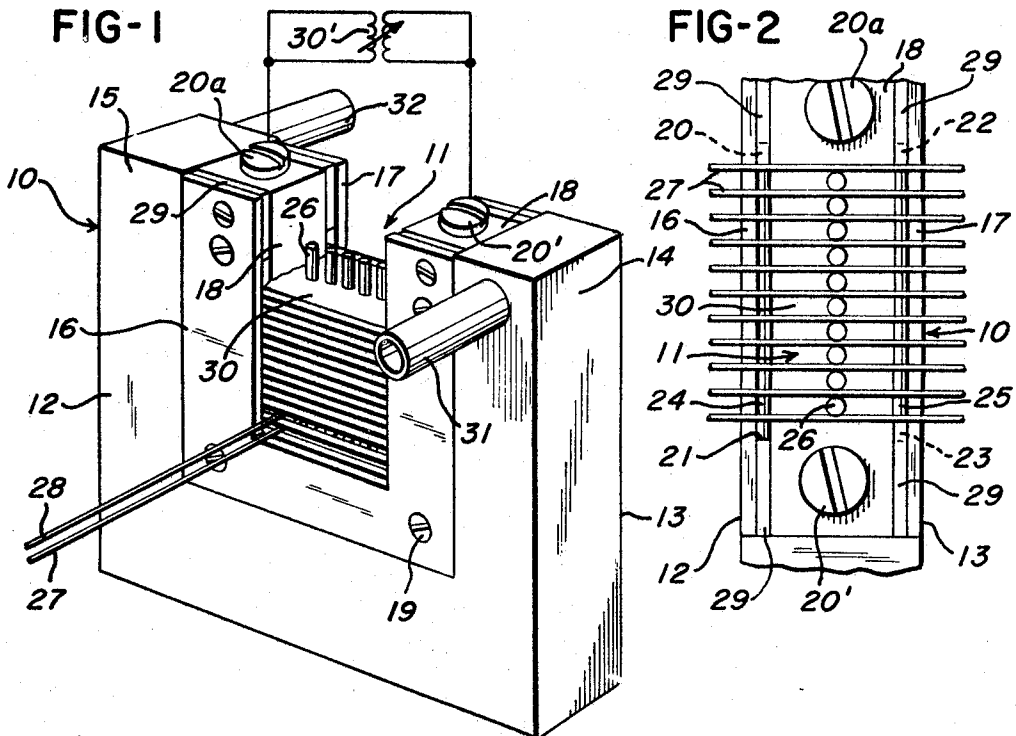
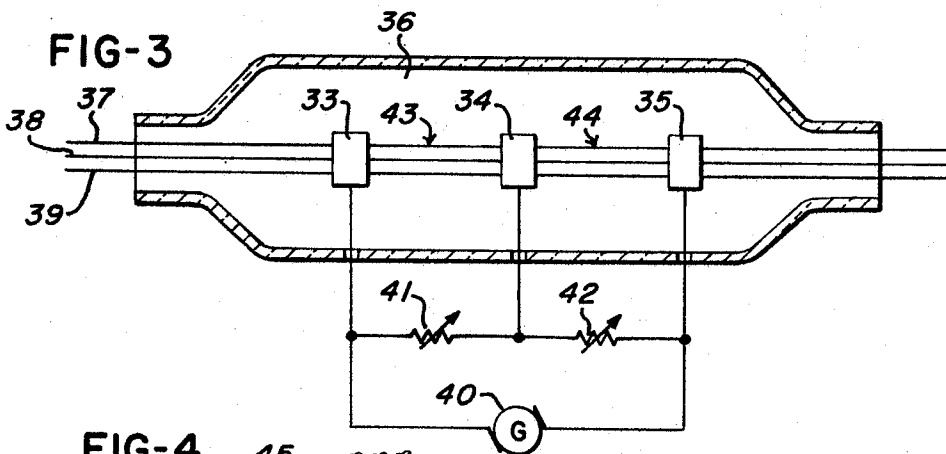
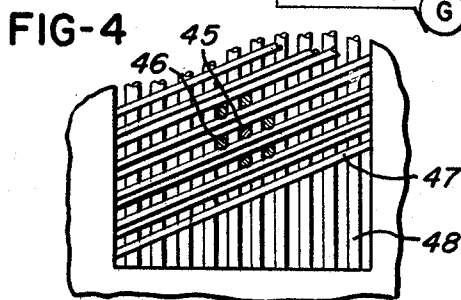


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R. L. HOUGH
 MULTIPLE FILAMENT GUIDE-ELECTRODE ASSEMBLY
 FOR PYROLYTIC DEPOSITION APPARATUS
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INVENTOR.
 RALPH L. HOUGH

BY *Harry C. Herbert Jr.*
 ATTORNEY

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MULTIPLE FILAMENT GUIDE-ELECTRODE ASSEMBLY FOR PYROLYTIC DEPOSITION APPARATUS

Ralph L. Hough, Springfield, Ohio, assignor to the United States of America as represented by the Secretary of the Air Force

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The invention described herein may be manufactured and used by or for the United States Government for governmental purposes without payment to me of any royalty thereon.

The present invention relates to a multiple filament guide and electrode assembly of the type which may be employed in conventional vapor deposition apparatuses for accommodating the movement and simultaneously imparting electrical energy to a plurality of filaments passing simultaneously through a deposition chamber.

The art of pyrolytic deposition which received its original impetus with the advent of the incandescent light bulb as a means for providing the filaments to be employed therein has recently been given much more attention as a means of providing continuous filaments of substantial lengths for the reinforcement of a variety of plastic composite materials and particularly those intended for refractory or ablative uses wherein the filament contributes not only to the reinforcement but to the high temperature properties of the composite because of the presence therein or thereon of a pyrolytically-deposited refractory material such as graphite or a variety of carbides, borides or nitrides. In one prominent method for the formation of such pyrolytic filaments, a finely drawn filamentous metal substrate such as a tungsten wire is led through a chamber containing the vaporized pyrolytic material such as a methane series gas for the deposition of graphite or other vaporized precursory materials according to procedures known to the art; and an electric current is caused to pass through the filament while it is within the chamber whereby it becomes heated to the point at which a gas phase plating reaction between the vapor and the substrate occurs resulting in the growth of a coating upon the substrate surface. According to more recent modifications of this general technique, it is now generally considered desirable that the amount of electricity passing through a particular portion of the substrate or of the partially coated filament should be increased in stepwise fashion from one segment to another while the deposition is underway; and this requires the positioning within the chamber of a plurality of linearly spaced electrode members capable of maintaining electrical contact with the moving filament.

In most if not all deposition apparatuses and particularly where the electrical contact with the filament is made at one or more points within the chamber, it is extremely important that no arcing of the electricity between the electrode and the filament occur, since the energy resulting therefrom interferes with the orderly heating, deposition rate and general control of the entire process. Similarly, because the filaments being treated are generally quite fragile, it is necessary in almost all cases, and particularly where the electrodes are positioned within the chamber, that they impart no substantial abrasion of, or other interference with, the moving filament. Similarly, it can be appreciated that the threading of the filament through the electrode members, particularly where they are within the deposition chamber, can be an intricate and time-consuming process. Moreover, since the necessary control of the process to provide a uniform high-quality coating requires the maintenance of a pre-

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cise balance of deposition conditions of heat, pressure and the like, the deposition apparatuses themselves are intricate, expensive and difficult to operate.

It is accordingly an object of the present invention to provide an electrode unit for use in combination within conventional vapor deposition apparatuses which can accommodate the simultaneous movement of a plurality of filaments through the deposition chamber whereby the capacity thereof will be substantially increased.

Yet another object of the invention is to provide a multiple filament guide-electrode assembly for use in conventional vapor deposition means.

Yet another object of the present invention is to provide such a filament guide-electrode assembly which will eliminate any likelihood of arcing between the electrode and the filaments passing therethrough or between the filaments themselves.

Yet another object of the invention is to provide such an assembly which will not abrade or otherwise interfere with the free movement of a plurality of filaments simultaneously through a deposition chamber.

Yet another object of the invention is to provide such an assembly which will prevent any arcing between the plurality of filaments while they are passing therethrough, even though they are at such time in close proximity.

Yet another object of the invention is to provide such an assembly which will accommodate a great number of filaments in a variety of patterns and arrangements which may be easily assembled and disassembled to associate the filaments therewith.

These and other objects and advantages which will appear from a reading of the following disclosure are achieved according to this invention by the provision of a block-like electrode frame member having a passage therethrough and opening upon the front and back surfaces thereof wherein are positioned, substantially centrally of the passage, a plurality of laterally spaced vertically extending filament guides. Spaced from the vertically extending filament guides on opposite sides thereof and adjacent the front and back surfaces of the frame member are a plurality of transversely extending rod-like members of quartz or other dielectric material, the ends of which are slidably positioned within grooves along the opposed vertical surfaces of the passage through the frame adjacent both the front and back surfaces thereof. When a plurality of such rods are stacked vertically on each other near both the front and back of the frame, they, together with the interior walls of the passage through the frame, define a closure or well surrounding the vertically positioned filament guide members. Within the well or closure thus formed may be positioned an electrically conductive material and particularly an electrically conductive liquid such as mercury or a molten metal which may then be electrically energized during the deposition process. The grid screen formed by the transversely spaced, vertically extending filament guides on the one hand and the transversely extending rod-like members spaced from both sides thereof near the front and back of the frame on the other presents a plurality of distinct openings through each of which a separate filament or filamentous substrate may pass during the deposition operation. In so doing, all of the filaments contact the electrically energized conductive liquid within the closure surrounding the filament guides; and a unique feature of the invention is that, even though the multiplicity of filaments are most closely spaced while passing through the guide member and are most likely therefore to touch each other to cause deleterious electrical arcing from one filament to the other, they are at this point surrounded by the liquid which eliminates any possibility of such arcing.

It is to be understood that, because the pyrolytic filaments of the type considered by the present invention are of relatively small diameter on the order of from 0.5 to 5.0 mils, the fact that they are interpositioned between the slidable rod-like members, which themselves are of a diameter within the range of from .025 to .075 inch in diameter, does not result in separation of the rods to an extent which would allow mercury or a molten metal to flow from the closure under the hydrostatic circumstances that would attend the fact that the conductive liquid is not higher than one or one and one-half inches in the well. It can be appreciated moreover that, because the vertically extending filament guides are fixed relative to the frame member and are open at their upper ends and because the rod-like members are freely slidable in and removable from the frame, it is a very easy matter to lay a transverse layer of individual filaments within the passage through the frame member in each of the spaces defined by the successive vertically extending filament guides and then to apply a rod in each of the grooves on both sides of the filament guides to provide vertical spacing from the first layer for a second layer to be so applied and so on until a plurality of transverse layers of filaments is built up vertically within the electrode unit. The fact that the outer portions of the guiding grid; viz, the transversely extending rod-like members, are of an electrically insulated material insures that the first solid contact of the filaments with the electrode will be non-electrical so that no arcing can occur. Moreover, the first instant of contact between the filaments and the electrical energy will be a non-arcing liquid contact which will be maintained throughout the electrical association of the electrode with the filaments.

The invention thus generally described may be more clearly understood by reference to the following detailed description of certain preferred embodiments thereof in connection with which reference may be had to the appended drawings.

In the drawings:

FIGURE 1 is a perspective view of a multiple filament guide-electrode assembly according to the present invention showing some filaments arranged for passage there-through.

FIGURE 2 is a fragmentary plan view of the grooved passage through the assembly of FIGURE 1.

FIGURE 3 is an elevational schematic illustration of the manner in which electrode-guide units of the type illustrated in FIGURE 1 may be advantageously employed in a conventional deposition chamber.

FIGURE 4 is a fragmentary elevational view in partial cross section showing a modified arrangement of the guiding components of the unit according to the present invention to accommodate a hexagonal arrangement of filaments simultaneously passing therethrough.

Referring now to FIGURES 1 and 2, one preferred unit according to the present invention is shown to comprise the block-like frame member 10 having the passage 11 extending therethrough and opening upon the front 12 and back 13 thereof. In this specific embodiment, the passage 11 is defined by the upwardly projecting legs 14 and 15 of the generally U-shaped member so that the passage 11 is also open at its upper end. Lining the inwardly disposed surfaces of the upwardly opening passage through the frame may be the assembly of front and rear U-shaped facing plates 16 and 17 and the intermediately disposed insert blocks 18 which may be held within the frame by suitable fasteners such as 19 to provide the pairs of opposed grooves 20 and 21 adjacent the front surface 12 and 22 and 23 adjacent the rear surface 13. These grooves are of such a width that the individual rod-like members 24 may be positioned for free slidable movement therein vertically of the frame. Positioned within the closure or well defined by the inwardly disposed surfaces of the passage 11 and by the superimposed rods 24 within the grooves 20 and 21 and the rods 25

within the grooves 22 and 23 are the vertically extending, laterally spaced filament guides 26 which may be in the form of a comb, the teeth of which are upwardly projecting and the base of which is affixed to the lower surface of the passage 11.

In the threading or application of filaments to the guide assembly thus constituted, it can be appreciated that all but one of the rod-like members of the groups 24 and 25 can be removed and a layer of transversely aligned filaments equal in number to the number of spaces between the teeth 26 of the comb may be laid across the passage 11. Thereafter a transversely extending rod may be positioned over the filament layer in each of the pairs of grooves represented by the grooves 20 and 21 on the one hand and 22 and 23 on the other, whereupon a second layer of transversely aligned filaments may be positioned over the rods and between the vertically extending filament guides after which additional pairs of rods and layers of filaments may be so applied until the desired number of filaments have been installed or the number of rods that can be accommodated within the grooves has been reached. If the number of rods spaced by the filaments such as those in the layers 27 and 28 do not completely fill the vertical height of the grooves, suitable spacers or shims 29 may be inserted in these grooves to lock the rods in place. On the other hand, the nature of the filament travel through the electrodes may be such that deflecting forces will not be imparted to the rods and they may be left to be freely slidable within the grooves in view of the fact that they will, even while moving nominally, continue to keep the filaments in the successive layers 27 and 28 vertically spaced and away from contact with each other. Within the guide member moreover and more particularly within the well or closure defined by the rods spanning the front and back of the passage 11 is positioned an electrically conductive material such as the electrically conductive liquid 30 which may be a liquid metal such as mercury or a molten metal; e.g., lead, tin, copper or a relatively reactive metal such as aluminum or a relatively inactive metal such as silver or gold. Where the conductive material is a molten metal and it is necessary to maintain it at a temperature above its fusion point, the frame member or at least the portion thereof lining the passage 11 may be heated as by the passage of an electric current imparted by a power source acting through the variable transformer 30' and its connection to suitable terminals which may comprise threaded fasteners 20 and 20a. On the other hand, where the position of the electrode-guide unit within the deposition chamber is such that the prevention of deposition upon the electrode itself requires cooling of at least the majority of the surfaces thereof, this may be accomplished by employing a block-like frame member 10 which has a hollow interior throughout in communication with which are the coolant inlet and outlet conduits or nipples 31 and 32. The circulation of a coolant through these conduits and the hollow interior of the chamber may be maintained during the deposition operation to carry away excessive heat and prevent the electrode from achieving a temperature at which the volatilized material within the chamber would tend to plate out upon its surfaces, the deposition being confined solely to the filaments where it is desired.

The electrode units thus constructed may be employed in a conventional vapor deposition apparatus as illustrated in FIGURE 3 wherein a plurality of such units 33, 34 and 35 are shown to be linearly spaced within the deposition chamber 36 which is filled with a vaporized pyrolytic material and through which a plurality of filaments in the layers 37, 38 and 39 may pass to be coated thereby. While so passing, the filaments are electrically energized by their contact with the electrodes according to this invention which themselves are electrically energized as by the generator 40 supplying power which, under the influence of variable resistors 41 and 42 imparts a different electromotive force and heating effect to the successive segments

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43 and 44 of the filaments. The connection of the electricity to the electrodes may be by suitable connections with the terminals 20 and 20a where, as is the preferred case, the entire unit is composed of an electrically conductive metal such as iron or steel which will transmit the electric current from the terminal member to the liquid reservoir 30.

While the foregoing description has referred to an embodiment for accommodating a rectangular arrangement of filaments; i.e., a plurality of vertically spaced superimposed transverse layers of filaments, under certain circumstances it may be desirable to have the filaments pass through the deposition chamber in a different pattern. One such instance is where some of the filaments to be coated by the deposition operation are not themselves and do not become electrical conductors and must therefore be heated by other means. One such other means involves their being positioned in close proximity to a heating substrate such as a tungsten or copper wire which remains electrically conductive and may therefore be heated to the point at which it will by radiation and convection heat those filaments closely spaced to it. One particular arrangement suitable for accomplishing this purpose is illustrated in FIGURE 4 wherein the electrically conductive heating substrate 45 is shown to be surrounded by the hexagonal pattern of filaments 46 which are to be pyrolytically coated. The hexagonal arrangement is accomplished by shimming or otherwise locking one end of the transversely extending rods 47 so that they extend at substantially thirty degree angles to the vertically extending comb or filament guides 48 within the frame.

While the within invention has been described in considerable detail in connection with certain specific embodiments and modifications thereof, it is to be understood that the foregoing has been for the purposes of illustration only and does not limit the scope of the invention as it is defined in the subjoined claims.

I claim:

1. A multiple filament guide and electrode assembly combination for use in pyrolytic deposition apparatuses comprising a frame member having a passage therethrough opening upon both the front and back surfaces thereof, opposed pairs of vertically extending grooves in the walls on opposite sides of said passage adjacent each of the front and back surfaces of said frame member, a plurality of superimposed transversely extending rod-like members of dielectric material the ends of which are positioned in said opposed pairs of grooves adjacent both the front and back surfaces of said frame member whereby said rods are vertically slidable and define with the side-walls of said passage a closure within said frame member, a plurality of vertically extending laterally spaced

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filament guide bars in fixed position between the rods adjacent the front surface of said frame member and the rods adjacent the back surface of said frame member, an electrically conductive material positioned within said closure and surrounding said vertically extending filament guides and means for electrically energizing said electrically conductive material.

2. An assembly according to claim 1 wherein said electrically conductive material is a conductive fluid.

3. An assembly according to claim 2 wherein said conductive liquid is a molten metal and said assembly includes means for heating said metal to maintain it in its molten state.

4. An assembly according to claim 3 wherein said molten metal is one of that class of metals which consists of lead, tin, aluminum, copper, silver and gold.

5. An assembly according to claim 3 wherein said means for heating said metal comprise means for passing an electric current through at least a part of said frame whereby the same is resistance heated by the passage of electrical current therethrough.

6. An assembly according to claim 2 wherein said electrically conductive liquid is mercury.

7. An assembly according to claim 1 wherein said rod-like members are composed of quartz.

8. An assembly according to claim 7 wherein said quartz rod-like members are cylindrical.

9. An assembly according to claim 1 wherein said frame member is hollow and means are provided for the circulation of a coolant therethrough.

10. An assembly according to claim 9 wherein said means comprise fluid inlet and outlet conduits associated with the hollow interior of said frame member on opposite sides thereof.

11. An assembly according to claim 1 wherein said rod-like members may be locked in place within said grooves.

12. An assembly according to claim 11 wherein said rod-like members may be fixed at diverse angles relative to the vertically extending filament guide bars.

13. An assembly according to claim 12 wherein said rod-like members may be shimmed within said grooves to hold them at various pre-determined angles relative to the vertically extending filament guide bars.

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RICHARD M. WOOD, *Primary Examiner.*

B. A. STEIN, *Assistant Examiner.*