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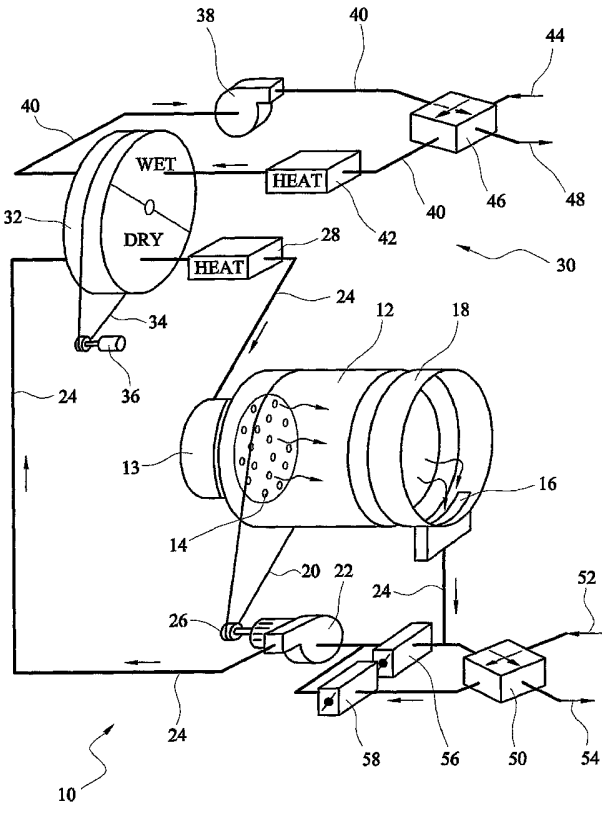
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(54) Title: DRYING APPARATUS



(57) Abstract: A tumble dryer (10) having a drum (12) and a fan (22) is disclosed. A first heating device (28) uses an electrical heating element to raise the temperature of a first air stream (24), and a drying device (30) removes the water from the first air stream (24) before it enters the drum (12). The dryer (30) has an adsorption rotor (32) containing a desiccant material such as silica gel. The rotor (32) is caused to rotate by drive belt (34) and stepper motor (36).

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DRYING APPARATUS

The present invention relates to an apparatus for drying, and relates particularly, but not exclusively, to tumble dryers.

Known tumble dryers generally have a cylindrical drum into which wet items of clothing are placed. The drum is rotated which results in the tumbling of the clothing within the dryer. A stream of air is passed through the drum and this stream of air is generally heated. The heated air in turn heats the wet clothing which causes evaporation of the water into the air stream. The air stream carries the evaporated water from the drum via an exhaust and the exhausted air stream is then vented from the apparatus to the atmosphere. Alternatively the air stream is passed through a condenser which uses the unheated air entering the apparatus to cause condensation of some of the water evaporated from the clothing which can be collected for disposal. This condenser also has the advantage that it utilises some of the excess heat before it is vented by warming the air entering the apparatus.

Tumble dryers of the prior art suffer from the disadvantage that in order to efficiently drive water from the clothing it is necessary to significantly raise the temperature of the wet clothing. Since many clothing articles are made from delicate fabrics which, for instance, should not be washed and therefore heated, beyond 40 or 50 degrees Centigrade, it is not advisable to use a tumble dryer to dry such garments. In an attempt to dry such clothing it is possible to decrease the heat applied to the garment and increase the drying time. However, increased drying times are unpopular with users of dryers and power consumed by the rotation of the drum and consumed by the heater becomes significant making the drying process inefficient.

CONFIRMATION COPY

Preferred embodiments of the present invention seek to overcome disadvantages of the prior art.

According to an aspect of the present invention, there is provided a drying apparatus comprising:-

at least one vessel for containing one or more articles to be dried;

at least one first air directing device for directing at least part of at least one first stream of air through at least one said vessel;

at least one first heating device for heating at least part of at least one said first stream of air prior to entry thereof into a said vessel; and

at least one drying device for removing moisture from at least part of at least one first stream of air prior to heating thereof by a said first heating device.

By providing a vessel having a heated air stream passing therethrough together with a drying device removing moisture from the air stream before it enters the vessel, the advantage is provided that because the air stream entering the vessel has had a significant amount of moisture removed from it, it is significantly easier to transfer water from the article to the air stream, i.e. evaporate it, since the air stream is significantly further from being saturated. As a result, it is possible to efficiently dry clothes without the need to heat them excessively or to leave them in the dryer on a low heat for an excessive length of time. Furthermore, by removing moisture from the air stream before it is heated the advantage is provided that the heating device only has to heat air and does not have to heat the moisture in the air. As a result, the apparatus is able to

work more efficiently than existing devices, thereby reducing energy consumption.

In a preferred embodiment, at least one said vessel comprises a respective drum.

In another preferred embodiment, at least one said drum is adapted to rotate.

At least one said first air directing device may comprise a respective fan.

At least one said first heating device may comprise at least one electrical heating element.

In a preferred embodiment, at least one said drying device includes at least one desiccant material.

Two examples of drying devices which could be used in connection with this apparatus are a condenser and a desiccator. By using a desiccator, the advantage is provided that the fluid can be removed without significantly decreasing the temperature of the airstream before it enters the vessel.

In a preferred embodiment, at least one said drying device further comprises at least one de-adsorption device adapted to remove said fluid from said desiccant material.

In another preferred embodiment, at least one said de-adsorption device comprises at least one second air directing device for directing at least part of at least one second air stream through at least one said desiccant material, and at least one second heating device for heating at least part of at least one said second air stream.

By providing the apparatus with a desiccant and de-adsorption device, the advantage is provided that the moisture can be removed from the first stream and transferred to a second stream from where it can be vented to the atmosphere.

The apparatus may further comprise at least one heat exchanger.

At least one said heat exchanger may act on at least one said first air stream.

At least one said heat exchanger may act on at least one said second air stream.

By incorporating a heat exchanger, the advantage is provided that the vented gas can be cooled before entering the atmosphere and at least some of energy used in heating the air streams is not lost and can be reused to heat the air streams as they enter the drying device.

In a preferred embodiment, at least some of said first air stream as it is exhausted from said vessel is re-circulated via said drying device.

In a preferred embodiment, at least one said first air stream comprises at least some re-circulated air and at least some air from outside of said apparatus.

By recirculating the gaseous materials from the first stream, the advantage is provided that as much heat as possible that has been applied to the first stream can be reutilised without being vented when conditions permit, for example when the moisture content in garments in the apparatus is less than in the incoming air stream.

The apparatus may further comprise at least one valve for regulating the proportion of re-circulated and external air comprising said first air stream.

The apparatus may also further comprise at least one sensor device for controlling at least one said valve in dependence upon the quantity of moisture in said first air stream exhausted from said vessel.

When clothes are initially put into the dryer, the air stream being vented from the vessel may be so saturated with moisture from the clothing that recirculating all of the first air stream via the drying device may not be possible. However, as the clothes begin to dry and the quantity of fluid vented from the first air stream reduces, more fluid can be removed via the desiccator.

According to another aspect of the present invention, there is provided a method for drying articles, the method comprising:-

producing at least one first air stream and directing at least part of at least one said first air stream to through at least one vessel containing at least one article;

heating at least part of at least one said first air stream; and

removing moisture from at least one said first air stream, prior to heating thereof.

A preferred embodiment of the present invention will now be described, by way of example only and not in any limitative sense, with reference to the accompanying drawings, in which:

Figure 1 is a schematic view of an apparatus embodying the present invention; and

Figure 2 is a perspective view inside the apparatus of Figure 1.

Referring to Figures 1 and 2, a tumble dryer 10 for drying articles, typically clothing, has a vessel or drum 12 which is adapted to contain at least one article of clothing (not shown). Drum 12 is provided with at one end a first plenum 13 having an inlet hole or holes 14 therein and at the other an outlet 16 which is located in a door 18 of the tumble dryer 10. The first plenum 13 and drum 12 are sealed relative to each other by seal 19. Typically outlet 16 is provided with a filter (not shown) which is designed to collect any lint which is discharged from the clothing being dried. When in use, drum 12 is caused to rotate by belt drive 20.

The apparatus 10 is also provided with a first air stream producing device or fan 22 which produces a first air stream 24. An output drive 26 of first fan 22 may be used to drive belt drive 20 and rotate drum 12. Alternatively, a separate drive can be provided independently of the fan if bi-rotational operation of the drum is required.

Also within apparatus 10 is a first heating device 28 which typically uses an electrical heating element to raise the temperature of the first air stream 24 so that it is higher than the temperature of air entering the first air stream from outside of the apparatus 10. A further component of the apparatus 10 is drying device or air stream dryer, which is generally indicated at 30. This component removes the water from the first air stream 24 before it enters the drum 12. Typically this air stream drying occurs before the first air stream is heated by heating device 28 and this therefore means that it is not

necessary to heat as much moisture present in the first air stream before it enters the drum. The air stream dryer 30 has an adsorption rotor or wheel 32 containing a desiccant material such as silica gel. The wheel 32 is caused to rotate by drive belt 34 and stepper motor 36. A second air stream producing device or fan 38 creates a second air stream 40 which is heated by a second heating device 42. Upon entering the second air stream 40 through inlet vent 44 the second air stream passes through heat exchanger 46 which adsorbs some excess heat from the second air stream 40 before it is vented through outlet vent 48.

The air stream dryer 30 retains heat from the second air stream 40 after heating by the heater 42. This heat is transferred to the first air stream 24 prior to the air stream 24 entering the first air stream heater 28. When moisture loads in the incoming air stream 40 are low, this heat will be sufficient to enable first air stream heater 28 to be switched off.

A further heat exchanger 50 is provided to heat first air stream 24 as it enters through inlet vent 52 thereby making use of any residual heat left in first air stream 24 before it is exhausted via outlet vent 54. The volume of air stream 24 which is exhausted through outlet vent 54 as opposed to the use of new air brought in through inlet vent 52 is regulated by modulating dampers or valves 56 and 58.

In use, one or more wet or damp garments clothing are placed within drum 12. After closure of door 18, drum 12 is caused to rotate by belt 20 and drive wheel 26. At the same time a first air stream 24 is created by fan 22, which draws air through either or both of inlet vent 52 or drum outlet 16. Air stream 24 passes through adsorption rotor 32 which adsorbs any water thereby removing it from the first air stream 24. Heating

device 28 heats the newly dried air stream 24 which then passes through the first plenum 13 and into drum 12 via vents 14.

As the first air stream 24 passes through the adsorption rotor 32 the rotor is caused to rotate by belt 34 and motor 36. The speed of rotation is such that as the moisture from first air stream 24 causes the adsorption rotor 32 to become damp a new dry portion of the rotor comes into contact with first air stream 24 allowing more moisture to be adsorbed from the first air stream 24. The rotation of the adsorption rotor causes this dampened area to be exposed to second air stream 40. This second air stream 40, which is created by second fan 38 and heated by second heating device 42, warms the adsorption rotor 32 causing the previously adsorbed water to be driven off into second air stream 40 and passes into the second plenum 43. This warm damp air (typically at 60 to 70°C) passes through heat exchanger 46 and is exhausted through outlet vent 48. The air passing into air stream 40 through inlet vent 44 is warmed as it passes through heat exchanger 46.

Because the air stream 24 entering drum 12 is heated and has a lower moisture content than the ambient air it is able to efficiently remove water from the articles of clothing. The air stream 24 passes through the filter located in exit vent 16 and then is either directed through heat exchanger 50 and exhausted through outlet vent 54 or re-circulated via modulating valve 56. Valve 56 is controlled by a detector which measures the moisture within the air stream 24 exiting the drum 12. When a garment is first placed into the drying apparatus 10 the water content within the first air stream 24, as it exits the drum via exit vent 16, may be to high for water removal device 30 to sufficiently dry the first air stream 24 as it is re-circulated. As a result it would be inefficient to re-circulate this air and it is therefore exhausted by heat exchanger 50 through outlet vent 54. In this instance it is necessary to open modulating

valve 58 and draw air in through inlet valve 52. This air is warmed in heat exchanger 50 by the air being exhausted through outlet vent 54. Both heat exchangers 46 and 50 are provided with condensation collection devices for collecting (not shown) any moisture which condenses during the heat exchange process.

It will be appreciated by persons skilled in the art that the above embodiment has been described by way of example only and not in any limitative sense, and that various alterations and modifications are possible without departure from the scope of the invention as defined by the appended claims. For example, each air inlet 44, 52 could also be provided with one or more suitable filters.

Claims

1. A drying apparatus comprising:-

at least one vessel for containing one or more articles to be dried;

at least one first air directing device for directing at least part of at least one first stream of air through at least one said vessel;

at least one first heating device for heating at least part of at least one said first stream of air prior to entry thereof into a said vessel; and

at least one drying device for removing moisture from at least part of at least one first stream of air prior to heating thereof by a said first heating device.

2. An apparatus according to claim 1, wherein at least one said vessel comprises a respective drum.

3. An apparatus according to claim 2, wherein at least one said drum is adapted to rotate.

4. An apparatus according to any one of the preceding claims, wherein at least one said first air direct device comprises a respective fan.

5. An apparatus according to any one of the preceding claims, wherein at least one said first heating device comprises at least one electrical heating element.

6. An apparatus according to any one of the preceding claims, wherein at least one said drying device includes at least a desiccant material.

7. An apparatus according to claim 6, wherein at least one said drying device further comprises at least one de-adsorption device adapted to remove said fluid from said desiccant material.

8. An apparatus according to claim 7, wherein at least one said de-adsorption device comprises at least one second air directing device for directing at least part of at least one second air stream through at least one said desiccant material, and at least one second heating device for heating at least part of at least one said second air stream.

9. An apparatus according to any one of the preceding claims, further comprising at least one heat exchanger.

10. An apparatus according to claim 9, wherein at least one said heat exchanger acts on at least one said first air stream.

11. An apparatus according to claim 9 or 10, wherein at least one said heat exchanger acts on at least one said second air stream.

12. An apparatus according to any one of the preceding claims, wherein at least some of said first air stream as it is exhausted from said vessel is re-circulated via said drying device.

13. An apparatus according to claim 12, wherein at least one said first air stream comprises at least some re-circulated air and at least some air from outside of said apparatus.

14. An apparatus according to claim 13, further comprising at least one valve for regulating the proportion of re-circulated and external air comprising said first air stream.

15. An apparatus according to claim 14, further comprising at least one sensor device for controlling at least one said valve in dependence upon the quantity of moisture in said first air stream exhausted from said vessel.

16. A drying apparatus substantially as hereinbefore described with reference to the accompanying drawings.

17. A method of drying articles, the method comprising:-

producing at least one first air stream and directing at least part of at least one said first air stream to through at least one vessel containing at least one article;

heating at least part of at least one said first air stream; and

removing moisture from at least one said first air stream, prior to heating thereof.

18. A method of drying articles, the method substantially as hereinbefore described with reference to the accompanying drawings.

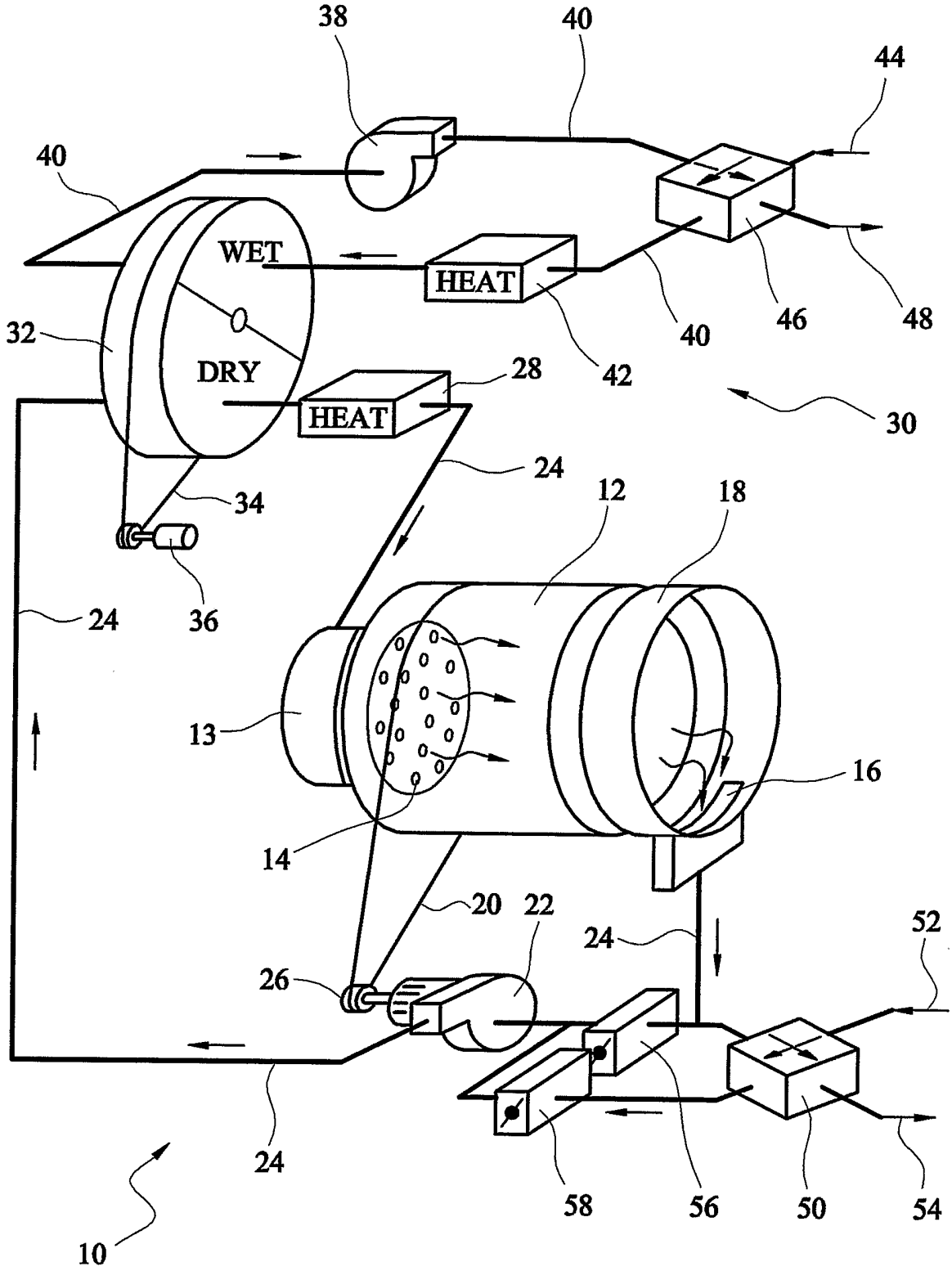

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FIG. 1

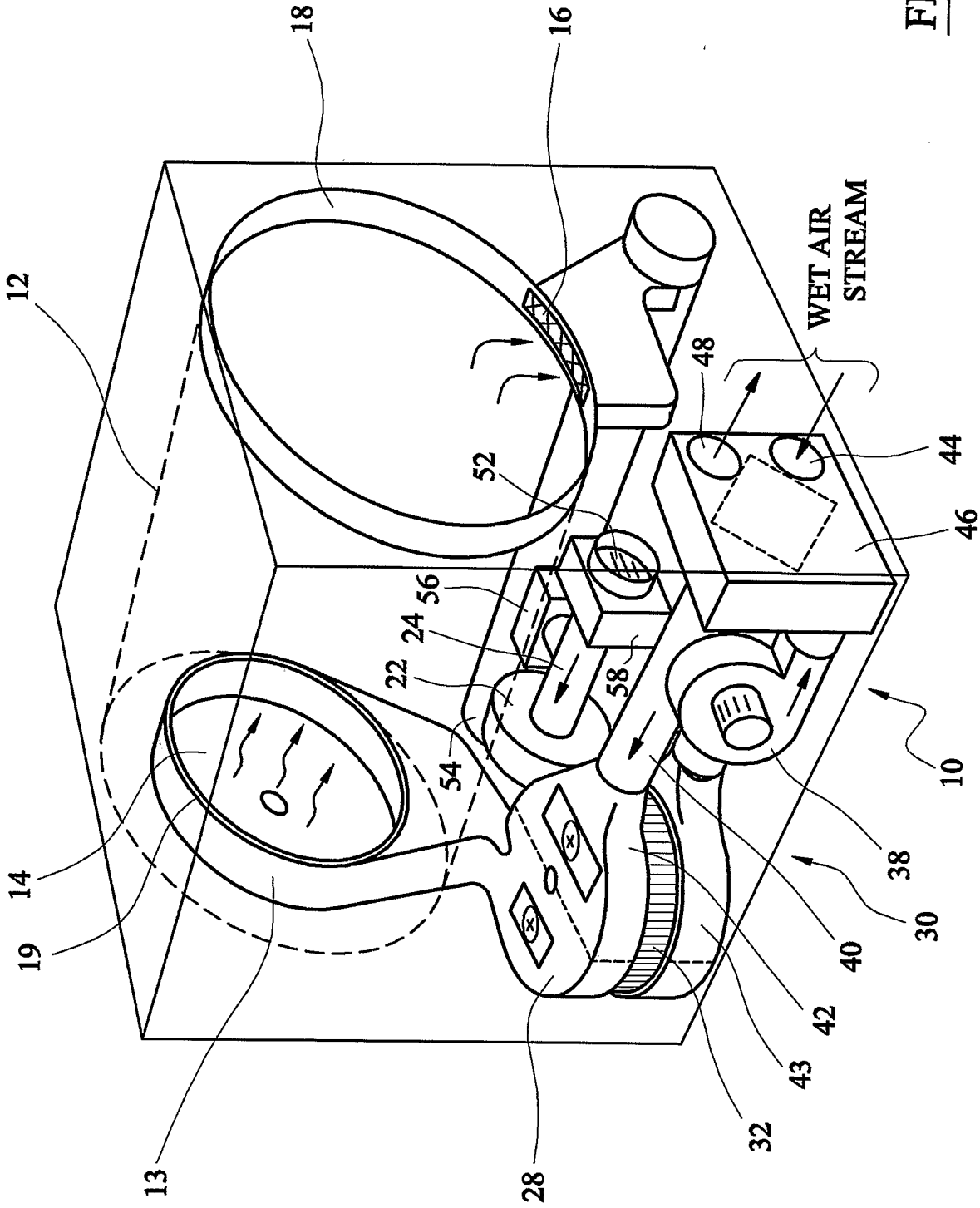

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FIG. 2

INTERNATIONAL SEARCH REPORT

International Application No
/GB2004/003292

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 D06F58/24 D06F58/26

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)
IPC 7 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, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	DE 36 26 887 A (MIELE & CIE) 11 February 1988 (1988-02-11) the whole document	1-8,12, 16-18 13-15
X	DE 43 40 065 A (BOSCH SIEMENS HAUSGERAETE) 1 June 1995 (1995-06-01) the whole document	1-9,11, 12,16-18
X	DATABASE WPI Section Ch, Week 198636 Derwent Publications Ltd., London, GB; Class F07, AN 1986-234686 XP002303707 -& JP 61 162985 A (MATSUSHITA ELEC IND CO LTD) 23 July 1986 (1986-07-23) abstract	1,17

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

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
4 November 2004	16/11/2004

Name and mailing address of the ISA	Authorized officer
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 777 998 A (WHIRLPOOL EUROP) 11 June 1997 (1997-06-11) the whole document	1,9,10
A	EP 1 247 888 A (GEN DOMESTIC APPLIANCES LTD) 9 October 2002 (2002-10-09) the whole document	1,12-14
Y	US 4 626 201 A (GRANTHAM CHARLES R) 2 December 1986 (1986-12-02) column 8, line 29 - line 48	13-15
A	US 6 094 835 A (CROMER CHARLES J) 1 August 2000 (2000-08-01) the whole document	1-16

INTERNATIONAL SEARCH REPORT

Ir ational Application No
1 ../GB2004/003292

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 3626887 A	11-02-1988	DE 3626887 A1	11-02-1988
DE 4340065 A	01-06-1995	DE 4340065 A1	01-06-1995
		FR 2712899 A1	02-06-1995
		GB 2284164 A ,B	31-05-1995
JP 61162985 A	23-07-1986	NONE	
EP 0777998 A	11-06-1997	EP 0777998 A1	11-06-1997
		AT 212817 T	15-02-2002
		DE 69525350 D1	21-03-2002
		DE 69525350 T2	14-08-2002
EP 1247888 A	09-10-2002	GB 2369422 A	29-05-2002
		EP 1247888 A1	09-10-2002
US 4626201 A	02-12-1986	NONE	
US 6094835 A	01-08-2000	NONE	