

- [54] **CENTRIFUGAL PUMPS FOR PUMPING LIQUIDS**
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- [73] Assignee: **Lucas Aerospace Limited**, Birmingham, England
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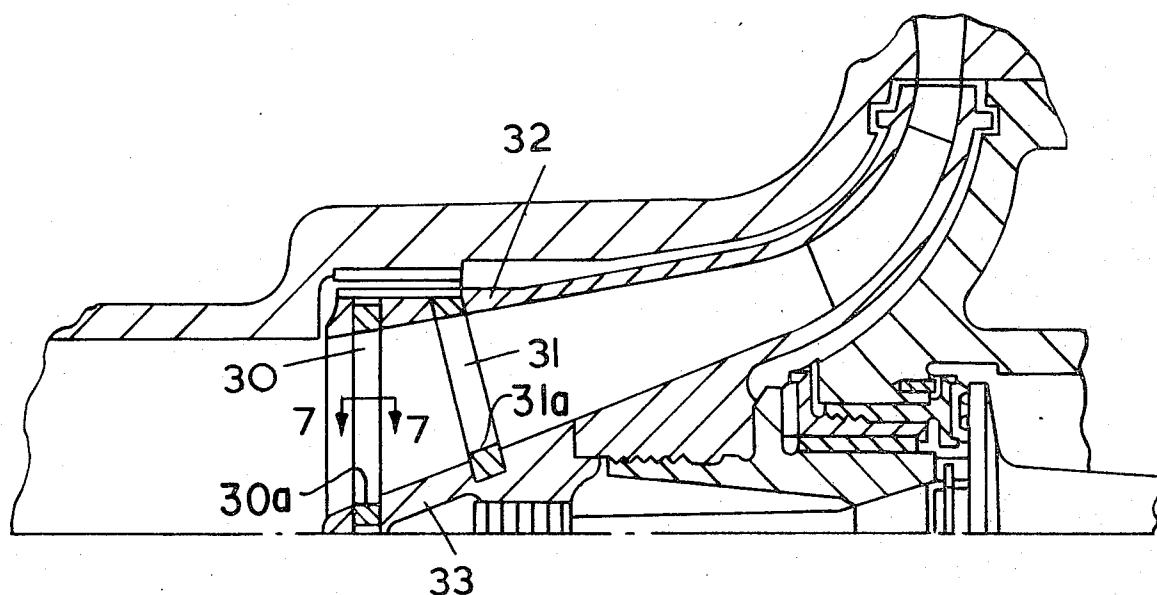
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- [52] U.S. Cl. .... **415/143, 416/183, 259/4, 261/84, 415/215**
- [51] Int. Cl. .... **F04d 3/02, F04d 7/00**
- [58] Field of Search ..... 416/181, 200, 183, 201; 415/DIG. 1, 53, 215; 259/4; 261/84, 28

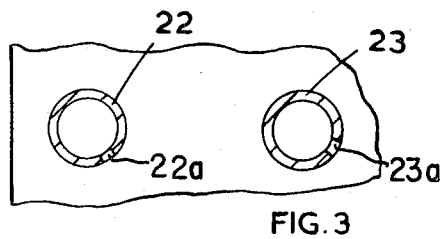
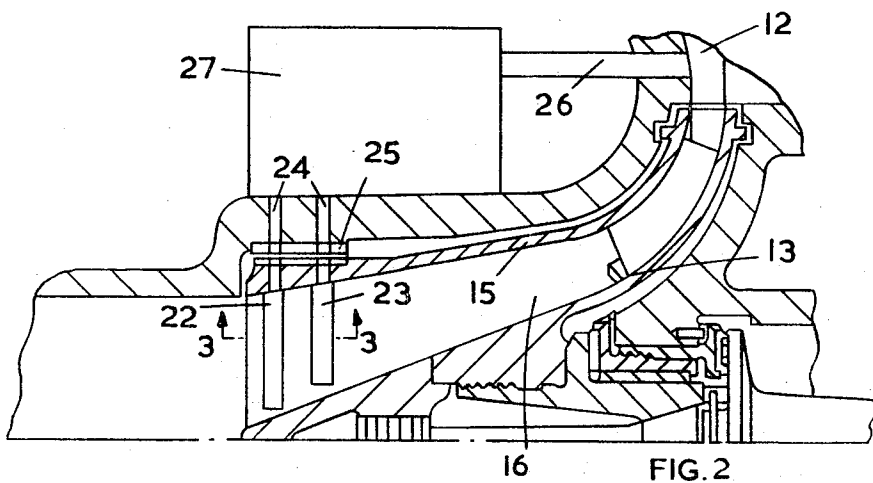
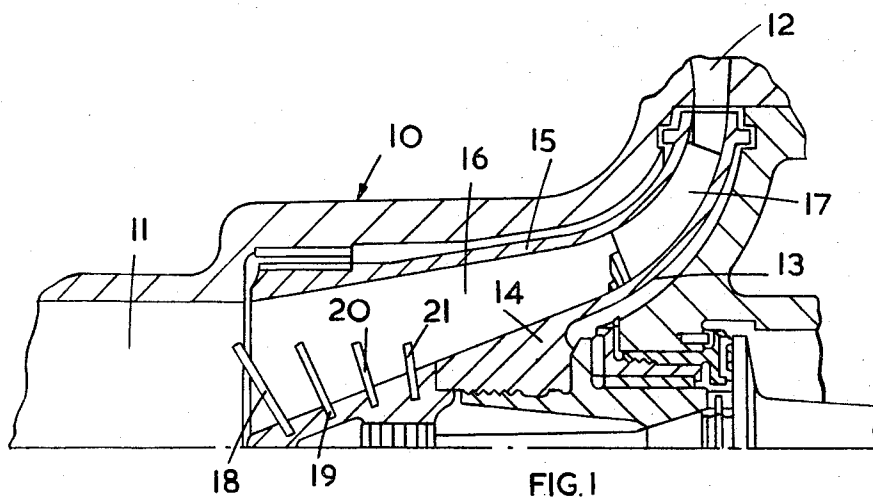
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[57] **ABSTRACT**

A centrifugal pump is provided with a body, a rotor in the body having a center body, a shroud and vanes connecting the center body to the shroud. On the center body or the shroud (or both) there are a plurality of rows of fingers which serve to impart rotation to liquid entering the passage between the center body and shroud.

**5 Claims, 7 Drawing Figures**





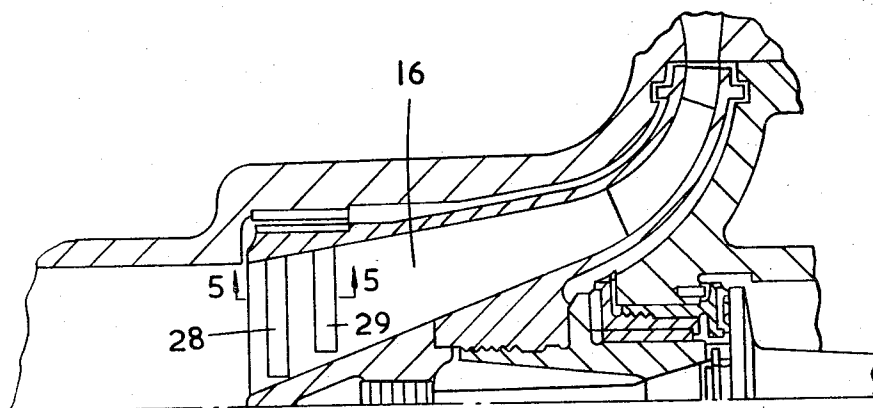


FIG. 4

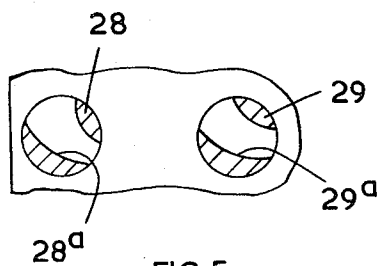
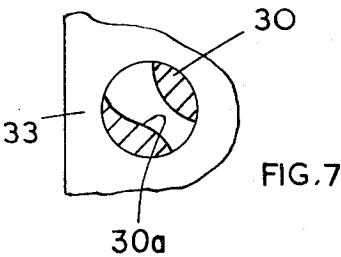
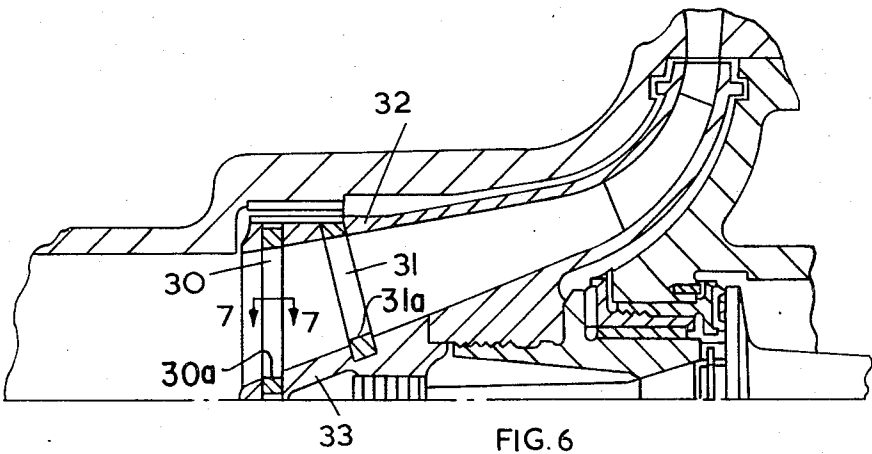


FIG. 5



# CENTRIFUGAL PUMPS FOR PUMPING LIQUIDS

## BACKGROUND OF THE INVENTION

This invention relates to centrifugal pumps for use in pumping liquids and is of particular utility in the pumping of liquids at temperatures near their boiling points.

## SUMMARY OF THE INVENTION

A centrifugal pump in accordance with the invention includes a body defining a pump inlet chamber, a rotor mounted within the body and including a center body tapering towards said chamber, a shroud surrounding the center body and defining therewith a passage of annular section, the internal and external diameters of which increase in one axial direction, vanes interconnecting the shroud and the center body at one end of said passage, namely that end thereof at which said diameters are greater, and a plurality of fingers mounted on the shroud and/or the center body adjacent the opposite end of said passage, with said fingers projecting across the passage and being arranged in a plurality of annular rows.

In the accompanying drawings:

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a section through one example of a pump in accordance with the invention;

FIG. 2 is a section through another example of the invention;

FIG. 3 is an enlarged fragmentary section on line 3—3 in FIG. 2;

FIG. 4 is a section through yet another example of the invention;

FIG. 5 is an enlarged fragmentary section on line 5—5 in FIG. 4;

FIG. 6 is a section through yet a further example of the invention; and

FIG. 7 is an enlarged fragmentary section on line 7—7 in FIG. 6.

## DETAILED DESCRIPTION OF THE EMBODIMENTS

Referring firstly to FIG. 1, the pump includes a body 10 which defines a pump inlet chamber 11 and an outlet 12. Rotatably mounted in the body is a rotor 13 which includes a center body 14 and a shroud 15. As will be apparent from the drawing, the center body 14 and the shroud 15 define therebetween an annular-section passage 16, the internal and external diameters of which both increase in one axial direction.

At that axial end of the rotor at which the internal and external diameters of the annular passage are maximum, i.e. at the end adjacent the outlet 12 in the body, the center body and the shroud are interconnected by a plurality of vanes 17, and at the opposite end of the rotor, i.e., adjacent the inlet chamber 11, a plurality of fingers 18, 19, 20, and 21 are mounted on the center body.

As will be apparent from the drawings, the fingers 18, which may consist simply of lengths of circular section wire inserted into sockets in the center body, are arranged in annular rows with the lengths of the fingers decreasing step by step along the passage in the direction towards the outlet 12. In addition, the fingers 18 are inclined to the axis of the rotor, with the fingers 18

in the row adjacent the inlet 11 being the least steeply inclined and the inclination increasing step by step along the passage towards the outlet 12.

Each of the fingers 18 creates a wake at a lower pressure. Vapor tends to occur less in the lower pressure wake and is then reabsorbed in the liquid. The fingers assist in initiating swirling movement of the liquid before it reaches the vanes 17 and also, provided there is already some movement of the liquid along the passage, help to induce such movement. Acceleration of liquid along the passage is therefore accomplished with less shock and therefore less vapor generation than can be achieved with a conventional screw type inducer which is only correctly pitched for a single flow rate/rotary speed condition.

In the example shown in FIG. 2 the rotor 13 is provided with inwardly protecting fingers 22 and 23 on the shroud 15. As shown in FIG. 3, these fingers are hollow and each is formed with a plurality of nozzles 22a, 23a through which liquid supplied to the interior of each finger issues into the passage 16. These nozzles 22a, 23a have their axes inclined to a plane including the axes of all the fingers of a row of the fingers. Moreover, the inclination of the axes of the nozzles 23a of the finger 23 is steeper than the inclination of the axes of the nozzles 22a in the finger 22.

Liquid under pressure is supplied to the interiors of the fingers 22, 23 via passages in the shroud communicating with grooves 24 in an hydrostatic bearing 25 which assists in supporting the rotor within the body 10. A tapping 26 is provided in the outlet 12 of the pump and a suitable control valve arrangement 27 is provided for controlling flow of the liquid from the outlet 12 to the fingers 22, 23 in accordance with the prevailing flow conditions.

It will be appreciated that, because of the inclination of the axes of the nozzles 22a, 23a in the fingers 22, 23, axial flow of liquid along the passage 16 is induced.

In the example shown in FIGS. 4 and 5, fingers 28, 29 which are again provided on the shroud are each formed with a diametral longitudinally extending slot 28a 29a and each such slot has its general plane inclined to the plane of the axes of the fingers in a row of the fingers. Moreover, the cross sectional shape of each slot is convergent so that liquid passing through the slot is accelerated. The inclination of the slots 29a is steeper than the inclination of the slots 28a so that, once again, flow along the passage 16 is again induced by the fingers 28, 29. It will be appreciated, however, that the shock produced by the fingers 28, 29 will be less than that produced by a conventional screw inducer, even though the angle of inclination of the slots may not exactly match the angle at which the liquid flows through the passage for all flow conditions.

Finally, the example shown in the FIGS. 6 and 7 is similar to that described with reference to FIGS. 4 and 5. However fingers 30, 31 are anchored at both ends in holes in the shroud 32 and the center body 33. The fingers 30 extend radially while the fingers 31 are inclined to the axis of the rotor. Each of the fingers 30, 31 is of circular cross-section externally so that it fits within simple bores in the shroud 32 and center body 33.

Each finger 30, 31 has a slot 30a, 31a which has a cross-sectional configuration as shown in FIG. 7 which converges from the leading portion of the finger to a throat and then diverges from the throat to the trailing portion of the finger.

I claim:

1. A centrifugal pump for use in pumping liquids comprising a body defining a pump inlet chamber, a rotor mounted within the body and including a center body member tapering towards said chamber, a shroud member surrounding the center body member and defining therewith a passage of annular section, the internal and external diameters of which increase in one axial direction, vanes interconnecting the shroud member and the center body member at one end of said passage, namely that end thereof at which said diameters are greater, and a plurality of fingers mounted on at least one of said members, adjacent the opposite end of said passage, said fingers projecting across the passage and being arranged in a plurality of annular rows, said fingers being cylindrical and provided with converging

slots of inclined to the axis of the center body member, whereby fingers generate axial flow through slots causing an emulsion of fuel and vapor to form.

2. The pump as claimed in claim 1 in which the slot of each finger has its general plane inclined to the plane of the row in which the finger is disposed.

3. The pump as claimed in claim 2 in which the inclinations of the planes of said slots increases from row to row along the passage towards said one end thereof.

4. The pump as claimed in claim 2 in which each said slot converges to a throat and then diverges.

5. The pump as claimed in claim 1, in which the fingers are mounted on the shroud member and center body member.

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