Dryer

The invention relates to a dryer which makes use of narrow streams of high velocity, high pressure air to dry a user's hands.

The use of air jets to dry hands is well known. Examples of hand dryers which emit at least one air jet for the purposes of drying hands are shown in GB 2249026A, JP 2002 034835A and JP 2002306370A. A further example of a known hand dryer is shown in JP 11244191. In this latter prior art document, the cavity into which the user is invited to place his or her hands is shaped by providing the cavity with curved walls. Nozzles are provided in the curved walls so that individual jets of air are blown onto the user's hands for the purpose of drying the user's hands. However, in the arrangement shown, the rate of drying will be different for different sides of the user's hands. This will result in the user needing to use the dryer to dry part of his or her hands after another part has already been dried. This will result in discomfort and is also inefficient.

It is an object of the invention to provide drying apparatus which, in use, dries the user's hands at an even rate as compared to the prior art. It is another object to provide an improved hand dryer in which the drying efficiency is improved in comparison to the prior art.

A first aspect of the invention provides hand drying apparatus having a casing, a cavity formed in the casing for receiving for receiving a user's hands, a fan located in the casing and capable of creating an airflow, and a plurality of openings communicating with the fan and arranged to direct an airflow transversely across the cavity, wherein the cavity has an entrance delimited by a front edge and a rear edge in which the openings are located, the shape of the front and rear edges being such that, when in use the user's hands are introduced to the cavity, the distance between the user's hands and the nearest opening is substantially uniform.

A second aspect of the invention also provides hand drying apparatus having a casing, a cavity formed in the casing for receiving for receiving a user's hands, a fan located in the casing and capable of creating an airflow, and a plurality of openings communicating with the fan and arranged to direct an airflow transversely across the cavity, wherein the cavity has an entrance delimited by a front edge and a rear edge in which the openings are located, one of the said edges being substantially straight and the other of the said edges being curved so that the distance between the said edges varies along the length of the cavity entrance.

Both aspects of the invention provide arrangements in which, in use, the distance between the openings through which drying air is emitted and the adjacent surfaces of the user's hands is kept substantially constant. This is particularly advantageous when the undersides (or palms) of the users hands are considered.

Preferably, the front edge of the cavity entrance is substantially straight and the rear edge is curved. More preferably, the rear edge comprises two curved portions which are arranged symmetrically about the centre of the cavity entrance, and the distance between the front and rear edges decreases towards the centre of the cavity entrance. These features result in a shape which corresponds closely to the shape of a user's hands when in a normal, relaxed state suitable for drying and so minimise the time required to dry the user's hands evenly and quickly.

In a preferred embodiment, the openings in the front and rear edges are formed by continuous slots. This minimises the risk of small areas of the user's hands not being dried by the drying apparatus.

An embodiment of the invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a side view of a hand dryer according to the invention;

Figure 2 is a perspective view of the hand dryer of Figure 1;

Figure 2a is a plan view of the cavity entrance of the hand dryer of Figure 1;

Figure 3 is a side sectional view of the hand dryer of Figure 1;

Figure 4 is a side sectional view, shown on an enlarged scale, of the upper ends of the air ducts forming part of the hand dryer of Figure 1;

Figure 5 is a schematic sectional side view, shown on a further enlarged scale, of the slot-like opening located in the front wall of the cavity of the hand dryer of Figure 1; and;

Figure 6 is a schematic sectional side view, shown on the same further enlarged scale, of the slot-like opening located in the rear wall of the cavity of the hand dryer of Figure 1.

Referring firstly to Figures 1 and 2, the hand dryer 10 shown in the drawings comprises an outer casing 12 having a front wall 14, a rear wall 16, an upper face 18 and side walls 20, 22. The rear wall 16 can incorporate fixing devices (not shown) for securing the hand dryer 10 to a wall or other structure prior to use. An electrical connection (not shown) is also provided on the rear wall or elsewhere on the casing 12. A cavity 30 is formed in the upper part of the casing 12 as can be seen from Figures 1 and 2. The cavity 30 is open at its upper end and delimited thereat by the top of the front wall 14 and the front of the upper face 18. The space between the top of the front wall 14 and the front of the upper face 18 forms a cavity entrance 32 which is sufficiently wide to allow a user's hands to be introduced to the cavity 30 through the cavity entrance 32. The cavity 30 is also open to the sides of the hand dryer 10 by appropriate shaping of the side walls 20, 22.

The cavity 30 has a front wall 34 and a rear wall 36 which delimit the cavity 30 to the front and rear respectively. Located in the lowermost end of the cavity 30 is a drain 38 which communicates with a reservoir (not shown) located in the lower part of the casing 12. The purpose of the drain and reservoir will be described below.

As shown in Figure 3, a motor (not shown) is located inside the casing 12 and a fan 40, which is driven by the motor, is also located inside the casing 12. The motor is connected to the electrical connection and is controlled by a controller 41. The inlet 42 of the fan 40 communicates with an air inlet 44 formed in the casing 12. A filter 46 is located in the air passageway connecting the air inlet 44 to the fan inlet 42 so as to prevent the ingress of any debris which might cause damage to the motor or the fan 40. The outlet of the fan 40 communicates with a pair of air ducts 50, 52 which are located inside the casing 12. The front air duct 50 is located primarily between the front wall 14 of the casing 12 and the front wall 34 of the cavity 30, and the rear air duct 52 is located primarily between the rear wall 16 of the casing 12 and the rear wall 36 of the cavity 30.

The air ducts 50, 52 are arranged to conduct air from the fan 40 to a pair of opposed slot-like openings 60, 62 which are located in the front and rear walls 34, 36 respectively of the cavity 30. The slot-like openings 60, 62 are arranged at the upper end of the cavity 30 in the vicinity of the cavity entrance 32. The slot-like openings 60, 62 are each configured so as to direct an airflow generally across the cavity entrance 32 towards the opposite wall of the cavity 30. The slot-like openings 60, 62 are offset in the vertical direction and angled towards the base of the cavity 30.

Figure 4 shows the upper ends of the air ducts 50, 52 and the slot-like openings 60, 62 in greater detail. As can be seen, the walls 54a, 54b of the air duct 50 converge to form the slot-like opening 60 and the walls 56a, 56b of the air duct 52 converge to form the slot-like opening 62. Even greater detail can be seen in Figures 5 and 6. Figure 5 shows that the slot-like opening 60 has a width of W1 and Figure 6 shows that the slot-like opening 62 has a width of W2. The width W1 of the slot-like opening 60 is smaller

than the width W2 of the slot-like opening 62. The width W1 is 0.3mm and the width W2 is 0.4mm.

Sensors 64 are positioned in the front and rear walls 34, 36 of the cavity 30 immediately below the slot-like openings 60, 62. These sensors 64 detect the presence of a user's hands which are inserted into the cavity 30 via the cavity entrance 32 and are arranged to send a signal to the motor when a user's hands are introduced to the cavity 30. As can be seen from Figures 1 and 3, the walls 54a, 54b, 56a, 56b of the ducts 50, 52 project slightly beyond the surface of the front and rear walls 34, 36 of the cavity 30. The inward projection of the walls 54a, 54b, 56a, 56b of the ducts 50, 52 reduces the tendency of the user's hands to be sucked towards one or other of the walls 34, 36 of the cavity, which enhances the ease with which the hand dryer 10 can be used. The positioning of the sensors 64 immediately below the inwardly projecting walls 54a, 54b, 56a, 56b of the ducts 50, 52 also reduces the risk of the sensors 64 becoming dirty and inoperative.

As can be seen from Figure 2, the shape of the cavity entrance 32 is such that the front edge 32a is generally straight and extends laterally across the width of the hand dryer 10. However, the rear edge 32b has a shape which consists of two curved portions 33 which generally follow the shape of the backs of a pair of human hands as they are inserted downwardly into the cavity 30 through the cavity entrance 32. The rear edge 32b of the cavity entrance 32 is substantially symmetrical about the centre line of the hand dryer 10. The intention of the shaping and dimensioning of the front and rear edges 32a, 32b of the cavity entrance 32 is that, when a user's hands are inserted into the cavity 30 through the cavity entrance 32, the distance from any point on the user's hands to the nearest slot-like opening is substantially uniform.

A plan view of the cavity entrance 32 is shown in Figure 2a. The dotted lines indicate the position and shape of the user's hands as they are normally inserted into the cavity 30 between the front and rear edges 32a, 32b. As can be seen, the distance between the front and rear edges 32a, 32b varies along the length of the cavity entrance 32. Also,

the distance between the user's hands and the nearest edge is substantially uniform. The curved portions 33 of the rear edge 32b are symmetrical about the centre line A-A of the cavity entrance 32 with the centre portion of the rear edge 32b being closer to the front edge 32a at the centre line than at a position spaced from the centre line. At the centre line, the distance d between the front and rear edges 32a, 32b is between 50mm and 80mm, in this embodiment 65mm. The maximum distance D between the front edge and the rear edge is between 70mm and 100mm, in this embodiment 85mm.

The arrows 70 shown in Figure 2a indicate the direction of the airflow emitted from the slot-like openings 60, 62 located in the edges 32a, 32b of the cavity entrance 32. As can be seen, the airflow is emitted in a direction which is perpendicular to the respective edge 32a, 32b. In this way, the airflow has the maximum possible momentum when it hits the surface of the user's hands.

The hand dryer 10 described above operates in the following manner. When a user's hands are first inserted into the cavity 30 through the cavity entrance 32, the sensors 64 detect the presence of the user's hands and send a signal to the motor to drive the fan 40. The fan 40 is thus activated and air is drawn into the hand dryer 10 via the air inlet 44 at a rate of approximately 20 to 30 litres per second, preferably 25 to 27 litres per second. The air passes through the filter 46 and along the fan inlet 42 to the fan 40. The airflow leaving the fan 40 is divided into two separate airflows; one passing along the front air duct 50 to the slot-like opening 60 and the other passing along the rear air duct 52 to the slot-like opening 62.

The airflow is ejected from the slot-like openings 60, 62 in the form of very thin, stratified sheets of high velocity, high pressure air. As the airflows leave the slot-like openings 60, 62, the air pressure is at least 15 kPa and preferably approximately 20 to 23 kPa. Furthermore, the speed of the airflow leaving the slot-like openings 60, 62 is at least 80 m/s and preferably at least 100 or 150 m/s, more preferably approximately 180m/s. Because the size of the slot-like opening 62 located at the end of the rear duct 52 is greater than the size of the slot-like opening 60 located at the end of the front duct

50, a larger volume of air is emitted from the duct 52 than from the duct 50. This provides a greater mass of air for drying the backs of the user's hands which is advantageous.

The two thin sheets of stratified, high velocity, high pressure air are directed towards the surfaces of the user's hands which, during use, are inserted fully into the cavity 30 and are subsequently withdrawn from the cavity 30 via the cavity entrance 32. As the user's hands pass into and out of the cavity 30, the sheets of air blow any existing water off the user's hands. This is achieved reliably and effectively because of the high momentum of the air leaving the slot-like openings 60, 62.

Each stratified sheet of air is directed towards the wall of the cavity 30 which is remote from the slot-like opening through which the respective sheet of air is emitted. Because the slot-like openings 60, 62 are also inclined towards the lowermost end of the cavity 30, the emitted airflows are directed into the cavity 30. This reduces the risk of turbulent air movement being felt by the user outside the casing, eg in the user's face.

It is envisaged that it will take only a small number of "passes" of the hand dryer described above to dry a user's hands to a satisfactory degree. (By "pass", we mean a single insertion of the hands into the cavity and subsequent removal therefrom at a speed which is not unacceptable to an average user. We envisage that a single pass will have a duration of no more than 3 seconds.) The momentum achieved by the airflows is sufficient to remove the majority of water found on the surface of the user's hands after washing during a single pass.

The water removed by the airflows is collected inside the cavity 30. Each airflow will rapidly lose its momentum once it has passed the user's hands and the water droplets will fall to the lower end of the cavity 30 under the forces of gravity whilst the air exits the cavity 30 either through the cavity entrance 32 or via the open sides of the cavity 30. The water, however, is collected by the drain 38 and passed to a reservoir (not shown) where it is collected for disposal. The reservoir can be emptied manually if desired.

Alternatively, the hand dryer 10 can incorporate some form of water dispersal system including, for example, a heater for evaporating the collected water into the atmosphere. The means by which the collected water is dispersed does not form part of the present invention.

In an alternative embodiment, the slot-like openings 60a, 62a can be arranged so that the sheets of air which are emitted therefrom are directed generally along planes which are substantially parallel to one another. This minimises the amount of turbulent flow present inside the cavity 30 whilst the drying apparatus is in use.

The invention is not intended to be limited to the precise detail of the embodiment described above. Modifications and variations to the detail which do not alter the scope of the invention will be apparent to a skilled reader. For example, the slot-like openings described above can be replaced by lines of nozzles, each of which emits an individual jet of air towards the user's hands. Also, the means by which the water removed from the user's hands is disposed of may be altered without departing from the essence of the present invention.

CLAIMS

1. Hand drying apparatus having a casing, a cavity formed in the casing for receiving for receiving a user's hands, a fan located in the casing and capable of creating an airflow, and a plurality of openings communicating with the fan and arranged to direct an airflow transversely across the cavity, wherein the cavity has an entrance delimited by a front edge and a rear edge in which the openings are located, the shape of the front and rear edges being such that, when in use the user's hands are introduced to the cavity, the distance between the user's hands and the nearest opening is substantially uniform.

2. Hand drying apparatus as claimed in claim 1, wherein one of the said edges is substantially straight and the other of the said edges is curved.

3. Hand drying apparatus having a casing, a cavity formed in the casing for receiving for receiving a user's hands, a fan located in the casing and capable of creating an airflow, and a plurality of openings communicating with the fan and arranged to direct an airflow transversely across the cavity, wherein the cavity has an entrance delimited by a front edge and a rear edge in which the openings are located, one of the said edges being substantially straight and the other of the said edges being curved so that the distance between the said edges varies along the length of the cavity entrance.

4. Hand drying apparatus as claimed in any one of claims 1 to 3, wherein the front edge of the cavity entrance is substantially straight.

5. Hand drying apparatus as claimed in any one of claims 1 to 4, wherein the shape of the rear edge comprises two curved portions.

6. Hand drying apparatus as claimed in claim 5, wherein the shape of the rear edge is symmetrical about the centre of the cavity entrance.

7. Hand drying apparatus as claimed in claim 7, wherein the distance between the front edge and the rear edge decreases towards the centre of the cavity entrance.

8. Hand drying apparatus as claimed in claim 7, wherein the distance between the front edge and the rear edge at the centre of the cavity entrance is between 50mm and 80mm.

9. Hand drying apparatus as claimed in claim 8, wherein the distance between the front edge and the rear edge at the centre of the cavity entrance is substantially 65mm.

10. Hand drying apparatus as claimed in any one of claims 7 to 9, wherein the maximum distance between the front edge and the rear edge is between 70mm and 100mm.

11. Hand drying apparatus as claimed in claim 10, wherein the maximum distance between the front edge and the rear edge is substantially 85mm.

12. Hand drying apparatus as claimed in any one of the preceding claims, wherein the openings are formed by continuous slots extending along the length of each of the front and rear edges.

13. Hand drying apparatus as claimed in claim 12, wherein the slots are arranged to emit air therefrom in a direction which is perpendicular to the extent of the slot.

14. Hand drying apparatus substantially as hereinbefore described with reference to the accompanying drawings.