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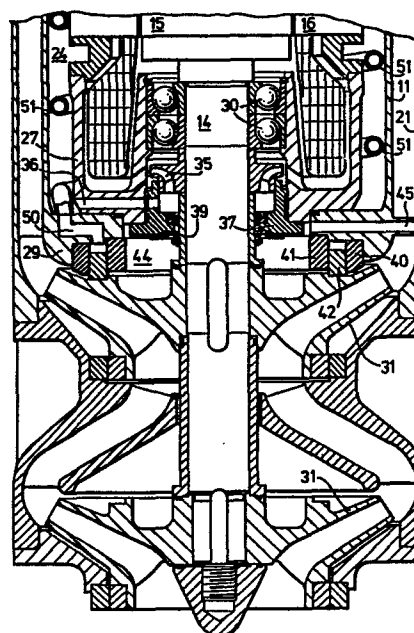
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54 **Submersible pump head cooling means.**

57 A pump head (4) has a casing (10, 20) containing an electric motor (15, 16) driving impeller means (31) for moving liquid upwardly of a pipe stack by which the pump head is suspended in the liquid. Cooling of the motor is improved by causing pumped liquid leaking between sealing rings (40 - 42) to flow through a helical tube (51) within the casing (10) and stator (16).



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-1-

SUBMERSIBLE PUMP HEAD COOLING MEANS
DESCRIPTION

The invention relates to the cooling of the motors of electrically driven submersible pump heads.

5 Pump systems such as are used for example on off-shore installations, or within the cargo tanks of ships used for carrying oil and bulk chemicals, may comprise a pump head, the pump head having a pumping section including an impeller and a motor chamber containing an
10 electric motor for driving the impeller, and a pipe stack arranged to be suspended from a support with the pump head carried at its lower end, the pipe stack having a discharge duct for the pumped fluid and electric supply conductors for supplying power to the
15 electric motor.

The electric motor in the pump head necessarily generates considerable waste heat and must be cooled if it is to have a reasonably long operational life. Some
cooling can be effected by directing the flow of the
20 liquid being pumped over the exterior of the casing containing the motor and/or by the circulation of a dielectric liquid through the casing, as taught by European Patent Publication 0 063 444.

The present invention however provides a pump head
25 for submersion in a fluid to be pumped, the pump head having impeller means for moving the fluid, a motor casing containing an electric motor for driving the

-2-

impeller means, and means for causing flow of the fluid within the motor casing so as to cool the motor.

By directing pumped fluid actually within the interior of the motor casing, it is possible to
5 establish a heat exchange relationship with the motor which is far more efficient than can be obtained by directing the fluid over the casing exterior. Preferably the pumped fluid is made to flow in one or more helical coils extending around the motor, between
10 it and the casing wall. The pumped fluid directed through the motor casing may conveniently represent only a very small proportion of total fluid moved by the impeller means. It can be discharged to the pump head exterior after flow through its path within the casing.

15 Although separate impeller means can be provided, the cooling fluid is preferably moved through the motor casing under the pressure generated by the pump head impeller means. As a consequence, the cooling flow will tend to increase with any restriction of the pump
20 head output, due for example to closure of an output valve to reduce the fluid flow at the discharge station to which the pump head moves the fluid. Such output flow reduction increases heat generation in the pump head, so the cooling arrangement of the present
25 invention provides an automatic increase in cooling in compensation. In some instances, the pump head may even be allowed to continue to operate through complete closure of the output valve without serious overheating.

30 Conveniently the pumped fluid directed through the casing is derived from leakage through the wear rings conventionally fitted between the rotating impeller means and the adjacent end of the casing, which normally amounts to some 3 to 5% of the total flow.

35 The casing interior may be filled with a dielectric liquid which may be circulated for cooling purposes through a circuit including the casing, passages

extending along the pipe stack by which pumped fluid is conveyed upwardly to a discharge station, and pump and a heat exchanger located at the discharge station, as taught by European Patent Publication 0 063 444.

5 However, with the cooling that can be achieved in accordance with the present invention, it will suffice in many instances merely to circulate the dielectric liquid within the casing.

10 The invention will be more readily understood from the following illustrative description and from the accompanying drawings, in which:

Figure 1 is a simplified schematic side view of a pump system with an electrically powered submersible pump head in accordance with the invention; and

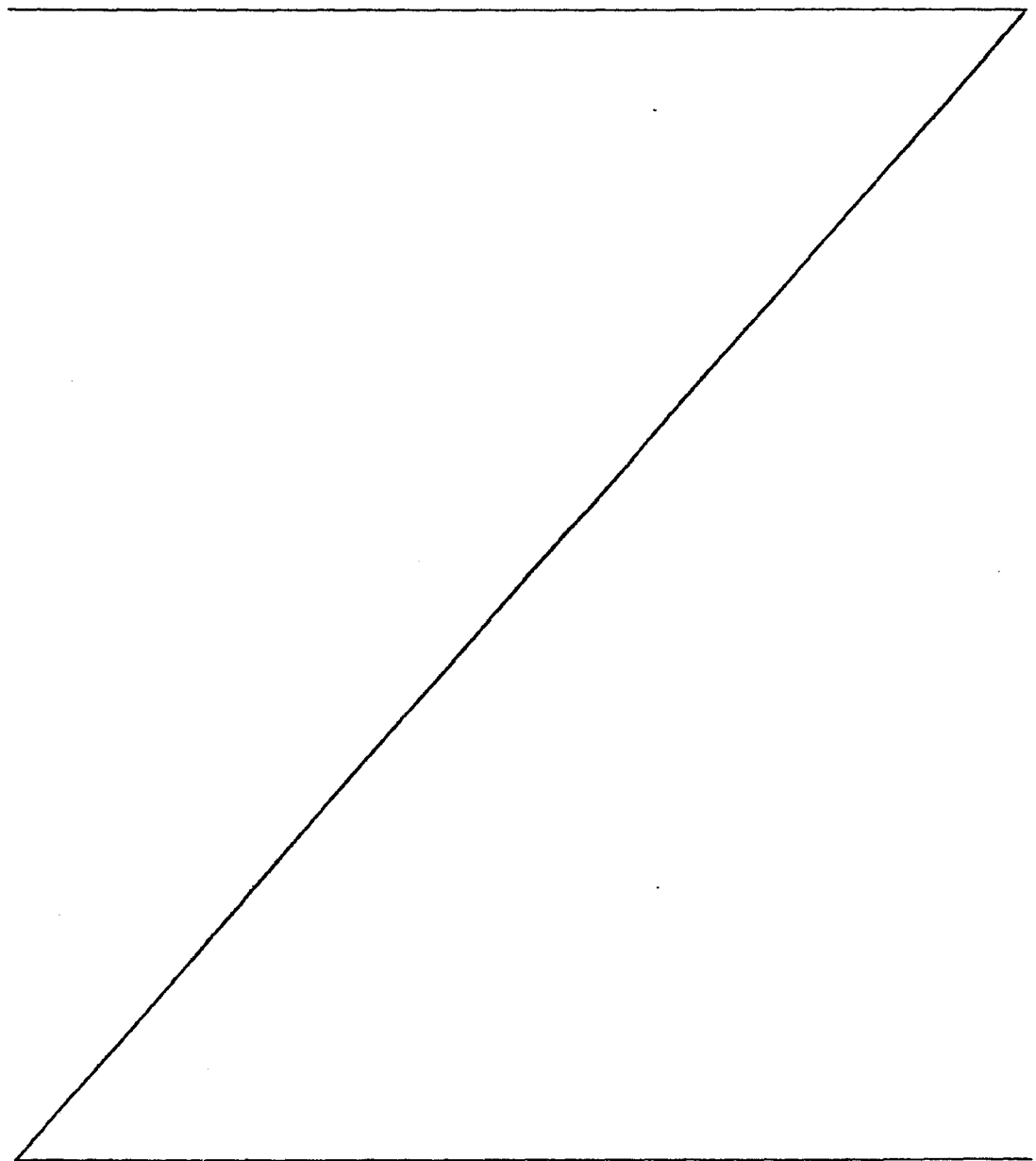
15 Figures 2A and 2B are respectively sectional side views on a much larger scale of upper and lower portions only of the pump head of Figure 1.

Referring now to the accompanying drawings, Figure 1 illustrates a pump system comprising a pipe stack 1
20 suspended from a support 2 with the pump head 4 at the lower end of the pipe stack immersed in a liquid to be pumped by impeller means of the pump head for discharge through an outlet valve (not shown) located at a discharge station at the support. The pipe stack 1
25 comprises concentric inner and outer pipes 5 and 6 and the interior of the inner pipe 5 receives electrical conductors extending from the support 2 to an electric motor in the pumped head 4 arranged to drive the impeller means. The annular space between the inner and
30 outer pipes 5 and 6 is a discharge duct carrying the liquid being pumped upwardly to the discharge station.

The pump head 4 as shown in Figures 2A and 2B comprises an inner casing 10 having a cylindrical side
35 wall 11 and an upper end fitting 12 by which the casing is connected to the pipe stack inner pipe 5. The casing

-4-

10 is received within an outer casing 20 similarly having a cylindrical side wall 21, which is concentric with the side wall 11, and an end fitting 22 connected to the outer pipe 6. The annular space between the casings 10,20 receives the liquid being pumped and communicates with the discharge duct of the pipe stack. The interior of the inner casing 10 contains an electric motor having a central drive shaft 14 carrying a rotor 15 surrounded by an annular stator 16.



-5-

At its upper end, the inner casing 10 contains a support member 17 comprising concentric sleeve portions joined by an upper annular web. The upper end of the motor drive shaft 14, is journaled at the lower end of the inner sleeve, and the outer surface of the outer sleeve forms with that of the stator 16 a cylindrical surface spaced from the wall 11, to define an annular chamber 24. The electrical conductors received within the inner pipe 5 of the pipe stack are connected to the stator 16 by means of connector bar assemblies 25 extending through insulating bushes 26 received in apertures in the annular web of the support member 17.

At the lower end of the casing 10, a lower support member 27 also comprises inner and outer concentric sleeves joined at their lower ends by an annular web which is seated on and sealed to an internally extending end flange portion 29 of the casing wall 11. The inner sleeve of the member 27 mounts the inner races of two axially spaced ball bearings 30 for supporting the drive shaft and rotor assembly and the outer sleeve exterior defines the annular space 24.

The drive shaft 14 extends downwardly through the flange portion 29 to mount an impeller assembly comprising impeller units 31 for moving the liquid to be pumped.

The interior of the end fitting 12 of the motor casing 10 communicates with the inner pipe 5 by which the casing is filled with a dielectric or insulating liquid which assists in dissipation of the heat generated by the motor and which acts as a lubricant for the drive shaft bearings. The dielectric liquid is supplied to the pipe 5 from a header tank 7 located on the support 2 at a level to maintain the dielectric liquid in the casing under static pressure sufficient to oppose leakage of the liquid being pumped into the casing.

Circulation of the dielectric liquid within the

motor casing 10 is effected by a subsidiary impeller unit 35 carried on the drive shaft 14 immediately below the bearings 30. The dielectric liquid is drawn by these impeller means from the annular chamber 24 through one or more radially directed passages 36 in the flange portion 29 and expelled upwardly into the bearings 30 and laterally into the space between the sleeves of the lower support member 27. Moving upwardly through the gap between the rotor 15 and stator 16, the liquid reaches the interior of the fitting 12 through one or more passages in the web portion of the support member 17. The circulating dielectric liquid then re-enters the chamber 24 through one or more passages formed at the outer edge of the web portion of the support member 17.

Beneath the subsidiary impeller unit 35, a seal holder 37 is secured to the support member 27 to define with the shaft 14 an annular inlet chamber for impeller unit. The seal holder carries sealing elements 39 which engage the shaft to seal the lower end of the inner casing 10.

The lower end flange portion 29 of the inner casing wall 11 mounts at its underside two spaced concentric wear rings 40,41 between which is received an upwardly projecting wear ring 42 secured to the impeller assembly 34, the free end of which is spaced from the flange portion.

Pumped liquid leaking inwardly through between the engaging faces of the wear rings 40,41 and 42 is received in an annular chamber 44 bounded above by the seal holder 37 and communicating with the exterior of the pump head through a radial passage 45 in the flange portion 29, so as to be at the pressure of the ambient liquid. Because the seal to the shaft 14 at the seal holder 37 is between this chamber 44 and the inlet chamber of the impeller unit 35, relatively low duty and therefore

-7-

inexpensive sealing elements 39 can be employed.

Heat generated by the electric motor will reach the casing 10 by conduction and will be removed to some extent by the heat transfer to the pumped liquid flowing over the casing exterior. The pump head however
5 incorporates additional means whereby heat can be removed from the motor by means of the pumped liquid.

Thus, the flange portion 29 includes a passage 50 opening into the space above the impeller wear ring 42 and between the fixed bearing rings 40 and 41. At its
10 upper end, this passage communicates with a tube 51 formed into a helical coil in the chamber 24, between the stator 16 and the fittings 17 and 27 on the one hand and the inner casing wall 11 on the other. At its
15 upper end, the coiled tube 51 communicates with an outlet tube 52 which extends through the upper end of the inner casing wall 11, across the space between the inner and outer casings and through the outer casing wall so as to open externally of the pump head. Some 3 to
20 5% of the liquid pumped by the impeller units 31 escape inwardly through the wear rings 40, 41, and 42, and of this amount a considerable part flows through the passage 50, the coiled tube 51 and the outlet tube 52. The tube 51 surrounds the motor and is in good heat
25 exchange relationship with the stator 16, enhanced by the dielectric liquid in the chamber 24. Heat removal from the motor is consequently very much increased, compared with heat removal through the inner casing wall 11 only. The operational life of the pump head is thus
30 extended, as are its operational capabilities, because flow through the tube 51 will increase as a consequence

of a build up of pressure in the discharge duct, so that the output flow at the discharge station can be restricted, even though the pump head motor continues to be energised, with a much reduced risk of overheating
5 compared with pump heads having conventional cooling systems.

The invention can be embodied in a variety of ways other than as specifically described and illustrated.

CLAIMS

1. A pump head for submersion in a fluid to be pumped, the pump head comprising impeller means for moving the fluid, a motor casing containing an electric motor for driving the impeller means, and means for causing flow of the fluid within the interior of the motor casing to cool the motor.

2. A pump head as claimed in claim 1 wherein the fluid flow within the casing is driven by the impeller means.

3. A pump head as claimed in claim 2 wherein the impeller means is located beneath the motor casing and the cooling fluid flow path extends upwardly within the casing to an outlet to the pump head exterior.

4. A pump head as claimed in claim 1, 2 or 3 having sealing means between the impeller means and the casing and wherein the cooling fluid flow is derived from leakage through the sealing means.

5. A pump head as claimed in claim 3 or 4 wherein the sealing means comprises a first pair of engaging seal faces between the impeller means fluid outlet and a second pair of engaging seal faces, the cooling fluid flow has a flow path of which the inlet is located between the first and second pairs of seal faces and an outlet to the pump head exterior, and a leakage path to the pump exterior has an outlet located inwardly of the second pair of seal faces.

6. A pump head as claimed in claim 5 wherein the sealing means comprises inner and outer wear rings on one of the casing and the impeller means and an intermediate wear ring on the other of the casing and the impeller means and received between the inner and outer rings, the cooling fluid flow having a flow path of which the inlet is located above the intermediate wear ring.

7. A pump head as claimed in claim 6 wherein a chamber within the inner wear ring communicates with

the pump head exterior.

8. A pump head as claimed in claim 7 wherein the motor is arranged to drive secondary impeller means in the casing for circulation of dielectric liquid
5 therein, the secondary impeller means having an inlet separated from the chamber by secondary sealing means between the casing and the motor.

9. A pump head as claimed in any preceding claim wherein the electric motor comprises an annular stator
10 portion located around a rotor assembly extending outwardly of the casing to drive the impeller means, the cooling fluid flow being guided between the stator and the casing.

10. A pump head as claimed in any preceding claim
15 wherein the cooling fluid flow is guided in a helical path within the casing and around the electric motor.

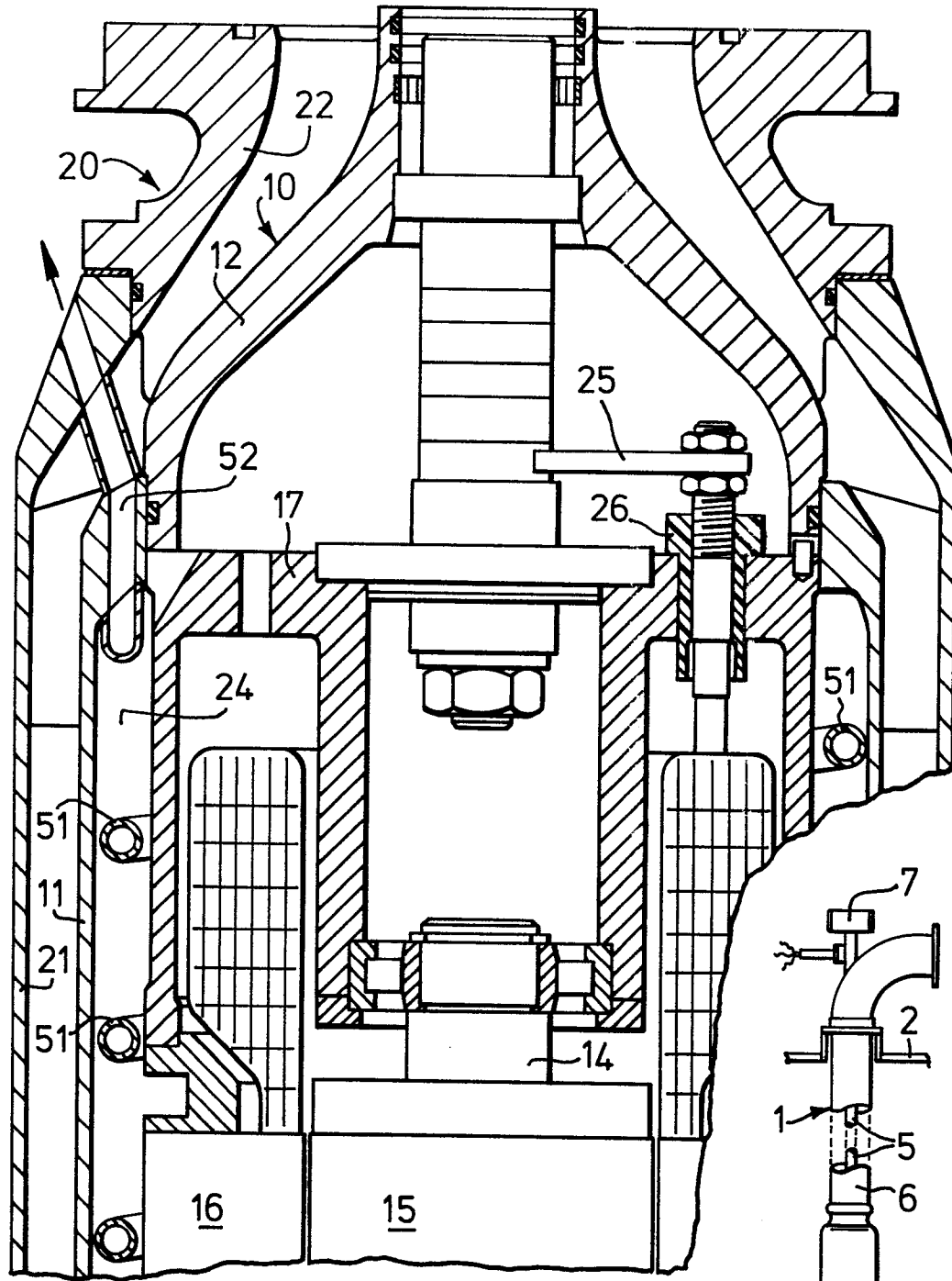


FIG.2A.

FIG.1.

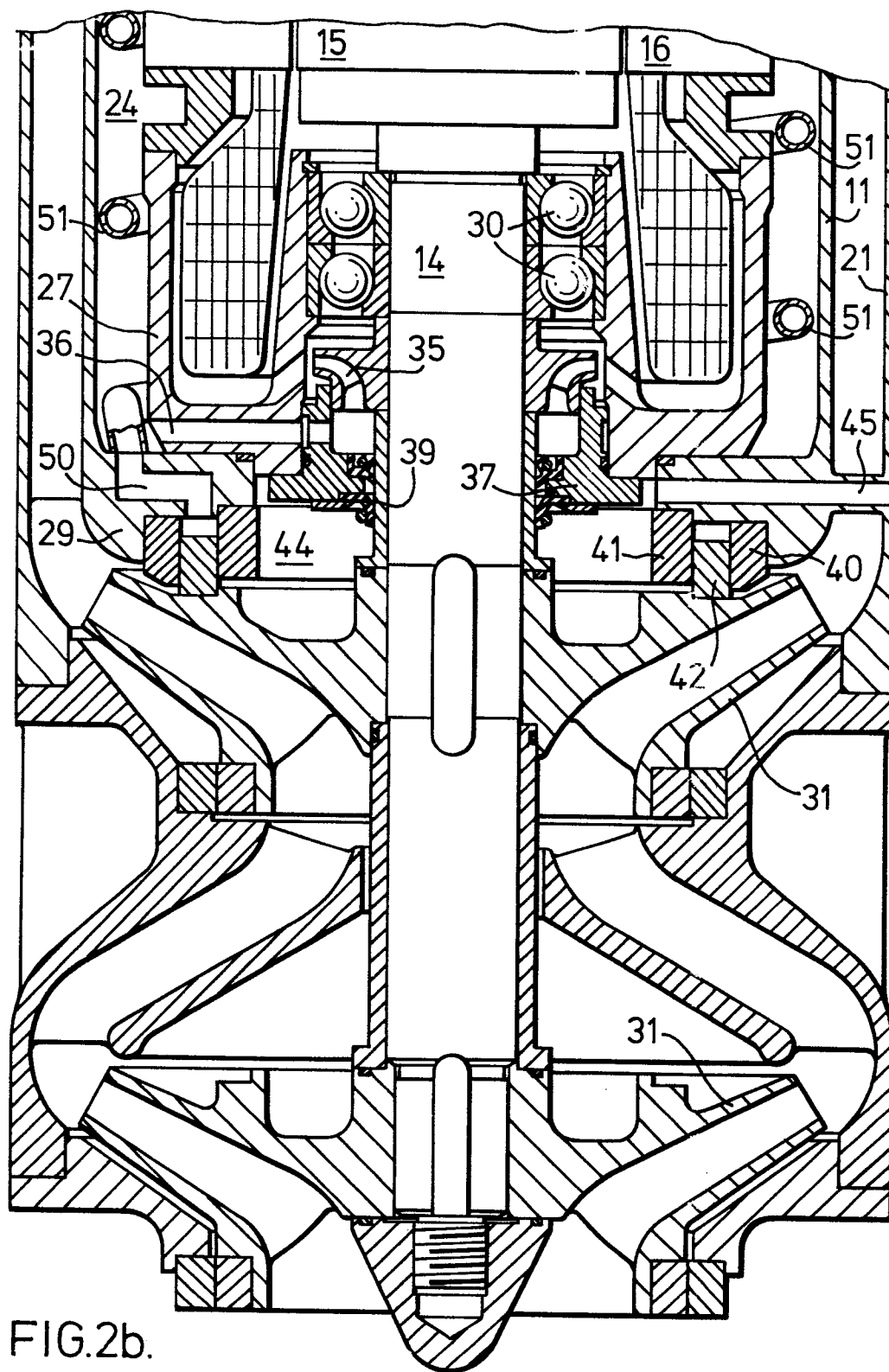


FIG. 2b.



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EUROPEAN SEARCH REPORT

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Application number

EP 85 30 6638

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	US-A-2 887 062 (CAMETTI) * Column 4, line 49 - column 5, line 14; figures 1,1A; column 7, line 21 - column 8, line 7; column 10; line 69 - column 11, line 36; figures 4,4A *	1,2,4,9,10	F 04 D 29/58 F 04 D 13/10
Y		8	
A		3	
X	--- DE-A-2 903 064 (STÄHLE) * Page 4, last paragraph; page 5, paragraph 1; page 6, last paragraph; page 7, first and last paragraph; page 8, first paragraph, figures 1,5 *	1-4,9	
A	--- CH-A- 485 123 (BORG WARNER) * Column 14, line 49 - column 15, line 19; figures 2-4,9; column 15, line 34 - column 16, line 12; column 18, line 6 - column 19, line 62 *	1,3,9,10	F 04 D
Y	--- -/-	8	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 30-12-1985	Examiner KAPOULAS T.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			



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EUROPEAN SEARCH REPORT

0178087

Application number

EP 85 30 6638

Page 2

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	US-A-3 644 067 (YOWELL) * Column 1, line 35 - column 2, line 18; figures *	1, 2, 4, 7	
A	DE-A-1 808 305 (GUSS- UND STAHL-VEREDLUNG)		
A	DE-A-2 507 846 (DEUTSCHE ITT INDUSTRIES)		
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
Place of search THE HAGUE		Date of completion of the search 30-12-1985	Examiner KAPOULAS T.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			