My Invention relates to an electrically energizable fabric which may be formed into a heating pad, heating blanket, heating clothing or the like, or used in any other manner where an electrically energizable fabric is desirable or necessary.

An important object of my invention is to provide an electrically energizable fabric of such character that it may be readily and inexpensively manufactured by knitting the same and by knitting into it an electrical element that constitutes one of the threads of the fabric.

Another object of my invention is to provide a flexible fabric having warp and weft threads, one of the threads comprising one or more electrical elements which are knitted into the fabric in a knitting machine with a resultant continuous length of fabric having the electrical element integral therewith and the continuous length of fabric being capable of being cut into individual units on a bench away from the knitting machine without severing the electrical element except at desirable points of a unit where electrical connections are made to the element, the cutting of the fabric into units not destroying the function of the electrical circuit through the element.

Still another object is to provide an endless fabric having as one of its threads an electrical element which may be either bare or insulated wire arranged throughout the length of the fabric and in either a substantially zig-zag manner through or in any predetermined pattern with a resultant structure that can be cut into individual units of various shapes as desired and then included by way of example, in a cover of blanket material or the like to form a heating pad, therapeutic blanket or heated clothing as the case may be, when the electrical element is formed of resistance wire energized with current

A further object is to provide an electrically energizable fabric having an electrical wire as part thereof and arranged in a predetermined pattern which pattern can be varied as desired, may be continuous, repeated, monocular or multicyclic or the like, as required, and which may be designed to produce any desired effect with predetermined or controlled results being attainable thereby.

Still a further object is to provide a method of forming an electrically energizable fabric consisting of knitting an endless length of fabric and knitting into it as one of the threads thereof an electrical element, then cutting the fabric into individual units and finally covering, coating or impregnating the units.

With these and other objects in view my invention consists in the construction, arrangement and combination of the elements of the electrically energizable fabric described and in the steps of the method for forming the same whereby the objects contemplated are attained as hereinafter more fully set forth, pointed out in my claims and illustrated in the accompanying drawings, wherein:

Figure 1 is a plan view of an electrically energizable fabric embodying my invention.

Figure 2 is an enlarged view of one corner of the fabric shown in Figure 1.

Figure 3 is a similar enlargement of the same taken from the reverse side.

Figure 4 is an enlarged sectional view on the line 4--4 of Figure 1.

Figure 5 is a diagrammatic view of a continuous length of the electrically energizable fabric to illustrate how it is cut into individual units, and

Figure 6 is a similar diagrammatic view showing a different arrangement of the resistance wire in a shape other than rectangular is desired.

On the accompanying drawings I have used the reference character F to indicate my electrically energizable fabric. In Figure 1 the fabric F is formed by weft threads 16 and 12 and by warp threads 14 by a knitting machine operation. By way of illustration I have shown the weft threads 16 and 12 knitted through the warp threads 14.

The weft threads 16 are relatively heavy or of cord-like type, while the warp threads 14 are relatively light. The weft threads 12 are approximately the same size as the weft threads 16 and include an electrical element such as a resistance wire R as a core which may be bare or insulated by a wrapping in one direction of threads 16 and then in the other direction by a wrapping of threads 18. The threads 16 and 18 may be of cotton or the like, or where relatively high temperatures are to be met with, as in a heating pad, the threads may be of asbestos. The resistance wire R is preferably stranded for maximum flexibility.

The weft thread 12 having the resistance wire therein is arranged substantially zig-zag along the fabric F with successive stretches spaced any distance apart such as illustrated in Figure 1. The spacing may be determined by the length of resistance wire desired for a predetermined area so that when the resistance wire is energized with an electric current of predetermined value, a predetermined temperature rise of such area, may be had. The spacing may be equal throughout the length of the fabric or unequal...
to secure greater heating effect in one area than in another as desired.

The continuous fabric $F$ may be cut into individual pieces as at 20 and 22 in Figure 5 with the wet thread 12 having the resistance wire in it cut at any desired point such as 24, and the terminal ends of the resistance wire brought out as at 25 for the connection of supply wires with the heating unit that is formed by the piece cut from the fabric. Various lengths as desired having the required resistance to attain a predetermined temperature for the individual unit may be calculated beforehand and the wet thread having the resistance wire may be spread out or conditioned in relation to the spacing illustrated on the drawings by first setting up the knitting machine for the pattern required. As already mentioned, the spacing may be uniform or non-uniform and the knitting machine may be so set up as desired.

My electrically energizable fabric is also adapted for cutting the individual units into odd shapes so as to form, for example, parts of an aviator clothing. Figure 6 showing how the resistance wire would be arranged for cutting oval-shaped heating units. The heating units can be cut as at 29 after the arrangement of the resistance wire has been precalculated and knitted into the fabric so as to avoid severing it except at desired points where electrical connections are made. Instead of cutting the fabric to shape after knitting, the fabric may be controlled during knitting so as to result in repetition of the desirable shape throughout a continuous sheet of the electrically energizable fabric.

The individual units may be of various sizes either for small sections of clothing and local use on the body or for blankets or the like having enough area to completely cover a bed. The electrically energizable element may be single or plural and arranged in identical patterns of each wire or different patterns of each wire as desired. For instance, in a unit of given length some portions may have the electrical element of finer pitch than other portions to provide greater heating where the pitch is finer. After an individual unit has been cut from the length of electrically energizable fabric and the desired electrical connections made thereto, the unit may be enclosed in a covering 38 of blanket material or the like or may be otherwise coated or impregnated to increase its durability.

From the foregoing description of my invention it is believed obvious that I have provided an electrically energizable fabric knitted in a substantially continuous length which may be cut into individual units for formation into pads, blankets or the like for heating or other purposes. The fabric may be closely knitted as disclosed or may be more openly knitted as in mesh or knitted form with the electrical element $R$ distributed in any desired shape or pattern and knitted into the fabric during the knitting operation. The method involved includes the steps of knitting the fabric with the electrical element as an integral thread thereof and then cutting the fabric into the desired patterns which are predetermined and relative to which the electrical element has been knitted so that it is severed only at the desired points for circuit connections when the patterns are cut from the continuous length of fabric.

Some changes may be made in my electrically energizable fabric and the steps of the method may be varied to some extent without departing from the real spirit and purpose of my invention. It is accordingly my intention to cover by my claims any modified forms of structure or use of mechanical equivalents or mechanically equivalent steps of the method which may be reasonably included within their scope.

I claim as my invention and desire to secure by Letters Patent of the United States:

1. A method of forming electrically energizable units comprising the steps of knitting an imperforate fabric including the knitting thereof into a portion of an electrical conductor as a wet traverse in one direction, knitting cloth wet traverses in closely packed relation to each other and to said conductor traverses while carrying another portion of said conductor parallel to the warp of said fabric, knitting a third portion of said conductor as a wet traverse in an opposite direction, knitting further cloth wet traverses in a closely spaced relation while carrying a fourth portion of said conductor parallel to the warp of said fabric and repeating the foregoing steps to produce imperforate fabric in endless lengths, cutting the length of fabric at predetermined points into short lengths, and severing the electrical conductor at points commensurate with the electric current with which the lengths of the electrical conductor are to be energized.

2. A heating unit comprising an electrically energizable thermal fabric and a cover therefor, said fabric comprising a knitted sheet having knitted thereto a resistance wire, said resistance wire assuming a controlled pattern distribution throughout the length and width of said sheet with stretches of said wire spaced apart and the intervening spaces entirely filled with wet threads placed edge to edge and with their terminal edges against the resistance wire stretches, said parallel stretches of wire and wet threads being carried, said sheet having warp threads knitted around said parallel stretches of wet and wet threads to hold them assembled, and being capable of being fashioned to a predetermined pattern without severing the resistance wire within the bounds of such pattern.

3. An electrically energizable fabric comprising a knitted sheet having carried thereon a wet part thereof of an electrical element in controlled pattern throughout the length of the sheet with parallel stretches of said electrical element spaced from each other and the intervening spaces completely filled with wet threads whereby said electrical element when energized with predetermined current will result in predetermined effect within a predetermined imperforate area of the sheet, said fabric including warp threads formed inknitted loops that hold said wet elements assembeld.

4. A method of forming an electrically energizable unit comprising the steps of knitting an imperforate fabric including the knitting thereof into a portion of an electrical conductor as a wet traverse in one direction, knitting cloth wet traverses edge to edge and against the edge of said wire traverse when carrying another portion of said conductor parallel to the warp of said fabric, knitting a third portion of said conductor as a wet traverse in an opposite direction and in edge to edge relation to said last cloth wet traverse, knitting further cloth wet traverses while carrying a fourth portion of said conductor parallel to the warp of said fabric and repeating the foregoing steps to produce an imperforate fabric in endless lengths, cutting the fabric at predetermined points into short lengths, sev-
5. A method of forming an electrically energizable unit comprising the steps of knitting a fabric from knitted warp and carried weft, said weft including as one thread thereof an electrical conductor in substantially zig-zag formation with some portions parallel to the weft and spaced apart and other portions at the ends of said first portions carried parallel to the warp of the fabric, said weft further including cloth weft threads in a plurality of traverses in the space between wire weft traverses to completely fill such spaces, the fabric being thus knitted in endless imperforate lengths, and cutting the length of the fabric along predetermined lines with the electrical conductor severed only adjacent such lines.

LOUIS K. SCHWARTZ.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>683,098</td>
<td>Baecker</td>
<td>Sept. 24, 1901</td>
</tr>
<tr>
<td>1,430,384</td>
<td>Craddick et al.</td>
<td>Nov. 21, 1922</td>
</tr>
<tr>
<td>1,703,005</td>
<td>Hewitt</td>
<td>Feb. 19, 1929</td>
</tr>
<tr>
<td>1,741,084</td>
<td>Graham</td>
<td>Dec. 24, 1929</td>
</tr>
<tr>
<td>1,965,542</td>
<td>Colvin</td>
<td>July 3, 1934</td>
</tr>
<tr>
<td>2,157,606</td>
<td>Harris</td>
<td>May 9, 1939</td>
</tr>
</tbody>
</table>