second compressors and impel the compressed air upwards towards the central outlets of the first and second compressors,
first and second pipe means respectively interconnecting the outlets of the first and second compressors of two adjacent forward and rear tandem compressors,
first delivery pipe means connecting the outlets of the first compressors of the forward tandem compressors with one end of the enlarged housing,
second delivery pipe means connecting the outlets of the second compressors of the forward tandem compressors with the other end of the enlarged housing,
third delivery pipe means connecting the outlets of the rear tandem compressors to the afterburners to deliver compressed air thereto,
a forward and rear centrifugal type impeller vane connected to the turbine to receive compressed air from the forward and rear first-stage compressors,
a manifold means connected to each forward and rear tandem compressors and to the forward and rear centrifugal-type turgine impellers to deliver first stage compressed air to the end inlets of the first and second compressors thereof,
means connected to the turbine to rotate the rotor shaft of the forward and rear tandem compressors, and
conduit means connected to the turbine to deliver gases therefrom to exhaust nozzles to form a portion of the propulsion force of the jet engine.

5. A jet engine comprising:
a jet engine body formed by a shell having a forward and a rear end,
said jet engine body having mounted therein
a plurality of circumferentially spaced afterburners mounted at the rear end,
an enlarged housing,
said enlarged housing having a plurality of compressed air apertures therein and a plurality of fuel nozzle apertures therein,
a coolant conduit,
a turbine radially outwardly spaced from the enlarged housing,
said turbine having contrarotating turbine blades rotating about the axis of the jet engine,
axially spaced baffles extending from the enlarged housing to form an annular turbine combustion chamber therebetween above the enlarged housing,
said turbine combustion chamber leading into the turbine,
a first plurality of branch coolant pipes connected to the coolant conduit and being mounted to

inject coolant between the baffles and the walls of the turbine,
a forward first-stage compressor connected to the turbine to rotate therewith,
a forward annular auxiliary compressed air tank mounted adjacent the turbine,
a rear first-stage compressor connected to the turbine to rotate therewith,
a rear annular auxiliary compressed air tank mounted adjacent the turbine,
means to deliver compressed air into the turbine combustion chamber,
first fuel pipe means for communicating the fuel conduit with the fuel apertures in the enlarged housing to deliver fuel therethrough into the turbine combustion chamber,
second coolant pipe means connected to the coolant conduit and the afterburners to deliver coolant to the afterburners,
second fuel pipe means connected to the fuel conduit and the afterburners to deliver fuel to the afterburners,
a plurality of circumferentially spaced forward tendem compressors,
a plurality of circumferentially spaced rear tandem compressors,
each of said forward and rear tandem compressors having
a first and second interconnected compressor having a common rotor shaft extending therethrough,
said first and second compressors each having a forward end inlet and a rear end inlet and a central outlet, and
means to receive compressed air from both ends of each of the first and second compressors and impel the compressed air upwards towards the central outlets of the first and second compressors,
first delivery pipe means connecting the outlets of first compressors of the forward tandem compressors with one end of the enlarged housing to flow compressed air towards the rear of the jet engine into the enlarged housing,
second delivery pipe means connecting the outlets of the second compressors of the forward tandem compressors with the other end of the enlarged housing to flow compressed air towards the forward end of the jet engine into the enlarged housing,
third delivery pipe means connecting the outlets of the rear tanden compressors to the afterburners to deliver compressed air thereto,
a forward and rear centrifugal-type impeller vane connected to the turbine to receive compressed air from the forward and rear first-stage compressors,
a manifold means connected to each forward and rear tandem compressors and to the forward and rear centrifugal-type turbine impellers to deliver first-stage compressed air to the forward and rear end inlets of the first and second compressors thereof,
means connected to the turbine to rotate the rotor shaft of the forward and rear tandem compressors, and
conduit means connected to the turbine to deliver gases therefrom to exhaust nozzles to form a portion of the propulsion force of the jet engine.

6. A jet engine comprising:
a jet engine body formed by a shell having a forward and a rear end,
said jet engine body having mounted therein
a plurality of circumferentially spaced afterburners mounted at the rear end of the jet engine body,
an enlarged housing being approximately at the center of the jet engine body,
said enlarged housing having a plurality of compressed air apertures therein and a plurality of fuel nozzle apertures therein,
a water conduit,
a fuel conduit,
a turbine radially outwardly spaced from the enlarged central housing,
said turbine having contrarotating turbine blades rotating about the axis of the jet engine, spaced circular baffles extending from the enlarged housing to form an annular turbine combustion chamber therebetween above the enlarged housing compressed air and fuel apertures,
said turbine combustion chamber leading into the turbine,
a first plurality of branch water pipes connected to the water conduit and being mounted to spray water in the spaces between the baffles and the walls of the turbine,
forward first-stage axially extending compressor rotor blades connected to the turbine to rotate therewith,
a forward annular auxiliary compressed air tank mounted adjacent the turbine,
forward first-stage axially extending compressor stator blades connected to said forward compressed air tank to cooperate with the forward first-stage compressor rotor blades,
rear first-stage axially extending compressor rotor blades connected to the turbine to rotate therewith,
a rear annular auxiliary compressed air tank mounted adjacent the turbine,
rear first-stage axially extending compressor stator blades connected to said rear compressed air tank to cooperate with the rear first-stage compressor rotor blades,
means connected to the compressed air apertures in the enlarged housing to deliver compressed air therethrough and into the turbine combustion chamber,
first fuel conduit means for communicating the fuel conduit with the fuel apertures in the enlarged housing to deliver fuel therethrough into the turbine combustion chamber,
second water pipe means connected to the water conduit and the afterburners to deliver water to cool the afterburners,
second fuel pipe means connected to the fuel conduit and the afterburners to deliver fuel to the afterburners,
a plurality of circumferentially spaced forward tandem compressors,
a plurality of circumferentially spaced rear tandem compressors,
each of said forward and rear tandem compressors having
a first and second interconnected radial compressor having a common rotor shaft extending therethrough,
said first and second compressors each having a forward end inlet and a rear end inlet and a central outlet,
each of said first and second compressors having an impeller-diffuser set adjacent each inlet to compress air entering the inlets and direct air towards the center of the first and second compressors,
a central centrifugal impeller located in the

center of both the first and second compressors,

each centrifugal impeller having directing vanes on each side thereof to receive compressed air from both ends of each of the first and second compressors and impel the compressed air upwards towards the central outlets of the first and second compressors,

first delivery pipe means connecting the outlets of the first compressors of the forward tandem compressors with one end of the enlarged housing to flow compressed air towards the rear of the jet engine towards the enlarged housing,

second delivery pipe means connecting the outlets of the second compressors of the forward tandem compressors with the other end of the enlarged housing to flow compressed air towards the forward end of the jet engine towards the enlarged housing,

third delivery pipe means connecting the outlets of the rear tandem compressors to the afterburners to deliver compressed air thereto,

a forward and rear centrifugal type impeller vane connected to the turbine to receive compressed air from the forward and rear first-stage compressors,

a manifold hood means connected to each forward and rear tandem compressors and to the forward and rear centrifugal-type turbine impellers to deliver first stage compressed air to the end inlets to the first and second compressors thereof,

means connected to the turbine to rotate the rotor shaft of the forward and rear tandem compressors, and

conduit means connected to the turbine to deliver gases therefrom to exhaust nozzles to form a portion of the propulsion force of the jet engine.

7. A jet engine comprising:

a jet engine body formed by a shell having a forward and a rear end,

said jet engine body having mounted therein

a plurality of circumferentially spaced afterburners mounted at the rear end of the engine body.

said enlarged housing portion having a plurality of compressed air apertures therein and a plurality of fuel nozzle apertures therein,

a coolant conduit,

a turbine radially outwardly spaced from the enlarged housing,

said turbine having contrarotating turbine blades,

said turbine forming an annular turbine combustion turbine chamber above the compressed air and fuel apertures in the enlarged housing leading into the turbine,

a first plurality of branch coolant pipes connected to the coolant conduit and being mounted to spray coolant along the walls of the turbine forming the turbine combustion chamber,

a forward first-stage compressor connected to the turbine to rotate therewith,

a rear first stage compressor connected to the turbine to rotate therewith,

means to deliver compressed air into the turbine combustion chamber from the enlarged housing,

first fuel pipe means communicating the fuel conduit with the fuel apertures in the enlarged housing to deliver fuel therethrough into the turbine combustion chamber,

a plurality of circumferentially spaced forward tandem compressors,

a plurality of circumferentially spaced rear tandem compressors,

each of said forward and rear tandem compressors having

a first and second innterconnected compressor,

said first and second compressors each having a forward end inlet and a rear end inlet and a central outlet, and

means to receive compressed air from both ends of each of the first and second compressors and impel the compressed air upwards towards the central outlets of the first and second compressors,

first delivery pipe means connecting the outlets of the first compressors of the forward tandem compressors with the enlarged housing,

second delivery pipe means connecting the outlets of the second compressors of the forward tandem compressors with the enlarged housing,

third delivery pipe means connecting the outlets of the rear tandem compressors to the afterburners to deliver compressed air thereto,

a forward and rear centrifugal-type impeller vane connected to the turbine to receive compressed air from the forward and rear first-stage compressors,

a manifold means connected to each forward and rear tandem compressors to deliver first-stage compressed air to the forward and rear end inlets of the first and second compressors thereof,

means connected to the turbine to rotate therewith a rotor for the forward and rear tandem compressors, and

conduit means connected to the turbine to deliver gases therefrom to exhaust nozzles to form a portion of the propulsion force of the jet engine.

8. A jet engine comprising:

a jet engine body formed by a shell having a forward and a rear end,

said jet engine body having mounted therein a turbine,

said turbine, having axially extending contrarotating turbine blades rotating about the axis of the jet engine,

said turbine forming an annular turbine combustion chamber leading into the turbine,

coolant pipes being mounted to spray coolant along the walls of the turbine forming the turbine combustion chamber,

a first-stage compressor connected to the turbine to rotate therewith,

means to deliver compressed air into the turbine combustion chamber,

first fuel pipe means to deliver fuel into the turbine combustion chamber,

a plurality of spaced tandem compressors, each of said tandem compressors having

a first and second interconnected compressor,

said first and second compressors each having a forward end inlet and a rear end inlet and a central outlet, and

means to receive compressed air from both ends of each of the first and second compressors and impel the compressed air upwards towards the central outlets of the first and second compressors,

first delivery pipe means connecting the first compressor outlets to flow compressed air towards the rear of the jet engine and into the turbine compressed air delivery means,

second delivery pipe means connecting the second compressor outlets to flow compressed air towards the forward end of the jet engine and into the turbine compressed air delivery means,

means connected to the tandem compressors to deliver air from the first-stage compressor to the end inlets of the first and second compressors thereof,

means connected to the turbine to rotate the tandem compressor rotor shaft therewith, and conduit means connected to the turbine to deliver gases therefrom to exhaust nozzles to form a portion of the propulsion force of the jet engine.

9. A jet engine comprising:

jet engine body formed by a shell having a forward and a rear end,

said jet engine body having mounted therein a plurality of circumferentially spaced afterburners mounted at the rear end of the jet engine body,

an enlarged housing,

said enlarged housing portion having a plurality of compressed air apertures therein and a plurality of fuel nozzle apertures therein,

a coolant conduit,

a turbine radially outwardly spaced from the enlarged housing,

said turbine having contrarotating turbine blades,

said turbine forming an annular turbine combustion chamber above the compressed air and fuel apertures in the enlarged housing leading into the turbine,

first coolant pipes connected to the coolant conduit and being mounted to spray coolant along the walls of the turbine forming the turbine combustion chamber,

a first-stage compressor connected to the turbine to rotate therewith,

enlarged housing means to deliver compressed air into the turbine combustion chamber,

first fuel pipe means communicating the fuel conduit with the fuel apertures in the enlarged housing to deliver fuel therethrough into the turbine combustion chamber,

second fuel pipe means connected to the fuel conduit and the afterburners to deliver fuel to the afterburners,

a plurality of circumferentially spaced tandem compressors,

each of said tandem compressors having

a first and second interconnected radial compressor with a common rotor shaft extending therethrough,

said first and second compressors each having a forward end inlet and a rear end inlet and a central outlet,

each of said first and second compressors having an impeller-diffuser set adjacent each inlet to compress air entering the inlets and direct air towards the center of the first and second compressors,

a central centrifugal impeller located in the center of both the first and second compressors,

each centrifugal impeller having directing vanes on each side thereof to receive compressed air from both ends of each of the first and second compressors and impel the compressed air upwards towards the central outlets of the first and second compressors,

first delivery pipe means connecting the outlets of the first compressors with the enlarged housing,

second delivery pipe means connecting the outlets of the second compressors with the enlarged housing,

means connected to the tandem compressors to deliver air to the end inlets of the first and second compressors thereof from the first-stage compressor,

means connected to the turbine to rotate the tandem compressor rotors therewith, and

conduit means connected to the turbine to deliver gases therefrom to exhaust nozzles to form a portion of the propulsion force of the jet engine.

10. A centrifugal compressor for a jet engine comprising

rotatable shaft,

a pair of single entry impellers mounted on the ends of said shaft for corotation therewith,

said impellers each having a pair of radially extending sides one of which faces axially outwardly of the shaft and the other of which faces axially inwardly of the shaft,

impeller vanes formed only on the axially outwardly facing side of each of said impellers,

a pair of diffuser members situated respectively adjacent the axially inwardly facing sides of said impellers,

each of said diffuser members having a radially extending wall facing the axially inwardly facing side of its corresponding impeller and a peripheral wall extending from the periphery of said radially extending wall axially and radially inwardly with respect to said shaft to provide one surface of a diffuser section,

a double entry impeller mounted for corotation on said shaft intermediate said single entry impellers and having a pair of oppositely facing radially extending sides formed thereon,

impeller vanes formed on both sides of said double entry impeller,

a hollow substantially cylindrical circumferentially continuous, unitary sheet-form structure completely surrounding said shaft, said impellers and said diffuser members and extending axially substantially the length of said shaft,

said sheet-form structure comprising a pair of inlet portions situated axially outwardly of said single entry impellers to provide inlets thereto and sloping, respectively, axially and radially inwardly toward their corresponding single entry impellers,

a pair of first portions extending axially inwardly from said inlet portions, respectively, and then sloping axially inwardly and radially outwardly and then axially and radially inwardly to surround, respectively, each of said single entry impellers and their corresponding diffuser members and to form with the peripheral walls of said diffuser members a pair of diffuser sections for receiving the air from said single entry impellers, and

a pair of second portions extending axially inwardly from said first portions, respectively, and sloping axially inwardly and radially outwardly to join each other in spaced surrounding relation about said double entry impeller, and

means forming an outlet in said structure in longitudinal alignment with said double entry impeller for directing the compressed air from said structure.

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July 12, 1966 L. W. KESTING 3,260,047

FLUID INJECTOR, SELF-COMPENSATING FOR LATERAL ACCELERATION

Filed Jan. 2, 1964 4 Sheets-Sheet 1

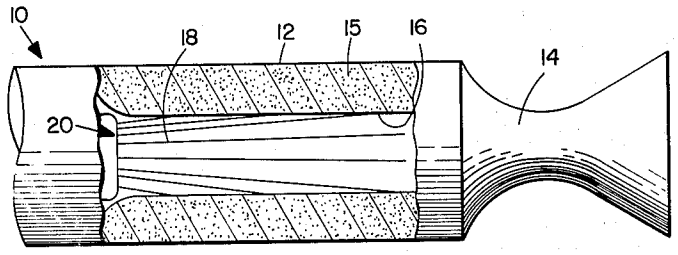


FIG. 1

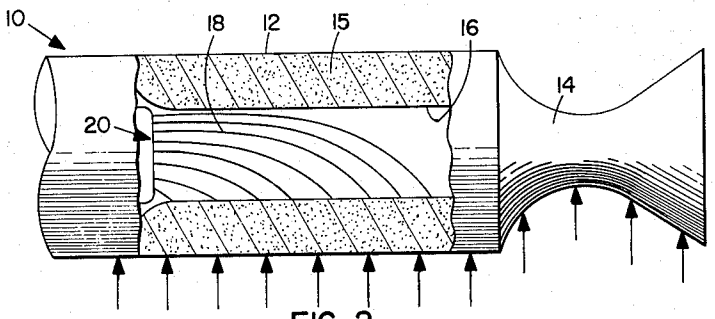


FIG. 2

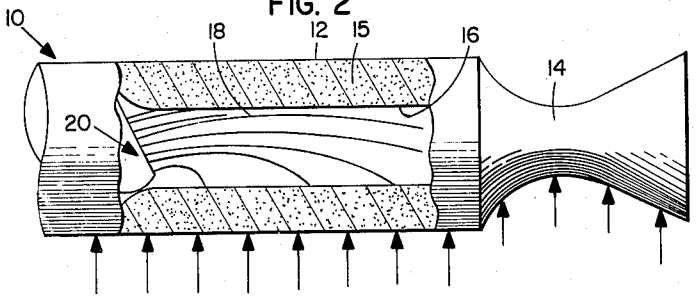


FIG. 3

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