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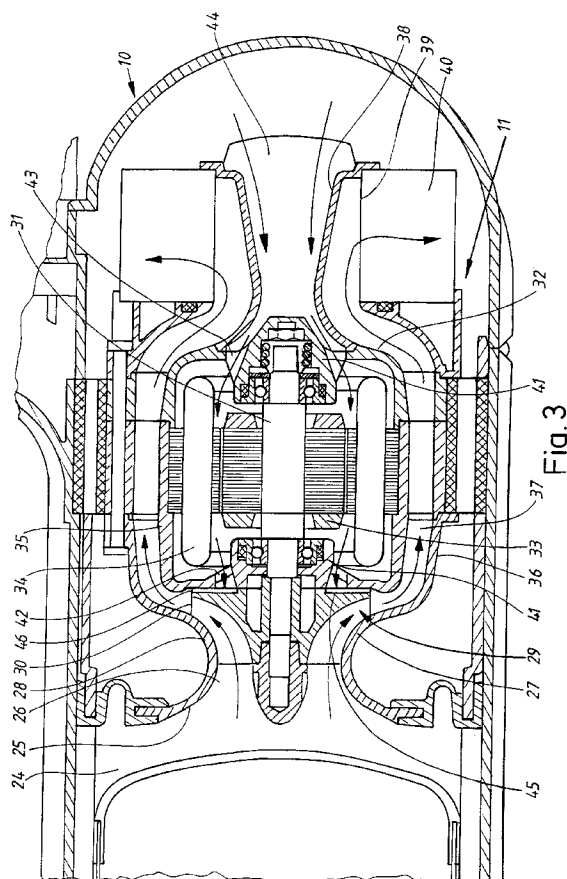
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(54) **Device for a vacuum cleaner.**

(57) This invention relates to a device for a vacuum cleaner having a suction nozzle and a dust bag (12) which is connected to the nozzle for instance by means of a tube connection, a turbo fan unit (27) driven by an electric motor and placed after the dust bag seen in the flow direction. The impeller (29) of the turbo fan unit is driven at a speed which is above 50.000 rpm the primary air flow created by the turbo fan unit (27) being arranged to directly or indirectly leave the unit via an outlet (30) to atmosphere. The vacuum cleaner is provided with means (45) by means of which a secondary air flow is created which at least partly cools the electric motor (32) and which flows into the electric motor via one or several inlets (44) for cooling air which are separated from the primary air flow.



This invention relates to a device for a vacuum cleaner having a suction nozzle and a dust bag which is connected to the nozzle for instance by means of a tube connection, a turbo fan unit driven by an electric motor and placed after the dust bag seen in the air flow direction, the impeller of the fan being driven at a speed which is above 50.000 rpm, the primary air flow created by the unit being arranged to leave the unit via an outlet to atmosphere.

Vacuum cleaners of the abovementioned type are described in WO 94/15518 and 94/15519 resp. and mainly have the advantage that they because of the small dimensions of the vacuum source can be manufactured as small hand held appliances which are easy to handle and store at the same time as the suction power is on the same level as previously known traditional vacuum cleaners i.e. such having a power demand of 500 - 1500 W.

In order to cool the electric motor in conventional vacuum cleaners usually the air flow, which is created by the fan and which is used for sucking up particles through the nozzle, is used. When the particles have been separated from the air in the dust bag and the air has flown through the fan the air passes outside and through the electric motor before it leaves to atmosphere. This method for cooling the electric motor can not be used in this connection since the air which reaches the motor despite the separation of the particles is contaminated and can cause damages in the motor. It is also desirable to use this technique for so called wet and dry suction cleaners i.e. such cleaners where the water or cleaning liquids are taken up by the nozzle together with the contaminates, the moist air flow if being allowed to pass through the motor in a very short time would damage it. It is further a risk that larger particles or details follow the air flow into the motor if for any reason the dust bag would break and that these particles because of the small dimensions of the motor and the narrow passages in the motor would damage it.

The purpose of this invention is to achieve a device which gives a reliable cooling of the electric motor at the high speed which is used in this connection. This is achieved with a device having the characteristics mentioned in the claims.

Since the high speed motor because of its small dimensions and hence the concentrated heat emission is sensitive for disturbances in the cooling air flow there is also a risk that the motor is quickly damaged if the cooling air flow should be blocked because the nozzle or air passages to the motor are clogged by dust or larger details. According to the major part of the embodiments of the invention shown below a sufficient cooling of the vacuum cleaner is achieved also if the air flow through the dust bag should be disturbed.

Some embodiments of the invention will now be described with reference to the accompanying draw-

ings in which Fig. 1 in a schematic perspective view shows a vacuum cleaner according to the invention, Fig. 2 is a longitudinal vertical section through the hand held motor housing of the vacuum cleaner, Fig. 3 is a longitudinal vertical section through the turbo fan unit in the motor housing, Fig. 4 shows in the same view as Fig. 3 an alternative embodiment of the turbo fan unit and Fig. 5-7 in the same view show three additional embodiments of the invention.

As appears from Fig. 1 and 2 the vacuum cleaner comprises a hand held motor housing 10 comprising a turbo fan arrangement 11 and a dust bag 12 the motor housing 10 via a tube shaft 13 being connected to a nozzle 14. The motor housing is via a cable 15 connected to a stationary unit 16 which by means of a cable 17 and a plug 18 can be connected to the electric supply system. The stationary unit comprises, with the exception of a cable reel, and additional accessories for the vacuum cleaner also the electronic equipment which is necessary for running the electric motor 18. Speed control is made by control means 19 placed on the motor housing.

The motor housing 10 comprises a plastic hood 20 having a handle 21 in which said control means are inserted. The front end of the plastic hood is shaped as a lid 22 with a tube socket 23 to be fastened on the pipe shaft 13. The tube socket 23 opens into the dust bag 12 which is surrounded by a shell so that a tube shaped channel 24 is created. The channel continues in the direction towards the rear part of the motor housing via a section 25 with gradually decreasing section area into an inlet 26 for a turbo fan unit 27 which is a part of the turbo fan arrangement 11. The turbo fan unit 27 comprises a shell forming an inlet section 28 with gradually increasing section area and a turbo fan impeller 29 having blades in close vicinity of the section 28. The turbo fan unit 27 also has an outlet 30.

The turbo fan impeller 29 which is a combined axial-radial impeller is fixed on a shaft 31 of an associated electric motor 32 the same shaft also supporting the rotor of the electric motor. The electric motor is driven at a speed which is above 50.000 rpm and which preferably is 70.000 - 120.000 rpm. The stator 34 of the electric motor is surrounded by a motor shell 35 which together with an outer shell part 36 forms an annular passage 37 in which the outlet 30 of the turbo fan unit opens. The rear end of the motor housing 35 is shaped as a cut off tapered sleeve 38 one end of which together with the shell part 36 forms a radial outlet 39 with a filter 40 through which the air flow which the turbo fan unit 27 creates can leave to atmosphere.

The shaft 31 of the electric motor is at each side of the rotor 33 resting in a hub part 41 of the motor shell 35 and the shell has several openings 42, 43 for cooling air placed outside and near the hub part 41. Cooling air which is drawn from an inlet 44 at the outer

part of the sleeve 38 is supplied to or withdrawn from the rotor and stator windings of the electric motor by means of a fan 45. This fan for cooling air is a centrifugal fan which is arranged at the rear side of the turbo fan impeller 29 so that the blades of the cooling fan are facing towards the electric motor. The shell of the electric motor forms a fan housing in which the openings 42 are the inlets for the cooling fan whereas the outlet 46 of the fan is placed in close vicinity to the outlet 30 of the turbo fan unit. The cooling fan 45 can of course be a part which is removable from the turbo fan impeller 29 or be integrated with it.

The device described in Fig. 1-3 operates in the following way. By activating the control means 19 the electric motor 32 is started which means that the shaft 31 with the turbo fan impeller 29 and the cooling fan 45 starts to rotate. The turbo fan impeller creates a flow of air which is sucked through the nozzle 14 and which via the tube shaft 13 enters into the dust bag 12 in which the dust particles are separated from the air flow. The air then continues through the channel 24 and the section 25, through the inlet 26 to the turbo fan unit 27 from which it escapes as a primary air flow through the outlet 30 to the annular passage 37 surrounding the motor shell 32 and cools the outside of the motor. At the same time air is sucked into the motor through the inlet 44 in the sleeve 38 by means of the fan 45 in a counter flow with respect to the air flowing through the annular passage. This cooling air, which is a secondary air flow enters the motor shell via the openings 43 and flows over the internal parts of the motor thereby effectively cooling bearings, stator and rotor before leaving to the cooling air fan 45 via the openings 42. The cooling air then flows through the outlet 46 into the air flow which is leaving the turbo fan unit. The two air flows are mixed with each other and then flow through the passage 37, the outlet 39 and the filter 40 to atmosphere.

It has also proved to be possible to desist from the blades of the cooling air fan and instead let the rear side of the turbo fan impeller be a mainly flat surface since the friction which is present between the rotating surface and the molecules of the air gases at these high speed is sufficient to throw the molecules towards the periphery so that a cooling air flow is created through the motor.

The device shown in Fig. 4 differs from the device which is shown in Fig. 3 only with respect to the cooling air fan which is missing. Instead the passage 37 has a narrow section 47 which together with through openings 48 in the motor shell 31 forms a venturi which sucks cooling air from the inlet 44 via the openings 43 and through the motor. However, this embodiment has the disadvantage that there is no cooling if the primary air flow is blocked which could happen if something clogges the nozzle or the tube shaft.

The embodiment shown in Fig. 5 has no separate cooling air fan. Instead the turbo fan impeller 29 is

used in order to suck the cooling air from the inlet 44 of the cooling air through the electric motor via one or several channels 49 extending from the inside 35 of the motor shell to a chamber 50 outside the shell part 36 the chamber via one or several openings 51 communicating with the inlet 26 of the turbo fan unit.

In the embodiment shown in Fig. 6 a cooling air fan 52 is used which is placed at the inlet 44 for the cooling air i.e. at the opposite side of the electric motor with respect to the turbo fan impeller. The air is by means of the cooling air fan forced through the electric motor and into the primary air flow through openings 53 in the motor shell.

By means of the suggested arrangements which are illustrated in Figs. 2-3 and 5-6 an effective cooling of the motor is always achieved at the high speed which is used this cooling effect mainly being independent of the air flow through the nozzle.

Fig. 7 shows an arrangement which is similar to the arrangement shown in Fig. 3 but in which there is a separate annular deflector plate 54 surrounding the rear part of the impeller 29. The plate 54 is placed at a distance from the motor shell 35 so that a passage 55 is formed through which the cooling air flow from the fan 45 enters into the primary flow in the passage 37 mainly in the same direction as the primary flow. This arrangement has proved to give a considerable increase in the suction power.

Claims

1. Device for a vacuum cleaner having a suction nozzle (14) and a dust bag (12) which is connected to the nozzle for instance by means of a tube connection (13), a turbo fan unit (27) driven by an electric motor and placed after the dust bag seen in the air flow direction the impeller (29) of the fan being driven at a speed which is above 50.000 rpm the primary air flow created by the turbo fan unit (27) being arranged to directly or indirectly leave the unit via an outlet (30) to atmosphere, **characterized in** that the vacuum cleaner is provided with means creating a secondary air flow which at least partly cools the electric motor (32) and which flows into the electric motor via one or several inlets (43) which are separated from the primary air flow.
2. Device according to claim 1, **characterized in** that said means comprises a fan (45) for cooling air which is placed at the same side of the electric motor (32) as the turbo fan unit (27) the fan preferably being of the radial type.
3. Device according to claim 2, **characterized in** that the fan (45) for cooling air and the turbo fan impeller (29) are an integrated unit.

4. Device according to any of the preceding claims, **characterized in** that the electric motor is provided with hub parts (41) which support bearings for the shaft (31) of the electric motor the cooling air inlets (43) to the electric motor being arranged close to one of said hub parts whereas the cooling air outlets (42) from the electric motor are arranged close to the other hub part. 5
5. Device according to any of claims 2-4, **characterized in** that at least a part of the secondary air flow from the cooling air fan (45) is directed into the primary air flow. 10
6. Device according to claim 2, **characterized in** that the cooling air fan is formed by the mainly flat rear side of the turbo fan impeller (29). 15
7. Device according to any of the preceding claims, **characterized in** that it comprises a passage (37) which is so arranged that the primary air flows around the shell (35) of the electric motor (31) whereas the cooling air flow is arranged to counterflow within the motor shell (35). 20
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8. Device according to claim 1, **characterized in** that said means is a venturi in which the primary air flow is the active medium of the venturi and in which the inlet (44) of the secondary air flow communicates with the suction side (48) of the venturi. 30
9. Device according to claim 1, **characterized in** that said means is the turbo fan unit (27) the space within the shell of the electric motor via a pipe connection or the like communicating with the inlet (26) of the turbo fan unit. 35
10. Device according to claim 1, **characterized in** that said means comprise a fan (52) for cooling air which is placed at the opposite side of the electric motor with regard to the turbo fan impeller (29). 40

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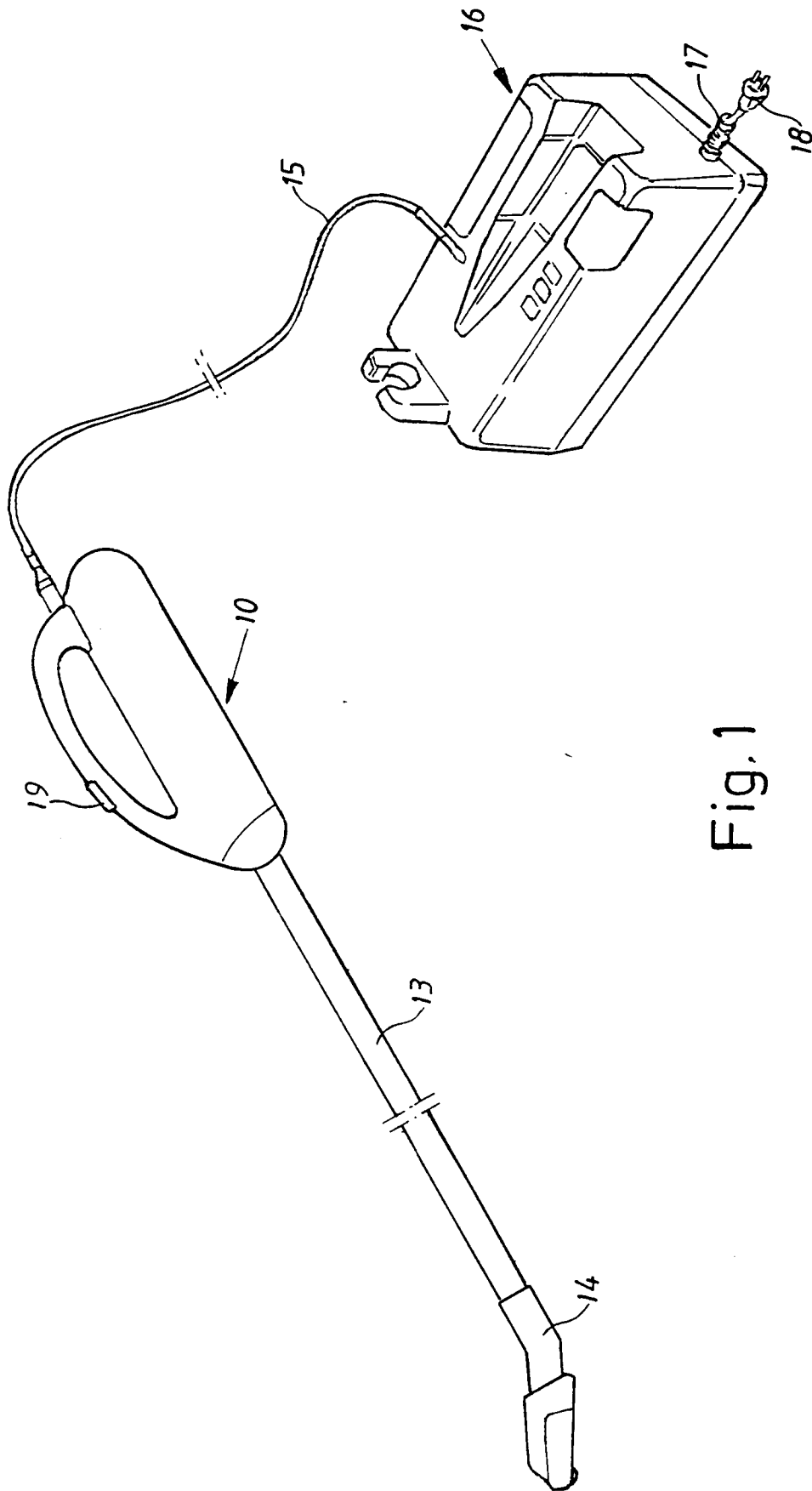


Fig. 1

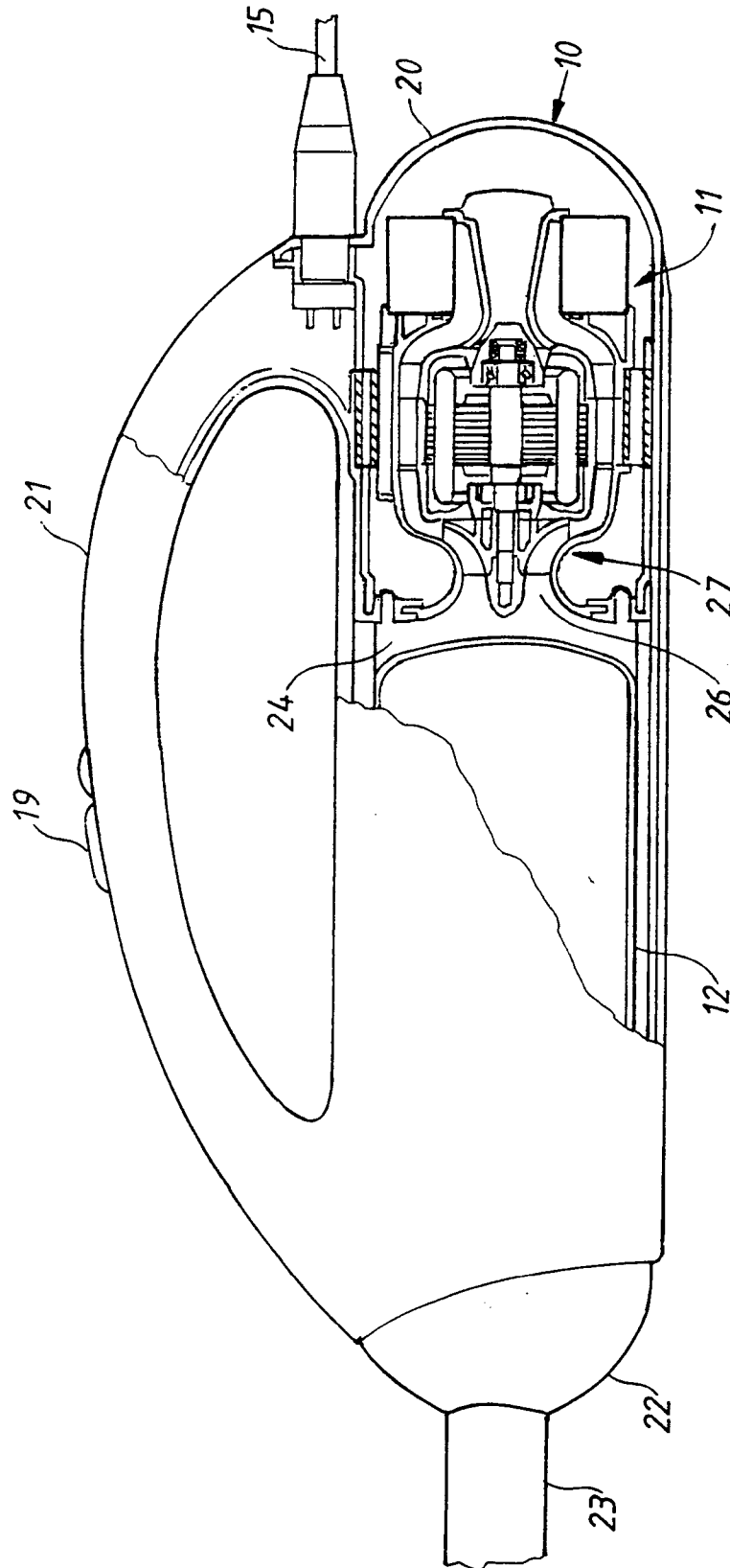
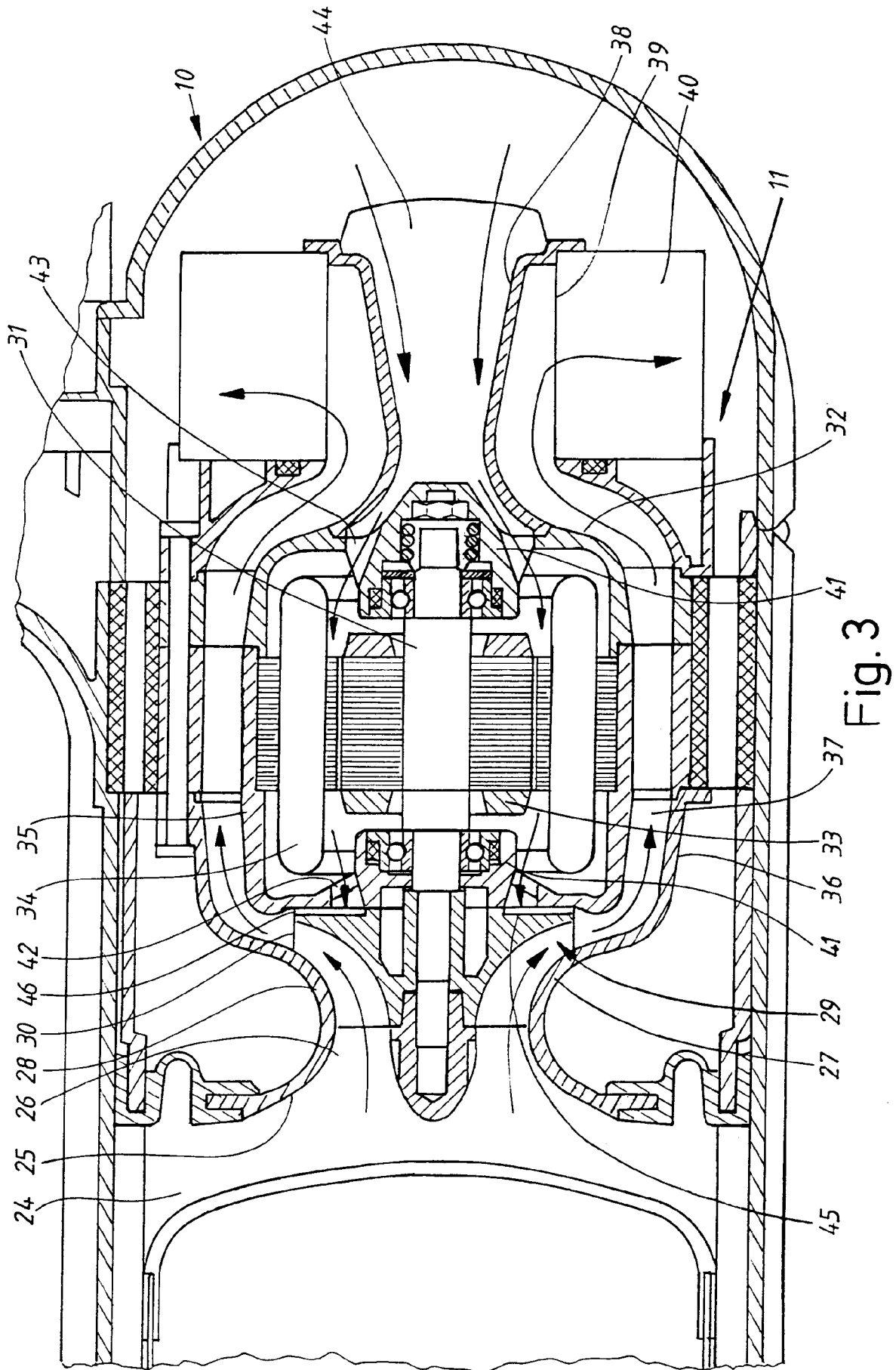


Fig.2



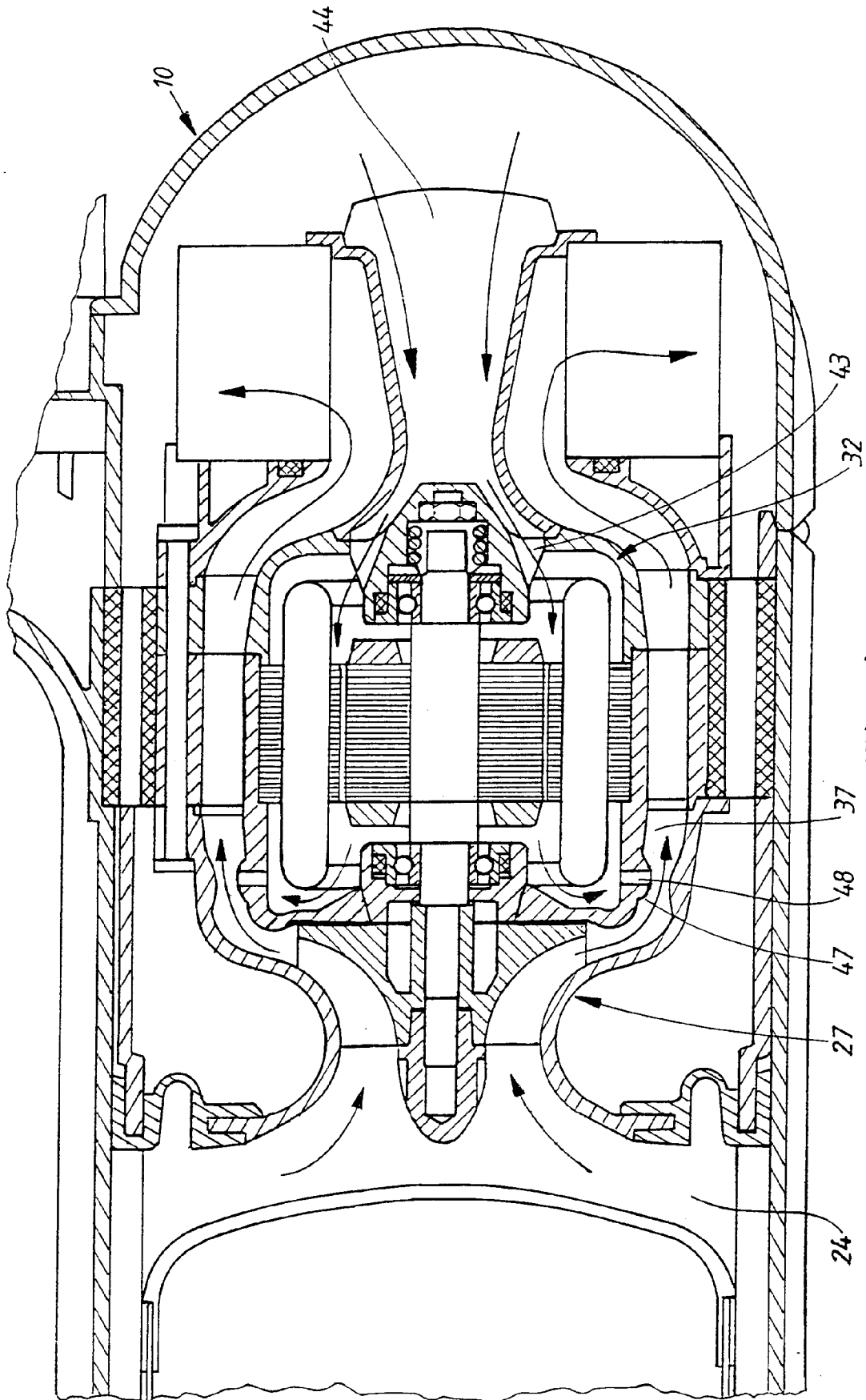
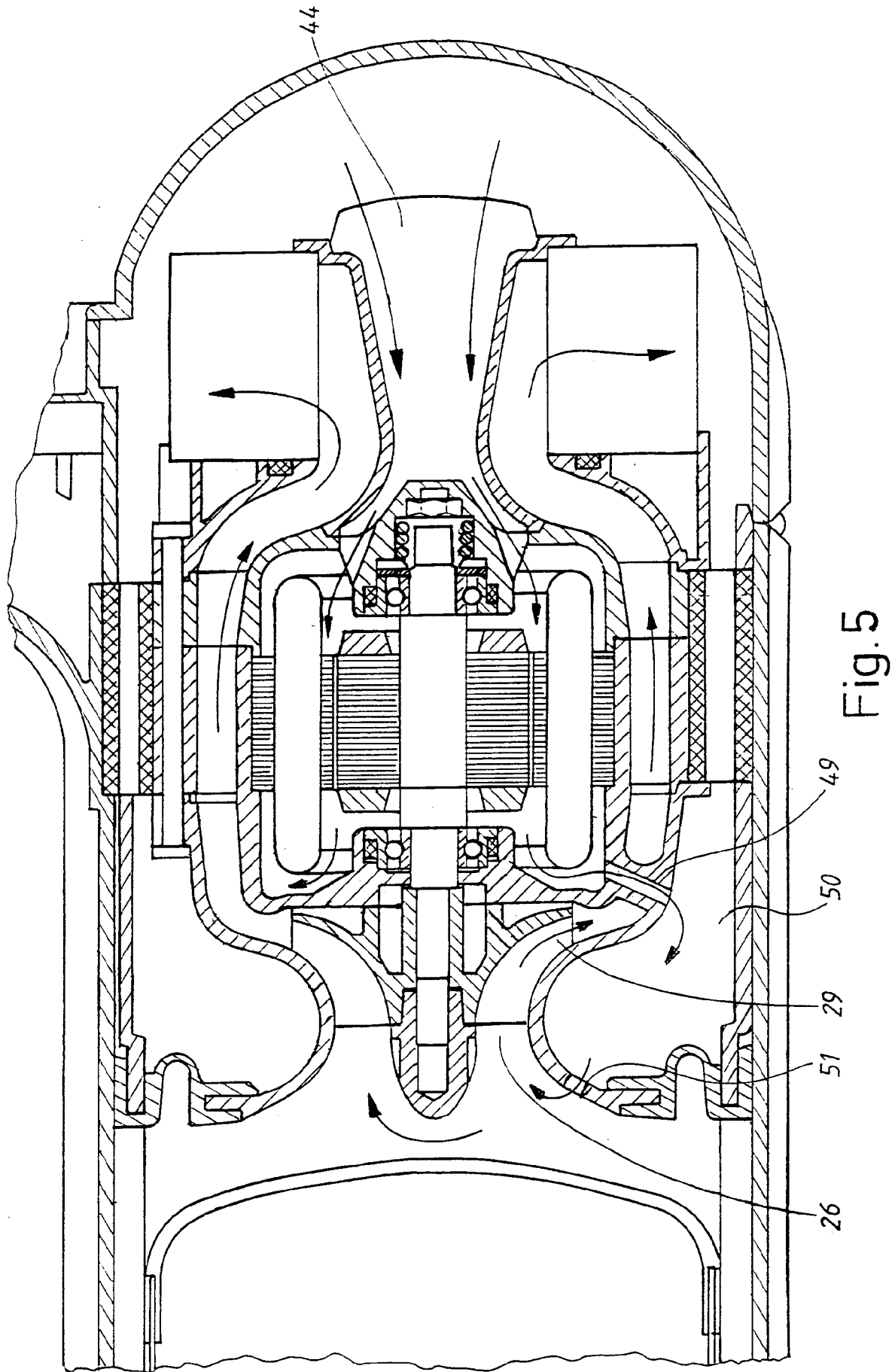


Fig. 4



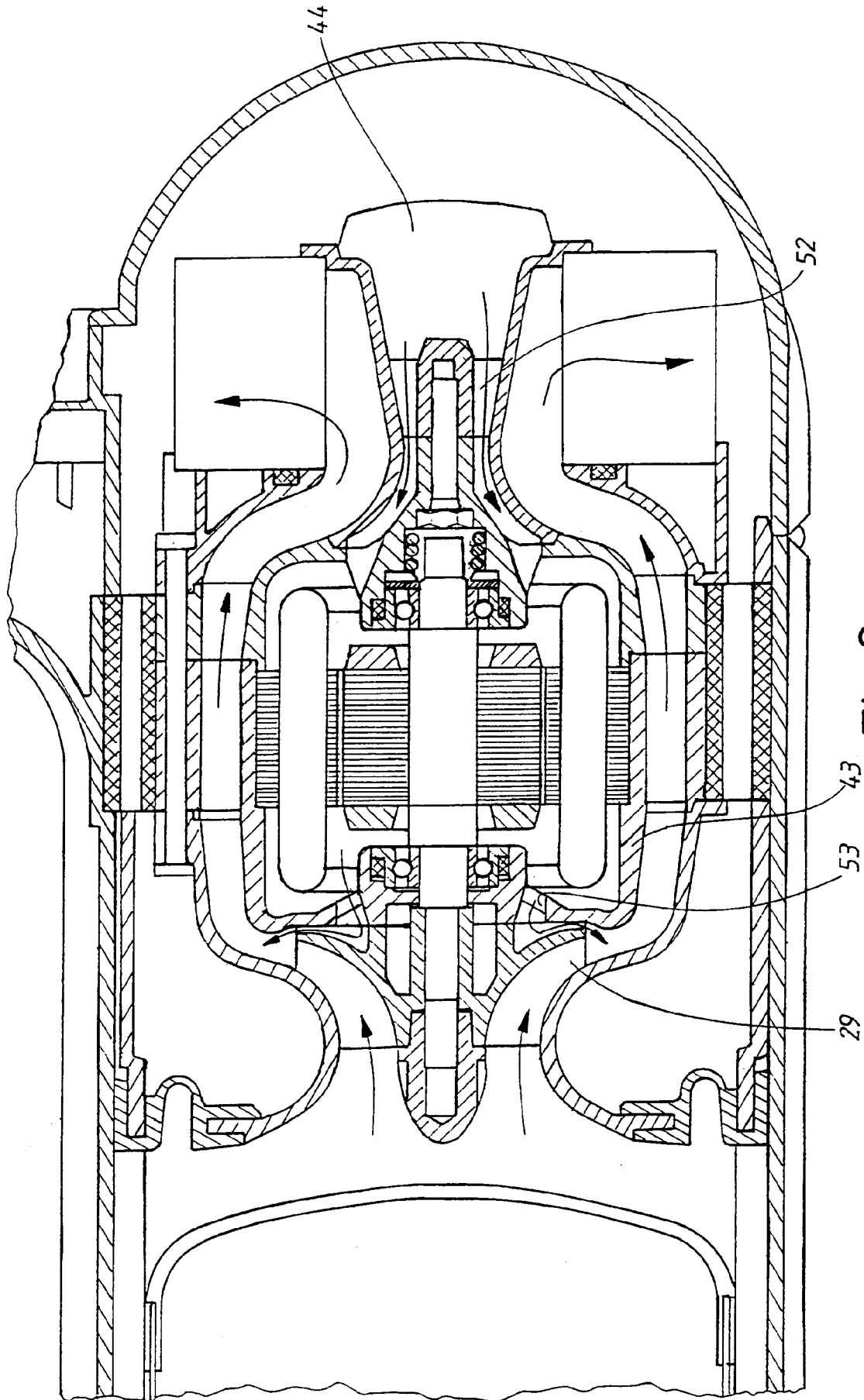
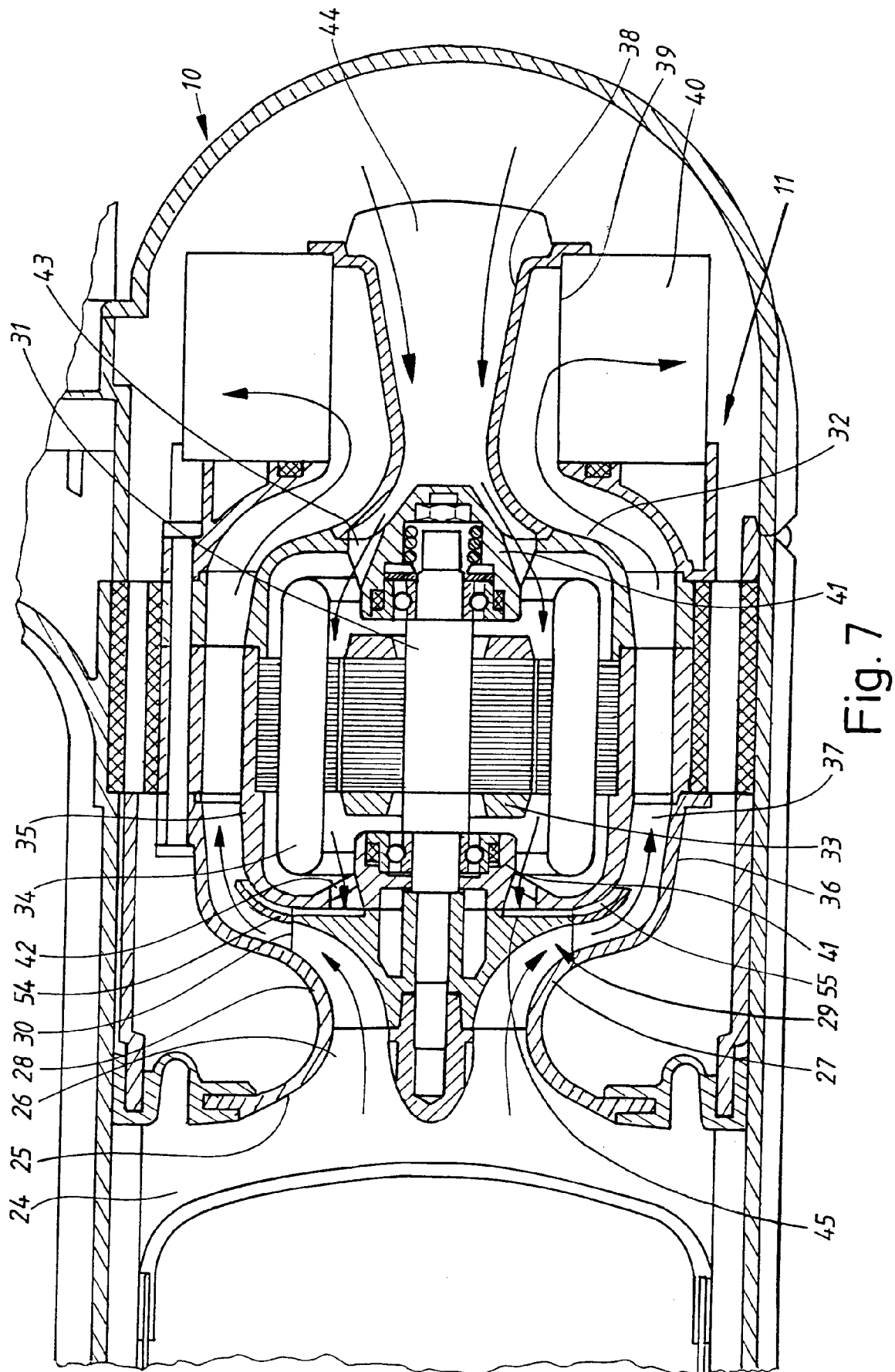


Fig. 6





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 94 85 0189

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.6)
P,D, A	WO-A-94 15519 (AB ELECTROLUX) * page 6, line 14 - page 7, line 11; figures 3,4 *	1	A47L9/22
A	FR-A-811 248 (MAUZ & PFEIFFER) * the whole document *	1	
A	DE-U-74 42 752 (VORWERK & CO INTERHOLDING GMBH)	1	
A	US-A-2 272 985 (L.C. SMITH)		
A	US-A-2 531 342 (H.E. METZ)		
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			A47L
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 2 February 1995	Examiner Vanmol, M
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