Dec. 9, 1941. J. A. MAIZE 2,265,920

METHOD AND APPARATUS FOR PERMANENT HAIR WAVING

Filed Oct. 27, 1939

Fig. 1

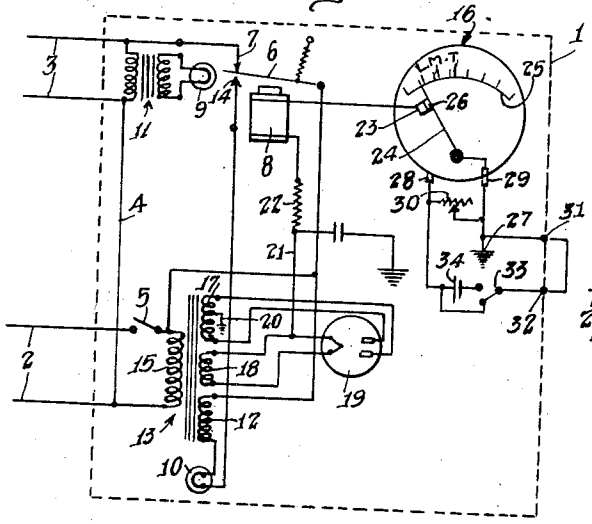


Fig. 1a

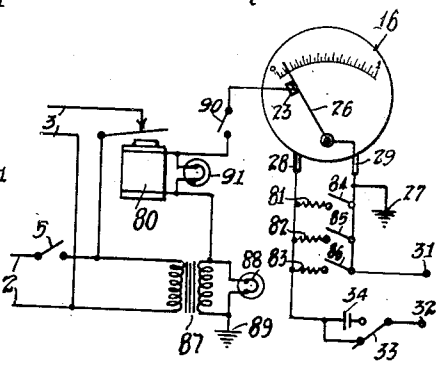


Fig. 2

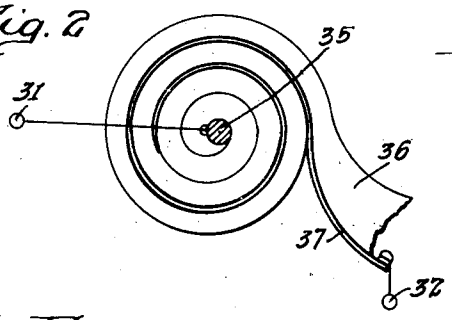


Fig. 3

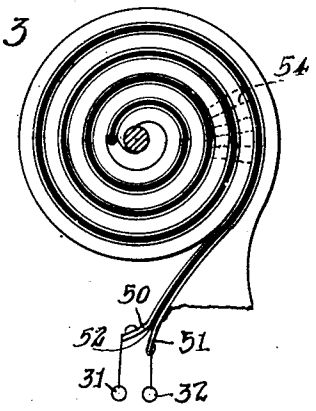


Fig. 5 Fig. 6 Fig. 8 Fig. 10

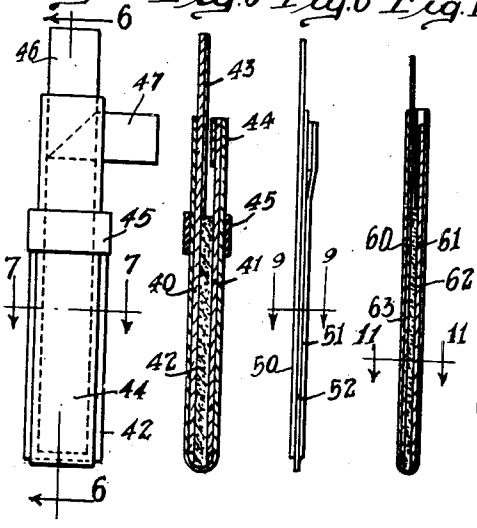


Fig. 7

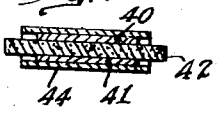


Fig. 9

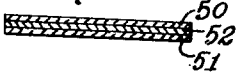


Fig. 11

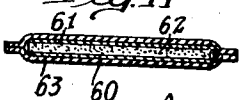
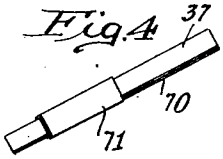


Fig. 4



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UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR PERMANENT HAIR WAVING

James A. Maize, Lamanda Park, Calif.

Application October 27, 1939, Serial No. 301,590

15 Claims. (Cl. 132—36)

This invention relates to apparatus for and method of waving hair, and particularly to the permanent waving of human hair.

A broad object of the invention is to automatically control the length of the steaming period (in permanent waving) in accordance with changes taking place in the hair during the heating process so that optimum results may be obtained in substantially all cases.

A more specific object is to follow the progress of changes occurring in the hair during the waving operation by measuring variations in electrical resistances of elements affected by the hair or by treating solutions in the hair.

Another object is to measure electrical characteristics of an element exposed to the hair-treating solution without employing an external source of electricity.

Another object is to produce current values indicative of changes in the hair during permanent waving thereof, which current values are substantially unaffected by unavoidable variations in technique in practicing the process.

Another object is to provide apparatus for gauging the steaming time in permanent hair waving, which apparatus is independent of the hair waving apparatus itself and may be employed with various types of waving apparatus.

Other more specific objects and features of the invention will become apparent from the detailed description of certain embodiments of my invention to follow:

In my prior Patent No. 2,235,895, issued March 25, 1941, I have disclosed that the electrical resistance of hair varies during the steaming operation (in permanent waving) and may be used as a guide to indicate the transformations taking place in the hair so that the steaming operation may be terminated at the proper time to obtain optimum results. Specifically, that application discloses the use of two electrodes separated by a mass of the hair being steamed, with an external source of potential and a current-indicating device connected in series with the electrodes.

In accordance with the present invention, I have discovered that the external source of potential can be dispensed with by employing electrode elements of dissimilar materials which form, in combination with the waving solution permeating the hair, a voltaic cell producing the potential necessary to cause the indicating current to flow.

I have also discovered that useful results can be obtained without passing the indicating current through the hair itself, but passing the current through a porous medium exposed to the waving solution on the hair. This method has the advantage that the spacing between the electrodes can be made uniform so that the range of current variations will always be substantially the same and the current-indicating device does not have to be recalibrated for each waving operation.

Further, in accordance with the present invention, I have discovered that expansion and contraction of the hair during the steaming process may be utilized to produce an indication of the progress of the process, by winding with the hair on the waving spindle or rod, a pressure-responsive element adapted to produce an indication of pressure variations thereon.

A full understanding of the invention may now be had from the following detailed description of certain specific embodiments thereof, with reference to the drawing.

In the drawing:

Fig. 1 is a schematic diagram of an electrical circuit that may be employed in practicing my invention;

Fig. 2 is a schematic cross section showing hair wound upon a waving spindle, together with electrode elements, in accordance with my invention;

Fig. 3 is a schematic diagram similar to Fig. 2 but illustrating an alternative electrode construction;

Fig. 4 is a perspective view of an electrode structure that may be employed with my method;

Fig. 5 is a face view of an alternative electrode construction;

Fig. 6 is a longitudinal sectional view taken along the line 6—6 of Fig. 5;

Fig. 7 is a cross section taken along the line 7—7 of Fig. 5;

Fig. 8 is an edge view of still another electrode structure;

Fig. 9 is a cross section taken in the plane 9—9 of Fig. 8;

Fig. 10 is a longitudinal sectional view of still another electrode structure;

Fig. 11 is a cross section taken along the line 11—11 of Fig. 10; and

Fig. 12 is a schematic diagram of an alternative electric circuit that may be employed in place of the circuit of Fig. 1, under certain conditions.

Referring first to Fig. 1, the electric circuit therein disclosed is adapted to automatically control the flow of current to an electrical hair

waving machine. Thus the apparatus enclosed within the dotted line 1 controls the supply of current from a supply line 2 to a feeder line 3 going to the hair waving machine. The supply line 2 may be the usual 110-volt lighting circuit. The line 3 may feed current directly to electrical heating elements in a permanent waving machine, or it may control a relay which in turn controls the application of heat to the hair. Whichever particular method is employed is of no importance in connection with the present invention which relates only to apparatus quite independent of the particular method of applying heat to the hair.

One side of the line 2 is permanently connected by a lead 4 to one side of the line 3. The other side of the line 2 is adapted to be connected through a switch 5 and through armature 6 and back contact 7 of a relay 8 to the other side of the line 3. Therefore when the switch 5 is closed and the relay 8 is de-energized, the line 3 extending to the waving machine is energized from the line 2. When the relay 8 is energized contact is broken between the armature 6 and the back contact 7, cutting off the current supply to the line 3 and de-energizing the waving machine.

A pair of signal lamps 9 and 10, respectively, may be employed to indicate the condition of the system. The lamp 9 is connected through a transformer 11 to the line 3, so that it is illuminated whenever the line 3 is energized. The lamp 10 is connected in series with a secondary winding 12 of a transformer 13 and the armature 6 and a front contact 14 of the relay 8. The transformer 13 has a primary winding 15 connected to the supply line 2 through the switch 5 so that this transformer is energized whenever the switch 5 is closed. It will be apparent from the circuit that when the switch 5 is open, both the lamps 9 and 10 will be dark and when the switch 5 is closed one or the other of the lamps, but only one, will be illuminated; thus when the relay 8 is de-energized the lamp 9 will be illuminated, and after relay 8 is energized the lamp 10 will be illuminated.

The relay 8 is adapted to be energized with direct current under the control of a combined relay and indicating meter 16. The source of direct current comprises secondary windings 17 and 18 on the transformer 13 and a rectifying tube 19. This source of direct current is of course energized whenever the switch 5 is closed. The output terminals of this source of direct current comprise a ground connection 20 on the transformer winding 17 and a lead 21 which is connected through a filter resistance 22 and the winding of relay 8 to a fixed contact 23 in the indicating device 16. The device 16 as shown consists of a sensitive current meter having a hand 24 adapted to move across a scale 25. The hand 24 carries a contact 26 adapted to rest against the fixed contact 23 so long as the current through the meter is less than a predetermined value. The hand 24 is connected to ground 27 thereby completing a circuit back to the tap on the transformer winding 17. It will be apparent that closure of the contact 26 on the contact 23 completes a circuit from the direct current source through the winding of the relay 8 to energize the latter and move armature 6 from the back contact 7 to the front contact 14. The actuating winding of the meter 16 (not shown) connects to a pair of terminals 28 and 29, terminal 29 being also connected to the hand 24. A variable resistance 30 is shunted across these terminals 28 and 29 to permit adjustment of the sensitivity of the meter. The terminal 29 in addition to being grounded at 27 is connected to a terminal 31 on the exterior of the case represented by the dotted line 1, and the meter terminal 28 is adapted to be connected to a second terminal 32 on the exterior of the case by a switch 33 operable into two positions, in one of which terminals 28 and 32 are connected directly together, and in the other of which terminals 28 and 32 are connected together through a battery 34.

The terminals 31 and 32 are adapted to be connected to electrodes associated with the hair being waved, and the switch 33 is manipulated to include or exclude the battery 34, depending upon the particular arrangement of electrodes that are to be employed.

One type of permanent waving machine that is in extensive use includes metal spindles or curling rods upon which tresses of hair are wound. The spindle is ordinarily of metal such as aluminum and was employed in the system of my prior application as one of the electrodes for measuring the resistance of the hair, the other electrode consisting of a strip of aluminum foil wound with the hair about the spindle. Thus, referring to Fig. 2, spindle 35, which may be of aluminum, supports a tress of hair 36 wound spirally thereupon and a strip of foil 37 is wound with the hair upon the spindle 35. The spindle 35 and the foil 37 are connected by suitable leads to the terminals 31 and 32.

It will be understood, of course, that prior to winding the hair 36 upon the spindle 35 it is treated with a suitable waving solution, the solution ordinarily containing a volatile alkali.

In accordance with my prior application, the electrode foil 37 would be made of the same material as the spindle 35 and the switch 33 would be actuated to include the battery 34 in series so that the current flowing in the meter 16 would be a function of the potential of the battery 34 (which is substantially constant) and the resistance of the hair 36 between the spindle 35 and the foil electrode 37.

In accordance with the present invention, I have discovered that by making the spindle 35 and the foil 37 of suitable different materials the battery 34 may be dispensed with, and the switch 33 manipulated to connect the electrodes in contact with the hair directly to the meter 16. With this arrangement the electrodes contacting the hair, and the waving solution permeating the hair, form a voltaic cell, the current output of which varies during the steaming period and affords an indication of the progress of the waving process. Suitable electrode materials that may be employed are aluminum and copper, although the invention is in no sense restricted to these two materials. Since it is common practice to make the waving spindles or rods of aluminum, it is convenient to make the foil electrode 37 of copper.

With the arrangement last described, I have found that the current developed by the voltaic cell, including the spindle 35 and the foil 37, is initially relatively low. As the heat is applied to the hair (in any known manner), the current output increases to a maximum value and then decreases, finally reaching a value which may be substantially less than the initial current. I have found that if the heating is stopped when the current developed in the electrodes 35 and

37 has decreased to a predetermined percentage of its maximum value, a wave of predetermined characteristics can be repeatedly obtained. Thus, if the heating is discontinued when the current has dropped to one-third of its maximum value, a tight curl or wave can be consistently obtained. If the heating is discontinued when the current has dropped to half of its maximum value, a medium curl can be consistently obtained. If the heating is discontinued when the current has dropped to about five-sevenths of its maximum value, a loose curl can be consistently obtained.

As an example, the fixed contact 23 of the meter 16 may be positioned to close with the movable contact 26 when the hand 24 is in a position to indicate a reading of .5 milliampere on the scale 25 and the scale may be provided with three auxiliary indicia, "L," "M," "T," signifying a loose wave, a medium wave, and a tight wave, respectively. Under the conditions described, the indicia L would be located opposite the .7 milliampere reading on scale 25. The indicia M would be located opposite the 1.0 milliampere reading on the scale and the indicia T would be located opposite the 1.5 milliampere reading on the scale.

The actual operation, assuming that a tight curl is desired, is as follows: the hair having been treated with the waving solution and wound upon the spindle 35, together with the foil 37, and the connections completed from the spindle and foil to the terminals 31 and 32, the switch 33 is actuated into the position shown in Fig. 1 to cut out the battery 34, and the resistance 30 is adjusted to its maximum value or completely cut out of the circuit. Thereafter the switch 5 is closed. As a result of the adjustment of the resistor 30, the instrument 16 would be very sensitive and the initial current developed in the spindle 35 and the foil 37 will be sufficient to move the contact 26 away from the contact 23, which de-energizes the relay 8 and energizes the line 3 going to the waving machine, thereby causing the application of heat to the hair. As the hair is heated, the current developed in the electrodes 35 and 37 increases, causing the hand 26 to rise on the scale 25, this movement of the hand continuing until the current reaches a maximum value, as indicated by the hand 24 first coming to rest and then receding. The operator observes the movement of the hand 24 and when it starts to recede the operator adjusts the resistor 30 to reduce its value and shunt a greater proportion of current from the meter 16. The value of resistor 30 is reduced sufficiently to bring the hand 24 back to the indicia T on dial 25, after which the operator pays no more attention to the machine, since from that point on it is fully automatic in operation. Thus, as the current developed in the electrodes 35 and 37 decreases, the hand 24 recedes and when the current has dropped to one-third its value the contact 26 will close on the contact 23, completing the circuit to energize the relay 8. This moves the armature 6 away from back contact 7 onto front contact 14, cutting off the current supply to the line 3 and the waving machine. It also extinguishes the lamp 9 and illuminates the lamp 10 to afford visual indication to the operator that the waving process is finished.

The procedure described would be the same if a medium or a loose curl were desired except that the resistor 30 would be adjusted to bring the hand 24 back to the index L or the index M.

When following the method described with particular reference to Fig. 2, it is necessary for the operator to initially adjust the resistor 30 to a high value and then readjust it when the current has reached its maximum value, to bring the hand 24 back to one of the indicia L, M, or T, because the absolute value of the current generated may differ considerably in successive operations, it being impossible to always wind the same amount of hair on the spindle 35 with the same degree of tightness. In general, the tighter the hair is wound and the less the thickness of hair, the larger will be the current. However, by employing a different electrode structure, the values of the current can be held substantially constant during successive waving operations. With this different electrode structure, the electrodes are maintained in fixed spaced relation to each other and are separated by an absorbent material such as blotting paper, instead of being separated by the hair itself.

A specific electrode construction that may be employed is shown in Figs. 5, 6, and 7. Thus, it may include a strip of copper foil 40 and a strip of aluminum foil 41 positioned in juxtaposed relation to each other but separated through the larger portion of their length by a piece of blotting paper 42, the latter being preferably of slightly greater width than the foils 40 and 41 so as to project therebeyond (as shown in Figs. 5 and 7) and prevent the possibility of contact and short circuit of the foils. Through the remainder of their juxtaposed portions, the foils 40 and 41 are separated by sheet insulating material 43 impervious to moisture. The exterior surface of the foils 40 and 41 are electrically insulated and mechanically protected by a strip of flexible impervious material 44 which extends around the lower ends of the foils 40 and 41, as clearly shown in Fig. 6. A collar 45 is preferably provided around the structure adjacent the upper end of the porous filler 42. To provide for ready electrical connection to the foils, the foil 40 may be extended beyond the end of the covering 44 to form a tab 46 and the foil 41 may be folded and extended laterally to form a tab 47. Electrical connections to these tabs 46 and 47 may be conveniently accomplished with ordinary test clips.

The electrode structure described with reference to Figs. 5, 6 and 7, is wound into the curl of hair on the curling spindle in the same general way as described with reference to Fig. 2, and the two strips of dissimilar metals 40 and 41, respectively, are connected to the terminals 31 and 32 of the circuit shown in Fig. 1. The blotting paper 42 is quickly permeated by the waving solution in the hair, creating with the dissimilar foil strips 40 and 41 a voltaic cell supplying current to actuate the meter 16. The procedure in the initial operation will be identical with that described in connection with the electrode structure shown in Fig. 2. Thereafter the variable resistor 30 need not be adjusted during subsequent curling operations (assuming the same type wave is wanted) because the current values produced during subsequent operations will be substantially the same as those produced during the initial operation. This is true because of the fact that the spacing between the electrodes 40 and 41 remains constant and variations in the current appear to be a function only of the electrolyte within the blotting paper 42. This electrolyte is, of course, the waving solution which permeates the hair, a portion of the solution

being transferred, chiefly by capillary attraction from the hair to the blotting paper. The increase and subsequent decrease in the current as the waving process proceeds is probably due in part at least to chemical changes in the waving solution, which changes are associated with and indicative of changes in the hair structure during the waving process.

An electrode structure identical with that described in connection with Figs. 5, 6 and 7, but having the two electrode elements 40 and 41 of the same metal, may be employed if an external source of potential is used. Thus the electrode elements 40 and 41 may both be of aluminum provided the switch 33 (Fig. 1) is actuated to cut the battery 34 into the circuit. The results obtained are then identical with those obtained when the electrode elements 40 and 41 are of dissimilar metals and the battery 34 is cut out of the circuit.

Still another electrode structure that may be employed is disclosed in Fig. 8. This electrode construction consists simply of two strips of metal foil 50 and 51, respectively, separated by a strip of impervious insulating material 52 such as Cellophane, rubber, or the like. The structure is wound into the hair as shown in Fig. 3 and the two foils 50 and 51, respectively, connected to the terminals 31 and 32, respectively. The foils 50 and 51 may be either of similar or dissimilar metals. If they are similar, then the switch 33 is adjusted to cut the battery 34 into the circuit. If the foils 50 and 51 are of dissimilar materials, capable of functioning with the hair waving solution as a voltaic cell, then the switch 33 is adjusted to cut the battery 34 out.

With the arrangement shown in Fig. 3, the electrical path between the two foils 50 and 51 is chiefly through the hair separating consecutive layers of the foil. Thus, some of the paths of current flowing between the electrodes 50 and 51, through the hair, are indicated by the dotted lines 54.

The arrangement of Fig. 3 has the disadvantage over the arrangement shown in Fig. 2, namely, that it is impossible to exactly reproduce the physical arrangements of the two electrodes during successive waving operations, so that the range of current values obtained is not constant and the resistor 30 must be adjusted during each waving operation. However, the electrode structure of Figs. 3 and 8 has the advantage that it is entirely separate from and independent of the curling spindle 35. This is desirable, among other reasons, because the spindle is subject to surface corrosion which affects its contact resistance. The foil electrode of Fig. 8 is not so subject to corrosion as the spindle and furthermore is very inexpensive so that it can be replaced frequently.

As previously indicated, it is also possible to indicate the progress of permanent waving processes by measuring pressure changes within the mass of hair wound upon the waving spindle. This is because the hair first expands under the influence of the heat and the waving solution and then contracts as the end of the process is approached. I can measure such variations in the size of the hair by employing a pressure sensitive electrode structure such as shown in Fig. 10, with the circuit of Fig. 1. This electrode structure comprises a pair of similar foil strips 60 and 61 separated by a layer of carbon particles 62. The electrodes are insulated and mechanically protected by an enclosing strip 63 of insulating and waterproof material, such as Cellophane or rubber. As shown in Fig. 11, the edges of the strips 63 extend beyond the foils 60 and 61 and are sealed together so that the carbon particles 62 cannot escape. The electrode structure of Fig. 10 is wound into the hair on the waving spindle exactly as shown in Figs. 2 and 3 and the two foils 60 and 61 are connected to the terminals 31 and 32, respectively. The battery 34 is cut into the circuit by means of switch 33. The procedure when employing the electrode of Fig. 10 is exactly the same as that previously described with the other electrode structures. Initially the current produced by the battery 34 is low because the electrode strips 60 and 61 press against the mass of carbon particles 62 with a relatively low pressure, and the electrical resistance of the mass of carbon is relatively high. However, as the waving process proceeds, the hair expands, thereby increasing the pressure on the foil strips 60 and 61 and compressing the carbon particles 62, which reduces their electrical resistance and permits an increased current to flow through the meter 16. So long as the hair continues to expand, the pressure and the current increase. Thereafter the hair contracts and the pressure and the current decrease.

The electrode 37 in Fig. 2 may consist simply of a strip of metal foil. However, in practice I find it convenient and desirable to employ a thin metal foil backed with a strip of insulating material, as shown in the perspective view of Fig. 4, in which the foil strip 37 is backed with a strip 70 of relatively strong material such as Cellophane. It also preferably has an impervious insulating collar 71, through a portion of its length, to definitely fix the length of the strip that is exposed to the hair. The end of the foil 37 is, of course, extended through and beyond the collar 71 to permit electrical connection thereto.

When employing an electrode structure of the type disclosed in Figs. 5, 6 and 7, in which the two electrode elements are spaced a fixed distance apart by an absorbent material, such as blotting paper, a simpler electric circuit than that disclosed in Fig. 1 may be employed. Such a circuit is shown in Fig. 12, which is adapted to be connected to a supply line and to the circuit going to the waving machine exactly the same as the circuit of Fig. 1. The supply line 3 going to the waving machine and the electrodes 31 and 32 therefore correspond to the same particular elements in Fig. 1. The meter 16 may also be of the same construction as in Fig. 1 and corresponding elements thereof bear the same reference numerals as in Fig. 1.

The essential differences between the circuits of Figs. 1 and 12, respectively, is that the D. C. relay 8 and the rectifying circuit of Fig. 1 have been eliminated and an alternating current relay 80 substituted; and the single variable resistor 30 of Fig. 1 has been replaced by three separate resistors 81, 82 and 83, respectively, any one of which is adapted to be connected in shunt across the terminals of the meter 16 by an associated switch 84, 85 or 86.

The arrangement of the signal lamps is also a little different in the circuit of Fig. 12. Thus the supply line 2 is connected through the switch 5 directly to the primary winding of a transformer 87, the secondary winding of which is connected directly to a signal lamp 88. One terminal of the secondary winding is also con-

nected to ground at 89 and the other terminal is connected through the winding of relay 80 to one terminal of a switch 90, the other terminal of the switch being connected to the fixed contact 23 in the meter 16. The hand 26 of the meter is connected to ground as in Fig. 1. A second signal lamp 91 is connected in shunt across the winding of the relay 80. The line 3 is adapted to be connected to the line 2 through the armature and back contact of relay 8.

The two electrode elements of the unit shown in Figs. 5, 6 and 7 are connected to the terminals 31 and 32. The operation thereafter is as follows: The operator closes one of the switches 84, 85 or 86 to select the type of wave wanted. Thus these switches may be identified by the letters "L," "M," and "T," respectively, designating the words "loose," "medium" and "tight." The resistor 81, associated with the "loose" switch 84, is of relatively low resistance; the resistor 82, associated with the "medium" switch 85, is of higher resistance, and the resistor 83, associated with the "tight" switch 86, is of still higher resistance. It will be apparent therefore that when the switch 84 is closed, the meter will be relatively insensitive and a relatively slight drop in the current will cause the hand 26 to drop back against the contact 23. If the switch 85 is closed, the meter will be more sensitive and the current through the terminals 31 and 32 will have to drop to a lower value before the hand 26 will return to contact 23. If the switch 86 is closed, cutting in the highest resistance 83, the circuit will be even more sensitive and the current through the terminals 31 and 32 will have to drop to a still lower value before the hand 26 will return to contact 23.

Having closed one of the switches 84, 85 or 86, depending upon the type of wave desired, the operator next opens the switch 90 and closes the switch 5, whereupon power is supplied through the contacts of relay 80 and through the line 3 to the waving machine and signal lamp 88 is illuminated. It is necessary to initially open the switch 90 because ordinarily the initial current through the meter 16 is insufficient to carry the hand 26 away from the contact 23 and the relay 80 would operate to prevent energization of the line 3. After the current has been on a few minutes, the current through the terminals 31 and 32 to the meter increases sufficiently to carry the hand 26 away from the contact 23, whereupon the operator closes switch 90. From then on the operation is automatic.

The current rises gradually to a maximum value carrying the hand 26 higher on the scale, after which the current gradually drops, permitting the hand 26 to drop back until it reaches the contact 23, whereupon the energizing circuit for relay 80 is completed, causing the latter to open its contacts and de-energize the line 3 going to the waving machine. At the same time the signal lamp 91 is lighted to indicate to the operator that the heat has been turned off.

The value of the resistors 81, 82 and 83 will depend, of course, upon the constants of the meter 16 and upon the dimensions of the electrode elements wound in the hair and may be determined by experiment in any individual case. However, if the effective portion of blotting paper 42 in the electrodes is one inch long, 5/8 inch wide and 1/32 of an inch thick, (the thickness is not critical, however), and the meter 16 is a millimeter of one mill full scale of deflection, and a resistance of 45 ohms, and with the contact 23 positioned to close at a reading of .15 milliampere, then resistor 81 may have a resistance of approximately 2.5 ohms, resistor 82 approximately 5 ohms, and resistor 83 approximately 10 ohms. Of course if the electrode structure has dissimilar electrodes, such as copper and aluminum, the switch 33 in Fig. 12 is positioned to cut out the battery 34. However, it is to be understood that substantially equivalent results can be obtained employing electrodes of similar materials by cutting in the battery 34. This battery 34 may consist of a single small dry cell, such as are employed in flashlights.

For the purpose of explaining the invention, certain specific embodiments thereof have been described in detail. It is to be understood, however, that many variations may be made from the particular practice described without departing from the invention, which is to be limited only to the extent set forth in the appended claims.

I claim:

1. The method of following the progress of a permanent hair waving operation comprising positioning a portion of the hair being waved between a pair of dissimilar spaced apart conductive plates to form a voltaic cell, and producing an indication of the electrical current produced by said cell.

2. The method of indicating the progress of a permanent hair waving operation which comprises forming a voltaic cell the electrolyte of which is constituted by the waving solution permeating the hair, and producing an indication of the electrical current produced by said cell.

3. The method of indicating the progress of a permanent hair waving operation which comprises closely positioning a portion of the hair being waved to a pair of dissimilar, spaced-apart, conductive plates to form a voltaic cell having said plates as its two electrodes and having the fluid permeating the hair as its electrolyte and producing an indication of the electrical current produced by said cell.

4. The method as described in claim 3 in which the spacing between said plates is substantially constant.

5. Apparatus for determining the progress of a permanent hair waving operation comprising a pair of spaced-apart electrodes of dissimilar conductive material adapted to be positioned in intimate relation with the hair during the actual waving thereof, and current responsive means connected to said electrodes.

6. Apparatus as described in claim 5 in which said electrodes consist of a pair of flexible plates separated by a strip of impervious insulating material.

7. Apparatus for determining the progress of a permanent hair waving operation comprising a pair of flexible conductive plates of dissimilar materials separated by a sheet of nonconductive porous material, the complete assembly being adapted to be wound with the hair to be waved, and current responsive means connected to said electrodes.

8. Apparatus for determining the progress of a permanent hair waving operation comprising a pair of flexible metal plates separated by impervious insulating material and adapted to be wound into the curl of hair to be waved, and a source of current and current responsive means connected in series with said plates.

9. Apparatus for determining the progress of a permanent hair waving operation comprising a pair of flexible conductive plate elements separated by a flexible sheet of non-conductive porous material, the whole forming an electrode assembly adapted to be wound into the curl of hair to be waved, and a source of potential and current responsive means connected in series with said electrodes.

10. Apparatus for determining the progress of a permanent hair waving operation comprising a pressure-responsive means adapted to be wound into a mass of hair and left there during the actual waving thereof, and means associated with said pressure-responsive means and responsive thereto for indicating variations in pressure.

11. Apparatus as described in claim 10 in which said pressure-responsive means comprises a pair of conductive electrode elements separated by a material having electrical conductivity that varies with pressure, and the means associated therewith comprising means responsive to variation in electrical conductivity.

12. An electrode unit for use with hair during permanent waving thereof and adapted to produce a current indicative of the progress of the waving process, said unit comprising a pair of foil elements of electrically conductive dissimilar materials capable of forming a voltaic cell in the presence of waving solution, and flexible means for relatively supporting said foil elements in substantially fixed spaced relation to each other, said unit being adapted to be wound with hair onto a waving spindle.

13. An electrode unit for use with hair during permanent waving thereof and adapted to produce a current indicative of the progress of the waving process, said unit comprising a pair of foil elements of electrically conductive dissimilar materials capable of forming a voltaic cell in the presence of waving solution and supporting means comprising a non-conductive sheet member interposed between and separating said foil elements.

14. An electrode unit as described in claim 13 in which said sheet member is of porous absorbent material.

15. An electrode unit as described in claim 13 in which said sheet member is substantially non-porous and non-absorbent.

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