

Oct. 26, 1965

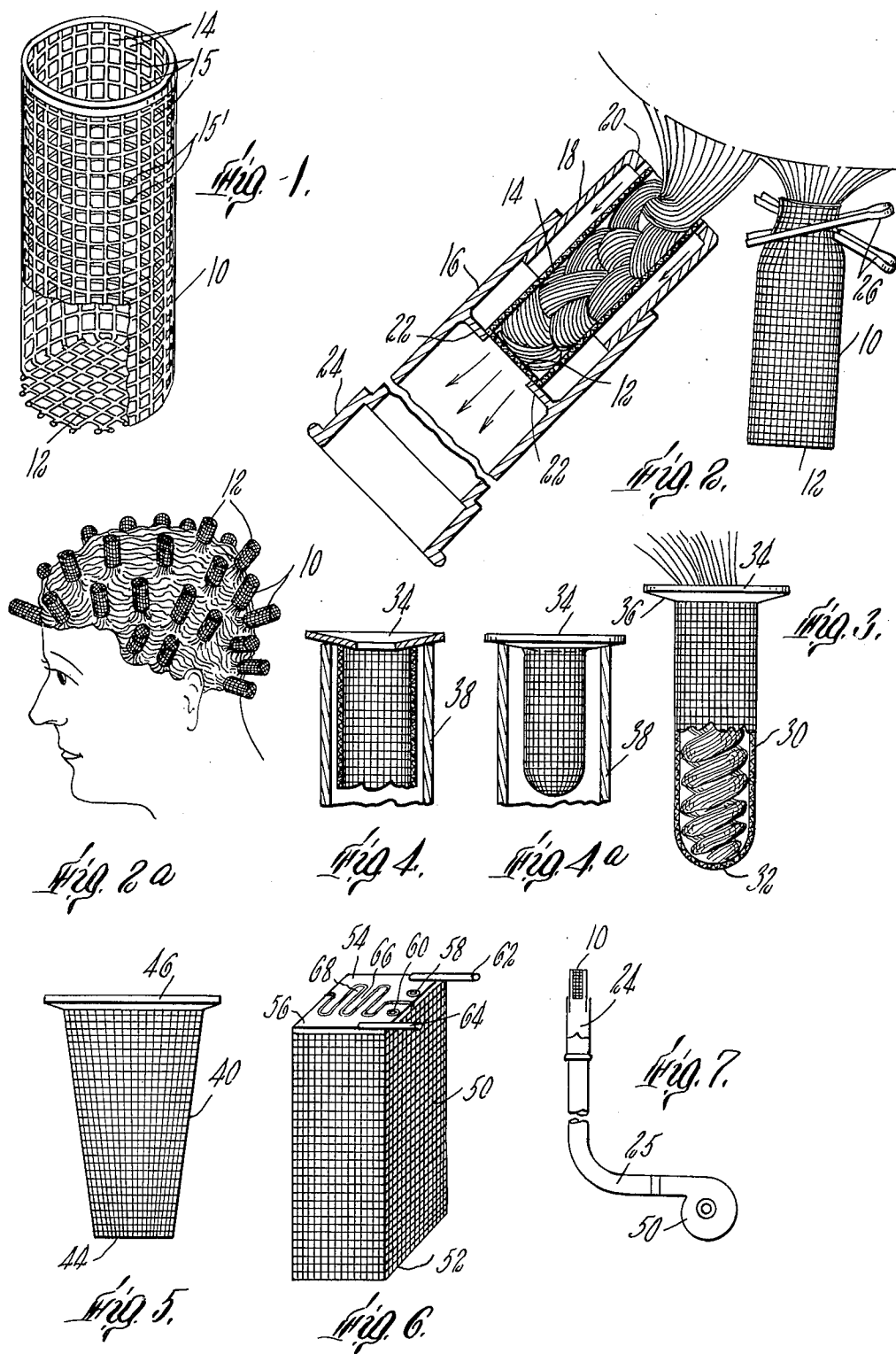
L. R. MIZELL ETAL

3,213,859

DEVICE FOR CURLING HAIR BY SUCTION

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2 Sheets-Sheet 2

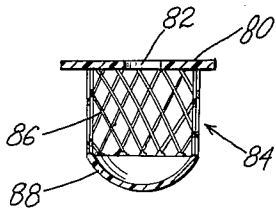


Fig. 9.

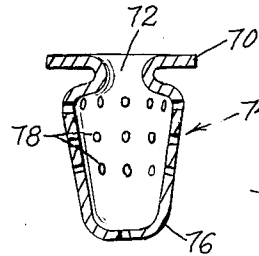


Fig. 8.

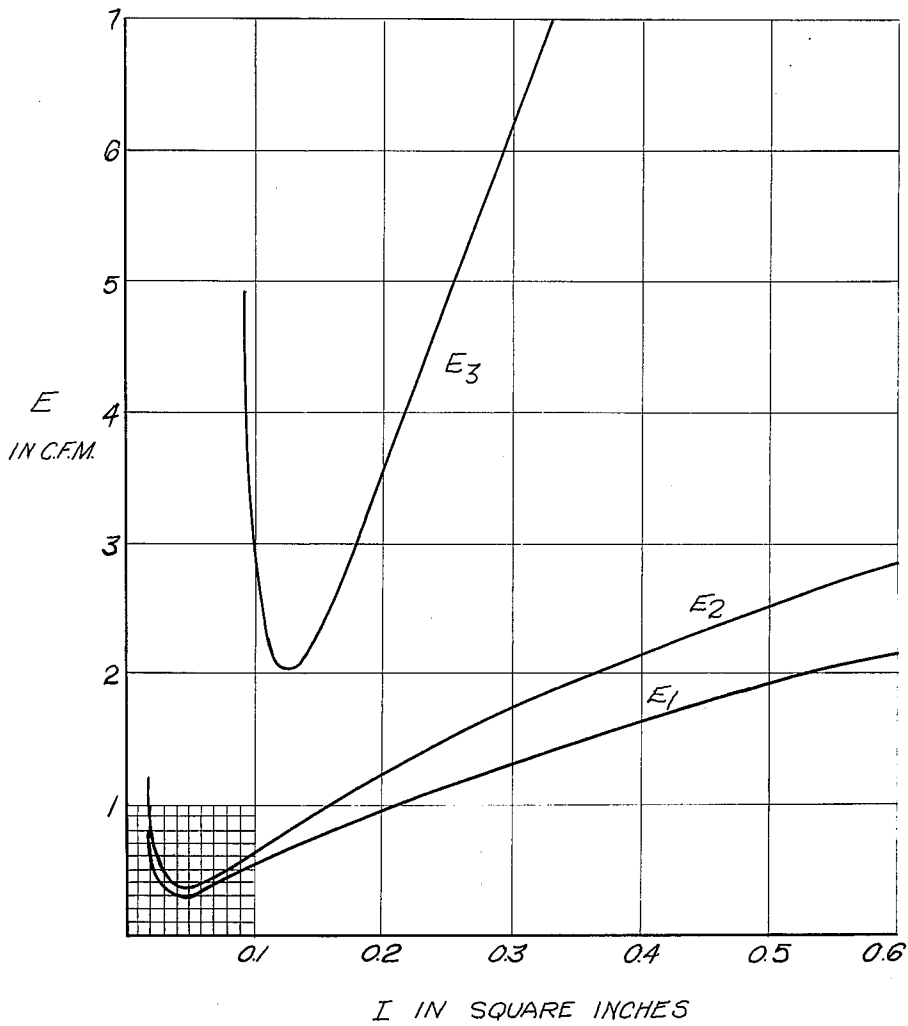


Fig. 10.

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3,213,859

DEVICE FOR CURLING HAIR BY SUCTION

Louis R. Mizell, Bethesda, and Charles G. Tewksbury and John P. Vitello, Silver Spring, Md., assignors to The Gillette Company, Boston, Mass., a corporation of Delaware

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9 Claims. (Cl. 132-7)

This application is a continuation-in-part of our co-pending application Serial No. 129,079 filed August 3, 1961, and now abandoned.

This invention relates to hair curling and more particularly provides a novel hair curler and novel means and method for utilizing the curler to pack and retain in convoluted form a hair tress under conditions suitable for imparting thereto a permanent wave or a temporary set as may be desired.

Hair curling as practiced in the past has involved the fundamental operation of winding the hair tress about a core or rod to place the hair in curled form and fastening the so-called tress to maintain the coiled form until the desired wave or curl retention is imparted. In permanent waving, the hair while so wound is subjected to the action of chemicals which require for effective action that the hair be under substantial strain, induced by a tight wind and clamping of the tress. For temporary set or styling, the coil may be looser, but the tress must be held in the coiled form until the hair takes the temporary set.

In either permanent waving or temporary setting the tress when wound may be removed from the core or rod, provided it is securely fastened against unwinding, as in the familiar practice of "finger waving" by winding the tress about a finger, slipping the coil from the finger and fastening it in coiled form by means of a bobby pin. Permanent waving using conventional rods has several difficulties. First of all, few women find it easy to roll their hair on the rods by themselves. Secondly, end papers normally must be used at the tips of the hair tresses to facilitate the start of the winding around the rod. As the hair is wound around the rod, the effective diameter of each successive wind is greater than the preceding, so that looser curls occur next to the scalp. The bunching of the hair around the rod also makes it difficult for waving lotions to penetrate to the tips of the hair first wound around the rod.

For temporary set or hair styling purposes, looser curls are desired. The most common practice is for women to use their fingers for this purpose; because of lack of adeptness many women are unable to wrap proper uniform curls, which is a difficult task even for the most skilled beautician. They are also unable to tuck the tips of hair in the curl in order to obtain satisfactory end curls. At the present time, large-diameter curlers are used for styling, but they too suffer from the difficulty mentioned above; namely, that women are not able to roll hair, particularly at the back of the head, on the curlers.

One object of this invention is to eliminate and/or minimize these disadvantages in present-day waving and styling methods, and to simplify and improve hair curling in both the beauty shop and the home.

Another object of the present invention is to make it possible to produce a wide variety of curls, including curls of the type produced by the spiral wrap as well as the croquignole wrap and curl forms not heretofore obtainable with a minimum of difficulty and at a high rate of speed.

Still another object of this invention is to provide novel hair curling equipment which makes it possible to produce a satisfactory wave or curl, without winding the tress upon

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a core or rod or around the finger, in a semi-automatic, virtually effortless and yet reliable operation.

Other and further objects will be apparent from the drawings and from the description which follows.

In the drawings:

FIG. 1 is an isometric view showing one embodiment of a curler of the present invention on an enlarged scale;

FIG. 2 is a view in section of a device for utilizing the curler in coiling a hair tress showing the operation of coiling the tress within the curler upon the head and also showing one mode of fastening the curler;

FIG. 2a is a view illustrating a head of hair with all tresses to be waved coiled and fastened within the curlers;

FIG. 3 is a view in side elevation, partly broken away and in section, of another embodiment of the hair curler of the invention showing another coiling operation;

FIG. 4 is a view in section partly broken away, of a device for using the hair curler constructed as in FIG. 3 in coiling a tress;

FIG. 4a is a fragmentary section view of the device of FIG. 4 shown with a smaller embodiment of the curler of FIG. 3 applied thereto;

FIG. 5 is a view in elevation showing still another embodiment of the hair curler of the invention;

FIG. 6 is an isometric view showing still another embodiment of the hair curler of the invention, including means for clamping the hair curler to the tress;

FIG. 7 is a view in elevation showing the device of FIG. 2 in combination with a pump for producing an air stream;

FIG. 8 is a view in cross-section showing a preferred embodiment of the curler of the present invention;

FIG. 9 is a view in cross-section showing another preferred embodiment of the curler of the present invention; and

FIG. 10 is a graphical representation of the relationship between the size of the mouth and the air-perviousness of the body portion of the curlers of the present invention.

Our invention involves the fundamental discovery that a hair tress may be coiled against the inner wall of an apertured, tubular member of suitable shape and dimensions, and held thereby in the coiled form and under strain such that a permanent wave or temporary set may be produced therein. Our invention involves the further important discovery that the coiling, looping or convoluting of the hair tress within the curler constructed in accordance with the invention may be effectively accomplished simply by moving the curler relatively longitudinally of the tress, from tip toward base, in a stream of air constrained to move in a path through the curler, the preferred and most advantageous usage of the curlers involving this automatic air current coiling as herein-after described. The coiling may also be accomplished by introducing first into the curler the part of the tress adjacent the scalp, or by introducing the midportion of the tress first.

Our invention not only eliminates the laborious task of rod-winding tresses, which has been essential to waving for many years, but makes it possible to eliminate also the tress-separation or "blocking" operation which normally precedes winding or, in some cases, setting. In addition, serious limitations of rod-waving or finger-setting such as in mass and length of tress which can be satisfactorily waved or set are overcome. Because the curlers of the present invention operate to confine the hair convolutions externally and to limit their maximum size or diameter, the act of forcing or packing an unusually large mass of hair into a curler of the present invention does not result in excessive elongation or en-

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largement of the hair convolutions or coils, as happens when excessive hair is wound on conventional curling rods. The novel curlers provide a tool of great versatility for the hair waving art, by their external molding action making it possible to form hair into coils or curls of a great variety of shapes, sizes, and configurations not obtainable with rod or pin curl waving. Also, the uniformity of curl obtained with a given curler on comparable tress masses is far above that obtainable heretofore. Moreover, the present invention makes it possible to form hair into suitable coils at a greatly increased rate of speed as compared with conventional methods and apparatus. Thus, by the invention hair curling is vastly simplified both for the beauty shop operator and for the home user and yet the range of curl types and shapes obtainable and the quality of curl are greatly improved. The greatly increased openness of hair coils together with elimination of end papers in the curlers of the present invention makes it possible to eliminate presaturation of the hair with waving lotion before coiling, and the removal of some of the moisture from wet hair by the air stream during coiling further facilitates penetration of the coiled tress by subsequently applied liquids.

There are certain limitations upon the size of the mouth of the receptacle or tubular member and upon the air-perviousness (e.g., the number and size of apertures) of the body portion thereof in order for the curlers of the present invention to be used effectively. The minimum possible size of the mouth is limited, of course, by the cross-sectional size of the hair tress (when compressed) with which it is to be used. Beyond this it is found that as the size of the mouth becomes very small, the decreased volume of air passing through it is less effective in entraining the hair fibers and guiding them up to the mouth, so that more manipulation is required. The minimum size mouth which can be used for a tress of hair of the smallest practicable size has an area of about 0.02 sq. in.; the maximum size of mouth is limited only by the diameter of the body portion. In general, the size of mouth preferred for most purposes has an area from 0.04 to 0.07 sq. in.

The air-perviousness of the body portion of the receptacle or tubular member should exceed a certain value which depends upon the size of the mouth or inlet through which the hair tress is passed into the receptacle. Unless this limitation is met, the hair tress will be drawn into and coiled up in the body portion only with difficulty even when considerably more manipulation is used than would be desirable from a practical point of view. In general, as the total area of the mouth or inlet, measured at its most restricted point, decreases, the air-perviousness required in the body portion also decreases, reaching a minimum when the total area of the mouth is approximately 0.04 sq. inch and thereafter increasing extremely rapidly. These limits can be expressed in fairly precise mathematical form; assuming for the sake of convenience that the pump or blower producing the air stream through the mouth of the curler is such that it produces a pressured drop of 150 mm. of mercury when its inlet is completely closed, the limits are as set forth below. The limits vary only a few percent even when a blower producing almost twice as large a pressure drop is used.

When the previousness of the body portion is expressed in terms of air flow (cubic feet per minute) at a pressure drop of 0.5 inch of water across the body portion of the curler, the minimum perviousness E_1 is defined as follows, where I is the total area in square inches of the mouth of the curler measured at its most restricted point:

$$E_1 = \frac{1}{32.9\sqrt{I} - 3.73} + 3.8\sqrt{I} - 0.82$$

In order to enable a reasonably skilled operator to load into a curler within three seconds a hair tress five inches

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long, weighing approximately 1.5 grams, the minimum required perviousness E_2 is defined as follows:

$$E_2 = \frac{1}{23.7\sqrt{I} - 2.75} + 5.2\sqrt{I} - 1.22$$

In employing a curler of the present invention without any mechanism for controlling the direction of lay of the coils formed within the body portion of the hair curler under the influence of the air stream, it is found that in the case of those curlers in which the mouth has an area of at least 0.09 sq. in., the air-perviousness of the body portion should not exceed a certain maximum for best results. When the maximum is exceeded under these conditions, it is found that portions of the fibers of the tress curl or loop in one direction while others are laid down in a different direction. Although uniform alignment of all hair fibers in a tress is not essential in all cases, particularly in permanent waving, the extent of uniformity, when desirable, can be maintained at a high level by employing curlers the air-perviousness of the body portion of which has a value between E_1 as defined above and E_3 as defined below, or preferably between E_2 and E_3 :

$$E_3 = \frac{1}{6.2\sqrt{I} - 1.71} + 30.0\sqrt{I} - 10.74$$

Referring now to the drawings, FIGS. 1 and 2 thereof show one embodiment of the curler of the invention having a body portion in the form of a tubular, generally cylindrical wall 10 and a flat, circular end closure 12, the opposite end being open and forming a mouth for receiving the tress. Desirably, the curler may be formed by molding as a single, integral, one-piece unit of a synthetic plastic composition which may be either rigid or flexible and resilient and which should be resistant to chemicals present in the tress in a permanent waving or temporary setting operation. Suitable plastic compositions are, for example, polyethylene, polypropylene, rubber, vinyl resins, polyurethane, nylon, Dacron, Teflon. However the curler may be formed by interweaving monofilaments or threads or staple fiber yarns of any suitable materials or corrosion-resistant metal wire and the like. The curler may also be formed from sheets of unwoven, bonded fibrous material of sufficient porosity. The body portion may be formed of an elastic material, the apertures increasing in size as the body portion is expanded by stretching in the air current, in which case the minimum required air-perviousness of the body portion, as defined above, is that measured when the body portion is in the expanded or stretched condition. The term "apertures" as used herein is intended to include the openings of such porous walls as the foregoing in which the openings are so small or of such irregular shape that their dimensions are difficult to define.

Wall 10 and in some cases also end closure 12 are porous, the apertures 14 therein, as shown, being provided by the spacing between intersecting longitudinal and transverse ribs 15 and 15', respectively, which form a cage-like receptacle having reticulate or retiform walls with a multiplicity of small apertures. For effective utilization of the curler in the method and apparatus hereinafter described, the apertures 14 should, as shown, be closely spaced and distributed substantially from end to end of at least a major portion of the side wall 10. The size of the individual apertures 14 may be uniform throughout the wall and end closure, or it may vary from one part to another. The dimensions of these apertures should be sufficient to allow free air flow through them, but not so great as to cause hair ends forced angularly against the inner face of the wall or enclosure to catch in them or escape through them or to permit bulging therethrough of a hair tress coiled against said face.

FIG. 2 illustrates means and method by which the curler of the invention, such as the embodiment of FIG. 1, may be utilized to coil hair with the aid of an air current. To this end there is provided an impervious tubular member 16 which frictionally receives a second impervious

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tubular member 18 in its outer end, the tube 18 having an inwardly extending lip 20 providing a reduced opening which closely surrounds a curler inserted therein. A plurality of inwardly projecting circumferentially spaced supporting elements 22 are provided in tubular member 16 spaced inwardly from the outer end thereof to provide a support for the bottom of the curler. Tubular member 18 is adjusted longitudinally of the tubular member 16 so that its imperforate lip 20 is approximately in the plane of, or slightly below, the mouth end of the curler, the latter having its opposite end resting on members 22 and having its side wall 10 spaced from the inner face of the wall of tubular member 16 and 18 so that the openings 14 in its side wall and end closure are substantially unobstructed. A strong air current flowing into the open ends of tubular member 18 and the curler is provided by connecting tubular member 16 to a suitable source of suction such as pump 50 (FIG. 7) by means of a fitting 24 and hose 25.

In using the device of FIG. 2, the end of tubular member 16 containing member 18 and the curler is advanced to the proximity of the tress of hair which it is desired to curl, which is preferably wet or damp, although it may be dry. When the suction device is turned on, the strong current of air being drawn through the open end of the curler sucks the tress of hair into the curler. By virtue of flange 20, the incoming air stream is directed first into the mouth of the curler and then some of the stream flows therethrough outwardly against the wall of tubular member 18 or 16 and along the space between tubes and curler.

By advancing the tubular members and curler toward the tress, the air stream is permitted to suck the tress into the curler and, as it does so, we have found that the action of the air automatically lays the tress in convolutions, either in the form of uniform helical curls with aligned hair coils falling one upon another in either clockwise or counterclockwise direction, as shown in FIG. 3, or in the form of loops, turns, or the like, as shown in FIG. 2, under pressure against both the end and side walls of the curler. In this manner the convolutions of the hair are under a strain of the same order of magnitude as that obtained in wrapping the tress on a core in a conventional way. When the encaging or packing of the hair is complete within the curler, the suction may be turned off, if desired, and the curler with its tress is withdrawn or ejected from the end of tubular member 18 and clamped to the hair tress adjacent its mouth end by a suitable clamping device, such as hairpins or bobby pins 26, as illustrated in FIG. 2. In the embodiment shown in FIG. 2, the apertures 14 adjacent the mouth of the curler are of sufficient size to permit the pins 26 to pass therethrough if desired. The tress is now held in a configuration to receive a permanent wave or temporary set and, if treating agents are to be applied, this may be readily done through the porous wall of the curler. The process is repeated until the entire head of hair has been enclosed in the curlers as shown in FIG. 2a. If desired, two or more tresses may be packaged simultaneously in separate curlers.

It is important in the proper functioning of the device that the mouth end of the curler and the inlet opening of the tubular connection to the suction device be so correlated that substantially all of the air entering the inlet opening passes into the mouth of the curler. In the embodiment of FIG. 2, this is accomplished by dimensioning the opening within lip 20 to closely surround the curler and by adjusting member 18 longitudinally so that substantially none of the open portions in the curler wall project outwardly beyond lip 20. When this is done, we have found that air current of adequate velocity flowing into the curler acts to gather a tress into a tight strand or rope and to feed it smoothly into the curler.

Where curlers of different inner diameters are to be employed, as may often be desirable, a plurality of the members 18 may be provided, with the diameter of the

aperture formed within lip 20 graduated accordingly, or the lip 20 may be made in sections, laterally inwardly and outwardly adjustable.

Provided the curler mouth is of proper size, we have found it is actually possible to use the apparatus to automatically select the correct amount of hair for the tress and thus dispense with the tedious blocking and sectioning steps which have normally preceded winding in the prior art. In such operation the device with the suction turned on is brought with the curler-containing open inlet end of the tubular member into proximity to the hair in an area of the head in which a curl is to be produced. A tress of hair of the desired mass is automatically selected and drawn into and coiled in the curler by the air stream. The process is repeated with another curler inserted in the suction device until all desired curls have been formed and fastened in the curlers. This automatic tress forming is particularly effective and accurate when the hair is wet, apparently because the hair in the zone influenced by the air stream tends to stick together and be fed in a smooth, rope-like body into the open mouth of the curler.

In FIG. 3 as illustrated another embodiment of the curler of the invention in which the tubular apertured wall 30 of the curler is provided with an integral apertured end closure 32, which is hemispherical in shape, presenting a concave inner face rather than flat as in the embodiment shown in FIG. 1. This change in the shape of the end closure tends to provide a coil of reduced diameter toward the ultimate end of the tress to form a correspondingly shaped coil, an advantage where a tight end curl is desired. In addition, it will be noted that the open end of the curler of this embodiment is provided with a laterally projecting impervious rim 34, which is slightly dished, as best shown in FIG. 4.

Rim 34 of this embodiment enables simplification of the suction apparatus which may be, as shown in FIGS. 4 and 4a, simply a tube 38 connected at one end to a source of suction as in FIG. 7 and receiving the curler in its opposite open end with the curler rim 34 seated on the outer end of tube 38. Thus rim 34 acts to support the curler in the tube, making it unnecessary to provide special supports in the tube such as supports 22 in the embodiment of FIG. 2. Further, the provision of a supporting rim on the curler itself makes unnecessary adjustment of tube length and permits elimination of the telescoping member 18 of the embodiment of FIG. 2, since the open end of the curler is always properly located in the mouth of the tube regardless of the length of the curler. By varying the width of the curler rim inversely in respect to the diameter of the curler mouth, it becomes possible to use one non-adjustable suction tube 38 for an entire set of curlers of different lengths and diameters, such as the relatively long and large diameter curler shown in FIG. 4 and the comparatively short and small diameter curler shown in FIG. 4a, as well as various other sizes which it may be desirable to provide in order to satisfy all waving requirements. The diameter of the opening in rim 34 which forms the curler mouth in this embodiment may be less than or equal to the diameter of the body of the curler. It may be desirable that the outer diameter of the rim be greater than that of tube 38 in order to facilitate removal while the suction is on. The dishing of rim 34 tends to minimize the formation of undesirable crimp marks on the hair when hairpins or bobby pins are used to clamp the rim to the hair tress.

The curler of FIG. 3 and suction apparatus of FIGS. 4 and 4a are used in the same manner as those of FIGS. 1 and 2, as previously described. Properly dimensioned, as hereinafter discussed, the curler as shown in FIG. 3 utilized in the method and apparatus of the invention, produces, with the aid of conventional permanent waving chemicals, permanent waves ranging from very loose to very tight, including the kind of waves obtainable with the present-day practice of rod winding of tresses for the

purpose. In addition to dispensing with the laborious winding operation of rod waving, it should be noted that our curlers and process eliminate the use of end papers which are applied over the tress ends in rod waving, a further substantial simplification in the waving procedure.

Actually, we have found that our curlers used in the manner described offer new possibilities in wave control and shaping and mitigate certain restrictions which attend rod waving. One of these restrictions is in the length and mass of tress which can be adequately treated. Whereas the conventional rod waving is ineffective on tresses above a certain length because the outer turns of the wrap become too large in diameter, our curlers can produce curls as desired throughout tresses of virtually any length, provided the volume of the curler is sufficient. Also, our curlers will wave shorter hair lengths than it is feasible to wrap on a rod and will satisfactorily wave tresses of considerably greater mass than is possible in rod waving. Further, because of their external confining action on the coil not present in rod waving, we are able, by varying the shape of our curlers, to impart waves varying from very loose to very tight and in a wide variety of configurations along the length of the curled hair tress.

In the curler embodiment shown in FIG. 5, the main portion of the hair curler is in the form of a hollow truncated cone 40 having apertures similar to those of the embodiments in FIG. 1 and FIG. 3. In this embodiment it will be noted that the size of the apertures varies along the length of the conical member. This embodiment is desirable in that it provides a coil of smaller diameter at the tip of the hair tress when the tress is introduced tip end first while permitting the coils to increase in diameter approaching the root of the tress. This embodiment, like that illustrated in FIG. 1, is provided with a generally flat circular end closure 44 and like that of FIG. 3 is provided with a supporting rim 46.

In the curler embodiment shown in FIG. 6, the main portion of the curler comprises an elongated tubular member 50 of generally square cross-sectional configuration having the same sort of apertured wall construction as the embodiment of FIG. 1. This embodiment is provided with a flat square end closure 52 and is also provided at its open end with a pair of clamping elements 54, 56 pivoted to the main body member on pivot pins 58, 60 and spring-loaded to the closed position as shown in FIG. 6. Projecting lever arms 62, 64 are adapted to be engaged by the fingers of the user to pivot the clamping elements 54, 56 to open position to permit a hair tress to be received within the curler and to secure the open end of the curler to the hair tress when released. Members 54, 56 are provided with meshing comb teeth 66, 68 which engage the hair to fasten the curler thereto. This embodiment gives particularly good permanent waves when used under the proper conditions.

Numerous other curler shapes may be used. For example, a curler of equilateral triangular cross-section otherwise similar to that of FIG. 6 may be employed, as well as other curlers in which the side wall is formed of a plurality of substantially flat wall portions angularly connected to each other. If it is desired to produce a curl which is larger and looser intermediate its ends, it is only necessary to provide an enlarged or bulbous or spherical section between the ends of any of the curlers previously described.

A preferred embodiment is shown in FIG. 8 in which a smooth imperforate generally flat flange 70 is provided extending laterally outwardly around the mouth 72, the diameter of flange 70 being somewhat greater than that of the tubular member (such as that shown at 16, 18 in FIG. 2 or at 38 in FIG. 4) in which the curler is to be supported while having a stream of air drawn through it. The effective area of the mouth of this embodiment, for the purpose of determining the

minimum air-perviousness of the body portion, must be measured at the minimum diameter of the mouth. The body portion 74 of the curler of FIG. 8 is circular in cross-section, increasing rapidly in diameter from the mouth to its maximum inside diameter which is from two to three times the mouth diameter, then decreasing gradually to the bottom or end 76 of the body portion which has a concave inner face. The mouth of the curler for best results should merge smoothly with flange 70 and with the inner face of the body portion 74, without any sharp angles or discontinuities. A multiplicity of perforations or apertures 78 are provided in the body portion to give the necessary minimum air-perviousness. In order to facilitate introduction of hair treating liquid into the hair tress while the latter is enclosed within the curler, it is preferred that the apertures be as large and as closely spaced as possible within the general limits set forth above, and that the outer face of the narrow body portions between apertures be convexly and sharply rounded to minimize loss by splashing when liquid is applied by spraying the outside of the curler. The curler of FIG. 8 combines the best features of the preceding embodiments and is therefore preferred.

Another preferred embodiment is shown in FIG. 9. This embodiment likewise includes a smooth imperforate generally flat flange 80 which extends laterally outwardly around mouth 82 and which has a diameter somewhat greater than the maximum diameter of body portion 84. The upper part of the body portion is generally cylindrical, being formed of crossed monofilaments 86 of synthetic plastic composition bonded together at their intersections in lattice form. Each of the monofilaments has a rounded outer face, being generally cylindrical in shape. The bottom portion of this embodiment is an imperforate dished member 88 presenting a concave inner face. Flange 80 and member 88 are preferably synthetic plastic compositions and are bonded to the body portion by a suitable adhesive or by heat-sealing.

In order to achieve maximum uniformity of alignment of all of the hair fibers within a tress, it is desirable, in addition to avoiding an air-perviousness of the body portion beyond E_3 when the area of the inlet is 0.09 sq. in. or more as explained above, to decrease the proportion of air flowing through the end (i.e., bottom) of the body portion, either by mounting a shield or baffle within the tubular member 16, 18 or 38 to cover the end portion only of the curler or by decreasing the perviousness of the end portion only. The former is preferred because the latter makes it more difficult subsequently to introduce hair treating liquids into and to distribute them uniformly throughout the hair while the latter is contained within the curler.

A plot of the foregoing relationships is shown in FIG. 10 of the appended drawing.

As will be appreciated, the hair curlers of this invention are useful not only in permanent waving of hair but also in the setting of hair into the desired ultimate configuration after it has, if necessary, received a permanent wave. In such case, the tress may be treated entirely in the dry state or may be wet with water and permitted to dry in the coiled state, or any of the conventional setting aids or agents may be used. Our tests have demonstrated that utilizing the air stream method of coiling the hair in the curler, permanent waves or temporary sets are obtainable which are comparable to those produced with conventional rod waving and setting procedures used heretofore.

Desirably the curlers of this invention are flexible for the comfort of the wearer, particularly in overnight waving or setting processes. However, the curlers may be rigid and substantially non-deformable if desired.

The dimensions of our curlers are variable over considerable ranges, depending upon a number of factors. The diameter of the curler mouth is related to the width or diameter of the hair tress which it is desired to treat

in the curler. For a hair tress of given size there is a corresponding minimum diameter which the curler mouth ought to have in order to pass the tress properly therethrough. Where the air stream device is used for tress forming or selection, the diameter of the curler mouth should not greatly exceed the minimum for the tress size which it is desired to form. Furthermore, as pointed out above, there is an absolute minimum size of about 0.02 square inch for the mouth for the smallest practicable hair tress. The curler body diameter and length are related to one another, to curler shape, and to the length and size of tress which the curler is designed to receive. They should provide a volume such that the desired tress length can be firmly coiled and packed therein by the air flow. If the curler is too short or too small to receive the entire length of tress, it will nevertheless function normally as respects the length that can be coiled therein. On the other hand, if the curler be somewhat too long, the consequence it to decrease the tightness of the coiled tress contained therein. Nevertheless, a single size of curler can be used for a considerable range of tress lengths and sizes. Preferably, a set of curlers of varying sizes will be used on a single head of hair to accommodate the varying lengths of hair on different parts of the head.

Diameter of the curler body is important since it controls tightness of the coil and the extent of permanent or temporary curl obtained. Here again there is a relation to the size of the tress to be treated. For a 3 to 6 inch long, about 1 gram tress, which may be taken as a usual tress size for the main part of the head of hair, we have found that for producing by our method a permanent wave comparable to what is considered a medium to tight wave in rod waving and which is substantially uniform throughout the tress length, the optimum curler dimensions are of the order of $\frac{3}{4}$ inch diameter for the curler body, with a curler length of about one-half to one inch. By employing an end closure of diminishing diameter, as in FIG. 3, a tighter end curl may be obtained. By varying the curler diameter, as for example in FIG. 5, curls of varying tightness may be obtained along the length of the tress.

In general, for obtaining on such tresses the full range of curl diameters which are desirable in permanent waving today, the diameter of the curler may range up to, but will not substantially exceed, about $1\frac{1}{2}$ inches nor be less than $\frac{1}{4}$ inch. Curl diameters which are desired for temporary set may be somewhat larger and for this purpose the curler diameter range for results acceptable to most women may be from about $\frac{1}{2}$ inch to about $2\frac{1}{2}$ inches.

For shorter hair lengths and for end curling, shorter curler lengths are desirable, with the minimum about $\frac{1}{4}$ inch. To facilitate use of our device as a tress-selecting means, with curlers of large body diameter it may be desirable to neck down the mouth of the curler to limit the size of the tresses selected.

Generally, the curler mouth diameter will be equal to or less than the curler length. While the shape of the mouth is not critical, it is preferably approximately circular, i.e., of such a shape that its minimum diameter or dimension does not differ greatly from the maximum. Generally, the preferred size for a circular mouth is, in round numbers, of a diameter from $\frac{1}{4}$ to $\frac{1}{2}$ inch; or in terms of area, from 0.04 to 0.07 square inch. Normally, the curler length will not exceed about $2\frac{1}{2}$ inches, but substantially longer curlers may be employed where unusually long tresses are to be waved. Preferably, the cross-sectional shape of the interior of the curler body is substantially a circle or regular polygon.

It is important in order to obtain best results that the side wall or walls of the curler be at least in major part spaced from the wall of tubular members 16, 18 or 38 in order to permit free flow of air through the apertures in the wall.

Our air coiling method requires an air stream of considerable velocity, 80 feet per second being about a mini-

mum at the beginning of the coiling operation. We prefer a velocity of about 130 to 600 feet per second. These velocities are mean velocities of the air stream measured at the most restricted portion of the mouth of the curler. Pumping equipment capable of producing such velocity may comprise, for example, a one- or two-stage radial or mixed flow vane impeller of a diameter between 4 and 6 inches driven by a universal type A.C. electric motor. This motor will normally require 500 to 1000 watts input for a curler used for a single tress of hair.

Although specific embodiments of the invention have been described herein, it is not intended to limit the invention solely thereto, but to include all of the obvious variations and modifications within the spirit and scope of the appended claims.

What is claimed is:

1. A curler for hair adapted to be detachably secured in an air stream to pack a tress of hair therein by air pressure comprising a receptacle having a mouth through which a hair tress may be passed, and a portion forming a hair enclosing body portion against the inner surface of which the tress of hair may be packed under pressure in convolutions of a size and shape suitable for curling, said mouth having a diameter of less than one-half of the diameter of said body portion, said body portion being provided with apertures to permit free air escape therefrom for at least the major part of its length, in which I, the total area of the mouth in square inches at its most restricted point, is at least 0.02, and in which the size and number of said apertures is such that the rate of flow of air therethrough, measured in cubic feet per minute at a pressure drop across the apertures of one-half inch of water, has a value at least as great as E_1 computed as follows:

$$E_1 = \frac{1}{32.9\sqrt{I} - 3.73} + 3.8\sqrt{I} - 0.82$$

2. A curler for hair as claimed in claim 1 including in addition means connected to said receptacle adjacent said mouth for securing said curler to the hair tress enclosed therein.

3. A curler as claimed in claim 1 in which the rate of flow of air is at least as great as E_2 computed as follows:

$$E_2 = \frac{1}{23.7\sqrt{I} - 2.75} + 5.2\sqrt{I} - 1.22$$

4. A curler as claimed in claim 1 in which I is at least 0.09 square inch and in which the rate of flow of air is between E_2 and E_3 computed as follows:

$$E_2 = \frac{1}{23.7\sqrt{I} - 2.75} + 5.2\sqrt{I} - 1.22$$

$$E_3 = \frac{1}{6.2\sqrt{I} - 1.71} + 30.0\sqrt{I} - 10.74$$

5. A curler as claimed in claim 1 wherein the receptacle includes a laterally extending impervious rim surrounding said mouth.

6. A hair curling device comprising a hair curling receptacle having an open mouth through which a hair tress may be passed and an air-pervious, hair retaining body portion against the inner surface of which the tress may be packed under pressure in contacting convolutions of a size and shape suitable for waving, said air-pervious body portion being circular in cross-section and increasing sharply in diameter in the direction away from the mouth to a maximum diameter, beyond which it decreases more gradually in diameter to an end closure having a concave inner face, the total area I of the mouth in square inches at its most restricted point being at least 0.02, and the size and number of the openings in the air-pervious body portion being such that the rate of flow of air therethrough, measured in cubic feet per minute at a pressure drop across the openings of one-

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half inch of water, has a value at least as great as E_1 computed as follows:

$$E_1 = \frac{1}{32.9\sqrt{I} - 3.73} + 3.8\sqrt{I} - 0.82$$

7. A hair curling device as claimed in claim 6 including in combination an impervious tubular member removably receiving and supporting in one end thereof said body portion of said receptacle with at least the major part of said body portion spaced from the inner wall of said member.

8. A curler for hair adapted to be detachably secured in an air stream to pack a tress of hair therein by air pressure comprising a receptacle having a mouth through which a hair tress may be passed and a portion forming a hair enclosing body portion against the inner surface of which the tress of hair may be packed under pressure in convolutions of a size and shape suitable for curling, said body portion being provided with apertures to permit free air escape therefrom for at least the major part of its length, in which I, the total area of the mouth in square inches at its most restricted point, is at least 0.02, and in which the size and number of said apertures is such that the rate of flow of air therethrough, measured in cubic feet per minute at a pressure drop

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across the apertures of one-half inch of water, has a value at least as great as E_1 computed as follows:

$$E_1 = \frac{1}{32.9\sqrt{I} - 3.73} + 3.8\sqrt{I} - 0.82$$

5 and means permanently connected directly to said receptacle adjacent said mouth for securing said curler to the hair tress enclosed therein.

10 9. A curler as claimed in claim 8 in which the means for securing the curler to the tress of hair includes a clamping member movable in a plane generally parallel to that of said mouth.

References Cited by the Examiner

UNITED STATES PATENTS

1,797,557	3/31	Stine et al.	15—344 X
2,791,225	5/57	Simmons	132—7
2,865,381	12/58	Stohr	132—40

FOREIGN PATENTS

1,079,501	5/54	France.
831,352	3/60	Great Britain.

RICHARD A. GAUDET, *Primary Examiner.*