United States Patent [19]

Van Toorn

[11] **3,758,750**

[45] **Sept. 11, 1973**

[54] **HEATING APPARATUS HAVING ONE OR MORE HEATING ELEMENTS IN ITS HEATING SURFACE**

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[22] Filed: **Jan. 20, 1972**

[21] Appl. No.: **219,390**

[30] **Foreign Application Priority Data**

Jan. 21, 1971 Netherlands 7100788

[52] **U.S. Cl.** **219/457,** 219/462, 219/464, 219/530, 219/540

[51] **Int. Cl.** **H05b 3/68**

[58] **Field of Search** 219/457, 540, 454, 219/455, 458, 462, 463, 464, 467, 468, 530; 338/252, 253; 29/613, 614, 615

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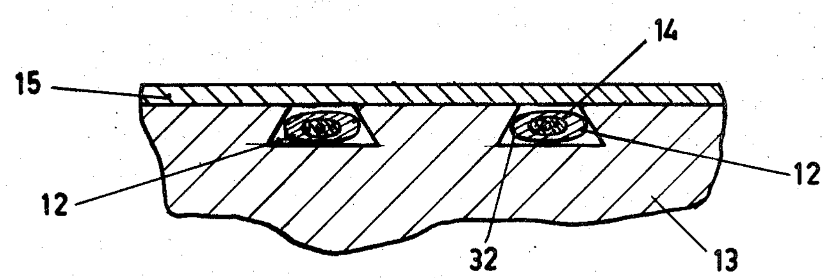
Attorney—Ernest A. Greenside

[57] **ABSTRACT**

Heating apparatus provided with resistance threads lying close to the temperature contact surface thereof and being embedded in grooves which show a cross-sectional area increasing towards and extending to the bottom of the groove, preferably dove-tail shaped, in which grooves the threads are rolled-in leaving clear near to the bottom a space around that thread half that is facing said groove bottom. Said space serves among other things as heat barrier and may be filled under extreme circumstances with a heat insulating material. The heating apparatus can have many applications such as a hot plate, or in calendering or rolling various kinds of material. A special application is stripping off the back-layer of a wide self-adhesive tape for which purpose a crack-back-roll has been developed in which the back-layer of the tape is caused to release from the adhesive layer by crack-building created by intensive radiation heat. Temperatures are lying in the reach between 1,000° and 2,000°C requiring special resistance threads. The invention describes how such resistance threads can be embedded into the grooves.

3 Claims, 11 Drawing Figures



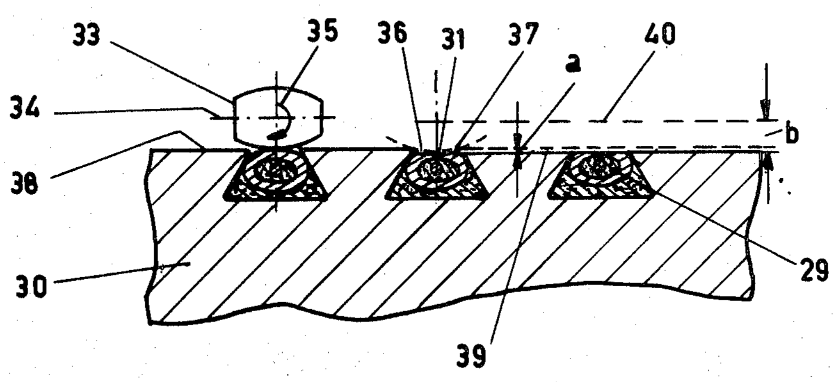


FIG. 1

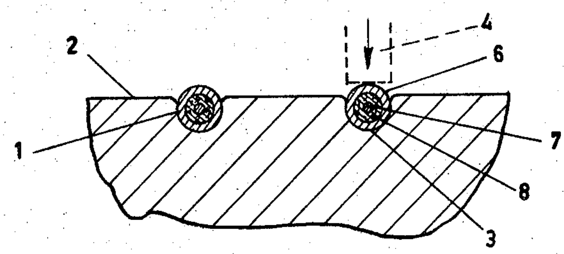


FIG. 2

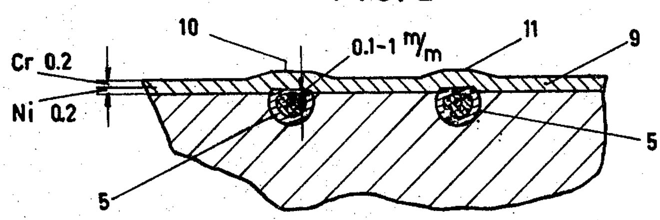


FIG. 3

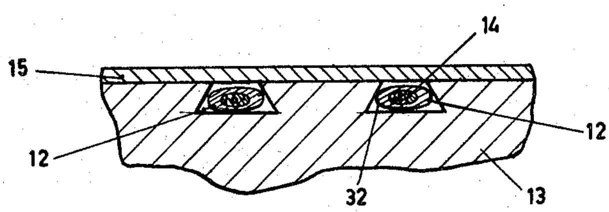


FIG. 4

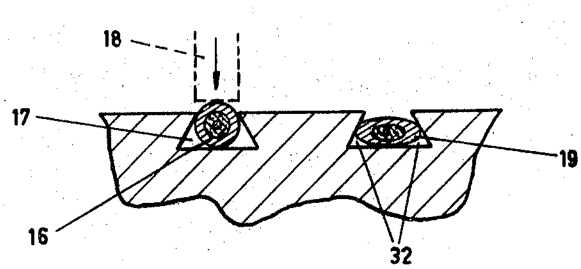


FIG. 5

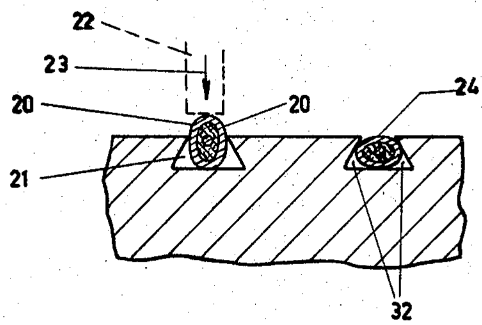


FIG. 6

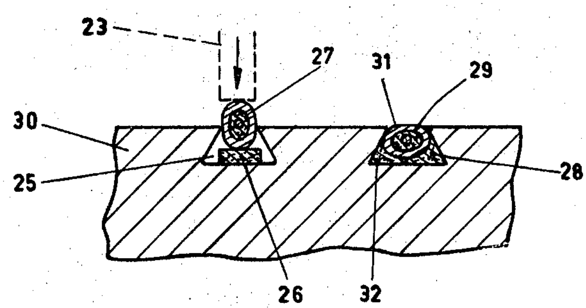


FIG. 7

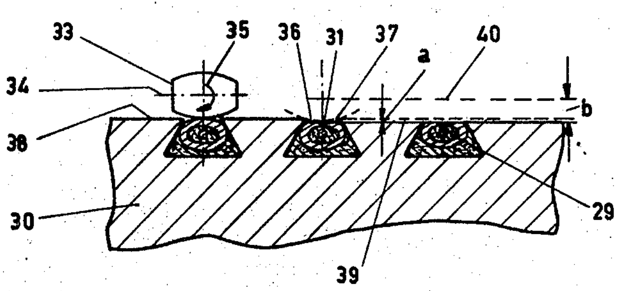


FIG. 8

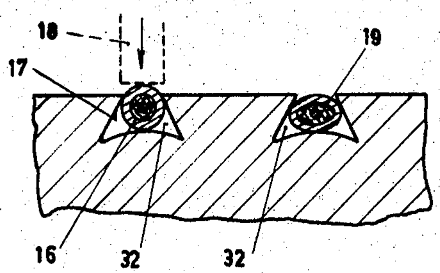


FIG. 9

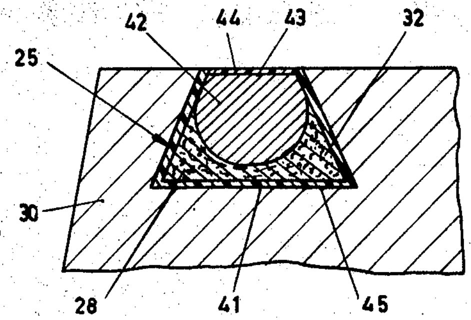


FIG. 10

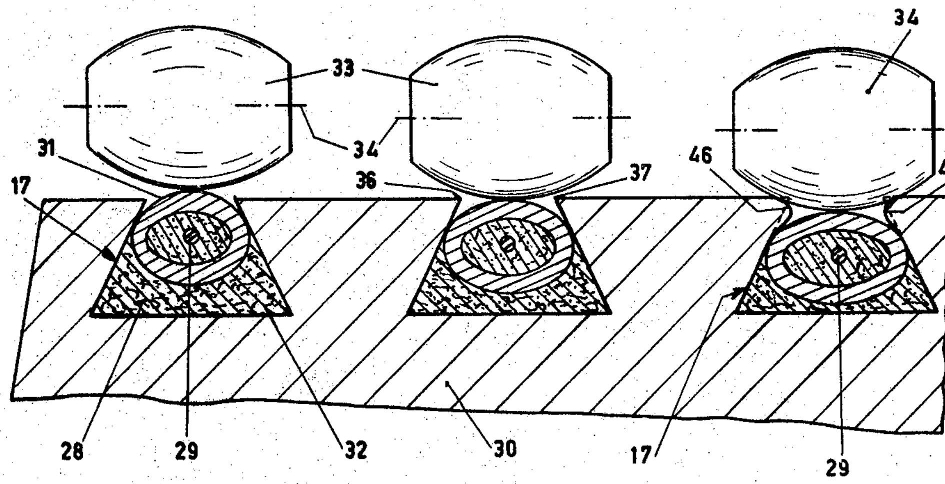
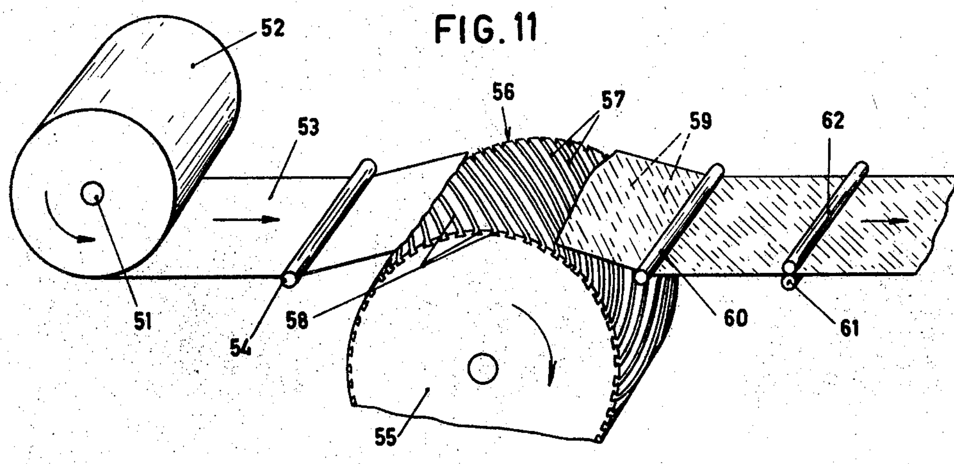


FIG. 11



HEATING APPARATUS HAVING ONE OR MORE HEATING ELEMENTS IN ITS HEATING SURFACE

The invention relates to a heating apparatus having a member being electrically heatable by means of one or more electrical resistance threads of the coaxial type, situated adjacent the temperature contact surface which elements are disposed in one or more grooves extending continuously in the material of the member, in each of which a resistance thread is rolled-in, the coverage of said threads being established by means of a separate thin metallic layer applied onto the member by spraying, shrinking or in any other suitable manner and constituting its temperature contact surface. Such a heating member can be shaped as a bent or a flat body.

In heating apparatus of the type aforementioned, it is usual to cover a thread being rolled in the surface groove, for instance by an electrical-plating or a coating applied by spraying of metal, said coating having to be finished by a surface treatment. It is important that after the rolling-in step the material of the thread fills the grooves such that, as it were, a smooth surface is obtained with grooves being no longer visible. Although such surface is well coverable with the coating to be applied, it cannot, however, well be finished for example by an end-spinning step with the aid of a suitable chisel for reasons to be explained hereafter.

On the one hand this originates from the difficulty of controlling the tolerances of both groove dimension and thread dimension such that the thread completely fills said groove. On the other hand it appears during disposal afterwards of a cover layer that said rolled-in thread pushes itself out of the groove again by the great heat applied and the differences in thermal expansion coefficients. This phenomenon is already annoying when layers are deposited by electro-plating but it becomes really disturbing when applying a layer by spraying a plasma of a material during which very high termperatures occur.

When such rolled-in thread with its exposed flattened surface is pressed out of the groove, the cover layer will show at that place a dislocation. Working of this often hard layer means a complication, increasing the costs for finishing substantially and even readily causing damage of the thread itself on account of these layers of material.

All these inconveniences can be eliminated when employing the construction in accordance with the invention being characterised in that the grooves are having a cross-sectional area flaring towards and extending to the bottom of the groove, each thread being more or less ovally flattened over its full length by the rolling-in step, such that the greatest dimension of the flattened thread runs parallel to the temperature contact surface, while still some space being left around that half of the threads facing the groove bottom.

The flaring shape of the cross-sectional groove area extending to the groove bottom, as used in the present construction, in combination with the in essence oval flattening of the resistance thread, provides a space bounded on the one hand by the walls of the groove bottom and groove flanks and on the other hand by that half of the resistance thread adjacent to the groove bottom. This space serves not only to compensate for the thermal expansion of the resistance thread but also as a heat barrier. The consequence of the first mentioned effect is that when after rolling-in the thread, the member is covered with a thin metallic layer, this thread is efficiently maintained in place at the high temperatures during applying said layer. The second effect is based upon the heat-insulating property of the air trapped within said space and has as a consequence that the greater part of the heat produced in the resistance thread is propagated over the shortest distance towards the temperature contact surface, whereas a minor portion of said heat flows away in the opposite direction or sideways in respect of the main direction of the heat flow. In known constructions the thread over its lower half is completely enclosed by the groove bottom and flanks so that relatively much heat is flowing away therethrough.

The favourable effect of a virtually one-way heat propagation thus obtained with the invention, can further be enhanced in accordance with a further feature of the invention in that the space around the thread halves facing the groove bottom is filled with a thermic well-insulating material (for example morganite).

Although in essence it suffices to place one of said walls in an oblique position, which most times already yields a markable improvement, in one embodiment of the invention the cross-sectional area of the groove is shaped as a dove-tail. Preferably the groove bottom is flat or has a curve being opposite to that of the adjacent thread half.

To insert a thread into the groove, use is made preferably of a method which is characterised by the steps that in the heating member a groove is shaped having a cross-sectional area flaring towards and extending to the groove bottom, and a heating resistance thread is disposed and rolled within said flaring groove under transverse deformation whilst leaving space around that half of the thread facing the groove bottom.

As such material asbestos material may be employed shaped in the form of a rope or ribbon, commercially available under the trade name "Fiberfrax."

The invention will further be explained with reference to some embodiments illustrated in the figures of the attached drawings, in which:

FIGS. 1 and 2 relate to a conventional method of rolling-in a heating resistance thread of the coaxial type into a surface of a heating member;

FIGS. 3, 4 and 5 show a first embodiment in accordance with the invention for placing a heat resistance thread into a heating member;

FIGS. 6 and 7 show a second embodiment in accordance with the invention in which use is made of an insulating material in the groove;

FIG. 8 shows an embodiment in accordance with the invention in which the bottom of the dove-tail groove is vaulted;

FIG. 9 shows an alternative embodiment in accordance with the invention in which use is made of a canthal thread as the resistance thread;

FIG. 10 shows an arrangement for the controlled adjustment of the distance between the heating thread and the object to be heated; and

FIG. 11 shows schematically an arrangement for a crack-back roll to be applied for stripping the backlayer of a self-adhesive tape.

In accordance with a conventional method (see FIGS. 1 and 2) a heating resistance thread or element 3 of the coaxial type is placed in a cylindrical surface 2 having therein a continuous spiral-shaped groove 1 and is flattened by the action of a roll **4**. It takes then the shape indicated at **5**. The thread comprises a metallic jacket **6** made of copper, a core **7** and an insulating mass **8** made of sintered aluminium oxyde. For reasons of making galvanic contact, it is desirable to select the shape and dimension of the groove in respect of the thread **3** such that the rolled-in thread projects a little above the surface **2**. When on said thread, after a suitable working step, a metallic layer **9** is applied, it will show a number of dislocations **10** and **11**. Said layer **9** is not smooth and ought to be ground. After grinding this layer, its thickness is extremely thin at the place of the dislocation. It appears that during the heat treatment the thread **3** can be pushed out of the groove **1** rather easily.

In accordance with the invention the thread or element can be kept in place well when the heating thread is enclosed in a groove **12** flaring towards its depth of which the cross-sectional area has the shape of a dove-tail (FIG. **3**). The heating base member **13** can be shaped as a plate, in which a plurality of grooves **12** are running parallel to each other. It can also be shaped as roll, having in its outer surface a continuous parallel shaped groove **12**. The thread **14** has a cross-sectional area, its width being greater than the smallest width of the groove. It does not project above the groove. This heating member **13** is covered with a metallic layer **15** being applied in the usual manner.

The more or less oval cross-sectional area of the thread **14** can be obtained by disposing into the groove **17** a thread **16** with circular cross-sectional area and thereafter deforming it by means of a tool **18** indicated with dotted lines; the thread will then obtain the shape indicated at **19** (FIG. **4**). It will be clear that the thread can only be deformed to a very restricted degree so that the dove-tail shaped cross-sectional area is filled only partially and a space **32** (FIGS. **3–5**) is left allowing compensation for thermal expansion and partially acting as a heat barrier.

Preferably use is made of a method in which already outside the groove a flattened shape is given to a round thread (FIG. **5**). The smallest thickness of the flattened thread **20** is a little smaller than the width of the groove **21**, permitting it to be readily placed into the groove. By the cooperation of a roller-shaped means **22** being movable according to arrow **23**, said thread **20** is deformed again and obtains the shape indicated at **24**.

If desired a ribbon **26** of thermic insulating material, for instance asbestos fibres, can be placed into the groove **25** prior to inserting the thread **27** (FIG. **6**). After deformation of said thread **27** this material will fill the groove space **32** and assume the shape indicated at **28**. The thread **29** is then over the greater part of its circumference thermically insulated from the heating member **30** except its side indicated at **31**, being the heating side of the member **30**. The introduction of a ribbon **26** has the additional advantage that the thread **27** can be deformed in a more efficient way.

Although in this manner the thread **29** is kept already efficiently in place in the groove, it may be of advantage to impart to the heating side **31** of the thread a hollow profile (FIG. **7**) by means of a dome-shaped roller **33**, of which the rotating axis **34** is displacable parallel to itself in a direction according to arrow **35**. In this way the surface **38** obtains the accommodation indicated at **36** and **37**. Thereafter a layer with thickness *a* is removed from the surface **38**. This yields a new smooth surface **39**, of which the exposed side of the thread **29** is forming part over the full width of the groove. This surface is subsequently coated by a thin, wear-resistant layer *b*, of which the side **40** constitutes the temperature contact surface.

Besides flat the bottom of the groove **12, 17** or **25** can also be vaulted, for instance, as shown in FIG. **8**, possessing a curve being opposite to the curve of the adjacent half of the flattened thread **19** so that a larger remaining space **32** and thus a better thermal insulation are obtained.

A heating plate or heating oven being provided in accordance to the invention with "grooved-in" resistance threads is particularly suitable for all kinds of heat treatments, for instance electrical cooking, calendering and rolling of various kinds of material, such as paper, fiber or plastic material. A special application can be made of the invention in the so called crack-back roll-heating. In this application a self-adhesive tape having a width of for instance 60 cm has to be stripped of its projecting backing-layer (back). Trials to remove this backing-layer in a chemical or mechanical way have sofar been crowned with little success. In the latter event the backing-layer is torn orthogonally from the tape, but this requires relatively large forces.

It has appeared that a satisfying method can be obtained by guiding the tape with its backing-layer in contact with the temperature contact surface **40** (see FIG. **7**) in such a manner over the heating member that the longitudinal direction of the tape forms an angle of 45° with respect to the heating thread **29** in the heating member. If said threads are grooved in the heating member as a spiral with a pitch of for instance 7 cm, the backing-layer after the temperature is increased to more than 1,000°C during which it cracks according to diagonally extending lines, can be pulled off the adhesive in a diagonal direction. While for many applications nickel chromium thread as the resistance thread in combination with a thermic insulating ribbon, such as morganite, (extruded aluminium oxyde), is satisfying at temperatures up to 1,000°C, one needs for this special application in which the possibility should be available to increase the temperature to 1,700°C or even higher, likewise a special resistance thread. For that purpose canthal-thread is particularly suitable since it maintains at this very extreme temperature a constant diameter and so a constant electrical resistance. This material has such a metallurgical composition that it forms, when heated, a skin, secluding itself from the air, so that it does not oxydize and therefore does not pulverize nor erode. In order to obtain the required insulation of this naked thread, the groove **25** (see FIG. **9**) in the heating member **30** is internally sprayed with a plasma **41** of aluminium oxyde. Thereafter a ribbon **28** of thermic insulating material is applied in the groove space **32** and subsequently the brittle, naked canthal-thread **42** is carefully disposed into the groove **25**. Since the exposed side **43** of the thread is not electrically insulated, a thin fleece of boran **44** is applied which fleece is electrically but not thermically insulating.

For temperatures under 1,200°C the canthal-thread as resistance thread can be replaced by disposing a coaxial cable into the groove, of which the insulating magnesium-oxide layer ensures the electrical insulation, but which is from a thermic point of view diathermic, so that the ribbon of for instance morganite cannot be dispensed with for the thermal insulation of the cable against the groove bottom.

A particular property of the canthal-thread 42 is that at the high temperatures to be applied it is affixed to the ribbon 28 by sintering, and the ribbon 28 in turn is affixed to the groove bottom 34 resulting in a rigid connection between the glow-element (the thread 42 itself) through the ribbon 28 towards the groove bottom 45. Something similar occurs with the co-axial cable in which a sintering connection is formed between the magnesium layer, the ribbon and the bottom of the groove.

Referring now to FIGS. 10 and 11 a practical arrangement to be applied in a method of stripping the back-layer of a self-adhesive tape, will be discussed. In order that this method will be successful, the paper of the back-layer may not be scorched nor burned but has to become exclusively by radiation heat so hot that it is cracking loose from the adhesive layer. So the resistance threads have to be arranged below the temperature contact surface at such a depth that the temperature delivered is nevertheless sufficient for the paper of the back-layer to get loose from the adhesive layer by radiation heat. While determining said depth one should also take into account the thickness which disappears during the finishing treatment by grinding off and the thickness of the finishing coating to be applied on the heating member. These thicknesses, minus and plus, are under given circumstances constant so that the adjustment of the correct distance for the radiation heating to be applied is completely defined by the distance over which the heat delivery side of the resistance thread has to be lowered under the surface of the heating member which surface acts for that purpose as a reference plane.

To arrive at the exact adjustment of the distance here concerned use can be made of the arrangement of FIG. 7. In FIG. 10 however part of this process is shown, for the sake of clarity, at enlarged scale. A co-axial thread 29 is disposed into the groove 17 in the surface of the heating member 30 after partially filling the space 32 first with a thermal insulating material 28. As soon as the thread 29 is rolled-in more or less, for which purpose use can be made of the flat roller 18 of FIG. 4, a second dome-shaped roller 33 is used which is rotatable about the axis 34 and by means of which the heating side 31 of the thread 29 is gradually pushed farther into the groove 17. Some phases of this process are shown in FIG. 10 in juxtaposed fassion. During this rolling-in with the dome-shaped roller the sharp edges 36 and 37 of the groove flanks are deformed simultaneously and folded more or less inwards, said folded edges 46 and 47 contributing likewise to a sturdy clamping of the thread 29 within the groove 17.

In FIG. 11 is schematically shown an arrangement of a crack-back roll. From left to right is represented a supply roll 52 containing the stock of the self-adhesive tape 53, said roll 52 being rotatable about an axis 51. The tape 53 is fed through a span roller 54 to a heating apparatus 55 and is shown interrupted at that place for reasons of clarity. The heating apparatus comprises a curved surface 56 in which a plurality of dove-tail shaped grooves 57 is arranged at an angle of 45° with respect to the travelling direction of the tape 53. As a consequence of the great heat of the resistance thread 58 the paper of the back-layer is caused to crack-off and to release from the adhesive layer. Said paper leaving continuously the heating apparatus 55 shows a pattern of burst lines 59 extending under an angle of 45° which lines are indicated as dotted lines in the figure. This pattern can, dependent on the travelling speed of the tape, be made coarser or finer. The tape passes subsequently a span roller 60 and leaves the installation through pinch rollers 61 and 62.

I claim:

1. An electric heating device comprising a base metal member having a heating surface provided with at least one continuous groove, the width of said groove increasing from its opening toward its bottom, an electrical sheathed heating element positioned in said groove, said heating element having a substantially oval cross section with the longest dimension thereof parallel to said heating surface and greater than the width of the groove opening, and the corss-sectional areas and shapes of said heating element and said groove being respectively so related to each other as to provide a space between the heating element and at least a portion of the groove bottom, said space being substantially filled with a thermally insulating material, whereby said heating element, upon thermal expansion, is confined within said groove, and whereby the major portion of the heat produced by said heating element is effectively transmitted directly toward said heating surface, with only a minor portion of said heat flowing in other directions outwardly from said groove, and a thin metallic layer covering the grooved heating surface.

2. A device according to claim 1, in which the groove has a dove-tail cross-sectional area.

3. A device according to claim 2, in which the groove bottom is convexly curved with reference to the heating element.

* * * * *