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(54) **Title:** ARRANGEMENT FOR AUTOMATICALLY CLEANING AIR FILTERS FOR A CLOTHES DRYING MACHINE

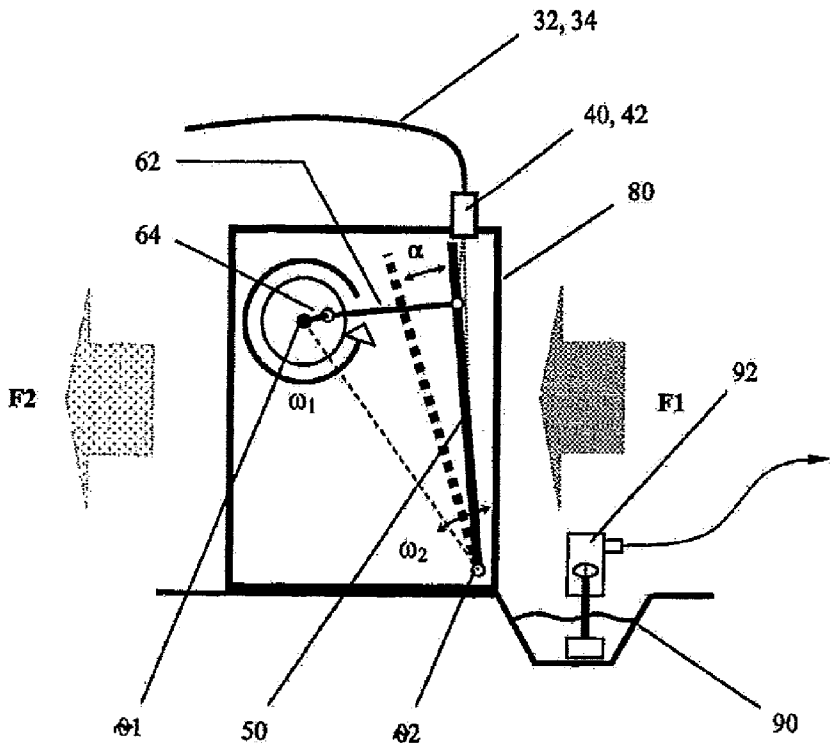


FIG. 2

(57) **Abstract:** An arrangement for automatically cleaning air filters, in particular adapted for use as applied to the drying circuit of a clothes drying machine operating according to a heat-pump principle, comprises at least one bladelike-jet spray nozzle (40, 42) for injecting a liquid and at least one air-filtering unit (50), wherein at least one of said air-filtering unit (50) and said liquid-injection nozzle (40, 42) is mounted so as to be able to move relative to a stationary frame (80), said relative movement being brought about by at least one actuator means (60) associated thereto.

WO 2009/015919 A1

ARRANGEMENT FOR AUTOMATICALLY CLEANING AIR FILTERS FOR A CLOTHES DRYING MACHINE

DESCRIPTION

The present invention relates to an automatic cleaning arrangement for air filters, in particular an automatic cleaning arrangement for air filters adapted for use as applied to the drying circuit of a clothes drying machine.

Appliances performing a drying duty, such as the nowadays widely used clothes drying machines or combined clothes washing and drying machines that will be simply referred to as tumble dryers hereinafter, may either be based on a heat-pump technology for their operation or make more traditionally use the condenser-type or exhaust-type working principles. The energy usage of a heat-pump tumble dryer is largely known to be smaller than the energy usage that is generally experienced in the use of a tumble dryer in which the process air, i.e. the air used for drying, is heated by means of electric heating elements. Now, such peculiar advantage of heat-pump tumble dryers persists, i.e. keeps up as such in time, provided that the drying circuit of the related machine remains perfectly efficient or, in other words, the air flow-rate in the drying circuit does not suffer any reduction for any reason whatsoever. In a tumble dryer based on such heat-pump technology, a battery of filters in a series arrangement is interconnected with the drying circuit of the machine in view of performing as a barrier provided to retain the lint generating from the clothes being tumbled and prevent it from continuing

along the circuit to eventually get trapped between the fins of the heat exchangers, thereby clogging them. For them to be prevented from being capable of affecting or even impairing the overall performance of the tumble dryer, as well as in view of preventing irregular conditions from arising to possibly affect the operation of the compressor included in the refrigeration circuit of the machine, these air filters must be subjected to frequent cleaning by the users.

Disclosed in EP 0 816 549 is a heat-pump tumble dryer, which is provided with a kind of self-cleaning air filter. The drying circuit of this machine comprises a heat exchanger and a lint-retaining air filter, which are removably housed in an enclosure mounted on the rear side of the outer casing of the tumble dryer. Provided on the bottom of such enclosure there are a pan for collecting condensation water and a pan for collecting the water used to flush and clean the air filter, respectively. Associated to these pans there are respective drain conduits allowing the water collecting thereinto to flow off. The pans themselves are provided and arranged to feature an adequate filling level so as to ensure that the filter flushing water would not overflow or gush back.

At the end of the drying process, the programme implemented in a hardware module in the tumble dryer calls for part of the rinsing water, or even the condensation water itself, to be conveyed towards a nozzle by means of a pump. A water flow diverter is provided in the water carrying circuit in proximity of the pump to cater for the case that it is more advantageous or appropriate for the rinsing or washing water to be recycled rather than being sent to the nozzle. Anyway, through said nozzle the air filter is hit by a jet of water that automatically flushes off the lint therefrom and causes it to collect and settle into the pan provided to collect the air-filter flushing water, as already mentioned hereinbefore. In another embodiment, the nozzle is supplied directly from the main water supply line.

The above-cited solution has a major drawback in that it makes use of a static air-filter cleaning arrangement. The air filter and the nozzle are in fact mounted in a stationary manner without any degree of freedom, so that they do not move relative to the structure of the tumble dryer as throughout the automatic cleaning

operation of the filter, i.e. as the air filter is automatically cleaned.

A further drawback derives from the fact that the nozzle only injects the water jet – always in the same direction and with the same intensity – onto just a part of the surface of the air filter.

Yet a further drawback lies in the complex construction of the related water-carrying circuit and the corresponding difficulties found in manufacturing it.

It is therefore an object of the present invention to provide an arrangement for automatically cleaning air filters that is effective in doing away with the drawbacks and disadvantages of prior-art arrangements of the same kind as they are known up to this time.

Within this general object, it is a purpose of the present invention to provide a dynamic kind of automatic cleaning arrangement for air filters, in which at least one of the nozzle and the air filtering unit is capable of moving relative to a reference system, in view of improving the cleaning action of the water jet issuing from the nozzle.

A further purpose of the present invention is to provide an automatic cleaning arrangement for air filters of the above-cited kind, which is further effective in attaining the above-noted object and purposes at fully competitive costs, .and is capable of being manufactured with the use of readily available equipment, tools and techniques.

Some advantageous developments and improvements are set forth in the appended claims, wherein it may be appropriate to put the emphasis on the fact that the inventive arrangement allows the surface of both faces of the air filtering unit to be flushed and cleaned, actually.

A further advantage relates to the possibility for the number of air filters to be arranged in series with each other for connection to the drying circuit to be reduced.

According to the present invention, the above-indicated aims, features and advantages, along with further ones that will become apparent from the following disclosure, are reached in an automatic cleaning arrangement for air filters incorporating the characteristics as defined and recited in the appended claims.

Features and advantages of the present invention will anyway be more readily understood from the description of an exemplary embodiment thereof that is given below by way of non-limiting example with reference to the accompanying drawings, in which:

- Figure 1 is a schematic view of the automatic cleaning arrangement for air filters according to the present invention; and

- Figure 2 is a schematic side view illustrating the kinematics used to actuate the filtering unit and control the relative movement thereof.

With reference to Figure1, the automatic cleaning arrangement for air filters according to the present invention comprises a reservoir 10 for collecting and storing a liquid mass, a plurality of water-flow adjusting means 22 and 24, a pump 30, a plurality of open-jet nozzles 40 and 42, an air filtering unit 50, an actuator means 60, and a control unit 70.

The reservoir 10 may for instance be in the shape of a parallelepiped and is connected on top to a water-supply conduit 25 and a vent conduit 26. The water-flow adjusting means 22, which may for instance be an electromagnetic valve, is associated to the conduit 25 and performs to adjust the liquid mass being let into the reservoir 10. From the lower portion of the surface of the reservoir 10 there extends a conduit 29, to which there is preferably associated a water-flow adjusting means 24, which may for instance be an electromagnetic valve, which is used to control the flow of the liquid mass being let out by means of the pump 30.

The pump 30 may for instance consist of a high-head, bi-directional delivery pump operated by a d.c. motor. From such pump there branch off a plurality of

pipes 32 and 34 connecting the pump 30 to a respective plurality of bladelike-jet nozzles 40 and 42.

Such bladelike-jet nozzles 40 and 42 are peculiar in that they provide a particular jet having a wide flare, i.e. opening-out angle, e.g. 110°, of the wedge-shaped fan formed by the liquid issuing from said nozzle at a high pressure. The bladelike-jet nozzles 40 and 42 are mounted in a conventional manner to a frame 80 (Figure 2) that consists of a container, as this shall be described in greater detail further on.

The air filtering unit 50 is comprised of a rigid load-bearing structure 52 in a preferably rectangular shape, to which there is attached a cloth 54 made of a medium-porosity (e.g. not in excess of 50 μm), single-yarn woven fabric or, anyway such fabric having a porosity allowing it to effectively retain such thin particles as lint. The air filtering unit 50 is accommodated within the frame 80 and is retained thereinside by means of a hinge Θ2. This hinge Θ2 is located at an end portion of the frame 80 lying opposite to the one at which the bladelike-jet nozzles 40 and 42 are mounted, so that the air filtering unit 50 is capable of also coming to lie in a position in which it is aligned with the spray plane of the bladelike-jet nozzles 40 and 42 thereabove.

The actuator means 60 is associated to the air filtering unit 50 in such manner as to enable the air filtering unit 50 to be actuated into performing a relative movement with respect to the frame 80. The actuator means 60 is secured to the frame 80 using conventional fastening means, and it is connected to the air filtering unit 50 via a connecting rod 62 and a crank 64 (Figure 2).

The control unit 70 controls the operation of the electromagnetic valves 22 and 24, the pump 30 and the actuator means 60 via a respective electric connection. Furthermore, the control unit 70 implements a firmware and holds data in a storage memory as required for enabling an application programme to be carried out.

Figure 2 is a schematic side view illustrating a kinematic arrangement provided

to cause the air filtering unit 50 to oscillate, i.e. to be brought into a swinging movement automatically. This kinematic arrangement forms an articulated quadrilateral of a crank-rocker arm type. Such articulated quadrilateral is formed of the crank 64, which has an end portion Θ1 that is firmly joined to the shaft (not shown) of the actuator means 60 perpendicularly thereto, the connecting rod 62, which has its two end portions rotatably connected to the crank 64 and a side of the bearing structure 52 of the air filtering unit 50, respectively, the air filtering unit 50 itself, which is linked to the frame 80 by means of a hinge Θ2, and – finally – the segment that, while joining Θ1 with Θ2, closes the articulated quadrilateral.

The actuator means 60 acts directly upon the crank 64 to thereby cause it to perform complete revolutions at an angular velocity ω1, whereas the air filtering unit 50 rotates in accordance with its hinge-type linkage Θ2 at an angular velocity ω2 to thereby perform a swinging movement involving oscillations of a given extent passing through a starting position with reference to the air filtering unit 50. Such starting position may in this case be defined, for example, as the position in which the air filtering unit 50 is inclined by some degree, relative to the spray plane of the two bladelike-jet nozzles 40 and 42 located thereabove, towards the actuator means 60.

The swinging movement of the air filtering unit 50 relative to the nozzle 40, 42 enables the surfaces of the same air filtering unit to be progressively flushed, and cleaned, starting from the upper end portion of the air filtering unit itself. This solution is particularly advantageous, since the jet issuing from the nozzle is capable of more effectively hitting each portion of the air filtering unit, while producing a kind of brushing action from the top to the bottom, which is effective in facilitating the separation of the lint for the latter to be then removed and let off.

The frame 80 is comprised of a container provided with a conduit having an appropriately sized cross-section area for letting in the air to be filtered F1, and a conduit having an appropriately sized cross-section area for letting out the filtered air F2. Between these conduits there is located the air filtering unit 50. Each one of said two conduits is provided with a respective connection mouth adapted to connect to a ventilation circuit, wherein air-tightness is in each case ensured at

each such connection by means of appropriate gaskets. The frame 80 further comprises a drain system (not shown) provided to let off the liquid mass used to flush, and wash, the air filtering unit 50. Anyway, the structure of such frame 80 is so designed as to enable it to fit, i.e. adapt to the whole assembly of functional parts and elements forming a tumble dryer and, in particular, to enable it to be located upstream to the heat exchanger that is provided for the water vapour contained in the moist air to condense thereon.

The drain system, which the frame 80 is provided with, leads into a collecting tank 90, which a drain pump 92 is associated to for said tank to be properly emptied as needed.

The way in which the automatic cleaning arrangement for air filters according to the present invention works is as follows: the control unit 70 causes the mass of liquid to flow into the reservoir 10 by switching the water-flow adjustment means 22 into opening. During this liquid inlet step, a sub-routine may be run or some other suitable measure can be taken to select whether or not the conduit 29 has to be shut through the water-flow adjustment means 24. The flushing process for cleaning the air filtering unit 50 starts as soon as the mass of liquid filled into the reservoir 10 reaches up to an adequate amount for such process to be carried out, e.g. one liter. In this initial phase of the process, the air filtering unit 50 is in its starting position as defined hereinbefore. The control unit 70 enables the pump 30 to deliver the above-cited mass of liquid to the bladelike-jet nozzles 40 and 42, preferably in a pulsed sequence so as to bring about a kind of chiseling effect on the air filtering unit 50. Concurrently, the control unit 70 causes the actuator means 60 to actuate the afore-described kinematic arrangement illustrated in Figure 2. As a result, while the bladelike-jet nozzles 40 and 42 start injecting the mass of liquid to thereby affect at first the end portion of the air filtering unit 50 that lies closer to the same nozzles, the air filtering unit 50 itself swings to slowly and gradually incline by an angle α, as determined by the constraints of the mechanism, relative to the spraying plane of the bladelike-jet nozzles 40 and 42, to eventually move back into its starting position under reversal of the direction of $\omega 2$. At the end of a complete cycle, the curtain or film of liquid mass that issues under pressure from the bladelike-jet nozzles 40 and 42 will have scanned the entire surface of a face

of the air filtering unit 50.

In this embodiment, the spraying plane of the bladelike-jet nozzles 40 and 42 is such as to affect a single face of the air filtering unit 50, since it is generally assumed that just a single face needs to be cleaned, actually. The inventive automatic cleaning arrangement for air filters is in fact preferably designed for use in the drying circuit in a clothes drying machine operating on a heat-pump principle and, therefore, the lint released by the clothes during the drying process tends to solely settle on a single face of the air filtering unit 50. With reference to such particular application of the inventive automatic cleaning arrangement for air filters, the air filtering unit 50 is flushed clean preferably upon conclusion of a clothes drying process, i.e. when the filter is heavily soiled, wherein, as a liquid mass for flushing the filter, use is made of the water recovered from a former rinse cycle of the clothes, the water resulting from the clothes drying process itself, or even the water being directly taken from the water supply line. In addition, it should be specially noticed that, through the use of the above-mentioned automatic cleaning arrangement for air filters as applied in a heat-pump tumble dryer, the number of filtering units that is usually required for due effectiveness of the filtering function in such kind of appliances can in fact be reduced, since the above-described arrangement proves particularly effective when applied to a single filtering surface.

Finally, the drain pump 92 is assigned the task of letting off the mass of liquid used to flush clean the filtering unit, and collected into the collecting tank 90, e.g. under control of the control unit 70.

Fully apparent from the above description is therefore the ability of the automatic cleaning arrangement for air filters according to present invention to effectively reach the aims and advantages cited afore by in fact providing a dynamic automatic air-filter cleaning arrangement that is particularly effective in ensuring efficient cleaning of the entire surface of at least one face of the air filtering unit 50.

It shall be appreciated that the inventive automatic cleaning arrangement for air filters as described above is subject to a number of modifications and may be

embodied in a number of different manners, or can be used in a number of different applications, without departing from the scope of the present invention as defined in the appended claims.

For example, the actuator means 60 may swingably actuate the bladelike-jet nozzles 40 and 42, whereas the air filtering unit 50 remains stationary, i.e. is excluded from such actuation, or two actuating means 60 may be used to swingably actuate both the air filtering unit 50 and the bladelike-jet nozzles 40 and 42, respectively, in a properly coordinated manner.

In addition, the air filtering unit 50 may be hinged either at a location close to the end portion of the frame 80, where also the bladelike-jet nozzles 40 and 42 are mounted, or in a different position.

The same applies to the bladelike-jet nozzles 40 and 42, which may be mounted or linked to the frame in any suitable manner whatsoever. In other words, further to being hinged thereto, they may for example be provided so as to slide on runners (shoe-and-rail type of linkage).

Furthermore, the driving or actuating shaft of the actuator means 60 may be positioned so as to coincide with the hinge.

More than that, the actuator means – as generally understood to include the whole assembly of the parts and members adapted to generate the above-mentionaed movement – may itself be driven by means of a cam drive.

In other words, all embodiments based on or making use of kinematic arrangements or mechanisms, in which at least one of the above-mentioned air filtering unit 50 and bladelike-jet nozzles 40 and 42 is caused to perform a movement relative to the frame 80, shall be understood as falling within the scope of the present invention.

CLAIMS

1. Arrangement for automatically cleaning air filters, comprising at least one nozzle (40, 42) for injecting a liquid and at least one air filtering unit (50), **characterized in that** at least one of said air filtering unit (50) and said liquid-injection nozzle (40, 42) is mounted so as to be able to move relative to a stationary reference frame (80), said relative movement being brought about by at least one actuator means (60) associated thereto.

2. Arrangement for automatically cleaning air filters according to claim 1, wherein at least one of said air filtering unit (50) and said liquid-injection nozzle (40, 42) is linked by means of a hinge (θ2) to the frame (80) so as to be able to perform a swinging movement through an angle of oscillation (α).

3. Arrangement for automatically cleaning air filters according to claim 1, wherein at least one of said air filtering unit (50) and said liquid-injection nozzle (40, 42) is linked to the frame (80) by means of an articulated quadrilateral.

4. Arrangement for automatically cleaning air filters according to any of the preceding claims, wherein said liquid-injection nozzle (40, 42) is of the bladelike-jet type that progressively hits and affects the entire surface of at least one face of the air filtering unit (50).

5. Arrangement for automatically cleaning air filters according to any of the

preceding claims, wherein said bladelike-jet spray nozzle (40, 42) is operated intermittently according to a pulsed sequence.

6. Arrangement for automatically cleaning air filters according to any of the preceding claims, wherein a control unit (70) operates said actuator means (60) and a pump (30) adapted to deliver the liquid under pressure to said nozzle (40, 42).

7. Heat-pump clothes drying machine, **characterized in that** it comprises an automatic air-filter cleaning arrangement according to any of the preceding claims.

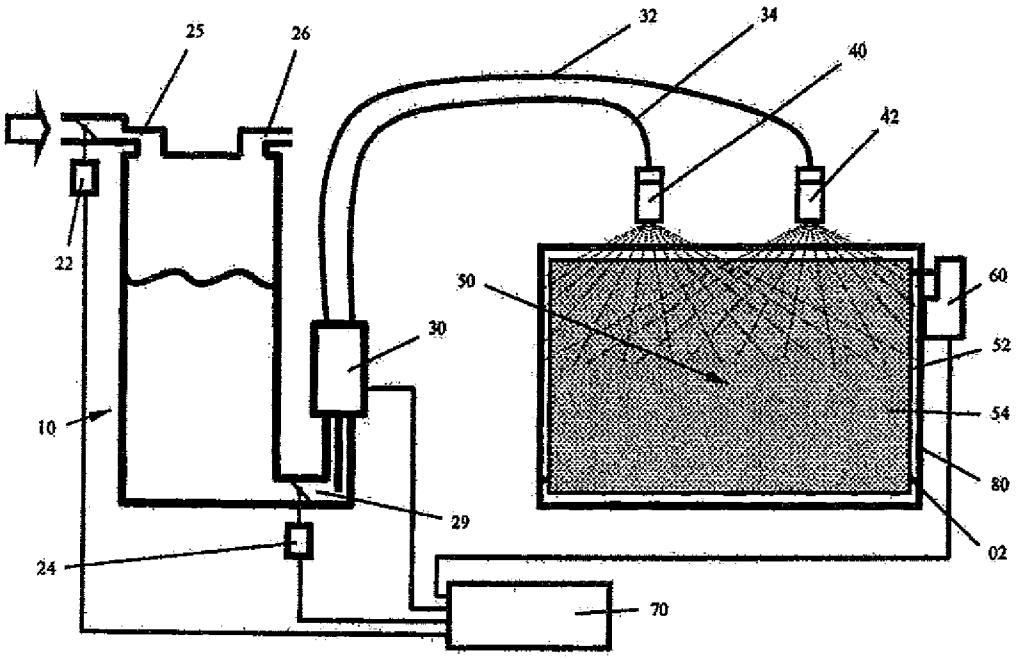


FIG.1

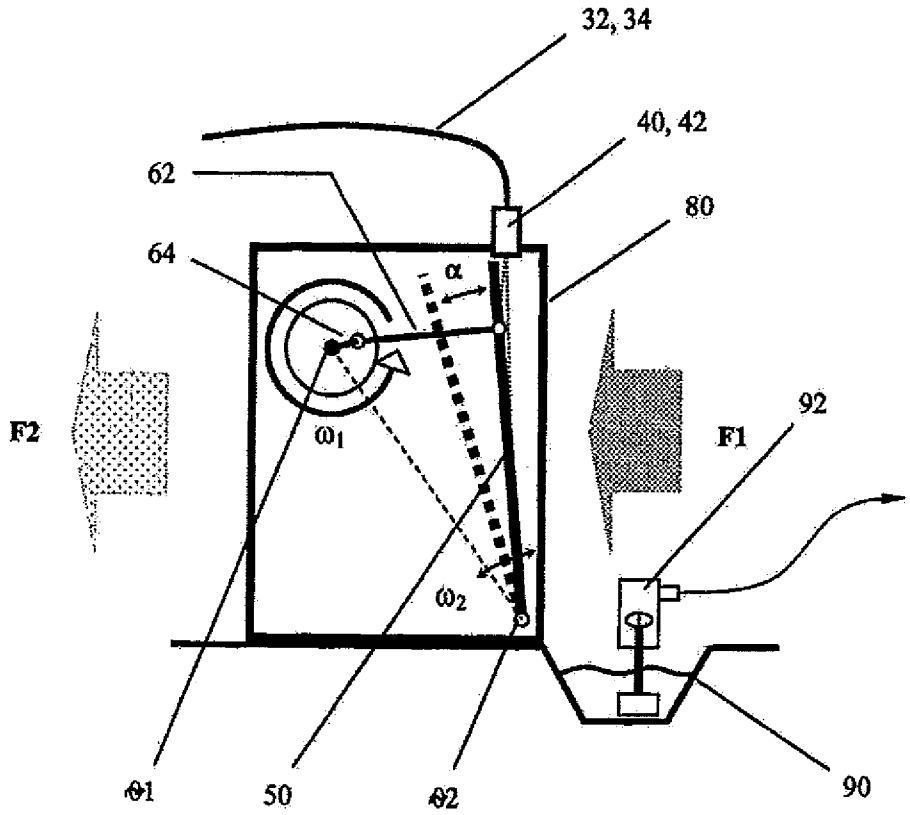


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2008/056330

A. CLASSIFICATION OF SUBJECT MATTER
INV. D06F58/22 D06F58/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 816 549 A (CANDY SPA [IT]) 7 January 1998 (1998-01-07) cited in the application column 6, line 2 - column 7, line 5; claims; figures	1-7
A	US 2004/221474 A1 (SLUTSKY DENNIS [US] ET AL) 11 November 2004 (2004-11-11) paragraphs [0025], [0034] - [0037]; claims; figures	1-7
A	EP 1 669 487 A (LG ELECTRONICS INC [KR]) 14 June 2006 (2006-06-14) paragraphs [0046] - [0052], [0063] - [0069]; claims 1-3; figures	1-7

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2008/056330

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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