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(54) **Laundry dryer**

(57) Clothes drying machine comprising a rotating drum (2) adapted to receive laundry items (3) to be dried, one or more clothes lifters (4) provided on an inner annular surface (5) of the drum (2), and an electric circuit for determining the electrical resistance and/or conductivity of the laundry contained in the rotating drum (2), each clothes lifter (4) comprises at least a first electrode (6) and at least a second electrode (7) adapted to contact the laundry and electrically insulated from each other, a first conductive contact member (8) and a second conductive contact member (9), extending all along an external annular surface (10) of the drum (2), are electrically connected to the first electrode (6) and to the second electrode (7), respectively, the conductive contact members (8, 9) are electrically insulated from each other, a first sliding contact (11) and a second sliding contact (12) are adapted to slide along the first conductive contact member (8) and the second conductive contact member (9), respectively, in constant galvanic connection therewith when the drum (2) is rotating, and a control unit (13) is electrically connected to both sliding contacts (11,12) for measuring an electrical quantity depending on the residual moisture content in the laundry being dried and connecting said first and second electrodes (6, 7).

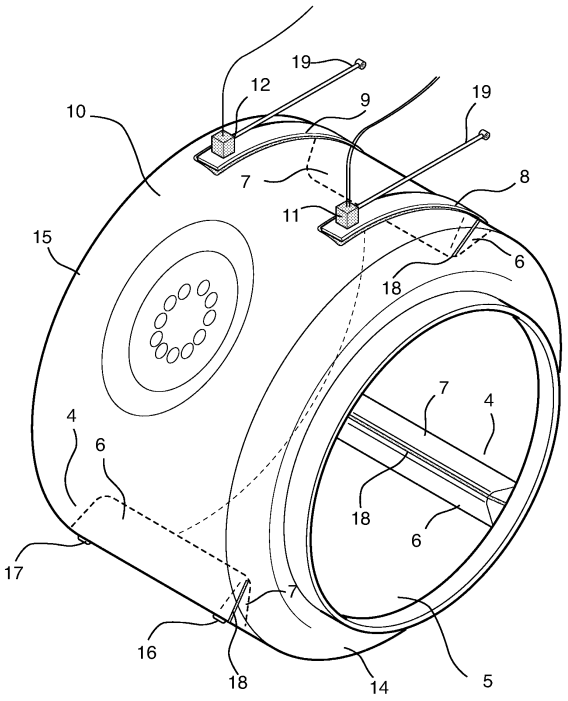

FIG 3

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Description

[0001] The present invention refers to a clothes drying machine.

[0002] In a laundry dryer, a very important feature is the ability to appropriately measure the degree of dryness of the clothes in order to adjust the duration of the drying cycle accordingly. To this purpose, a laundry dryer is generally provided with an electric circuit adapted to measure the residual moisture content in the clothes based on such parameter as the electric conductivity or resistance. Such circuit provided to carry out these moisture measurements generally comprises an electrically conductive contact strip supported on the metal annular wall of the dryer drum. The strip is electrically insulated from the drum by an electrically non-conductive pad bonded to the drum and interposed between the strip and the drum. On the other hand, the strip itself is electrically connected to electrodes, i.e. electric terminals, provided on the clothes rising ribs, or lifters, disposed on the metal inner surface of the annular wall of the drum.

[0003] The electrodes are adapted to contact the laundry placed within the drum as it is tumbled during the rotation of the same drum, and they are suitably insulated from the metal inner surface of the drum annular wall by means of non-conductive elements.

[0004] A scanning arm carrying a brush is mounted on the machine casing such that the brush is able to engage the conductive strip. The brush itself is electrically connected to a control unit, which is also electrically connected to the metal inner surface of the drum annular wall acting as the electric terminal of the circuit.

[0005] The wet clothes inside the drum enable the electrodes on the drum clothes lifters to establish an electric communication with the metal inner surface of the drum, thereby closing, i.e. completing the circuit.

[0006] In practice, the wet clothes connect the electric terminals of the circuit, i.e. the electrodes on the one side and the metal inner surface of the drum on the other side.

[0007] When an electric current is supplied to the circuit, this current can therefore flow through the wet clothes being dried, and a control unit in the machine can calculate the resistance and/or the conductivity of said clothes, thereby determining the appropriate duration of the drying cycle being performed.

[0008] As the clothes tumble within the drum, they keep falling against the metal inner surface of drum, wherein heavier clothing items, as well as buttons, zippers and other metal or, anyway, hard ornaments that may be associated with the clothes being dried or hanging loose thereamong (e.g. coins) have a tendency to strike against the metal inner surface and generate noise in the course of the drying process. Furthermore, the metal drum works in this case as a resonant chamber, so that the level of the thus generated noise is eventually boosted.

[0009] A need is therefore felt for the noise generated by clothes and other items tumbling within the dryer drum to be suitably reduced.

[0010] To compensate for or reduce the noise generated by the clothes and items being tumbled in the dryer drum, use is currently made of sheets of plastic foam, such as for instance polypropylene foam, to line the metal inner surface of the drum as a soundproofing means, or use is even made of a drum that is entirely made of such polymeric materials as resins or plastics that are inherently effective in dampening noise.

[0011] However, both these sound-deadening solutions have the drawback of making the inner surface of the drum electrically non-conductive, since polymeric materials, as they are generally used to this purpose, are good electric insulators.

[0012] It readily appears, therefore, that the afore-described electric circuit used to measure the residual moisture content of the clothes being dried would not be able to operate in this case, since the inner surface of the drum annular wall - owing to its being electrically non-conductive - cannot act as an electric terminal, i.e. is not in a position as to perform as an electric contact of the circuit to be connected - via the clothes - to the other electric terminals of the circuit, i.e. the electrodes provided on the clothes lifters inside the drum.

[0013] It is therefore a main object of the present invention to provide a drying machine, which is effective in doing away with the above-noted drawbacks of the cited prior art.

[0014] According to the present invention, this aim, along with further ones that will become apparent from the following disclosure, is reached in a drying machine that incorporates the features as defined and recited in the claims appended hereto.

[0015] Features and advantages of the present invention will anyway be more readily understood from the description that is given below by way of nonlimiting example with reference to the accompanying drawings, in which:

- Figure 1 is a front elevational, cross-sectional view of a drying machine according to the present invention;
- Figure 2 is an enlarged view of a detail of Figure 1;
- Figure 3 is a perspective view of the drum of the drying machine according to the present invention;
- Figure 4 is a perspective view of the drum according to a second embodiment of the present invention.

[0016] With reference to the above-cited Figures, the drying machine, as generally indicated with the reference numeral 1, comprises a rotating drum 2 adapted to receive and hold clothes items 3 to be dried, one or more clothes lifters 4 provided on an inner annular surface 5 of the drum 2, and an electric circuit for determining the resistance and/or conductivity of the laundry contained

in the rotating drum 2.

[0017] Each clothes lifter 4 comprises at least a first electrode 6 and at least a second electrode 7 adapted to contact the laundry, wherein said electrodes are electrically insulated from each other.

[0018] There are provided a first conductive contact member 8 and a second conductive contact member 9, which extend round an external annular surface 10 of the drum 2 and are electrically connected to the first electrode 6 and to the second electrode 7, respectively; such conductive contact members 8, 9 are electrically insulated from each other.

[0019] A first sliding contact 11 and a second sliding contact 12 are provided to slide along the first conductive contact member 8 and the second conductive contact member 9, respectively, under constant galvanic connection therewith when the drum 2 is rotating.

[0020] A control unit 13 is electrically connected to both sliding contacts 11, 12 for measuring an electrical quantity depending on the residual moisture content in the laundry being tumbled in the drum and connecting said first and second electrodes 6, 7.

[0021] The drying machine is provided with an outer casing adapted to allow the control panel of the machine to be mounted thereon, as well as a rotating drum 2 to be accommodated therein, along with motor and blower means.

[0022] Such outer casing is provided with a door enabling the user to gain access to the interior of the drum through an access opening. The drum 2 is mounted inside this casing for rotation about the central axis thereof, as driven by a motor arranged to drive the drum 2.

[0023] Within said outer casing, the drum 2 is also arranged so as to be included in an air flow-path, thereby enabling dry heated air to be forced therethrough to remove moisture from the clothes being tumbled therein.

[0024] The drum 2 can comprise a side wall made of metal, in particular stainless steel, and lined inside with a sound-dampening layer in the form of an electrically non-conductive sheet, or it can comprise a side wall made of electrically non-conductive polymeric material, the latter embodiment being the one illustrated in the Figures accompanying this description.

[0025] One or more clothes lifters 4, adapted to assist in appropriately tumbling the clothes being dried in the drum 2, are provided on the inner annular surface 5 of the drum side wall.

[0026] The drum 2 can include a front flange 14 with a clothes-loading access opening and a rear flange 15 that is mechanically connected to a shaft about which the drum 2 is adapted to rotate. The flanges 14, 15 may be made both of metal and plastics and - possibly - in a single-piece unitary construction with the side wall of the drum.

[0027] In an alternative embodiment, the drum can be comprised of a cylindrical side wall that is open at the front and rear ends thereof. The cylindrical side wall is rotatably fitted to a front support and a rear support to close the respective ends of the drum, while allowing the cylindrical side wall to rotate relative to the front and rear head members, which are stationary relative to the outer cabinet. Sealing members, fitted between the front support and the cylindrical side wall and the rear support and the cylindrical side wall, are provided for both allowing relative motion and preventing leakages.

[0028] Each clothes lifter 4 comprises at least a first electrode 6 and at least a second electrode 7 that are electrically insulated from each other and adapted to contact the laundry placed within the drum 2 as it is tumbled during the rotation of the same drum 2. The first and the second electrode 6, 7 may for instance be provided in the form of a pair of metal surfaces that are electrically insulated from each other and associated externally to a support structure, which is advantageously made of an electrically non-conductive material, is applied to the inner annular surface 5 of the drum 2.

[0029] It will of course be most readily appreciated that the greater is the extension of such surfaces, the greater will be the ability thereof to come into contact with the clothes being dried and, hence, the greater will be the accuracy in the measurement of the conductivity of the same clothes, in particular when such clothes have already reached a relatively advanced stage of the drying process, i.e. are already in a near-dry condition, or when the laundry load in the drum is a relatively small one.

[0030] The first electrode 6 of each clothes lifter 4 is electrically connected to the first electrically conductive contact member 8 consisting of a metal strip provided on the external annular surface 10 of the drum 2. For such electrical connection there is provided a first electrically conductive member 16 passing through a passage provided in the cylindrical wall of the drum 2 in correspondence to the portion of the drum 2 where the first electrode 6 of each clothes lifter 4 is situated. Such first electrically conductive member 16 protrudes from the cylindrical wall of the drum 2 in such manner as to bring about and establish the electric contact with the metal strip of the first electrically conductive contact member 8.

[0031] In a fully similar manner, the second electrode 7 of each clothes lifter 4 is electrically connected to the second conductive contact member 9, which is in turn formed of a metal strip provided on the external annular surface 10 of the drum 2. The connection itself is ensured by a second electrically conductive member 17 that passes through a further passage provided in the cylindrical wall of the drum 2 in correspondence to the portion of the drum 2 where the second electrode 7 of each clothes lifter 4 is situated. Such second electrically conductive member 17 protrudes from the cylindrical wall of the drum so as to contact the second electrically conductive contact member 9.

[0032] The electrically conductive members 16, 17 passing through the wall of the drum are of course so positioned as to prevent them from being capable of coming into contact with each other, while ensuring an effective electrical insulation between the first and the second

electrode 6, 7.

[0033] Advantageously, the first and second electrically conductive members 16, 17 are provided in a single-piece unitary construction, i.e. integral with the first and second electrodes 6, 7, respectively, and may for instance consist of metal tongues, or the like, arranged to pass through appropriate passages extending through the cylindrical wall of the drum 2 in correspondence to the positions where the clothes lifters 4 are situated.

[0034] In the case that the drum 2 is made of an electrically non-conductive material, e.g. a polymeric plastic material, there is no need for the electrodes 6, 7 and the respective electrically conductive members 16, 17 to be electrically insulated from the drum 2, actually.

[0035] In the case that the drum 2 is on the contrary made of metal, the electrodes 6, 7 are advantageously applied on to a support structure of the clothes lifters, which - further to ensuring proper electrical insulation between the first electrode 6 and the second electrode 7 - is also effective in electrically insulating the electrodes 6, 7 from the same drum 2. Insulating means are further provided between each electrically conductive member 16, 17 and the corresponding passageway through the wall of the drum, so as to electrically insulate each such electrically conductive member 16, 17 from the drum 2.

[0036] In a preferred embodiment of the present invention, each clothes lifter 4 is comprised of a first metal portion 6 and a second metal portion 7 acting as a first and a second electrode, respectively, which are applied to the inner annular surface 5 of the drum 2, as separated and electrically insulated from each other by a spacer member 18. In an advantageous manner, each clothes lifter 4 is comprised of two metal halves 6, 7 that are separated from each other through the insulating spacer member 18. These two halves 6, 7 may be positioned in a side-by-side arrangement relative to each other along a direction extending parallel or perpendicular to the axis of rotation of the drum, with the spacer member 18 arranged between such two halves as illustrated in Figures 3 and 4.

[0037] In the case that the drum 2 is made of metal, insulating means are provided to electrically insulate the first and the second metal half 6, 7 of each clothes lifter 4 from the drum 2. To such purpose, use can be made of the sound-dampening sheet lining the inner annular surface 5 of the drum 2. In addition, further insulating means are provided to electrically insulate the electrically conductive members 16, 17 of each metal half 6, 7 of the clothes lifters from the side, i.e. annular metal wall of the drum 2 made of metal.

[0038] It can of course be readily appreciated that, when the drum 2 is entirely made of an electrically non-conductive material, the metal clothes lifters 4 are directly associated to the inner annular surface 5 of the drum 2, without any insulating means having to be interposed therebetween.

[0039] Each conductive contact members 8, 9, which may for instance be a metal strip or band, is attached to the external annular surface 10 of the drum 2 with the help of appropriate fastening means or by adhesive bonding.

[0040] If the drum 2 is made of an electrically conductive material, both the metal strip of each conductive contact member 8, 9 and the related fastening means will of course be suitably insulated electrically from the drum 2 with the use of insulating means to be properly placed between the various electrically conductive bodies or members.

[0041] For example, in view of ensuring the required electrical insulation between the drum 2 and the conductive contact members 8, 9, electrically non-conductive members - usually made of rubber or plastics - are interposed between receptacles provided to extend through the wall of the drum and the fastening means due to be received therein, while a plastic band is positioned between the external annular surface of the drum 2 and the conductive contact member 8, 9 concerned.

[0042] On the other hand, an adhesive layer of electrically insulating glue would be able to provide the required electrically insulating effect, without any need arising for further or additional insulating means to be interposed between the conductive contact members 8, 9 and the drum 2, actually.

[0043] All this is further effective in ensuring that the first conductive contact member 8 and the second conductive contact member 9 are electrically insulated also from each other.

[0044] In addition, according to the present invention the clothes drying machine is also provided with a first sliding contact 11, which is adapted to slide on the first conductive contact member 8 in a constant galvanic connection therewith, and a second sliding contact 12, which is in turn adapted to slide on the second conductive contact member 9 in constant galvanic connection therewith, while the drum 2 is rotating.

[0045] The sliding contacts 11, 12 are made of graphite, copper or a similar material, and each one of them is preferably provided in the form of a contact wiper, or brush, associated to the internal structure of the machine so as to maintain a stationary, i.e. fixed position relative to the same machine. A scanning arm 19 may for example be provided for carrying each such brush, i.e. each such sliding contact 11, 12.

[0046] Each scanning arm 19 is mounted on the machine casing so as to be able to slidably engage the respective conductive contact members 8, 9 and enable the first and the second sliding contact 11, 12 to stay in a condition of electric contact constantly established with the first and the second conductive contact member 8, 9, respectively, while these members rotate jointly with the drum 2 during a drying cycle.

[0047] Both sliding contacts 11, 12 are electrically connected with a control unit 13 to form an electric circuit adapted to determine the variation in the electric conductivity and/or the electric resistance of the clothes contained and being handled in the rotating drum 2 during a

drying cycle.

[0048] The above-cited electric circuit is therefore basically comprised of a first contact path including the first electrode 6 of each clothes lifter 4, the first conductive contact member 8 and the first sliding contact 11, and a second contact path including the second electrode 7 of each clothes lifter 4, the second conductive contact member 9 and the second sliding contact 12, wherein the control unit 13 connects the two contact paths with each other.

[0049] The wet clothes inside the drum enable the first electrode 6 of each clothes lifter 4 to establish an electric communication with the second electrode 7 of each clothes lifter 4, thereby closing, i.e. completing the circuit.

[0050] The control unit 13 is adapted to power the electric circuit so that an electric current is able to flow across the electric circuit and, as a result, also through the wet clothes residing in the drum. Since the resistance or the conductivity, as the case may be, of the electric circuit depends on the residual moisture content in the clothes being dried, the control unit 8 is able to continuously determine the degree of dryness reached by the laundry at each moment during the operation of the drying machine, so as to be in a position as to identify an end-of-cycle condition, at which the drying cycle is to be interrupted upon reaching the final degree of dryness selected by the user for the clothes being handled.

[0051] It should further be noticed that the adhesive layer and the conductive contact members 8, 9 form a kind of sound-deadening lining that is particularly effective and advantageous in absorbing the sound waves generated by the clothes falling upon or colliding against the metal wall of the drum as the latter is rotating, especially when striking against such wall are some hard items generally associated to garment pieces, such as buttons or zippers.

[0052] This is of particular advantage in the case that the drum is made of metal, since it would contribute to boosting the noise-dampening effect generally ensured by the non-conductive sound-deadening sheet lining the inner metal surface of the drum.

[0053] The sound waves that are generated by the pulse-like occurrences deriving from the clothes striking against the inner surface of the drum are for the most part absorbed by the adhesive layer which, by the effect of its viscoelastic properties, substantially converts these sound waves into heat, thereby heating up the adhesive layer.

[0054] On the other hand, the sound waves that succeed in passing through and issuing from the glue layer are transmitted to the conductive contact members 8, 9, where they undergo further dampening.

[0055] In a particularly advantageous embodiment of the present invention, the conductive contact members 8, 9 are provided to cover most of the external annular surface 10 of the metallic drum 2, so as to be able to maximize the sound-wave absorption effect. In practice, the conductive contact members 8, 9 can be wrapped around the entire external annular surface of the drum 2, while of course ensuring due electrical insulation between the first and the second conductive contact member 8, 9.

[0056] Conclusively, it can therefore be stated that the clothes drying machine according to the present invention enables the electric conductivity and/or the electric resistance of the clothes being handled within the rotating drum to be determined, even when the inner surface of the drum adapted to come into contact with said clothes is made of an electrically non-conductive material.

Claims

1. Clothes drying machine comprising a rotating drum (2) adapted to receive laundry items (3) to be dried, one or more clothes lifters (4) provided on an inner annular surface (5) of the drum (2), and an electric circuit for determining the electrical resistance and/or conductivity of the laundry contained in the rotating drum (2), **characterized in that** each clothes lifter (4) comprises at least a first electrode (6) and at least a second electrode (7) adapted to contact the laundry and electrically insulated from each other, a first conductive contact member (8) and a second conductive contact member (9), extending all along an external annular surface (10) of the drum (2), are electrically connected to the first electrode (6) and to the second electrode (7), respectively, said conductive contact members (8, 9) being electrically insulated from each other, a first sliding contact (11) and a second sliding contact (12) are adapted to slide along the first conductive contact member (8) and the second conductive contact member (9), respectively, in constant galvanic connection therewith when the drum (2) is rotating, and a control unit (13) is electrically connected to both sliding contacts (11,12) for measuring an electrical quantity depending on the residual moisture content in the laundry being dried and connecting said first and second electrodes (6, 7).

2. Clothes drying machine according to claim 1, wherein each clothes lifter (4) comprises a first metal portion that acts as the first electrode (6), and a second metal portion that acts as the second electrode (7), such portions being applied to the inner annular surface (5) of the drum (2) and electrically insulated from each other by an insulating spacer member (18).

3. Clothes drying machine according to claim 2, wherein each clothes lifter (4) is comprised of two metal halves that are separated from each other by said insulating spacer member (18).

4. Clothes drying machine according to any of the preceding claims, wherein a first electrically conductive

member (16) extends through the wall of the drum (2) to electrically connect said first electrode (6) of each clothes lifter (4) with said first conductive contact member (8).

5. Clothes drying machine according to any of the preceding claims, wherein a second electrically conductive member (17) extends through the wall of the drum (2) to electrically connect said second electrode (7) of each clothes lifter (4) with said second conductive contact member (9).

6. Clothes drying machine according to claims 4 and 5, wherein said first and second electrically conductive members (16, 17) are provided in the form of a single-piece unitary construction with the first and the second electrode (6, 7), respectively.

7. Clothes drying machine according to any of the preceding claims, wherein said electric circuit comprises a first contact path including the first electrode (6) of each clothes lifter (4), the first conductive contact member (8) and the first sliding contact (11), and a second contact path including the second electrode (7) of each clothes lifter (4), the second conductive contact member (9) and the second sliding contact (12), wherein the control unit (13) connects the two contact paths with each other.

8. Clothes drying machine according to any of the preceding claims, wherein each conductive contact member (8, 9) is attached to the external annular surface (10) of the drum (2) by means of an adhesive layer.

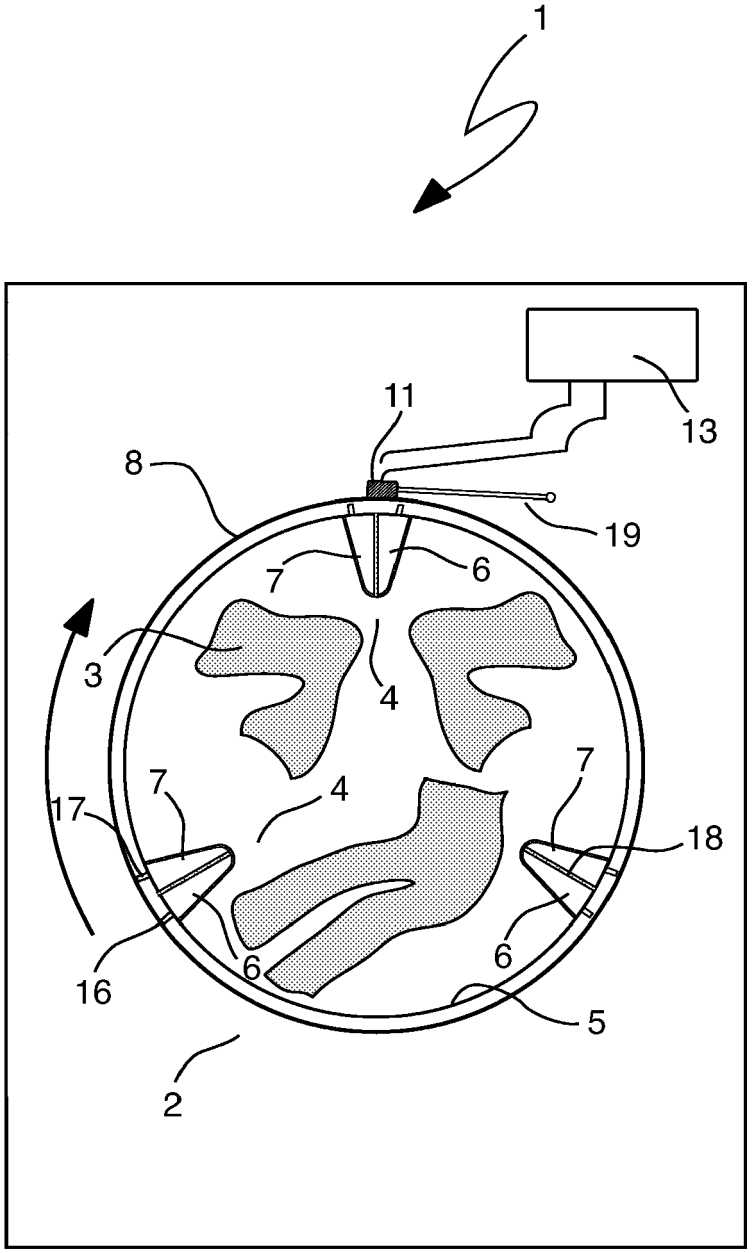

FIG 1

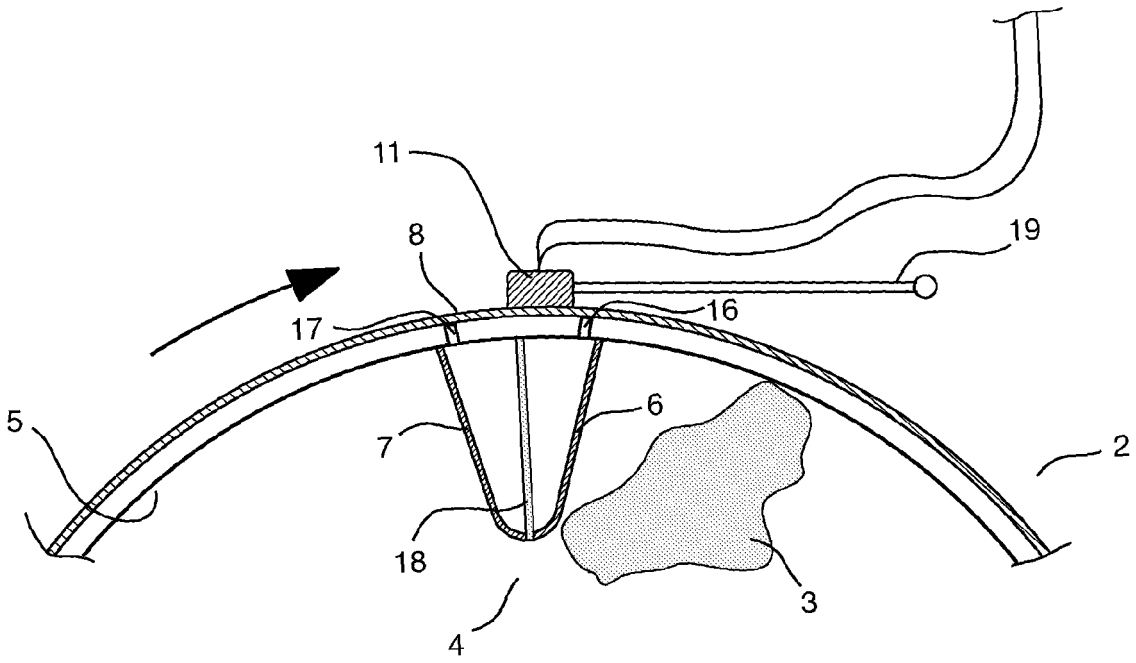

FIG 2

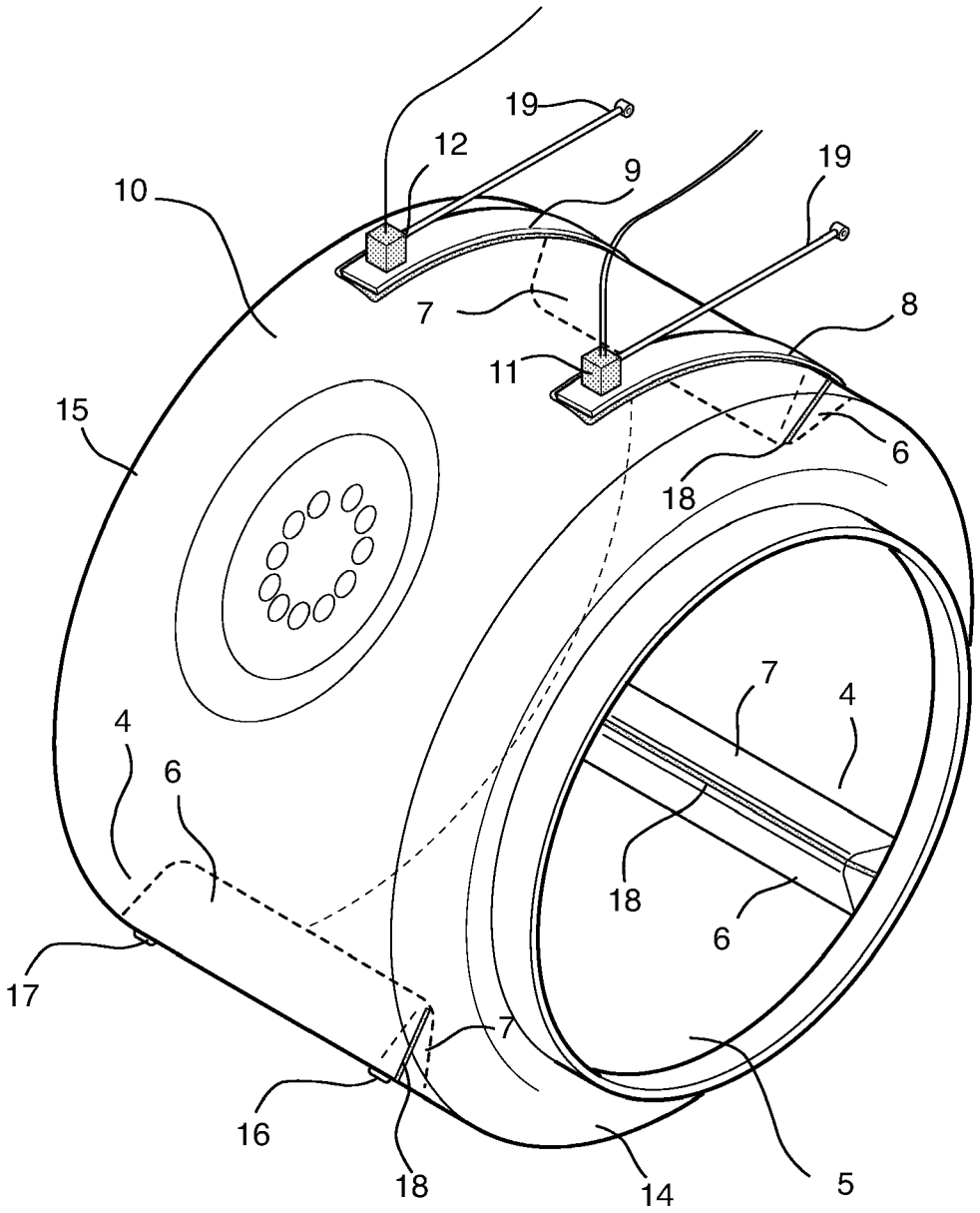

FIG 3

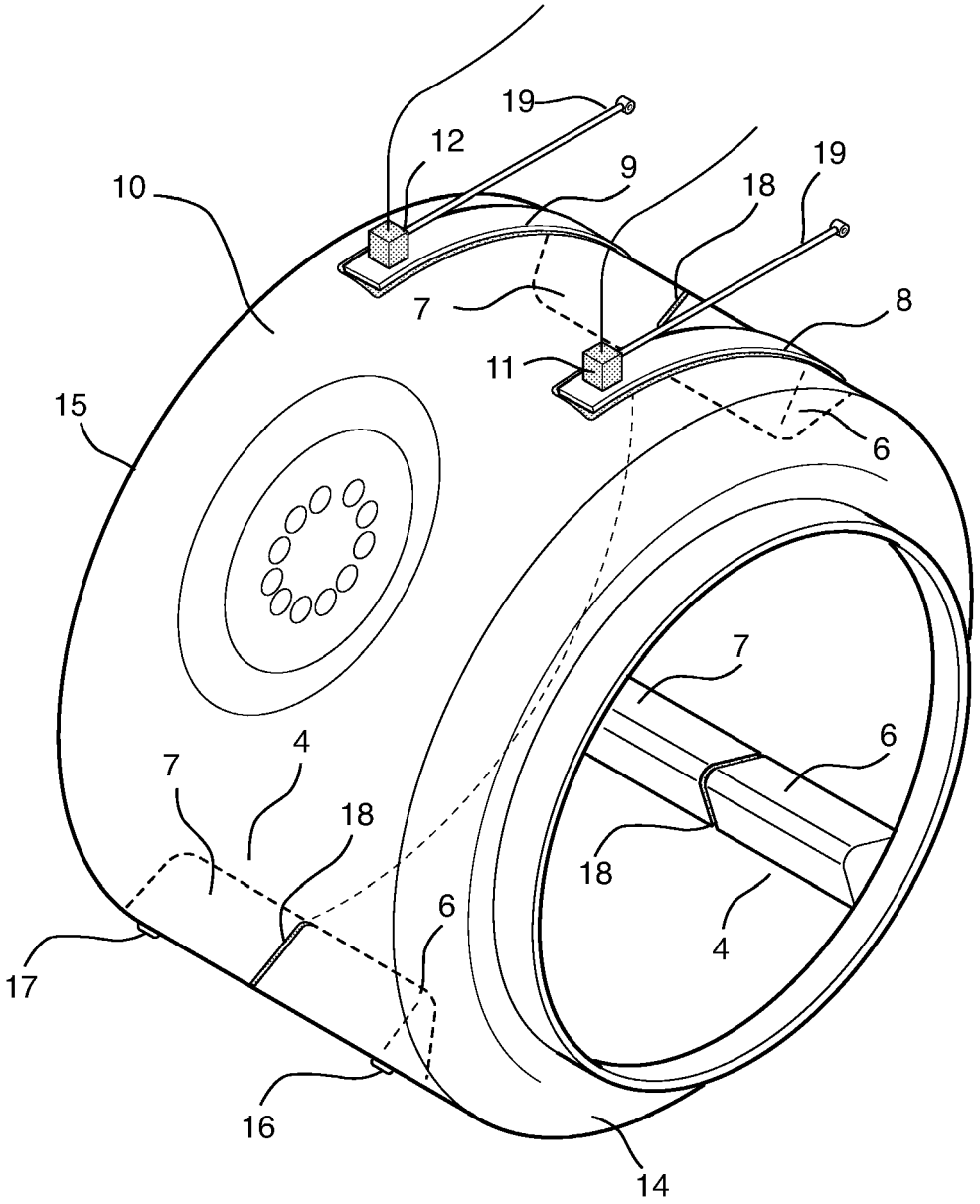

FIG 4

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EUROPEAN SEARCH REPORT

Application Number
EP 07 10 2792

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	8 August 2007	Jezierski, Krzysztof

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