Jan. 24, 1956 D. C. PULLIAM 2,731,707

METHOD OF ASSEMBLING A FILAMENT AND SUPPORT

Filed June 14, 1950

3 Sheets-Sheet 1

Fig. 1

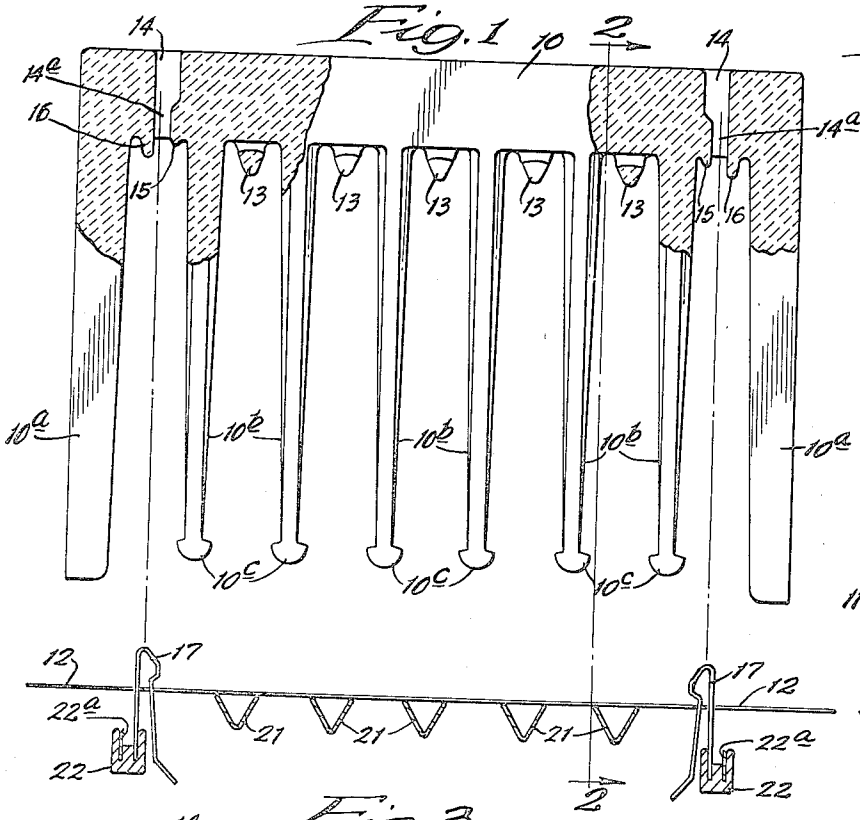

Fig. 2

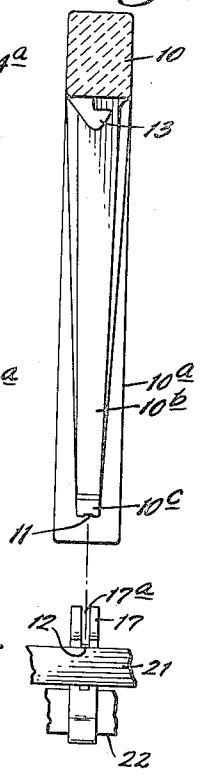

Fig. 3

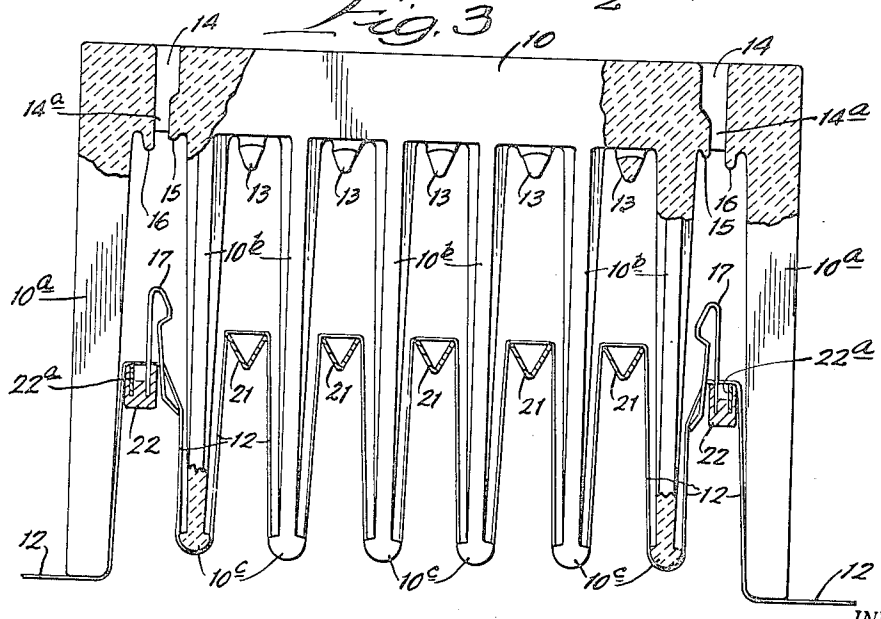

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Fig. 4

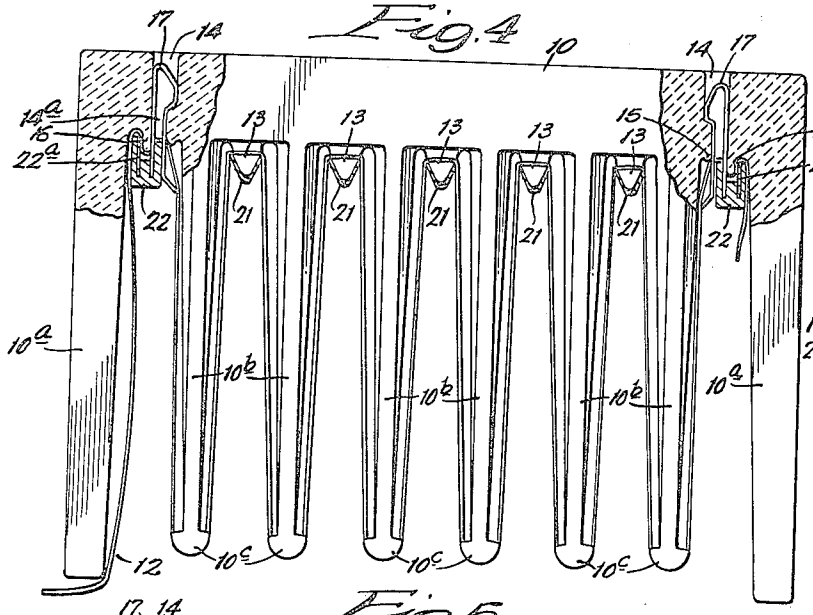

Fig. 6

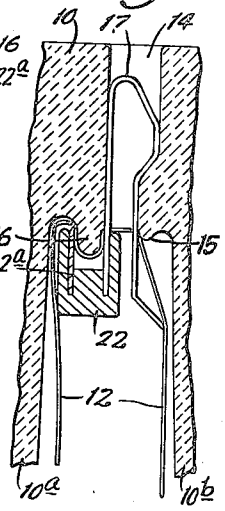

Fig. 5

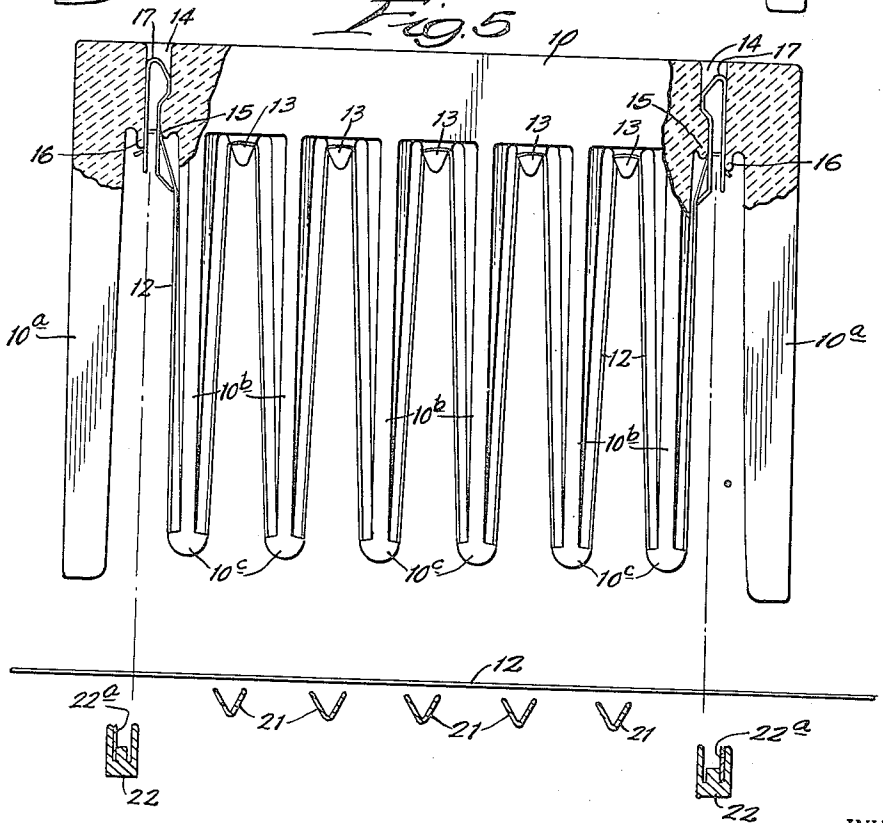

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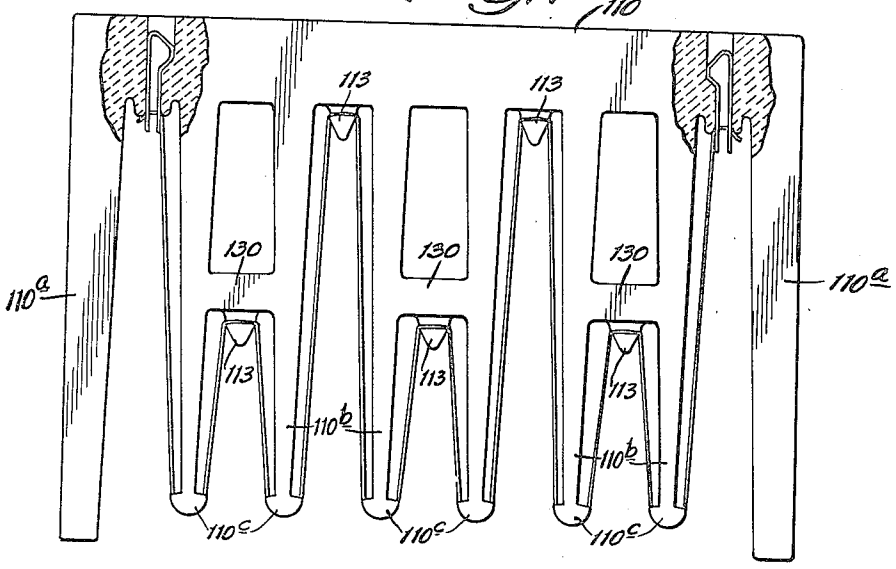
Fig. 7



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METHOD OF ASSEMBLING A FILAMENT AND SUPPORT

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Application June 14, 1950, Serial No. 168,115

4 Claims. (Cl. 29—155.5)

This application relates broadly to filament supports and to a method for assembling them; in particular, it concerns a filament-supporting structure which is simple and inexpensive, involves only four parts, including the filament itself, and which may be assembled with a minimum of manual effort.

Filament-supporting structures are encountered in many branches of technology, and my invention is applicable to a wide variety of specific types of devices. I am particularly concerned, however, with the use of my invention in the electrical appliance field as a heating element.

Heating elements for electrical appliances, in the prior art, have usually consisted of a frame, formed of mica, porcelain, or other refractory material, on which a metallic ribbon or filament formed of Nichrome or other resistance wire, is wound. Electrical terminals to facilitate the flow of current through the resistance ribbon are customarily affixed to the frame with rivets or bolts. Such heating elements have, in the past, been assembled, and the resistance ribbon has been wound thereon, by hand. The resulting high labor cost has made electrical heating elements for appliances expensive out of proportion to the cost of the actual materials employed therein.

In the present invention, I provide a filament-support structure, particularly adapted for use as an electrical heating element, wherein a high degree of mechanical ruggedness and extraordinarily good performance is accomplished with remarkable simplicity of parts and virtually no manual assembly cost.

It is accordingly an object of my invention to provide a method of assembly of my distinctive filament-support structure which greatly reduces over prior art methods the manual steps required in assembly.

Other and additional objects and advantages of my invention will appear as the specification proceeds.

In the accompanying drawing, I have shown a typical embodiment of my invention, adapted in this case as an electrical heating element, and have shown in the various figures the method whereby my novel filament-support structure is assembled. In particular, Fig. 1 is a view, partly in section, of the frame of my novel filament-support device, shown in company with the assembly mechanism which has been "loaded" in preparation for mounting on the frame structure the other elements of a completed filament-support structure according to my invention; Fig. 1 is a plan view, wherein the parts are seen from above as they occupy their normal position on a bench or jig in the assembly operation. Fig. 2 is a sectional view, taken along the line 2—2 of Fig. 1. Fig. 3 is a view similar to Fig. 1 showing the various elements of my invention at a later stage of assembly. Fig. 4 is a view similar to that of Fig. 1 but showing the frame member and the associated parts of my filament-support structure in the position which they occupy when my assembly mechanism is fully advanced and ready for withdrawal. Fig. 5 is a view showing my filament-support structure fully assembled, lying in position on the jig or bench after the assembly machine has been withdrawn.

This figure also shows in plan view, partly in section, the assembly apparatus ready to be "loaded" for another assembly operation. Fig. 6 is a greatly enlarged view, in section, of a part of Fig. 4, showing in greater detail the operation of my assembly mechanism at the completion of its advance movement. Fig. 7 is a view showing the modified form of fully assembled heating element according to my invention which is structurally adapted to provide substantially uniform radiation of heat over a rectangular area when the heating element is operated in a vertical position, as in a room heater or toaster.

In Fig. 1, the frame of my filament-support structure—in this embodiment a heating element—is denoted **10**. It is made of porcelain, high-temperature plastic, or other material capable of withstanding the operating temperatures of electrical resistance ribbon. The general conformation of frame member **10** resembles that of a comb, in that it is provided with a pair of end members **10***a* and a plurality of "tines" **10***b*. As may be seen from Fig. 2, end members **10***a* are, in the particular embodiment shown, similar in thickness to the transverse frame **10** proper and are slightly longer than tines **10***b*. This construction enables end members **10***a* to act as mechanical protective structures to shield tines **10***b* from damage, either when the heating element is lying on its side or when it is mounted in a vertical position.

Each of the tine elements **10***b* is provided with a modified outer end **10***c* which carries a groove **11**. End members **10***c* serve as supports or struts for the electrical resistance ribbon **12**, and notches **11** are oriented in members **10***c* in alignment with one another. Notches **11** may be relatively shallow as shown in the drawing, or may, if desired, be substantially deeper so as to form a slot at the outer end of each tine member **10***b*. I have found that good mechanical strength and stability can be obtained by using relatively shallow notches **11**.

The transverse base or frame structure **10** is itself provided, between each pair of tines **10***b*, with a molded-end hook or projection member **13**, shown in front elevation in Figs. 1, 3, 4 and 5, and shown in side elevation in Fig. 2.

Between the outermost tines **10***b* and the end portions **10***a*, frame member **10** is modified with a pair of molded end slots **14** extending entirely through frame **10** as shown. Slots **14** are uniform in internal width through most of their length, but have a reduced-width portion **14***a* in the portion of the slots **14** nearest the inner face of frame **10**. Reduced-width portion **14***a* is formed by a molded boss or projection **15**, which extends into slot **14** from the wall thereof immediately adjacent one of the tines **10***b*.

Slots **14** are provided with another pair of bosses or projections **16** extending downward from frame member **10** flush with the wall of each slot **14** which lies opposite boss **15**. This boss or projection **16** serves a distinctive function in the operation of my assembly mechanism, as will be hereinafter explained in greater detail.

My completely assembled filament-support structure, as shown in Fig. 5, comprises the frame member **10** just described in detail, with a pair of spring clamp members **17** seated in slots **14** and providing terminal anchorage for an electrical resistance ribbon **12** which is supported on frame **10** zigzag between the spring clamp terminals **17**, ribbon **12** being in turn carried on the end members **10***c* of tines **10***b* and on hook members **13**, as may be readily seen from Fig. 5. Spring clamp members **17** not only provide secure terminal anchorage for the ribbon **12**; they also provide secure and effective spring contact means for connecting electrical wires to the resistance ribbon to permit passage of electrical current therethrough.

Spring clamp members **17** comprise once-folded leaf springs having, in addition to the main fold, an additional bent portion slightly posterior of the main fold so as to provide a latch or self-trapping head portion which may readily be forced through a narrow opening but which, once past the narrow opening, will lock itself in position and require substantially greater force to withdraw it. The legs of the spring clamp members **17** opposite the extra fold just mentioned are straight, while the leg which constitutes a continuation of the leaf spring on the side having the extra fold is somewhat longer than the other leg and is bent slightly outward at its lower end.

An axial slot **17***a* is cut into each of the spring clamps **17**, the slot bisecting the clamp from its principal fold about ⅔ of the distance to the lower end of the shorter leg. The width of slot **17***a* is adjusted to accommodate snugly, without crowding, the resistance ribbon **12**. As may be seen from Fig. 5, the resistance ribbon **12**, in the assembled heating element, is anchored in the frame **10** by passing through slot **17***a* and pressing firmly against bosses **15** and **16**, spring clamp **17** being firmly anchored in slot **14**.

The manner of assembly of my novel filament-support structure, avoiding manual operations almost entirely, is brought out in Figs. 1–5, inclusive. My assembly machine is shown in the figures only in plan view; it consists of a very simple structure comprising a plurality of elements mounted in a vertical position on any type of suitable carriage adapted for periodic advancement and retraction. Since I do not claim herein the details of mounting and moving my assembly machine, those details are not shown in the drawing. It may be understood, however, that any suitable means may be employed for that purpose. The critical operative elements of my assembly machine comprise a number of ribbon-carrying fingers **21**, equal in number to the number of hook projections **13**. These fingers have a generally V-shaped sectional conformation, and are oriented in transverse alignment with their open legs facing in the direction of advance of the assembly machine.

Mounted at each end of the row of fingers **21**, and slightly behind such fingers, is a pair of clamp-carrying members **22**. The members **22** perform two functions—(1) they serve as the means for advancing the clamp members **17** into seated position in frame **10**, and (2) they provide the means for cutting the ribbon **12** after the assembly of the heating element has been completed. This last-mentioned function is accomplished by means of a knife-blade **22***a* which is carried in a suitable recess in member **22** opposite the recess provided for support of spring member **17**. The two slots just mentioned are oriented relative to one another such that when member **22** is fully advanced into frame member **10**, as shown in Fig. 4, the knife-blade **22***a* and the straight leg of spring member **17** pass on opposite sides of boss **16**. This action is clearly brought out in Fig. 6.

At the outset of the assembly process, the frame **10** is placed in a horizontal position on a suitable jig so as to permit the carriage which supports elements **21** and **22** to pass beneath it, giving fingers **21** liberty to advance up to and lap over hook projections **13**. The ribbon **12**, normally coiled on a large reel, is drawn from the reel sufficiently to pass between the fingers **21** and the tips **10***c* of tines **10***b* at the level of notches **11**. The end of ribbon **12** may, prior to the assembly operation, be anchored in any suitable manner, the reel being left free to turn and thus release additional quantities of ribbon **12** as needed. Meanwhile, members **22** are suitably "loaded" with spring members **17** supported in the position shown in Figs. 1, 3, and 4. This "loading" operation may be accomplished by hand or, if desired, by means of an automatic work feeder such as industrial engineers frequently employ in mass-production apparatus. The carriage carrying members **21** and **22** is then advanced toward frame member **10**, spring members **17** intercepting ribbon **12** in slots **11** as they advance. The apparatus is shown in Fig. 1 shortly after the advance of the assembly machine has commenced.

As fingers **21** and members **22** enter the spaces between elements **10***a* and **10***b*, the ribbon **12** is trapped in notches **11** and it begins to unwind from the reel (not shown) with further advance of the members **21** and **22**. At this stage, also, the ribbon **12** passes over end members **10***a* of frame **10** and ribbon **12** thereupon seats in the bottom of slots **17***a* of spring members **17**. This intermediate position of the assembly machine is shown in Fig. 3.

When the carriage carrying members **21** and **22** reaches its most advanced position, the fingers **21** will have carried ribbon **12** into the zigzag position shown in Fig. 4, and the ribbon will be ready for seating in hooks **13**. At the same time, members **22** will have forced spring clamps **17** into seated position within slots **14** and, as knife edges **22***a* come into pressure contact with bosses **16**, ribbon **12** is severed. At this time, the carriage carrying members **21** and **22** may be lowered a small fraction of an inch, or, alternatively, means may be provided for lowering members **21** and **22** in their carriage mount. This causes spring clamp members **17** to become dislodged from clamp carrying members **22**, and, at the same time, ribbon **12** is thus seated within the notches **13**.

The assembly machine is then retracted to its starting position and restored to its original level. The frame **10**, at that stage, is a fully assembled heating element as shown in Fig. 5, and may be removed from the jig and replaced by another frame **10** ready for assembly. The ribbon **12** may then be again placed in position for an assembly operation (this may be accomplished automatically by means well known to industrial engineers, or it may be done by hand). Similarly, the clamp carrying members **22** are again "loaded" with spring clamps **17**, and a new assembly operation is commenced by once again advancing the carriage carrying members **21** and **22**.

Numerous modifications and variations in the machine which I have outlined may suggest themselves to persons skilled in the art. I have found it desirable, to insure accurated seating of the ribbon **12** in notches **13**, to maintain the normal position of members **21** somewhat ahead of members **22** while giving them liberty, either by elasticity in the fingers themselves, or by a suitable spring mounting, to move backward into alingnment with members **22** at the final advanced position shown in Fig. 4. This arrangement may be changed in many ways according to the preference of particular engineers or the requirements of particular applications. Similarly, the illustrated method of assembly produces a stub of ribbon **12** running from one of the clamp-carrying members **22** to the anchor point of the free end of ribbon **12**—a loss of perhaps 7 or 8 inches in a typical case. In the embodiment shown, I accept this slight loss of ribbon in the interest of maintaining simplicity of assembly structure, since the ribbon is inexpensive and represents a negligible part of the cost of the total assembly.

Spring members **17**, it may be noted, provide an admirably effective and simple means of making electrical contact with the terminals of ribbon **12**, since spade-type contact prongs connected to an external circuit can readily be slid into slots **14** and placed in spring engagement with clamp members **17**.

In my description of the assembly method which comprises a part of my invention, I have assumed that frame member **10** should be held stationary in a jig and asssembly machine parts **21** and **22** be advanced and retracted with respect to the frame member. It will, of course, be obvious to persons skilled in the art that, if desired, this arrangement can be reversed, members **21** and **22** being held stationary and frame member **10** being advanced and retracted. In other words, relative movement between the assembly machine and the frame mem-

ber is the essential element of the assembly method. Vertical assembly, with the frame **10** held in a vertical plane, may of course be employed if desired.

I have shown in Fig. 7 a heating element assembled according to my invention but having a modified structure particularly adapted for use in toasters, room heaters, and other electrical appliances in which the heating element is normally supported in a vertical plane but in which uniform radiation of heat over a substantial area is desired.

Due to the tendency of heated air to rise, a conventional heating element of the type in Fig. 5 will usually tend to be substantially hotter in its upper zone than in its lower zone, when mounted in a vertical position. In the form of heating element shown in Fig. 7, a substantially greater quantity of heat is radiated from the lower half of the frame structure than from the upper half, with the result that, after the effects of rising hot air are taken into account, the heat radiated over the frame area is substantially uniform.

As may be seen by referring to Fig. 7, this is accomplished by providing a modified zigzag mounting arrangement in which alternate hooks are carried on a transverse cross member rather than on the transverse body of the frame proper, as in the Fig. 5 embodiment. For convenience, the reference numerals in Fig. 7 are like those of corresponding elements in the other figures except that they have been increased by 100. As may be seen, the frame **110** is provided with end pieces **110***a* and tines **110***b*. Similarly, each of the tines **110***b* has an end portion **110***c* formed identically with terminals **10***c* in the Fig. 5 embodiment. Hooks **113** serve the same function as in the other embodiment of my invention, but, it may be noted, only alternate hooks are molded as part of the transverse frame portion **110**. The other hooks **113** are molded onto cross members **130** which bridge adjacent tines **110***b* at about half the distance from their base portions to their tips.

The assembly of the structure of Fig. 7 may be accomplished in the same manner as described with the Fig. 5 embodiment, the only difference being that alternate fingers **21** would, in the assembly of the Fig. 7 embodiment, be staggered with alternate fingers held in a substantially more advanced position than the others.

While I have in this specification, for purposes of illustration, described in considerable detail two specific embodiments of my invention, it will be understood that many variations and changes can be made therein by persons skilled in the art without departing from the spirit of my invention. It is, accordingly, my desire that the scope of my invention be determined primarily with reference to the appended claims and that the particular embodiments described in the specification be regarded as exemplary only.

I claim:

1. The method of assembling a heater filament and support structure therefor having a frame equipped with spaced-apart filament-carrying tines and hooks carried at the base of the tines and interposed therebetween and a slot adjacent each end thereof for receiving clamp members, comprising the steps of extending a filament strip the length of said frame in planar alignment with

said tines and securing a free end thereof, advancing the filament into engagement with said tines, pressing the filament downwardly between said tines and advancing clamp members into engagement with said filament and toward said slots, seating the filament upon said hooks and advancing said clamps into said slots to clamp said filament to said frame, and severing said filament at points adjacent said slots.

2. In a method of assembling a heater filament and a comb-shaped support structure providing a row of spaced-apart tines and hooks disposed between the tines and adjacent the bases thereof, the steps of extending a heater filament across said tines adjacent the outer ends thereof and in planar alignment therewith, advancing said filament into engagement with the outer end of said tines, further advancing said filament between said tines, securing said filament to said hooks, and severing said filament and clamping the ends thereof adjacent the ends of said support structure.

3. In a method of assembling a heater filament and a comb-shaped support structure providing a row of spaced-apart tines and hooks disposed between the tines and adjacent the bases thereof, said support structure having clamp-receiving slots flanking the row of tines, the steps of supporting a heater filament for free withdrawal and extending the filament across said tines adjacent the outer ends thereof and in planar alignment therewith, securing the free end of said filament, advancing said filament into engagement with the outer ends of said tines and inwardly and into the spaces therebetween, securing said filament to said hooks, providing clamp members adapted to receive said filament therein and advancing the clamp members into said slots to secure said filament, and severing said filament adjacent said slots and clamp members.

4. The method of claim 3 in which said clamps are seated in said slots and said filament is severed simultaneously.

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