

Feb. 10, 1970

F. LITTLEFORD
FLUID FLOW MACHINE

3,494,539

Filed March 14, 1968

2 Sheets-Sheet 1

Fig. 1

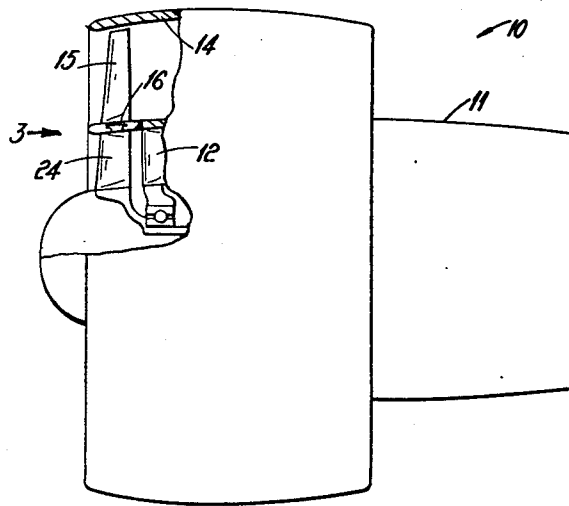
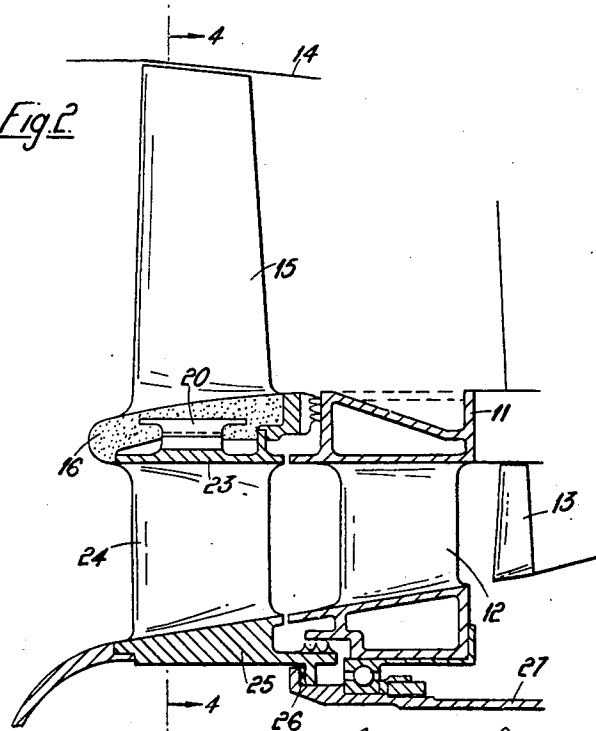


Fig. 2



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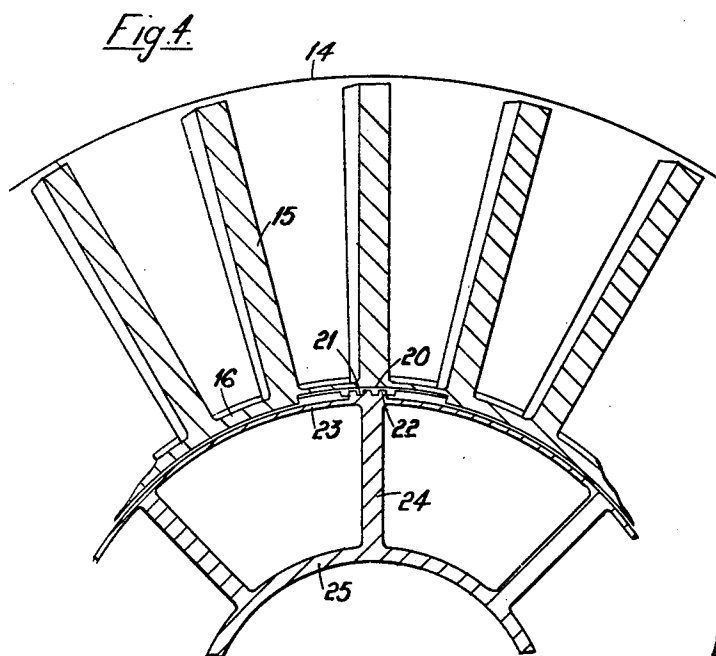
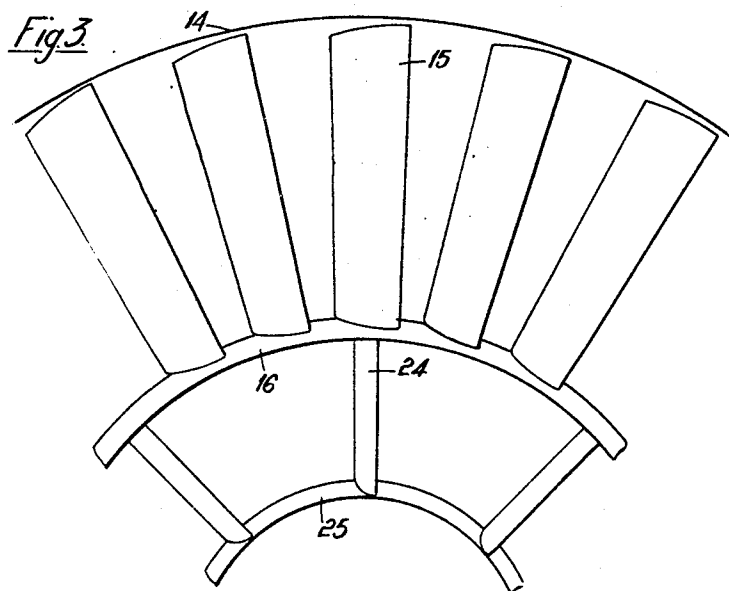
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FLUID FLOW MACHINE

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U.S. Cl. 230—116

10 Claims

ABSTRACT OF THE DISCLOSURE

A fluid flow machine having a plurality of angularly spaced apart rotor blades carried by and extending radially outwardly of a sleeve member, an inner sleeve which is mounted within the sleeve member, the inner sleeve and sleeve member having intermeshing parts to transmit drive therebetween, and a hub member which is mounted concentrically within the inner sleeve and which is connected thereto by a plurality of angularly spaced apart struts, the angular spacing between adjacent struts being substantially greater than that between adjacent blades means being provided to permit limited radial movement between the hub member and the sleeve member.

This invention concerns a fluid flow machine such, for example, as either a compressor or a turbine of a gas turbine engine, or a ducted fan driven thereby. According to one aspect of the present invention, there is provided a fluid flow machine having a plurality of angularly spaced apart rotor blades, an annular sleeve member, the rotor blades being carried by and extending radially outwardly thereof, a hub member mounted concentrically within the sleeve member, a plurality of angularly spaced apart struts which extend radially outwardly of the hub member, means to transmit drive between the struts and the sleeve member and means to permit limited radial movement between the hub member and the sleeve member.

In another aspect of the present invention, there is provided a fluid flow machine having a plurality of angularly spaced apart rotor blades carried by and extending radially outwardly of an annular sleeve member, an inner annular sleeve which is mounted within the sleeve member, the inner sleeve and sleeve member having intermeshing parts to transmit drive therebetween, and a hub member which is mounted concentrically within the inner sleeve and which is connected thereto by a plurality of angularly spaced apart struts, the angular spacing between adjacent struts being substantially greater than that between adjacent blades means being provided to permit limited radial movement between the hub member and the sleeve member.

As will be appreciated, in a fluid flow machine in accordance with the present invention overcrowding of the blades at the hub member is avoided.

Preferably the struts are open to the fluid flow but are so shaped as to have substantially no effect upon the energy imparted to or taken from the fluid flowing through the machine.

The said blades are preferably so shaped as to have a substantially constant effect from their roots to their tips upon the energy which they impart to or take from the fluid flowing through the machine.

Since, as made clear above, overcrowding of the blades at the hub member is avoided, the blades may be so shaped as to have the said substantially constant effect whereby to maximise the efficiency of the machine. Such maximum efficiency could not, however, be achieved if the said overcrowding were allowed to occur.

The angular spacing between adjacent struts is preferably at least twice as great as that between adjacent blades.

A plurality of angularly spaced apart sectors of the inner sleeve and of the sleeve member may be provided with intermeshing teeth.

Except in the said sectors, the inner sleeve and sleeve member may be radially spaced apart to permit said limited radial movement therebetween.

Thus the sleeve member may be formed of fibre-reinforced or other material having angularly spaced apart sector-shaped inserts therein which are provided with the said teeth.

The said blades preferably effect compression of the said fluid. Thus the said blades may be those of a ducted fan mounted about and driven by a gas turbine engine.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:

FIGURE 1 is a diagrammatic view, partly in section, of a gas turbine engine provided with a front ducted fan in accordance with the present invention,

FIGURE 2 is a broken-away sectional view on a larger scale of part of the structure shown in FIGURE 1,

FIGURE 3 is a broken-away front elevation looking in the direction of the arrow 3 of FIGURE 1, and

FIGURE 4 is a broken-away section taken on the line 4—4 of FIGURE 2.

In FIGURE 1 there is shown a power plant for the forward propulsion of an aircraft comprising a gas turbine engine 10 having an engine casing 11 within which there are mounted in flow series, inlet guide vanes 12, one or more compressors 13 (FIGURE 2), combustion equipment (not shown) and one or more turbines (not shown).

Mounted concentrically about the front portion of the engine casing 11 is a fan casing 14 within which are mounted a plurality of angularly spaced apart rotor blades 15 of a ducted front fan. The rotor blades 15 which may, if desired, be formed of an epoxy or other synthetic resin, are carried by and extend radially outwardly of a sleeve member 16.

The sleeve member 16 is formed of compacted fibre-reinforced material. Thus, the fibres may be carboniferous, boron, or glass fibres coated with an epoxy or other synthetic resin or, alternatively, coated with a metal or alloy, e.g. with a nickel-chromium alloy.

The sleeve member 16 has a plurality (e.g. three or four) of angularly spaced apart sector-shaped inserts 20 embedded therein. The inserts 20 are provided with teeth 21 (FIGURE 4) which mesh with teeth 22, the teeth 22 being provided at a plurality of correspondingly angularly spaced apart sectors of an inner sleeve 23 which is mounted within the sleeve member 16. Except in the said sectors, the inner sleeve 23 and the sleeve member 16 are radially spaced apart so as to permit limited radial movement therebetween.

The inner sleeve 23 is connected to the radially outer ends of a plurality of angularly spaced apart aluminum or other struts 24 which extend radially outwardly from a hub member 25, the latter being mounted concentrically within the sleeve member 16 and inner sleeve 23. As will be seen from FIGURES 3 and 4, the angular spacing between adjacent struts 24 is very much greater than that between adjacent blades 15 and may, as shown, be more than twice as great. The effect of this is that the overcrowding of the blades 15 at the hub 25 which could otherwise occur, if the blades extended to the latter, is avoided. Moreover, this enables the blades 15 to be shaped as shown in FIGURES 3 and 4 so that, from their roots to their tips, they effect substantially constant work on the air passing through the ducted fan and compressed thereby.

Such constant work blades are desirable to maximise the efficiency of the ducted fan.

If, however, in contrast to this, overcrowding of the blades at the hub member were permitted, then although constant work blades could be provided, the work produced thereby would be very small because it could not be greater than the maximum amount of work produced at the root of the blade and the latter amount is limited by the speed of the blade, which is at a minimum at the root. In the case of the present invention, however, the blade roots are at some distance from the hub and therefore move with greater velocity.

The struts 24, on the other hand, although open to the air passing through the gas turbine engine, are so shaped as to do substantially no work on this air.

As shown in FIGURE 2, the hub member 25 may be driven by way of a coupling 26 (e.g. that sold under the registered trademark "Curvic") from a shaft 27 which is driven by the turbine (not shown) of the engine. This drive is transmitted to the rotor blades 15 by way of the struts 24 and the teeth 21, 22 limited radial movement thus being possible between the hub member 25 and the sleeve member 16. This limited radial movement will compensate for some differential thermal expansion.

We claim:

1. A fluid flow machine having a plurality of angularly spaced apart rotor blades, an annular outer sleeve member, said rotor blades being carried by and extending radially outwardly from said outer sleeve, an inner annular sleeve member which is mounted within said outer sleeve member, said inner sleeve and said outer sleeve members having intermeshing parts along at least portions of their respective outer and inner surfaces to transmit drive therebetween, a hub member which is mounted concentrically within said inner sleeve, a plurality of angularly spaced apart struts which connect said hub member to said inner sleeve, the angular spacing between adjacent ones of said struts being substantially greater than the spacing between adjacent ones of said blades and means provided to permit limited radial movement between said hub member and said sleeve member.

2. A fluid flow machine as claimed in claim 1 in which the struts are exposed to the fluid flowing through the machine but are shaped to have substantially zero effect upon the energy exchanged with the fluid.

3. A fluid flow machine as claimed in claim 1 in which the said blades are shaped to have a substantially constant effect from their roots to their tips upon the energy which they exchange with the fluid flowing through the machine.

4. A fluid flow machine as claimed in claim 1 in which

the angular spacing between adjacent ones of said struts is at least twice as great as that between adjacent ones of said blades.

5. A fluid flow machine as claimed in claim 1 in which the inner sleeve and the outer sleeve member each have a plurality of angularly spaced apart sectors on the respective outer and inner surfaces thereof upon which are mounted said intermeshing teeth.

6. A fluid flow machine as claimed in claim 5 in which, except for the intermeshing of said teeth on said sectors, the inner sleeve and the outer sleeve member are radially spaced apart to permit limited radial movement therebetween.

7. A fluid flow machine as claimed in claim 6 in which the outer sleeve member is formed of fibre-reinforced material having angularly spaced apart sector-shaped inserts therein which are provided with the said teeth.

8. A fluid flow machine as claimed in claim 1 in which the said blades comprise means to effect compression of the said fluid.

9. A fluid flow machine as claimed in claim 8 in which the said blades are those of a ducted fan, and having in addition a gas turbine engine mounted within the fan and driving said fan.

10. A fluid flow machine having a plurality of angularly spaced apart rotor blades, an annular sleeve member, said rotor blades being carried by and extending radially outwardly from said annular sleeve member, a hub member mounted concentrically within said annular sleeve member, a plurality of angularly spaced apart struts which extend radially outwardly from said hub member, means for transmitting rotational energy between said struts and said annular sleeve member and means to permit limited radial movement between said hub member and said sleeve member.

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U.S. Cl. X.R.

415—135; 416—244, 220