Feb. 14, 1967 W. T. ACKERMANN ETAL 3,303,859

METHOD OF MANUFACTURE OF ELECTRON DISCHARGE TUBE GRID ELECTRODES

Filed May 7, 1964



Fig. 2.

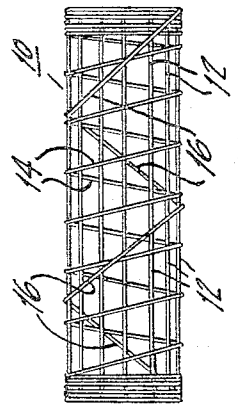


Fig. 1.

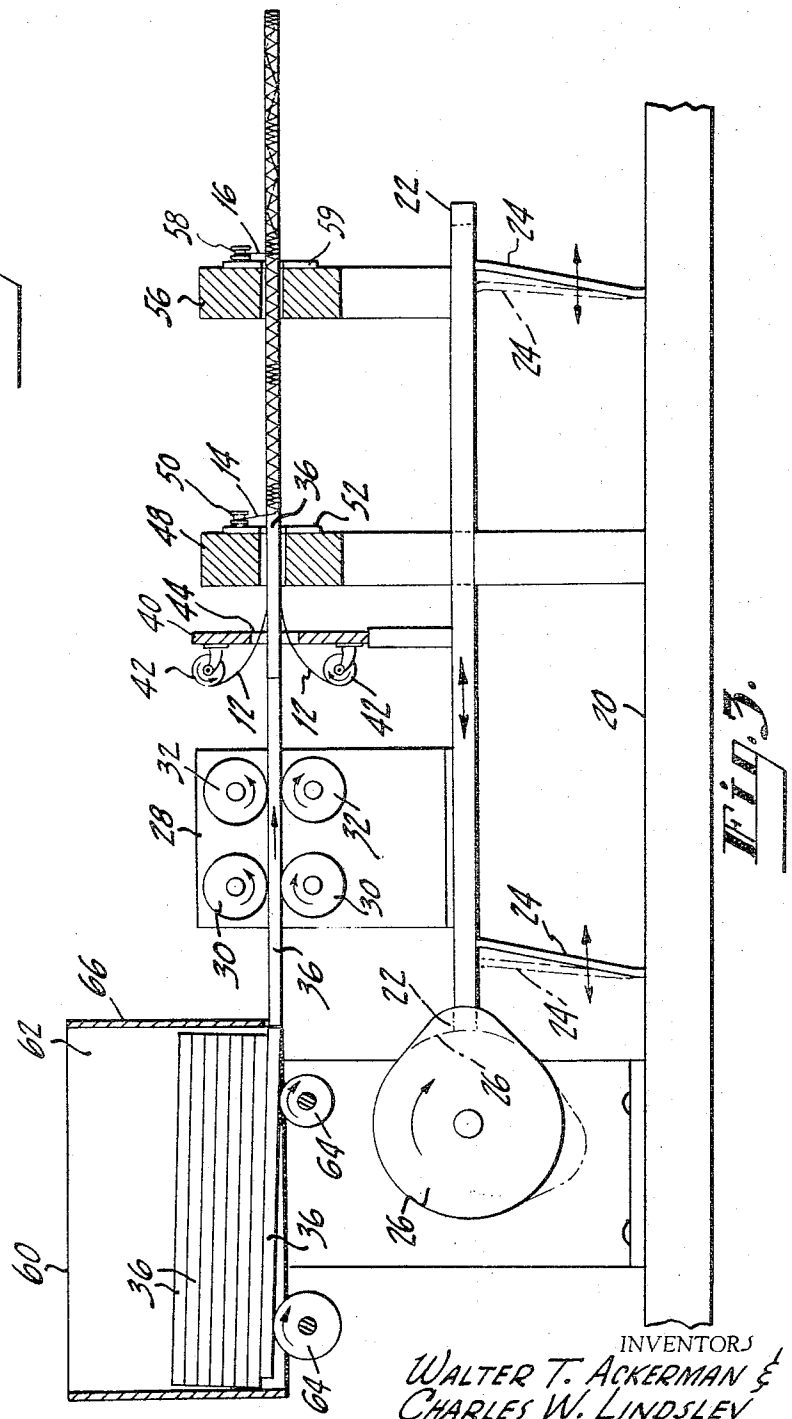


Fig. 3.

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United States Patent Office 3,303,859 Patented Feb. 14, 1967

3,303,859

METHOD OF MANUFACTURE OF ELECTRON DISCHARGE TUBE GRID ELECTRODES

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Filed May 7, 1964, Ser. No. 365,596
5 Claims. (Cl. 140—71.5)

This invention relates to a method of manufacturing grid electrodes for electron discharge tubes.

In the manufacture of one type of grid electrode, a plurality of side rods are disposed in cylindrical and parallel array around a mandrel, the mandrel and side rods are axially advanced, and a lateral wire is wound in a helix around the advancing side rods and mandrel. The pitch of the helix is determined by the rate at which the rods are advanced and by the rotational rate at which the lateral wire is wound around the side rods and mandrel. Thereafter, the lateral wire is brazed to the side rods.

In some instance, it is desired that a second or truss winding be wound on top of the lateral wire winding. In the past it has been the practice to first wind the lateral wire around the side rods, braze the lateral wire to the side rods, and thereafter in a second winding operation, wind the truss winding over the side rods and lateral wire winding. Then, the truss wire winding is brazed to the lateral wire and side rods in a second brazing step.

A disadvantage of the prior art method is that it requires two separate winding operations and two separate brazing operations which add to the cost of the grid.

It is an object of this invention to provide a new and improved method of fabricating cylindrical electron tube grid electrodes wherein at least two wire helices are wound simultaneously around the side rods, whereby only a single winding operation and a single brazing operation are required.

It is also sometimes desired that the lateral wire helix be wound with a variable pitch. This is accomplished in the prior art by varying the rate at which the side rods and mandrel are advanced. Generally, however, it is desired that the truss winding be wound with a constant pitch. In the prior art, the lateral wire helix is wound with a variable pitch, the lateral wire is brazed to the side rods, the truss winding is thereafter wound with a constant pitch, and the truss winding is brazed to the lateral wire winding and side rods in a second brazing opreation.

It is a further object of this invention to provide a new and improved method of fabricating cylindrical electron tube grid electrodes wherein at least two wire helices are wound simultaneously around the side rods, and wherein at least one of the helices is wound with a variable pitch while at least one other of the helices is wound with a constant pitch.

For achieving the objects of this invention, methods are provided wherein, according to one embodiment of the invention a plurality of side rods are advanced in circular array past a first and second winding head, in that order. Each of the winding heads is rotated at a constant rate to wind a wire around the side rods, the first winding head winding a lateral wire winding around the side rods, and the second winding head winding a truss wire winding around the prior wound lateral wire winding and the side rods. No brazing operation is performed between the winding of the lateral wire and the truss wire.

For providing a variable pitch lateral wire winding, incremental movements along the direction of advance

of the side rods are imparted to the side rods whereby the rate at which the side rods move past the first winding head is varied. For providing a constant pitch truss wire winding, in spite of the variation in the rate of advance of the side rods, the same incremental movements imparted to the side rods are imparted to the second winding head whereby the rate of movement of the side rods relative to the second winding head remains constant.

In the drawings:

FIG. 1 is a side view of a type of electron tube grid which may be made according to this invention;

FIG. 2 is an end view of the grid shown in FIG. 1; and,

FIG. 3 is a side elevational view, partly in section, of apparatus which may be used for practicing the methods of this invention.

The cylindrical electron tube grid electrode 10 shown in FIGS. 1 and 2 comprises a plurality of side rods 12 arranged in circular cylindrical array. Surrounding the side rods 12 and brazed thereto is a lateral wire helix 14. Adjacent each end of the grid 10 the lateral wire helix 14 is wound with a smaller pitch (as measured by the distance between adjacent turns) than along the central length of the grid so as to provide a relatively large number of lateral wire turns adjacent each end of the grid. The turns of smaller pitch provide greater strength for the grid electrode. Wound on top of the lateral wire helix 14 is a truss winding 16 which is brazed to the lateral wire winding and side rods 12. The truss winding 16 is wound with much larger pitch, that is, greater axial distance between adjacent turns of wire, than the lateral wire winding and is wound with constant pitch throughout the length of the grid. The truss winding greatly strengthens the grid structure.

Apparatus for practicing the method of this invention is shown in FIG. 3 and comprises a table or base 20 on which a platform 22 is mounted. Platform 22 is supported on a pair of flat rectangular springs 24. Springs 24 permit movement of platform 22 to the right and left, as shown in FIG. 3. The amount of required movement of platform 22 compared with the dimensions of platform 22 and springs 24 are such that, for all practical purposes, the platform 22 moves back and forth along a straight line. For providing the forward and backward movement of platform 22, a cam 26 is provided which engages one end of platform 22. Means for rotating the cam is not shown.

Mounted on platform 22 is a mandrel feeding device 28 comprising two pairs 30 and 32 of oppositely disposed rollers. The rollers of each pair 30 and 32 are spring biased towards one another, and the rollers advance mandrel sections 36 to the right, as shown in FIG. 3, at a constant rate. Mandrel feeding devices suitable for feeding mandrels at a constant rate are well known and are not further described.

Also mounted on platform 22, and disposed to the right of mandrel feeding device 28, is an annular support plate 40 supporting a plurality of spools 42 (only two of which are shown). Each of the spools 42 contains a side rod wire 12 which extends from the spool through a central hole 44 in plate 40 and towards a mandrel section 36 fed by mandrel feeding device 28 through hole 44 in plate 40.

To the right of plate 40, but not mounted on platform 22 (being fixedly mounted on table 20 instead and extending over platform 22), is a lateral wire winding head 48. Winding head 48 comprises a lateral wire supply spool 50 which is supported on an annular rotating disk 52 through which the mandrel sections 36 are advanced. To the right of winding head 48 is a second or truss wire winding head 56. Winding head 56 is similar to winding head 48 except that winding head 56 is mounted on plat-

form 22 for movement therewith. Although only one spool 58 is shown mounted on the annular rotating disc 59 of winding head 56, it is sometimes preferable to mount several spools 58 on disc 59. In such case, several interspaced truss wire helices are simultaneously wound.

Details of the support plate 40 and winding heads 48 and 56 are not shown since such devices for leading the side rods 12 from spools 42 into circular array around the mandrel sections 36, and for winding the lateral wire 14 and truss wire 16 around the side rods 12 and mandrel sections 36 are well known in the art.

A mandrel sections magazine 60 is supported on table 20 to the left of the mandrel feeding device 28 and comprises a narrow and elongated rectangular sleeve 62 for receiving mandrel sections 36. The top and bottom of the magazine sleeve 62 are open. Extending into the open bottom end of sleeve 62 are a pair of rollers 64 which engage the bottom-most mandrel section 36 and advance it through a hole in the wall 66 of sleeve 62 and into the mandrel feeding device 28. Magazine rollers 64 are operated at a rate tending to feed the mandrel sections 36 at a faster rate than the mandrel sections are fed by the mandrel feeding device 28. The rate of advance of the mandrel sections 36 through the mandrel feeding device 28, however, is controlled by device 28 because the opposing rollers of roller pairs 30 and 32 are spring biased towards one another while rollers 64 of magazine 60 are frictionally engaged with the mandrel sections 36.

In the operation of the apparatus described, a string of mandrel sections 36 are first manually fed through mandrel feeding device 28, hole 44 in support plate 40, and winding heads 48 and 56. An end of the lateral wire 14 is secured to the mandrel section 36 adjacent winding head 48 by the use of tape or the like, and an end of the truss wire 16 (or wires, if several are used) is likewise secured to the mandrel section 36 adjacent winding head 58. The apparatus is then energized. Rollers 64 of magazine 60 and roller pairs 30 and 32 of the mandrel feeding device 28 are rotated whereby the mandrel sections 36 are driven past the winding heads 48 and 56. The mandrel sections 36 passing through the winding heads 48 and 56 are pushed along by the following mandrel sections. Also, the spools containing the lateral wire 14 and the truss wire 16 are caused to rotate around the mandrel sections at a constant rate.

Ignoring, for the moment, the movement of platform 22, the side rods 12 are unspooled from spools 42 and advance through and past winding heads 48 and 56. Rotation of the lateral wire 14 around the advancing side rods 12 and mandrel sections 36 winds the lateral wire helix around the side rods 12. Likewise, rotation of the truss wire 16 around the mandrel sections 36 causes the truss wire to be wound in a helix on top of the lateral wire helix already wound. In the absence of movement of platform 22, both the lateral wire 14 and the truss wire 16 are wound with constant pitch.

For providing a variable lateral wire winding pitch, platform 22 is moved by cam 26. Since the lateral wire winding head 48 is stationary, movement of platform 22 to the right, as shown in FIG. 3, causes an increase in the rate of advance of mandrel sections 36 and side rods 12 past winding head 48. The increased rate of advance of mandrel sections 36 and side rods 12 causes the lateral wire 14 to be wound with increased pitch. Conversely, while platform 22 moves to the left, as shown in dashed lines in FIG. 3, the pitch of the lateral wire winding is decreased.

Since winding head 56 and mandrel feeding device 28 are both mounted on platform 22, movement of platform 22 in either direction has no affect upon the rate of advance of the mandrel sections 36 and the side rods 12 past winding head 56. Thus, regardless of the changes in the rate of advance of mandrel sections 36 and side rods 12 with respect to the lateral wire winding head 48, the truss wire winding head 56 winds the truss wire 16 with a constant pitch.

As shown, magazine 60 is mounted on table 20 and does not move with platform 22. Upon movement of platform 22 to the right, as shown in FIG. 3, the mandrel section 36 still engaged with the magazine rollers 64 is advanced at a sufficiently fast rate by rollers 64 to maintain the end of this mandrel section 36 in contact with the end of the mandrel section engaged with and being fed by the mandrel feeding device 28. Upon movement of platform 22 to the left, rollers 64 of magazine 60 slip against the mandrel section being fed by these rollers while still maintaining a sufficient rate of advance of the mandrel section to maintain it in engagement with the mandrel section being fed by roller pairs 30 and 32 of device 28.

For winding the lateral wire helix 14 with two constant pitches, as shown in FIG. 1, cam 26 has a development suitable to cause platform 22 to advance and return at constant speeds. Suitable variations for winding the lateral wire helix 14 with different pitches will be apparent to persons skilled in the art.

After the winding operations, the lateral and truss windings are brazed to the side rods and one another in a single brazing operation; the side rods, lateral wire, and truss wire are cut through at the ends of the mandrel sections 36; and the cylindrical grids 10 are slid off the mandrel sections 36. Preferably, the side rods 12, lateral wire 14, and truss wire 16 are copper plated. Upon heating, the copper melts to provide the brazed joints. The mandrels are made of a material non-wettable by copper, such as a nickel-chrome alloy commercially known as "Nichrome."

What is claimed is:

1. A method of fabricating a cylindrical grid having a lateral wire wound around a plurality of side rods and a truss wire wound over said lateral wire, said method comprising advancing said side rods in cylindrical array past a pair of winding heads, rotating said winding heads around said side rods at a constant rotational rate for winding a pair of helices around said side rods, and incrementally moving said side rods and one only of said winding heads relative to one another along the axis of advance of said side rods for changing the rate of advance of said side rods and said one winding head relative to one another while not changing the rate of advance of said side rods relative to said other winding head.

2. A method of fabricating a cylindrical grid having a lateral wire wound around a plurality of side rods and a truss wire wound over said lateral wire, said method comprising advancing said side rods in cylindrical array past a pair of winding heads, rotating said winding heads around said side rods at a constant rotational rate for winding a pair of helices around said side rods, and incrementally moving said side rods and one only of said winding heads along the axis of advance of said side rods for changing the rate of advance of said side rods past the other of said winding heads while not changing the rate of advance of said side rods past said one winding head.

3. A method of fabricating a cylindrical grid having a lateral wire winding around a plurality of side rods and a truss wire winding wound over said lateral wire winding, said method comprising advancing said side rods in cylindrical array successively past first and second winding heads, rotating said winding heads around said side rods at a constant rotational rate for causing said one winding head to wind a lateral wire helix around said side rods and for causing said second winding head to wind a truss wire around said lateral wire winding and said side rods, and incrementally moving said side rods and said second winding head only along the axis of advance of said side rods for changing the rate of advance of said side rods past said first winding head

while not changing the rate of advance of said side rods past said second winding head.

4. A method of fabricating a cylindrical grid having a lateral wire winding around a plurality of side rods and a truss wire winding wound over said lateral wire winding, said method comprising advancing said side rods in cylindrical array successively past first and second winding heads, rotating said winding heads around said side rods at a constant rotational rate for causing said one winding head to wind a lateral wire helix around said side rods and for causing said second winding head to wind a truss wire around said lateral wire winding and said side rods, incrementally moving said side rods and said second winding head only along the axis of advance of said side rods for changing the rate of advance of said side rods past said first winding head while not changing the rate of advance of said side rods past said second winding head, thereafter brazing said side rods, lateral wire, and truss wire to one another, and cutting through said side rods, lateral wire and truss wire at spaced intervals to provide individual grids.

5. A method of fabricating a cylindrical grid having a lateral wire winding around a plurality of side rods and a plurality of interspaced truss wire windings wound over said lateral wire winding, said method comprising advancing said side rods in cylindrical array successively

past first and second winding heads, rotating said winding heads around said side rods at a constant rotational rate for causing said one winding head to wind a lateral wire helix around said side rods and for causing said second winding head to wind a plurality of interspaced truss wires around said lateral wire winding and said side rods, providing said side rods and said second winding head only with incremental movements along the axis of advance of said side rods for changing the rate of advance of said side rods past said first winding head while not changing the rate of advance of said side rods past said second winding head, thereafter brazing said side rods, lateral wire, and truss wires to one another, and cutting through said side rods, lateral wire and truss wires at spaced intervals to provide individual grids.

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