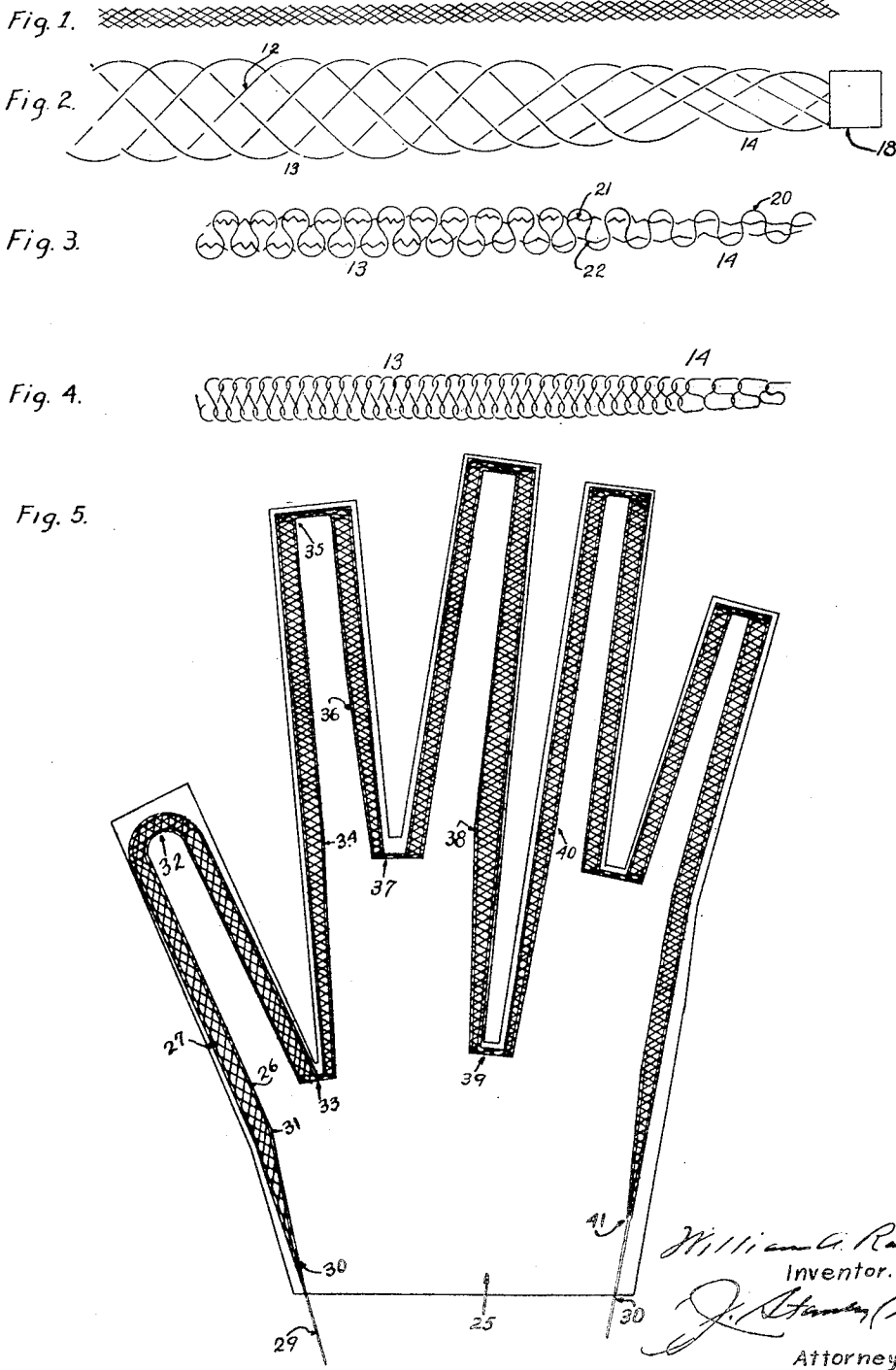


W. A. RANKIN.
ELECTRIC HEATING DEVICE.
APPLICATION FILED AUG. 15, 1918.

1,362,351.

Patented Dec. 14, 1920.



UNITED STATES PATENT OFFICE.

WILLIAM A. RANKIN, OF CHICAGO, ILLINOIS, ASSIGNOR TO EDISON ELECTRIC APPLI-
ANCE COMPANY, INC., A CORPORATION OF NEW YORK.

ELECTRIC HEATING DEVICE.

1,362,351.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, WILLIAM A. RANKIN, a citizen of the United States of America, residing at Chicago, in the county of Cook, State of Illinois, have invented certain new and useful Improvements in Electric Heating Devices, of which the following is a specification.

My invention relates to electric heating, and has for some of its objects the provision of a flexible electric heater in which the heating element is in the form of a flexible fabric or ribbon adapted to be stitched or otherwise secured to a flexible carrier.

The heating elements of my invention comprise interlaced conductors, that is, conductors loosely braided, twisted, woven, crocheted, etc., in the form of a flexible ribbon or narrow fabric. Preferably in each element is a plurality of parallel connected conductors interlaced together, loosely braided flat. In another form a single conductor is bent back and forth and interlaced with itself. In an optional arrangement, the conductor or conductors are interlaced with a non-conducting filament, either with or without some interlacing of the conductor or conductors themselves. The mass of conductor parts thus interlaced is contracted, or the conductor parts crowded together at intervals to develop more heat locally, and correspondingly extended or stretched out in other places to develop less heat thereat per unit length. The heat developed in the element may thus be proportioned or distributed along the length of the element as desired.

A plurality of conductors interlaced as indicated may be connected in series or in multiple. This arrangement is however peculiarly adapted for the parallel connection of the conductors, in which case very little or no insulation between the conductors is necessary. The heating element thus described is carried by a flexible carrier as, for example, a narrow fabric. The element may be stitched or otherwise secured to the carrier.

A device of my invention may be thin, and may be expansible and contractible and generally plastic without having a material definite "set"; the heat thereof is locally

distributed as desired; sharp turns are readily arranged for in the laying of the element; the heat developed at the turns or angles of the element may be minimized (if desired); the insulation and short circuiting between conductor parts and the necessity of looping the conductors back on themselves or crossing them over themselves is reducible to a minimum; the elements to an extent are self supporting during manufacture and thereafter; and substantially any number of layers or rows of the conductors may be laid together to obtain the desired temperatures.

In the accompanying drawings and the following description, I have illustrated and described in some detail the best forms of my invention of which I am now aware.

Figure 1 represents a braid of conductors as received from the braiding machine; a braid of a corresponding number of conductors as received from the machine, is, however, generally narrower and more tightly braided than shown in this figure, especially when the individual conductors are of small cross sections. Fig. 2, shows somewhat enlarged, a preferred form of heating element of my invention in which there are a plurality of conductors. Fig. 3 shows a form of my invention wherein a single conductor is interlaced with non-conducting filaments. Fig. 4 shows a form of my invention wherein a single conductor is interlaced with itself. Fig. 5 illustrates a heating unit of my invention.

In constructing the heating elements and heating units of my invention, I preferably employ, and start with, a braid of conductors as the braid is received from a braiding machine, for example a braid like that of Fig. 1. The individual conductors of this conducting fabric are preferably slightly insulated from each other by any suitable insulation; for example, each conductor may have a common form of cotton covering. I determine how much this braid must be contracted to concentrate within each linear or running inch of the element, enough wire to develop the greatest amount of heat required from any running or linear inch of the completed heating element. The braid is then passed between a pair of rollers to contract

the braid longitudinally, or, conversely, to expand the braid in a direction transversely to itself, to give the braid preferably uniformly the greatest width desirable anywhere in the given element. For example, the braid is contracted to the width at 13 at the left hand end of the heating element of Fig. 2. Passing the braid between rollers causes each traverse 12 of the braid to assume a position more nearly at right angles to the length of the braid, and correspondingly contracts the braid longitudinally, expanding it in width, and opens up the meshes of the braid. After I have thus (or otherwise) secured a loose meshed braid of the greatest width I desire for the given heating element, as at part 13 of Fig. 2, and after I have determined how much heat is to be developed in each running inch of the completed unit, and correspondingly how much wire must be concentrated in each running inch of the completed heating unit, I more or less extend or stretch out and thereby narrow some part or parts of the braid, for example as shown at 14 of Fig. 2, until the requisite amount of wire is found in each linear inch thereof. It will be observed that in any linear or running inch of the braid of Fig. 2 within the part 13, more heat is developed than in a linear or running inch of the part 14, due to the fact that more wire is concentrated within a linear inch of the part 13 than within the part 14.

The terminal 18 of the heating element of Fig. 2 electrically connects all the conductors of that element together at one end. If a corresponding terminal is used at the opposite end of the element of Fig. 2, then the element comprises parallel connected conductors.

In Fig. 3, I have shown another form of my invention, an element of but one conductor. The single conductor 20 is looped back and forth on itself, all the loops lying in something like one plane; two non-conducting filaments 21 and 22, which are preferably spun threads of any suitable material, are interlaced with the conductor 20 to assist in maintaining the looped portions of the conductor 20 in place. The loops of the conductor 20 are crowded together, as it were, in the contracted parts 13 of this heating element, and the interlaced filaments 21 and 22 are correspondingly very loose in these parts of the heating element; correspondingly in the extended parts like 14 of the heating element, the filaments 21 and 22 are more nearly extended to their limits.

Still another form of my element invention is shown in Fig. 4. In this heating element also there is but one conductor. This conductor is interlaced only with itself. The interlacing of the conductor with itself may assume various forms and be accomplished by various methods.

It will be observed that the heating elements I have described above are thin, and are expansible and contractible. They are generally plastic without having a material definite set; that is, they may be bent into almost any shape and but very slightly resist any change in shape. The heat developed by any element is proportioned along the length of the element and distributed locally as desired; that is, contracted portions like 13 are readily obtained and disposed where the most heat is desired, and correspondingly more extended parts like 14 are readily arranged for where any less degree of heat is desired. The heating elements are readily carried through sharp turns, without excessive heating if desired, as later appears. Little or no insulation between the conductors or parts of the same conductors is required since the points where the conductors cross each other or themselves are points of but little differences of potential. For the same reason there is almost no tendency for the conductors to become short circuited. Since the elements can be contracted almost indefinitely (or suitably contracted portions otherwise produced) there is little or no necessity for any, or at least for extensive looping of the conductors or heating elements back on themselves in order to produce a requisite amount of heat at any given point; this again minimizes the insulation required between conductor parts and minimizes short circuiting. The conductor or conductors of each element being intertwined and more or less forming a fabric or ribbon, each element is self supporting in the same manner as a common fabric.

Fig. 5 is a representation of a complete heating unit of my invention. This heating unit comprises a flexible carrier 25, preferably of cloth, to which is attached and which carries a loosely constructed expansible and contractible fabric of a conductor or conductors, or otherwise intertwined conductors, preferably a loose flat braid of a plurality of conductors such as previously described. Fig. 5, specifically shows a heating unit to be applied to, as, or with a glove, the heating element being such a braid. The five fingers are separate as illustrated, and the heat developed by the unit is proportioned over the unit both by the location of the traverses of the heating element itself on the carrier 25 and by the disposition of the contracted and extended portions of the heating element on the carrier. As illustrated in this figure, the heating element is preferably attached to the carrier 25 by sewing it thereto by the lines 26 and 27 of stitches; the threads of 26 and 27 are stitched along both edges of the braid. This sewing or stitching may be done by hand or by machine; I have found that this work may be done rapidly

on an ordinary household sewing machine in which the foot has been modified or cut away in part so that the part of the conducting fabric under or slightly in front of the needle may be kept slightly raised from the carrier to which it is being stitched. A needle with a slightly rounded or blunted point is satisfactory and has less tendency to sever the wires. The terminals 29 and 42 connect the conductors of the braid together at each end of the heating element. For a glove, the heating elements are generally preferably disposed at the back of the hand rather than at the palm.

Beginning at the lower left hand corner of Fig. 5, the scheme on which the braid is disposed to secure a desired proportioning or distributing of the heat is as follows: At the base of the hand adjacent the thumb only comparatively little heat is desired; accordingly from 30 the heating element is gradually widened until at 31 the element appears fully contracted, or of its greatest width. From 31 the element is carried along both sides of the back of the thumb to 33. It is substantially uniform in width from 31 to 33, and is carried around the end of the thumb at 32 in a smooth arc without any reduction in width (or extension of the element). This manner 32 of making a turn results in some concentration of heat at the turn, or the development of no more heat per unit length of the heating element than it developed per unit length in any other part of the heating element. At 33 the heating unit reaches the base of the thumb at the side thereof adjacent the second finger, and is given a sharp turn; from 33 the element is laid along the outer side of the second finger at the back thereof. The point 33 being fairly well over the hand and the traverses from 32 to 33 and from 33 along one side of the second finger being fairly close together adjacent 33, it is not desirable to develop the maximum amount of heat per unit length of heating element at this point, for otherwise the unit would become too hot adjacent 33. Correspondingly, the part of the element making the turn at 33 is extended to the maximum, and the element is bent or makes the turn within this greatly extended part of the element; and while the element is contracted somewhat beyond 33 it is not contracted to its greatest degree immediately beyond 33. Therefore, while immediately beyond 33 more heat is developed per unit length than at the turn 33, less heat is developed per unit length from 33 to 34 (34 being at the base of the second finger) than is developed where the unit is contracted to its greatest degree, for example from 31 to 32. In the illustration the degree of contraction of the heating element increases gradually and substantially uni-

formly from 33 to 34, the degree of heat developed increasing gradually accordingly. From 34 to 35 at the end of the second finger, the element is uniformly contracted to its greatest degree. At 35 the element is again extended to substantially its greatest degree and carried across the end of the second finger without developing a material amount of heat thereat. From the end of this finger toward its base at the opposite side, the element is carried to the point 36 with substantially its maximum degree of contraction and maximum degree of heat development per unit length. In order that an undue amount of heat may not be developed between the bases of the second and third fingers, but still in order to get a desired quantity of heat delivered adjacent these points, I have chosen to gradually decrease the contraction from 36 to 37 at the base of the second and third fingers, where it is again greatly extended and turned to the adjacent side of the third finger and from thence with a uniform degree of contraction laid along one side of the third finger to the end thereof. At the end of this finger the element is again completely extended, bent, and then carried back to 38 at the bases of the third and fourth fingers with the maximum degree of contraction. From 38 the heating element is carried farther toward the wrist over the back of the hand, and in order that this part of the hand may not receive too much heat the element is gradually extended more and more to the point 39 which is nearest the wrist; there it is completely extended and turned back toward the fingers, being gradually more and more contracted from 39 until it reaches the point 40 near the bases of the third and fourth fingers. From the point 40 the element is carried about the fourth and fifth fingers and down the adjacent side of the hand to the point 41 where it meets the terminal 30 in a quite similar manner. From 40 to 41 the element is contracted and extended in parts as may be necessary or desirable to proportion the heat over the adjacent parts of the heating unit.

While the heating unit of Fig. 5 is designed to warm a human hand and to be included with a glove, it is representative of other flexible heating units and illustrates the general scheme of distributing or proportioning over the heating unit the heat developed therein. It should be understood however that the heat is to be distributed or proportioned in every instance in accordance with each particular case.

While I have illustrated in the accompanying drawings and described above in some detail the best forms of my invention of which I am now aware, it must be understood that my invention is not limited to the forms of my invention herein illustrated

and described, but that I regard as my invention everything included within the following claims.

I claim:

- 5 1. An electrically heated article comprising a flexible carrier and an interlaced conductor, constituting a self-supporting ribbon secured to said carrier.
2. An electrically heated article comprising a flexible carrier and interlaced or
10 braided conductors, constituting a self-supporting ribbon or fabric secured to said carrier.
3. An electrically heated article comprising a flexible carrier and a loosely constructed fabric having a conductor as the
15 filament thereof secured to said carrier.
4. An electrically heated article comprising a flexible carrier and an interlaced conductor constituting an expansible and
20 contractible self-supporting fabric or ribbon secured to said carrier.
5. An electrically heated article comprising a flexible carrier and a plurality of conductors intertwined flat, constituting an ex- 25
pansible and 'contractible' self-supporting ribbon or fabric secured to said carrier.
6. An electrically heated article comprising a flexible carrier and a loosely constructed expansible and contractible fabric 30
having a conductor as a filament thereof secured to said carrier, said fabric being extended in part and contracted in part to proportion over the article the heat developed in said fabric. 35
7. An electrically heated article comprising a flexible carrier, a loose braid of a plurality of conductors stitched to said carrier, said braid being laid over said carrier and being extended in part and contracted in 40
part to proportion over said article the heat developed in said braid.

In witness whereof I have hereunto set my hand this 26th day of July, 1918.

WILLIAM A. RANKIN.