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AIR COOLING SYSTEM

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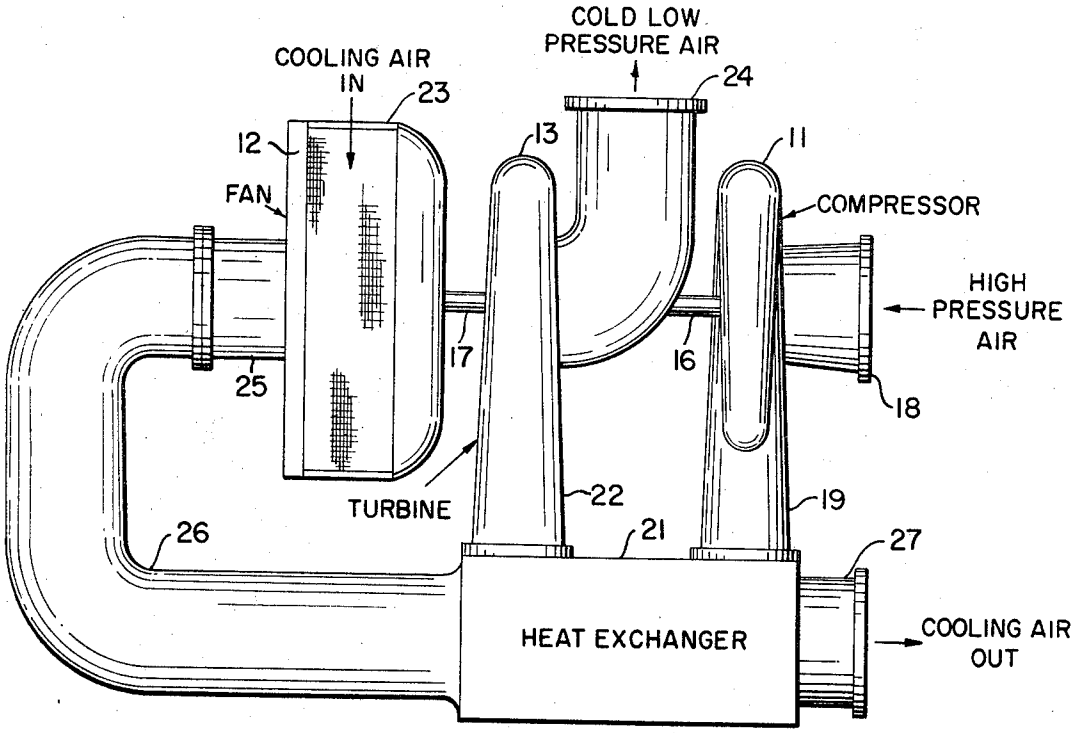


FIG. 1

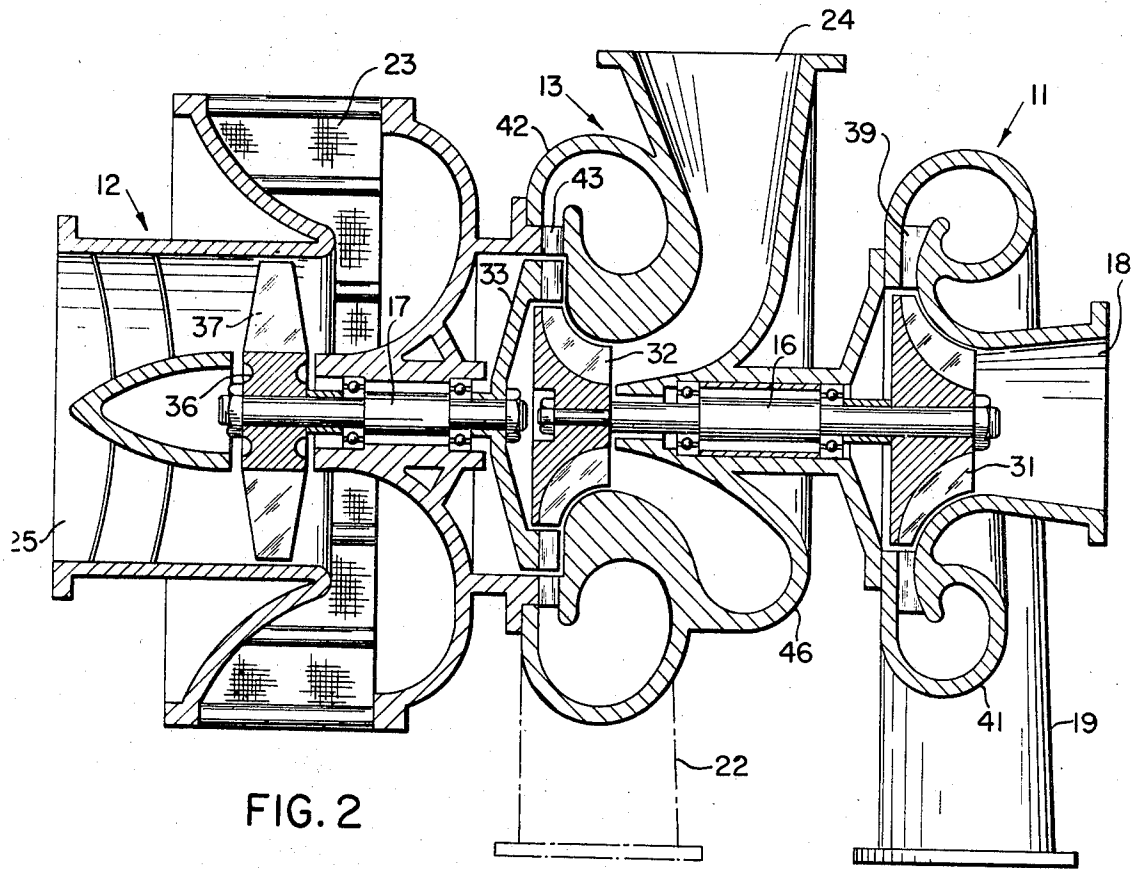


FIG. 2

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AIR COOLING SYSTEM

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ABSTRACT OF THE DISCLOSURE

An air cooling system having a source of pressurized air wherein the air is further compressed in a centrifugal compressor, cooled in a heat exchanger to ambient temperature, and then expanded through a turbine having two turbine spools which rotate at different speeds. The faster spool powers the centrifugal compressor while the slower spool operates a fan to move ambient coolant air through the heat exchanger.

This invention relates to an air cooling system and, in particular, to a system for reducing the temperature of air which system does not involve the use of a condensible refrigerant.

Air conditioning or cooling systems, as encountered on aircraft, utilize high pressure air, that is bled from the engine, to pressurize the cabin and supply fresh cool air to the passengers. The system includes a compressor to compress the bleed air, a heat exchanger to cool it to substantially ambient temperature, and a turbine to expand the air and transfer energy to the compressor. When the aircraft is flying, the coolant for the heat exchanger is ram air, but, when the aircraft is on the ground, fans are needed to move ambient air through the heat exchanger.

Therefore, an object of this invention is to provide an air cooling system of the type described having incorporated therewith means for moving coolant air through the heat exchanger.

A feature of this invention is the provision of a two-spool turbine for an air cooling system wherein one spool operates an air compressor and the other operates a fan.

Another feature of this invention is a two-spool turbine having coaxial turbine wheels or rotors wherein the gas flows inwardly through one wheel and then through the other wheel. The outer wheel is of the impulse type having a limited angular speed at no load and the inner wheel is primarily of the reaction type to cause the inner wheel to rotate at relatively high angular velocities.

These and other objects and features of advantages of the present invention will become apparent from a review of the following description of a preferred embodiment and claims when taken in conjunction with the drawing, wherein:

FIG. 1 is a schematic embodiment of the novel air conditioning system; and

FIG. 2 is an enlarged detailed axial section of the rotating machine for the air conditioning system.

Referring to the drawing and to FIG. 1 in particular, a cooling system is shown having a compressor **11** and a fan **12** both of which are powered by a turbine **13**. A shaft **16** transfers power from the turbine **13** to the compressor **11** while a shaft **17** transfers power from the turbine to the fan **12**. The compressor **11** has an inlet **18** which is coupled, for example, to a source (not shown) of pressurized air which is at a relatively high pressure. The pressurized air is further compressed and the compressed air is discharged from the compressor **11** through an outlet **19**. A heat exchanger **21** is coupled to the outlet **19** and to an inlet **22** of the turbine **13** so that any fluid flowing out of the compressor enters the turbine after the fluid has been cooled within the heat exchanger, in a manner to be described hereinafter. The fluid expands within the turbine giving up energy to shafts **16** and **17**, and then the fluid is discharged through an outlet **24** at a lower temperature and pressure than when it entered the turbine. Energy is transferred to the compressor **11** to compress the incoming bleed air, and energy is transferred to the fan **12**. The fan **12** draws the coolant, for example, ambient air through an annular inlet **23** and discharges the air through an outlet **25** into an inlet duct **26** for the heat exchanger **21**. The ambient air passes through the heat exchanger **21**, where it picks up heat from the compressed air, described above, and the ambient air is discharged through an outlet duct **27**.

As mentioned above, the function of the fan **12** is to move relatively large quantities of low pressure ambient air through the heat exchanger **21** while the function of the compressor is to further compress the high pressure air so that the heat exchanger can effectively remove internal energy therefrom. To substantially compress the high pressure air, the compressor should rotate at relatively high speed, much higher than the fan. The fan should rotate at a relatively low speed to maintain a low noise level and high efficiency. Referring to FIG. 2, there is shown an axial section of a preferred embodiment of the fan **12**, turbine **13** and compressor **11**. The compressor inlet **18** opens into a suitable housing for the compressor **11** wherein is disposed a rotating impeller **31** suitably fixed to one end of the shaft **16**. The impeller **31** is of standard design for compressing air. At the other end of the shaft **16** is fixed an inner turbine rotor **32**. The impeller **31**, shaft **16** and rotor **32** form one of the rotating spools. The other rotating spool is formed by an outer turbine rotor **33** fixed on the shaft **17**, and a fan hub **36** with blades **37** also fixed on shaft **17**. The blades **37** are of a standard design for moving relatively large volumes of air. The compressor has a diffuser **39** opening into a scroll **41**, as is standard in the art, so that the high velocity is converted to high pressure. The fan's inlet **23**, for simplicity of design, is preferably annular so that very little flow resistance is encountered. The inlet **23** is part of a contoured fan housing wherein the outlet **25** is axially disposed.

The turbine **13** is of the radial flow type and includes a suitable scroll **42** wherein the high pressure gas is distributed to suitable nozzles **43** that are distributed around the axis. The nozzles **43** are designed so that the velocity of the air exiting therefrom is substantially constant under wide load requirements. The outer rotor **33** is a standard impulse type that rotates under all load conditions with a peripheral speed that is less than the velocity of the air exiting the nozzles **43**. The air then enters inner rotor **32** wherein the remaining energy in the air causes this rotor **32** to rotate. The inner rotor **32** is preferably of the reaction type, allowing this rotor to achieve a very high angular velocity.

In the light of the above teachings, various modifications and variations of the present invention are contemplated that would be apparent to those skilled in the art without departing from the spirit and scope of the invention. Therefore, the invention is not limited to the exemplary apparatus or procedures described, but includes all embodiments within the scope of the claims.

What is claimed is:

1. In combination:

first means for supplying compressed fluid,

second means for supplying a stream of cooling fluid,

turbine means for driving both said first and second means,

third means for receiving both said compressed fluid and said cooling fluid to cool said compressed fluid with said cooling fluid,

fourth means for conducting said compressed fluid from said third means to said turbine means, and said turbine means having an outer wheel and an inner wheel,

a first shaft connecting one of said wheels with said second means, and

a second shaft connecting said other wheel with said first means.

2. In the combination of claim **1** wherein said one wheel is of the impulse type so that its angular velocity is limited.

3. In the combination of claim **2** wherein said one wheel is the outer wheel.

4. In the combination of claim **1** wherein said outer and inner wheels rotate at different angular velocities.

5. In the combination of claim **2** wherein siad outer and inner wheels rotate at different angular velocities.

6. In the combination of claim **3** wherein said outer and inner wheels rotate at different angular velocities.

7. In the combination of claim **1** wherein said first and second shafts are aligned.

8. In the combination of claim **1** wherein said one

wheel is the outer wheel and is of the impulse type and the other wheel is said inner wheel and is of the reaction type.

9. In the combination of claim **2** wherein said first and second shafts are aligned.

10. In the combination of claim **6** wherein said first and second shafts are aligned.

11. In the combination of claim **8** wherein said first and second shafts are aligned.

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