



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
28.10.2009 Bulletin 2009/44

(51) Int Cl.:
D06F 37/20 (2006.01)

(21) Application number: **09155091.3**

(22) Date of filing: **13.03.2009**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA RS

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(30) Priority: **22.04.2008 IT PN20080032**

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(54) **Household-type clothes washing machine with improved washing tub**

(57) Household clothes washing machine comprising a perforated rotating drum, a washing tub (3) mounted on to the outer casing of said washing machine and accommodating said rotating drum therein, an electric motor comprising a stator (6) and a rotor (7) arranged coaxially with the axis of rotation of said drum, and mounted externally to said tub on the rear side thereof, a counterpoise ballast (9) fixedly mounted on the outside of said wash tub, wherein the stator is applied on to a side surface of said counterpoise ballast.

Preferably, a pulley (10) is fixedly arranged on the outer end portion of said rotary drive shaft (8), and said rotor comprises a plurality of permanent magnets that are applied onto the outer ring of said pulley.

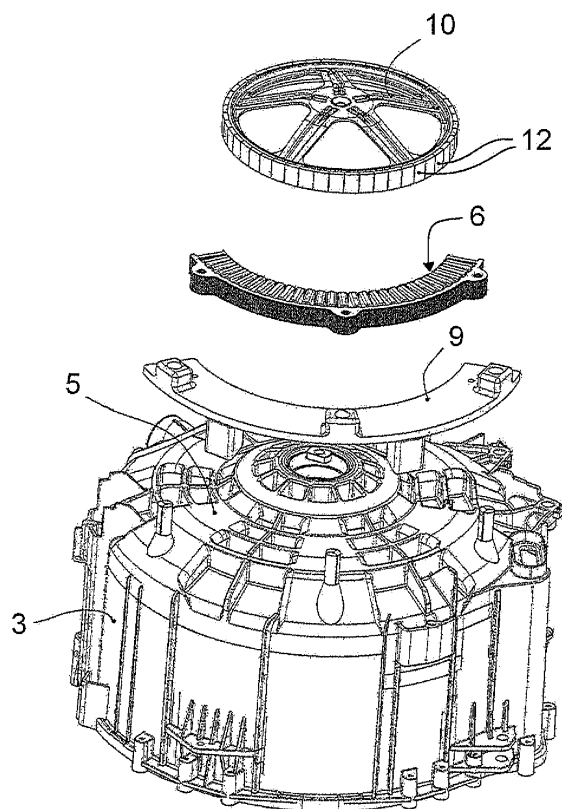


FIG. 6

Description

[0001] The present invention refers to an improved kind of clothes washing machine, which may be either of the front-loading or the top-loading type, and which is provided with a washing tub, a rotating drum housed within said washing tub, and a rotary drive shaft connecting said drum to a drive motor provided outside said tub, wherein said motor is of the kind involving a configuration that is generally referred to as "direct-drive" configuration in the art, characterized in that the rotor is directly press-fitted or shrink-fitted onto said rotary drive shaft of the drum, and therefore co-axially thereto, while the stator is associated to and firmly joined with the same washing tub.

[0002] In particular, the present invention relates to the manner in which such motor is embodied and arranged.

[0003] Clothes washing machines based on techniques that make use of such "direct-drive" kind of motor arrangements are largely known in the art by now, as extensively disclosed and described in a number of prior patent publications, among which there may be mere way of non-exhaustive documentary reference be cited following ones:

- EP 1428924 A1,
- EP0413915A1,
- US 2005/0210604 A1,
- US 2002/0059817 A1,
- EP 1619286 A2,
- DE 19937229 A1,
- European patent application no. 05111751.3 filed on Dec. 6th, 2005.

[0004] Accordingly, for the sake of greater simplicity and brevity, a detailed description of this kind of machines and motor configurations is intentionally omitted, since they are exhaustively described in the above-cited publications, which reference should therefore be made to for a closer view thereof.

[0005] The advantages of these clothes-washing machines using the technique based on the use of such motors, in which the rotor is directly press-fitted or shrink-fitted onto the rotary drive shaft of the drum are largely known and appreciated in the art by now; anyway, these mainly include the simplicity in the construction, a considerable space saving effect inside the outer casing of the machine, i.e. exactly where space is largely known to be generally at a premium, a substantial simplification in assembly, as well as a reduction in part count, i.e. in the number of parts that make up both the motor (shields, bearings, motor shaft, and so on) and the same machine (driving belt, pulleys).

[0006] However, it should equally be noticed that, for such overall reduction in the part count and manufacturing costs of the motor on the one side, the use of motors of the above-mentioned kind does on the other side require the related washing tubs to be specially designed

and constructed, so as to be adapted to be specially fitted to allow for such motors to be mounted and, in particular, the related stators to be duly associated and accommodated thereon.

[0007] Of course, it can be most readily appreciated that this special-purpose embodiment of said washing tubs requires them to be completely re-designed. Similarly, also all related production means and tools, such as dies, jigs, templates, and the like, as needed for manufacturing said washing tubs mounting such "direct-drive" motors, must be renovated accordingly.

[0008] Since completely re-designing the washing tubs and re-engineering the related industrial manufacturing process turn out as being quite expensive and demanding a course to be followed, this translates into a constraint that quite often tends to preclude the general advantage of using direct-drive motors, i.e. a circumstance that *de facto* puts a hindrance to a potentially advantageous re-engineering of the washing tub in general and, as a result, the use of direct-drive motors of the afore-mentioned kind.

[0009] It would therefore be desirable, and it is actually an object of the present invention, to provide a clothes washing machine fitted out with a synchronous motor mounted directly on to the rotary drive shaft of the rotating drum in a so-called direct-drive configuration, and provided with stator mounting means that enable a washing tub according to the prior art - and, therefore, already mass-produced on an industrial basis and freely and generally available to washing machine manufacturers - to be used in the application, without any need or constraint arising for a novel kind of washing tub to be designed and engineered for industrial production and, as a result, without any burden to be incurred in terms of high additional costs.

[0010] According to the present invention, these aims, along with further ones that shall become apparent from the following description, are reached in a particular kind of washing tub in a clothes washing machine that uses a synchronous motor of the above-mentioned direct-drive type, so as this is described in greater detail below by way of non-limiting example with reference to the accompanying drawings, in which:

- Figure 1 is a perspective, simplified view of the rear wall of a washing tub provided with a synchronous motor and a counterpoise ballast according to the present invention;
- Figure 2 is a detail view of the counterpoise ballast of the washing tub shown in Figure 1;
- Figure 3 is a front view of the rear wall of the washing tub according to the present invention in an improved embodiment thereof, as viewed orthogonally to the axis of rotation of the motor;
- Figure 4 is a perspective view of the washing tub

shown in Figure 3;

- Figure 4A is a detail view of the pulley illustrated in Figure 4;
- Figure 4B is an exploded view of the pulley illustrated in Figure 4, comprising the rotor magnets;
- Figure 5 is a detail view of the stator illustrated in Figures 3 and 4;
- Figure 6 is an exploded view of the washing tub and the motor in the embodiment illustrated in Figure 3;
- Figure 7 is a median cross-sectional, symbolical view of the outer casing and the washing tub in a clothes washing machine according to the present invention;
- Figure 8 is a same view as the one shown in Figure 7, but illustrating the motor arrangement in an improved embodiment of the present invention.

[0011] A clothes washing machine according to the prior art comprises a perforated rotating drum (not shown) for holding and handling the clothes to be washed, a washing tub 3 mounted on - even in a suspended or oscillating manner - to the outer casing of said washing machine and accommodating said drum, which is therefore housed rotatably inside said tub, a synchronous motor comprising a stator 6 and a rotor 7, arranged coaxially with the axis of rotation X of said drum and mounted externally to said tub on the rear side thereof, wherein said rotor 7 is shrink-fitted on to the rotary drive shaft 8 of said drum in a manner and with means as generally known as such in the art.

[0012] In addition, on to an outer surface of said washing tub 3 there is usually applied an appropriate counterpoise ballast, the purpose of which is largely known to those skilled in the art, along with the principles and peculiarities of constitution and application thereof in association with the washing tub 3.

[0013] According to the present invention, the counterpoise ballast 9 that is mounted to said washing tub is so shaped, formed and assembled onto the tub as to be able to comply with following two basic requirements, i.e.:

- a) it must be able to be coupled to said washing tub without any need arising for the latter to undergo any design modification or - if a modification is anyway required - this must be simple and marginal enough to avoid implying either an expensive re-design of the tub or a need for new dies and/or manufacturing tools to be generated;
- b) upon being associated to said washing tub, it must ensure such overall shape and configuration as to be able to adequately support said stator 6, when of course arranged in the most appropriate position for

it to be able to electromagnetically couple with said stator in as efficient as possible a manner.

[0014] Basically, and with particular reference to Figures 1 and 2, the present invention is based on the fact that the counterpoise ballast 9 is constructed and mounted against the rear wall 5 of the washing tub in such manner as to be able to not only perform its actual duty of constituting a means for balancing and damping the oscillations of the washing tub, but also to perform as a mechanical interface means between said washing tub and said stator 6, so that the same washing tub will not require any radical modification, which - as repeatedly noted hereinbefore - is the actual purpose and advantage of the present invention.

[0015] It can at the same time be most readily appreciated that the design and the size of each counterpoise ballast, as well as the kind of coupling provided for the latter to be associated to the washing tub, shall be defined and selected based on both the shape and the size of the stator, as well as on the actual configuration of the coupling means, such as holes, undercuts, and the like, that are provided on said tub for them to be able to then engage corresponding means on said counterpoise ballast 9.

[0016] The present invention as described above does further allow for a number of advantageous improvements.

[0017] So, according to a first aspect, with reference to Figures 3, 4 and 4A, on the outer end portion of the rotary drive shaft 8 there is provided - coaxially thereto - a pulley 10; preferably, such pulley is of the kind that is usually associated to said rotary drive shaft when the related clothes washing machine does not make use of a direct-drive motor configuration, but is rather based on the use of a drive motor of a conventional type, in which the whole motor is situated on an outer side of the tub, and is connected to said pulley 10 via a driving belt of a kind as generally known as such in the art.

[0018] On the outer side of this pulley 10, on the cylindrical surface 11 thereof, which would otherwise be engaged by the driving belt, there is mounted a ring of a ferromagnetic material 14, onto which there is applied a plurality of permanent magnets 12, as this can most clearly be seen in the above-cited Figures 3, 4 and 4A.

[0019] These permanent magnets 12 are distributed along and firmly joined with said cylindrical surface 11 in an orderly, regular manner, and preferably in contact with each other, so as to form the magnetic portion of the rotor of a permanent-magnet motor of a kind as generally known as such in the art.

[0020] In this way, a particularly simple and low-cost kind of rotor is practically obtained, since the support structure thereof is already and anyway available in the sense that use is simply made of the pulley of the rotary shaft comprised in the tub-drum-rotary shaft-pulley assembly of any existing clothes washing machine being currently produced, actually, whereas the permanent

magnets can most easily and readily be provided and associated to the outer cylindrical surface of said pulley with the help of means that are largely known as such in the art.

[0021] In addition, the circumstance of having the outer cylindrical, continuous surface of the pulley as a support surface for the permanent magnets, allows for said permanent magnets to be applied and arranged there according to a desired, optimum distribution pattern, which in other words means that they may be even distributed along such support surface as spaced from each other by any given separation interval.

[0022] According to a second aspect, and with reference to Figures 3, 4 and 5, another improvement can be obtained if the stator is constructed by applying individual stator coils 13 solely along a single arc "a" - lying coaxially to said rotary drive shaft 8 - of the full circumference.

[0023] Of course, each one of said stator coils 13 is firmly joined to said counterpoise ballast 9 independently using means and methods as generally known as such in the art. Above all, however, such stator coils are energized, i.e. power-supplied by a control unit of the machine (not shown), which delivers appropriate signals to and controls each single one of said coils in a synchronized manner depending on both

- the particular geometrical distribution pattern of said permanent magnets 11, and
- the actual speed at which said drum is due to be caused to rotate in accordance with the particular operating step of a washing programme it is required to go through.

[0024] Conclusively, and with particular reference to Figure 3, it can be seen that a kind of linear motor is in this way embodied, in which the rotating element, i.e. the individual permanent magnets 12 are not distributed according to a rectilinear arrangement, as this is conventionally the case, but rather along the above-mentioned arc "a".

[0025] Therefore, those skilled in the art will also be able to appreciate that even the power-supply control means used to energize the individual stator coils 13 shall be designed and embodied - and of course also connected to the respective stator coils - in a manner that is consistent with the particular structure of said "arc-shaped" stator and the kind of performance being required each time.

[0026] A further advantage of the above solution lies in the fact that the simplified construction of said counterpoise ballast 9 allows for the number of stator coils to be easily increased, this being a circumstance that significantly promotes a great flexibility in the performance abilities and, as a result, in the production of clothes washing machines made in accordance with the present invention.

[0027] In a third aspect, and with particular reference to Figures 7 and 8, a further improvement can be obtained

if, as this is frequently the case with clothes washing machines of the front-loading type, the axis of rotation X of the drum is slightly inclined by an angle "i" upwards so as to enable the user to more conveniently gain access to the loading opening of the drum.

[0028] Under such circumstance, the rear portion 19 of the washing tub turns out as being of course inclined downwards, when viewed according to a fore-to-rear orientation thereof.

[0029] As a logical consequence, in this case, the lower portion 20 of the wash tub comes to lie in a re-entrant position relative to the position of the higher portion 21 thereof, which practically means that said higher or upper portion 21 behaves as a sloping canopy, i.e. overhang over said lower portion 20.

[0030] As a result, in the lower region of the space defined by this sloping overhang, contiguously to the rear wall 19 of the wash tub, a lower volume 22 is created, which is free of any outer obstruction whatsoever.

[0031] This free lower volume 22 may therefore be used to an advantage for said stator 6 to be accommodated there, so that the rearward bulk of said stator, i.e. the space taken by it rearwards, does not extend beyond a vertical plane V passing through the upper edge 23 of the rear wall of the tub and extending parallel to the rear wall 24 of the outer casing of the machine, as this is symbolically represented in Figure 8.

[0032] It will therefore be most readily appreciated that, advantageously, said stator does not require any additional space to be available at the rear of said tub for it to be accommodated, thereby enabling the depth size of the same tub to be increased without any other design condition or feature having to be altered or modified, or, as an alternative thereto, the outer case of the machine can itself be made correspondingly slimmer in the same direction, thereby favouring an overall reduction in the size and space requirements of the machine.

[0033] As all those skilled in the art are well aware of, both above-cited circumstances are largely appreciated and highly demanded not only by washing machine manufacturers, but also - and primarily - by washing machine users themselves.

Claims

1. Household clothes washing machine, either of the front-loading or the top-loading type, comprising:

- a perforated rotating drum,
- a washing tub (3) mounted on to the outer casing of said washing machine and accommodating said rotating drum therein,
- a synchronous permanent-magnet motor comprising a stator (6) and a rotor (7), arranged coaxially with the axis of rotation (X) of said drum, and mounted externally to said tub on the rear side thereof, said rotor (7) being shrink-fitted on

to the rotary drive shaft (8) of said drum,
 - a counterpoise ballast fixedly mounted on the
 outside of said wash tub (3), **characterized in**
that said counterpoise ballast (9) is mounted to
 the rear wall (5) of said wash tub, and said stator
 (6) is applied on to a side surface of said coun-
 terpoise ballast (9).

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2. Clothes washing machine according to claim 1,
characterized in that a pulley (10) is fixedly ar-
 ranged on the outer end portion of said rotary drive
 shaft (8), and **in that** on the outer side of this pulley
 (10) there is applied a ring of a ferromagnetic material
 (14), wherein a plurality of permanent magnets (12)
 are applied onto said ring (14). 10
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3. Clothes washing machine according to claim 1,
characterized in that said stator (6) comprises a
 plurality of coils (13), which are arranged according
 to and distributed along an arc (a) of a circumference
 (c), the remaining arc of said circumference being
 on the contrary free of any stator coil whatsoever. 20
4. Household clothes washing machine according to
 claim 3, **characterized in that** the axis of rotation
 (X) of said shaft rotary drive (8) is slightly inclined by
 an angle (i) relative to a horizontal plane, and **in that**
 said stator coils (13) are arranged on the rear lower
 portion (20) of said tub. 25
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5. Clothes washing machine according to claim 4,
characterized in that said stator coils are distribut-
 ed so that the space occupied by them at the rear
 thereof does not extend beyond, i.e. is delimited by
 the vertical plane (V) passing through the rear upper
 edge (23) of said tub and extending parallel to the
 rear wall (24) of the outer casing of the machine. 35
6. Clothes washing machine according to any of the
 claims 2 to 5, **characterized in that** said motor (8)
 is a linear motor. 40

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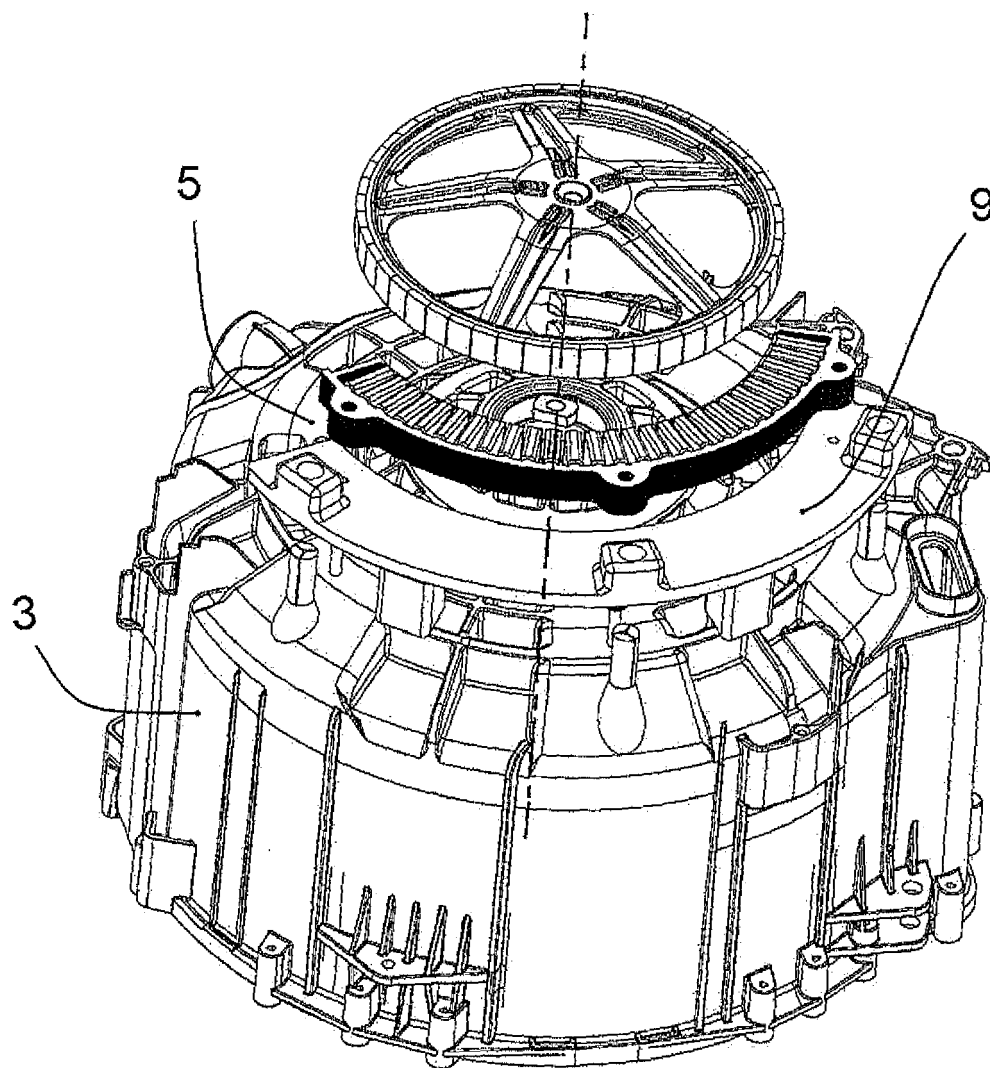


FIG. 1

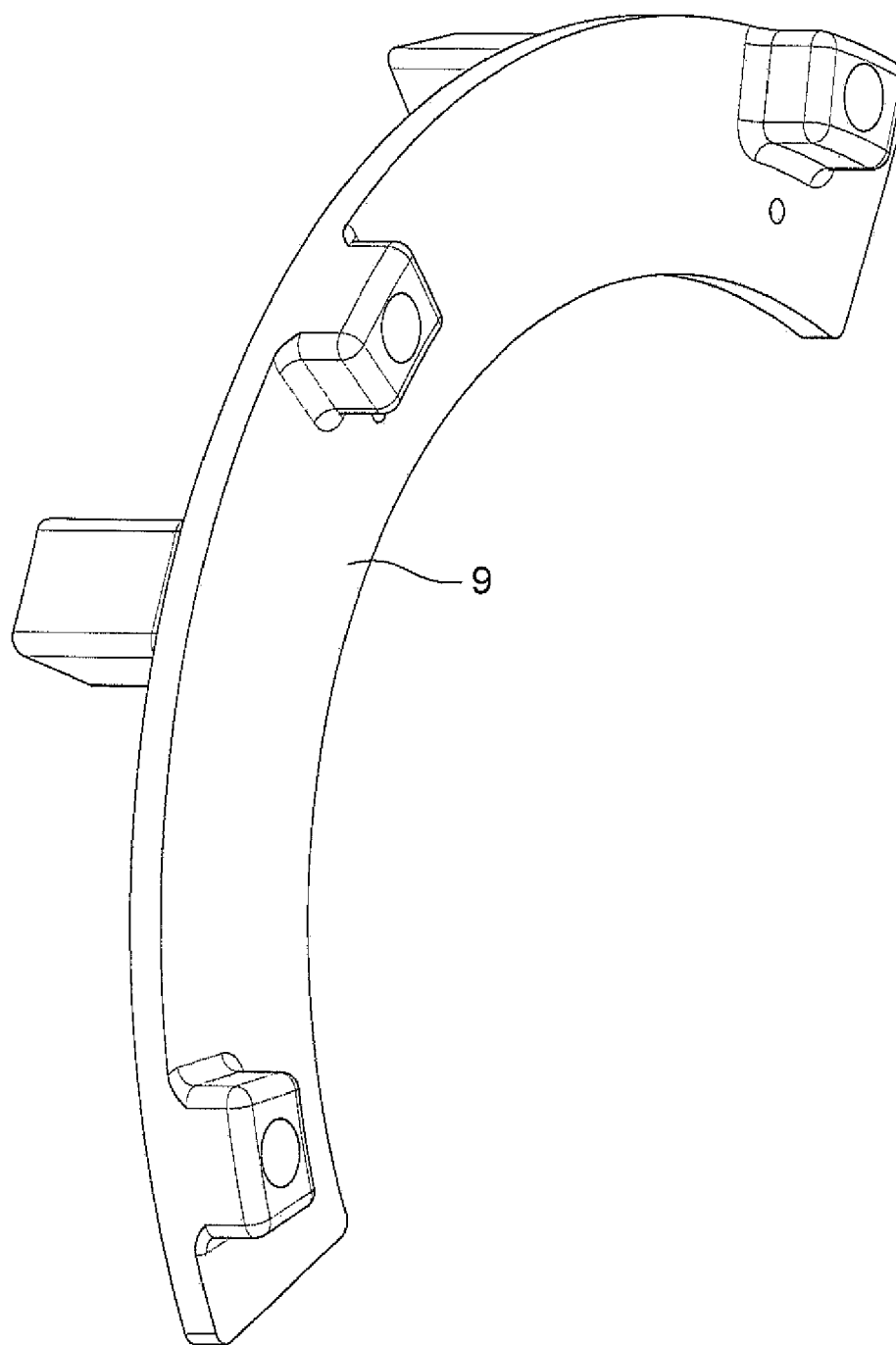


FIG. 2

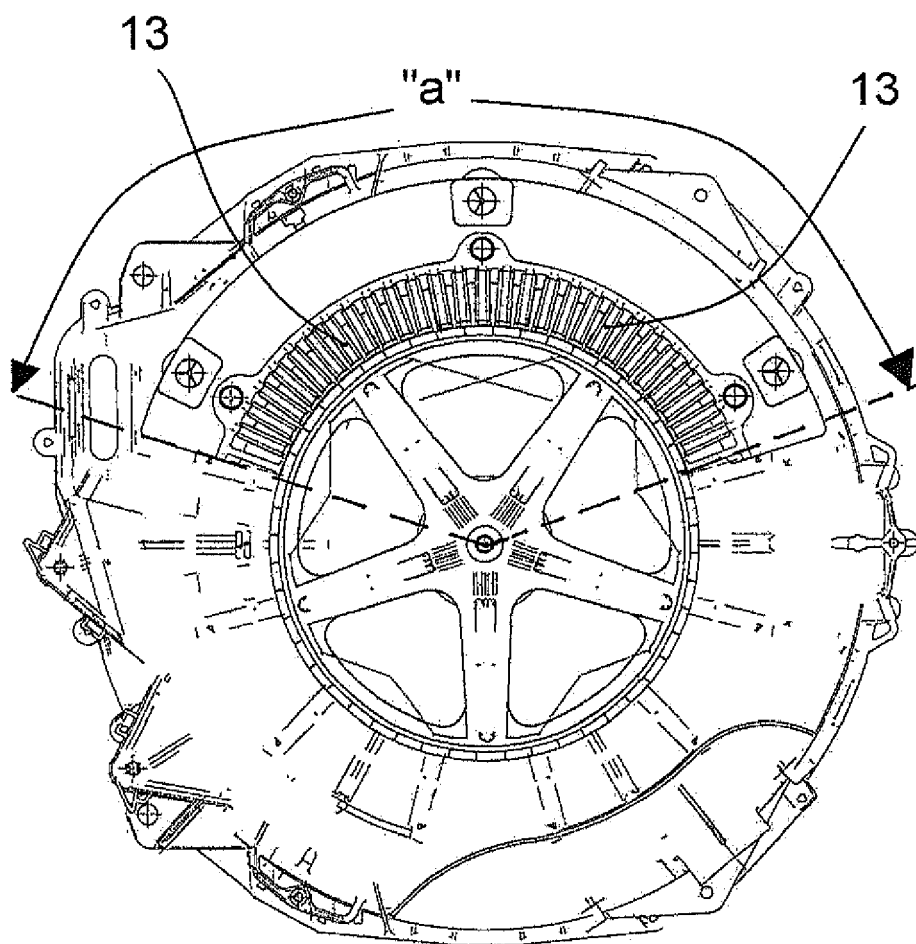


FIG. 3

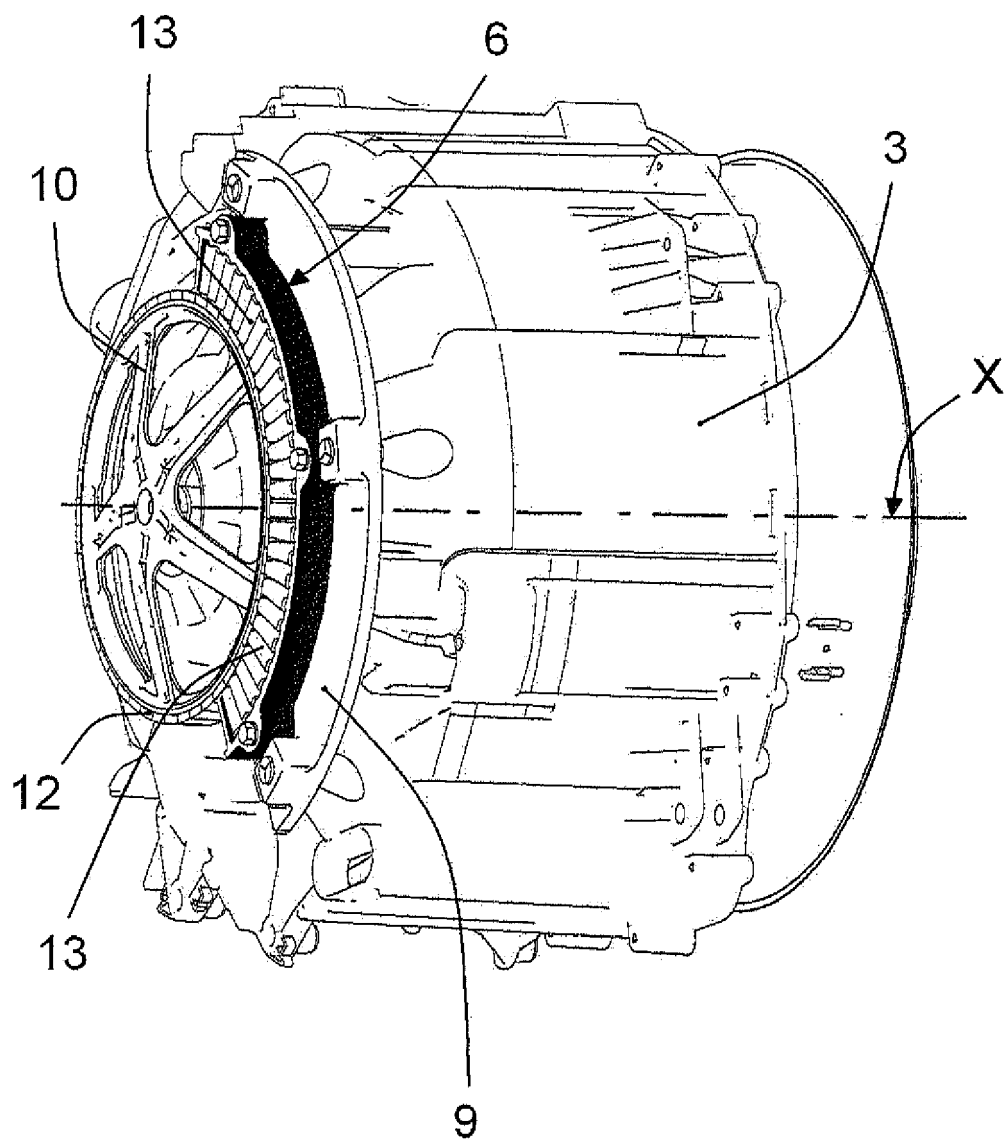


FIG. 4

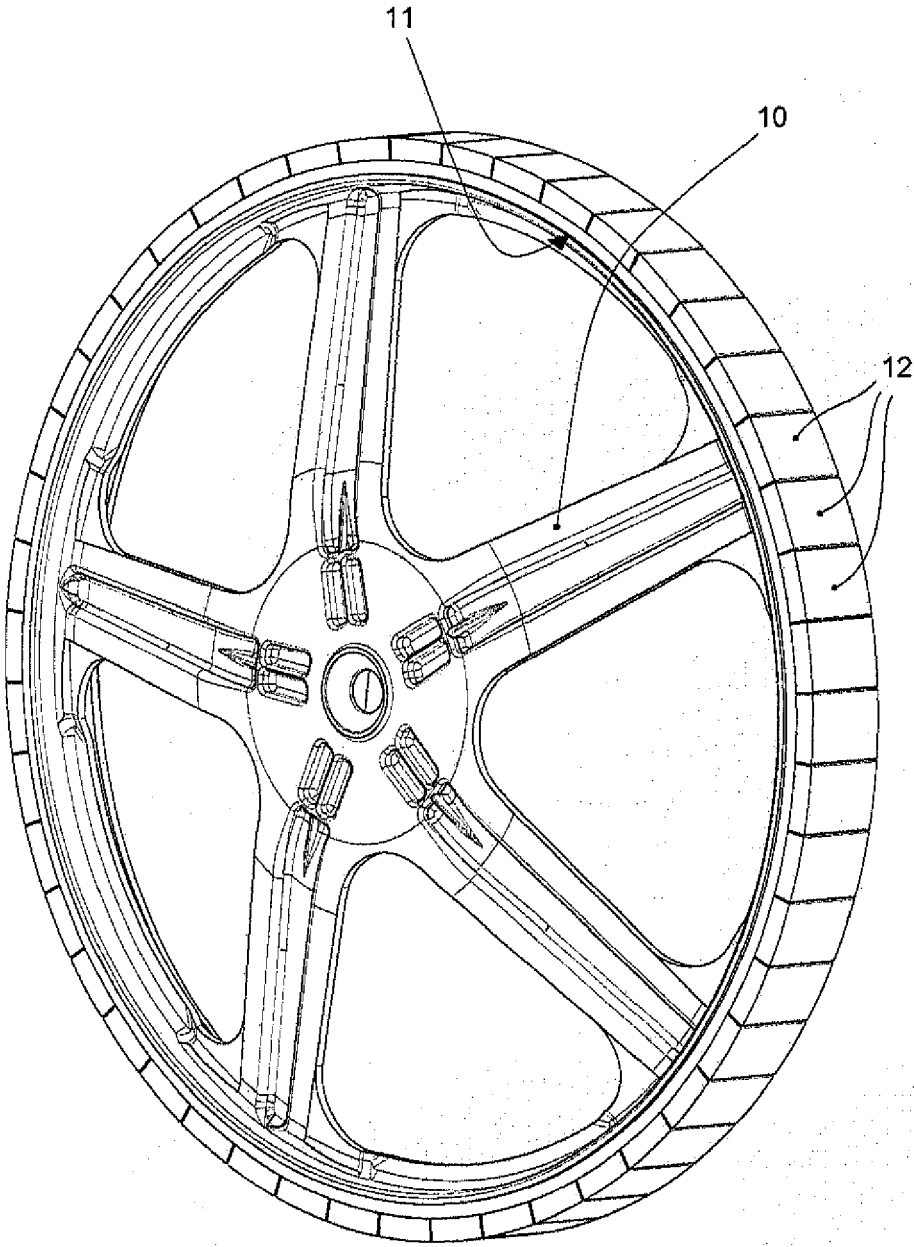


FIG. 4A

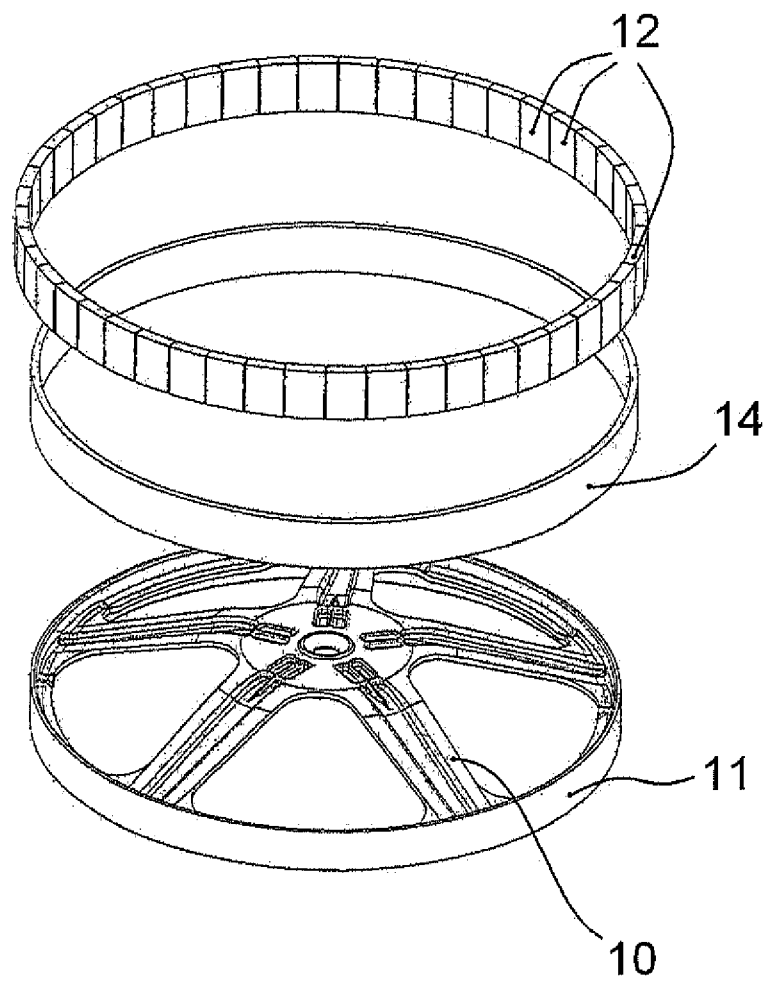
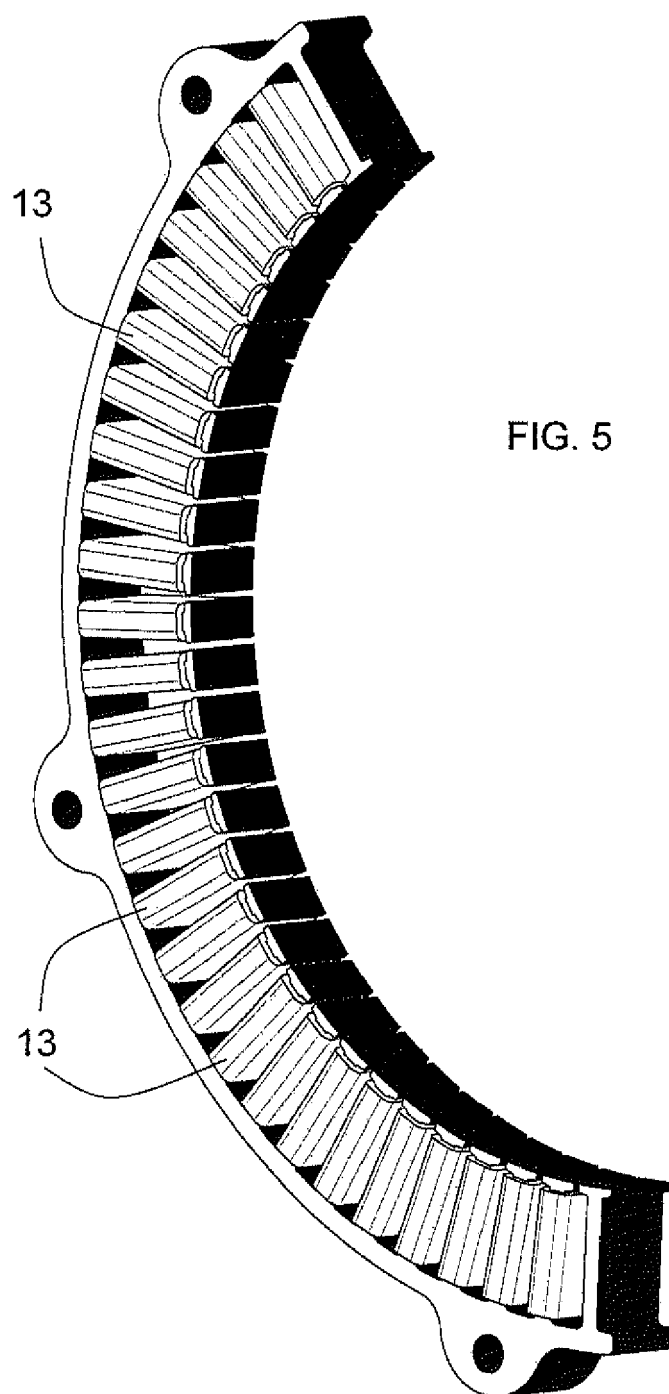


FIG. 4B



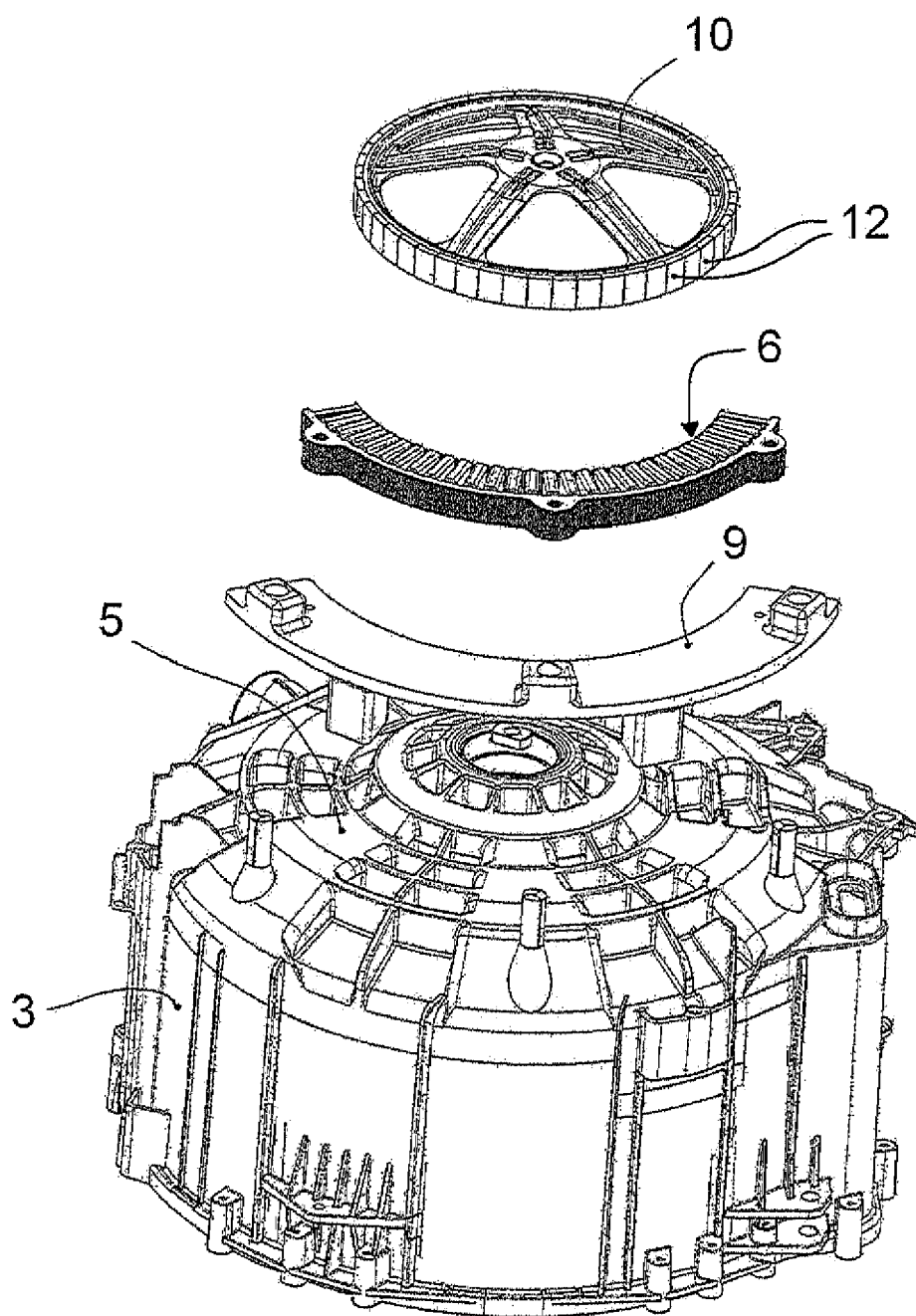


FIG. 6

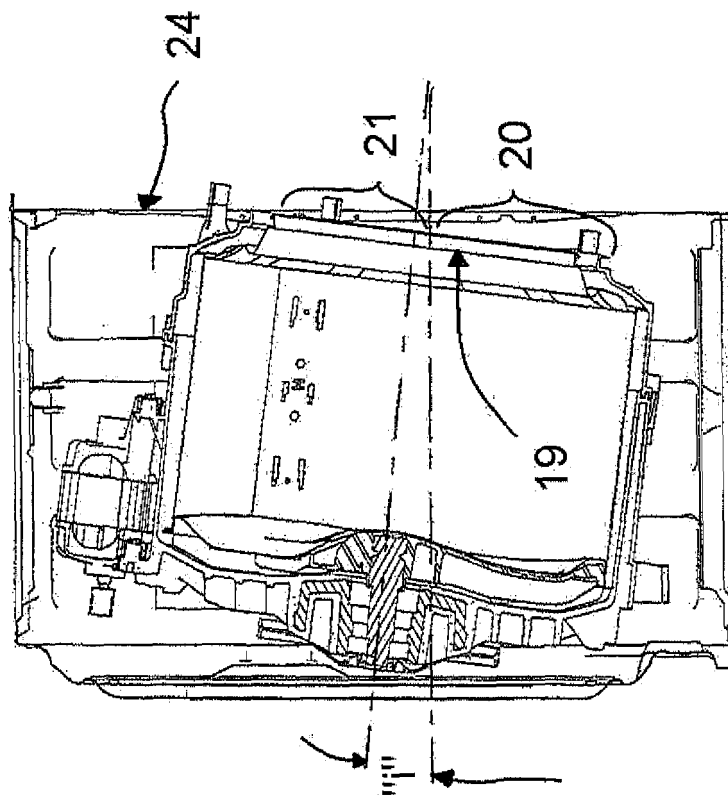


FIG. 7

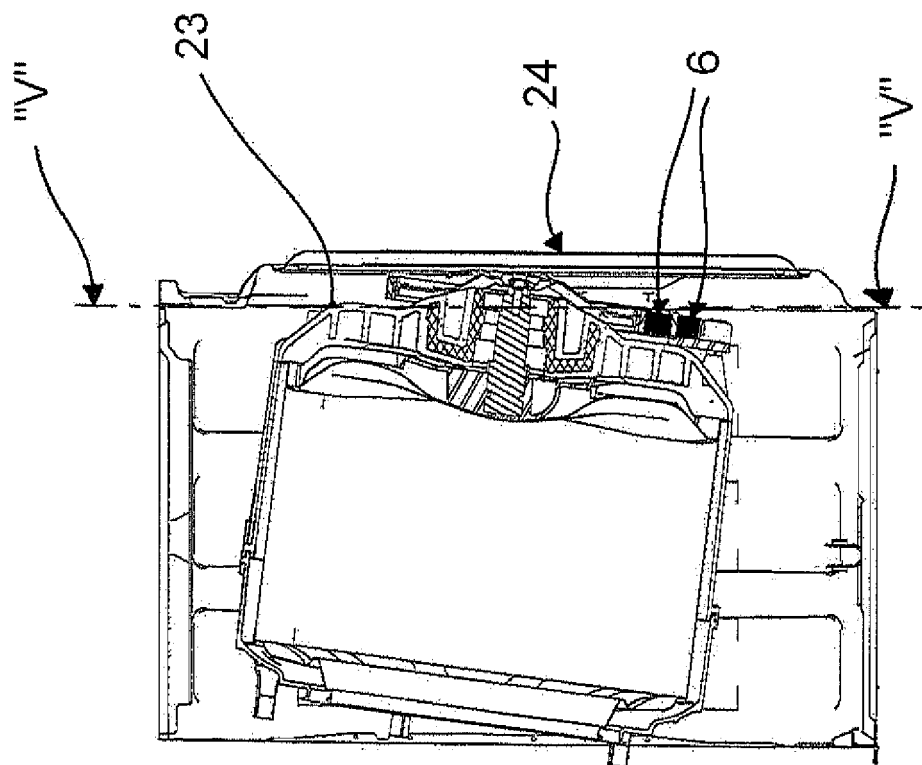


FIG. 8



EUROPEAN SEARCH REPORT

Application Number
EP 09 15 5091

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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 17 July 2009	Examiner Hannam, Martin
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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