Title: IMPROVED AIRFLOW SYSTEM & APPARATUS AND METHOD FOR AIRFLOW SYSTEM

Abstract: An airflow system enhances airflow in a hand-drying apparatus which expels a stream of sterilised, hot air for drying of hands. Inside the apparatus, the airflow is decelerated by one or more filters. Therefore, the system is provided with an airflow-pathway that is progressively smaller along its pathway in respect of flowthrough cross-section. The airflow is enhanced by flowing initially through a larger part of the airflow-pathway, and subsequently through a smaller part of the airflow-pathway after which the airflow exits the apparatus. To enhance the airflow, a universal commutator motor is used to drive an appliance that provides air movement. The motor comprises magnetic field generating means, a rotating armature adapted for rotational motion in operative association with the magnetic field. A ratio of magnetic field strength at the armature to the magnetic field strength within the magnetic field is less than about 1 to 1.
Improved Airflow System & Apparatus and Method for Airflow System

Related Applications

This application claims priority to Australian Provisional Patent Application No. 2007901255 in the name of Alpha Global Holdings Pry Ltd, which was filed on 12 March 2007, entitled "Improved Airflow System & Apparatus and Method for Airflow System" and, the specification thereof is incorporated herein by reference in its entirety and for all purposes.

Field of Invention

The present invention relates to airflow systems, and also apparatus and methods for airflow systems, in particular, appliances adapted to produce air movement, such as for example, air dryers adapted to produce a stream of sterilised air for 'clean' drying conditions. In one form, the present invention is suitable for use in hand dryers and it will be convenient to hereinafter describe the invention as it relates to sterilising hand dryers that produce a stream of sterilised, heated air, particularly for drying hands, where airflow inside the apparatus may be decelerated by one or more filters through which the airflow passes. However, it should be appreciated that the invention is not limited to that use, only.

Background of the Invention

Throughout this specification the use of the word "inventor" in singular form may be taken as reference to one (singular), more than one (plural), or all (plural) inventors of the present invention. The inventor has identified the following related art.

Hand dryers may be used to emit a stream of heated or warm airflow to dry a user's hands. These hand dryers are typically used in public toilets, and in environments, such as in the medical profession, where the user hopes to retain maximum cleanliness by avoiding contact with potential bacteria-sources such as paper towels, cloth towels or tissues.

It is often assumed that use of such hand drying apparatus is more hygienic. Contrary to assumptions, however, the inventor has found that these related art hand drying apparatus are actually a mechanism for spreading germs. The warm airflow from these related art hand drying apparatus is, itself, laden with airborne bacteria. The hand dryers draw in air from the bacteria-
laden atmosphere of the toilet, and expel the warm, germ-infested airflow onto the wet hands of the user.

In the present applicant's corresponding International Application PCT/AU2005/001803 (filed in the name of Panache Global Holdings Pty Ltd), a plurality of filters are placed in the path of the airflow through the dryer, each filter either having a function of killing and/or removing bacteria particles, or effusing a beneficial substance into the airflow, however, a problem is that the airflow of the apparatus tends to be slowed down by these filters, because the air has to pass through such a large number of filters that impede the airflow.

At least one response to this problem may be to solely rely on a larger, more powerful fan motor in the dryer that can provide higher torque and faster fan-speed. In the related art, when designers wished to have faster exit airflow speed, there may be a tendency to use a faster, more powerful fan motor. But there would be problems with this approach of solving the problem by solely using a larger fan motor, for example, as follows:

First, it must be remembered that the ambient air of a public toilet can often be laden with airborne bacteria. Therefore, without being limited by theory, it is believed that using a larger fan-motor may result in a stronger suck-in rate of air entering the dryer. The present inventor reasons that a greater rate of incoming airflow, into the dryer, may mean a greater amount of bacteria entering into the dryer. Hence, a more powerful motor, with its associated faster suck-in rate, may not be the most ideal solution to the problem.

Secondly, faster fan-motors tend to be more expensive, and can tend to have a greater amount of internal wear and tear, tending towards shorter lifespan of the motor.

Thirdly, larger fan-motors can run hotter, and can tend to produce more noise.

Fourthly, faster fan-motors tend to be larger, leading to motors burning out, which may require the apparatus-housing of the dryer to be larger to accommodate the larger motor.

In general, the inventor has identified that, in motors that may be used for appliances adapted for air movement, the carbon brush life may not be sufficient to meet the specification of the appliance. Further, the inventor has identified that the speed of motors in such appliances may be too low to overcome back pressure that may build up. This has been particularly noted by the inventor with respect to appliances that make use of the present applicant's bactericidal filter system, with respect to impeded air flow through an appliance. Further, commutators used for motors in such applications as the above noted appliances may be normally 'shell type' commutators. Shell type commutators are generally manufactured from a copper strip and moulded material such as phenolic thermoset moulding material. The copper strip may be blanked and formed, the formed copper shell is then moulded with the thermoset moulding
material such as phenolic as noted. After moulding, the copper shell is separated into the required individual bars or segments. This type of commutator is suitable for low to moderate operating speeds and low electrical currents. However, at higher speeds and higher electrical currents the risk exists of individual segments or bars moving or lifting. The reason for this effect may be attributed to the fact that the material used to mould the commutator (eg Phenolic Thermoset and equivalent materials) may not adhere to the copper and, as the inventor has identified, the bond may be only mechanical in nature. Should a commutator bar lift, move or distort through heat or rotational speed, the motor may start sparking and destroy itself. At the very least it may drastically reduce the carbon brush life of the motor. Some attempts have been made to improve upon commutator design such as disclosed in US patent No 5,491,373 (Cooper et al) where a non-conducting ring is embedded in the internal core of the device and is in contact with copper conductor.

With respect to the example of hand dryers, it is desirable to reduce hand drying time, which only contributes to one or more of the above noted drawbacks.

An additional difficulty that the inventor has identified with respect to appliances providing air movement is that testing and operating conditions may often tend to be opposite in their specifications. For example, it may be a requirement that the testing of a motor for providing air movement in an appliance is performed with the motor under continuous operation. In direct contrast, in normal operating conditions for the appliance, the motor may be required to work in short intervals, such as about 30 seconds, at full performance or in other words, up to full load for short intervals over a relatively long expected lifetime.

It has also been recognised that motors used to address the above difficulties may be modified to perform outside of their standard operating range and accordingly may be subject to failure.

An object of the present invention is to overcome or at least ameliorate one or more of the problems in the related art, or to provide an improved alternative.

In particular, an object of the present invention is to provide at least an improved alternative to the option of simply providing a larger fan-motor, when confronted by the problem of one or more filters decelerating the airflow through a hot air hand drying apparatus.

In this specification, discussion of related art, either individually or in combination, should not be construed as an admission of any state of the common general knowledge of the skilled addressee in this field of art of sterilising hand dryers.
The present invention excludes from its scope those sterilising hand dryers that do not use filters in the path of the internal airflow, since such dryers would not have to address the present problem of decelerated airflow resulting from the filters being placed in the airflow path.

Summary of Invention

The present specification contains more than one aspect of the present invention.

According to a first aspect of the present invention, there is provided an airflow system adapted to enhance airflow in a hand-drying apparatus which expels a stream of substantially sterilised, hot air that is heated by a heating-means for drying of hands, where the airflow inside the apparatus is decelerated by one or more filters through which the airflow passes, wherein the system, downstream of the heating-means, is provided with an airflow-pathway that is progressively smaller along its pathway in respect of flowthrough cross-section, such that, in use, the airflow is enhanced by flowing initially through a larger part of the airflow-pathway, and subsequently through a smaller part of the airflow-pathway after which the airflow exits the apparatus.

The airflow-pathway may include at least a part that has a degree of taper.

The degree of taper is able to be selectively varied by the user.

The degree of taper of the airflow-pathway may be able to be selectively varied by the user substituting a replacement airflow-pathway device of different size preferably selected from a range of passageways of differing degrees of taper.

The airflow-pathway may include parts that are not tapered.

The hand-drying apparatus, in which the system is adapted to be used, may comprise a completely sealed apparatus-housing that includes therein a fan-casing containing a fan.

In an exemplary embodiment, all airflow enters the apparatus-housing through initial main-inlet-means on the apparatus-housing, and all airflow subsequently enters the fan-casing through final main-inlet-means on the fan-casing, wherein the initial main-inlet-means is larger than the final main-inlet-means such that, in use, the airflow is enhanced by flowing initially through the larger initial main-inlet-means, and subsequently through the smaller final main-inlet-means.
The larger initial main-inlet-means and the smaller final main-inlet-means may have flowthrough cross-sections which have a ratio of around 1.38 relative to one another.

The fan may be a dual-fan comprising two fan-halves each of which is adapted to draw in airflow into the fan-casing.

The airflow inside the apparatus is decelerated by a plurality of filters through which the airflow passes,

wherein the method includes providing the apparatus with an airflow system which, downstream of the heating-means, includes an airflow-pathway that is progressively smaller along its pathway in respect of flowthrough cross-section,

and, in use, enhancing the airflow by causing the airflow to flow initially through a larger part of the airflow-pathway, and subsequently through a smaller part of the airflow-pathway after which the airflow exits the apparatus.

According to a third aspect of the present invention, there is provided a hand-drying apparatus airflow system adapted to enhance airflow in an apparatus that expels a stream of substantially sterilised, hot air that is heated by a heating-means for drying of hands, where the airflow inside the apparatus is decelerated by one or more filters through which the airflow passes,

wherein the hand-drying apparatus comprises a completely sealed apparatus-housing that includes therein a fan-casing containing a fan,

wherein the fan is a dual-fan comprising two fan-halves each of which is adapted to draw in airflow into the fan-casing.

According to a fourth aspect of the present invention, there is provided a universal commutator motor adapted to drive an appliance for providing air movement, the motor comprising:

magnetic field generating means for generating a magnetic field;
a rotating armature adapted for rotational motion in operative association with the magnetic field;
wherein a ratio of magnetic field strength at the armature to the magnetic field strength within the magnetic field is less than about 1 to 1.

The ratio of magnetic field strength may be about 0.9 to 1.

The armature may comprise:
a lamination armature structure having an arc of winding of about slot 1 to about slot 11 and about slot 12 to about slot 22, respectively.

The motor may further comprising:
at least two carbon brushes;
at least two brush holders operatively associated with the at least two carbon brushes;
wherein flexible conducting material is adapted to provide electrical connection to a commutator under variable operating conditions.

The flexible conducting material may comprise braided copper wire.

The motor may further comprise:
a commutator comprising a reinforcing ring located within the body of the commutator such that it is isolated from conducting segments and adapted to substantially reduce bar to bar movement.

According to a fifth aspect of the present invention, there is provided a universal commutator motor adapted to drive an appliance for providing air movement, the motor comprising:
magnetic field generating means for generating a magnetic field;
a rotating armature adapted for rotational motion in operative association with the magnetic field, wherein a ratio of magnetic field strength at the armature to the magnetic field strength within the magnetic field is less than about 1 to 1;
wherein the armature comprises a lamination armature structure having an arc of winding of about slot 1 to about slot 11 and about slot 12 to about slot 22, respectively;
at least two carbon brushes;
at least two brush holders operatively associated with the at least two carbon brushes
wherein flexible conducting material is adapted to provide electrical connection of the carbon brushes to a commutator under variable operating conditions; and,
the commutator comprises a reinforcing ring located within the body of the commutator such that it is isolated from conducting segments and adapted to substantially reduce bar to bar movement.

The appliance for providing air movement may comprise an air dryer.

According to a sixth aspect of the present invention, there is provided a method of operating a universal commutator motor, the motor adapted to drive an electric appliance for providing air movement, the method comprising the steps of:
generating a magnetic field within the motor;
operatively associating a rotating armature of the motor with the magnetic field;
maintaining a ratio of magnetic field strength at the armature to the magnetic field
strength within the magnetic field at less than about 1 to 1.

The ratio of magnetic field strength may be about 0.9 to 1.

The method may further comprise the step of:
providing an increased magnetized area for the armature corresponding to a lamination armature structure having an arc of winding of about slot 1 to about slot 11 and about slot 12 to about slot 22, respectively.

The method may further comprise the steps of:
providing at least two carbon brushes;
providing at least two brush holders operatively associated with the at least two carbon brushes;
provide electrical connection to a commutator under variable operating conditions by use of flexible conducting material adapted to provide electrical connection to a commutator under variable operating conditions.

The flexible conducting material may comprise braided copper wire.
The method may further comprise the steps of:
providing a commutator comprising a reinforcing ring located within the body of the commutator such that it is isolated from conducting segments and adapted to substantially reduce bar to bar movement.

According to a seventh aspect of the present invention, there is provided a method of operating a universal commutator motor, the motor adapted to drive an electric appliance for providing air movement, the method comprising the steps of:
operatively associating a rotating armature of the motor with the magnetic field;
maintaining a ratio of magnetic field strength at the armature to the magnetic field strength within the magnetic field at less than about 1 to 1;
providing an increased magnetized area for the armature corresponding to a lamination armature structure having an arc of winding of about slot 1 to about slot 11 and about slot 12 to about slot 22, respectively;
providing at least two carbon brushes;
providing at least two brush holders operatively associated with the at least two carbon brushes;
providing electrical connection to a commutator under variable operating conditions by use of flexible conducting material adapted to provide electrical connection of the carbon brushes to a commutator under variable operating conditions; and,
providing a commutator comprising a reinforcing ring located within the body of the commutator such that it is isolated from conducting segments and adapted to substantially reduce bar to bar movement.

The appliance for providing air movement may comprise an air dryer.

The appliance for providing air movement may comprise a hand-drying apparatus airflow system as described.

According to an eighth aspect of the present invention, there is provided an airflow system adapted to enhance airflow in a hand-drying apparatus which expels a stream of substantially sterilised, hot air that is heated by a heating-means for drying of hands, where the airflow inside the apparatus is decelerated by one or more filters through which the airflow passes.
wherein the system is provided with an airflow-pathway that is progressively smaller along its pathway in respect of flowthrough cross-section,
such that, in use, the airflow is enhanced by flowing initially through a larger part of the airflow-pathway,
and subsequently through a smaller part of the airflow-pathway after which the airflow exits the apparatus.

In this eighth aspect, the airflow-pathway, that is progressively smaller along its pathway, may be provided downstream of the heating-means.

**Brief Description of the Drawings**

In order that the present invention might be more fully understood, embodiments of the invention will be described, by way of example only, with reference to the accompanying drawings, in which:

- Figure 1A is a front view of an embodiment of a sterilising hand-drying apparatus which has a internal airflow that is decelerated by several filters, and which incorporates an embodiment of an improved airflow system that enables enhanced airflow through the apparatus;
- Figure 1B is a side view of the hand-drying apparatus of Figure 1A;
- Figure 1C is an underside view of the bottom of the hand-drying apparatus of Figure 1A;
- Figure 2 is a rear perspective view of the hand-drying apparatus of Figure 1A, when the apparatus-housing is opened to reveal its interior, and when viewed from the perspective of arrow A in Figure 1B;
- Figure 3 shows a perspective view of an embodiment of four main filter holders that hold filters, with the first holder shown with its filter withdrawn, being filters that decelerate airflow in the embodiment of Figure 1A;
- Figure 4A shows a perspective view of an embodiment of a fan-casing and a fan motor, with a pair of subsequent filter holders and filters which are attached to the fan-casing;
- Figure 4B shows an exploded view of the apparatus of Figure 4A, showing an embodiment of a dual fan that is contained inside the fan-casing;
- Figure 4C shows a further exploded view of the apparatus of Figure 4A, showing more details of the dual fan;
- Figure 4D is a side, cross-sectional view of the dual-fan of Figures 4B and 4C;
Figures 4E and 4F are side views of the dual-fan of Figures 4B, 4C and 4D, each viewed from a different side of the fan respectively;

Figure 4G is a section view of the embodiment of the dual-fan in Figures 4B, 4C, 4D, 4E and 4F.

Figure 5 shows three different embodiments of exit-passageways that can be used interchangeably in the embodiment of Figures 1A to 2, each embodiment have a different degree of taper through which airflow leaves the fan-casing and exits the hand-drying apparatus;

Figure 6A shows a plan view of an example arc winding in relation to a lamination arm in an electric motor in accordance with at least one related art technique identified by the inventor;

Figure 6B shows a plan view of arc winding in an electric motor in accordance with a preferred embodiment;

Figure 6C is a plan view of a field assembly of a universal motor with an exploded view of its components in accordance with a preferred embodiment;

Figure 6D is a component parts listing for the field assembly of Figure 6C;

Figure 6E is plan view of a brush commutator housing assembly of a universal motor with an exploded view of its components in accordance with a preferred embodiment;

Figure 6F is a component parts listing for the brush commutator housing assembly of Figure 6E;

Figure 6G is plan view of an armature assembly of a universal motor with an exploded view of its components in accordance with a preferred embodiment;

Figure 6H is a component parts listing for the armature assembly of Figure 6G;

Figure 6I is a plan view of a drive end housing assembly of a universal motor with an exploded view of its components in accordance with a preferred embodiment;

Figure 6J is a component parts listing for the drive end housing assembly of Figure 6I;

Figure 6K(a) shows a commutator of a preferred embodiment of the present invention in top plan view;

Figure 6K(b) shows a cross sectional side view of the commutator of Figure 6K(a) taken along the direction of line A-A in Figure 6K(a); and

Figure 6K(c) is an expanded view of section B in Figure 6K(b).

In the embodiments, like components are labeled with like reference numerals merely for the sake of ease of understanding the different embodiments and modifications.
Detailed Description

Referring to the accompanying drawings, Figure IA shows a front view of a sterilising hand-drying apparatus in the form of a hand dryer 1.

Figure IB shows a side view of the dryer 1, and Figure IC shows an underside view of the same dryer 1.

Figure 2 shows a rear perspective view of the dryer 1 when it is opened, showing its interior.

The dryer 1 draws in ambient air. Bacteria in the airflow is killed and preferably removed. The airflow is heated, and then expelled from the dryer, typically directly onto the user's hands for drying.

In Figure 2, the hand dryer 1 has an apparatus-housing 10, 11 which includes a main hood 10 and a baseplate 11. The hood 10 is mounted to the baseplate 11 by hinges 12.

The baseplate 11 can be secured to a wall with screws, bolts or other appropriate fastening mechanism.

Figure IA shows the hood 10 arranged in a closed position, installed ready for use, for example, mounted on a wall.

Air-Flow

The hand dryer 1 is adapted to expel an airflow or stream of substantially sterilised, hot air for drying hands. In the embodiment, the operational range of the heated air is around 55 to 65 degrees Centigrade.

In summary, when the dryer 1 is operated to dry a user's hands, ambient air is sucked into the apparatus housing, then heated, and expelled from the apparatus.

Air is sucked into the dryer 1 (depicted by arrow 200A in Figure IA), and eventually is expelled from the dryer (depicted by arrow 200E in Figure IA).

Main Filters

(Figure IA is a front view, whereas Figure 2 is a rear view. In Figure IA, the airflow 200A enters the dryer in the region of the left hand side of the diagram. Whereas, in Figure 2, the incoming airflow 200A would enter the dryer 1 in the region of the right hand side of the drawing).
In Figure 2, inside the dryer 1, the incoming air 200A passes through a main-filter assembly 410. In the embodiment, this main filter assembly includes four main filter holders 410A, 410B, 410C, 410D (seen in more detail in Figure 3).

The function of these main filter holders and their filters is to kill and remove bacteria particles, to the extent that in the embodiment, the airflow can be made substantially bacteria-free, and preferably 100% bacteria-free. The features of an example of the filters, and their role in killing bacteria, is described in the present inventor's earlier corresponding International Patent Application PCT/AU2005/001803 (filed in the name of Panache Global Holdings Pty Ltd), which is incorporated herein by reference into this present description merely as a non-limiting example of the function of these filters. The information in PCT/AU2005/001803 explains how an exemplary embodiment of a dryer is able to expel a substantially bacteria-free airflow, preferably a 100% bacteria-free airflow.

Subsequent Filters

In this embodiment, after the airflow passes through the filters of the main filter holders 410A, 410B, 410C, 410D, the airflow is drawn towards a fan-casing 400A, 400B that contains a fan.

Part of the airflow enters the fan-casing through one 400A of the sides of the casing, passing through the filters of some subsequent filter holders 420A, 420B. The purpose of these subsequent filters, which are further upstream, is to effuse and add beneficial substances to the airflow. For example, the filters of one of these subsequent filters 420A or 420B can effuse another anti-bacterial substance into the airflow.

This subsequent anti-bacterial substance, effused from the filters of the subsequent holders 420A or 420B, stays in the airflow until it is expelled from the dryer 1 in the exit airflow 200E, where the substance can become coated onto the hands of the user.

Any one or more of the filters, from either the main holders, preferably the latter ones 410C, 410D, or from the subsequent holders 420A, 420B, can be used to effuse a beneficial substance into the airflow.

That substance can be ultimately coated onto the hands of the user when it exits the dryer 1, or alternatively the substance can spread into the ambient air surrounding the hand dryer 1. For example, a fragrance can be effused into the airflow so that the washroom atmosphere smells pleasant. As another example, an anti-bacterial substance can be effused into the washroom atmosphere to minimise airborne bacteria.
Many people that use public toilets, after washing their hands, are slightly uneasy about having to touch the bacteria-laden doorhandles of the toilet door. It almost defeats the purpose of washing hands, if bacteria will return immediately by touching the dirty toilet door handle. Some users try to open the door with the feet, to avoid touching the door handle. In the embodiment, the airflow coats the user's hands with a small amount of the expellable-substance. For example, the user's hands can be coated with a small amount of an anti-bacterial substance. In the embodiment, the amount is sufficient to provide a greater degree of protection for the user's hands when touching the bacteria-coated handle of the toilet door.

In some examples, the effused substance on the hands of user may be of a sufficient amount to feel like a cream on the hands. This gives the user tangible evidence that something beneficial has been coated onto the hands.

Some examples of substances, that can be effused into the airflow for this purpose, are described in the present inventor’s corresponding International Patent Application PCT/AU2006/001815 (filed in the name of Panache Global Holdings Pty Ltd), which is incorporated herein by reference into this present description merely as a non-limiting example of chemical substances that can be thus effused into the airflow.

It is preferable to effuse the expellable-substance from a subsequent filter (420A or 420B) that is located on the fan-casing 400A, 400B, rather than from the earlier main filters holders 410A, 410B, 410C, 410D. This ensures that substantially all the expellable-substance will enter the fan-casing. If, on the other hand, the expellable-substance were to be effused primarily using one of the main filters in the main filter holders 410A, 410B, 410C, 410D, then a portion of the expellable-substance may otherwise deposit on internal surfaces of the housing 10, 11. This depends of the nature of the expellable-substance, and so the user should decide where the optimum location for a filter, that contains a particular expellable-substance, is on the main filter holders 410A, 410B, 410C, 410D, or on the subsequent filter holders 420A, 420B.

After the airflow is drawn into the fan-casing 400A, 400B, it is expelled from the dryer 1, through an exit-nozzle 14 as an outflow 200E of air.

Filter Options

The number of filters, used in practice, is determined by a user of the dryer 1 who may be responsible for installation and/or maintenance.
Figures 3 and 4C show that the filters can be removed from their holders 410A, 410B, 410C, 410D and 420A, 420B. For example, when the active ingredient in a particular filter has reached its lifespan, the maintenance user can replace the filter with a new filter.

As another example, different filters can contain different active ingredients that are intended to be infused into the airflow, hence, the maintenance user can purchase different filters to suit the particular need. For instance, the substance that are effused into the airflow, for use by medical staff such as surgeons, might differ from different substances that are effused in dryers used in public toilets, for example.

Air Heater

Referring to Figure 4A, the dryer 1 is provided with an electric heating element 4 (not shown in detail). The heating element is located at a heating means location 5 which is close to an opening of the fan-casing 400A, 400B, behind a protective grille 15. The heating element includes a grid of wires or plates adapted to be heated up electrically when the dryer 1 is emitting the hot airflow 200E.

Initial-Main-Inlet & Final-Main-Inlet

In the embodiment, it is a requirement that the housing 10, 11 of the dryer 1 is completely sealable, for instance with rubber gasket seals. The complete sealing of the housing is achieved by providing seals at all points of contacting between the main hood 10 and the baseplate 11. The sealing is to such a degree that, when the housing 10, 11 is closed, absolutely all air entering the dryer 1 must pass through an initial-main-inlet in the form of the initial main aperture 405A. This ensures that all incoming air will be filtered by the filters in the main filter holders 410A, 410B, 410C, 410D. If not, then any air that were to leak into the housing, other than through the initial-main-inlet, would not be subjected to filtration through the filters in the main holders 410A, 410B, 410C, 410D.

Hence, all of the airflow that enters the dryer 1 through the initial main aperture 405A, must pass through the sequence of filters in the holders 410A, 410B, 410C, 410D.

In the embodiment of Figure 1A, there is only one initial main aperture 405A, however, in other embodiments, the initial opening can be divided into several openings, provided that the combined area of the plurality of initial-main-inlets is larger than the area of the final-main-inlet on the fan-casing.
The air then enters into a chamber area inside the completely-sealed, closed housing. (The apparatus has a cut-off switch so that the airflow cannot be generated when the housing is open).

Next, the airflow is drawn, from the chamber, into the fan-casing 400A, 400B. Part of the airflow enters the fan through the final-main-inlet in the form of final main apertures 405B, which is the part 400A of the fan casing that is filtered by the filters in the subsequent filter holders 420A, 420B.

Another part of the airflow is drawn into the fan-casing through another portion of the final-main-inlet in the form of final main apertures 405C, which is the part 400B of the fan-casing that is not filtered, and which is closer to the fan motor 430.

**Fan**

The airflow through the dryer 1 is created by a fan 401, shown in Figures 4B, 4C and 4D. The fan rotates inside the fan-casing 400A, 400B.

The rotation of the fan 401 is operated by a motor 430. In the example, the motor may be a universal motor capable of up to or greater than a speed of 7500 rpm under operating conditions and is discussed further herein.

In the embodiment, the fan blade 401 is made of injection-moulded plastic. The fan should not be made of a material that would readily shatter extremely high rotation speeds.

Also, the fan should not be so flexible that it would warp at high rotation speeds. The fan of the embodiment is made of a nylon composite material, although other suitable materials can be used.

**Dual Fan-Blade**

By way of background, the filters in the filter holders 410A, 410B, 410C, 410D and 420A, 420B tend to decelerate the airflow through the dryer.

A feature that at least ameliorates this problem is to make the fan 401, in the embodiment, to be a dual-fan, seen in Figures 4C and 4D.

The dual-fan has two regions that each has a similar function to a normal single fan. In other words, one fan item acts as if it were two fans.

In Figure 4D, even though the fan 401 is manufactured as a single item, it is regarded as a dual-fan, because it has two separate fan regions, which are separated by a central web 403 that
extends from a central, axial spindle 404. The spindle 404 is connected to the drive shaft (not shown) of the motor 430.

In the embodiment, the dual-fan consists of two fan-halves.

Figure 4D shows a cross-sectional view of the two halves of the fan-halves 402A, 402B in cross-section.

Figure 4E shows a side view of the fan 401, showing the fan-half 402A that is closer to the final main aperture 405B that is filtered.

Similarly, Figure 4F shows the other side of the same fan, showing the fan-half 402B that is closer to the opposite final main aperture 405C which is nearer the fan-motor 430.

Figures 4E and 4F show that the circumferential rim of the fan 401 is provided with a series of fan-blades 406 evenly disposed around the circular rim. When these fan-blades 406 rotate, air is drawn into the fan-casing, thereby also causing ambient air to be sucked into the dryer 1.

Figure 4G is similar to Figure 4D, except that the present Figure 4G shows a section view, or "slice view", of the dual-fan 401, when a slice is taken along the dotted line 407 in Figure 4E. The embodiment of the dual-fan could be described roughly as having a cylindrical outer rim, which carries the fan blades, where the cylinder has a central partition or central web 403. The central web divides the cylinder roughly into two halves.

Without being limited by theory, it is believed that the use of the dual-fan lessens the degree of turbulence in the airflow that is expelled from the fan. It is believed that the airflow, coming out of the dual-fan, is more streamlined, with less turbulence, compared to the airflow that would come from a single, non-dual fan. It is believed that an advantage of having less turbulence is that there would be less likelihood of back-pressure building up particularly inside the fan and the exit nozzle 14. Therefore, the dual-fan is able to contribute to the enhanced airflow, for example, by minimizing the occurrence of internal turbulence in the airflow that is expelled from the fan via the exit nozzle 14.

It is an advantage to minimize back-pressure in the exit nozzle 14, because back-pressure can, amongst other things, slow down the exit airflow and/or increases the level of noise.

In the side cross-sectional view of Figure 4D, the fan is slightly tapered, in the sense that the diameter of the first fan-half 402A is slightly smaller than the diameter of the second fan-half 402B. In other words, the cross-section of the dual-fan is slightly frusto-conical.
Exit Nozzle

As mentioned, the filters in the filter holders 410A, 410B, 410C, 410D and 420A, 420B have a detrimental effect of decelerating the airflow through the dryer.

A feature that at least ameliorates this problem is to provide the airflow system, of the dryer 1, downstream of the location 5 of the heater, with an airflow-pathway that is progressively smaller along its pathway in respect of flowthrough cross-section.

In the embodiment, the airflow-pathway is in the form of the exit nozzle 14 that is downstream from the heater location 5. The nozzle 14 is tapered, so that it fulfils the criteria of being progressively smaller along its pathway in respect of flowthrough cross-section. The airflow is enhanced by flowing initially through a larger part of the nozzle, and subsequently through a smaller part of the nozzle.

Airflow velocity tends to increase, when it is forced to flow through progressively smaller flowthrough cross-sections of the nozzle 14.

The airflow exits the dryer 1 through an outlet-means in the form of the exit nozzle 14.

Providing the exit-nozzle 14 with a tapered passageway enables a faster speed of the exit airflow 200E, without, at the same time, necessarily requiring a larger and faster fan-motor, which may result in the associated problems, as discussed in the above preamble of this specification.

In the embodiment of Figure 2, the exit nozzle 14 has a taper of around 7 degrees to the vertical, however, the degree of taper in other embodiments can be modified. Figure 5 shows several other alternative embodiments 14A, 14B, 14C of nozzles with different degrees of tapering.

When the dryer 1 is used in different environments by a range of users, each end-use situation may have different requirements.

Another criteria is that the degree of taper can affect the noise level as airflow rushes through the nozzle 14.

**Different Uses**

In some environments, the user requires the exit airflow to be as fast as possible. For example, when effusing a beneficial substance in the airflow, the need is to spread that beneficial substance as far as possible into the ambient environment outside the dryer 1. For example, such an aim occurs in a public toilet or washroom where it is desirable to effuse a fragrance throughout...
the atmosphere of a washroom. This requires the exit airflow 200E to be as fast as possible, so that it can have a chance to reach the furthest reaches of the washroom. This application can benefit from a narrower nozzle 14C in Figure 5.

In other uses, while the speed of the exit airflow 200E remains important, the end-user may prefer to have a wider size of airflow to ensure that his hands are fully or effectively coated with the beneficial substance that is in the exit airflow 200E. This application can benefit from a slightly wider nozzle 14A in Figure 5.

In some other situations, there needs to be a compromise, so that both the above applications can be achieved using one apparatus. This application can benefit from a medium-sized nozzle 14B in Figure 5.

The variation in the size of the nozzles produces different sound noise, with smaller nozzles tending to produce louder noise levels than the larger nozzles.

In the nozzles in Figure 5, the different models of the nozzles can be used interchangeably in the embodiment of Figure 2.

Back Pressure

In the context of other parameters of the dryer 1, if the degree of taper is too great, then a problem of back pressure can occur. Without being limited by theory, it is believed that when the degree of tapering is excessive, the desired laminar airflow through the nozzle 14 can be compromised, and there can be a reduction of the exit speed of the exit airflow 200E.

Hence, the problem of build-up of back pressure can occur when the airflow cannot exit the dryer fast enough. This back pressure can build up inside the nozzle, and possibly inside the dryer.

Although tapering of the nozzle can enhance the exit speed, on the other hand, excessive tapering can inadvertently slow down the airflow speed, due to build-up of back pressure. Hence, when the designer is determining the limit of tapering beyond which back pressure occurs, it is also necessary for the designer to consider a number of other parameters of the dryer.

In the present embodiment, the optimum taper was found to be about 7 degrees to the vertical, however, some experimentation may be required when the dryer is modified in terms of its shapes of the internal chamber, the design and power of the fan-motor, the diameter of the fan, the length of the nozzle, the number of filters, the degree of internal surface smoothness of the nozzle, and other variables that affect the overall speed of airflow through the dryer. All these factors can influence the optimum degree of taper for a particular embodiment of a dryer.
Modifications of the Nozzle

In other modifications, there can be different means of achieving an airflow-pathway that is progressively smaller along its pathway in respect of flowthrough cross-section.

For example, the nozzle can consist of an initial non-tapered region having a larger flowthrough cross-section, which is followed by a subsequent non-tapered region having a smaller flowthrough cross-section. In other words, this feature is not limited to embodiments that have tapering.

In some other embodiments, the degree of tapering of the nozzle is not only defined in terms of slope, but can also be defined in terms of the transition from, for example, a square cross-section at one end of the nozzle, can transition to a circular or differently-shaped aperture at the other end of the same nozzle.

There can be a variation of noise level of airflow through different nozzles, and so this must be considered in the context of the nature of the use of the dryer. Some environments may be more or less critical of high noise levels.

Enhancement of Airflow

In the specification, the notion of enhanced airflow does include the concept of having faster airflow, however, the notion of enhanced airflow also includes the concept of maintaining a suitable airflow through and out of the dryer in spite of the decelerating effect of the filters. In other words, the enhancement comes from overcoming the deceleration that normally would occur when one or more filters would otherwise impede the airflow inside the dryer to a detrimental degree.

Hence, in some embodiments, the invention is able to, but not necessarily limited to, achieving faster airflow.

The invention may include cases where the airflow speed is not substantially reduced, even with the use of one or several impeding filters, compared to a situation where none of the improved features of the present embodiments were incorporated in the dryer.
Motor Design

The airflow, that flows through the airflow system in the hand dryer 1, is driven by the fan 401. In the embodiment, the fan is rotated and thus activated by a universal commutator motor.

In providing the dryer 1 with a motor to address the problems identified hereinabove and meet the requirements of an appliance such as a sterilising hand drying apparatus described herein, the inventor has identified a need to establish a relationship between the stationary field of preferably a universal motor and its rotating armature. The failing of motors of this type is very often the result of the failing of the bearing due to overheating which may result in the leaking out of lubricant resulting in at least one of the following: Noisy Bearing; Higher Friction; More Heat generated to overcome the friction and the final result may be the burning out of the motor.

Accordingly, the magnetic relationship has been established to achieve a relatively cooler Armature. The traditional design of universal motors attempts to keep the magnetic force (or magnetic field strength) at a ratio of 1 to 1 between armature and stationary field.

In the magnetic relationship established in accordance with a preferred embodiment, a ratio of less than 1 to 1 is provided. Preferably, the ratio is about 0.9 to 1. This provides for a cooler armature when operating even up to full power corresponding to full load on the motor. In fact, the inventor has found that this relationship contributes to an increase in power at the same time as a reduction in heat dissipation from the armature.

With reference to Figures 6A and 6B showing a lamination arm 600 in plan view, it is further preferable in accordance with embodiments to increase the magnetised area of the armature of a universal motor. As shown in Figure 6A, traditional motors provide an arc of winding 601, 602 from slot 2 to 10 to slot 12 to 20. The inventor has found that it is advantageous to provide an arc of winding of about slot 1 to 11 and about slot 12 to 22, respectively. In Figure 6A and 6B the magnetic field is shown in accordance with convention in which crosses within the lamination arm structure indicate the direction of the field to be heading out of the plane of the page and circular markings within the lamination arm structure indicate the direction the magnetic field to be heading into the plane of the page.

Further, it has been found to be advantageous to provide for a positive electrical connection at all operating times between brushes and the commutator.

Preferably, at least one Carbon Brush and Brush Holder may be modified to provide good electrical connection and flexible conductor is preferably used to ensure a positive electrical connection at all times.
In an exemplary embodiment, two carbon brushes and brush holders, i.e. two carbon brushes each with a brush holder, may be modified to provide the good electrical connection and flexible conductor.

In this respect, it is preferable to provide flexible braided copper wire inserted into the carbon brush at one end thereof the brush and have the copper attached, for example, soldered or crimped, at the other end to the terminal connecting to the field wiring. Other suitable materials for the flexible conductor may be silver, brass or other conducting materials which would be recognised by the person skilled in the art. A commutator of high performance grading with a reinforcing ring may be used to substantially eliminate any Bar to Bar movement at high speed. With reference to Figure 6K(a) to 6K(c), a solution provided in preferred embodiments is to use a commutator 610 with individual copper segments 611 and a conducting reinforcing ring 612 that is positioned or located within the commutator body 613 at a distance from the conductive segments 611 and moulded within the moulding material 614 of the commutator 610. The conducting material used for the reinforcing ring 612 may be a metal with sufficient strength to provide suitable reinforcement under high speed operation and durability to the commutator, for example, steel or aluminium. The commutator 610 of Figure 6K has the following advantages which may ensure that the commutator bars or segments 611 do not lift or move even at high speeds:

A. The solid and rigid copper segment 611 will not get distorted or bend even in elevated temperatures.

B. The reinforcing ring 612 which is moulded into the commutator 610 acts like a reinforcing as in concrete.

C. The reinforcing ring 612 being made of a strong material to provide rigidity to the commutator 610 and may be useful where individual copper segments 611 are used in the commutator 610. It is noted that the commutator of Cooper et al mentioned above may not be applicable to such commutators.

With the above described features in mind, the universal motor has been tested to operate at speeds in excess of 7,500rpm. For example, trials of the motor operating have given a free load speed of up to 25,000rpm +/- about 15-20%. Exemplary testing results are noted below.
3. Performance

(1) Life test 30 seconds on / 30 seconds off for c.c.w. direction more than 500 hours.

(2) Insulation Grade Class E

(3) Characteristic

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<th>Characteristic</th>
<th>Value</th>
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<tr>
<td>Voltage</td>
<td>AC 240V/50Hz</td>
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<tr>
<td>No-load Input</td>
<td>220.0 W max</td>
</tr>
<tr>
<td>No-load Current</td>
<td>0.95 A max</td>
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<tr>
<td>No-load Speed</td>
<td>25000 ± 15% R.P.M.</td>
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<td>Rated Torque</td>
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<td>Rated Current</td>
<td>2.55 ± 12% A</td>
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<tr>
<td>Rated Speed</td>
<td>12000 ± 12% R.P.M.</td>
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<tr>
<td>Rated In-put</td>
<td>585.0 ± 12% W</td>
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</tbody>
</table>

4. No-load Starting Voltage

Less than 100 V at 50Hz
5. Insulating Resistance
   More than 100M ohm at DC500V (under normal temp. & humidity)

6. Dielectric Strength
   Withstand for 1500V for 1sec. LOmA.

7. Noise
   Less than 80dB(A) when measured 1 meter from the motor on unresonant rubber.

8. Vibration
   No abnormal vibrations.

9. Structure & Construction
   
   (9-1) External Dimension: As DWG.NO. W5R32
   (9-2) Shaft: S45C φ12.0
   (9-3) Bearing: ball bearing (629-2RS LTN9 & 627-2Z)
   (9-4) Bracket: 1.2 mm steel-cold dull black
   (9-5) Commutator: 22 seg
   (9-6) Poles: 2 poles
   (9-7) Lead Wire: 0.75 mm² 7.5A PVC V90-110°C 250V
   (9-8) Motor Weight: 1.45 KGS
   (9-9) Thermal Protector: VDE Licen NO: 104216 SEKJ ST-22 105°C

10. Rotor End-play: Less than 0.5 MM

11. Screw Clamp Torque: 15.0kg-cm(screw 3/16"-24) & 10.0kg-cm(screw M4x0.7)

The universal motor of preferred embodiments also comprises a thermal fuse/protector as a useful safety and failsafe addition.

The advantages provided with the above noted features of the universal motor in combination are as follows.

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   The motor performs at lower armature temperature
   The motor has a longer life expectancy
   The motor is serviceable
   The motor is suitable for short interval operation as well as continuous operation
   The motor can operate in higher ambient temperatures.
A preferred embodiment of the universal motor with suitable components and example construction is illustrated in Figures 6C to 6J.

**Synergy Of Various Enhancing Features**

The above description highlights a few features, each of which, by themselves, is able to enhance or speed up the airflow of the dryer when used alone in embodiments. In the embodiment, these enhancing features include: the use of a dual fan, and/or provision of the tapered exit nozzle and/or use of a suitable constant speed motor.

However, where all these features are combined in the one drying apparatus, as it is in the embodiment of Figures 1A to 2, there is an added synergy when all those features act together to further enhance the internal and exit airflow of the apparatus beyond conventional expectations.

In the embodiment of Figures 1A to 2, the exit airflow 200E can be around 72 m/s.

**Other Modifications**

In another modification, rather than substituting different nozzles, a single nozzle can be designed with a mechanism that allows the user to mechanically adjust the shape of the taper of the nozzle, so that this one single user-variable nozzle can be used in all environments.

The apparatus can be provided with multiple exit nozzles that incorporate the principles of faster airflow, described herein. Hence, the reference to a downstream exit airflow-pathway includes the option of more airflow-pathways.

The system can be used with dryers that have one or more filters, although the benefits of the system are best seen in dryers that have a plurality of filters. For example, the embodiment in Figure 2 has potentially six filters that can each decelerate the speed of the airflow.

The embodiments have been advanced by way of example only, and modifications are possible within the scope of the invention as defined by the appended claims.

In other modifications, it is conceivable and possible that, in a further embodiment of the system, upstream of the heating-means is provided with the airflow-pathway that is progressively smaller along its pathway in respect of flowthrough cross-section, i.e. in this embodiment, a or the heater is provided at the end of the tapered nozzle.

In this specification, where the words comprise or comprises or derivatives thereof are used in relation to elements, integers, steps or features, this is to indicate that those elements,
steps or features are present but it is not to be taken to preclude the possibility of other elements, integers, steps or features being present.
CLAIMS:

1. An airflow system adapted to enhance airflow in a hand-drying apparatus which expels a stream of substantially sterilised, hot air that is heated by a heating-means for drying of hands, where the airflow inside the apparatus is decelerated by one or more filters through which the airflow passes,
   
   wherein the system, downstream of the heating-means, is provided with an airflow-pathway that is progressively smaller along its pathway in respect of flowthrough cross-section, such that, in use, the airflow is enhanced by flowing initially through a larger part of the airflow-pathway,
   
   and subsequently through a smaller part of the airflow-pathway after which the airflow exits the apparatus.

2. A system of claim 1 wherein the airflow-pathway includes at least a part that has a degree of taper.

3. A system of claim 2 wherein the degree of taper is able to be selectively varied by the user.

4. A system of claim 1 or 2 wherein the degree of taper of the airflow-pathway is able to be selectively varied by the user substituting a replacement airflow-pathway device of different size preferably selected from a range of passageways of differing degrees of taper.

5. A system of any one of claims 2 to 4 wherein the airflow-pathway includes parts that are not tapered.

6. A system of any one of the preceding claims wherein the hand-drying apparatus, in which the system is adapted to be used, comprises:
   
   a completely sealed apparatus-housing that includes therein a fan-casing containing a fan.

7. A system of claim 6 wherein all airflow enters the apparatus-housing through initial main-inlet-means on the apparatus-housing,
   
   and all airflow subsequently enters the fan-casing through final main-inlet-means on the fan-casing.
wherein the initial main-inlet-means is larger than the final main-inlet-means such that, in use, the airflow is enhanced by flowing initially through the larger initial main-inlet-means, and subsequently through the smaller final main-inlet-means.

8. A system of claim 7 where the larger initial main-inlet-means and the smaller final main-inlet-means have flowthrough cross-sections which have a ratio of around 1.38 relative to one another.

9. A system of claim 6 wherein the fan is a dual-fan comprising two fan-halves each of which is adapted to draw in airflow into the fan-casing.

10. A system of any one of the preceding claims wherein the airflow inside the apparatus is decelerated by a plurality of filters.

11. An airflow system of any one of the preceding claims in which the airflow through the system is driven by a fan apparatus that is activated by a universal commutator motor according to any one of claims 17 to 25.

12. A sterilising hand-drying apparatus which includes an improved airflow system of any one of claims 1 to 11.

13. A method of enhancing airflow through a hand-drying apparatus that expels a stream of substantially sterilised, hot air that is heated by a heating-means for drying of hands, where the airflow inside the apparatus is decelerated by one or more filters through which the airflow passes,

wherein the method includes providing the apparatus with an airflow system which, downstream of the heating-means, includes an airflow-pathway that is progressively smaller along its pathway in respect of flowthrough cross-section,

and, in use, enhancing the airflow by causing the airflow to flow initially through a larger part of the airflow-pathway,

and subsequently through a smaller part of the airflow-pathway after which the airflow exits the apparatus.
14. A method of claim 13 wherein the system is in accordance with any one of claims 1 to 12.

15. A hand-drying apparatus airflow system adapted to enhance airflow in an apparatus that expels a stream of substantially sterilised, hot air that is heated by a heating-means for drying of hands, where the airflow inside the apparatus is decelerated by one or more filters through which the airflow passes,
   wherein the hand-drying apparatus comprises a completely sealed apparatus-housing that includes therein a fan-casing containing a fan,
   wherein the fan is a dual-fan comprising two fan-halves each of which is adapted to draw in airflow into the fan-casing.


17. A universal commutator motor adapted to drive an appliance for providing air movement, the motor comprising:
   magnetic field generating means for generating a magnetic field;
   a rotating armature adapted for rotational motion in operative association with the magnetic field;
   wherein a ratio of magnetic field strength at the armature to the magnetic field strength within the magnetic field is less than about 1 to 1.

18. A motor of claim 17 wherein the ratio of magnetic field strength is about 0.9 to 1.

19. A motor of claim 17 or 18 wherein the armature comprises:
   a lamination armature structure having an arc of winding of about slot 1 to about slot 11 and about slot 12 to about slot 22, respectively.

20. A motor of claim 17 to 19 further comprising:
   at least two carbon brushes;
   at least two brush holders operatively associated with the at least two carbon brushes;
   wherein flexible conducting material is adapted to provide electrical connection to a commutator under variable operating conditions.
21. A motor of claim 20 wherein the flexible conducting material comprises braided copper wire.

22. A motor of claim 17 to 20 further comprising:
   a commutator comprising a reinforcing ring located within the body of the commutator such that it is isolated from conducting segments and adapted to substantially reduce bar to bar movement.

23. A universal commutator motor adapted to drive an appliance for providing air movement, the motor comprising:
   magnetic field generating means for generating a magnetic field;
   a rotating armature adapted for rotational motion in operative association with the magnetic field, wherein a ratio of magnetic field strength at the armature to the magnetic field strength within the magnetic field is less than about 1 to 1;
   wherein the armature comprises a lamination armature structure having an arc of winding of about slot 1 to about slot 11 and about slot 12 to about slot 22, respectively;
   at least two carbon brushes;
   at least two brush holders operatively associated with the at least two carbon brushes wherein flexible conducting material is adapted to provide electrical connection of the carbon brushes to a commutator under variable operating conditions; and,
   the commutator comprises a reinforcing ring located within the body of the commutator such that it is isolated from conducting segments and adapted to substantially reduce bar to bar movement.

24. A motor of any one of claims 17 to 23 wherein the appliance for providing air movement comprises an air dryer.

25. A motor of any one of claims 17 to 23 wherein the appliance for providing air movement comprises an airflow system of any one of claims 1 to 11.

26. A method of operating a universal commutator motor, the motor adapted to drive an electric appliance for providing air movement, the method comprising the steps of:
   generating a magnetic field within the motor;
   operatively associating a rotating armature of the motor with the magnetic field;
maintaining a ratio of magnetic field strength at the armature to the magnetic field strength within the magnetic field at less than about 1 to 1.

27. A method of claim 26 wherein the ratio of magnetic field strength is about 0.9 to 1.

28. A method of claim 26 or 27 further comprising the step of:
   providing an increased magnetized area for the armature corresponding to a lamination armature structure having an arc of winding of about slot 1 to about slot 11 and about slot 12 to about slot 22, respectively.

29. A method of claim 26 to 28 further comprising the steps of:
   providing at least two carbon brushes;
   providing at least two brush holders operatively associated with the at least two carbon brushes;
   provide electrical connection to a commutator under variable operating conditions by use of flexible conducting material adapted to provide electrical connection to a commutator under variable operating conditions.

30. A method of claim 29 wherein the flexible conducting material comprises braided copper wire.

31. A method of claim 26 to 29 further comprising the steps of:
   providing a commutator comprising a reinforcing ring located within the body of the commutator such that it is isolated from conducting segments and adapted to substantially reduce bar to bar movement.

32. A method of operating a universal commutator motor, the motor adapted to drive an electric appliance for providing air movement, the method comprising the steps of:
   operatively associating a rotating armature of the motor with the magnetic field;
   maintaining a ratio of magnetic field strength at the armature to the magnetic field strength within the magnetic field at less than about 1 to 1;
   providing an increased magnetized area for the armature corresponding to a lamination armature structure having an arc of winding of about slot 1 to about slot 11 and about slot 12 to about slot 22, respectively;
providing at least two carbon brushes;
providing at least two brush holders operatively associated with the at least two carbon brushes;
providing electrical connection to a commutator under variable operating conditions by use of flexible conducting material adapted to provide electrical connection of the carbon brushes to a commutator under variable operating conditions; and,
providing a commutator comprising a reinforcing ring located within the body of the commutator such that it is isolated from conducting segments and adapted to substantially reduce bar to bar movement.

33. A method of any one of claims 26 to 32 wherein the appliance for providing air movement comprises an air dryer.

34. A method of any one of claims 26 to 32 wherein the appliance for providing air movement comprises a hand-drying apparatus airflow system of any one of claims 1 to 11.

35. An airflow system adapted to enhance airflow in a hand-drying apparatus which expels a stream of substantially sterilised, hot air that is heated by a heating-means for drying of hands, where the airflow inside the apparatus is decelerated by one or more filters through which the airflow passes,

    wherein the system is provided with an airflow-pathway that is progressively smaller along its pathway in respect of flowthrough cross-section,
    such that, in use, the airflow is enhanced by flowing initially through a larger part of the airflow-pathway,
    and subsequently through a smaller part of the airflow-pathway after which the airflow exits the apparatus.

36. A system of claim 35 where the airflow-pathway that is progressively smaller along its pathway is provided downstream of the heating-means.

37. A system, device, apparatus or component as herein disclosed.

38. A method as disclosed herein.
Figure 4G
Figure 6C
### Component Parts List

**Manufactured Item:** 1310364 MOTOR FAN ASSY 240V VVC3

**Sub-assembly:** 0610282 FIELD ASSY VVC3

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<th>INVENTORY</th>
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**Manufactured Item:** 0610282 FIELD ASSY VVC3

**Sub-assembly:** 0610621 FIELD STACK 1"

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*Total Quantity required for 1000 Motors

**Figure 6D**

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**Manufactured Item:** 1310364 MOTOR FAN ASSY 240V VVC3

**Sub-assembly:** 0311236 COMBND HOUS STEEL ASSY VVC3

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<th>MATERIAL</th>
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**Manufactured Item:** 0311236 COMBND HOUS STEEL ASSY VVC3

**Sub-assembly:** 0910075 INSUL BRUSH TUBE RD VC1195

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<th>INVENTORY</th>
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*Total Quantity required for 1000 Motors

**Figure 6F**
Figure 6G
## Component Parts List

**Manufactured Item:** 1310364, MOTOR FAN ASSY 240V VCP1C

**Sub-assembly:** 0110310 ARMATURE ASSY VG98

### Table 1

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<th>PART NO.</th>
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*Total Quantity required for 1000 Motors
No. = Number per assembly*

Figure 6H

---

## Component Parts List

**Manufactured Item:** 1310364, MOTOR FAN ASSY 240V VCP1C

**Sub-assembly:** 0410440 DRIVE END HOUS ASSY VG98

### Table 2

<table>
<thead>
<tr>
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<th>DESCRIPTION</th>
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*Total Quantity required for 1000 Motors
No. = Number per assembly.

Figure 6J
Figure 61
INTERNATIONAL SEARCH REPORT

A CLASSIFICATION OF SUBJECT MATTER

Int. Cl.  
A47K 10/48 (2006.01)  H02K 1/06 (2006.01)  HOIR 4/01 (2006.01)  H02K 13/00 (2006.01)  
H02K 23/26 (2006.01)  F24H 3/12 (2006.01)  H02K 3/04 (2006.01)  

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)

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 practicable, search terms used)

DWPI, A47K 10/48 A61L 2/06 key words FILT+, SIEV+, GAUZ+, TAPER+, WEDG+, NARRO W+, CONSTRUCT+, INCREASE+, GREATER*, HIGHER+, ENHANCE+, VELOCITY+, FLOW+, SPEED+, ACCELERAT+

DWPI, A47K 10/48, F24H 3/12, H02K 13/00, 23/26 key words HAND+, DRY+, DRI+, MAGNET+, AIR+


C DOCUMENTS CONSIDERED TO BE RELEVANT

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<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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<tr>
<td>A</td>
<td>WO 1990/001287 A (INTERNATIONAL DRYER COMPANY PTY LTD) 22 FEBRUARY 1990 Whole document</td>
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</table>

[ X ] Further documents are listed in the continuation of Box C  [ X ] See patent family annex

* Special categories of cited documents  
"A" document defining the general state of the art which is not considered to be of particular relevance  
"E" earlier application or patent but published on or after the international filing date  
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)  
"O" document referring to an oral disclosure, use, exhibition or other means  
"P" document published prior to the international filing date but later than the priority date claimed  
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention  
"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone  
"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art  
"&" document member of the same patent family

Date of the actual completion of the international search  
03 June 2008

Date of mailing of the international search report  
20 JUN 2003

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PO BOX 200, WODEN ACT 2606, AUSTRALIA  
E-mail address pct@ipaustralia.gov.au
Facsimile No +61 2 6283 7999

Authorized officer  
SARAVANAMUTHUPONNAMPALAM
AUSTRALIAN PATENT OFFICE  
(ISO 9001 Quality Certified Service)
Telephone No (02) 6283 2070
<table>
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<td>A</td>
<td>DE 433651 8 A (DEKANY A) 11 May 1994 Whole document</td>
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</table>
Box No. II  Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III  Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

(a) Claims 1 - 14, 35 & 36
(b) Claims 15 & 16
(c) Claims 17 - 34

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

   1 - 14, 35 & 36
   &
   17 - 34

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.
INTERNATIONAL SEARCH REPORT

Supplemental Box
(To be used when the space in any of Boxes I to IV is not sufficient)

Continuation of Box No: III

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

In assessing whether there is more than one invention claimed, I have given consideration to those features which can be considered to potentially distinguish the claimed combination of features from the prior art. Where different claims have different distinguishing features they define different inventions.

This International Searching Authority has found that there are different inventions as follows:

- Claims 1-14, 35 & 36 are directed to an airflow system. It is considered that the airflow is enhanced by flowing initially through a larger part of the airflow pathway, and subsequently through a smaller part of the airflow pathway after which the airflow exits the apparatus comprises a first distinguishing feature.

- Claims 15 & 16 are directed to a hand drying apparatus. It is considered that use of dual fan comprises a second distinguishing feature.

- Claims 17-34 are directed to a universal commutator. It is considered that wherein a ratio of magnetic field strength at the armature to the magnetic field strength within the magnetic field is less than about 1 to 1 comprises a third distinguishing feature.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

Each of the abovementioned groups of claims has a different distinguishing feature and they do not share any feature which could satisfy the requirement for being a special technical feature. Because there is no common special technical feature it follows that there is no technical relationship between the identified inventions. Therefore the claims do not satisfy the requirement of unity of invention apriori.
This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX