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GB 2613606 A **GB 2608155 A**
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(54) Title of the Invention: **Hair styling device, attachment for a handle of a hair styling device, and method for straightening or curling hair using the hair styling device**
Abstract Title: **A hair styling device with a second arm which receives airflow from a first arm**

(57) A hair styling device comprises first and second arms 14, 16 coupled together at a first end and arranged to receive hair within a cavity 64 formed between the arms in the closed position. The first arm comprises a first plenum 38, said first plenum comprising a first air outlet 42 for emitting air towards hair within the cavity. The second arm comprises a first air inlet 60 for receiving air emitted from the first air outlet. The second arm preferably has a first exhaust 58 through which air can exit. In one embodiment the second arm has a second plenum 52 and a second outlet 56 for emitting air towards the cavity. Air from the second arm can be received by a second air inlet 46 on the first arm and is exhausted via a second exhaust 44 on the first arm. Hair may be wrapped around the device and heated by air exiting the first and second exhaust. The outer walls 36, 50 may be removably attached to the inner walls 18 of the first and second arms.

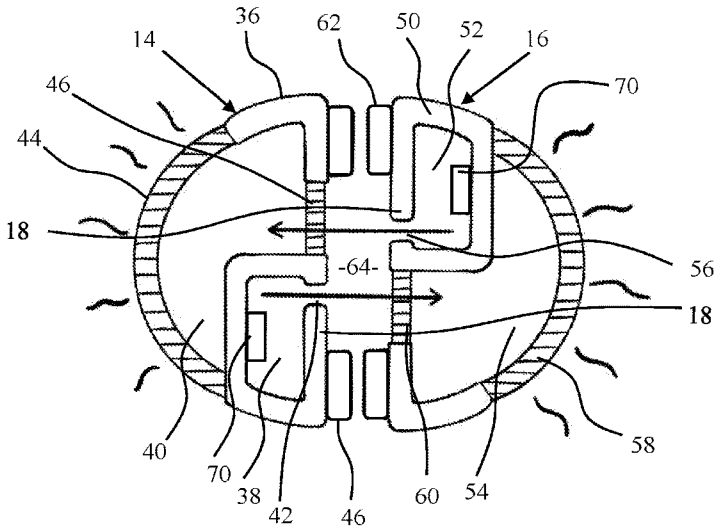

Fig. 2

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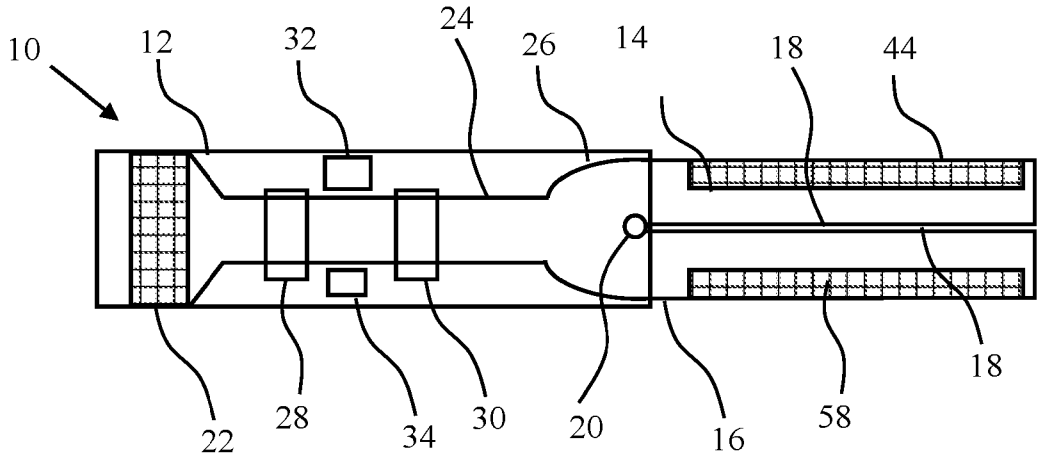
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Fig. 1

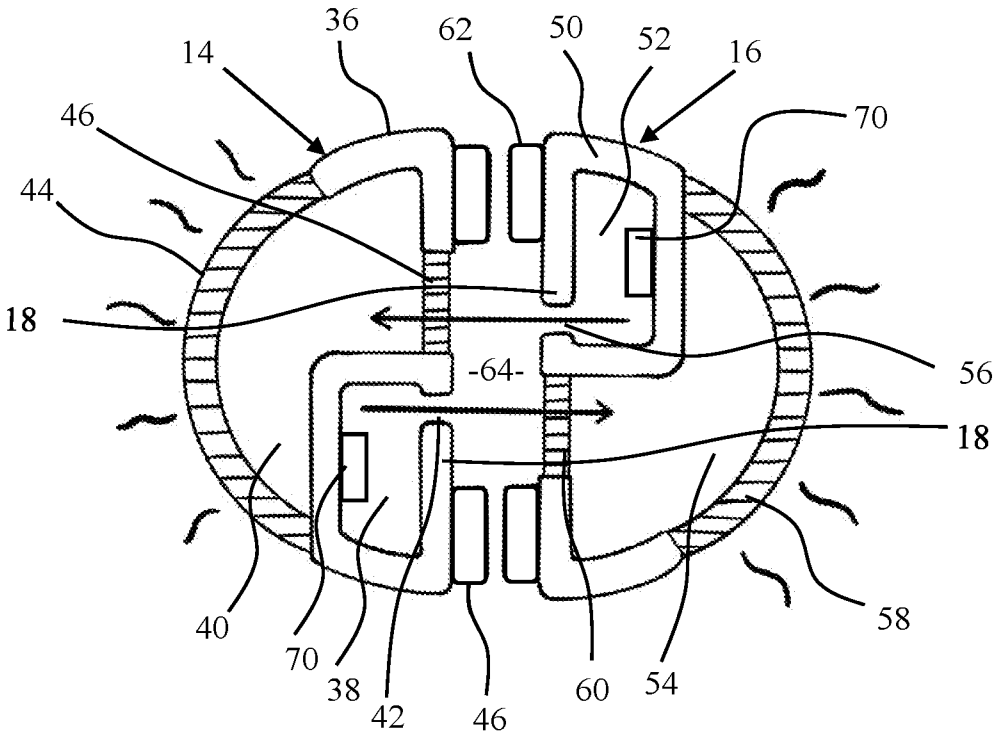
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Fig. 2

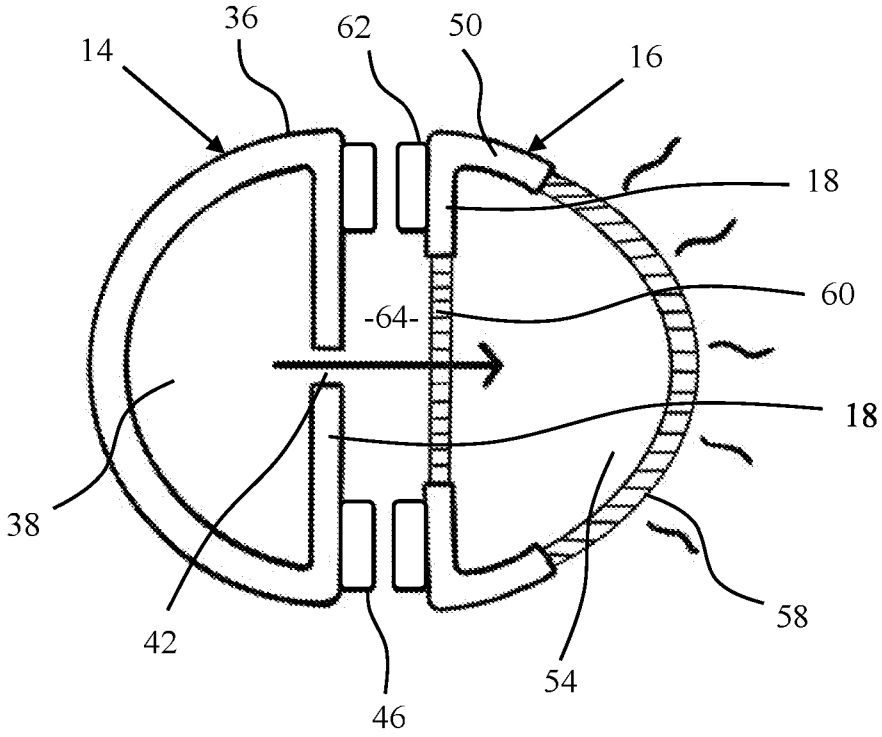

Fig. 3

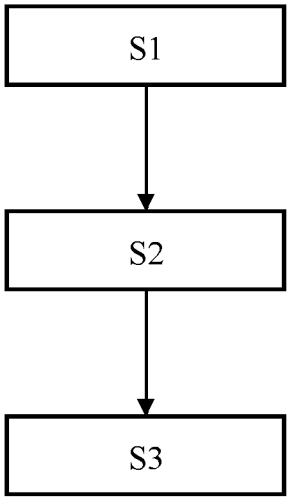

Fig. 4

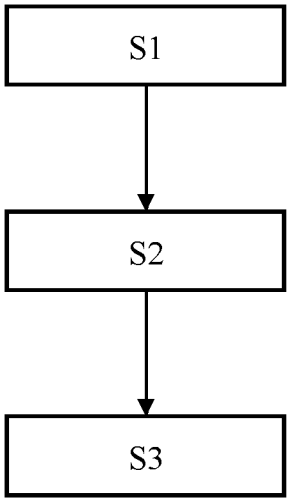

Fig. 5

Hair styling device, attachment for a handle of a hair styling device, and method for straightening or curling hair using the hair styling device

BACKGROUND

Hair straightening, shaping, and curling using heat has been used for over a hundred years, and conduction has traditionally been used as the method of transferring heat into the hair. An example of this technology is a hot-plate straightener, which uses electricity to heat two plates, one in each of the straightener arms. A device of this nature requires sufficiently high temperatures to ensure that the mean average temperature of the majority of the section of hair in question is heated to a level so that it can be styled.

Hair fibre structure in the α-keratin phase is held in place by hydrogen bonds, salt bridges and disulphide bonds. Hydrogen bonds and salt bridges can be easily disrupted and reformed during styling. This is because applying heat causes the keratin fibres to vibrate, breaking some of the hydrogen bonds, making it easier to tension and style hair into a new shape. When hair cools, these vibrations cease, and the bonds reform in the desired shape, effectively sealing in the style.

This lowest temperature at which styling is achieved is generally at 135°C, as this is when most of disulphide bonds are cleaved and reading to be reformed during styling. However, extreme heat changes the shape of keratin strands within hair. At over 150°C the α-keratin slowly convert to β-keratin which, over time, makes hair weaker and less elastic. Over 230°C hair begins to burn or melt, and the strong disulphide bonds break down quickly. Hair can be easily broken in this state. Overall, thermal damage causes the hair to become weaker, less elastic, and easier to damage by other factors, such as UV, mechanical or chemical means.

SUMMARY

At its most general, the invention relates to a penetrative flow of hot air for straightening hair. For example, a hair styling device includes a first arm and a second arm between which hair can be clamped or grasped. Air can flow from a first air outlet on the first arm to a first air inlet on the second arm. Thereby, the air from the first air outlet passes through

hair between the first arm and the second arm before being received at the first air inlet on the second arm. In this way, the hair can be heated by hot air which may be used for straightening and/or styling the hair.

In one aspect of the invention, a hair styling device is provided which comprises a first arm and a second arm coupled together at a first end thereof. An inner wall of the first arm is facing an inner wall of the second arm. The first arm and the second arm are arranged to receive hair within a cavity formed between the first arm and the second arm. The first arm comprises a first plenum which comprises a first air outlet for emitting air towards hair within the cavity. The second arm comprises a first air inlet for receiving air emitted from the first air outlet.

In another aspect of the invention, an attachment configured to be coupled to a handle of a hair styling device is provided. The attachment comprises a first arm and a second arm configured to be removably coupled to the handle of the hair styling device, for example during maintenance and/or servicing the hair styling device and/or for modifying the hair styling device. An inner wall of the first arm is facing an inner wall of the second arm. The first arm and the second arm are arranged to receive hair within a cavity formed between the first arm and the second arm. The first arm comprises a first plenum which includes a first air outlet for emitting air towards hair within the cavity. The second arm comprises a first air inlet for receiving air emitted from the first air outlet.

In another aspect of the invention, a set or kit of attachments is provided wherein each attachment in the set or kit differs in one parameter, such as shape, length, and/or diameter. Optionally, each attachment in the set or kit can be attached to the same handle.

As mentioned in above section “Background”, hot plate straighteners must heat some of the hair to very high temperatures (150°C and above) to ensure that the hair’s mean average temperature of the hair grasped between the arms of the hot plate straighteners is heated to a level so that it can be styled (above 135°C). Thereby, conduction is used as a method of heat transfer, e.g. the hairs in contact with the hot plate are heated by the hot plate and the heated hairs pass on the elevated temperature to hairs in contact with the

heated hairs but not in direct contact with the hot plate. As a result, hair temperatures must exceed healthy levels at the surface of the hot plates, so that the non-surface hair can reach temperatures in which styling can occur (e.g. above 135°C). This principle does not apply when using penetrative airflow, as the method of heat transfer allows the non-surface hair to be heated directly using heated air. In other words, the heating of non-surface hair and surface hair is the same, namely by hot air.

Thus, the penetrative airflow technology of this invention is able provide an even heating effect across on a thickness of a tress of hair. In other words, due to the penetrative air flow caused between the first air outlet and the first air inlet, each hair in the tress can be heated in the same way and, therefore, up to the same temperature. For example, hairs in direct contact with the first arm or with the second arm may be heated to the same temperature as hairs which are not in direct contact with first arm or with the second arm. This is because the hot air penetrates the tress of hair and, therefore, can reach each hair in the tress. In other words, the invention uses convection for the transport of heat compared to conduction with conventional hot plate straighteners. Nevertheless, the same principles as outlined in above section “Background” can apply for straightening or curling hair with this invention – only the method how the hair is heated differs from devices having a hot plate.

Further, a tress of hair can be straightened by clamping a tress of hair between the arms of the hair styling device and pulling – in the closed or clamping position of the arm – the hair styling device along the tress. With conventional hot plate hair straighteners, the temperature of the hot plate is cooled by the hair when pulling the hotplate along the tress. So, hair at the tip of the tress may not be heated as much compared to hair close to the root. With the invention, there is no cooling effect of hot plates because no hotplates are provided. Rather, the temperature of the air that is exhausted at the first air outlet can be kept at a constant so that the heating temperature at the beginning (e.g. close to the root of the hair) is the same at the end (e.g. close to or at the tip of the hair). So a tress can be straightened to the same degree over its entire length and/or tips of the hair are not left under styled. Thus, users can confidently and consistently style hair using only full passes

from hair root to tip. This simplifies the styling journey with users not having to inspect tip sections and re-pass these parts specifically.

A further benefit of the invention is that users with type 3 and 4 hair will be able to style their hair to a straighter style using penetrative airflow than hotplates. This is because these hair types have a larger impact on the hotplate straightener's ability to thermal energy to non-surface hair via the surface hair. Penetrative airflow can pass through the hair and the amount to which the non-surface hair's temperature is affected by the type is less.

Type 1 hair is often considered to be straight hair. Type 2 is often described as wavy. Type 3 hair is often considered to be curly hair, and type 4 is often considered to be coily hair.

The benefits of the invention can be summarized as: by using penetrative airflow within a traditional 'clamping' hair straightener, the hair can be heated more evenly on the surface and within the tress. This heating of the hair via convection, rather than conduction, means that the mean temperature that the majority of the hair reaches during styling is reduced, lowering damage levels. This also means that the problems with under-styled tips that are present when using a hot plate straightener can be reduced, as the airflow can provide a constant rate of energy transfer to the hair, allowing for more consistent root-to-tip straightening and styling. Further, fewer passes for styling and/or straightening a tress can be required compared to conventional hair styling devices.

The hair styling device is a device for straightening and/or curling hair. The hair styling device optionally includes a handle, the first arm, and/or the second arm. The handle may include an air channel, a fan, a heater, a bellows, and/or a controller. The fan may be a conventional fan for providing an airflow in the air channel. The heater may be an electrical heater, such as a resistive heater, for heating the airflow provided by the fan. The air channel may connect a filter inlet to the first plenum of the first arm. This means, air flows from the filter inlet through the fan and the heater to the first plenum. The fan and/or the heater may be provided within the air channel. The air channel may be a passage within the handle for guiding air from the filter inlet to the first plenum.

The handle may include a housing providing an outer surface of the handle. The filter inlet may be an opening in the housing for allowing an airflow into the air channel. The filter inlet may include a mesh or other types of filter which prevents air, dirt, and/or debris from entering the air channel.

The first arm and/or the second arm may be movably (e.g., pivotally or rotatably) coupled to the handle. For example, the first arm and the second arm can be rotated with respect to each other via a hinge or joint that is provided with the handle. In this case, both the first arm and the second arms are movable. In another embodiment, the first arm or the second arm is fixedly attached to the handle while the other one of the first arm and the second arm is pivotally or rotatably attached to the handle.

The rotatability and/or movability of the first arm and/or the second arm allows to move the first arm and/or the second arm with respect to each other and/or the handle. For example, in an open position, the first arm and the second arm are maximally spaced apart for providing a space therebetween. In the open position, hair can be placed between the first arm and the second arm. In the closed position, the first arm and the second arm can contact each other and/or lie parallel to each other. In the closed position, hair can be grasped or clamped between the first arm and the second arm. The cavity may be formed between the first arm and the second arm in the closed position.

The inner wall of the first arm may extend parallel to the inner wall of the second arm in the closed position. The inner walls of the first arm and/or the second arm may be flat. The first arm may further include a first outer wall and/or the second arm may further include a second outer wall. In the closed position, the inner wall of the first arm can be identified as that wall which faces the inner wall of the second arm while the first outer wall and the second outer wall can provide an outer surface of the first arm and the second arm in the closed position. So, in the closed position, the inner walls of the first arm and/or the second arm may not be exposed while the first outer wall and the second outer wall are exposed.

In an optional embodiment, the first arm includes a first engaging section protruding from the inner wall of the first arm for contacting hair in the closed position and/or the second

arm includes a second engaging section protruding from the inner wall of the second arm for contacting hair in the closed position. The first engaging section optionally protrudes from the inner wall towards the second arm. The second engaging section optionally protrudes from the inner wall towards the first arm. The first engaging section and/or the second engaging section may include a rib or bar which can be made from an elastically deformable material such as rubber or the like.

In the closed position, a section of the first engaging section or the entire first engaging section abuts against a corresponding section of the second engaging section or the entire second engaging section, respectively. Alternatively, a section of the first engaging section or the entire first engaging section abuts against the second wall (e.g., no second engaging portion is present or the first and second engaging portions are offset), or a section of the second engaging section or the entire first engaging section abuts against the first wall (e.g., no first engaging portion is present or the first and second engaging portions are offset).

The first engaging section may include a first section which extends along the direction of extension of the first arm on a first side of the inner wall. The first engaging section may include a second section which extends along the direction of extension on a second side of the inner wall opposite to the first side. The second engaging section may include a third section which extends along the direction of extension of the second arm on a first side of the inner wall. The second engaging section can include a fourth section which extends along the direction of extension on a second side of the inner wall opposite to the first side. The first section may contact the third section in the closed position, for example over their entire lengths. The second section may contact the fourth section in the closed position, for example over their entire lengths.

The inner walls of the first arm and the second arm, the first engaging section, and the second engaging section may define the cavity in the closed position. In this case, the inner walls of the first arm and the second arm are spaced apart from each other or are parallel to each other in the closed position. The hair may be clamped or grasped between the first engaging section and the second engaging section and may not be clamped by the inner

walls of the first arm and the second arm so that hair may move freely between the inner walls of the first arm and the second arm, i.e., within the cavity. This may help that the air can flow through the air with less resistance since the hair is not clamped between the inner walls of the first arm and the second arm.

The first engaging section and the second engaging section may be used to grasp or clamp the hair and to seal the cavity. So, when the hairstyling device is pulled from the root to the tip of the hair during hair straightening, the hair is pulled between the first engaging section and the second engaging section. The first engaging second and the second engaging section may be made from a material that has reduced friction with air for reducing the force that is required to pull the hairstyling device in the closed position along the tress. So, the first engaging section and/or the second engaging section can be considered tension plates (for tensioning the hair/tress) which can be used instead of conventional hot plates.

The first arm and/or the second arm may be free from hot plates or from electric or electronic components in general. For example, there may be no electric or electronic connection between the first arm and/or the second arm and the handle. This is a further difference to conventional hot plate hair straightener which require an electric connection between the arms (including the hot plates) and the handle.

The first plenum may be a cavity, space, or chamber within the first arm that is in air communication with the air channel of the handle. In other words, the first plenum is configured to receive (hot) air at the first end thereof - the first end may be that end of the first arm that is coupled or connected to the handle. In case that the first arm is movable relative to the handle, the first plenum may be connected to the air channel via a bellows which is made from a flexible material (e.g., rubber) for receiving and/or absorbing the movement of the first arm (e.g., the first plenum) relative to the handle (e.g. air channel).

The first plenum may extend from the first end of the first arm to a free end of the first arm which can be the end of the first arm opposite to the first end. So the first plenum may have an elongate shape. The first plenum may be a closed chamber or space so that air can only

escape or exit the first plenum at the first air outlet. Air may only enter the first plenum at the first end of the first arm. So, the first plenum can be configured to distribute the air received from the air channel (i.e., provided by the fan and/or heater) along or over the first air outlet. The inner wall of the first arm and/or the first outer wall may at least partially define the first plenum, e.g., are walls defining the first plenum.

The first air outlet may be provided within or on the inner wall of the first arm. The first air outlet provides air communication between the first plenum and the cavity. So, hot air that is generated by the fan and/or the heater flows from the air channel through the first plenum and the first air outlet into the cavity. As such, hair is heated by air which flows from the air channel via the first plenum through the first air outlet to the hair.

In the closed position of the first arm and the second arm, the air flow generated by the fan and/or the heater and exiting the first arm at the first air outlet increases the air pressure within the cavity. So, in the closed position, the air exiting the first plenum at the first air outlet exits the cavity at the first air inlet which can be arranged within or on the inner wall of the second arm. So, the first air inlet and the first air outlet can be arranged on opposing surfaces (e.g. the inner walls) in the closed position of the first arm and the second arm. Optionally, the first air outlet directly faces the first air inlet in the closed position so that there is a straight air flow between the first air outlet in the first air inlet. For example, in the closed position, the airflow exiting the first air outlet is perpendicular to the inner wall of the first arm and/or the airflow entering the first air inlet is perpendicular to the inner wall of the second arm.

The first air inlet and/or the first air outlet may include one or more (elongate) through-holes in the respective inner wall.

In an optional embodiment, the second arm further comprises a first air chamber coupled to the first air inlet. Optionally, the second arm comprises a first exhaust coupled to the first air chamber for emitting air from the first air chamber.

The first air chamber may be a cavity, space, or chamber within the second arm that is configured to receive air from the first air inlet. So the first air inlet provides an air communication between the cavity and the first air chamber. The first air chamber may a be closed chamber or space so that air can (only) enter the first air chamber at the first air inlet and/or can (only) escape or exit first air chamber at the first exhaust. The first air chamber can be configured to distribute the air received from the cavity (e.g. via the first air inlet) along or over the first exhaust. The inner wall of the second arm and/or the second outer wall may at least partially define the first air chamber, e.g. is a wall defining the first air chamber.

The first exhaust may be provided within the second outer wall. The first exhaust may provide a communication between the surrounding of the second arm and the first air chamber. In the closed position, the first exhaust may be exposed on the second arm so that even in the closed position air can exit the second arm via the first exhaust. In other words, an airflow exits the first plenum via the first air outlet and enters the first air chamber via the first air inlet. Subsequently, the air exits the hair styling device, in particular the second arm, at the first exhaust. If hair is arranged between the first arm and the second arm, this air can be heated by the airflow between the first air outlet and the first air inlet. Further, hair that is arranged on the second outer wall, for example covers the first exhaust, may be heated by air that exits the first air chamber via the first exhaust. The first exhaust may be used for curling hair as we will be described in the following. As described above, the first air outlet and the first air inlet can be used for straightening the hair.

In an optional embodiment, the second arm comprises a second plenum. The second plenum may comprise a second air outlet for emitting air towards hair within the cavity. Optionally, the first arm comprises a second air inlet for receiving air emitted from the second air outlet. Further optionally, the first arm further comprises a second air chamber coupled to the second air inlet. Optionally, the first arm comprises a second exhaust coupled to the second air chamber for emitting air from the second air chamber.

In this embodiment, both the first arm and the second air arm include a plenum, i.e. the first plenum and the second plenum, respectively, and an air chamber, i.e. the second air

chamber and the first air chamber, respectively. The second plenum may have the same characteristics, optional features, and/or advantages as the first plenum. The second air chamber may have to same characteristics, optional features, and/or advantages as the first air chamber.

In this embodiment, each arm includes a plenum, an air outlet, an air inlet, an air chamber, and an exhaust. The first arm may be mirror symmetric or rotationally symmetric to the second arm in the closed position. The first arm may be identical to the second arm except for their respective orientation with regard to the handle. So, both arms supply air to the cavity (via respective the plenums and the air outlets) and receive air from the cavity (e.g. via the respective air inlets and the air chambers). Further, both arms exhaust air via their respective exhausts. This provide a more even heating of hair that is wrapped around the first and second outer walls in the closed position because both arms include a respective exhaust.

The second plenum may be a cavity, space, or chamber within the second arm that is in air communication with the air channel of the handle. In other words, the second plenum is configured to receive (hot) air at the first end thereof - the first end may be that end of the second arm that is coupled or connected to the handle. In case that the second arm is movable relative to the handle, the second plenum may be connected to the air channel via the bellows provided for receiving and/or absorbing the movement of the second arm (e.g. the second plenum) relative to the handle (e.g. air channel).

The second plenum may extend from the first end of the second arm to a free end of the second arm which can be the end of the second arm opposite to the first end. So the second plenum may have an elongate shape. The second plenum may be a closed chamber or space so that air can only escape or exit the second plenum at the second air outlet. Air can may only enter the second plenum at the first end of the second arm. So, the second plenum can be configured to distribute the air received from the air channel (i.e. provided by the fan and/or heater) along or over the second air outlet. The inner wall of the second arm and/or the first outer wall may at least partially define the second plenum, e.g. are walls defining the second plenum.

The second air outlet may be provided within or on the inner wall of the second arm. The second air outlet provides air communication between the second plenum and the cavity. So, hot air that is generated by the fan and/or the heater flows from the air channel through the second plenum and the second air outlet to the cavity. As such, hair is additionally heated by air which flows from the air channel via the second plenum through the second air outlet to the hair. In other words, there are two air flows across the cavity in the closed position. The first air flow is from the first plenum to the first air chamber and the second air flow is from the second plenum to the second air chamber. The provision of two air flows can provide a more even heating of the hair because the same section of a tress is heated twice (e.g. by the first and second air flows) when the tress is pulled through the cavity. Further, the first air flow and the second air flow have opposite flow directions. This further enhances an even heating of the tress because the tress is heated (penetrated) from both sides.

The second air inlet and the second air outlet can be arranged on opposing surfaces (e.g. the inner walls) in the closed position of the first arm and the second arm. Optionally, the second air outlet directly faces the second air inlet in the closed position so that there is a straight air flow between the second air outlet and the second air inlet. For example, in the closed position, the airflow exiting the second air outlet is perpendicular to the inner wall of the second arm and/or the airflow entering the second air inlet is perpendicular to the inner wall of the first arm.

The second air inlet and/or the second air outlet may include one or more (elongate) through-holes in the respective inner wall.

In an optional embodiment, the first arm includes only the first plenum and the second arm includes only the first air chamber.

In this embodiment, the first arm and the second arm may not be rotationally symmetric or mirror symmetric to each other as with the embodiment described before. Rather, the first arm has the sole purpose of emitting air into the cavity via the first air outlet and the

second arm has the sole purpose of receiving air from the cavity via the first air inlet. This is in contrast to the previous embodiment described herein, in which both the first arm and the second arm have the double purpose of emitting air into the cavity via the respective air outlets and receiving air from the cavity via the respective air inlets. Such a configuration provides a simpler structural set up which can be easier to manufacture as only the first air flow is provided with this embodiment.

The first air outlet may include one or more through-holes in the inner wall of the first arm and/or first air inlet may include one or more through-holes in the inner wall of the second arm. The through-holes of first air outlet and the through-holes of the first air inlet may each be arranged side-by-side in a direction parallel to the longitudinal direction of the first arm and the second arm, respectively. This is not possible with respect to the above-described embodiment with which each arm includes an air inlet and air outlet so that each inner wall includes the respective air inlet and the respective air outlet. As only one of the air inlet other air outlet is provided with this embodiment, there is more variety and flexibility for arranging the air inlet and the air outlet.

In an optional embodiment, the hair styling device further comprises a handle which includes an air channel and a fan for providing an airflow in the air channel to the first plenum and/or the second plenum. Optionally, the first air chamber is configured to receive air from the air channel only via first plenum and/or the second air chamber is configured to receive air from the air channel only via the second plenum.

The first air chamber and/or the second air chamber may not be in fluid communication or air communication with the air channel. For example, the first arm includes a first separation wall which separates the second air chamber from the air channel and/or the first plenum. Similarly, the second arm may include a second separation wall which separates the first air chamber from the air channel and/or the second plenum. So, the first air chamber and/or the second air chamber may not be in direct air communication with the air channel or may not be directly connected to the air channel. In other words, air from the air channel cannot directly flow to the air chambers in this embodiment. Rather, air from the air channel flows via the respective plenums and the cavity into the respective air

chambers. In other words, air can only indirectly flow from the air channel to the respective air chamber, namely via the respective plenums and the cavity.

In an optional embodiment, the first air outlet and/or the second air outlet each include (i) one slit extending along a direction of extension of the first arm and the second arm, respectively, and/or (ii) a plurality of openings distributed along the direction of extension of the first arm and the second arm, respectively.

The slit and/or the openings can be through-holes in the inner walls of the first arm and/or the second arm. The openings may be elongate and can be considered slits of a shorter length than the slit extending along a direction of extension of the first arm and the second, respectively. The plurality of openings may be arranged in a (straight) line which extends along the direction of extension of the first arm and the second arm. The slit may also be straight.

Both the slits and the plurality of openings may extend from the first end to the free end of the respective arm. This may ensure that hot air is blown into the cavity over the (substantially) entire length of the cavity and/or the (substantially) entire length of the respective arm. This may help to ensure that the tress is heated over its complete width, i.e., perpendicular to the direction of pulling the hair styling device along the tress.

In an optional embodiment, the first air outlet is offset with respect to the second air outlet.

The first air outlet may be offset to the second air outlet perpendicular to the direction of extension of the first arm and the second arm in the closed position. So, the first air outlet and the second air outlet may not overlap in the closed position. The slit and/or the plurality of openings of the first air outlet and/or the second air outlet may each be arranged side-by-side in a top view on the inner walls in the closed position. So, the first airflow (the airflow from the first air outlet via the cavity into the first air inlet) and the second airflow (the airflow from the second air outlet via the cavity into the second air inlet) may be parallel to each other (e.g., along the direction of extension of the first arm

and the second arm) and offset to each other perpendicular to along the direction of extension of the first arm and the second arm.

In an optional embodiment, the first plenum and/or the second plenum each include a plurality of vanes distributed along a direction of extension of the first arm and the second arm, respectively. Optionally, the vanes are shaped, dimensioned, and/or positioned so that an intensity or a mass flow rate of an airflow exiting the first air outlet and/or the second air outlet is substantially constant along the direction of extension of the first arm and the second arm, respectively.

The vanes may be arranged in the first plenum and the second plenum, respectively, opposite to the respective air outlets. So, the vanes may face the respective air outlets but are spaced apart from each other so that air can flow between the vanes and the respective air outlets.

The vanes are provided for directing air coming from the air channel and flowing along the first and second plenums to the respective air outlets. For example, the vanes are equally distributed along the direction of extension of the first arm and the second arm, respectively. Alternatively, the fewer vanes may be provided towards the free ends.

The air pressure at the first end of the arms is higher compared to a position at the free end because air pressure decreases along the extension of a pipe (here the first plenum and the second plenum, respectively). So, without the vanes and/or other measures, the intensity (mass flow rate) of the airflow closer to the first end would be higher compared to the intensity (mass flow rate) of the airflow closed the free end. To counteract this, the vanes can be provided. For example, the size and/or the orientation of the vanes may change along the direction of the extension of the first arm and the second arm, respectively. For example, the vanes closer to the free end are larger compared to the vanes closer to the first end and/or an angle between the vanes and the wall of the respective plenums increases from the first end to the free end. Alternatively or additionally, a diameter or cross-section of the first plenum and/or the second plenum may decrease from the first end to the free

end for increasing the pressure of the airflow closer to the free end in order to counteract the natural pressure drop along the direction of the respective plenum.

In an optional embodiment, in a closed position, the inner walls of the first arm and the second arm are configured to grasp hair therebetween so that, for straightening the hair, hot air can flow from the first air outlet through the hair to the first air inlet and/or air can flow from the second air outlet through the hair to the second air inlet.

The first airflow and/or the second airflow can be provided for straightening the hair. To this end, hair is grasped or clamped between the first arm and the second arm, in particular between the first engaging section and the second engaging section, and heated up by the first airflow and/or the second airflow. Subsequently, the hair styling device in the closed position is pulled along the tress so that the hair is heated over its entire length and, therefore, straightened. By grasping or clamping to hair between the first arm and the second arm in the closed position, the hair is straightened so that, after heating the hair using the first airflow and/or the second airflow, the hair remains in the straightened configuration resulting in straightened hair.

So, in one aspect, a method for straightening hair using the hair styling device is provided. The method comprises the steps of placing hair in the cavity and bringing the first arm and the second arm to a closed position, and heating the hair by generating a flow of hot air (e.g., the first air flow and/or the second air flow) through the hair between the first arm and the second arm.

The step of placing hair in the cavity and bringing the first arm and the second arm to the closed position provides that the hair is clamped or grasped between the first arm and the second time so that it can be manually straightened and that the hair is arranged in the cavity to receive the first airflow and/or the second airflow.

In an optional embodiment, the first air inlet occupies an area on the inner wall of the second arm that is larger than an area occupied by the first air outlet on the inner wall of the first arm. Optionally, the second air inlet occupies an area on the inner wall of the first

arm that is larger than an area occupied by the second air outlet on the inner wall of the second arm.

A size or cross-section of the first/second air inlet in a plane of the inner wall can be larger than a size or cross-section of the first/second air outlet in the plane of the inner wall. The increased size of the air inlet may facilitate that the air in the cavity can reliably and without/reduced friction exit the cavity via the respective air outlets. This may help to ensure a steady flow of air in the first airflow and the second airflow.

Further, the comparatively reduced size or cross-section of the first/second air outlet may help to focus and/or direct the airflow to the hair arranged in the cavity. The comparatively increased size or cross-section of the first/second air inlet may be provided because the hair diffuses or perturbs the focused or directed airflow generated by the respective first/second air outlets.

In an optional embodiment, the first air inlet and/or the second air inlet each include a first mesh for preventing hair from entering the first air chamber and the second air chamber, respectively.

The first mesh can be provided within the through-hole, slit, and/or opening of the air inlet so that the first airflow and/or the second airflow needs to pass the first mesh before entering the first air chamber and the second air chamber, respectively. The first mesh may have a mesh size sufficiently small for preventing hair from entering the first air chamber and the second air chamber, respectively.

The first mesh may include a plurality of wires, strands or the like which can be interwoven or otherwise connected to each other. The first mesh may be made from metal or a plastic material. Further, the first mesh may be a unitary component with the inner wall. For example, the inner wall is manufactured in a way that the respective air inlets are provided with the first mesh, e.g., injection molding.

In an optional embodiment, the first arm includes a first outer wall which is curved. Optionally, the second arm includes a second outer wall which is curved. Further optionally, for curling the hair in the closed position, the first outer wall and the second outer wall define a common outer surface of the first arm and the second arm so that hair can be wrapped around the first outer wall and the second outer wall for heating the hair by hot air supplied from the first exhaust via the first plenum and the first air chamber and/or by hot air supplied from the second exhaust via the second plenum and the second air chamber.

In a cross-sectional view of the first arm, the first outer wall connects a first side of the inner wall to a second side of the inner wall. The first outer wall may be convex, for example with regard to the inner wall. In a cross-sectional view of the first arm, the first outer wall and inner wall may form a semicircle wherein the inner wall is the diameter of the semicircle. However, the first outer wall may deviate from a strict semicircle and may have an oval or ellipsoid shape.

In a cross-sectional view of the second arm, the second outer wall connects a first side of the inner wall to a second side of the inner wall. The second outer wall may be convex, for example with regard to the inner wall. In a cross-sectional view of the second arm, the second outer wall and inner wall may form a semicircle wherein the inner wall is the diameter of the semicircle. However, the second outer wall may deviate from a strict semicircle and may have an oval or ellipsoid shape. The radius, diameter, or curvature of the first outer wall may be the same as the radius, diameter, or curvature of the second outer wall.

In a closed position, the first outer wall and the second outer wall may substantially provide the outer surface of the first arm and the second arm in the closed position, for example except for a small gap between the inner wall of the first arm and the inner wall of the second arm which can be provided by the first engaging section and a second engaging section as described above. The first outer wall and the second outer wall may provide the outer surface in the closed position in the shape of a cylinder or cone, wherein a random

cross-section of the cylinder or cone is defined by the combined cross-sections of the first arm and the second arm in the closed position.

So, in the closed position, the first outer wall and the second outer wall provide a common outer surface around which hair can be wrapped. The common outer surface may provide a barrel for wrapping hair around. The common outer surface of the first arm and the second arm may be used for curling hair. So a radius, diameter, or curvature defined by the first outer wall and the second outer wall in the closed position may define the radius, diameter, or curvature of the curled hair.

So wrapping the hair around the first outer wall and the second outer wall in the closed position puts the hair to be curled in the configuration to be achieved. Subsequently the hair is heated up by hot air that is exhausted from the first air chamber and/or the second air chamber at the first exhaust and/or the second exhaust, respectively. As discussed above, the air in the first air chamber and/or the second air chamber is not directly coming from the air channel (i.e., direct directly coming from the fan and heater) but is provided via the first airflow and/or the second airflow. So, for curling the hair, the airflow is generated by the fan and/or the heater in the air channel of the handle and is supplied to the first air chamber and or the second air chamber via the respective plenums, air outlets, the cavity, and air inlets. In this case, no hair can be arranged in the cavity so that the first airflow and/second airflow is not disturbed within the cavity increasing the intensity (mass flow rate) of the airflow arriving at the first air chamber and/or the second air chamber. After that, the air exits the first air chamber and/or the second air chamber by the respective exhausts for heating the hair that is wrapped around the first outer wall and the second outer wall, i.e., the common outer surface in the closed position.

So, in one aspect, a method for curling hair using the hair styling device is provided. The method comprises the steps of bringing the first arm and the second arm to a closed position, curling hair around the first arm and the second arm in the closed position, and heating the hair by a flow of hot air exiting the hair styling device at the first exhaust and/or the second exhaust.

It is noted again that the air that is exhausted at the second arm (e.g., at the second exhaust) does not directly come from the handle or the air channel but is directed via the first arm and the cavity. Similarly, the air that is exhausted at the first arm (e.g., at the first exhaust) does not directly come from the handle or the air channel but is directed via the second arm and the cavity.

Further, in another aspect, a set or kit is provided which includes a plurality of first outer walls and/or second outer walls wherein each first outer wall and/or each second outer wall in the set or kit differs in one parameter, such as curvature and/or diameter. Optionally, each first outer wall can be attached to the same inner wall of the first arm and/or each second outer wall can be attached to the same inner wall of the second arm.

The above-described characteristics, features and/or optional embodiments can equally apply for the first outer walls and/or each second outer walls of the kit or set. So, the set or kit of first outer walls and/or second outer walls can be used to provide curls of different size and/or diameter.

In a further aspect, an arm attachment is provided that can be removably coupled or connected to the first arm and/or the second arm. Optionally, the arm attachment includes one or more attachment exhausts for allowing an air flow passing through the arm attachment.

The arm attachment can be provided for changing/altering the curvature and/or diameter of the first arm and/or the second arm in the closed position without replacing the first arm, the second arm, the first outer wall, or the second outer wall. Instead, the arm attachment is added/attached to the first arm and/or the second arm for covering the first outer wall and/or the second outer wall which changes the effective diameter and/or the curvature of the hair styling device. So, the arm attachment can be used to provide curls of different size and/or diameter. If the arm attachment is connected to the hair styling device, the hair or tress can be wrapped around the arm attachment instead of the first arm and/or second arm.

The arm attachment may be connected to the first arm, the second arm, the first outer wall, and/or the second outer wall using a snap-fit connection or other removable fastening means.

The arm exhaust may include the same features, characteristics, and/or optional embodiments as the first exhaust and/or the second exhaust (e.g. the arm exhaust includes the second mesh). The arm exhaust is provided to exhaust air from the arm attachment. For example, the arm exhaust may allow an air flow provided by the first exhaust and/or the second exhaust to pass through the arm attachment. The arm attachment may not or only slightly change the exhaust air flow but can be instead provided for changing the curvature and/or diameter of the surface around which the hair can be wrapped.

The arm attachment may include a hollow body that can be arranged around the first outer surface and the second outer surface. In this case, the first arm and the second arm in the closed position may be inserted into the arm attachment. The hollow body may have a cylindrical or cone-shaped outer surface of a different diameter and/or curvature compared to ones of the first outer wall and the second outer wall. In a cross-sectional view, the hollow body may have a shape of a circle, ellipsis, or oval.

The arm attachment may include a half-shell that can be attached to the first arm (e.g. the first outer wall) or the second arm (e.g. the second outer wall). The half-shell may have a semi-cylindrical or semi-cone-shaped outer surface of a different diameter and/or curvature compared to the first outer wall and the second outer wall. In a cross-sectional view, the hollow body may have a shape of a semi-circle, semi-ellipsis, or semi-oval. Optionally, a first arm attachment is provided for the first arm and/or a second arm attachment is provided for the second arm. The first arm attachment may be identical or symmetrical to the second arm attachment (e.g. when attached to the hair styling device in the closed position).

The arm attachment may have the same features, characteristics, and/or optional embodiments as the first outer wall and/or the second outer wall except for that the arm

attachment does not replace the first outer wall and/or the second outer wall but is attached onto the first outer wall and/or the second outer wall.

Further, in another aspect, a set or kit is provided which includes a plurality of arm attachments wherein each arm attachment in the set or kit differs in one parameter, such as curvature and/or diameter.

In an optional embodiment, the second exhaust occupies an area which is at least 50%, at least 60%, at least 70%, at least 75, or at least 80% of the first outer wall. Optionally, the first exhaust occupies an area which is at least 50%, at least 60%, at least 70%, at least 75, or at least 80% of the second outer wall.

So, in this embodiment, the first exhaust and/or the second exhaust occupy a large area of the first outer wall and/or the second outer wall, respectively. The larger size of the first exhaust and/or the second exhaust is, the larger is the area of the hair wrapped around the common outer surface that is heated. This may help to facilitate an even heating of the hair that is wrapped around the common outer surface, i.e., only short sections of a tress that is wrapped around the common outer surface are not heated, for example those sections which are not in contact or not face the first exhaust and/or the second exhaust.

In an optional embodiment, the first outer wall is removably attached to the inner wall of the first arm and/or the second outer wall is removably attached to the inner wall of the second arm.

For example, the hair styling device includes a set or kit including a plurality of first outer walls and/or second outer walls that each can be removably attached to the respective inner wall. Each one of the plurality of the first outer walls and/or second outer walls may have a different curvature, radius, or diameter. So, curls of different size or diameter can be provided by using different ones of the first outer walls and/or second outer walls in the kit or set.

The outer walls may be removably attached to the respective inner walls by a snap fit connection or other mechanical and removable means. The replacement of the outer walls

is simplified with the hair styling device compared to conventional hair curlers since no electrical components (e.g., hotplates) are provided on the common outer surface. Rather, the heating of the hair only requires mechanical components (e.g., the outer walls) in the arms so no electric components need to be removed for changing the radius, curvature and/or diameter of common outer surface.

In an optional embodiment, the first exhaust and/or the second exhaust include a second mesh for preventing hair from entering the first air chamber and the second air chamber, respectively.

The second mesh may provide a section of the common outer surface. The second mesh may have the same radius, curvature and/or diameter as the radius, curvature and/or diameter of the respective outer wall.

The second mesh can be provided within the through-hole and/or opening of the exhaust so that the air needs to pass the second mesh before leaving the first air chamber and the second air chamber, respectively. The second mesh may have a mesh size sufficiently small for preventing hair from entering the first air chamber and the second air chamber, respectively.

The second mesh may include a plurality of wires, strands or the like which can be interwoven or otherwise connected to each other. The second mesh may be made from metal or a plastic material. Further, the second mesh may be a unitary component with the respective outer wall. For example, the outer wall is manufactured in a way that the respective exhaust is provided with the second mesh, e.g., injection molding.

The second mesh may be provided for diffusing or providing a homogeneous airflow exiting the first exhaust and/or the second exhaust, respectively. So, the second mesh may provide some resistance for the air leaving the first air chamber and the second air chamber, respectively. This may allow to the build-up of some pressure in the first air chamber and/or the second air chamber, respectively, so that an intensity (mass flow rate)

of air flow exiting the first exhaust and the second exhaust can be constant over the areas of the first exhaust and/or the second exhaust.

In an optional embodiment, the first mesh and/or the second mesh are removably attached to the hair styling device.

The first mesh may be attached to the first and/or second air inlet by a snap fit connection or the first mesh may be elastically deformable for placing first mesh in an undercut of respective air inlet (e.g. groove or slot along a perimeter of the respective air inlet). The second mesh may be attached to the first and/or second exhaust by a snap fit connection or the second mesh may be elastically deformable for placing second mesh in an undercut of respective exhaust (e.g. groove or slot along a perimeter of the respective exhaust).

The first mesh and/or the second mesh may be removed for cleaning the respective mesh from dirt or other debris that is stuck to the first mesh and/or the second mesh. Further, the first mesh and/or the second mesh may be replaced with a new one in case the first mesh and/or the second mesh is broken. So the interchangeability of the first mesh and/or the second mesh can simplify the cleaning of the hair styling device and/or the repair or maintenance of the hair styling device.

In an optional embodiment, the first arm and/or the second arm are removably attached to the handle.

So, in this embodiment, the first arm and/or the second arm may be exchanged with the hair styling device. For example, the first arm and/or the second arm may be removably attached to the joint arranged within the handle. The first arm and/or the second arm may form the attachment that can be removably attached to the handle of the hair styling device. The interchangeability may simplify the repair and maintenance of the hair styling device, for example the first arm and/or the second arm may be replaced if broken. Further, the first arm and the second arm can be cleaned more simply if the first arm and/or the second arm can be removed from the handle. Here again, the replacement of the first arm and/or the second arm is simple since no electrical components are provided with the first arm

and/or the second arm unlike conventional hotplate hair straighteners or curling devices which include electrical components (heaters) in the first arm and/or the second arm. So, better serviceability and repairability can be provided.

A plurality of first arms and/or second arms may be provided for forming a set or kit. The first arms and/or the second arms of the kit or set may differ in the radius, diameter, or curvature of the respective outer walls. Further the first arms and/or the second arms of the kit or set may differ in their lengths, allowing users to customise the hair styling device to their hair length, as they may desire a longer or shorter curling surface.

This set or kit may be provided instead of providing a set or kit of outer walls. In other words, with this embodiment, the first arm and the second arm are changed as a whole for setting a different curvature for curling the hair compared to replacing the outer walls.

In an optional embodiment, the hair styling device comprises a heater for heating the air flow generated by the fan, a controller for controlling the fan and the heater, and/or an antenna for providing data communication with a mobile device. Optionally, the controller is configured to control a mass flow rate (or intensity) of an air flow exiting the first air outlet and/or the second air outlet, the air temperature at the first air outlet and/or the second air outlet, and/or the duration of an air flow exiting the hair styling device based on data received from the mobile device via the antenna.

The temperature of the air at the first air outlet and/or the second air outlet can be controlled and/or set by controlling the fan (e.g., mass flow rate of the air flow) and the heater. By controlling the temperature of the air at the first air outlet and/or the second air outlet, the temperature at the first exhaust and/or the second exhaust can also be set. In other words, the control of the temperature of the air flow and/or the intensity (mass flow rate) of the airflow may be used for both the straightening mode and the curling mode because both straightening and curling the hair is done using a stream of hot air.

The controller may include a processor and/or a memory on which an application (app), programs, algorithms and/or software can be stored that is executed by the processor. The

controller may be in data communication (e.g., via wires) with the fan, the heater, and/or the antenna for the control thereof. The controller may also be in data communication with an input device (e.g., including a switch, button, or dial) with which the intensity (mass flow rate) of the airflow and the temperature can be set similar to conventional hair straightening devices or curling devices.

The antenna may be a transceiver for wirelessly exchanging data with an external device such as a cell phone, smartphone, or tablet, e.g., using Bluetooth®. Companion software (e.g., an application (app)) that can be saved on a smartphone or tablet could allow the user to control the hair styling device, e.g., to customise elements of their curling and/or straightening mode. These include, but are not limited to, the flow level of air (intensity of air flow), the air temperature, and duration of the hot and cold portions of the sequence for each tress. Additional features (e.g., implemented in the app) could include activating a higher temperature setting by acknowledging the hair styling device will then operate with 'extreme heat', educating users that high temperatures are not required in most cases for styling, and/or that temperatures above 150°C.

The invention may also be described as follows:

The embodiment of the double-sided diffusion airflow (when the first air flow and the second air flow are present) can address a problem of how the air can be safely and effectively exhausted from the device once it had passed through the hair. The invention uses a penetrative flow. This means that when the air has passed through the hair tress, it can immediately enter the other arm if it not going to become immediately restricted.

In one embodiment, a single sided diffusion airflow can be employed (the first air only includes the first plenum and the second air only includes the first air chamber). Thereby, an airflow was passed exclusively from one arm's airflow, and into the other, via a tress clamped between the two arms. This meant that air need only be vented from one arm.

A restrictive mesh can be provided with the hemi-cylindrical outer edge of the receiving arm (e.g. the second mesh) for reducing the velocity of the exhaust flow. This can help to

ensure that the hair styling device is thermally comfortable and safe to use, and that the exhaust air was not travelling at high velocity into the user's hands, scalp, or face.

Further, the inventors realised that the exhausted air could be used for curling when the tress was wrapped around the outside of the arms. The curls can be improved if the airflow path was changed from single- to double-sided. In this embodiment, half the airflow from the motor (fan) is passed into each arm (via the heater and rubber bellows). It then exits the one arm through the air outlet (e.g. an air slot) and passes into the opposite arm. This is done via the hair in straightening mode (clamped between the arms), whereas when curling, the air passes through one and into the other with no obstruction, before entering the hair wrapped around the common outer surface in the closed position (e.g. forming a barrel). The airflow path may remain almost constant between flow modes, it is only where the hair is being contacted by the airflow that is changing.

A significantly lower level of user skill can be required to create curls with this product when compared with a traditional hotplate straightener. 'Waste' airflow can be repurposed to give increased functionality of the device, allowing the users who usually create large loose curls/waves with other devices but do not with a straightener, a chance to do so.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a schematic view of a first embodiment of a hair styling device;

Figure 2 shows a cross-sectional view of a first arm and a second arm of the hair styling device of Fig. 1;

Figure 3 shows a cross-sectional view of a first arm and a second arm of a hair styling device according to another embodiment;

Figure 4 shows a block diagram of a method for straightening hair using the hair styling device; and

Figure 5 shows a block diagram of a method for curling hair using the hair styling device.

DETAILED DESCRIPTION

Fig. 1 shows a hair styling device 10 which includes a handle 12, a first arm 14, and a second arm 16. The first arm 14 and/or the second arm 16 may form an attachment that can be removably attached to the handle 12.

The first arm 14 and/or the second arm 16 are pivotably attached to the handle 12. For example, the first arm 14 and the second arm 16 can each be pivotable relative to the handle 12 so that an inner wall 18 of the first arm 14 and the inner wall 18 of the second arm 16 can be moved or rotated away from each other for arranging the first arm 14 and the second arm 16 in an open position. In Fig. 1, the first arm 14 and the second arm 16 are shown in the closed position in which inner walls 18 of the first arm 14 and the second arm 16 extend parallel to each other or substantially parallel to each other. The inner walls 18 of the first arm 14 and the second arm 16 are closer to each other in the closed position compared to the open position. The handle 12 may include a joint 20 providing rotational movement of the first arm 14 and/or the second arm 16 relative to the handle 12.

The handle 12 may further include a filter inlet 22, an air channel 24, a bellows 26, a fan 28, a heater 30, a controller 32, and/or an antenna 34. The filter inlet 22, the air channel 24, the bellows 26, the fan 28, and/or the heater 30 provide a stream of flow of warm or hot air which is directed to the first arm 14 and/or the second arm 16. For example, the filter inlet 22 is an opening in a housing of the handle 12 for providing an air passage between the air channel 24 and a surrounding of the handle 12. A mesh and/or an air filter may be provided with the filter inlet 22 for preventing that hair, particles, or any other object may enter the air channel 24.

The air channel 24 is a passage or channel within the handle 12 which is provided for guiding air from the filter inlet 22 to the first arm 14 and/or the second arm 16. The air channel 24 may be rigid and/or is fixedly attached within the handle 12. The bellows 26 may be made from a flexible material and/or is flexible for connecting the air channel 24 to the first arm 14 and/or the second arm 16. In particular, the bellows 26 is configured to absorb and/or receive the movement/rotation of the first arm 14 and/or the second arm 16 relative to the handle 12. In other words, the bellows 26 is a flexible component for

providing a flexible connection between the movable first arm 14 and/or the second arm 16 and the fixedly arranged air channel 24.

The fan 28 may include an electric motor and an impeller. The fan 28 is a powered machine used for generating a flow of air or air flow in the air channel 24. The impeller of the fan 28 includes a rotating arrangement of vanes or blades which act on the air in the air channel 24. The impeller is rotated by the electric motor. The impeller and/or the electric motor may be arranged within the air channel 24.

The heater 30 can be arranged downstream of the fan 28 within the air channel 24. The heater 30 may be a resistive heater which converts electrical energy into thermal heat. The heater 30 and/or the fan 28 may be in data communication with the controller 32 and/or can be controlled by the controller 32.

The controller 32 which can include a processor and a memory. The memory may be configured to store applications (apps), programs, algorithms, and/or applications which can be executed by the processor. The controller 32 may be in data communication with the antenna 34 which may be a transceiver for receiving and/or sending data, for example for providing a data communication with external device such as a cell phone, smartphone, tablet, or the like. Further, not shown in figures, the hair styling device 10 may include an input device such as switches, bottoms, dials and/or the like for controlling the heater 30 and/or the fan 28. The input device may be in data communication with the controller 28 so that an actuation of the input device may be received by the controller 32 for correspondingly controlling the fan 28 and/or the heater 30.

The fan 28, the heater 30, the controller 32, and/or the antenna 34 can be powered by a battery and/or by an electrical connection to an external power supply, e.g. an AC electrical network.

As visible from Fig. 2, the first arm 14 includes the inner wall 18, a first outer wall 36, a first plenum 38, a second air chamber 40, a first air outlet 42, a second exhaust 44, a second air inlet 46, and/or a first engaging section 48. The second arm 16 includes the

inner wall 18, a second outer wall 50, a second plenum 52, a first air chamber 54, a second air outlet 56, a first exhaust 58, a first air inlet 60, and/or a second engaging section 62.

The first engaging section 48 protrudes from the inner wall 18 of the first arm 14 towards the second arm 16 in the closed position. The second engaging section 62 protrudes from the inner wall 18 of the second arm 16 towards the first arm 14 in the closed position. In the closed position, the first engaging section 48 and the second engaging section 62 contact each other and/or clamp or grasp hair therebetween. The first engaging section 48 and/or the second engaging section 62 may include a rib or bar that extends on opposing sides of the inner wall 18 along a longitudinal direction of the first arm 14 and the second arm 16, respectively. Further, the first engaging section 48 and/or the second engaging section 62 may form a loop, i.e. the ribs or bars that extend on opposing sides of the inner wall 18 can be connected to each other on a free end of the first arm 14 and the second arm 16, respectively. So, the first engaging section 48, the second engaging section 62, and the inner walls 18 of the first arm 14 and the second arm 16 can define a cavity 64 therebetween in the closed position. The first engaging section 48 and/or the second engaging section 62 may seal the cavity 64 in the closed position so that air in the cavity 64 is prevented from leaving the cavity 64 and/or a pressure within the cavity 64 can be maintained (at least to a certain degree). The first engaging section 48 and/or the second engaging section 62 can be made from elastically deformable material, such as rubber or the like.

The first outer wall 36 is curved and extends from a first side of the inner wall 18 of the first arm 14 to a second side of the inner wall 18 of the first arm 14. For example, in a cross-sectional view, the first arm 14 has a shape of a semicircle wherein the inner wall 18 corresponds to the diameter of the semicircle. Similarly, the second outer wall 50 is curved and extends from a first side of the inner wall 18 of the second arm 16 to a second side of the inner wall 18 of the second arm 16. For example, in a cross-sectional view, the second arm 16 has a shape of a semicircle wherein the inner wall 18 corresponds to the diameter of the semicircle. The first outer wall 36 and the second outer wall 50 may provide a (common) outer surface of the first arm 14 and the second arm 16 in the closed position. In other words, hair that can be wrapped around the first arm 14 and the second arm 16 in the

closed position essentially contacts only the first outer wall 36 and the second outer wall 50. The first outer wall 36 and the second outer wall 50 may have the shape of a cylinder, barrel, or truncated cone in a closed position.

The first outer wall 36 includes the second exhaust 44 and the second outer wall 50 includes the first exhaust 58. An area occupied by the second exhaust 44 on the first outer wall 36 may be more than 50%, 60%, 75%, or 80% of the surface area of the first outer wall 36. In other words, the second exhaust 44 occupies a substantial area of the first outer wall 36 as visible in Fig. 1. An area occupied by the first exhaust 58 on the second outer wall 50 may be more than 50%, 60%, 75%, or 80% of the surface area of the second outer wall 50. In other words, the first exhaust 58 occupies a substantial area of the second outer wall 50 as visible in Fig. 1.

The first plenum 38 is provided by a section of the inner wall 18 of the first arm 14, a section of the first outer wall 36, and/or a first separation wall 66 extending between the first outer wall 36 and the inner wall 18. The first plenum 38 may extend from a first end of the first arm 14 that is connected to the joint 20 to the free end of the first arm 14. The first plenum 38 is in air communication with the air channel 24 (e.g. via the bellows 26). This means that air from the air channel 24 can flow into the first plenum 38, for example due to the positive pressure provided by the fan 28. Air that is pressed into or supplied to the first plenum 38 can exit the first plenum 38 at the first air outlet 42 which is arranged on the inner wall 18 of the first arm 14. So, air that exits the first plenum 38 via the first air outlet 42 enters the cavity 64. The first air outlet 42 can be an elongate slot in the inner wall 18 of the first arm 14 that extends along the longitudinal direction, for example from the first end to the free end of the first arm 14.

The second air chamber 40 is provided by a section of the inner wall 18 of the first arm 14, a section of the first outer wall 36, and/or the first separation wall 66. Thus, the second air chamber 40 can be separated from the first plenum 38 by the first separation wall 66. The second air chamber 40 may extend from the first end of the first arm 14 to the free end of the first arm 14. The second air chamber 40 is not in a direct fluid or air communication with the air channel 24. This means that air from the air channel 24 cannot directly enter

the second air chamber 40 from the air channel 24. For example, a further wall is provided between the air channel 24 and the second air chamber 40 or the first separation wall 66 also separates the second air chamber 40 from the air channel 24 at the first end of the first arm 14.

Air can enter the second air chamber 40 via the second air inlet 46 and can exit the second air chamber 40 via the second exhaust 44. Thus, the second air chamber 40 may be a means for distributing air received at the second air inlet 46 to the second exhaust 44. The area occupied by the second air inlet 46 can be (significantly) smaller than the area of the second exhaust 44.

The second air inlet 46 is provided on the inner wall 18 of the first arm 14. The second air inlet 46 is an elongate slot within the inner wall 18 which can extend from the first end of the first arm 14 to its free end. The second exhaust 44 can also extend from the first end to the free end of the first arm 14 as seen in Fig. 1.

The second plenum 52 is provided by a section of the inner wall 18 of the second arm 16, a section of the second outer wall 50, and/or by a second separation wall 68 extending between the second outer wall 50 and the inner wall 18. The second plenum 52 may extend from a first end of the second arm 16 that is connected to the joint 20 to the free end of the second arm 16. The second plenum 52 is in air communication with the air channel 24 (e.g. via the bellows 26). This means that air from the air channel 24 can flow into the second plenum 52, for example due to the positive pressure provided by the fan 28. Air that is pressed into or supplied to the second plenum 52 can exit the second plenum 52 at the second air outlet 56 which is arranged on the inner wall 18 of the second arm 16. So, air that exits the second plenum 52 via the second air outlet 56 enters the cavity 64. The second air outlet 56 is an elongate slot in the inner wall 18 of the second arm 16 that extends along the longitudinal direction, for example from the first end to the free end of the second arm 16.

The first air chamber 54 is provided by a section of the inner wall 18 of the second arm 16, a section of the second outer wall 50, and/or the second separation wall 68. Thus, the first

air chamber 54 is separated from the second plenum 52 by the second separation wall 68. The first air chamber 54 may extend from the first end of the second arm 16 to the free end of the second arm 16. The first air chamber 54 is not in a direct fluid or air communication with the air channel 24. This means that air from the air channel 24 cannot directly enter the first air chamber 54 from the air channel 24. For example, a further wall is provided between the air channel 24 and the first air chamber 54 or the second separation wall 68 also separates the first air chamber 54 from the air channel 24 at the first end of the second arm 16.

Air can enter the first air chamber 54 via the first air inlet 60 and can exit the first air chamber 54 via the first exhaust 58. Thus, the first air chamber 54 may be a means for distributing air received at the first air inlet 60 to the first exhaust 58. The area occupied by the first air inlet 60 can be (significantly) smaller than the area of the first exhaust 58.

The first air inlet 60 is provided on the inner wall 18 of the second arm 16. The first air inlet 60 is an elongate slot within the inner wall 18 which can extend from the first end of the second arm 16 to its free end. The first exhaust 58 can also extend from the first end to the free end of the second arm 16 as seen in Fig. 1.

The first air inlet 60 and the second air inlet 46 each include a first mesh for preventing hair from entering the first air chamber 54 and the second air chamber 40, respectively. The first air inlet 60 faces or is opposite to the first air outlet 42 in the closed position. The first air inlet 60 and the first air outlet 42 may have the same length along the respective arms 14, 16. Further, a width of the first air inlet 60 (e.g. measured perpendicular to the longitudinal direction) is greater than a width of the first air outlet 42 (e.g. measured perpendicular to the longitudinal direction). So, the relative position of the first air outlet 42 and first air inlet 60 and their respective size provides that air exiting the first plenum 38 at the first air outlet 42 enters the first air chamber 54 via the first air inlet 60. In other words, air flows from the air channel 24 via the first plenum 38 to the first air chamber 54 (see arrow in Fig. 2). If hair is arranged in the cavity 64, the air passes through or penetrates the hair on its way from the first plenum 38 to the first air chamber 54 (see lower arrow in Fig. 2). This may also be considered a first air flow.

The second air inlet 46 faces or is opposite to the second air outlet 56 in the closed position. The second air inlet 46 and the second air outlet 56 may have the same length along the respective arms 14, 16. Further, a width of the second air inlet 46 (e.g. measured perpendicular to the longitudinal direction) is greater than a width of the second air outlet 56 (e.g. measured perpendicular to the longitudinal direction). So, the relative position of the second air outlet 56 and second air inlet 46 and their respective size provides that air exiting the second plenum 52 at the second air outlet 56 enters the second air chamber 40 via the second air inlet 46. In other words, air flows from the air channel 24 via the second plenum 52 to the second air chamber 40 (see arrow in Fig. 2). If hair is arranged in the cavity 64, the air passes through or penetrates the hair on its way from the second plenum 52 to the second air chamber 40 (see upper arrow in Fig. 2). This may also be considered a second air flow.

The pair of first air inlet 60 and the first air outlet 42 and the pair of the second air inlet 46 and the second air outlet 56 are offset to each other or spaced apart in a direction perpendicular to the longitudinal direction in the closed position of the first arm 14 and the second arm 16. This allows providing two air flows in the cavity 64: the first air flow flows from the first plenum 38 to the first air chamber 54 and the second air flow flows from the second plenum 52 to the second air chamber 40. The side-by-side arrangement of the two air flows can provide that air flows over the entire extension of the width of the first arm 14 and the second arm 16 (i.e. perpendicular to the longitudinal direction). For example, the two air flows basically extend over the complete distance between the sections of the first engaging portion 46 and the second engaging portion 62 that extend on opposing sides of the inner wall 18. Further, it is apparent that the second air chamber 40 and the first air chamber 54 only receive air via the second plenum 52 and the first plenum 38, respectively, i.e. not directly from the air channel 24.

The second exhaust 44 and the first exhaust 58 each include a second mesh for preventing hair from entering second air chamber 40 and the first air chamber 54, respectively.

Further, the second mesh can provide an equal distribution or emission of air from the second air chamber 40 and the first air chamber 54.

The first plenum 38 and/or the second plenum 52 include a plurality of vanes 70 which are distributed along the longitudinal direction, e.g. along the extension of the first air outlet 42 and the second air outlet 56, respectively. The vanes 70 are shaped, dimensioned, and/or positioned so that an intensity or mass flow rate of the air flow exiting the first air outlet 42 and/or the second air outlet 56 is constant along the direction of extension of the first arm 14 and the second arm 16, respectively.

The first mesh can be removably attached to the first air inlet 60 and/or the second air inlet 46. Similarly, the second mesh can be removably attached to the first air outlet 42 and/or the second air outlet 56. This provides better serviceability and repairability of the first arm 14 and the second arm 16.

Further, the first outer wall 36 can be removably attached to the inner wall 18 of the first arm 14 and/or the second outer wall 50 can be removably attached to the inner wall 18 of the second arm 16. For example, the hair styling device 10 includes a kit of first outer walls 36 and/or second outer walls 50 for changing the shape of the respective outer walls 36, 50 and/or for changing the second exhaust 44 and the first exhaust 58, respectively, for example with regard to the size. This allows to customise the hair styling device 10 to a desired curvature/size of the curls by providing smaller or larger outer surfaces (as formed by the first outer wall 36 and the second outer wall 50). Further, the first outer walls 36 and/or the second outer walls 50 may have different curvatures for providing curls of different diameter.

The hair styling device 10 shown in Fig. 3 has the same characteristics and/or features as the hair styling device 10 of Figs. 1 and 2, except for the differences described in the following.

The first arm 14 only includes the first plenum 38 but no second air chamber 40 (and consequently no second air inlet 46 and no second exhaust 44). So, the first arm 14 can be

considered as consisting only of the first plenum 38 - the first plenum 38 is defined by the inner wall 18 of the first arm 14 and the first outer wall 36, i.e. the first arm 14 does not include the first separation wall 66. Again, the first plenum 38 is in air communication with the air channel 24.

The second arm 16 only includes the first air chamber 54 but no second plenum 52 (and consequently no second air outlet 56). So the second arm 16 can be considered as consisting of the first air chamber 54 - the first air chamber 54 is defined by the inner wall 18 of the second arm 16 and the second outer wall 50, i.e. the second arm 16 does not include the second separation wall 68. Again, the first air chamber 54 is not in direct air communication with the air channel 24, but only indirectly via the first plenum 38.

With the hair styling device 10 of Fig. 3, there is only one air flow between the first arm 14 and the second arm 16, i.e. from the first plenum 38 to the first air chamber 54. Further, air is only exhausted on the second arm 16, namely via the first exhaust 58. No air is exhausted at the first arm 14 since the first arm 14 does not include the second exhaust 44.

A method of straightening hair is described in connection with the block diagram of Fig. 4.

In step S1, hair, e.g. a tress, is placed between the inner walls 18 of the first arm 14 and the second arm 16. Subsequently, the first arm 14 and the second arm 16 are brought to the closed position such that the hair is clamped or grasped between the first arm 14 and the second arm 16, for example between the first engaging section 48 and the second engaging section 62. For example, the hair extends across the cavity 64 perpendicular to the longitudinal direction and perpendicular to the arrows depicting the air flow in Figs. 2 and 3. Thus, the hair is arranged so that the airflow(s) provided by the hair styling device 10 penetrate the hair.

In step S2, the hair arranged in the cavity 64 is heated by providing the airflow between the first plenum 38 and the first air chamber 54 and/or between the second plenum 52 and the second air chamber 40. The airflow is generated by the fan 28 and heated by the heater 30. The mass flow rate or intensity of the airflow, the temperature of the air, and/or durations

of hot and cold portions of the sequence can be set using a mobile device (not shown in the figures) which communicates with the antenna 34 for controlling the fan 28 and the heater 30.

In step S3, the hair styling device 10 is pulled along the extension of hair/tress for heating and, therefore, straightening the hair/tress along its entire length. Due to the heating of the hair by hot air, the hair or tress can be heated up to the same temperature along the entire length of the hair/tress. In other words, the temperature of the air flow through the cavity 64 does not significantly change when pulling the hair styling device 10 along the hair/tress. This provides straightened hair along its entire length.

A method of curling hair is described in connection with the block diagram of Fig. 5.

In step S1, the first arm 14 and the second arm 16 are brought to the closed position. For example, the first engaging portion 48 contacts the second engaging portion 62.

In step S2, hair, e.g. a tress, is curled/wrapped around the first outer wall 36 and the second outer wall 50 which provides the outer surface of the first arm 14 and the second arm 16 in the closed position

In step S3, the hair curled/wrapped around the first outer wall 36 and the second outer wall 50 is heated by air exiting the first arm 14 and/or the second arm 16 via the second exhaust 44 and/or the first exhaust 58, respectively. The air from the first exhaust 58, i.e. from the first air chamber 54, is provided by an air flow from the air channel 24 via the first plenum 38, through the cavity 64 and into the first air chamber 54. The air from the second exhaust 44, i.e. from the second air chamber 40, is provided by an air flow from the air channel 24 via the second plenum 52, through the cavity 64 and into the second air chamber 40. The airflow is generated by the fan 28 and heated by the heater 30. The level of the airflow, the temperature of the air, and/or durations of hot and cold portions of the sequence can be set using a mobile device (not shown in the figures) which communicates with the antenna 34 for controlling the fan 28 and the heater 30.

CLAIMS

1. A hair styling device, comprising

a first arm and a second arm coupled together at a first end thereof,

wherein an inner wall of the first arm is facing an inner wall of the second arm,

wherein the first arm and the second arm are arranged to receive hair within a cavity formed between the first arm and the second arm,

wherein the first arm comprises a first plenum, said first plenum comprising a first air outlet for emitting air towards hair within the cavity, and

wherein the second arm comprises a first air inlet for receiving air emitted from the first air outlet.

2. The hair styling device of claim 1, wherein the second arm further comprises a first air chamber coupled to the first air inlet,

wherein the second arm comprises a first exhaust coupled to the first air chamber for emitting air from the first air chamber.

3. The hair styling device of claims 1 or 2, wherein the second arm comprises a second plenum, said second plenum comprising a second air outlet for emitting air towards hair within the cavity, and

wherein the first arm comprises a second air inlet for receiving air emitted from the second air outlet,

wherein the first arm further comprises a second air chamber coupled to the second air inlet, and

wherein the first arm comprises a second exhaust coupled to the second air chamber for emitting air from the second air chamber.

4. The hair styling device of claims 1 or 2, wherein the first arm includes only the first plenum and the second arm includes only the first air chamber.

5. The hair styling device of any one of the claims 2 to 4, further comprising a handle including an air channel and a fan for providing an air flow in the air channel to the first plenum and/or the second plenum,

wherein the first air chamber is configured to receive air from the air channel only via the first plenum and/or the second air chamber is configured to receive air from the air channel only via the second plenum.

6. The hair styling device of any preceding claim, wherein the first air outlet and/or the second air outlet each include

one slit extending along a direction of extension of the first arm and the second arm, respectively, and/or

a plurality of openings distributed along the direction of extension of the first arm and the second arm, respectively.

7. The hair styling device of any one of the claims 3, 5 or 6, wherein the first air outlet is offset with respect to the second air outlet.

8. The hair styling device of any preceding claim, wherein the first plenum and/or the second plenum each include a plurality of vanes distributed along the direction of extension of the first arm and the second arm, respectively,

wherein the vanes are shaped, dimensioned, and/or positioned so that an intensity of an air flow exiting the first air outlet and/or the second air outlet is constant along the direction of extension of the first arm and the second arm, respectively.

9. The hair styling device of any preceding claim, wherein, in a closed position, the inner walls of the first arm and the second arm are configured to grasp hair therebetween so that, for straightening the hair, hot air can flow from the first air outlet through the hair to the first air inlet and/or air can flow from the second air outlet through the hair to the second air inlet.

10. The hair styling device of any preceding claim, wherein the first air inlet occupies an area on the inner wall of the second arm that is larger than an area occupied by the first air outlet on the inner wall of the first arm, and/or

wherein the second air inlet occupies an area on the inner wall of the first arm that is larger than an area occupied by the second air outlet on the inner wall of the second arm.

11. The hair styling device of any preceding claim, wherein the first air inlet and/or the second air inlet each include a first mesh for preventing hair from entering the first air chamber and the second air chamber, respectively.

12. The hair styling device of any preceding claim, wherein the first arm includes a first outer wall which is curved,

wherein the second arm includes a second outer wall which is curved, and

wherein, for curling the hair in the closed position, the first outer wall and the second outer wall define a common outer surface of the first arm and the second arm so that hair can be wrapped around the first outer wall and the second outer wall for heating the hair by hot air supplied from the first exhaust via the first plenum and the first air chamber and/or by hot air supplied from the second exhaust via the second plenum and the second air chamber.

13. The hair styling device of claim 12, wherein the second exhaust occupies an area which is at least 50% of the first outer wall, and/or

wherein the first exhaust occupies an area which is at least 50% of the second outer wall.

14. The hair styling device of claims 12 or 13, wherein the first outer wall is removably attached to the inner wall of the first arm and/or the second outer wall is removably attached to the inner wall of the second arm.

15. The hair styling device of any one of the claims 3 to 14, wherein the first exhaust and/or the second exhaust include a second mesh for preventing hair from entering the first air chamber and the second air chamber, respectively.

16. The hair styling device of any one of the claims 11 to 15, wherein

the first mesh and/or the second mesh are removably attached to the hair styling device, and/or

the first arm and/or the second arm are removably attached to the handle.

17. The hair styling device of any preceding claim, further comprising a heater for heating the air flow generated by the fan, a controller for controlling the fan and the heater, and an antenna for providing data communication with a mobile device,

wherein the controller is configured to control a mass flow rate of the air flow exiting the first air outlet and/or the second air outlet, the air temperature at the first air outlet and/or the second air outlet, and/or the duration of an air flow exiting the hair styling device based on data received from the mobile device via the antenna.

18. An attachment for a hair styling device, comprising

a first arm and a second arm configured to be removably coupled to the hair styling device,

wherein an inner wall of the first arm is facing an inner wall of the second arm,

wherein the first arm and the second arm are arranged to receive hair within a cavity formed between the first arm and the second arm,

wherein the first arm comprises a first plenum, said first plenum comprising a first air outlet for emitting air towards hair within the cavity, and

wherein the second arm comprises a first air inlet for receiving air emitted from the first air outlet.

19. A method for straightening hair using the hair styling device of any one of claims 1 to 17, or the attachment of claim 18, the method comprising the steps of

placing hair in the cavity and bringing the first arm and the second arm to a closed position, and

heating the hair by generating a flow of hot air through the hair between the first arm and the second arm.

20. A method for curling hair using the hair styling device of any one of claims 3 to 17 or the attachment of claim 18, the method comprising the steps of

bringing the first arm and the second arm to a closed position,

curling hair around the first arm and the second arm in the closed position, and

heating the hair by a flow of hot air exiting the hair styling device at the first exhaust and/or the second exhaust.

Intellectual Property Office

Application No: GB2304485.2 **Examiner:** Emma Tonner

Claims searched: 1-20 **Date of search:** 7 September 2023

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1, 2, 4, 6, 9, 11, 17, 18, 19	US2013/247407 A1 (RICHMOND et al.) see paragraphs 0019-0025
X	1, 2 5, 6, 8-11, 17-19	GB2608155 A (DYSON TECHNOLOGY) see p.9, line 10-p.10, line 5 and figure 7
X,E	1-3, 6, 7, 9, 12, 13, 18, 19	GB2613606 A (DYSON TECHNOLOGY) see p.19, lines 1-22 and figure 5
X	1, 6, 9, 11, 17, 18	GB2498417 A (JEMELLA LTD) see figure 3a and p.19, lines 9-13

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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A45D

The following online and other databases have been used in the preparation of this search report

SEARCH-PATENT

International Classification:

Subclass	Subgroup	Valid From
A45D	0001/06	01/01/2006
A45D	0002/00	01/01/2006
A45D	0020/10	01/01/2006