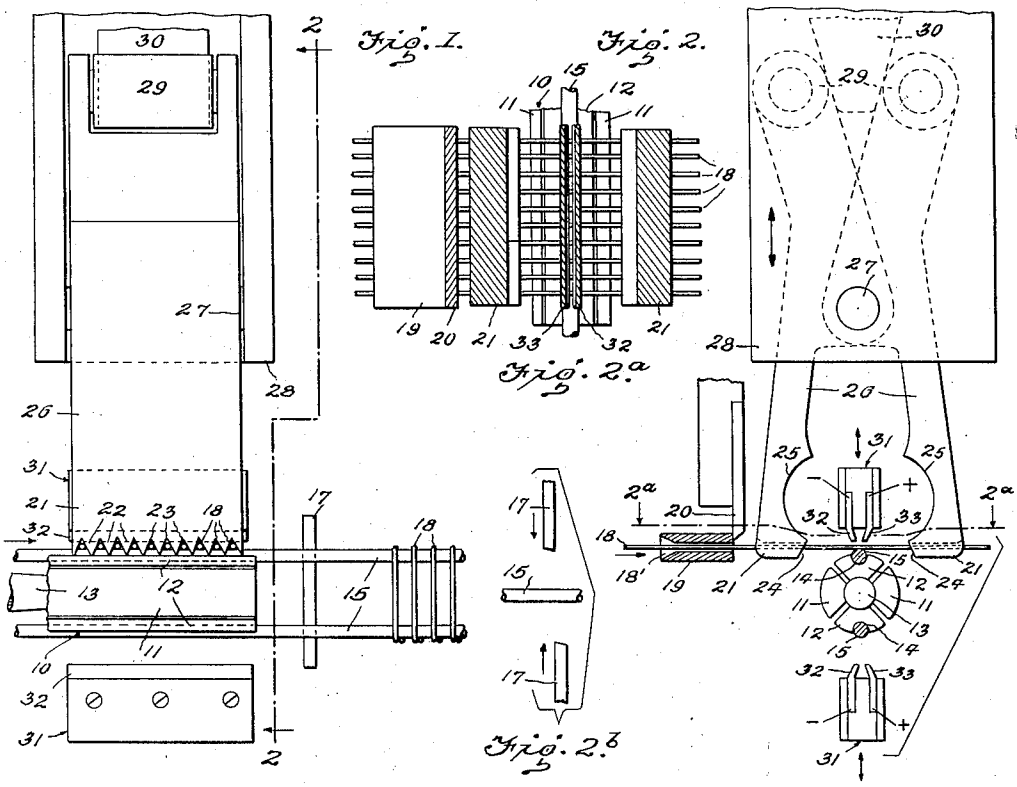
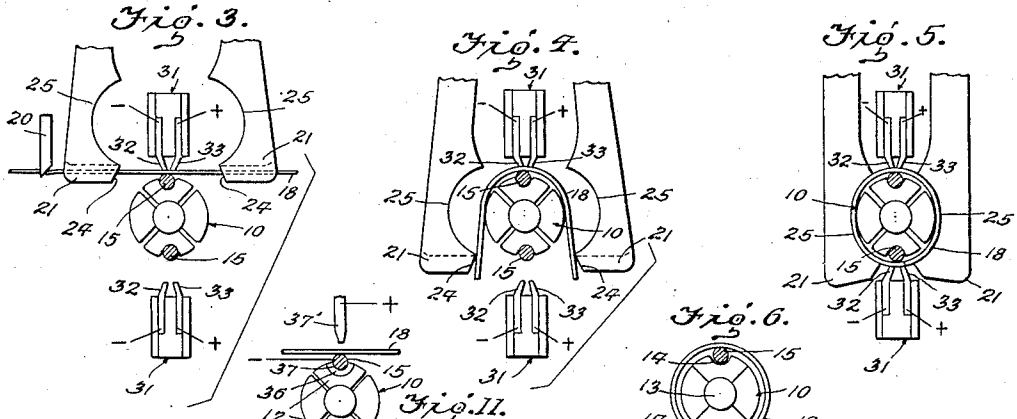
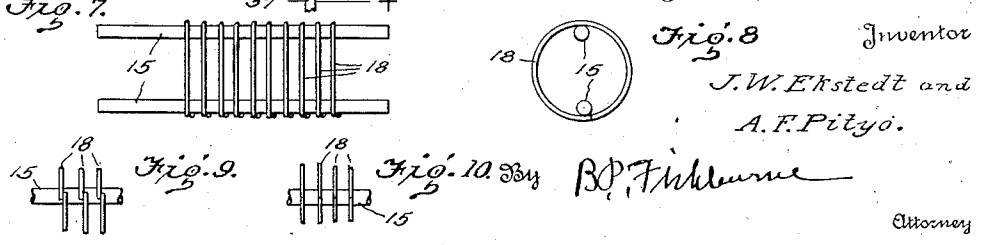
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METHOD OF PRODUCING GRIDS FOR ELECTRON DISCHARGE DEVICES

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METHOD OF PRODUCING GRIDS FOR ELECTRON DISCHARGE DEVICES

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The present invention relates to a method of producing grids for electron discharge devices, such as radio tubes or the like.

An important object of the invention is to provide a method of the above mentioned character for utilizing a single set of spaced grid wires which are formed and attached to side rods.

A further object of the invention is to provide a method of the above mentioned character, for producing grids in succession, in a completed manner, except for stretching and sizing.

A further object of the invention is to provide a method of the above mentioned character which will produce the grids quickly and economically.

A further object of the invention is to provide a method of the above mentioned character which is accurate and reliable in operation.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawing, forming a part of this application and in which like numerals are employed to designate like parts throughout the same,

Figure 1 is a side elevation of apparatus employed in the practice of the method, parts omitted,

Figure 2 is an end elevation of the same, taken on line 2—2 of Figure 1,

Figure 2^a is a horizontal section taken on line 2^a—2^a of Figure 2,

Figure 2^b is a plan view of the cutting means for the side rods,

Figure 3 is a view similar to Figure 2, parts broken away, showing a further step in the method,

Figure 4 is a similar view showing a further step,

Figure 5 is a similar view showing a further step,

Figure 6 is a similar view showing a further step,

Figure 7 is a side elevation of the produced grid,

Figure 8 is an end elevation of the same,

Figure 9 is a bottom plan view of the grid, parts broken away,

Figure 10 is a bottom plan view of a slightly different form of grid, and

Figure 11 is an end elevation of a modified form of mandrel and welding jaws.

In the drawing, wherein for the purpose of illustration is shown a preferred embodiment of apparatus used in the practice of the method, the numeral 10 designates a mandrel which is suitably supported and is held stationary and preferably horizontally arranged. This mandrel is not bodily rotated. This mandrel includes segments 11 and 12, and a reciprocatory tapered plunger 13. The mandrel has a normal circumferential size before the grid wires are bent or formed about the same, and after the grid is produced, the tapered plunger 13 is shifted toward its large end so that the segments 11 and 12 are radially collapsed, to permit of the removal of the grid from the mandrel. The segments 12 are provided in their peripheries with longitudinal grooves 14, to receive the metal side rods 15, which are moved longitudinally therein. These grooves constitute a pair which are preferably arranged in a vertical plane, thereby holding the side rods 15 in a vertical plane.

The side rods are severed by a cutting means including reciprocatory blades 17, and this cutting means is arranged near the discharge end of the stationary mandrel 10.

The side rods 15 are supported and guided into the grooves 14 and any suitable means is employed to effect a step-by-step longitudinal feeding movement of the side rods.

The numeral 18 designates a single set of spaced grid wires, which may be paid out from a spool or drum and guided and fed longitudinally, in an intermittent manner, by any suitable means. The grid wires 18 pass through openings 18' in a stationary guide 19, forming one blade of a cutting device for the grid wires. This cutting device includes a coacting reciprocatory blade 20.

Arranged near and upon the discharge side of the guide 19 are jaws 21, the lower ends of which are provided with downwardly tapering teeth 22, forming tapered openings or notches 23, between them. These notches are equi-distantly spaced and taper upwardly and receive therein the grid wires 18, and center and hold them. The two sets of teeth 22 of the jaws 21 serve to arrange and hold the grid wires in equi-distantly spaced parallel relation. The jaws 21 are provided at their lower ends with beveled faces 24. The jaws 21 have curved faces 25, corresponding to the curvature of the mandrel. The jaws 21 are carried by arms 26 and these arms are pivotally connected with each other by a pin 27 or the like, secured to a vertically reciprocatory head 28. The arms 26 extend above the pivot 27 and carry rollers 29, to be engaged by a wedge 30, which is movable vertically with the head 28 and with relation thereto.

The numeral 31 designates carriages of upper and lower welding devices, which carriages are

vertically reciprocated by any suitable means. Each carriage carries a pair of welding jaws 32 and 33, which are rigidly attached to the carriage and insulated therefrom and connected with the opposite poles of a source of welding current.

The practice of the method in connection with the apparatus herewith shown and described is as follows:

The jaws 21 are shifted to the uppermost position, Figures 1 and 2, and the side rods 15 are held within the grooves 14 of the mandrel 10, the mandrel being then in the normal expanded condition. This mandrel is held stationary. The set of grid wires 18 are advanced a step and then brought to rest, Figure 2. The grid wires are fed through the notches 23 and over and in contact with the upper side rod 15 and the grid wires are then horizontally disposed and positioned at a right angle to the longitudinal axis of the upper side rod. The teeth 22 of the jaws 21 hold the grid wires in the set equi-distantly spaced and in parallel relation. The grid wires 18 are now at rest and the next step in the method is to clamp the grid wires to the upper side rod 15, which is effected by bringing the carriage of the upper welding device downwardly toward the mandrel so that the upper welding jaws 32 and 33 clamp the grid wires to the upper side rod. The blade 20 of the cutting device is now moved downwardly and severs the leading portions of the grid wires. The severed grid wires now extend for equal distances upon the opposite sides of the upper side rod and are of the proper length to pass around the mandrel 10, and their length is determined by the extent of the step-by-step feed movement of the set of grid wires. The severed grid wires are now being clamped to the upper side rod against displacement, and the jaws 21, while remaining open, are now moved downwardly, Figure 4, and exert a downward pressure upon the severed grid wires near their ends and bend the severed grid wires downwardly about the upper portion and sides of the mandrel 10, Figure 4. The jaws 21 continue to move downwardly and when they have reached the lowermost position, so that their curved faces 25 are in proper alignment with the mandrel, the wedge 30 is moved downwardly while the jaws 21 are held at the lowermost elevation, and the faces 25 form the lower portions of the severed grid wires about the lower portion of the mandrel, Figure 5. The carriage 31 of the lower welding device is now moved upwardly and the lower welding jaws 32 and 33 clamp the ends of the formed grid wires against the lower side rod 15. The ends of each formed grid wire 18 preferably slightly overlap, although they may abut. The welding circuits are now closed and the current passes from one welding jaw to the other, in each pair, and through the adjacent portion of the wires 18 and side rod 15, and these wires are welded to each side rod. While it is preferred to delay the welding, until both welding devices clamp the grid wires to the side rods, yet the grid wires may be welded to the upper side rod 15 as soon as the upper welding device clamps the grid wires to the upper side rod, and the grid wires will then be subsequently welded to the lower side rod 15, when the lower welding device clamps the grid wires to the lower side rod. After the welding operation, the welding devices are moved from the mandrel 10 and the jaws 21 are moved laterally from the mandrel and returned to the raised position, Figure 2, at which time the mandrel is collapsed to release the formed grid, Figure 6. The side rods 15 are still within the grooves 14 and the side rods are now fed longitudinally a step, depending upon the desired length of the side rods, the formed grid being shifted longitudinally off of the mandrel, and the side rods are severed by the blades 17. This completes the cycle of operation of the method.

The produced grid now drops upon a conveyor or the like and is carried to an operator who may place the same upon a separate expansible mandrel, upon which the grid is stretched, shaped and sized.

In Figure 11, we have shown a slightly different form of mandrel and welding jaws. The segments 12 are shown as provided with insulating material 36, having grooves 37 formed therein to receive the side rods. Upper and lower welding jaws 37' are provided. Each welding jaw 37' is connected with one pole of a welding source of current while the opposite pole is connected with the side rod. When the welding jaw 37' engages the grid wires it clamps the grid wires to the side rod and when the welding circuit is closed, the current passes from the welding jaw 37' through the grid wires 18 and side rod to the opposite pole of the source of current. The welding jaws 37' extend entirely across the set of grid wires, and the same is true of the welding jaws 32 and 33. All other parts of the apparatus remain identical with those shown and described in connection with the first form of apparatus, and all other steps of the method remain identical with those described in connection with the first form of method.

The invention is not restricted to the use of a circular mandrel nor the circularly curved faces 25, as these parts may be in different shapes depending upon the desired shape of the grid to be produced.

As shown in Figures 7 to 9, the grid produced includes side rods 15 and grid wires 18 welded to the same. These grid wires are shown as circular, but the invention is not limited to this shape. The grid thus produced is subsequently placed upon an expansible mandrel and stretched, shaped and sized. The formed grid wires are accurately spaced and are parallel. The spacing of the grid wires and their number may be varied, as desired. The ends of each grid wire 18 slightly overlap, Figure 9, although they may be arranged to abut, Figure 10.

While we have shown the welding of the grid wires to the side rods, the grid wires may be secured to the side rods by notching or by any other suitable means.

It is to be understood that the form of our method herewith shown and described is to be taken as a preferred example of the same, and that changes may be made in the order of the steps of the method, and in the steps, without departing from the spirit of the invention or the scope of the subjoined claims.

Having thus described our invention, what is claimed is:

1. The method of producing a grid for electron discharge devices, comprising supporting laterally spaced side rods upon a stationary mandrel and arranging them substantially diametrically opposite to each other, arranging a set of separate spaced substantially parallel grid wires which are separate from the side rods transversely of one side rod and bringing the intermediate portions of the grid wires adjacent to such side rod and extending the grid wires for substantially equal

substantial distances upon opposite sides of such side rod, bending the end portions of the grid wires about the stationary mandrel to form closed loops which surround the mandrel and bringing the opposite ends of the grid wires into the engagement with the other side rod, welding the intermediate portion of the grid wires to the adjacent side rod, and welding the opposite ends of the grid wires to the other side rod.

2. The method of producing a grid wire for electron discharge devices, comprising supporting side rods in laterally spaced relation upon a stationary mandrel and arranging the side rods in a substantially vertical plane, feeding a set of continuous spaced separate grid wires transversely over the upper side rod while holding the grid wires substantially parallel and bringing the intermediate portion of the grid wires in contact with the upper side rod and extending the grid wires upon opposite sides of the upper side rod for substantial distances, clamping the intermediate portion of the grid wires to the upper side rod, severing the grid wires at a point spaced from the upper side rod so that the grid wires extends for substantially equal distances upon opposite sides of the upper side rods, engaging the grid wires upon opposite sides of the upper side rod and holding them properly spaced and forcing the grid wires downwardly into engagement with the mandrel to form closed loops which surround the mandrel and bring the opposite ends of the grid wires into engagement with the lower side rod, clamping the opposite ends of the grid wires to the lower side rod, simultaneously welding the intermediate portion of the grid wires to the upper side rod and the opposite ends of the grid wires to the lower side rod, and removing the grid from the mandrel.

3. The method of producing a grid for electron discharge devices, the steps of supporting laterally spaced side rods upon a mandrel and holding the mandrel against rotation, substantially simultaneously feeding a continuous set of separate substantially parallel grid wires transversely across one side rod so that the grid wires extends for substantial distances upon opposite sides of such side rod and the grid wires has an intermediate portion adjacent to such side rod, then clamping the intermediate portions of the grid wires to the adjacent side rod, then severing the grid wires at a point spaced from such side rod, then substantially simultaneously bending the grid wires about the mandrel and bringing the opposite ends of the grid wires in contact with the other side rod, and then welding the intermediate portions of the grid wires to the adjacent side rod and the opposite ends of the grid wires to the other side rod.

4. In the method of producing a grid for electron discharge devices, the steps of supporting side rods upon a stationary mandrel and circumferentially spacing the side rods upon the mandrel so that they are laterally spaced, feeding a continuous set of spaced substantially parallel grid wires transversely across one side rod so that the intermediate portions of the grid wires are adjacent to such side rod and the grid wires extend for substantial distances upon opposite sides of such side rod, holding the grid wires thus arranged against displacement in certain directions with relation to such side rod, then severing the grid wires at a point spaced from such side rod, then substantially simultaneously applying pressure to the opposite end portions of the grid wires and bending the grid wires around the mandrel for forming closed loops which surround the mandrel and bringing its opposite ends adjacent to the other side rod, and then securing the intermediate portion of the grid wires to the first named side rod and the opposite ends of the grid wires to the other side rod.

5. The method of producing a grid for electron discharge devices, comprising supporting side rods upon a stationary mandrel and holding the side rods stationary and generally parallel and laterally spaced, arranging a plurality of spaced separate grid wires which are separate from the side rods transversely of and adjacent to one side rod and bringing the intermediate portions of the grid wires into engagement with such side rod and causing the grid wires to extend for substantial distances upon opposite sides of such side rod, bending the opposite end portions of the grid wires about such side rod and mandrel for forming closed loops which surround the mandrel and bringing the opposite ends of the grid wires into engagement with the other side rod, and attaching the intermediate portions of the grid wires to the first named side rod and the opposite ends of the grid wires to the other side rod.

6. The method of producing a grid for electron discharge devices, comprising supporting side rods upon a stationary mandrel for holding them stationary and generally parallel and laterally spaced, arranging a plurality of spaced substantially parallel separate grid wires which are separate from the side rods transversely of and adjacent to one side rod and bringing the intermediate portions of the grid wires adjacent to such side rod and causing the grid wires to extend for substantial distances upon opposite sides of such side rods, bending the opposite end portions of the grid wires about such side rod and mandrel while maintaining the grid wires substantially parallel for forming closed loops which surround the mandrel and bringing the opposite ends of the grid wires adjacent to the other side rod, attaching the intermediate portions of the grid wires to the first named side rod and the opposite ends of the grid wires to the other side rod, and removing the assembled grid from the mandrel.

7. The method of producing a grid for electron discharge devices, comprising supporting laterally spaced side rods upon a stationary mandrel and holding them generally parallel, arranging a plurality of spaced separate grid wires which are separate from the side rods transversely of and adjacent to one side rod and causing the grid wires to extend for substantial distances upon opposite sides of such side rod while holding the separate grid wires substantially parallel, clamping the intermediate portions of the grid wires to the first named side rod, bending the end portions of the grid wires about the first named side rod and mandrel for forming closed loops which surround the mandrel and bringing the opposite ends of the grid wires adjacent to the other side rod, attaching the intermediate portions of the grid wires to the first named side rod and the opposite ends of the grid wires to the other side rod, and removing the assembled grid from the mandrel.

8. The method of producing a grid for electron discharge devices, comprising supporting laterally spaced side rods upon a stationary mandrel, moving a single set of spaced separate grid wires which are separate from the side rods transversely across one side rod while maintaining the grid wires substantially parallel and bringing the intermediate portions of the grid

wires adjacent to such side rods, clamping the intermediate portions of the grid wires to the adjacent side rod, severing the grid wires at a point spaced from such side rod so that the grid wires extend upon opposite sides of such side rod for substantial distances, substantially simultaneously bending the end portions of the severed grid wires about the mandrel to form closed loops surrounding the mandrel and bringing the opposite ends of the grid wires adjacent to the other side rod, attaching the grid wires to the side rods, and removing the assembled grid from the mandrel.

9. The method of producing a grid for electron discharge devices, comprising supporting laterally spaced side rods upon a mandrel, moving spaced separate grid wires which are separate from the side rods longitudinally so that they extend transversely across one side rod and have their leading ends spaced from such side rod, clamping the grid wires to such side rod, severing the grid wires at a point spaced from such side rod so that the grid wires extend for substantial distances upon opposite sides of such side rod, bending the end portions of the grid wires about the mandrel to form closed loops which surround the mandrel and bringing the opposite ends of the grid wires adjacent to the other side rod, attaching the grid wires to the side rods, moving the side rods longitudinally to shift the formed grid from the mandrel, and severing the side rods to separate out the formed grid.

10. The method of producing a grid for electron discharge devices, comprising holding laterally spaced side rods upon a stationary mandrel having a normal selected diameter, moving a set of spaced separate grid wires which are separate from the side rods longitudinally so that they extend transversely across one side rod while holding the grid wires substantially parallel and arranging their intermediate portions adjacent to such side rod so that the grid wires project beyond such side rod for substantial distances, clamping the grid wires to such side rod, severing the grid wire and a point spaced from such side rod, bending the end portions of the severed grid wires about the mandrel to form closed loops which surround the mandrel and bringing the opposite ends of the grid wires adjacent to the other side rod, attaching the intermediate portions of the grid wires to the first named side rod and their opposite ends to the other side rod, collapsing the mandrel to free the formed grid for longitudinal movement, moving the side rods longitudinally to shift the formed grid from the mandrel, and severing the side rods to separate out the formed grid.

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