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(71) Applicant: **ROTFIL S.r.l.**
10044 Pianezza (IT)

(72) Inventor: **RAVAGLIA, Mario Roberto**
Robassomero (Torino) (IT)

(74) Representative: **Rapisardi, Mariacristina**
Ufficio Brevetti Rapisardi S.r.l.
Via Serbelloni, 12
20122 Milano (IT)

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A request for correction of the drawings has been filed pursuant to Rule 139 EPC. A decision on the request will be taken during the proceedings before the Examining Division (Guidelines for Examination in the EPO, A-V, 3.).

(54) ELECTRICAL HEATER

(57) The electric heater (1) comprises an outer casing (6), at least one electrically insulated electrical resistor (2) housed within the outer casing (6), and at least one

gap (4) positioned between the electrically insulated electrical resistor (2) and the outer casing (6), the gap (4) presenting a metal grit filler (15).

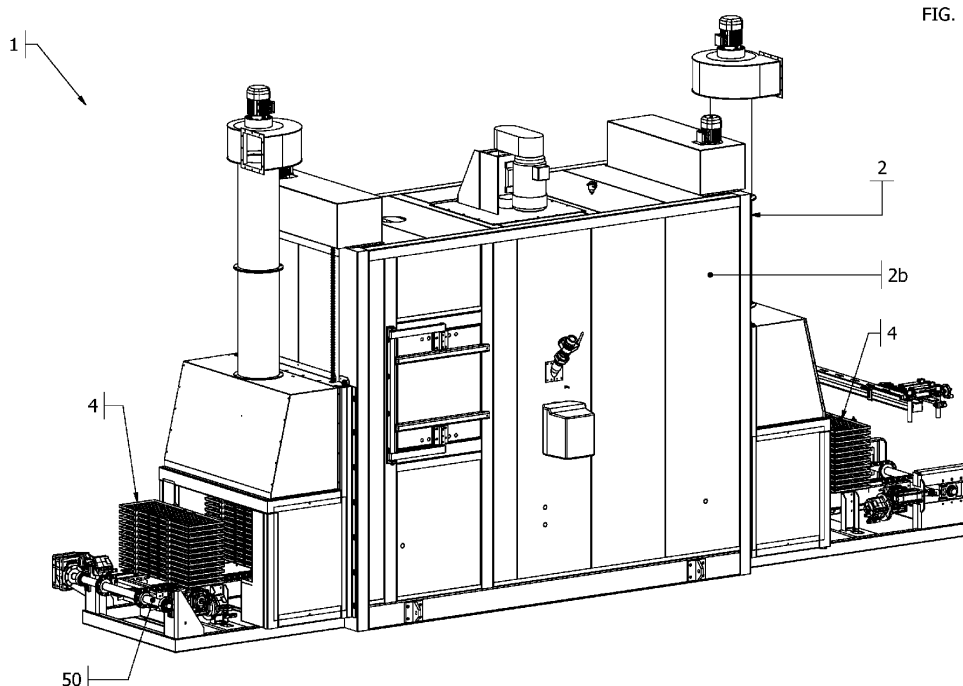


FIG. 1

EP 4 539 598 A1

Description

[0001] The present invention relates to an electric heater.

[0002] The preferred but not exclusive field of application is in the heating of fluids, whether in liquid form, typically but not exclusively water, or in gas form, typically but not exclusively air.

[0003] The electric heater according to the invention can be used in various fields of technology, for example for heating air in electric radiators or for generating hot water and/or steam in appliances for domestic or industrial use, in particular but not exclusively coffee machines. Electric heaters with various power densities, comprising a cartridge or an armoured electrical resistor, have long been on the market.

[0004] Such heaters involve cascading heat transmission through the contact surfaces between the electrical insulation and an outer metal casing.

[0005] To ensure efficient heat transfer, the metal mass of the electric heater must be appropriately dimensioned.

[0006] Too much or too little metal mass can in fact be detrimental to efficient heat transfer.

[0007] In some versions for heating a fluid, such electric heaters include a gap through which the fluid is circulated.

[0008] In this case, heat transfer can be penalised by the limited size of the heat exchange surfaces available for the fluid.

[0009] In other versions, such electric heaters are immersed in the fluid to be heated, but even in this case, heat transfer can be penalised by the limited heat exchange surfaces available for the fluid. Other electric heaters include a cast aluminium or bronze block as a heating element.

[0010] These electric heaters have the limitation of requiring, for their construction, a considerable amount of raw material, namely aluminium or bronze, which can be particularly expensive and not always readily available on the market.

[0011] The technical task proposed by the present invention is, therefore, to realise an electric heater that can eliminate the technical drawbacks of the known technique.

[0012] As part of this technical task, one aim of the invention is to realise an electric heater capable of improving heat transfer efficiency at the same installed electrical power density.

[0013] Another aim of the invention is to realise an electric heater with high heat exchange efficiency that can be constructed simply and cheaply using inexpensive and readily available raw materials.

[0014] The technical task, as well as these and other purposes, according to the present invention are achieved by realising an electrical heater, comprising an outer casing, at least one electrically insulated electrical resistor housed within said outer casing, and at least one gap positioned between said at least one electrically

insulated electrical resistor and said outer casing, characterised by the fact that said at least one gap has a metal grit filler.

[0015] Preferably, but not necessarily, the electrical resistor is cartridge or armoured.

[0016] Preferably, but not necessarily, the electric heater is configured to heat a fluid, be it in a liquid or gaseous state.

[0017] The present invention also discloses a method of heating with an electrical heater comprising an outer casing and at least one electrically insulated electrical resistor housed within said outer casing, characterised by affording at least one gap between said at least one electrical resistor and said casing, by filling said at least one gap with a metal grit, and by transferring thermal energy through heat exchange with said metal grit.

[0018] Metal grit provides a significantly increased heat exchange surface area compared to conventional solutions in use, and is also readily available commercially at extremely competitive costs.

[0019] Moreover, the construction of the electric heater can be considerably simplified by requiring the filling of a gap with metal grit.

[0020] Depending on the application, the gap may vary in size to accommodate different quantities of metal grit, but this can be achieved without complicating the production process.

[0021] In particular, it should be emphasised that traditional electric heaters with heating blocks made of cast aluminium or bronze can be replaced by electric heaters designed according to the present invention in which metal grit is used in place of the casting material so as to achieve comparable performance but with the use of cheaper, more readily available materials and moreover with the adoption of a simpler production process involving the filling of a gap with a metal grit instead of the aluminium or bronze die-casting that requires a special mould.

[0022] Other features of the present invention are also defined in subsequent claims.

[0023] Further features and advantages of the invention will become more apparent from the description of preferred but not exclusive forms of execution of the electric heater according to the invention, illustrated by way of illustration and not limitation in the accompanying drawings, in which

Figure 1 shows a partially sectioned view of a cartridge heater conforming to a first embodiment of the invention;

Figure 2 shows a partially sectioned view of a cartridge heater conforming to a second embodiment of the invention;

Figure 3 shows a sectional side elevation view of a cartridge heater conforming to a third embodiment of the invention;

Figure 4 shows a sectional perspective view of a heater conforming to a fourth embodiment of the

invention;

Figure 5 shows a electric heater for die-casting extension conforming to a fifth embodiment of the invention;

Figure 6a shows a perspective view of an electric heater with a cast-metal outer casing, in accordance with a sixth embodiment of the invention;

Figure 6b shows a plan view of the electric heater in figure 6a.

[0024] Equivalent parts of the invention will be indicated with the same numerical reference.

[0025] With reference to the above-mentioned figures, an electric heater is shown overall with reference number 1, of the type comprising at least one electrically insulated resistor 2.

[0026] The at least one electrical resistor 2 is housed inside an outer casing 6 of the electrical heater 1. The electric heater 1 has at least one gap 4 positioned between the at least one electric resistor 2 and the outer casing 6.

[0027] In the applications of Figures 1 - 4 the outer casing 6 is metallic.

[0028] Advantageously, the at least one gap 4 has a filler material of metal grit 15.

[0029] The metal grit 15 can be made of aluminium, nickel chrome or another material that is a good thermal conductor, and its grit size can preferably vary between 0.1 mm and 2 mm.

[0030] Depending on the application, the metal grit 15 may fill the at least one gap 4 in varying proportions such that the grits have a more or less pronounced mobility within the at least one gap 4 or remain substantially stationary in the case of complete filling of the at least one gap 4.

[0031] It should be noted that even in the case of a complete filling of at least one gap 4, a multitude of gaps between the grains is still formed inside the at least one gap 4, as the irregular shape of the outer surface of the grains results in point contact between the grains, which creates gaps between the grains.

[0032] The at least one gap 4 surrounds at least in part the at least one electrical resistor 2.

[0033] At least one electrically insulated resistor 2 can come in different forms.

[0034] In some cases at least one electrical resistor 2 may comprise a resistive wire, in other cases a ceramic PTC plate.

[0035] The solutions shown in Figures 1 and 2 refer to a cartridge-type electric heater 1 in which the at least one electric resistor 2 is formed of a single resistive wire 8 wound in a spiral on a cylindrical central support core 7.

[0036] The at least one electrical resistor 2 may also be formed from several resistive wires 8 wound with interspersed coils on the central support core 7.

[0037] In other solutions within the scope of the invention, the at least one electrical resistor 2 may be of an armoured type, for example fitted with a steel armour.

[0038] The resistive wire 8 is encapsulated in a tubular matrix 9 covered by a tubular shell 10 whose outer side surface delimits with the inner side surface of the casing 6 the at least one gap 4, in particular only a single gap 4.

[0039] Preferably, the core 7 is made of magnesium oxide; the resistive wire 8 is preferably, but not necessarily, made of 80/20 chrome nickel, which is ideal for its characteristics of resistance to high working temperatures, self-protection from oxidation, total absence of magnetism and low coefficient of variation of resistivity with temperature variation; matrix 9 is also made of magnesium oxide, whose granular structure ensures high dielectric insulation and excellent heat transmission, generated by the resistive wire 8, towards shell 10; shell 10 is made of a metal with excellent thermal conductivity, high resistance to oxidation at high temperatures, high resistance to chemical corrosion, and structural stability even after numerous heating and cooling cycles. The spatial distribution of the resistive wire coils 8 can be varied along the axial development of the support core 7, so that locally the cartridge heater 1 can provide different working temperatures.

[0040] The structure of the cartridge heater is completed by the metal electrodes 11 supplying power to the resistive wire 8, which are arranged through a cap 12 closing one open base of the shell 10, the other base of the shell 10 being closed.

[0041] The solution shown in figure 1 involves immersing the cartridge heater 1 in the fluid to be heated, as the outer casing 6 is completely closed.

[0042] In contrast, the solution shown in figure 2 involves the passage of the fluid to be heated through the cartridge heater 1 and in this regard the at least one gap 4 has a fluid inlet path 13 and a fluid outlet path 14.

[0043] The fluid inlet path 13 and the fluid outlet path 14 are formed by nozzle on the outer casing 6. To ensure the retention of the metal grit 15 in the at least one gap 4, at least the outlet nozzle 14 and preferably also the inlet nozzle 13 are fitted with respective plugs 16, 17 permeable to the fluid but not the metal grit 15.

[0044] The plugs 16, 17 can be formed, for example, from a calibrated mesh.

[0045] In other solutions, it is possible to provide for filters downstream of at least the outlet nozzle 14 and preferably also the inlet nozzle 13, such filters being obtained through the use of suitable metal straws, to ensure the retention of the metal grit 15.

[0046] The solution shown in figure 3 refers to a cartridge-type electric heater 1 in which each electric resistor 2 consists of a ceramic PTC plate 8.

[0047] In particular, a stack of PTC ceramic plates 8 connected by means of metal electrodes 11 is encased in a tubular matrix 9, particularly in magnesium oxide or Kapton, covered by a tubular metal shell 10 whose outer lateral surface delimits with the inner lateral surface of the casing 6 the at least one gap 4.

[0048] The metal electrodes 11 supplying power to the PTC ceramic plates 8 are arranged through a cap 12 of an

open base of the shell 10, the other base of the shell 10 being closed.

[0049] The solution shown in figure 3 provides for the immersion of the cartridge heater 1 in the fluid to be heated, since the outer casing 6 is completely enclosed, but it is possible to envisage a version with passage of the fluid to be heated through the cartridge heater 1 simply by arranging the gap 4 with a fluid inlet path and a fluid outlet path, again preferably formed by nozzle on the outer casing 6.

[0050] In the solutions shown in Figures 1 - 3, the outer casing 6 is impermeable to the fluid to be heated.

[0051] In other types of electric heaters 1, such as the one illustrated in figure 4, the outer casing 6 may also be permeable to the fluid to be heated.

[0052] In particular, in the solution illustrated in figure 4 the outer casing 6 has walls permeable to fluid, i.e. porous walls with pores sized to retain the filler material 15 but allow fluid to pass through. In the solution shown in figure 4, the electrically insulated resistors 2 are distributed as a bundle of parallel longitudinal elements enclosed by the outer casing 6.

[0053] In this case, a plurality of gaps 4 is delineated: first gap 4 between adjacent elements of the bundle and second gaps 4 between the outer elements of the bundle and the facing walls of the casing 6.

[0054] The solution shown in figure 4 is particularly suitable for heating a gas, e.g. air, forced to pass through the electric heater 1.

[0055] Other types of electric heaters not illustrated fall within the scope of the invention, for example electric heaters in which the at least one electric resistor is formed by an electrically insulated resistive circuit screen-printed on a substrate which borders the at least one gap with the outer casing.

[0056] The invention also includes a method for heating with an electric heater 1 of the type comprising an outer casing 6 and at least one electrically insulated resistor 2 housed within the outer casing 6.

[0057] The method involves forming at least one gap 4 between the at least one electrical resistor 2 and the casing 6, filling the at least one gap 4 with a metal grit 15, and transferring thermal energy through a heat exchange with the metal grit 15.

[0058] More precisely, as evident for example from the solutions illustrated in Figures 2 and 4, in the case of heating a fluid, the method involves forcing the fluid to pass through at least one gap 4. The forceful circulation of fluid through the at least one gap 4 can be determined by a fan, particularly in the case of a fluid in gas form, or by a pump, particularly in the case of a fluid in liquid form.

[0059] An electric heater 1 for a die casting extension, such as the one illustrated in Figure 5, is also within the scope of the invention.

[0060] A die casting extension is used in injection moulding machines for material such as zinc alloys (zamak) or magnesium, and the flow of molten material flows through it.

[0061] In a die-casting extension heater 1, the electrically insulated electrical resistor 2 is usually an armoured resistor coiled around a calibrated inner tube 100, which is then fitted to the die-casting extension.

5 [0062] The electric heater 1 is completed by the tubular outer casing 6 and two ring end flanges 103 as well as possibly control thermocouples (not shown).

10 [0063] Given the high operating temperature values involved (500/600 °C for zamak, over 700 °C for magnesium) within the inner tube 100, the armoured type heating element could lose the original geometric arrangement of its coils after a few operating cycles. This could result in unwanted accumulations among coils that could cause malfunctioning ('bad' moulds) or even perforation of the extension due to excessive local overheating that causes temperature values suitable to corrode the die-casting material.

15 [0064] According to the invention, however, the electric heater 1 for die-casting extension foresees that the metal grit 15 fills the gap 4 between the outer casing 6 and the inner tube 100 and thus also the spaces between the coils of the armoured resistor.

20 [0065] This solution improves heat conduction between the parts and at the same time makes the conformation and configuration of the armoured heating element 101 more stable.

25 [0066] An electric heater 1 with a cast metal casing, such as the one illustrated in Figures 6a, 6b, is also within the scope of the invention.

30 [0067] The outer casing 6 of electric heater 1 can be made of cast aluminium or bronze.

[0068] In the solution shown, the cast metal outer casing 6 is shaped like a plate.

35 [0069] In other solutions, the cast metal outer casing 6 can be realised in other forms, for example in the form of a sleeve with a possibly grooved outer surface.

[0070] In this case, the metal grit 15 fills the gap 4 that is specially created between the outer casing 6 and the electrical resistor 2.

40 [0071] The electric heater thus conceived is susceptible to numerous modifications and variations, all within the scope of the inventive concept; moreover, all details can be replaced by technically equivalent elements.

45 [0072] In practice, the materials used, as well as the dimensions, can be any according to requirements and the state of the art.

Claims

50 1. Electric heater (1), comprising an outer casing (6), at least one electrically insulated electrical resistor (2) housed within said outer casing (6), and at least one gap (4) positioned between said at least one electrically insulated electrical resistor (2) and said outer casing (6), **characterised in that** said at least one gap (4) has a metal grit filler material (15).

2. Electric heater (1) according to claim 1, **characterised in that** said at least one gap (4) surrounds said at least one electric resistor (2) at least in part.
3. Electric heater (1) according to any of the preceding claims, **characterised by** the fact that said electric resistor (2) is of the cartridge or armoured or screen printed type.
4. Electric heater (1) according to any preceding claim, **characterised by** the fact that said at least one gap (4) has an inlet path (13) for a fluid and an outlet path (14) for the fluid.
5. Electric heater (1) according to any preceding claim, **characterised by** the fact that said outer casing (6) is impermeable to fluids.
6. Electric heater (1) according to any of claims 1 to 3, **characterised by** the fact that said outer casing (6) is permeable to fluids.
7. Electrical heater (1) according to any preceding claim, **characterised in that** said at least one electrical resistor (2) comprises a coiled wire (8) wound on an electrically insulating cylindrical support core (7) embedded in an electrically insulating cylindrical tubular matrix (9).
8. Electric heater (1) according to the preceding claim, **characterised by** the fact that said cylindrical tubular matrix (9) is enveloped by a metal tubular shell (10) delimiting said at least one gap (4) in cooperation with said outer casing (6).
9. Electrical heater (1) according to any one of claims 1 to 6, **characterised by** the fact that said at least one electrical resistor (2) comprises a ceramic PTC element (8).
10. Electric heater (1) according to the preceding claim, **characterised by** the fact that said PTC ceramic element (8) is embedded in an electrically insulating cylindrical tubular matrix (9).
11. Electric heater (1) according to the preceding claim, **characterised by** the fact that said electrically insulating cylindrical tubular matrix (9) delimits said at least one gap (4) in cooperation with said outer casing (6).
12. Electric heater (1) for die-casting extension according to claim 1, **characterised in that** it has an inner tube (100) on which said electric resistor (2) is wound as a spiral including an armoured resistor, said inner tube (100) delimiting said gap (4) with said outer casing (6), said metal grit (15) filling said gap (4) including the spaces between the coils of said armoured resistor.
13. Electric heater according to claim 1, **characterised in that** said outer casing (6) is made of cast metal, and said metal grit (15) fills said gap (4) between said outer casing (6) of cast metal and said electrical resistor (2).
14. A heating method using an electric heater (1) comprising an outer casing (6) and at least one electrically insulated resistor (2) housed within said outer casing (6), **characterised by** affording at least one gap (4) between said at least one electrical resistor (2) and said casing (6), by filling said at least one gap (4) with a metal grit (15), and by transferring thermal energy through heat exchange with said metal grit (15).
15. Method for heating a fluid according to the preceding claim, **characterised by** forcing said fluid to pass through said at least one gap (4).

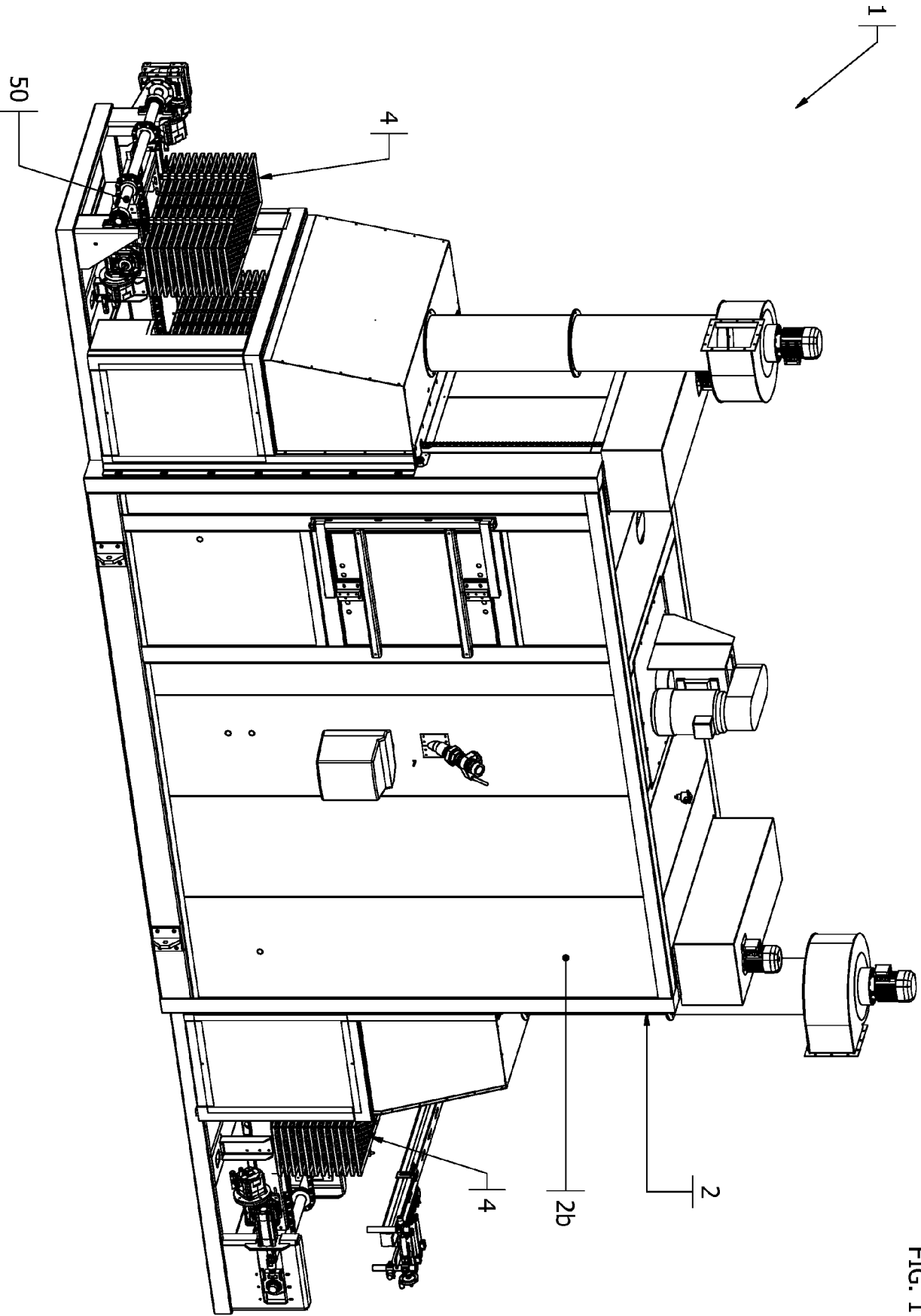


FIG. 1

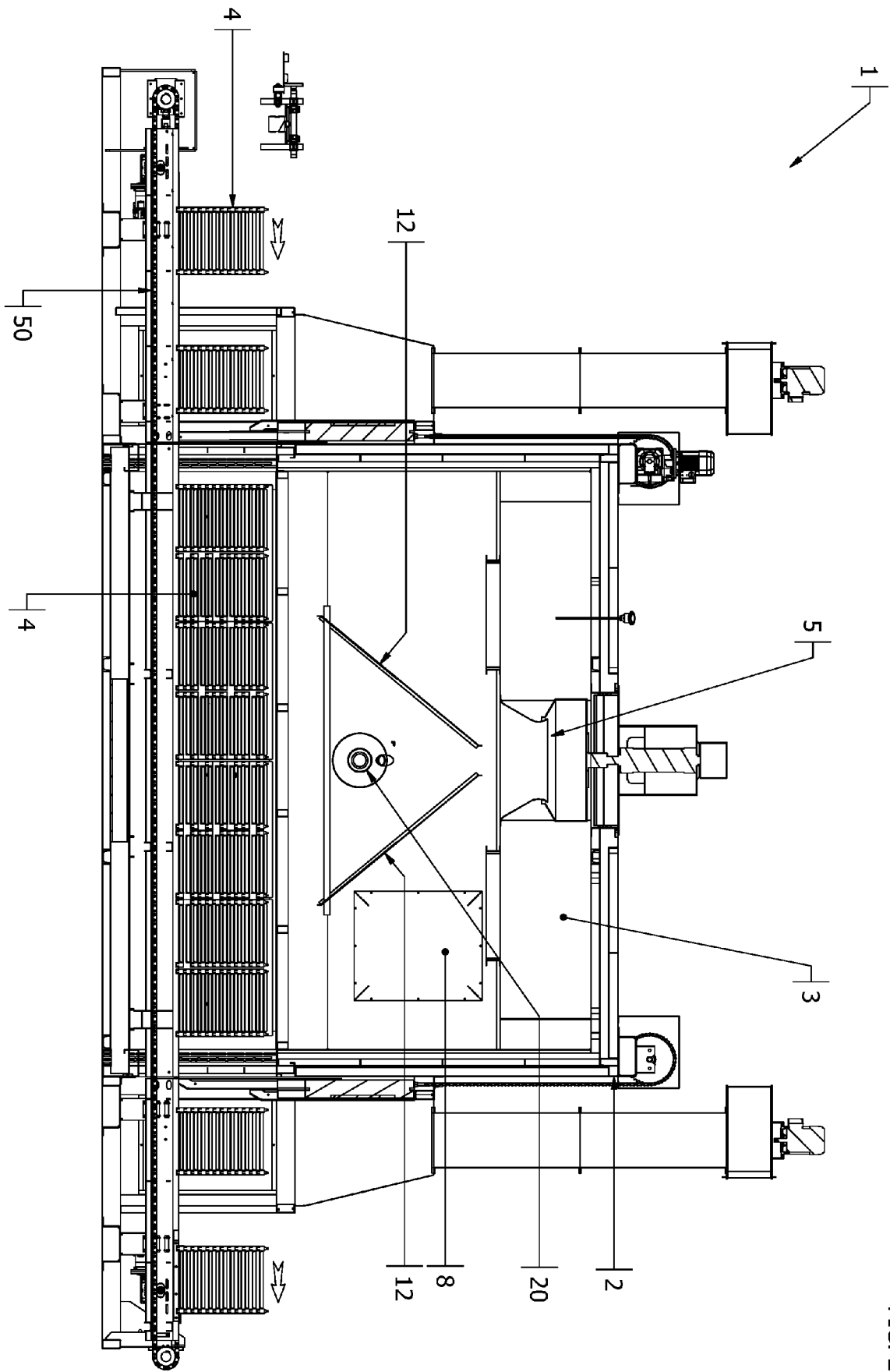
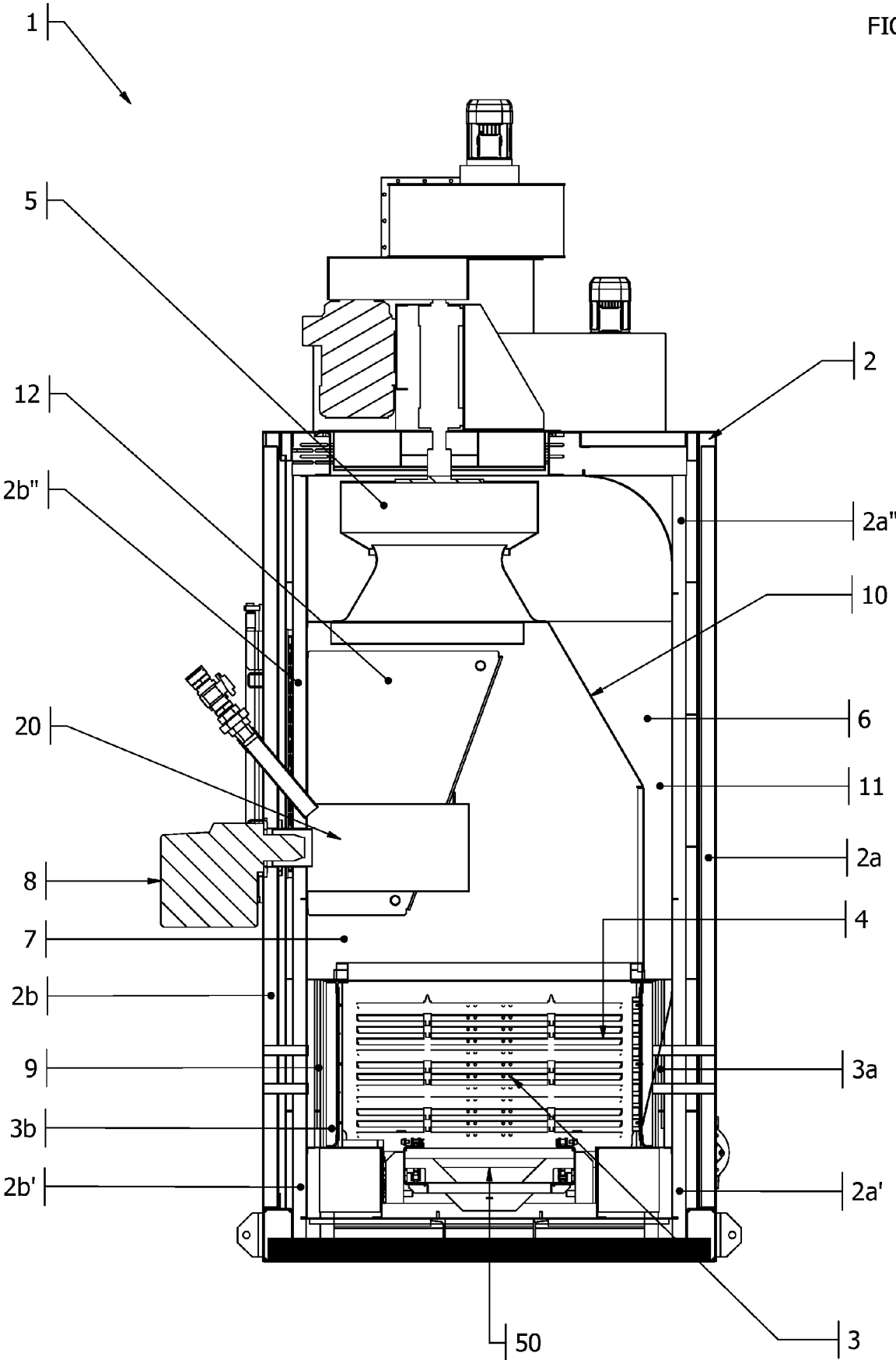
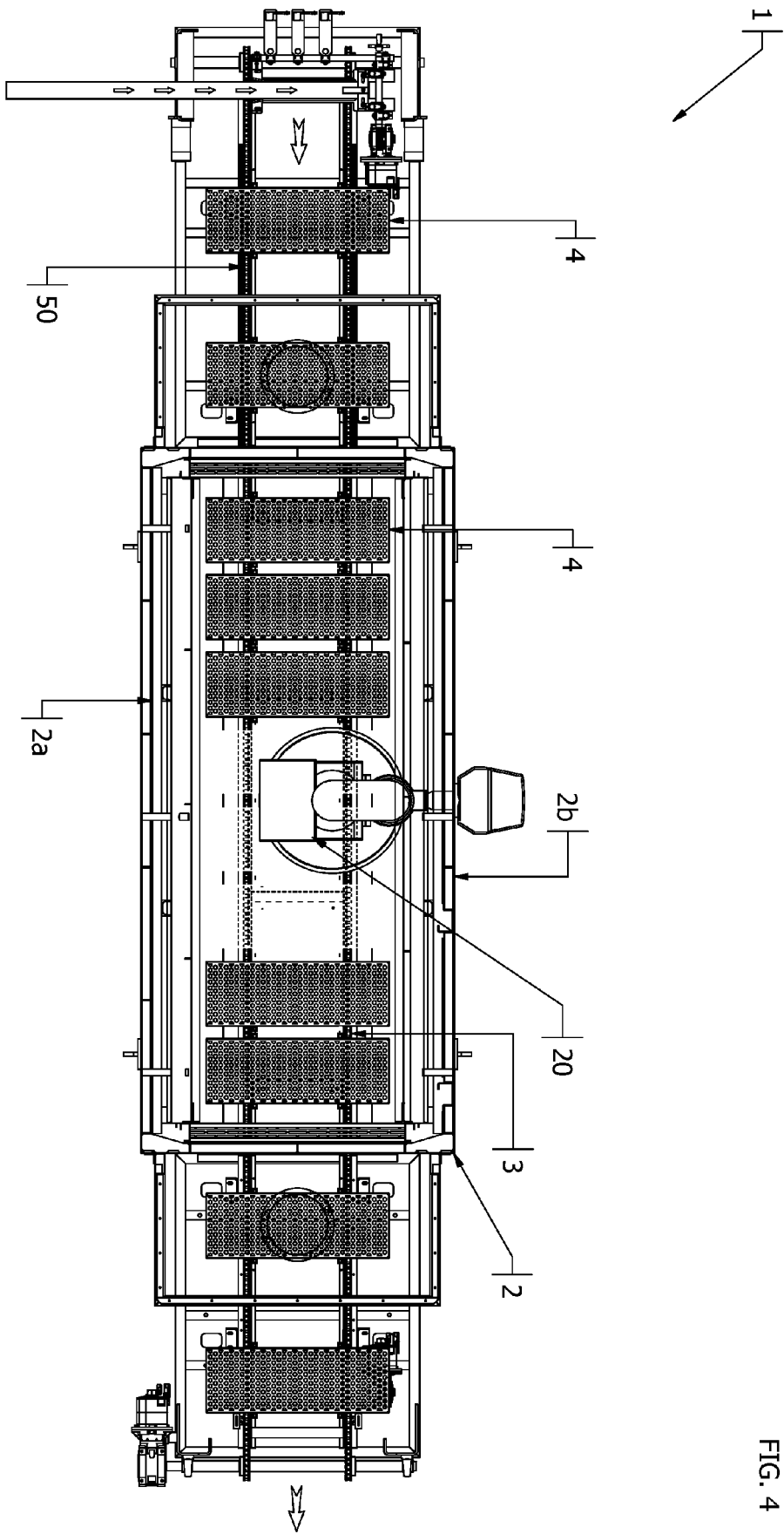


FIG. 3







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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 25 March 2024	Examiner Aubry, Sandrine
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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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

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