May 3, 1960 A. E. LEPLEY 2,935,295

THROTTLE CONFIGURATION VARYING APPARATUS AND CONTROL MEANS THEREFOR

Filed Jan. 26, 1951

Fig. 1

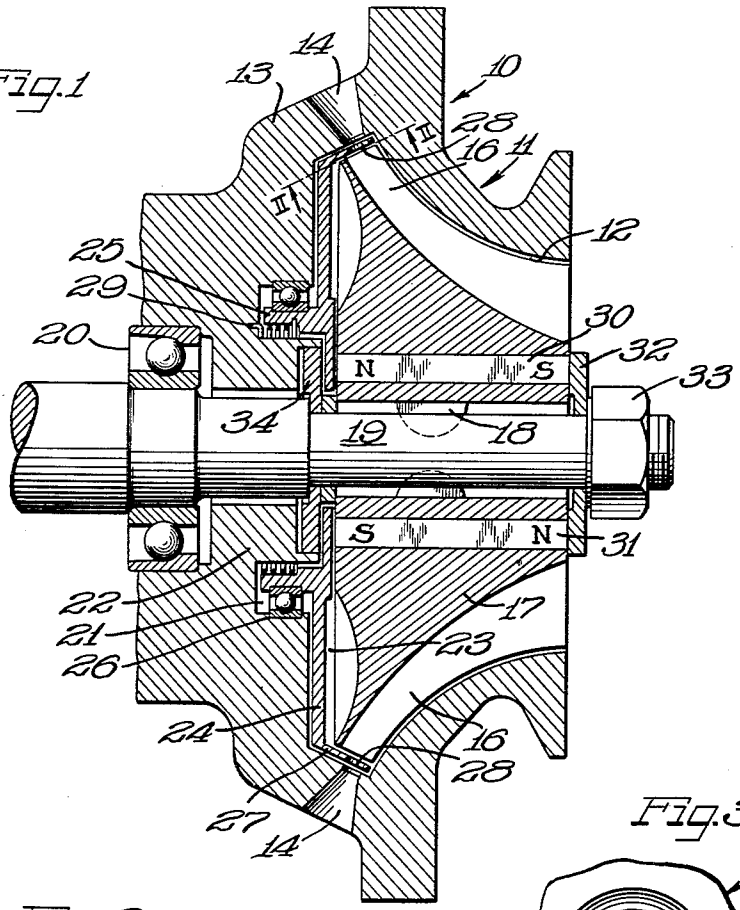


Fig. 2

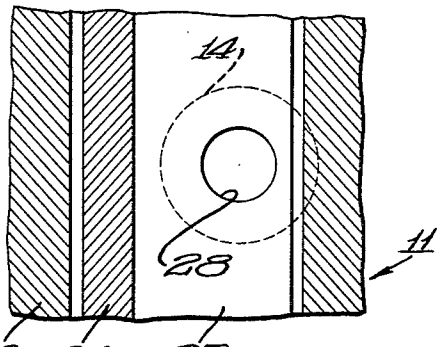


Fig. 3

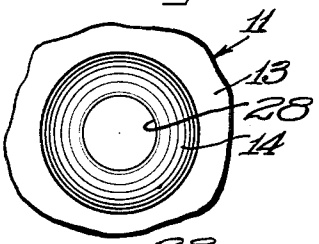
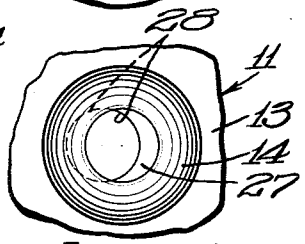


Fig. 4



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THROTTLE CONFIGURATION VARYING APPARATUS AND CONTROL MEANS THEREFOR

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9 Claims. (Cl. 253—52)

This invention relates generally to a throttle structure and more particularly to a nozzle inlet of a turbine having means to control a variable inlet area in response to operating conditions, thereby to selectively throttle inlet fluid to a turbine impeller.

According to the general features of the present invention, a housing is provided having a nozzle block portion with a plurality of nozzle inlets arranged to expand a fluid in the direction of a rotatable impeller carried on a shaft journaled in said housing. An air gap is provided between the impeller and the housing and a valve or other area controlling device, for example, a valve having a plurality of throttling apertures corresponding in number and size to the nozzle inlets, is movably mounted in the air gap so that the throttling apertures may be moved into and out of registry with the nozzle inlets, thereby to control the flow of fluid from the inlets to the impeller. Torque-producing means responsive to the rotation of the impeller are connected to the rotary valve to control positioning of the valve upon rotation of the impeller, thereby to impart a torque to the valve by means of which the positioning of the throttle apertures may be regulated.

It is an object of the present invention to provide a turbine construction wherein the effective throat area of a nozzle inlet may be controlled by a throttling member which is directly responsive to a variable condition.

Another object of the present invention is to provide a turbine construction having a rotary valve or other area controlling member arranged to throttle inlet air to the turbine in response to actuation by condition sensitive means.

A further object of the present invention is to provide a rotary valve for a turbine construction wherein the valve comprises the rotor of an eddy current device by means of which the positioning of the valve may be selectively controlled.

Yet another object of the present invention is to provide a rotary valve for a turbine construction adapted to have a torque imparted thereto in response to the speed of rotation of the turbine impeller.

A further object of the present invention is to provide a new and improved eddy current throttle.

Many other features, advantages and additional objects of the present invention will become manifest to those versed in the art upon making reference to the detailed description which follows and the accompanying sheets of drawings in which a preferred embodiment of a structure incorporating the principles of my invention is shown.

On the drawings:

Figure 1 is a cross-sectional view with parts shown in elevation showing one structural embodiment of a turbine construction incorporating the principles of the present invention;

Figure 2 is an enlarged fragmentary cross-sectional view taken substantially on line II—II of Figure 1;

Figure 3 is an enlarged fragmentary elevational view looking through one of the nozzle inlets and showing the rotary valve of the present invention positioned so as to provide a fully open port; and

Figure 4 is a view similar to Figure 3, but showing the rotary valve of the present invention positioned to partially restrict the nozzle inlet port.

As shown on the drawings:

Although the principles of the present invention find a particular applicability to a turbine construction, it will be understood that I do not wish to be limited to the specific environment herein described by way of illustrative example only.

The improved throttling arrangement of the present invention is shown in connection with a turbine construction indicated generally by the reference numeral **10** and includes a housing **11** having an impeller chamber **12** and an annular nozzle block **13** in which is formed a plurality of spaced nozzle inlets **14** arranged to expand and direct a fluid toward the vane elements **16** of an impeller **17** keyed as at **18** to a shaft **19** journaled for rotation in a bearing means **20** mounted in the housing **11**.

The housing **11** is formed with an internal annular recess **21** concentrically disposed relative to a hub portion **22**. The impeller chamber **12** of the housing **11** is also constructed to provide a substantially annular air gap **23** between the impeller **17** and the inlet side of the housing **11**.

A rotary valve **24** is mounted for movement in the air gap **23** and includes an axially extending annular flange **25** which is arranged to encircle the hub **22** in the locale of the recess **21**, an annular bearing **26** being carried by the housing **11** so as to journal the valve **24** for movement in the air gap **23**.

It will be noted that the air gap **23** extends radially to the nozzle inlets **14** and the valve **24** is provided with a control portion **27** having a plurality of throttling apertures **28** corresponding in number with the nozzle inlets **14** and arranged to be moved into and out of registry with the nozzle inlets **14**, thereby to selectively restrict the effective area of opening of the nozzle inlets **14** and thereby to control the flow of fluid from the nozzle inlets **14** to the vane elements **16** of the impeller **17**.

It will be understood that the throttling apertures **28** by way of exemplification of the present inventive principles are preferably of the same size as that portion of the nozzle inlet directly adjacent the control portion **27** of the rotary valve **24**.

The rotary valve **24** is normally held in either an open or closed flow position by means of an appropriate control device which in this particular embodiment takes the form of a torsion spring **29** having one end thereof operatively connected to the housing **11** and the other end thereof operatively connected to the flange **25** of the rotary valve **24**.

It will be apparent that the flow of fluid from the nozzle inlets **14** to the vane elements **16** of the impeller **17** will be at a maximum when the throttling apertures **28** are in full open registry with the nozzle inlet **14** as shown in Figure 3. To cut down the flow of fluid, the rotary valve **24** is rotated selectively so as to move the throttling apertures **28** out of registry with the nozzle inlet **14** as shown in Figure 4.

In order to impart the necessary torque to the rotary valve **24**, the present invention contemplates the provision of a condition sensitive control device to position the rotary disc-type valve **24**, for example, by imparting a torque tending to move the valve in response to the rotational speed of the impeller **17**.

Because the rotary valve **24** is generally disc-shaped and develops a throttling function, the relationship thereof to the inventive subject matter is sometimes identified herein by use of the terms "disc" and "throttle member" as well as the term "control valve."

The torque-producing means may, by way of example, take the form of at least a pair of bar magnets indicated

at 30 and 31. The magnet 30 is shown with its north pole arranged directly adjacent the air gap 23 and the magnet 31 is shown with its south pole similarly situated but spaced apart from the magnet 30. A washer 32 of paramagnetic material bridges the opposite ends of the magnets 30 and 31 and also serves to engage a nut 33 threaded on the end of the shaft 19 to hold the impeller 17 in assembly therewith.

In order to promote a full flux flow through the air gap 23 in the vicinity of the rotary valve 24, a washer 34 made of paramagnetic material may be carried by the shaft 19 on the housing side of the rotary valve 24, thereby completing a magnetic circuit through the air gap 23.

In order to minimize flux leakage, the shaft 19 is preferably made of non-magnetic material.

In operation, the magnetic lines of flux produced by the magnets 30 and 31 pass through the disc-type rotary valve 24. Upon rotation of the impeller 17 changing flux linkages result in portions of the disc-type valve 24 in proximity to the magnets 30 and 31 and an electromotive force is generated which, in turn, causes eddy currents to flow in the valve 24. The eddy currents, in establishing their own magnetic fields which interact with the fields of the magnets 30 and 31, impart a torque to the rotary valve 24, thereby tending to move the control portion 27 of the valve 24 so as to control the flow of fluid through the nozzle inlets 14 to the vane elements 16 of the impeller 17.

It may be noted that the torque imparted to the rotary valve 24 will, in accordance with well known physical relationships, be related in a predetermined proportion to the speed of rotation of the impeller 17. Thus, the rotary valve 24 can be effectively employed to throttle the inlet fluid flow to the turbine impeller 17.

It will be understood, of course, that flux producing means carried by the impeller 17 is particularly characterized by being capable of establishing a flux pattern in the air gap 23 so that the torque imparted to the rotary valve 24 could be controlled as a function of the rotational speed of the impeller 17.

The mounting of the rotary valve 24 for rotation independent of the rotation of the impeller 17 makes it feasible to apply a torque to the rotary valve 24. Accordingly the speed responsive eddy current device herein described by way of a preferred embodiment is merely exemplary of one form of actuating mechanism responsive to such different variable factors involved in the operation of the turbine as pressure, flow volume, temperature, or any other measurable quantity.

Although various minor structural modifications might be suggested by those versed in the art to the preferred embodiment herein described in great detail for the sake of clarity only, it should be understood that I wish to embody within the scope of this patent all such modifications as reasonably and properly come within the scope of my contribution to the art.

I claim as my invention:

1. In a turbine construction, a housing, a shaft journaled for rotation therein, an impeller carried by said shaft for rotation in said housing, said housing having an annular nozzle block portion forming an annular row of nozzle inlets arranged to expand a fluid toward said impeller to rotatably drive said impeller, said impeller and said housing together with one another forming an annular air gap therebetween extending to said nozzle inlets, a rotary valve journaled in said housing for rotation in said air gap, said valve having an annular control portion in said air gap with an annular row of openings therein corresponding in number to said plurality of nozzle inlets and being so selectively moved into and out of register with said inlets to restrict the flow of fluid from said nozzles to said impeller upon relative movement of said valve with respect to said housing, a control spring operatively connected between said housing and said valve to load said valve in a predetermined angular direction and magnetic eddy current torque-producing means between said valve and said impeller to impart a turning torque to said valve in response to rotation of said impeller to overcome said control spring for controlling the effective area of said nozzle inlets.

2. In a turbine construction, a housing, a shaft journaled for rotation therein, an impeller carried by said shaft for rotation in said housing, said housing having an annular nozzle block portion forming a plurality of nozzle inlets arranged to expand a fluid toward said impeller to rotatably drive said impeller, said impeller and said housing together with one another forming an annular air gap therebeteween extending to said nozzle inlets, a disc made of paramagnetic material carried by said housing for movement in said air gap, said disc having a control portion with an annular row of openings therein corresponding in number to said plurality of nozzle inlets and being moved into and out of register with said inlets to selectively restrict the flow of fluid from said nozzles to said impeller upon relative movement of said disc with respect to said housing, a control spring operatively connected between said housing and said disc to load said disc in a predetermined angular direction and magnetic flux-producing means carried by said impeller and arranged to induce eddy currents in said disc, thereby to impart a turning torque to said disc in response to rotation of said impeller to overcome said control spring for controlling the effective area of said nozzle inlets.

3. In a turbine construction, a housing, a shaft journaled for rotation therein, an impeller carried by said shaft for rotation in said housing, said housing having an annular nozzle block portion forming a plurality of nozzle inlets arranged to expand a fluid toward said impeller to rotatably drive said impeller, said impeller and said housing together with one another forming an annular air gap therebetween extending to said nozzle inlets, a disc made of paramagnetic material carried by said housing for movement in said air gap, said disc having a control portion with a plurality of openings therein corresponding in number to said plurality of nozzle inlets and cooperating therewith to provide a plurality of variably sized flow passages through said air gap to selectively restrict the flow of fluid from said nozzles to said impeller upon relative movement of said disc with respect to said housing, a control spring operatively connected between said housing and said disc to load said disc in a predetermined angular direction and magnetic flux-producing means carried by said impeller and arranged to induce eddy currents in said disc, thereby to impart a turning torque to said disc in response to rotation of said impeller to overcome said control spring for controlling the effective area of said nozzle inlets, said magnetic flux-producing means including at least a pair of bar magnets carried by said impeller with opposite poles arranged adjacent said air gap.

4. In a turbine construction, a housing, a shaft journaled for rotation therein, an impeller carried by said shaft for rotation in said housing, said housing having an annular nozzle block portion forming a plurality of nozzle inlets arranged to expand a fluid toward said impeller to rotatably drive said impeller, said impeller and said housing together with one another forming an annular air gap therebetween extending to said nozzle inlets, a disc made of paramagnetic material carried by said housing for movement in said air gap, said disc having a control portion comprising an offset flanged rim with a plurality of openings therein corresponding in number to said plurality of nozzle inlets and arranged to selectively restrict the flow of fluid from said nozzles to said impeller upon relative movement of said disc with respect to said housing, a control spring operatively connected between said housing and said disc to load said disc in a predetermined direction and magnetic flux-pro-

ducing means carried by said impeller and arranged to induce eddy currents in said disc, thereby to impart a turning torque to said disc in response to rotation of said impeller to overcome said control spring for controlling the effective area of said nozzle inlets, a washer of paramagnetic material on said shaft on one side of said disc and at least a pair of bar magnets carried by said impeller with opposite poles spaced apart from one another and arranged adjacent said air gap on the other side of said disc.

5. In a turbine construction, a housing, a shaft journaled for rotation therein, an impeller carried by said shaft for rotation in said housing, said housing having an annular nozzle block portion forming a plurality of nozzle inlets arranged to expand a fluid toward said impeller to rotatably drive said impeller, said impeller and said housing together with one another forming an annular air gap therebetween extending to said nozzle inlets, a disc made of paramagnetic material carried by said housing for movement in said air gap, said disc having a control portion comprising a flange with a plurality of openings therein corresponding in number to said plurality of nozzle inlets and arranged to selectively restrict the flow of fluid from said nozzles to said impeller upon relative movement of said disc with respect to said housing, a control spring operatively connected between said housing and said disc to load said disc in a predetermined direction and magnetic flux-producing means carried by said impeller and arranged to induce eddy currents in said disc, thereby to impart a turning torque to said disc in response to rotation of said impeller to overcome said control spring for controlling the effective area of said nozzle inlets, a washer of paramagnetic material on said shaft on one side of said disc and at least a pair of bar magnets carried by said impeller with opposite poles spaced apart from one another and arranged adjacent said air gap on the other side of said disc, and a washer of paramagnetic material bridging the opposite ends of said bar magnets, thereby to complete a closed magnetic circuit through said air gap.

6. In a turbine construction, a housing, a shaft journaled for rotation therein, an impeller carried by said shaft for rotation in said housing, said housing having an annular nozzle block portion forming a plurality of nozzle inlets arranged to expand a fluid toward said impeller to rotatably drive said impeller, said impeller and said housing together with one another forming an annular air gap therebetween extending to said nozzle inlets, a disc made of paramagnetic material carried by said housing for movement in said air gap, said disc having a control portion with a plurality of openings therein corresponding in number to said plurality of nozzle inlets and arranged to selectively restrict the flow of fluid from said nozzles to said impeller upon relative movement of said disc with respect to said housing, a control spring operatively connected between said housing and said disc to load said disc in a predetermined direction and magnetic flux-producing means carried by said impeller and arranged to induce eddy currents in said disc, thereby to impart a turning torque to said disc in response to rotation of said impeller to overcome said control spring for controlling the effective area of said nozzle inlets, a washer of paramagnetic material on said shaft on one side of said disc and at least a pair of bar magnets carried by said impeller with opposite poles spaced apart from one another and arranged adjacent said air gap on the other side of said disc, and a washer of paramagnetic material bridging the opposite ends of said bar magnets, thereby to complete a closed magnetic circuit through said air gap, said shaft being of nonmagnetic material, thereby to minimize flux leakage.

7. In a turbine construction, a housing, bearing means therein, a shaft journaled for rotation in said bearing means, an impeller carried by said shaft and rotatable in said housing, said housing having an annular row of nozzles arranged to expand a fluid toward said impeller, thereby to rotatably drive said impeller, a throttle member mounted in said housing for rotation independent of said impeller and having a control portion formed with an annular row of apertures arranged to be moved into and out of register with said nozzles to selectively control the flow of driving fluid to said impeller, control means normally biasing said throttle member in one angular direction with said nozzles and said apertures in full open register, and condition-sensitive means to move said throttle relative to said nozzles to restrict flow through said nozzles in response to variations from a reference condition, said condition-sensitive means comprising an eddy current device wherein said throttle member comprises a rotatable valve of paramagnetic material and magnetic flux-producing means carried by said shaft and said impeller in inductive relationship with said throttle member, thereby to impart a turning torque to said throttle member, the quantitative value of said torque being proportional to the speed of rotation of the impeller.

8. In a turbine construction, a housing, bearing means therein, a shaft journaled for rotation in said bearing means, an impeller carried by said shaft and rotatable in said housing, said housing having an annular row of nozzles arranged to expand a fluid toward said impeller, thereby to rotatably drive said impeller, a throttle member mounted in said housing for rotation independent of said impeller and having a control portion formed with an annular row of apertures complementary to said nozzles and arranged to be moved into and out of register with said nozzles to selectively control the flow of driving fluid to said impeller, control means normally biasing said throttle member in one angular direction with said nozzles and said apertures in full open register, and condition-sensitive means to move said throttle member relative to said nozzles to restrict flow through said nozzles in response to variations from a reference condition comprising an eddy current device wherein said throttle member consists of a rotatable disc valve of paramagnetic material and said shaft and said impeller carry magnetic flux-producing means in inductive relationship with said throttle member to impart a turning torque to said throttle member proportional in quantitative value to the speed of rotation of the impeller, said shaft being made of a non-magnetic material to minimize flux leakage.

9. A turbine construction comprising in combination, a housing, a rotor mounted for rotation in the housing and provided with circumferentially spaced vane elements, a fixed nozzle member adjacent said vane elements and through which motive fluid is supplied to the vane elements, an annular throttling member between the fixed nozzle member and the vane elements and having spaced openings therein, bearing means supporting the throttling member so that the throttling member is capable of continuous angular adjustment between a first position in which the motive fluid can freely flow therethrough to the vane elements and a second position in which all of the motive fluid is deflected by the throttling member away from the vane elements, torque-applying means driven by the rotor and operatively connected between said rotor and said throttling member to adjust said throttling member in angular direction as a function of the speed of rotation of the rotor so that the throttling member is angularly displaced by the said torque-applying means into positions of adjustment between said first and second positions for deflecting the motive fluid away from the vane elements as a function of the speed of the rotor, and spring means interconnecting the housing and the throttling member and applying a continuous biasing force urging the throttling member into its first position, said torque-applying means comprising an eddy current device and said throttling member consisting of a rotatable disk valve of conductive

material, and said eddy current device more particularly including magnetic flux-producing means rotatably driven by the rotor in inductive relation to said throttling member for the purposes set forth.

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