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microwave energy to the drying chamber (4); the microwave energy source (15) is fixed to a front panel (16), which is supported by the casing (2) and has a central opening (17) coaxial with the front access opening (6) of the drying chamber (4).



Description

TECHNICAL FIELD

[0001] The present invention relates to a microwave laundry drier.

BACKGROUND ART

[0002] Known laundry driers operate in various ways, and in particular may condense a stream of hot air blown into a drying drum to remove moisture from the laundry, or may exhaust the stream of moisture-laden hot air directly from the drier. Known laundry driers comprise a ventilation system (i. e. usually a blower comprising a fan and an electric fan motor) and a heating arrangement, which draw air from outside, and heat and blow the air into and through the laundry drum; and the hot drying air is then either exhausted directly from the drier or fed to condensing means to condense the moisture collected in the hot air.

[0003] A known condensation laundry drier comprises a laundry drum; an air intake conduit for feeding the hot drying air into the drum through an inflow opening; and an air outlet or exhaust conduit for exhausting the hot drying air from the drum through an outflow opening. The air conduits are connected to each other by a condenser for condensing the moisture in the hot drying air flowing through it.

[0004] At present, drying is by indirect heating: an electric heating element heats an airflow, and the air removes moisture from the laundry. Using this method, standard drying cycle time can only be shortened by increasing either heating power or airflow. A commercial drier heating element, however, absorbs 2.2-2.4 kW electric power, and, since, in certain European countries (e.g. Italy), most houses have a contract which allows maximum electric power absorption from the mains of 3kW, no significant increase can be made in the heating power of the heating element. And, since airflow is limited by the size of the air ducts, fans, and the machine itself, increasing airflow is complicated and expensive, by involving complete redesign of the machine. Furthermore, increasing airflow results in a corresponding increase in the noise level of the machine, and so calls for high-cost noise-damping improvements.

[0005] As disclosed, for example, in Patents US4356640A1, US4490923A1, US4765066A1, US4510361A1 and US6393725A1, driers employing other heating technologies, such as microwaves, have been proposed. Microwaves show considerable potential in shortening drying time, by coupling directly with water (direct heating). For example, a microwave drier comprises a casing housing a drying chamber; a blower connected by a duct to the drying chamber to draw air through the chamber from openings in both the chamber and the casing; and a microwave energy source for directing microwave energy to the drying chamber. As the microwave

energy heats and vaporizes the water in the laundry to be dried, the evaporated moisture is drawn out of the drying chamber by the air flowing through it, and is exhausted into the atmosphere. The drying chamber may be in the form of a revolving tumble drum mounted inside the casing, or in the form of a stationary container; and airflow into the drying chamber may be preheated to improve removal of the evaporated moisture from the drying chamber.

[0006] The main problem in a microwave laundry drier is containing the microwaves inside the drying chamber, to ensure user safety and maximize energy transfer to the laundry, which means forming around the drying chamber a closed environment which perfectly reflects (and so contains) the microwaves. The weak area of such a closed environment is the door, for loading/unloading wet/dry laundry into/from the drying chamber, and which constitutes a possible microwave leakage point.

[0007] In known microwave laundry driers, the door configuration is complicated and expensive, and does not always guarantee perfect isolation of the microwaves.

DISCLOSURE OF INVENTION

[0008] It is an object of the present invention to provide a microwave laundry drier designed to eliminate the aforementioned drawbacks, and which is cheap and easy to implement, and in particular has a door configuration which completely seals the closed environment around the drying chamber to maximize energy transfer to the wet laundry and prevent microwave leakage to the surrounding outside environment.

[0009] According to the present invention, there is provided a microwave laundry drier as claimed in the accompanying Claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] A non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a schematic side view of a microwave laundry drier in accordance with the present invention;

Figure 2 shows a view in perspective of a front panel of the Figure 1 microwave laundry drier;

Figure 3 shows an enlarged view in perspective of a portion of the Figure 2 front panel; and

Figure 4 shows a section of a lateral portion of a door of the Figure 1 microwave laundry drier.

PREFERRED EMBODIMENTS OF THE INVENTION

[0011] Number 1 in Figure 1 indicates as a whole a laundry drier comprising a casing 2 resting on a floor on a number of feet. Casing 2 supports a revolving laundry drum 3 which defines a drying chamber 4, rotates about

a horizontal rotation axis 5 (in alternative embodiments not shown, rotation axis 5 may be tilted or vertical), and has a front access opening 6 closed by a door 7 hinged to a front wall of casing 2. Drum 3 is rotated by an electric motor (not shown), and is fed through with a stream of drying air fed into drum 3 by an exhaust-type ventilation system 8 (i.e. in which the hot drying air from drum 3 is exhausted directly into the external environment).

[0012] Ventilation system 8 comprises an air intake conduit 9 for drawing in outside air, heating the air, and feeding the hot drying air into drum 3 through an inflow opening 10; an air exhaust conduit 11 for exhausting the moist, hot drying air from the drum to the outside through an outflow opening 12; and a centrifugal fan 13 and a heating device 14 located along air intake conduit 9.

[0013] It should be pointed out that the arrangement of ventilation system 8 is referred to here purely by way of example in connection with one embodiment of the present invention, and may be different. For example, ventilation system 8 may comprise a condenser located along air exhaust conduit 11 to condense the vapour in the stream of moist, hot air from drum 3, and at least part of the dry air from the condenser may be fed back into air intake conduit 9.

[0014] Microwave laundry drier 1 comprises a microwave energy source 15 for directing microwave energy to drying chamber 4. As shown in Figures 1 and 2, microwave energy source 15 is fixed to a front panel 16, which is supported by casing 2 (in particular, may form part of or be fixed to casing 2) and has a central opening 17 coaxial with front access opening 6 of drying chamber 4. Microwave energy source 15 comprises four magnetrons 18 arranged symmetrically around central opening 17 in front panel 16 and fixed (screwed) to the back of front panel 16 to prevent microwave leakage inwards of casing 2. Each magnetron 18 has a magnetron body 19 located inside casing 2; and a magnetron antenna 20, which emits the microwave energy and is located outside casing 2 through a hole 21 in front panel 16.

[0015] As shown in Figures 3 and 4, microwave energy source 15 comprises, for each magnetron 18, a waveguide device 22 to guide the microwaves towards drying chamber 4. Each waveguide device 22 comprises a housing 23, which is supported by front panel 16, surrounds magnetron antenna 20, and has an open side 24 towards the centre of central opening 17 in front panel 16. Each waveguide device 22 also comprises a deflector 25, which is supported by door 7, when door 7 is closed, is located in front of open side 24 of housing 23, and is designed to direct the microwaves towards drying chamber 4. In a preferred embodiment, each deflector 25 has an inclined surface 26 facing open side 24 of housing 23 when door 7 is closed.

[0016] In the preferred embodiment shown in Figure 1, air intake conduit 9 is connected to microwave energy source 15 so that at least part of the drying air flows past microwave energy source 15 to transfer heat from microwave energy source 15 to the drying air. More specifically,

ly, the fresh drying air (i.e. the drying air from outside, not yet heated by heating device 14) flows past magnetron bodies 19 of magnetrons 18 to cool magnetron bodies 19 and, at the same time, preheat the fresh drying air upstream from heating device 14 (which, of course, is located downstream from microwave energy source 15).

[0017] In connection with the above, it is important to point out that magnetrons 18 may have heat losses of up to 50% of energy supply. For example, to get 0.9 kW microwaves (nominally 1 kW), they need approximately 1.4 kW electric energy from the mains, and so dissipate into heat about 0.4-0.7 kW. Feeding the fresh drying air past microwave energy source 15 optimizes energy consumption, by virtue of all the electric energy supplied to magnetrons 18 being used for machine purposes : part is converted to microwave energy, and part is used to heat the drying air.

[0018] As shown in Figure 1, microwave laundry drier 1 comprises an annular reflecting element 27 surrounding central opening 17 in front panel 16 to form a microwave barrier. In equivalent embodiments, annular reflecting element 27 may be supported by door 7, by front panel 16, or by casing 2. For example, annular reflecting element 27 creates an electromagnetic field discontinuity that blocks the microwaves, and is defined by a number of small T-shaped projections equal in size to one-quarter of the microwave energy wavelength to create impedance decoupling and reflect the microwaves.

[0019] Microwave laundry drier 1 as described above has numerous advantages, by being cheap and easy to implement, and by providing a rational arrangement of microwave energy source 15. More specifically, fixing microwave energy source 15 to the front panel provides for optimizing use of the inner volume of casing 2, for easy connection of air intake conduit 9 to microwave energy source 15, and for easily directing all the microwaves inside drying chamber 4, thus ensuring perfect microwave isolation.

Claims

1. A microwave laundry drier (1) comprising:

- a casing (2);
 - a drying chamber (4) housed inside the casing (2) and having a front access opening (6);
 - a door (7) hinged to the casing (2) to close the access to the drying chamber (4); and
 - a microwave energy source (15) for directing microwave energy to the drying chamber (4);
- the microwave laundry drier (1) being **characterized in that** the microwave energy source (15) is fixed to a front panel (16), which is supported by the casing (2) and has a central opening (17) coaxial with the front access opening (6) of the drying chamber (4).

2. A microwave laundry drier (1) as claimed in Claim 1, wherein the microwave energy source (15) comprises at least one magnetron (18) having a magnetron body (19) located inside the casing (2), and a magnetron antenna (20) emitting the microwave energy and located outside the casing (2); the front panel (16) comprising a hole (21), through which the magnetron antenna (20) is fitted. 5
3. A microwave laundry drier (1) as claimed in Claim 2, wherein the microwave energy source (15) comprises a number of magnetrons (18) arranged symmetrically around the central opening (17) in the front panel (16). 10
4. A microwave laundry drier (1) as claimed in Claim 2 or 3, and comprising, for each magnetron (18), a waveguide device (22) to guide the microwaves towards the drying chamber (4). 15
5. A microwave laundry drier (1) as claimed in Claim 4, wherein each waveguide device (22) comprises a housing (23), which is supported by the front panel (16), surrounds the magnetron antenna (20), and has an open side (24) towards the centre of the central opening (17) in the front panel (16). 20
6. A microwave laundry drier (1) as claimed in Claim 5, wherein each waveguide device (22) comprises a deflector (25), which is supported by the door (7), when the door (7) is closed, is located in front of the open side (24) of the housing (23), and is designed to direct the microwaves towards the drying chamber (4). 25
7. A microwave laundry drier (1) as claimed in Claim 5, wherein each deflector (25) has an inclined surface (26) facing the open side (24) of the housing (23) when the door (7) is closed. 30
8. A microwave laundry drier (1) as claimed in any of Claims 1 to 7, and comprising a ventilation system (8), which blows drying air through the drying chamber (4), and comprises an air intake conduit (9) for feeding the drying air into the drying chamber (4) through an inflow opening (10), and an air exhaust conduit (11) for exhausting the drying air from the drying chamber (4) through an outflow opening (12); the air intake conduit (9) is connected to the microwave energy source (15) so that at least part of the drying air flows past the microwave energy source (15) to transfer heat from the microwave energy source (15) to the drying air. 35
9. A microwave laundry drier (1) as claimed in Claim 8, wherein the ventilation system (8) comprises a heating device (14) located downstream from the microwave energy source (15) to heat the drying air. 40
10. A microwave laundry drier (1) as claimed in any of Claims 1 to 9, and comprising an annular reflecting element (27), which surrounds the central opening (17) in the front panel (16) to create a microwave barrier. 45
11. A microwave laundry drier (1) as claimed in Claim 10, wherein the annular reflecting element (27) is supported by the door (7). 50
12. A microwave laundry drier (1) as claimed in Claim 10, wherein the annular reflecting element (27) is supported by the front panel (16) or the casing (2). 55
13. A microwave laundry drier (1) as claimed in Claim 10, 11 or 12, wherein the annular reflecting element (27) creates an electromagnetic field discontinuity that blocks the microwaves, and is defined by a number of small T-shaped projections equal in size to one-quarter of the microwave energy wavelength to create impedance decoupling and reflect the microwaves.
14. A microwave laundry drier (1) as claimed in any of Claims 1 to 13, wherein the drying chamber (4) is defined by a revolving laundry drum (3).

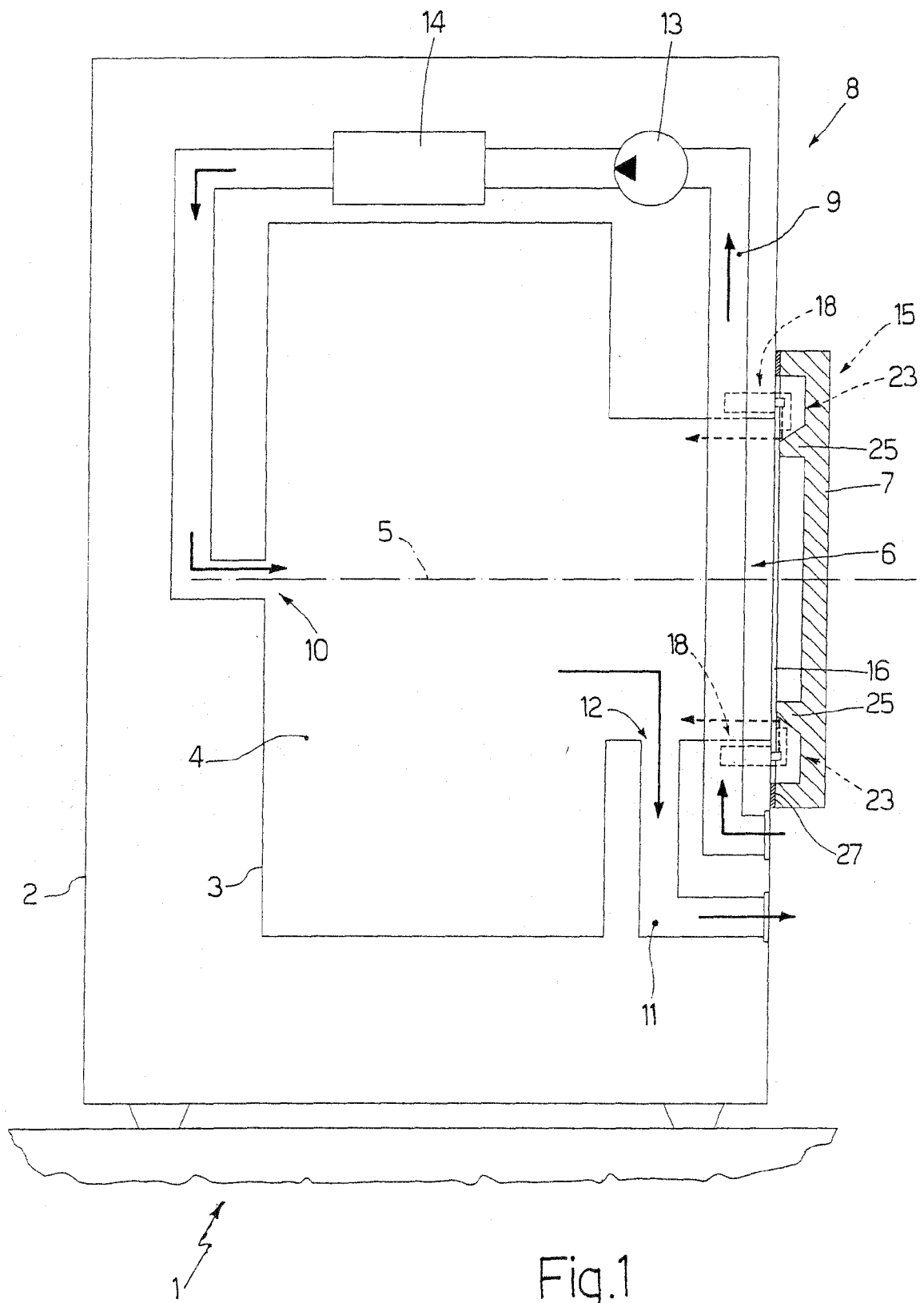


Fig.1

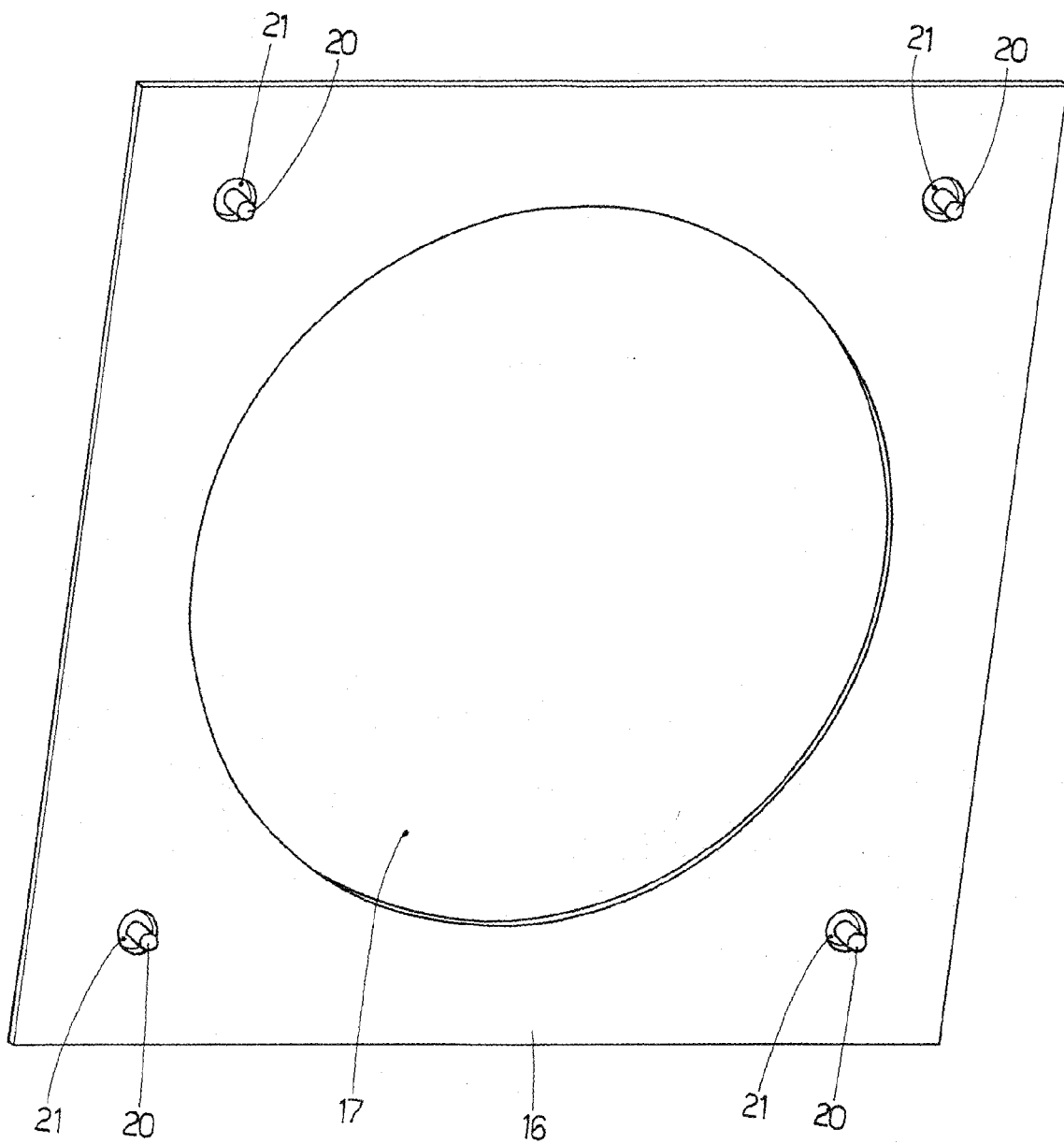


Fig.2

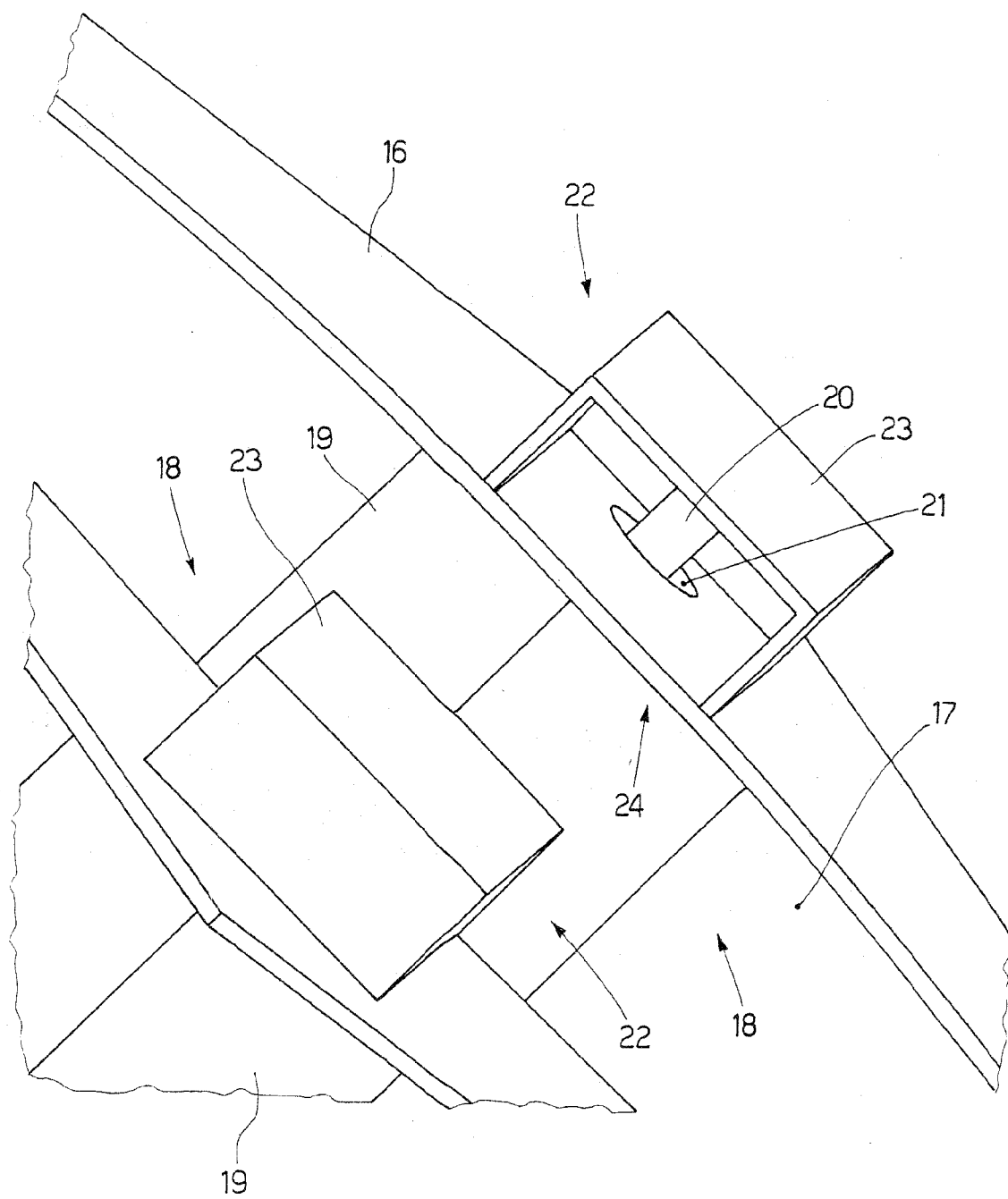
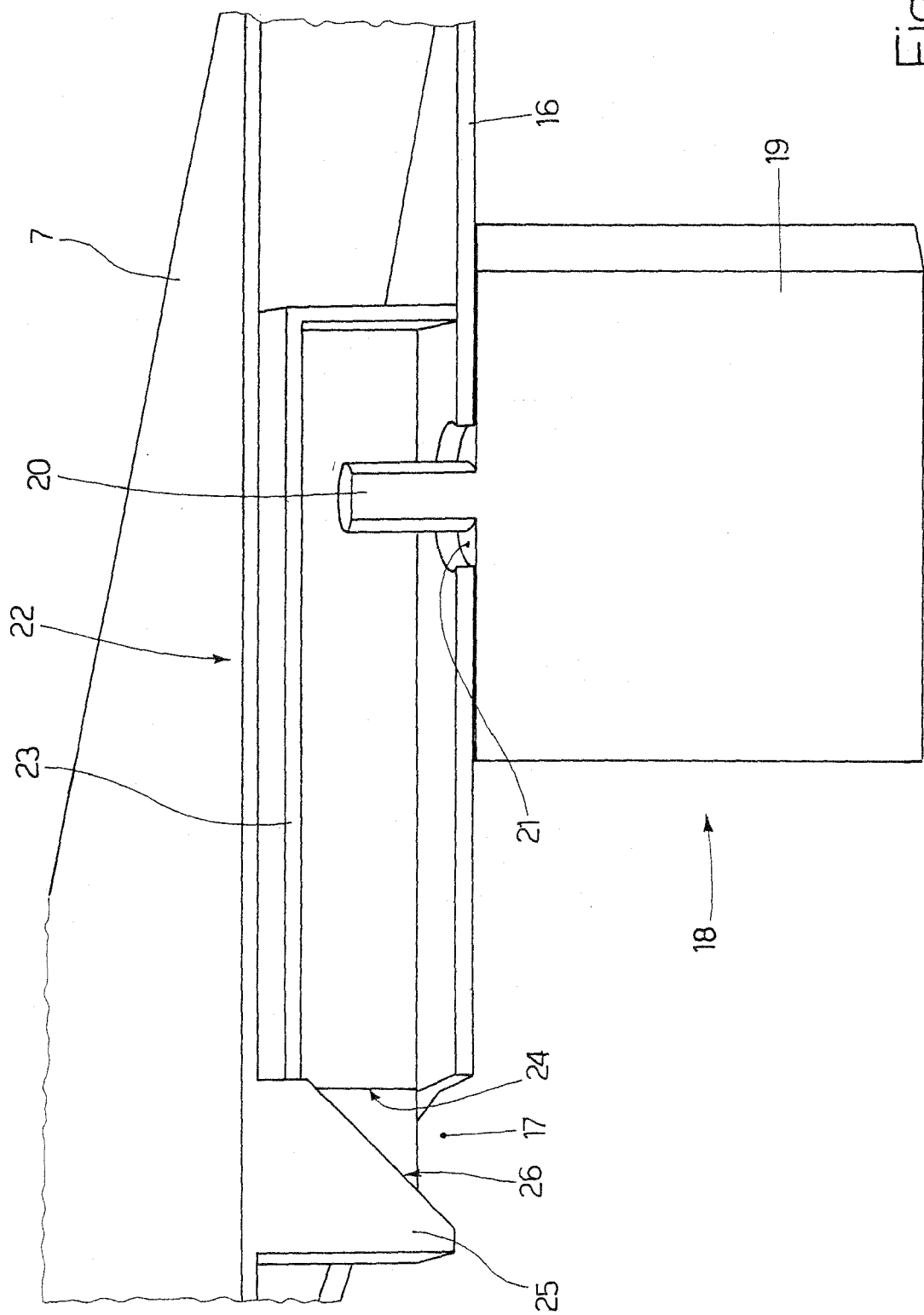


Fig.3





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 11 2491

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Place of search Munich		Date of completion of the search 16 November 2007	Examiner DIAZ, M
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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EPO FORM 1503 03.92 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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