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FLUID PROPULSION APPARATUS

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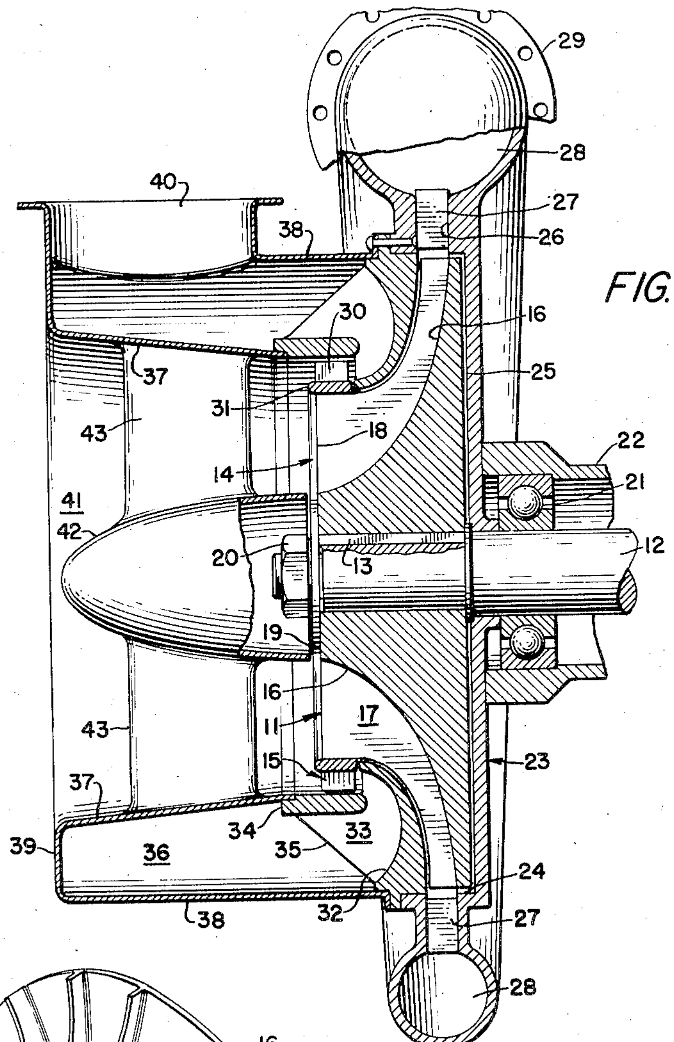

FIG. 1.

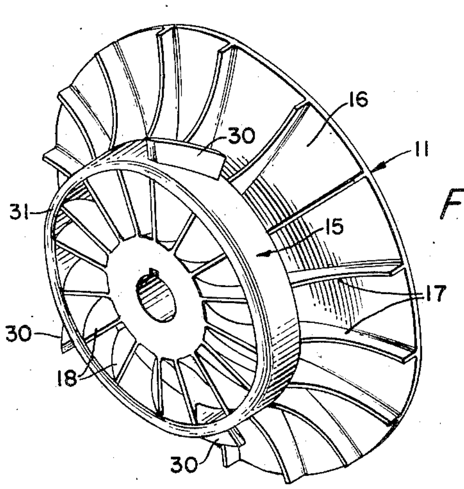

FIG. 2.

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FLUID PROPULSION APPARATUS

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5 Claims. (Cl. 253—55)

This invention relates to fluid propulsion apparatus, and more specifically to the provision of means for increasing the efficiency and utility of centrifugal compressors, centripetal turbines or similar rotary fluid pressure converting devices wherein there is an interchange of energy between a rotor and a fluid.

In fluid propulsion apparatus, such as centrifugal compressors that draw their supply of air through an inlet duct, or centripetal turbines that discharge air through an outlet duct, the efficiency of the apparatus is dependent upon a smooth and even entrance or exit of the air. If, for example, the air flowing through a duct to the impeller of a centrifugal compressor is obstructed or impeded by frictional drag on the sides of the duct, the efficiency of the compressor is lowered. Similarly, if the air discharged from the rotor of a centripetal turbine is obstructed or impeded by frictional drag on the sides of the duct, the efficiency of the turbine is reduced.

The invention is herein discussed as applied to fluid propulsion apparatus for use with air. It is not, however, limited to such usage, but rather it has utility in compressors and turbines operating with any elastic or gaseous fluid, and it may also be used in pumps and turbines operating with inelastic fluids or liquids.

It is an object of the invention to provide novel means to increase the efficiency of fluid propulsion apparatus of the type that utilizes a duct either to convey fluid to an impeller or to conduct fluid from a turbine rotor.

Another object of the invention is to provide a new and novel fluid propulsion apparatus adapted to simultaneously utilize or deliver fluid at different volumes and pressures.

It is a further object of the invention to provide a novel fluid propulsion apparatus requiring a minimum of power loss in its operation.

Still another object of the invention is to provide a novel impeller member adapted to deliver separate supplies of fluid at different volumes and pressures.

Still another object of the invention is to provide a novel turbine member adapted to utilize separate supplies of fluid at different volumes and pressures.

Another object of the invention is to provide a novel turbine rotor.

Another object of the invention is to provide a novel impeller.

Another object of the invention is to provide a novel turbine.

Another object of the invention is to provide a novel compressor or pump.

Other objects of the invention will become apparent from the disclosure in the following specification and appended claims, taken in connection with the accompanying drawing, which is for illustrative purposes only, and wherein like reference numbers indicate like parts:

Fig. 1 is a sectional view of a centrifugal compressor embodying the invention, and

Fig. 2 is an isometric view of the impeller member of the compressor.

Referring to the drawing, the compressor impeller member **11** is mounted on the end of a drive shaft **12** and secured against rotation relative thereto by a keyed connection **13**.

The impeller member **11** is designed to deliver a plurality of air streams simultaneously, at different volumes and pressures, and comprises a compressor portion **14** adapted to deliver a volume of compressed air and a fan portion **15** formed to supply a quantity of air at low pressure.

The compressor portion **14** is shown here as a conventional compressor impeller formed by mounting, on one surface of a circular disk **16**, a plurality of substantially radially disposed impeller blades **17**, having their entry edges **18** bent in the direction of rotation to provide smooth entry of the air.

The impeller member **11** is secured on the drive shaft **12** by a washer **19** and a nut **20**. The drive shaft **12** is journalled within a bearing **21**, located in a carrier **22**, and may be further supported by other bearings not shown.

The compressor portion **14** is journalled to rotate within a housing having, as a portion thereof, a main casing **23** recessed as at **24** to form the rear wall of an impeller chamber **25**. The impeller chamber **25** is surrounded by a diffusor passage **26** wherein a plurality of guide vanes **27** direct the compressed air smoothly into a volute discharge chamber **28**. A connection flange **29** is fixed on the discharge end of the volute discharge chamber **28** for ease of assembly to an adjoining duct, not shown. While the diffusor passage and the volute discharge chamber are shown as being formed as one casting integral with the main casing **23**, it will be understood by those skilled in the art that these elements may be sectionally fabricated and assembled in many different ways.

The impeller fan portion **15** consists of a plurality of peripherally spaced blades **30** formed on a cylindrical ring **31** which is mounted on the periphery of the entry edge **18** of the impeller blades **17**. The ring **31** is arranged to overlap and run close to the septum **32** so that it serves as a seal to prevent the high pressure fluid in the impeller chamber **25** from leaking back past the blade tips of the compressor impeller. The fan is of the axial flow type and is designed to deliver a quantity of air at low pressure. The blades **30**, for purposes of illustration, are shown in the form of generally flat blades angularly disposed with respect to the plane of rotation.

Attached to the main casing **23** is a septum **32** that defines on one side, the forward wall of the impeller chamber **25**, and on the other side the rearward wall of an air passage **33** leading from the low pressure fan **15**. An inner annular vane supporting member **34**, spaced from the septum **32** but supported therefrom by a plurality of spaced vanes **35**, defines the forward wall of the air passage **33**.

An air collector **36** bounded by an inner annular wall **37** attached to the vane supporting member **34**, an outer annual wall **38** attached to the septum **32**, and an end portion **39** is provided to conduct the low pressure air from passage **33** to an outlet **40**.

Centrally located within an air inlet passage **41**, and defined by the annular wall **37**, a hollow fairing cone **42** is supported from the wall **37** by a plurality of circumferentially spaced struts **43**.

In operation, when the impeller member **11** is rotated, a supply of air is drawn axially through the air inlet passage **41** to the compressor portion **14** and the fan portion **15**. That portion of the air propelled by the fan blades **30**, through passage **33** and into the air collector ring **36**, may be utilized for heat transfer purposes, for example, or in many other ways which will suggest themselves to those skilled in the art. The remainder of the air flowing through the air inlet passage 41 enters the inlet of the compressor portion 14 and is impelled radially to the volute discharge chamber 28 where it is discharged under high pressure, to be used as required.

The air drawn through the inlet passage 41 to the fan portion 15 flows in an annular stream adjacent the wall 37 and thereby forms a boundary layer flow within the inlet passage. The air flowing through the inlet passage to the compressor portion 14 flows concentrically within, and laminar with, the boundary layer of air flowing to the fan portion. Due to this concentric pattern of laminar flow, disturbances caused by frictional drag on the sides of the duct are eliminated from the stream of air flowing to the compressor portion of the impeller. Removal of these disturbances or obstructions in the stream of air flowing to the compressor markedly increases its efficiency.

An additional increase in the general efficiency of the compressor is obtained due to the annular ring 31 serving as a seal to prevent the high pressure air in the impeller chamber 25 from leaking back past the blade tips of the compressor impeller and creating turbulence in the stream of air flowing to the impeller.

The invention has special utility when applied in the manner described above to a unit such as a gas turbine compressor in which it is required to provide simultaneously a major volume of compressed air at high efficiency for combustion and other purposes, and a further quantity of air to be used as a cooling medium in a heat exchanger for cooling lubricating oil. The invention not only provides for the supplying of two streams of air simultaneously, but, due to the increase in the efficiency of the compressor portion resulting from the improved flow pattern within the inlet passage, it expends a minimum of power in so doing. It has been found by comparison, for example, that the power expended in operating a centrifugal compressor, having a three-bladed axial flow fan mounted as described above to supply a quantity of air used for oil cooling purposes, is no greater than the power consumed in operating a compressor of identical size without the axial flow fan arrangement.

Although the invention has been described, by way of illustration, with particular reference to an axial flow fan mounted on the entry portion of a compressor impeller, it will be appreciated that the principles herein set forth may be employed to good advantage in other forms. For example, the centrifugal compressor shown in the drawing will operate as a centripetal turbine if the flow is reversed, with air under pressure supplied to the volute at the connection flange 29. In such a case the axial flow fan blades 30 would operate to draw air in through the outlet 40 and to force it leftwardly in the direction of discharge of the main air flow from the turbine rotor along the inner annular wall 37. A concentric pattern of flow would thus be formed within what has in this instance become the turbine discharge duct, and the discharge from the turbine, flowing within the air discharged by the fan, would be substantially free of disturbances caused by skin friction. The removal of these frictional disturbances in the discharge stream of the turbine increases the efficiency of the turbine, and it would, of course, be entirely feasible to employ the flow of fan air for useful purposes by drawing it in as a coolant through a heat exchanger connected to what formerly was the outlet 40.

It will be apparent to those skilled in the art that further variations may also be effected in the arrangement and structure described without departing from the spirit and scope of the invention, and that the principles of the invention may be applied to propulsion apparatus such as pumps and turbines operating with inelastic fluids or liquids.

We claim:

1. A gaseous fluid propulsion apparatus comprising: a rotatably supported shaft; an impeller axially mounted on said shaft; a plurality of compressor blades on said impeller having a generally radially disposed main portion; means carried by said impeller providing a continuous annular axially extending wall having a generally cylindrical outer surface and defining an inlet at the radially inner ends of said blades, said inlet being disposed substantially in a plane normal to the axis of said impeller; a casing enclosing said impeller and extending into running sealing engagement with said means; a first discharge duct for conducting the fluid flow from said compressor blades; a plurality of axial flow blades secured to rotate with said impeller and extending radially outwardly from said generally cylindrical surface of said axially extending wall; wall means enclosing said axial flow blades to form an axial flow inlet encircling the inlet to said compressor blades; a second discharge duct for conducting the fluid flow from said axial flow blades; and a common intake duct extending longitudinally from said wall means and coaxially aligned with the axis of said impeller so that the fluid flowing through said common intake duct to the compressor blades and axial flow blades flows in contiguous concentric streams substantially parallel to the axis of said intake duct.

2. A gaseous fluid propulsion apparatus as recited in claim 1 wherein said compressor blades have an axially extending entry portion, said continuous annular wall comprises an annular ring secured on said entry portion of said compressor blades, and said axial flow blades are mounted on the exterior of said annular ring.

3. A gaseous fluid propulsion apparatus comprising: a rotatably supported shaft; a rotor axially mounted on said shaft; a plurality of turbine blades on said rotor having a generally radially disposed main portion; means carried by said rotor providing a continuous annular axially extending wall having a generally cylindrical outer surface and defining an outlet at the radially inner ends of said blades, said outlet being disposed substantially in a plane normal to the axis of said rotor; a casing enclosing said rotor and extending into running sealing engagement with said means; a first inlet duct for conducting the fluid flow to said turbine blades; a plurality of axial flow blades secured to rotate with said rotor and extending radially outwardly from said generally cylindrical surface of said axially extending wall; wall means enclosing said axial flow blades to form an axial flow outlet encircling the outlet to said turbine blades; a second inlet duct for conducting the fluid flow from said axial flow blades; and a common discharge duct extending longitudinally from said wall means and coaxially aligned with the axis of said rotor so that the fluid flowing through said common intake duct from the turbine blades and axial flow blades flows in contiguous concentric streams substantially parallel to the axis of said intake duct.

4. A gaseous fluid propulsion apparatus comprising: a rotatably supported shaft; an impeller axially mounted on said shaft; a plurality of compressor blades on said impeller having a generally radially disposed main portion; means carried by said impeller providing a continuous annular axially extending wall having a generally cylindrical outer surface and defining an inlet at the radially inner ends of said blades, said inlet being disposed substantially in a plane normal to the axis of said impeller; a casing enclosing said impeller and extending into running sealing engagement with said means, said casing having front and rear walls blending into a volute discharge chamber for conducting the fluid flow from said impeller; a plurality of axial flow blades secured to rotate with said impeller and extending radially outwardly from said generally cylindrical surface of said axially extending wall; wall means enclosing said axial flow blades to form an axial flow inlet encircling the inlet to said compressor blades, said wall means further forming an annular chamber on the forward side of said front wall of said casing for conducting low pressure fluid from said axial flow blades, one wall of said annular chamber forming a

common inlet passage extending longitudinally from the wall means encircling the inlet to said compressor and coaxially aligned with the axis of said impeller so that fluid flowing through said common intake duct to the compressor blades and axial flow blades flows in contiguous concentric streams substantially parallel to the axis of said intake duct.

5. A gaseous fluid propulsion apparatus comprising: a rotatably supported shaft; an impeller axially mounted on said shaft; a plurality of compressor blades on said impeller having a generally radially disposed main portion and an axially extending entry portion, each of said blades having its entry edge bent in the direction of rotation of the impeller; a cylindrical ring mounted on the periphery of the entry edges of said compressor blades; a casing enclosing said impeller and extending into running sealing engagement with one end of said cylindrical ring; a diffusor passage formed between said front and rear walls of said casing in the discharge region of said impeller; a volute discharge chamber communicating with said diffusor passage; guide vanes in said diffusor passage for directing fluid discharge from said compressor blades into said volute discharge chamber; a plurality of axial flow blades on said cylindrical ring; wall means enclosing said axial flow blades to form an axial flow inlet encircling the inlet to said compressor blades; wall means forming an annular passage on the forward side of said front wall of said casing for conducting low pressure fluid from said axial flow blades; said wall means further forming an annular chamber communicating with said annular passage, one wall of said annular chamber extending forward of said front wall of said casing and forming a common inlet passage extending longitudinally from the wall means encircling the inlet to said compressor and coaxially aligned with the axis of said impeller so that fluid flowing through said inlet passage to the compressor blades and axial flow blades flows in contiguous concentric streams substantially parallel to the axis of said passage.

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