Oct. 18, 1960 G. T. STROKES 2,957,154

RESISTANCE HEATING UNIT

Filed June 16, 1958

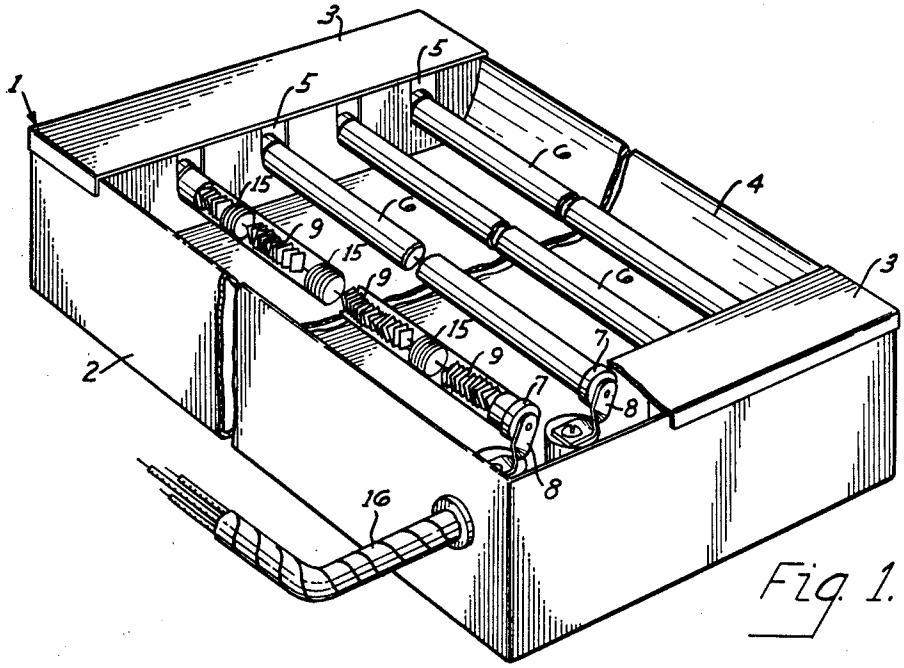

Fig. 1.

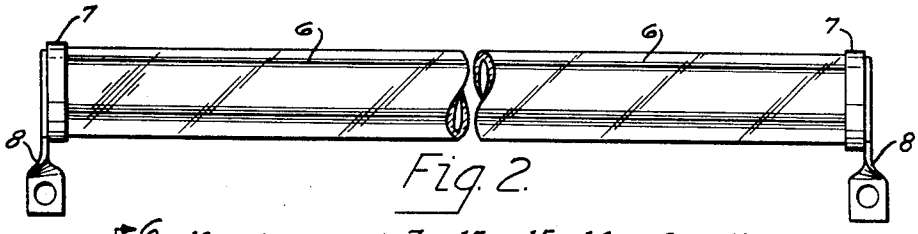

Fig. 2.

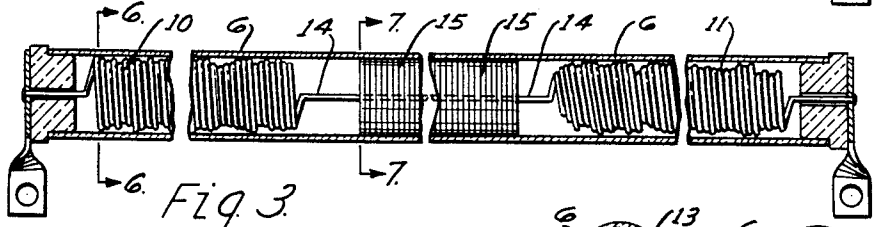

Fig. 3.

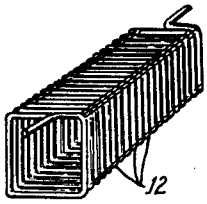

Fig. 4.

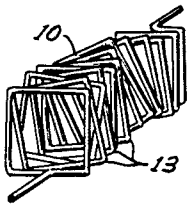

Fig. 5.

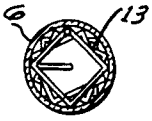

Fig. 6.

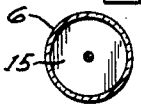

Fig. 7.

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RESISTANCE HEATING UNIT

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10 Claims. (Cl. 338—299)

This invention relates to a tubular resistance heating unit of one of the types commercially used for infrared heating and, more particularly, to a novel form of resistance element for incorporation in such a unit.

In the past, tubular resistance heating units have been rather widely used. They have, however, been characterized by short useful lives, as a rule not over about six months, largely in consequence of the fact that the type of resistance element incorporated in a typical unit has had a pronounced tendency to burn out near one or the other of the two ends of the unit. This defect has been a concomitant of the fact that the alloys used in preferred types of resistance elements, notably those alloys which contain high chromium and aluminum contents along with iron, carbon and the other conventional elements, are characterized by uncontrollable grain growth. This results in growth of the resistance element as a whole, producing crowding and burn out near the points where the element engages the end pieces closing off the tube ends.

Also, the resistance elements of the kinds known in the past have had a tendency to sag the tube, because each coil has been tangent to the tube only at the bottom of the tube.

It is an object of the present invention to provide a tubular resistance heating unit and in particular a resistance element in which burn-out and sagging are largely obviated, as a result whereof the average life of the unit is extended from a period of a few months to a period more nearly of the order of two years. This the invention does by providing cool zones at intervals along the length of the tube, along with ways and means for preventing sagging of the tube by the resistance element. Grain growth may or may not take place as before, but its effect is not to crowd those portions of the unit near the ends of the tube with the resulting development of temperatures beyond those which the resistance element can tolerate. Thus one of the principal objects of the invention contemplates using these features to overcome objections directed to resistance elements and tubular resistance heating units of the kinds used in the past.

Other objects, advantages and features of the invention will be apparent from the specification which follows and in the accompanying drawings, in which:

Figure 1 is an isometric view of a heating panel incorporating certain of the features of the invention.

Figures 2 and 3 are, respectively, an elevation of and a section through one of tubular resistance heating units appearing in Figure 1.

Figure 4 is an isometric view of one of the coil portions of the resistance element prior to the removal of the mandrel indicated in dotted lines.

Figure 5 shows the same coil portion with the mandrel removed.

Figure 6 is an elevation from line 6—6 of Figure 3.

Figure 7 is an elevation seen from line 7—7 of Figure 3.

In the main, the heating panel shown in Figure 1 is conventional except as regards the tubular resistance heating units and resistance elements used therein. Panel 1

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includes body portion 2, top portions 3, and a polished metal reflector 4. Slots 5 accommodate the ends of tubular resistance heating units 6, of which four appear in the figure. As more clearly appears from Figures 2 and 3, tubular resistance heating units 6 take the form of cylindrical tubes of quartz, fused silica or the like provided at their extremities with ceramic end pieces 7. Clips 8 of conventional form receive and hold the outer ends of resistance element 9, which is described at greater length below. Suitable connections (not shown) are made between resistance element 9 and the leads housed in cable 16 (Figure 1).

In the preferred embodiment of the invention, resistance element 9 is formed of a metal wire, preferably a high electrical resistance alloy wire of the type supplied by The Kanthal Corporation under the name of "Kanthal" (Grades A, A-1 or D) or, more recently, those supplied the C. O. Jelliff Mfg. Corporation under the name "Jelliff Alloy K." Such alloys are usable at temperatures up to and above about 2,000° F. They are particularly useful under difficult environmental conditions, as in sulphurous atmospheres. In the main, they consist of iron, chromium, aluminum and cobalt, sometimes with other elements as additives. They are well known to the trade, by which they are described as high-chromium, high-aluminum alloys. They are available in wire form, ribbon form and in the form of rods.

Alloys of the kind described have many advantages, among them tensile strengths of the order of 100,000 pounds per square inch and Brinell hardness values upwards of 200. They have the disadvantage that at elevated temperatures the resistance element into which they are formed grows in length due to growth of the individual crystals. When they are used in the form of a cylindrical helix inside a cylindrical tube of quartz, fused silica or the like, the resulting growth tends to produce sagging of the resistance element within the tube; also, the growth of the resistance element tends to produce burn-out at the ends. In that they drastically limit the life of the resistance heating unit as a whole, these are serious disadbantages.

It has been now found that whereas ordinary resistance elements of helical form have a maximum life of perhaps six months, the useful life can be extended up to about two years by (1) taking steps to prevent sagging of the tube and (2) providing an opportunity for the wire to extend in relatively cool zones in which burn-out is not likely to occur. Although these features may advantageously be used together, either may be used without the other. They will be described below in the order in which they have just been mentioned; that is to say, the anti-sagging feature will be described first and the means permitting elongation will be described second.

According to the invention, the resistance element, when it is being formed into a helix, is given a quasi- or pseudo-cylindrical rather than a truly cylindrical shape. This may be accomplished in other ways, but is preferably done by winding the wire on a square mandrel, removing the mandrel, and permitting adjacent turns to become displaced at random. The result is to provide a large number of individual points where enduring contact can be made with the tube. The manner in which this is done will be apparent from Figures 3 to 6 of the drawings.

Referring first to Figure 3, it will be seen that resistance element 9 has a plurality of pseudo-cylindrical portions 10 and 11 in which adjacent turns are displaced from actual registry with each other. This is by contrast with the ordinary cylindrical coil, in which adjacent turns tend to retain the original registration. It is as a result of this tendency to retain the registration that the resistance element tends to produce sag in units of

the kinds heretofore available. The coils make the tube sag because they are tangent to the tube at the bottom of the tube with the result that temperatures are higher in this area than at other points over the circumference of the unit.

By winding the wire on a square mandrel in the manner indicated in Figure 4, a square coil is obtained. Such coil is made up of adjacent turns 12 which are square in shape, of similar size, and, so long as they are on the mandrel, in perfect registry with each other. Once the mandrel is removed, adjacent turns move out of registry with each other, becoming displaced laterally as indicated in Figure 5, wherein the reference character 13 is applied to several non-registering turns. When a pseudo-cylindrical coil of this type shown in Figure 4 is introduced into a cylindrical tube such as tube 6, the corners of the turns make contact with the interior of the tube at a multiplicity of points. This contact provides support and actually prevents sagging of the helix as a whole within the tube.

Although the resistance element may consist of only a single pseudo-cylindrical portion, it is usually advantageous to provide a rectilinearly extending portion 14 (Figure 3) between two pseudo-cylindrical portions such as those indicated at 10 and 11. If this is to be done, it should be done at intervals of a few inches, preferably about six or eight inches, as by pulling on the wire to extend it. The effect of introducing one or more rectilinearly extending portions 14 is to provide one or more cool zones along the length of the tube. This permits grain growth to make itself felt in the cool zone or zones, where it can do no harm. It does not produce burnout.

Preferably, mica washers 15 of circular shape are located as shown on the rectilinearly extending portion 14 of resistance element 9. Such washers may, if desired, be provided with radial slits, one for each washer, to facilitate the task of mounting the washers on rectilinear portion 14. However, it is also possible to string the washers on the wire before it is formed into coils. In such case, the first coil portion 10 may be formed as shown in Figure 4 on a square mandrel on one side of a group of washers 15 and the second coil portion 11 may be similarly formed on the other side of the same group of washers, likewise by winding the wire over a square mandrel. Upon removal of the mandrels, the resistance element may be assembled with end pieces 7 and clips 8, all as previously described.

Thus the invention provides cool zones, one or more, along the length of the tubular resistance heating unit wherein the effect of grain growth can be allowed to assert itself without doing any particular harm. As spacing means, mica washers of circular shape are used in the preferred embodiment of the invention in the cool zones so provided. It is a feature of the invention that the coil portions are quasi- or pseudo-cylindrical in shape, thus providing the desired multiplicity of points of contact with the interior of the tube and preventing appreciable tube sag even at temperatures in the range between about 1800° and 2200° F.

It is evident that, without departing from the spirit of the invention, changes may be made by those skilled in the art. Thus washers 15, rather than being round, may be polygonal in shape, stelliform, or formed after the fashion of spiders. In lieu of forming the pseudo-cylindrical portions in the manner described, as by winding the wire over a square mandrel and allowing adjacent coils to move out of registry, the coil portions may be formed in the first instance in such manner as to introduce the desired multiple contacts with the interior of the tube; e.g., by making the coils hexagonal or octagonal rather than square in shape. Other changes are likely to suggest themselves to those skilled in the art to which the invention relates.

It is intended that the patent shall cover, by summarization in appended claims, all features of patentable novelty residing in the invention.

What is claimed is:

1. A resistance heating unit comprising a tube of heat-transparent material; end pieces of electrical insulating material closing off the ends of the tube; and a resistance element between the end pieces, said resistance element taking the form of a generally helical metal wire in which adjacent turns are of non-circular cross-section, of substantially the same size, and as a rule out of registry with each other.

2. A resistance heating unit comprising a straight tube of heat-transparent material; end pieces of electrical insulating material closing off the two ends of the tube; a pseudo-cylindrical resistance element between the two end pieces, said resistance element taking the form of a modified helix characterized by straight wire portions separated from each other by coiled wire portions in which adjacent turns are of non-circular shape; and, carried by the straight wire portions, spacing means of electrical insulating material.

3. A resistance heating unit according to claim 1 in which, within the coiled portions, adjacent turns are of rectangular shape.

4. A resistance heating unit according to claim 3 in which adjacent turns are square in shape.

5. A resistance heating unit comprising a tube of heat-transparent material; end pieces of electrical insulating material closing off the ends of the tube; a pseudo-cylindrical resistance element between the end pieces, said resistance element taking the form of a modified helix characterized by rectilinearly extending wire portions and coiled wire portion of non-cylindrical contour that alternate with each other; and, carried by the rectilinearly extending portions, spacing means of electrical insulating material.

6. A resistance heating unit comprising a tube of heat-transparent material; end pieces of electrical insulating material closing off the ends of the tube; and, between the end pieces, a pseudo-cylindrical resistance element taking the form of a modified helix characterized by coiled wire portions and rectilinearly extending wire portions that alternate with each other, said coiled portions being of non-cylindrical contour.

7. A resistance heating unit according to claim 6 in which, within the coiled wire portions, adjacent turns are of rectangular shape.

8. A resistance heating unit according to claim 7 in which adjacent turns are displaced slightly from each other in a circumferential direction.

9. A resistance heating element comprising a generally helical metal wire of pseudo-cylindrical shape characterized by alternately disposed rectilinearly extending and coiled portions in the latter of which adjacent turns are of non-circular shape, of substantially the same size, and as a rule out of registry with each other.

10. A resistance heating element comprising a generally helical wire characterized by coiled portions separated by rectilinearly extending portions carrying washers of electrical insulating material, the turns in said coiled portions being of non-circular shape, of substantially the same size, and as a rule out of registry with each other.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,957,154 October 18, 1960

George T. Strokes

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, line 41, for "disadbantages" read -- disadvantage --; column 4, line 22, for the claim reference numeral "1", read -- 2 --.

Signed and sealed this 11th day of April 1961.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

ARTHUR W. CROCKER
Acting Commissioner of Patents

UNITED STATES PATENT OFFICE

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