May 16, 1967 J. G. WOEHLING 3,319,310

MANUFACTURE OF GRID ELECTRODES

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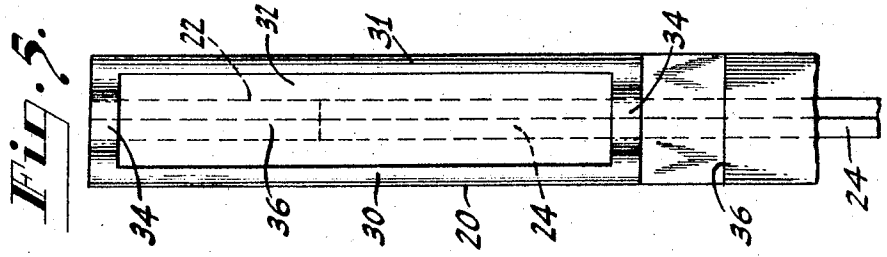

Fig. 5.

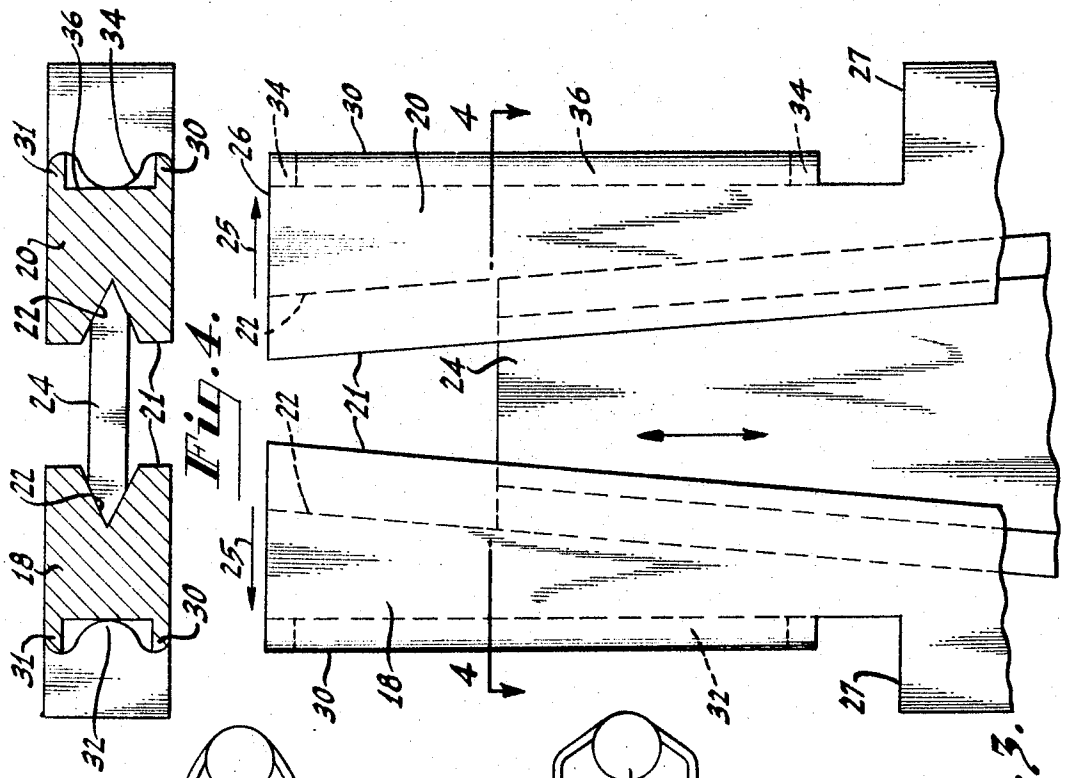

Fig. 4.

Fig. 3.

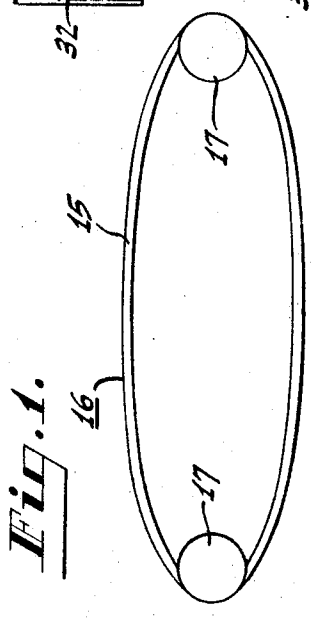

Fig. 1.

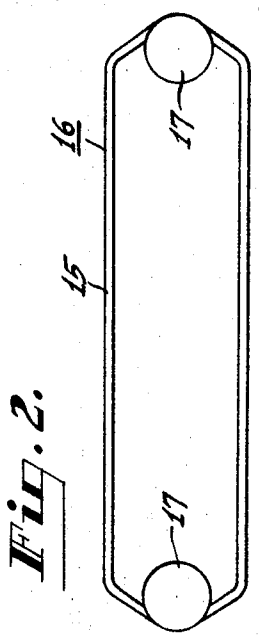

Fig. 2.

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Fig. 7.

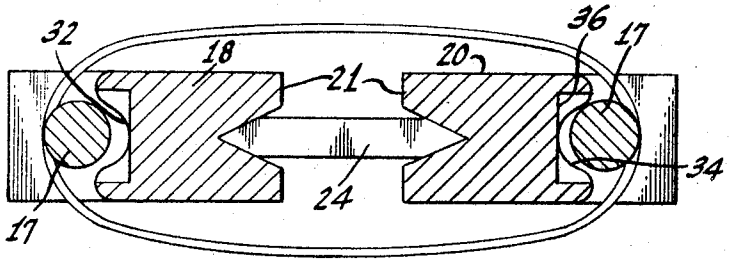
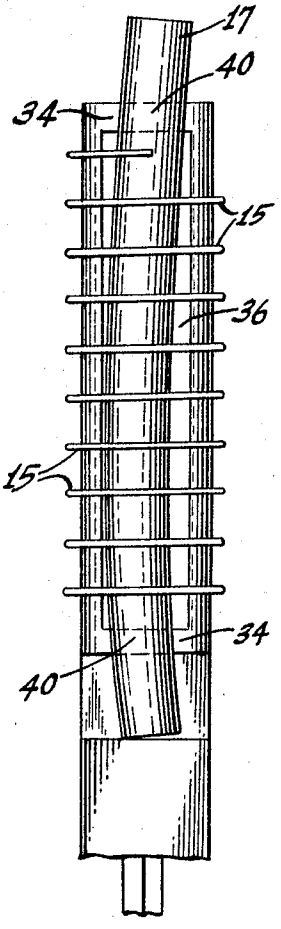


Fig. 8.



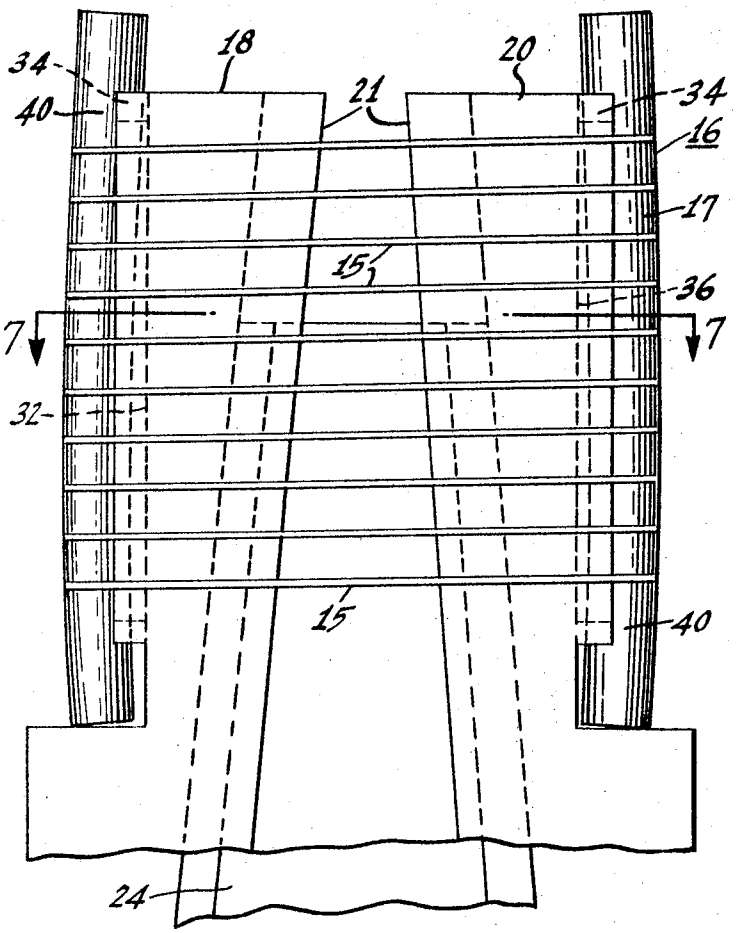


Fig. 6.

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Fig. 10.

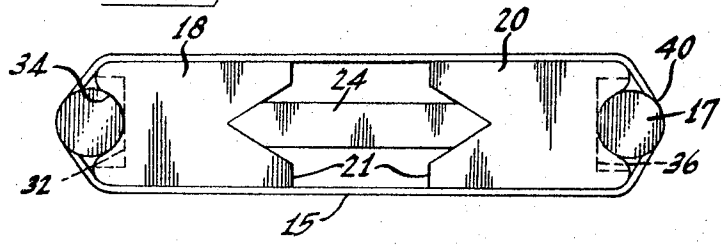
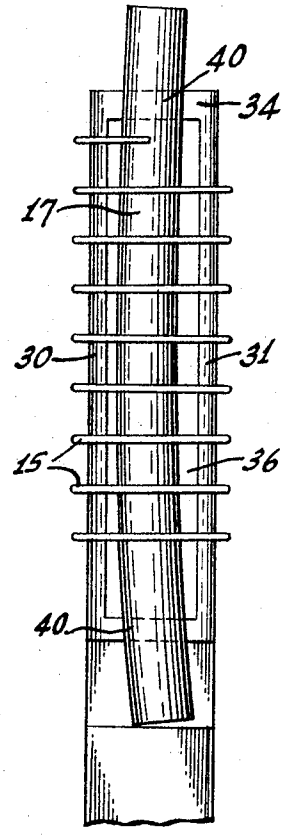


Fig. 11.



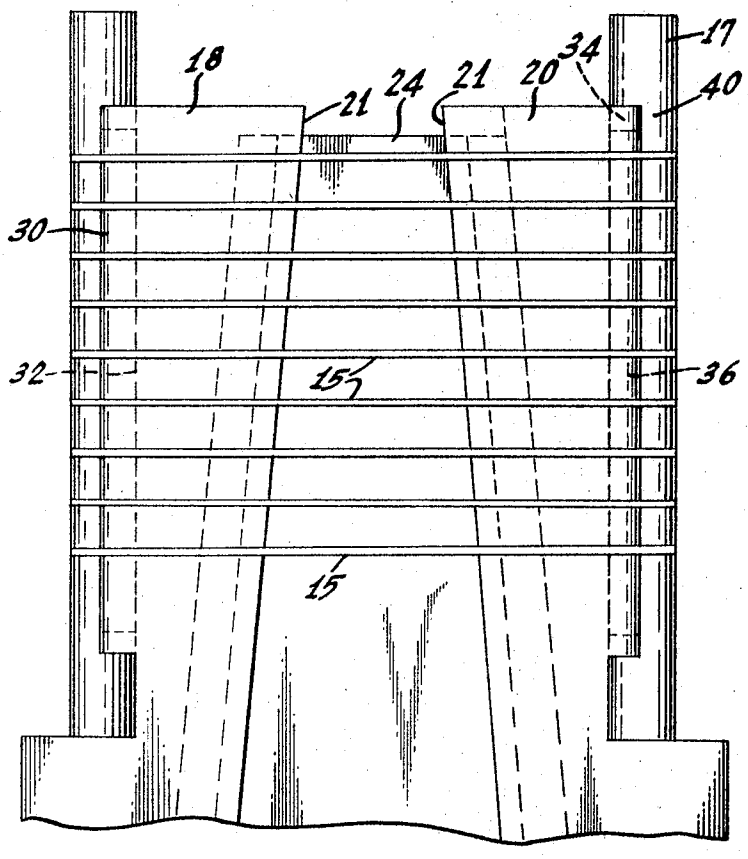


Fig. 9.

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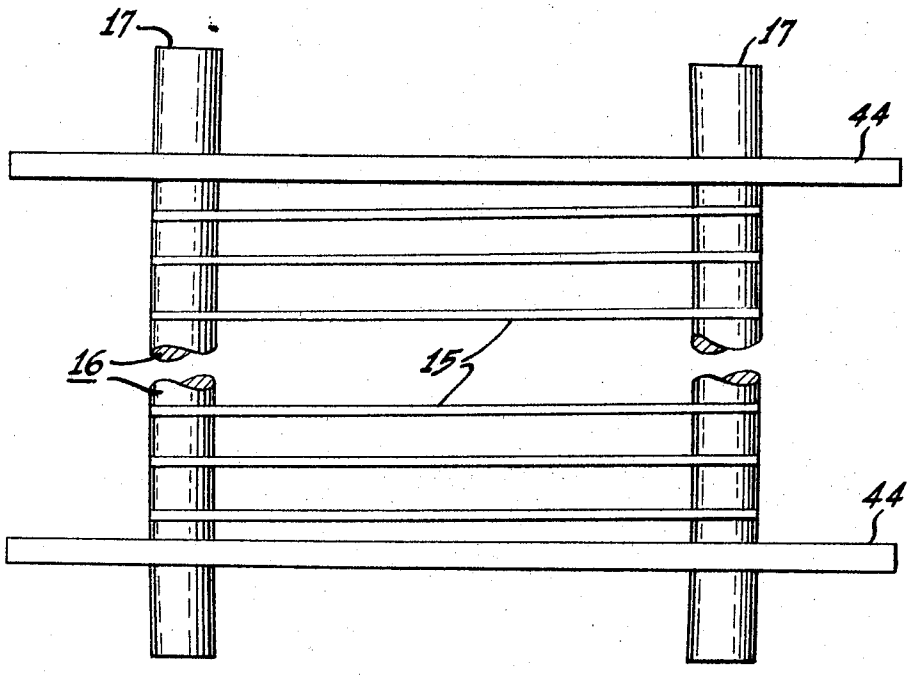
Fig. 12.



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3,319,310

MANUFACTURE OF GRID ELECTRODES

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Filed May 20, 1964, Ser. No. 368,866
1 Claim. (Cl. 29—25.18)

This invention relates to the manufacture of grid electrodes for use in electron discharge tubes, and particularly to improvements in the step in the manufacture of such grids known as sizing.

In certain types of grid electrodes comprising a pair of spaced apart side rods and a lateral wire wound in a helix around and secured to the side rods, it is the practice to size the grid electrodes to the desired grid dimensions and shape. The sizing step comprises mounting the grid around a pair of jaws, known as "sizing blades," and spreading the blades apart. Each blade has a semicircular groove along the outer side of the blade in which a side rod is received, and the blades have a cross section of the size and shape of the desired inner size and shape of the lateral wire helix. Upon the spreading apart of the blades, the side rods are forced apart thereby stretching the turns of the lateral wire helix and conforming them to the shape of the blades. Also, the side rods are pressed against the walls of the grooves and straightened.

A problem long recognized in the prior art is that when grids having side rods of resilient materials, such as molybdenum, are sized, the sizing operation is often only partially successful. The reason for this is that if the side rods are bowed before sizing, the resilient side rods are not permanently straightened by the sizing operation, and the side rods spring back to their original bowed shape after removal of the grid from the sizing blades. Since the lateral wire turns are stretched and shaped to their correct dimensions while the side rods are held straight by the sizing blades, the rebowing of the side rods after sizing causes distortion of the sized lateral wire turns. When used in electron tubes, the grids having distorted lateral wire turns cause variations from the desired electron tube electrical characteristics.

An object of this invention is to provide an improved method of fabricating grid electrodes.

A further object of this invention is to provide an improved method of sizing grid electrodes having bowed side rods.

For achieving the objects of this invention, a method is provided wherein the side rods of a grid electrode are forced apart to stretch and shape the lateral wire turns, but wherein straightening of the side rods occurs only to a small extent. That is, during sizing, only certain components of the side rod bow are removed or straightened, while other components of the side rod bow are unaffected. Thus, upon removal of the grid electrode from the sizing blades, little spring-back of the side rods to their original shape occurs due to the small amount of straightening of the side rods during the sizing operation. Also, in the assembly of the grid electrode into an electron tube, the side rods are mounted in such manner as to hold at least portions of the side rods in substantially the same relative position as these side rod portions were held during the sizing operation.

Advantages of this method will be described in connection with the drawings, wherein:

FIGS. 1 and 2 are end views of a grid electrode before and after the grid has been sized;

FIG. 3 is a front elevation of a portion of apparatus which may be used to size grid electrodes in the practice of the method of this invention.

FIG. 4 is a sectional view taken along line 4—4 of FIG. 3;

FIG. 5 is a side elevation of the apparatus shown in FIG. 3;

FIGS. 6, 7, and 8 are views similar to FIGS. 3, 4, and 5, respectively, and showing an unsized grid mounted on the sizing apparatus, the bow of the side rods of the grid being shown exaggerated;

FIGS. 9 and 11 are views similar to FIGS. 6 and 8, respectively, and showing a grid being sized by the apparatus;

FIG. 10 is a plan view of the apparatus shown in FIG. 9; and

FIG. 12 is a front elevation, partly broken away, of a grid electrode mounted between a pair of spacer plates of an electrode tube, other electrodes of the tube not being shown.

FIGS. 1 and 2 show the effect of grid sizing on the lateral wire turns **15** of a grid **16**. In the winding of the grid **16** the lateral wire turns **15** are wound with a generally elliptical shape (FIG. 1). After sizing (FIG. 2), the lateral wire turns assume a generally rectangular shape. Also, the sizing operation slightly increases the spacing between the side rods **17** over that of the unsized grid **16**.

FIGS. 3, 4, and 5 show sizing blades which may be used for sizing the grid shown in FIG. 1 to the shape shown in FIG. 2. The blades **18** and **20** are mounted on a support, not shown, which permits movement of each blade to the right or left, as shown in FIG. 3. Spring means, not shown, bias the blades toward one another. The inner side **21** of each blade **18** and **20** tapers away from the opposite blade from the top **26** to the bottom **27** of the blades, and each side **21** of the blades is provided with a dovetail groove **22** in which a tapered slide **24** may move. Upon upward movement of slide **24** between blades **18** and **20**, the blades are forced apart in the direction of the arrows **25** shown in FIG. 3.

Slide **24** is mounted on the support used to support blades **18** and **20** and means, not shown, are provided for moving slide **24** upwardly and downwardly. A stop, not shown, is provided for limiting the upward movement of slide **24**. Suitable blade and slide supporting and actuating means are well known in the art and are not described.

The outer sides **30** of blades **18** and **20** are provided with extending lips or walls **31** which extend almost the entire length of the blades and which provide side rod receiving grooves **32**. Adjacent the lower ends **27** and at the top ends **26** of the blades, portions **34** of the grooves **32** are semicircular in cross section (FIG. 4). The semicircular groove portions **34** are of such size as to receive portions **40** of the side rods **17** adjacent the ends of the side rods relatively snuggly in the grooves and to engage about one half of the circumference of the side rods, as shown in FIGS. 10 and 11. Between the semicircular groove portions **34**, portions **36** (FIGS. 4 and 5) of groove **32** are rectangular in cross section. As shown in FIGS. 8 and 11, the rectangular groove portions **36** have a width substantially greater than the diameter of side rods **17**, and the bottoms of groove portions **36** make only a substantially "line contact" with the side rods **17**, as shown in FIG. 10.

When slide **24** is fully inserted between blades **18** and **20** (FIGS. 9, 10 and 11) the blades have a size and shape corresponding to the desired inside size and shape of the lateral wire turns **15** of the grid electrode **16**. Also, at this time the semi-circular groove portions **34** are spaced apart a distance equal to the spacing between the apertures in the spacer plates **44**)FIG. 12) through which the grid side rods **17** are inserted during the assembly of the grid electrode **16** into an electron tube, as known. In FIG. 12 other electrodes, such as cathode and anode electrodes, normally also mounted between the spacer plates

44 of electron tubes are not shown for reasons of clarity.

In operation, a grid **16** to be sized is mounted around the blades **18** and **20** (FIGS. 6, 7, and 8) with the grid side rods **17** disposed adjacent grooves **32** and with the side rod portions **40** disposed adjacent the semicircular groove portions **34**. At this time, as shown in FIG. 6, slide **24** is in its downward position and blades **18** and **20** are in their inwardly biased position.

As shown exaggerated in FIGS. 6 and 8, the side rods **17** are bowed, and when mounted on blades **18** and **20** the side rods are not coaxial with grooves **32**. FIG. 6 shows the component of bow of the side rods in a first plane, and FIG. 8 shows the component of bow of the side rods in a plane perpendicular to the first plane.

Slide **24** is then moved upwardly between blades **18** and **20** (FIGS. 9, 10, and 11) thereby forcing blades **18** and **20** apart and in opposite directions. Side rods **17** are also forced apart thereby stretching and shaping the lateral wire turns **15** into conformity with the shape of blades **18** and **20**, as shown in FIG. 10.

When the side rods **17** are forced apart, the components of bow of the side rods parallel to the directions of movement of blades **18** and **20** are straightened, as shown by comparison of FIGS. 6 and 9. The components of bow of the side rods non-parallel to these directions, however, are not straightened, as shown by comparison of FIGS. 8 and 11. Straightening of these latter components of bow does not occur because the side walls **31** of rectangular groove portions **36** do not engage the sides of the central length portions of side rods **17**, and do not force these central length portions in directions other than the directions of separation of the side rods. During the sizing operation, therefore, only a small amount (as compared with prior art sizing methods) or straightening of the side rods occurs.

Upon removal of the grid **16** from the sizing blades **18** and **20**, comparatively little spring-back of the side rods **17** occurs due to the comparatively little straightening of the side rods during sizing. Some spring-back of the side rods may occur due to the straightening of the side rods in the directions of movement of the sizing blades **18** and **20**. It is found, however, that the effects of this latter side rod straightening and spring-back are generally not so great as to significantly impair the quality and usefulness of the sized grid electrodes. In any event, the reduction in the amount of straightening of the side rods during sizing, and the reduction in the attendant spring-back of the side rods upon removal of the grid from the sizing blades, results in a significant improvement in the quality of grids made as compared to grids made according to prior art sizing methods.

Further, during the sizing operation, the side rod portions **40**, which are positioned adjacent the semicircular groove portions **34** when the grid is mounted on the sizing blades, are engaged along the inner half of the circumference of the side rods by the walls **31** of groove portions **34** and moved into the same positions with respect to each other that the side rod portions **40** assume when the grid is assembled between the spacer plates **44** of an electron tube, as shown in FIG. 12. Therefore, regardless of any spring-back of the side rods **17** when the grid is removed from the sizing blades, upon assembly of the grid into an electron tube, the side rod portions **40** will be held in the same relative positions as they were held during sizing. Holding the side rod portions **40** in the sized position tends to also hold the remaining lengths of the side rods **17** and the lateral wire turns **15** in the sized position, thereby providing a high degree of uniformity in the size and shape of the grids from tube to tube.

What is claimed is:

A method of sizing a grid electrode having a pair of spaced-apart side rods and a lateral wire wound around and secured to said side rods, said method comprising:

positioning a pair of forming jaws within said grid electrode, said jaws having longitudinal grooves matching said side rods at short length end portions and oversize in width at the intermediate portion,

moving said jaws away from each other for engaging inner portions of the side rods along the lengths of the side rods and engaging side portions of the side rods only along said short length portions, and

continuing the movement of said jaws away from each other until appropriate stretching and shaping of said lateral wire result and simultaneously the matching groove portions act on the short length portions only of the side rods to dispose them in preselected positions.

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WILLIAM I. BROOKS, *Primary Examiner.*