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3,038,698

MECHANISM FOR CONTROLLING GASEOUS FLOW IN TURBO-MACHINERY

Filed Aug. 30, 1956

2 Sheets-Sheet 1

FIG. 1

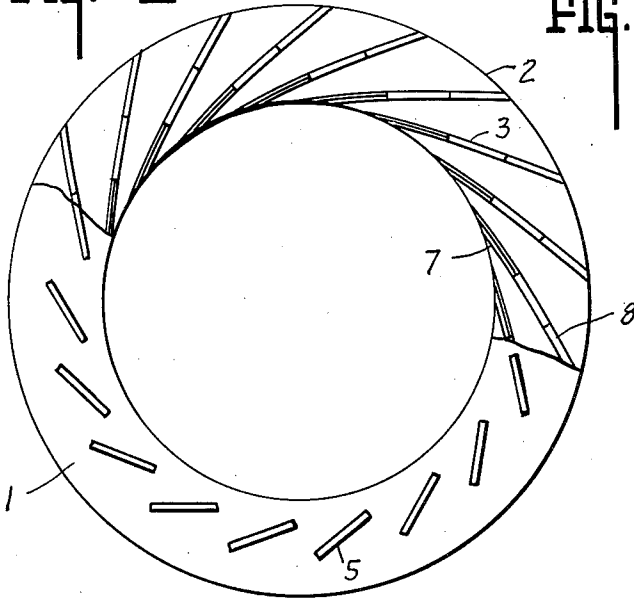


FIG. 2

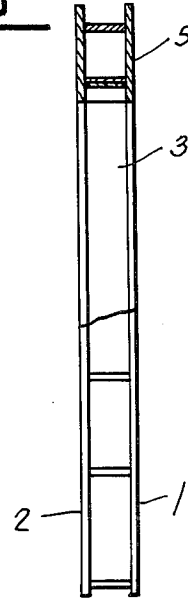


FIG. 3

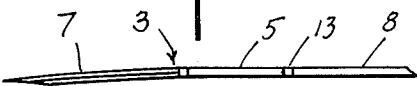


FIG. 4



FIG. 5

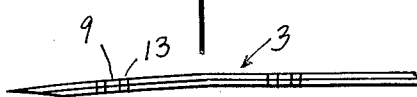


FIG. 6

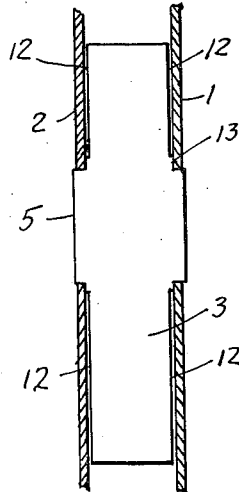
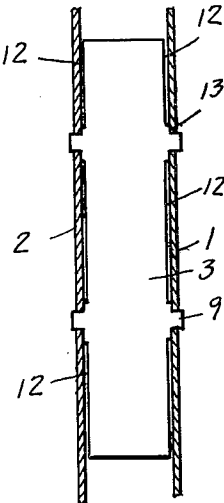


FIG. 7



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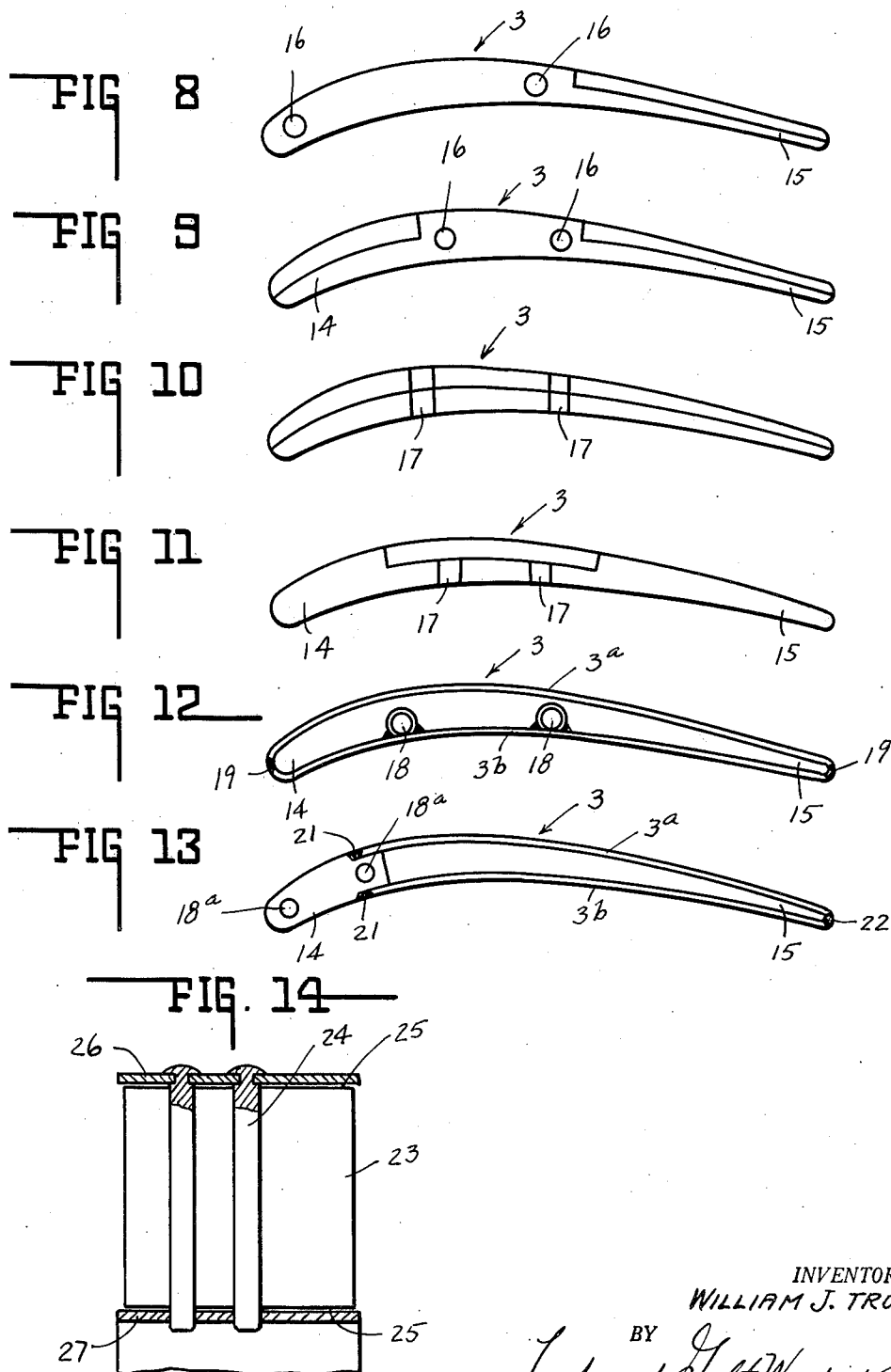
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**MECHANISM FOR CONTROLLING GASEOUS FLOW IN TURBO-MACHINERY**

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1 Claim. (Cl. 253-78)

This invention relates generally to turbo-machinery, and more particularly to mechanisms for controlling gaseous flow in turbo-machinery. By the term "turbo-machinery" as used in this specification and claim, I mean any rotary machinery in which the principle of operation depends upon the directed flow of one or more gaseous substances through one or more channels or passageways of non-rotating elements either from or into passageways or channels of one or more rotating elements of the machinery.

It has long been a matter of common knowledge among those experienced in the art that higher overall efficiency can be obtained by varying the angles of attack on stator and diffuser vanes and the openings in nozzles and nozzle rings in accordance with the loading or the output of the device or other operating conditions.

Various systems of mechanical and thermal control of the pertinent elements of turbo-machinery have been devised. All of these systems, however, depend upon complicated or expensive mechanical devices controlled remotely by manual or temperature-responsive devices or depend upon thermal growth of a portion of the machinery turning an element of fixed shape within its restraining housing.

Although advantages of control devices for turbo-machinery have been a matter of common knowledge for many years, none previously known have been sufficiently satisfactory or simple to warrant their usage on a very significant percentage of the units built, particularly among the smaller high speed units that must be sold at a very economical price. The common practice in the industry has been to use fixed stator vanes, diffuser vanes and nozzles and to so design these elements that a compromise between performance at the design point and performance under other conditions will be reached.

My proposal of utilizing the thermal activity of vanes or blading constructed of two or more metals having different coefficients of linear expansion offers a simple, sensitive, and economical method of controlling performance of turbo-machinery so that maximum efficiencies can be obtained at the design point and high efficiencies maintained throughout the operating range of the machine. This proposal offers a method of control wherein the control mechanism is an integral part of the vane, nozzle or blading and as such, requires only a change in shape of the element itself rather than a twisting or turning of an element of fixed shape as a whole within its restraining housing.

The apparatus for obtaining this control consists generally of vanes, blading, or nozzle enclosures for turbo-machinery wherein one or more portions or sections of the element is fabricated of two or more metallic substances having different coefficients of linear expansion and bonded or otherwise held in intimate contact or wherein the element is fabricated of two or more metallic substances having different coefficients of thermal expansion and welded or otherwise restrained in such a manner as to cause a change in shape in the element with changes in temperature.

I propose to describe in detail certain embodiments of this invention as applied to rotary turbines and compressors. The invention, however, is applicable to other turbo-machinery such as axial or centrifugal fans.

The full nature of the invention will be understood

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from the accompanying drawings and the following description and claim:

FIG. 1 is an end view partially cut away, of a radial in-flow turbine nozzle ring or radial flow compressor diffuser ring.

FIG. 2 is a side view, partially cut away, of the same nozzle or diffuser ring shown in FIG. 1.

FIG. 3 is a side elevation of one of the individual vanes showing the bimetallic construction of one portion of the vane.

FIG. 4 is a side elevation of a similar vane except that it shows bimetallic construction of two portions of the vane.

FIG. 5 is a side elevation of a similar vane showing a bimetallic construction of the entire vane.

FIG. 6 is a sectional view through an assembled nozzle ring looking down upon one of the nozzle vanes and showing a possible method of attachment of a vane.

FIG. 7 is a similar view showing another possible method of attachment of a vane.

FIGS. 8 through 11 are end views of vanes or blades of a type that is used as one of the elements of an axial flow compressor or turbine stator showing various embodiments of the bimetallic vane construction.

FIGS. 12 and 13 are end views of vanes or blades of modified types.

FIG. 14 is a partial sectional view through a stator ring and vane showing a possible method of attachment of vanes shown in FIGS. 8, 9, 12 and 13.

Referring to FIGS. 1, 2, 6 and 7, reference numbers 1 and 2 indicate the housing or walls of a nozzle ring or diffuser ring of the type used in radial flow turbo-machinery. A plurality of vanes or blades, one of which is indicated by reference numeral 3 in FIG. 1 and variations of which are shown in FIGS. 3, 4 and 5 are spaced between the walls 1 and 2. All or portions of the said vanes or blades are of bimetallic construction. The vane or blade illustrated in FIG. 3 has only the leading portion 7 of bimetallic construction. The vane or blade illustrated in FIG. 4 has both the leading portion 7 and trailing portion 8 of bimetallic construction. That illustrated in FIG. 5 is entirely of bimetallic construction.

The projections or locking ears indicated at 5 and 9 in FIGS. 6 and 7 extend from the vanes into apertures provided in at least one wall of the ring and are rigidly attached to at least one of these walls. There is a clearance 12 between the vanes and walls sufficiently large to allow free movement of the bimetallic portion with changes in temperature except at the projections 5 and 9. A slightly increased width 13 of the blade near the projections spaces the housing walls and assures that the clearance 12 is maintained. The bimetallic vane or bimetallic portions thereof are so selected and arranged that the desired changes in area between adjacent vanes and the desired angles of incidence and departure of the gases are obtained by the thermal growth of the vane itself due to changes in temperature of the gaseous media.

FIGS. 8 through 13 illustrate vanes 3 of streamlined design and of the type normally used in the stators of axial flow turbo-machinery. Similarly shaped vanes can also be used, if desired, instead of those pictured in FIGS. 1 through 7, particularly for radial flow turbo-machinery if the design warrants their use. FIG. 8 illustrates a vane having only the trailing edge 15 of bimetallic construction. FIG. 9 illustrates a vane having both leading edge 14 and trailing edge 15 of bimetallic construction. FIG. 10 illustrates a vane entirely of bimetallic construction. FIG. 11 illustrates a vane having its center portion of bimetallic construction.

The non-bimetallic portions of the vanes in FIGS. 8 and 9 may be secured to the housing walls 1 and 2 by

the pins 16. In FIGS. 10 and 11 the vanes may be secured to the housing 1 and 2 by the tabs 17.

FIGS. 12 and 13 illustrate vanes constructed of two or more metals having different coefficients of linear expansion and overlapped and welded or otherwise rigidly fixed with respect to each other in such a manner that a change in temperature will cause a change in the shape of the vane due to the difference in thermal growth of the metals. FIG. 12 illustrates a vane 3 having a leading edge 14 and trailing edge 15 fabricated by joining at their ends as indicated at 19, two such metals, 3a and 3b, previously formed to their desired initial shape. Pins 18 shown welded to one of the metals can be used for attaching the vane or blade to its retaining housing. FIG. 13 illustrates a vane 3 fabricated by joining two such metals 3a, 3b, together at one end 22, and both to a third member 14 at 21, which in this illustration is the larger portion or leading edge of the vane and is used for attaching the vane between its housing walls 1, 2 by the pins 18a.

FIG. 14 illustrates an installation of the vanes or blades and method of attaching them, such as used in the stator of an axial flow turbo-machine. The blade or vane is indicated at 23. The pins 24 are fixed to the blade, and a clearance between blade and housing is indicated at 25. The outer housing wall ring is indicated at 26, and the inner housing wall ring is indicated at 27. The blade may be readily secured between the walls by providing one end of each pin with a shouldered reduced end to extend through apertures in the wall and be peened over, the opposite ends extending freely through the other wall.

The selection and arrangement of different metals in these blades or vanes is dictated by the particular performance desired and the application of the turbo-machine. Some advantages of the mechanism are:

Maintaining high efficiencies over a large speed or load range; obtaining torque curves of a shape desired for the particular installation; preventing excessive speed in the turbo-machine; preventing excessive pressures and temperatures in the turbo-machine and connected equipment; and preventing surge in the desired operating range of turbo-machines.

The operation of the mechanism is entirely automatic.

The materials and construction are so selected that changes in temperature of the gaseous operating media effect a change in the shape of the blades or vanes and consequently a change in the nozzle areas in accordance with the desired performance of the turbo-machine.

While the invention has been disclosed and described in some detail in the drawings and foregoing description, they are to be considered as illustrative and not restrictive in character, as other modifications may readily suggest themselves to persons skilled in this art and within the broad scope of the invention, reference being had to the appended claim.

The invention claimed is:

15 Machinery wherein a gaseous medium is directed through a passageway of a non-rotating element, said mechanism comprising a stator casing having spaced apart turbo-blades mounted therein and forming passageways in said casing, each blade having end portions fabricated from a plurality of metals of different coefficients of linear expansion and rigidly secured to each other in such manner that changes in temperature of the gaseous medium acts to cause a change in the shapes of the end portions due to the difference in thermal growth of the different metals, said end portions being connected by an intermediate portion fabricated from only one of said metals.

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