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METHOD OF MAKING WIRE-WOUND GRIDS FOR ELECTRON TUBES

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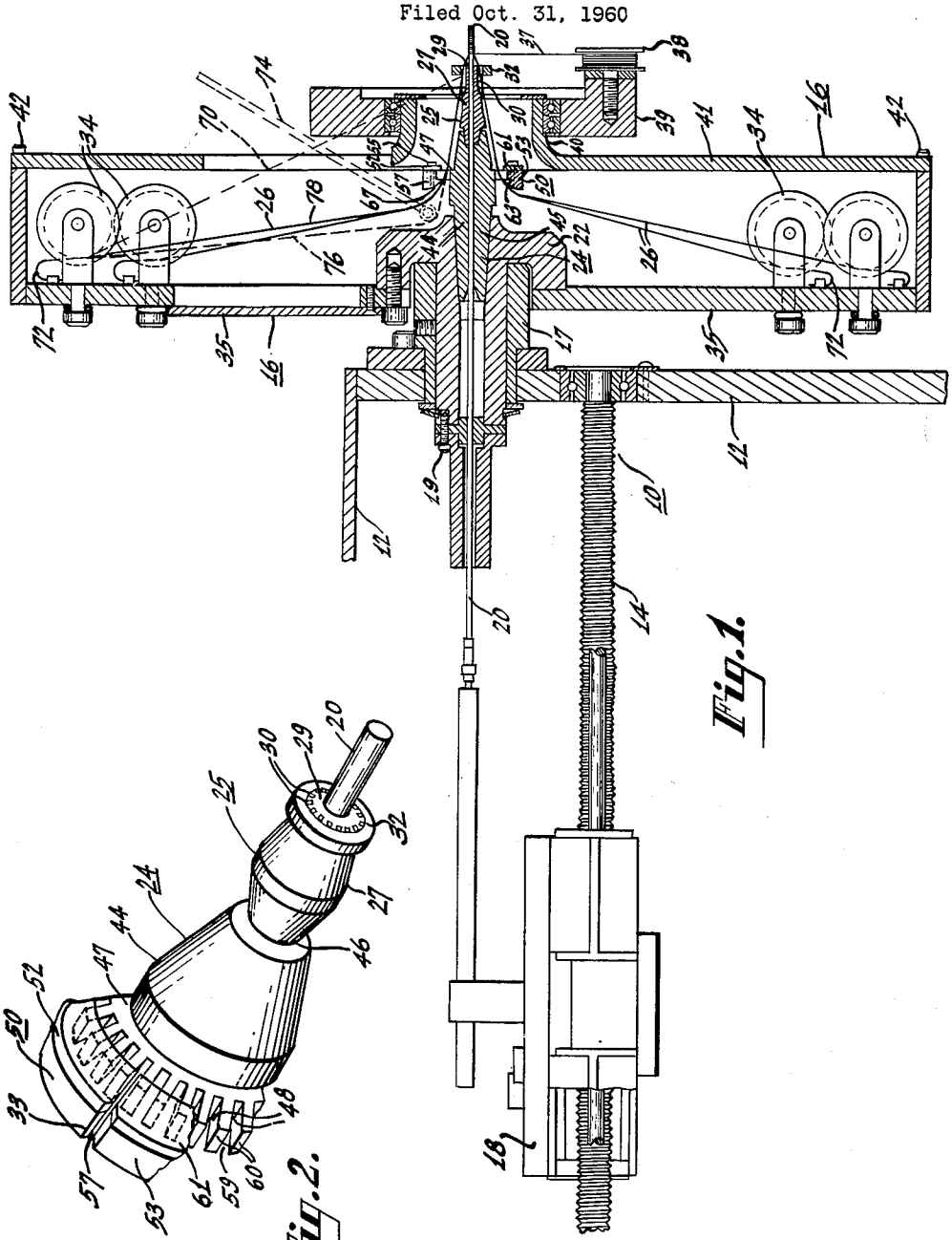

Fig. 1.

Fig. 2.

INVENTOR.
OTTO H. SCHADE, SR.
BY
William A. Galesak
ATTORNEY

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METHOD OF MAKING WIRE-WOUND GRIDS FOR ELECTRON TUBES

Otto H. Schade, Sr., West Caldwell, N.J., assignor to Radio Corporation of America, a corporation of Delaware

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This invention relates to apparatus for making wire-wound grids for electron tubes and particularly to an improved apparatus and a method for threading and guiding wires in such apparatus.

In the fabrication of one form of wire-wound grid, a plurality of side rod wires are first laid down longitudinally along the cylindrical mandrel of a grid lathe and then a lateral wire is wound therearound in a plurality of helical turns. In the grid lathe for winding such grids, the side rode wires are fed from supply spools and guided onto the mandrel through slots uniformly spaced around the circumference of an annular wire guide nose piece. The nose piece contains a central bore through which the mandrel is fed. The tip of the nose piece is encircled by a metal ring which encloses the otherwise opened slots and thus forms an array of passageways through which the wires are fed.

According to prior art design, auxiliary wire guides are provided for guiding the side rod wires from the supply spools to the nose piece slots. The wire guides comprise long, small diameter tubes which extend from the spools and converge upon the nose piece. Because wire will curl if it is passed over an edge at a sharp angle, it is desirable that the change in direction of the side rod wires as they leave the ends of the guide tubes and enter the nose piece slots be gradual to avoid pressing and curling of the side rod wires against the end edges of the guide tubes. Curling of the side rod wires is undesirable because it causes harmful warping of grid electrodes made therefrom.

To minimize the change in direction of the side rod wires as they emerge from the guide tubes, it is necessary that the end of each guide tube be in line with a nose piece slot. Moreover, because it has been consided desirable to extend the guide tubes close to the nose piece to prevent breakage or entanglement of the side rod wires, it is necessary that the diameter of the circle formed by the converging ends of the guide tubes closely match the diameter of the nose piece tip. For small grid electrodes having, for example, an inside diameter of 66 mils, and seventy side rods, each of which is 0.75 mil in diameter, the diameter of the nose piece tip employed to fabricate such grids may be 73 mils, with but 1.5 mil spacing between the slots therein. Thus, in the attempt to match the diameter of the guide tube circle to that of the small nose piece tips used in the fabrication of small grid electrodes, it is the practice in the prior art apparatus to employ very small diameter guide tubes, and to space the converging ends of the tubes as close together as possible.

One disadvantage to this construction is that the threading of the fine side rod wires through the narrow bore guide tubes is a difficult and time-consuming operation. Also, because of the closeness of spacing of the ends of the guide tubes and the small spacing between the nose piece slots, it has been found especially difficult to grasp each side rod wire extending from its guide tube and to thread the side rod wire through the proper nose piece slot without entangling it with, or breaking the other side rod wires already threaded through the nose piece.

A further problem is caused by the clogging of the relatively long guide tubes by dust or metal dirt particle. Such dirt particles are often of an appreciable size compared to the bore of the guide tubes, and cause variable friction and hence variable tension of the side rod wires fed onto the mandrel. This in turn, causes distortion of the grid electrodes and undesirable electrical characteristics of tubes made with such grid electrodes.

It is therefore an object of this invention to provide improved means and method for feeding and guiding a plurality of wires particularly fine wires to means utilizing said wires.

More particularly, it is an object of this invention to provide improved means and method for threading a plurality of wires from supply spools through slots in the nose piece of a grid winding lathe.

A further object of this invention is to provide an improved wire guide in which clogging by dirt and interference with the feed of wires therethrough is minimized.

According to the invention, a slotted annular member coaxial with the nose piece is used to guide the wire. The slots, preferably uniformly spaced, are provided about the circumference of the annular member, each slot being in line with a corresponding slot in the nose piece. Encircling the annular member and rotatable about it is a draw ring which is adapted to close the annular member slots. The draw ring has a fine, radial aperture or slit which, by rotating the ring, may be slid over each annular member slot in turn. The method of threading the side rod wires through the nose piece slots, according to this invention, comprises threading the side rod wire through one of the slots in the nose piece. The draw ring slit is aligned with the slot in the annular member corresponding to the threaded nose piece slot and an intermediate section of the wire extending between the spool and nose piece is passed through the draw ring slit and into this annular member slot. The draw ring is then rotated to move the slit past the annular member slot, thereby closing the slot and enclosing the side rod wire therein. The advantage to this method is that each side rod wire may be readily picked-up at its supply spool, threaded into a nose piece slot, and then positioned out of the way to avoid interference with the threading of the next side rod wire.

The use of the apparatus as herein disclosed also minimizes clogging of the auxiliary wire guide by dirt particles as will be described hereinafter.

In the drawing:

FIG. 1 is a side elevation partly in section of a part of a grid winding machine incorporating this invention; and

FIG. 2 is an enlarged, partially broken away view in perspective showing the side rod wire guides of the machine shown in FIG. 1.

In FIG. 1 a part of a grid winding apparatus 10 includes a frame 12 on which a rotatable lead screw 14 and a winding head 16 are mounted. A carriage 18 is supported on the lead screw 14 and is adapted to be moved therealong in response to a rotation of the lead screw. Motor and drive means (not shown) are provided for rotating the lead screw 14. A mandrel 20 suitable for fabricating the grid thereon is mounted on the carriage 18.

The winding head 16 includes a support bushing 22 which is mounted within a tubular support 17 fixed to the grid winding apparatus frame 12. Winding head 16 is fastened to support 17 by bolts 19 (one shown) and is readily detachable from the frame 12 to facilitate substitution of winding heads therein and to facilitate adjustment and threading of wires within the winding head, as will be described.

Also included in winding head 16 is an auxiliary wire guide 24 which is mounted within support bushing 22.

Within wire guide 24, in turn, is mounted a wire guide nose piece 25 which comprises a tubular member 27 having at one end thereof a wire guide cylindrical tip section 29 in which a plurality of rectangular slots 30 (FIG. 2) are provided. The slots are spaced uniformly about the circumference of tip section 29, and a ring 32 is fitted therearound to form the end portions of the open slots 30 into an array of rectangular passageways. The support bushing 22, the wire guide 24, and the nose piece 25 are provided with aligned central bores in which the mandrel 20 may be advanced for a grid winding operation.

A plurality of side rod wire supply spools 34 are provided mounted on an annular spool plate 35 fastened to support bushing 22. For reasons to be described, the supply spools 34 are spaced relatively far apart from each other.

In the fabrication of a grid electrode, side rod wires 26 are fed from the supply reels 34 through wire guide 24, through slots 30 in the nose piece 25, and onto mandrel 20. A lateral wire 37 is wound around and upon the side rod wires 26 on the mandrel 20 from a lateral supply reel 38. The lateral wire supply reel 38 is supported on an annular rotatable member 39 mounted on a bushing 40 extending outwardly of disk 41. Disk 41 is fastened to spool plate 35 by bolts 42. The rotatable member 39 is rotated by motor and drive means (not shown).

As shown in FIGS. 1 and 2, the auxiliary wire guide 24 comprises a tubular member 44 having at one end an enlarged tapered opening 46 for receiving nose piece 25, and at the other end a slightly tapered frustro-conical section 45 for receipt by the support bushing 22. Centrally disposed on the tubular member 44 is an annular, gear-like member 47, having a plurality of slots 48 spaced uniformly about the circumference thereof. Wire guide 24 and nose piece 25 are mounted coaxial with each other, and each one of the slots 48 in annular member 47 is in line with a corresponding slot 30 in the nose piece tip section 29. Rotatably and snugly mounted about annular member 47 is a draw ring 50 which comprises a washer-like member 52 and a ring-like member 53 fastened together by screws 55. Except for a single fine slit 57 which extends radially through draw ring 50, the draw ring completely encircles the annulus 47. The inner or lower width of slit 57 is less than the width of the teeth 60 forming slots 48, and, when draw ring 50 is rotated to position slit 57 directly over one of the teeth 60, draw ring 50 closes all the outermost or radially outward ends 59 of slots 48. Washer-like member 52 and ring-like member 53 have portions or lips 61 and 63, respectively, which extend inwardly on either side of annulus 47 for snugly clamping the draw ring 50 to annulus 47, and for partially closing the open side ends of slots 48 for reasons to be described. Lip 63 of ring-like member 53 is provided with an outer polished surface 67 which is curved inwardly towards slots 48 for guiding the side rod wires 26 from spools 34 into the slots 48.

In the threading of the side rod wires 26 through the nose piece slots 30 in accordance with this invention, an end of side rod wire 26 is picked up at a supply spool 34 and extended directly to the nose piece tip section 29, as indicated by dashed line 70 of FIG. 1. During the side rod wire threading operation, disk 41 and the lateral wire winding devices mounted thereon are detached from spool plate 35 to allow access to the side rod wire spools 34 and to the wire guides 24 and 25. The side rod wire is threaded through one of the slots 30 in the nose piece tip section 29 and secured by a piece of tape or the like to mandrel 20 protruding therefrom to prevent subsequent dethreading of the side rod wire. Since the supply spools 34 are spaced relatively far apart from each other on the spool plate 35, as mentioned, the side rod wire ends do not become entangled with each other, and may

be readily found and grasped by tweezers or the like for slot threading.

To prevent unraveling of the supply spools 34 and to maintain the side rod wires 26 under tension to prevent entanglement of the threaded wires, a spring 72 is provided at each supply spool which rides lightly against the wires 26 wound about spools 34.

After the side rod wire 26 is threaded through the nose piece slot 30, the draw ring 50 is rotated about annulus 47 until slit 57 is positioned over a slot 48 which is in alignment with the threaded nose piece slot. An intermediate length of the side rod wire 26 extending between the supply spool 34 and the threaded nose piece slot 30 is then depressed through slit 57 and into the aligned slot 48. To accomplish this, a small tool 74 (shown in phantom) having a bifurcated end for engaging the wire 26 is employed, and the wire is disposed from the position indicated by dashed line 70 to the position shown by dashed line 76. This latter position insures that the side rod wire is clear of slit 57 and fully inserted into slot 48 to avoid shearing off the wire 26 between draw ring 50 and the top edges of the slot walls when slit 57 is moved past the slot.

Draw ring 50 is then slid or rotated to position slit 57 over an adjacent empty slot 48, whereby the draw ring closes the loaded slot and traps the wire 26 therein. The closed wire threaded slot 48 thus serves as a duct for guiding a side rod wire 26 from a spool 34 to the nose piece tip 29. Tool 74 is withdrawn and the supply spool 34 is rotated by hand to take up the slack of the side rod wire and to tension the wire against the curved outer surface 67 of ring-like member 63, as shown by solid line 78. The threading process is repeated for each of the side rod wires 26 in turn, each side rod wire 26 being first threaded through a nose piece slot 30, and then passed through the slit 57 and inserted into a slot 48 in alignment with the threaded slot 30.

The advantage to the method of threading, as herein disclosed, is that the threaded side rod wires are positioned out of the way of the side rod wires to be threaded. That is, the path 78 of the threaded wires 26 from the supply spools 34 through the auxiliary wire guide 24 to the nose piece 25 is displaced well away from the path 70 of the wires from the spools 34 directly to the nose piece 25. Hence, pick up of the ends of the wires 26 at the spools and the threading of the wires through the nose piece slots 30 is relatively unimpeded by the prior threaded closely spaced wires.

As mentioned, a gradual rate of change in the direction of the side rod wires 26 as they emerge from the auxiliary wire guide 24 is necessary to prevent excessive curl of the wires. Another reason for minimizing the rate of change of wire direction is to reduce the wear of the nose piece slots 30 through which the wires are fed. If different slots wear away different amounts, the uniformity of side rod spacing about the mandrel 20 as provided by the slots 30 would be affected. Non-uniform side rod spacing in grid electrodes produces undesirable electrical characteristics of tubes using such grid electrodes.

According to this invention, the direction of the side rod wires extending between the supply spools 34 and the nose piece 25 is gradually changed within wire guide 24 by feed of the wires 26 over the curved outer surface 67 of lip 63. Moreover, because it has been found that there is no tendency of the wires extending between the wire guide 24 and the nose piece 25 to become entangled, it is possible to space the wire guide at a relatively large distance from the nose piece to minimize the angle of emergence of the wires 26 from the wire guide 24.

A further purpose of lip 63 is to guide the side rod wires 26 into interior portions of the slots 48 during feed of the side rod wires therethrough. The reason for this is to avoid possible snaring of the fine wires between

the draw ring **50** and the top edges of the teeth **60**, which would result in breakage of the side rod wires.

The side rod wires **26** are guided through the wire guide **24** along the curved outer surface **67**, and are maintained in line with the nose piece slots **30** by the sides of slots **48**. The bottoms of the slots **48** serve no wire guiding function, and hence, the height of the slots **48** may be made sufficiently large to avoid clogging of the slots due to dirt particles. In this manner, variable friction of the feed of the side rod wires through the wire guide **24** is avoided, and the tension of all the side rod wires fed onto the mandrel may be kept uniform to prevent warping of the grid electrodes.

What is claimed is:

1. A method of threading a plurality of fine wires through passageways in a nose piece, said method utilizing a wire guide comprising an annular member having a plurality of slots therein, and a slidable member mounted on said annular member partially closing said slots, said method comprising extending a wire from a spool along a first path to said nose piece, threading said wire through a passageway therein and securing the threaded end of said wire to prevent subsequent dethreading, disposing an intermediate length of said extended wire through a slit in said slidable member and into a slot in said annular member, and sliding said slidable member to move said slit past said slot to maintain said wire portion therein, whereby the path of said wire from said spool to said nose piece is other than said first path.

2. A method of threading a plurality of fine wires through passageways in a nose piece, said method utilizing an auxiliary wire guide comprising an annular member having a plurality of slots therein, and a rotatable member mounted on said annular member adapted for closing said slots, each of said slots being in line with a corresponding passageway in said nose piece, and said rotatable member having a fine radial slit therethrough, said method comprising extending a wire from a spool along a first path to said nose piece, threading said wire through a passageway therein and securing the threaded end of said wire to prevent subsequent dethreading, rotating said rotatable member to position said slit above a slot in line with said threaded passageway, disposing an intermediate length of said extended wire through said slit, and rotating said rotatable member for closing said aligned slot to trap said wire therein, whereby the path of said wire from said spool to said nose piece is other than said first path.

3. A method of threading a plurality of fine wires through passageways in a nose piece, said method utilizing a wire guide comprising an annular member having a plurality of slots therein, and a slidable member mounted on said annular member partly closing said slots, said method comprising extending a wire from a spool along a first path to said nose piece, threading said wire through a passageway therein and securing the threaded end of said wire to prevent subsequent dethreading, disposing an intermediate length of said extended wire through a slit in said slidable member and into a slot in said annular member and out of contact with said slidable member, and sliding said slidable member to move said slit past said slot to maintain said wire portion therein while maintaining said wire out of contact with said slidable member, whereby the path of said wire from said spool to said nose piece is other than said first path.

4. A method of threading a plurality of fine wires through passageways in a nose piece, said method utilizing an auxiliary wire guide comprising an annular member having a plurality of slots therein, and a rotatable member mounted on said annular member adapted for closing said slots, each of said slots being in line with a corresponding passageway in said nose piece, and said rotatable member having a fine radial slit therethrough, said method comprising extending a first wire from a first spool along a first path to said nose piece, threading said first wire through a first passageway therein and securing the threaded end of said first wire to prevent subsequent dethreading, rotating said rotatable member to position said slit above a slot in line with said first passageway, disposing an intermediate length of said extended first wire through said slit, rotating said rotatable member for closing said aligned slot to trap said first wire therein, whereby the path of said first wire from said first spool to said nose piece is other than said first path, thereafter extending a second wire from a second spool along a path substantially parallel to said first path, and threading said second wire through a second passageway in said nose piece.

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