Dec. 19, 1939. V. D. BARKER 2,183,635

METHOD OF AND APPARATUS FOR MAKING ARTICLES

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FIG. 1

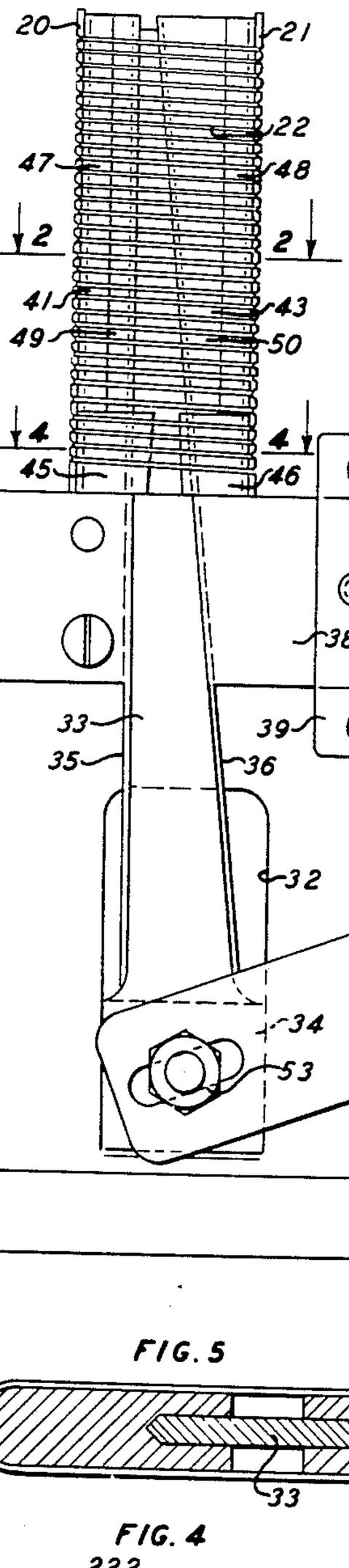

FIG. 3

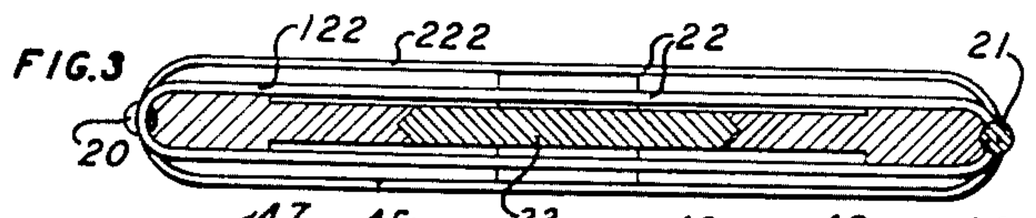

FIG. 2

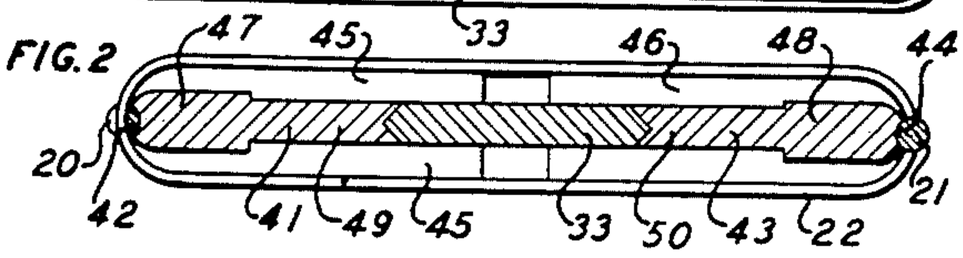

FIG. 5

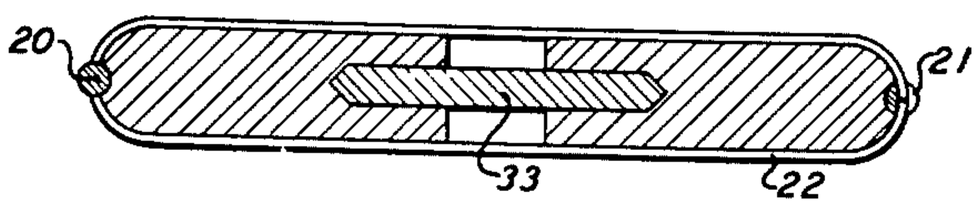

FIG. 4

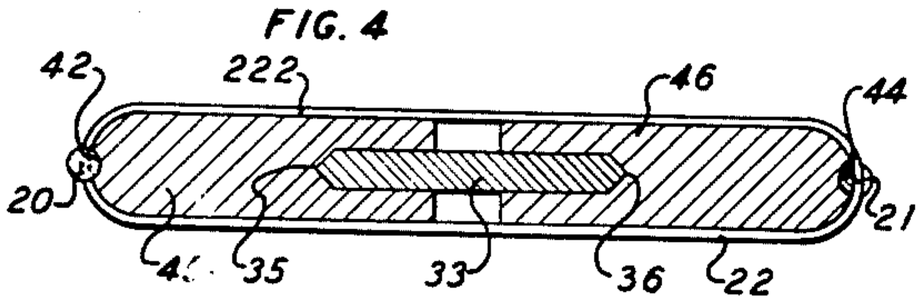

FIG. 12

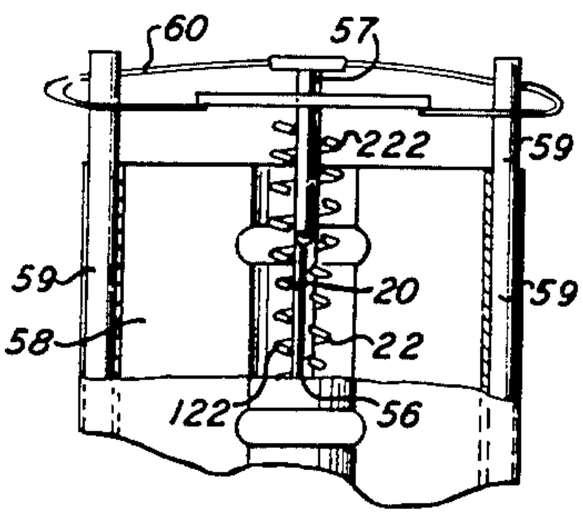

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FIG. 6

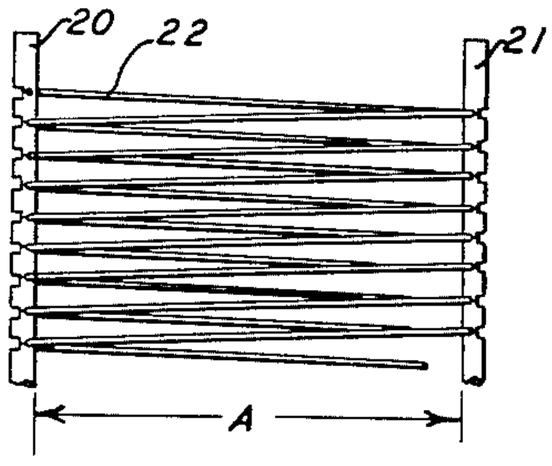


FIG. 7

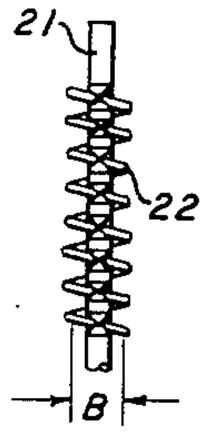


FIG. 8

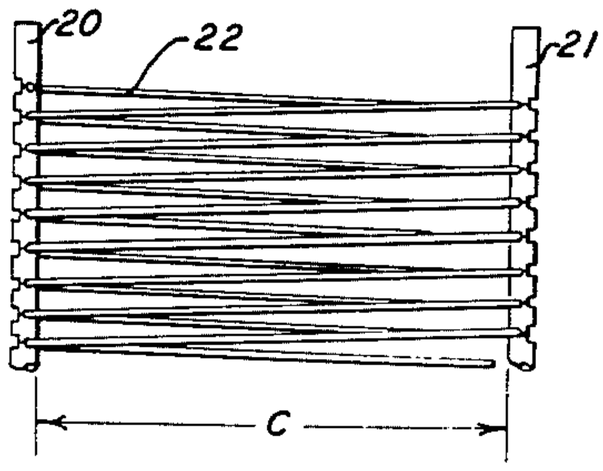


FIG. 9

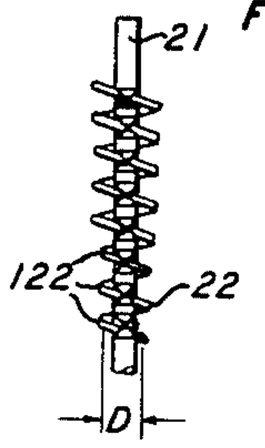


FIG. 10

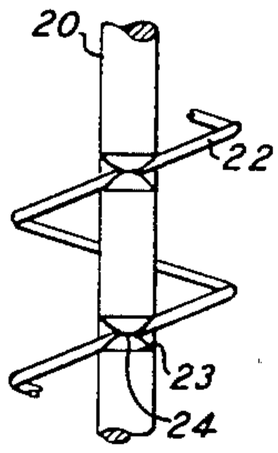
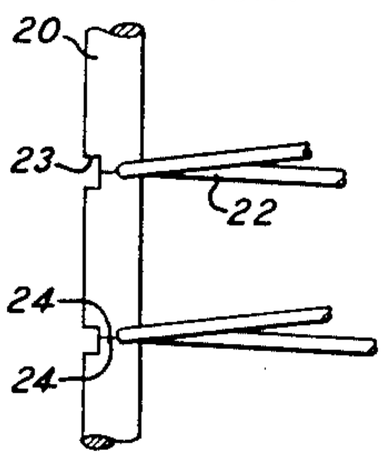


FIG. 11



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2,183,635

UNITED STATES PATENT OFFICE

2,183,635

METHOD OF AND APPARATUS FOR MAKING ARTICLES

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Application March 10, 1937, Serial No. 130,070

2 Claims. (Cl. 140—71)

This invention relates to a method of and apparatus for making articles, and more particularly to a method of and a device for making grid electrodes for vacuum tubes.

In certain kinds of apparatus dependent upon electron streams, a grid electrode may be used comprising a flat helix of metal wire supported upon two or more substantially rigid wires or posts each lying along a generatrix or element of the cylindrical surface which is enveloped by the helix. In some such instances a filament is positioned within the helix, comprising a wire extending in one or more flat loops or coils oriented in a plane substantially parallel to and between the flat sides of the helix. The filament itself, thus formed and disposed, is substantially flat and occupies a portion of space of substantially uniform thickness, but the members used to support the filament between and yet out of contact with the wires of the grid, must generally be thicker and so will tend to approach the grid more closely than the filament proper.

An object of the present invention is to provide a method and apparatus for making a grid, which shall afford sufficient space for other elements to be housed within the grid without danger of accidental contact therewith or harmful approach thereto.

One embodiment of the invention as a method comprises steps of winding a strand of metal, capable without rupture of a sufficient degree of elongation, about a pair of spaced, parallel, rodlike supports in a flat helix, securing the turns of the helix to the supports at the intersections, forcing the supports apart to stretch and set the coils of the helix, and simultaneously stretching one or more coils at one portion only of the helix transversely of the flat helix as well as parallel thereto.

Another embodiment of the invention as an apparatus presents a device for stretching and setting the coils of an electrode such as described, the apparatus including means to support the electrode supports in spaced parallelism, means to force the electrode supports apart whereby to force the helix coils of the electrode to assume and to become set in a longer and narrower form, and means to simultaneously prevent one or more coils of the helix at one portion thereof only from becoming narrower.

Other objects and features of the invention will appear from the following detailed description of one embodiment thereof taken in connection with the accompanying drawings in which the same reference numerals are applied to identical parts in the several figures and in which

Fig. 1 is a broken view in side elevation of a device for forming and setting a grid electrode;

Fig. 2 is a section on the line 2—2 of Fig. 1;

Fig. 3 is a view similar to Fig. 2 after the stretching operation;

Fig. 4 is a section on the line 4—4 of Fig. 1;

Fig. 5 is a view similar to Fig. 4 after the stretching operation;

Fig. 6 is a broken side view of an unstretched grid;

Fig. 7 is a broken edge view of an unstretched grid;

Fig. 8 is a broken side view of a grid after stretching;

Fig. 9 is a broken edge view thereof;

Fig. 10 is an enlarged broken detail edge view of a portion of a stretched grid;

Fig. 11 is a corresponding side view thereof, and

Fig. 12 is a broken side view of a portion of an electron tube assembly including a grid as shown in Figs. 8 and 9.

The principal embodiment of the invention herein disclosed is a method of making a grid electrode such as is disclosed in Figs. 8, 9 and 12. The grid comprises a pair of spaced, parallel, rodlike, metal supports 20 and 21, and a metal wire 22 wound in a flat helix about the two supports. The supports and wire may be made of any metals, pure or alloyed in any way, appropriate to the subsequent intended use of the grid. The wire, however, must have sufficient capacity for elongation without rupture to endure the stretching to which it will be subjected as hereinafter described. In one instance, in practise, supports of substantially pure nickel and a wire of substantially pure molybdenum were found to be satisfactory.

In the preliminary steps of winding the wire on the supports, it may be found preferable to preform the supports with spaced notches 23 (Figs. 10 and 11) to receive the wire, the walls of the notches being subsequently staked down, as at 24, over the wire to clamp the latter tightly in the supports.

The article shown in Figs. 6 and 7, has the wire 22 wound in substantially uniform flat coils on the supports 20 and 21, the distance apart A of the supports (Fig. 6) being somewhat less than their intended final distance C from each other (Fig. 8), and the width B of the coils of the helix (Fig. 7) being somewhat greater than the intended with D of a majority of the coils (Fig. 9).

To carry out the method of the invention, a device such as shown in Fig. 1 may be used. This comprises a base 30 to stand on or be secured to a bench, table or other support not shown, and has a vertically upstanding, principal supporting member 31, the latter having a vertically oriented guide slot 32 therein. A tapering wedge 33 lies against and is vertically slidable on the flat front face of the member 31, and has a rearwardly offset rectangular guide portion 34 positioned in and guided by the slot 32. The left and right edges 35 and 36 of the wedge 33 may preferably be doubly bevelled, as indicated in Fig. 4. The left edge 35 is guided in and supported by the complementarily shaped right edge of a guide plate or member 37 rigidly secured on the front face of the support 31. A coacting guide member 38 receives the edge 36 in its complementarily formed left edge, and is mounted to be horizontally slidable on the front face of the support 31, in a suitable housing 39 secured to the member 31. A spring 40 is provided to press the guide member 38 yieldingly to the left and thus to hold the wedge 33 against the guide member 37.

A fixed grid receiving post 41 is mounted on or formed integral with the member 37. The convexly rounded left vertical edge of this post has a groove 42 dimensioned to receive and support the grid support 20 (Fig. 4); and the right vertical edge of the post is formed as a continuation of the right edge of the member 37 and receives and supports the left edge of the wedge 33. A movable grid receiving post 43 is mounted on or formed integral with the member 38 and its convexly rounded right vertical edge is formed with a groove 44 dimensioned to receive and support the grid support 21 (Fig. 4). The left edge of the post 43 is a sloping continuation of the left edge of the member 38 and is formed to receive the right edge of the wedge 33.

The lower portion, 45 and 46 respectively, of each of the posts 41 and 43 is of uniform thickness from front to back substantially equal to the interior width B of the coils of the helix 22 as originally wound and as shown in Figs. 6 and 7. This thickness is maintained upwardly from the bottom of the posts to a distance predetermined by the number of coils of the finished grid which are to have this interior dimension.

The remaining upper portions of the posts 41 and 43 are formed with outer portions 47 and 48 respectively of thickness from front to back substantially equal to the predetermined desired internal width D of a part of the coils of the finished grid. The remaining portions 49 and 50 of the posts 41 and 43 are thinner than the portions 47 and 48 are substantially of like thickness with the wedge 33.

An operating lever 51 is pivotally secured, as at 52, on the flat front face of the member 31, and, as at 53, to the wedge 33. An adjustable stop 54 is provided to accurately adjustably limit the downward motion of the outer arm of the lever 51 and thus both the upward motion of the wedge 33 and the consequent spreading of the posts 41 and 43. The outer lever arm may be held up by a spring 55.

It may be advantageous to subject the grid structure shown in Figs. 6 and 7, which will be termed a "raw" grid for the purposes of this specification, to a suitable annealing operation as a preliminary step, e. g. the raw grid may be heated in a reducing atmosphere such as hydrogen to a temperature dependent upon the material of the grid, for the double purpose of destroying or driving off surface contaminations and of reducing each part of the grid to a uniform physical state.

With the lever 51 in the position shown in Fig. 1, i. e. with the posts 41 and 43 at their nearest approximation to each other, the annealed grid is turned upside down and slipped down over the posts 41 and 43, the grid supports 20 and 21 sliding in the grooves 42 and 44, until the grid is positioned on the posts 41 and 43 as shown in Figs. 1, 2 and 4. The parts of the device of Fig. 1 are so proportioned and arranged that the unstretched grid fits smoothly but not loosely into this position on the device.

The outer arm of the lever 51 is then forced down, preferably with smooth steady motion, until it is stopped by the stop 54. The lever drives the wedge 33 up and forces the member 38 and its post 43 to the right a predetermined distance farther from the fixed member 37 and its post 41. The coils 222 of the grid, which embrace the post portions 45 and 46 as shown in Fig. 4, are thus forced to assume the form shown in Fig. 5 in which their length has increased from A to C while their width remains unchanged at the value B since the post portions 45 and 46 are of thickness B. The remaining coils 122 of the grid, embracing the post portions 47 and 48, are also forced to increase in length from A to C, but are simultaneously allowed to decrease in width from B to D (Figs. 2 and 3), since the post portions 47 and 48 are themselves of thickness D.

Preferably the various dimensions involved are so proportioned and related that the sum total of the increase A to C and decreased B to D effects a sufficient increase in length of each half coil embracing 47 and 48 to stress the material of the wire 22 beyond its elastic limit. Hence each of these coils 122, after the stretching operation will be permanently set in its new form. At the same time the stretching of the coils 222 which embrace the portions 45 and 46 is more severe, since these are subjected to the same increase in length while being permitted no decrease in width. Hence the parts of the device of Fig. 1 are further so dimensioned that while the coils 122 are stressed beyond the elastic limit of the wire, the more heavily stressed coils 222 are not brought to the rupture point. In the case of the grid now under consideration, the molybdenum wire has an elongation between 15% and 20% while the actual stretch in the coils 122 is roughly 10½% and that in the coils 222 is about 12½%.

It may be advantageous to have the coils of the wire 22 clamped into the supports 20 and 21 in the manner disclosed, or to have them secured to the supports in some similar fashion, especially if the preliminary annealing step be omitted, since this forces each half coil to be stretched uniformly with and independently of the others, thus ensuring substantially uniform physical condition upon the coils 122 relatively to each other and upon the coils 222 relatively to each other.

When the spring 55 is permitted to raise the lever 51 again, the spring 40 will force the member 38 and post 43 towards the member 37 and post 41, whereupon the stretched grid can be easily drawn upwardly off the posts. The stretched grid then has the form and dimensions shown in Figs. 8 and 9 as compared with those of the unstretched or raw grid shown in Figs. 6 and 7.

The particular grid herein disclosed is intended for use in a vacuum tube whose relevant related parts only are shown assembled in Fig. 12, wherein **20**, **22**, **122**, **222** are the stretched grid, **56** is a filament positioned within the coils **122** and supported on a hook **57** positioned within the fractionally wider coils **222**, and **58** is a plate of sheet metal surrounding the grid and filament, these parts being supported by a gallows-like structure **59**, **59**, **60**. It is the hook **57**, wider of necessity than the filament **56** which, in this instance, necessitates the widening of the coils **222** as compared with the coils **122**.

A characterizing feature of the invention, whether considered as a method of making an article, or an apparatus for applying the method, is the fact that during the process the strand **22** is stressed beyond its elastic limit so that it is set in its final desired form since its physical character is that of material released from tensile stress above its elastic limit and it has no elastic tendency to depart from its final form.

The embodiments of the invention herein disclosed are illustrative only and may be departed from and modified in many ways without departing from the spirit and scope of the invention as pointed out in and limited only by the appended claims.

What is claimed is:

1. An apparatus for treating a grid electrode comprising a metal strand formed in connected loops substantially equal in size secured to spaced supporting members, which apparatus comprises spaced elements to receive a grid electrode and having wide portions and narrow portions, and means to move the elements relative to each other a sufficient distance to simultaneously stretch the loops adjacent the wide portions without decreasing their width and decrease the width of the loops adjacent the narrow portions without stretching them and continue to move the elements to further stretch the first stretched loops and stretch the narrowed loops beyond their elastic limits.

2. A method of treating a grid electrode comprising a metal strand formed in connected loops substantially equal in size secured to spaced supporting members, which method comprises the steps of stretching certain of the loops without decreasing their width, simultaneously therewith narrowing the width of the other loops, and subsequently continuing the stretching of the first stretched loops and stretching the narrowed loops until all the loops are stretched beyond their elastic limits.

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