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CATHODE SLEEVE STRUCTURE AND FABRICATION PROCESS

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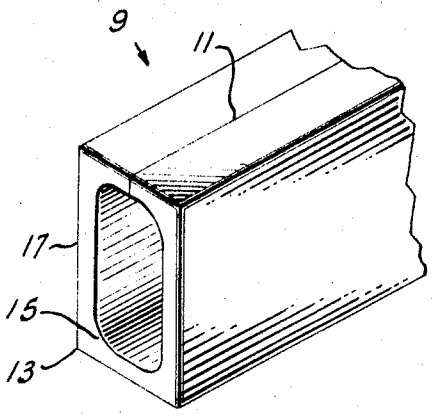

Fig. 1

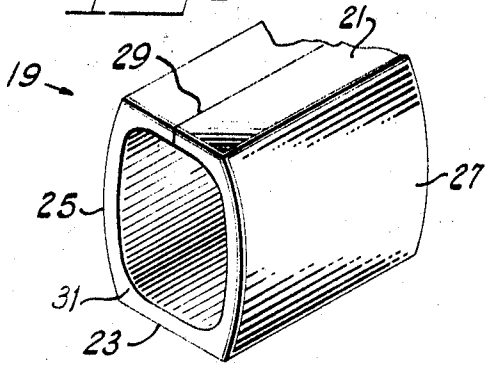

Fig. 2

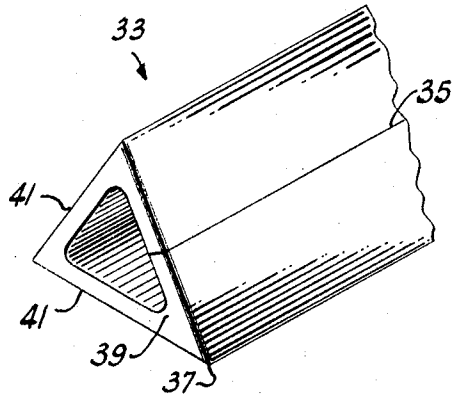

Fig. 3

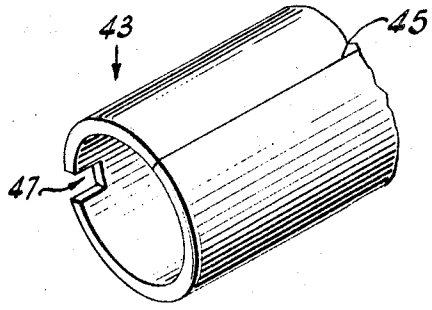

Fig. 4

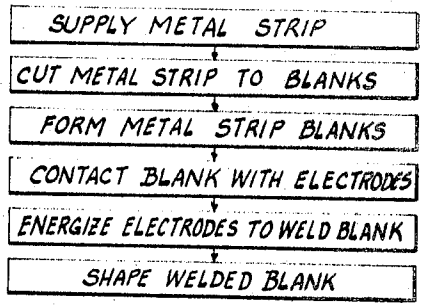

Fig. 5

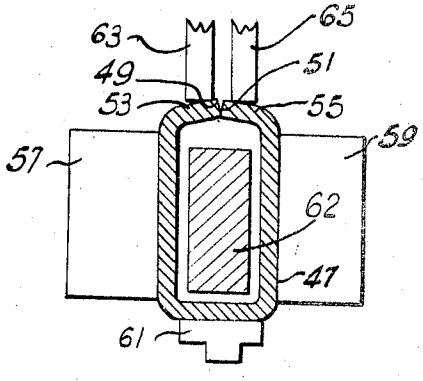

Fig. 6

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CATHODE SLEEVE STRUCTURE AND FABRICATION PROCESS

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U.S. Cl. 313—356 4 Claims

ABSTRACT OF THE DISCLOSURE

A cathode sleeve structure for electron discharge devices wherein the edges of strip material along the longitudinal axis thereof are butted and secured to one another by a weld.

This invention relates to cathode sleeves adapted for use in indirectly heated electron discharge devices and to a process for fabricating such sleeves.

The prior art suggests a variety of types of metallic cathode sleeves suitable for use in indirectly heated electron discharge devices. For instance, one of the more common cathode sleeves is the so-called seamless sleeve wherein a seamless tube is drawn to the desired diametrical dimensions. Other readily available cathode sleeves include the lapseam cathode sleeve wherein strip material is formed to provide an overlapping portion extending along the longitudinal axis, the lockseam cathode sleeve wherein the longitudinal edges of the strip material are formed into interlocking engagement, and the butt-seam cathode sleeve wherein the strip material is formed to provide a butting arrangement of the longitudinal edges.

While each of the above-mentioned types of cathode sleeve has been extensively used and provided acceptable results in numerous varieties of electron discharge devices for a great number of years, it has been found that each leaves something to be desired in the manufacture of certain present-day types of electron discharge devices. For example, it has been found that the manufacture of certain "strap frame" types of discharge devices, such as type 6ER5 for instance, requires a consistent grid to cathode spacing in the vicinity of 0.001-inch or less in order to provide the necessary limited range of electrical characteristics. Unfortunately, experience indicates that commercially obtainable cathode sleeves which have and consistently maintain such a necessarily limited range of exterior dimensions are unavailable.

More specifically, it has been found that the less expensive varieties of cathode sleeves such as the above-mentioned lapseam and lockseam cathode sleeves have an intolerable range of exterior dimensions. Further, the more expensive seamless cathode sleeve, costing about ten times the price of lockseam cathode sleeves, also fails to consistently meet the necessary exterior dimensional tolerances. Moreover, the die-type technique of fabricating seamless cathode sleeves tends to provide a product which gradually shifts from one dimensional tolerance extreme to the other in accordance with die wear. Obviously, shifting dimensional tolerances resulting in varying electrical characteristics is highly undesirable. Also, experiences with the buttseam type of cathode sleeve indicate that the original dimensional tolerances are not particularly meaningful due to the tendency of the structure to deform and the butted longitudinal edges to separate during the application of heat in a normal discharge device processing operation.

Therefore, it is an object of this invention to provide an enhanced cathode sleeve adapted for use in an indirectly heated electron discharge device.

Another object of the invention is to improve the exterior dimensional tolerances of a cathode sleeve adapted for use in an indirectly heated electron discharge device.

Still another object of the invention is to enhance the rigidity and resistance to bowing of a cathode sleeve adapted for use in an indirectly heated electron discharge device.

A further object of the invention is to provide an improved process for fabricating cathode sleeves adapted for use in an indirectly heated electron discharge device.

A still further object of the invention is to provide an improved and economical process for fabricating cathode sleeves of enhanced rigidity and exterior dimensional tolerances.

These and other objects are achieved in one aspect of the invention by a cathode sleeve structure of strip material having the edges along the longitudinal axis thereof butted together and secured by a weld. Also, the cathode sleeve structure is fabricated by a process wherein metal strip material is supplied from a source, cut to predetermined length, formed about a mandrel, contacted by welding electrodes, welded, and shaped by applying pressure thereto.

For a better understanding of the present invention, together with other and further objects, advantages, and capabilities thereof, reference is made to the following disclosure and appended claims in connection with the accompanying drawing in which:

FIGS. 1–4 illustrate various cathode sleeve embodiments in accordance with the present invention;

FIG. 5 is a flow chart illustrating a preferred process for fabricating the cathode sleeve embodiments of FIGS. 1–4; and

FIG. 6 is an explanatory illustration of a portion of the process of FIG. 5.

Referring to the drawings, FIGS. 1–4 will serve to illustrate several alternative embodiments of cathode sleeve structures in accordance with the invention. In FIG. 1, a substantially rectangular-shaped cathode sleeve **9** is formed from metal strip materials with the butted edges of the strip material secured by a weld **11** extending along the longitudinal axis of the cathode sleeve **9**.

The cathode sleeve **9** is formed by pressure, as will be explained hereinafter, in a manner such that the exterior dimensions are uniform and consistent and the exterior corners **13** are sharp, rather than rounded, rendering an enhanced planar surface suitable for the application of potentially emissive materials. Moreover, each of the exterior corners **13** has an interior fillet **15** joining adjacent ones of the side members **17** as a result of the pressure technique of fabricating the cathode sleeve **9**.

FIG. 2 is an alternative cathode sleeve structure **19** which includes a pair of spaced substantially parallel side members, **21** and **23** respectively, and a pair of spaced arc-like segments **25** and **27** intermediate and joined to the parallel side members **21** and **23**. As mentioned with respect to the cathode sleeve structure **9** of FIG. 1, metal strip material is employed to provide the cathode sleeve structure **19** and a weld **29** extending along the longitudinal axis thereof serves to secure the butted ends of the strip material.

Also, pressure is utilized in the fabrication process in a manner such that very uniform and consistent dimensional tolerances are obtainable. Further, an interior fillet **31** joins each of the parallel side members **21** and **23** to each of the arc-like segments **25** and **27** greatly enhancing the rigidity of the cathode sleeve structure **19**.

Another alternative embodiment is the substantially triangular-shaped cathode sleeve structure **33** illustrated in FIG. 3. Therein, the butted ends of strip material are secured along the longitudinal axis of the structure **33** by a weld **35**, the exterior dimensions of the structure **33** are uniform and consistent, the exterior corners **37** are sharp

providing a maximum surface area for potentially emissive materials, and an interior fillet **39** of material joins adjacent ones of the sides **41**.

FIG. 4 illustrates still another embodiment of the invention in the form of a substantially round cathode sleeve structure **43**. This cathode sleeve structure **43** is formed from strip material as mentioned above with the ends thereof butted together and secured by a weld **45** extending along the longitudinal axis of the structure **43**.

Also, a slot **47** has been included in this particular embodiment merely as a means for orienting the substantially circular structure during a fabricating process. Obviously, orientation of a substantially circular structure is necessary in order to have the butted edges aligned with the necessary welding apparatus and any one of a large number of techniques for orientation are equally applicable and appropriate.

Referring now to a process for fabricating the above cathode sleeve structures, a preferred fabricating process is illustrated in the flow chart of FIG. 5. As enumerated therein, metal strip material available from a continuous source is supplied to metal cutting apparatus. Preferably, the metal strip material is supplied by an indexing technique and any one of a number of well-known forms of cutting apparatus and indexing techniques suitable for providing metal strip material blanks is appropriate and applicable to the process.

The metal strip material blank is formed about a mandrel in a manner such that the edges thereof extending along the longitudinal axis of the strip material blank are slightly spaced from one another and both are slightly spaced from the mandrel. In other words, each of the longitudinal edges is spaced from the mandrel and the strip material blank tapers from the spaced longitudinal edge to a point of contact with the mandrel.

Then, the metal strip material blank is contacted immediately adjacent each of the longitudinal edges by a welding electrode means. This electrode means tends to remove the above-mentioned taper from the strip material blank forcing the edges into an abutting relationship along the longitudinal axis. The electrode means is energized from an electrical source, in a manner well known in the art, whereupon heat is provided in an amount sufficient to cause the metal strip material in the vicinity of and intermediate the electrode means to melt and flow to form a buttseam weld securing the contacting edges together along the longitudinal axis.

To more clearly illustrate the above discussion relating to the formation of a buttseam weld, reference is made to the explanatory diagram of FIG. 6. Therein, a metal strip material blank **47** is shown formed into a substantially rectangular configuration to provide a pair of edges, **49** and **51** respectively, spaced from and substantially parallel to each other and extending along a longitudinal axis. The strip material blank **47** has portions, **53** and **55** respectively, tapering toward the edges **49** and **51**. Also, the strip material blank **47** is positionally held by a pair of holding tools **57** and **59** and a bottom holding tool **61** which is preferably, not necessarily, pivotable. Further, a mandrel **62** is disposed within the blank **47** and serves merely to provide a means for transportation of the blank **47**.

An electrode means in the form of a pair of electrodes **63** and **65** is positionally mounted and movable in a direction substantially normal to the portions **53** and **55** of the blank **47** which taper toward the edges **49** and **51**. Each of the electrodes **63** and **65** is positioned to contact one of the portions **53** and **55** of the blank **47** at a point substantially immediately adjacent one of the edges **49** and **51** and to exert pressure thereon in an amount sufficient to cause removal of the taper forcing the edges **49** and **51** into a butting relationship with one another along the longitudinal axis of the blank **47**. Also, the previously mentioned pivotable bottom holding tool **61** adjusts in a manner such that substantially uniform contact between

the electrodes **63** and **65** and the blank **47** is provided throughout the longitudinal length thereof.

Thus, it can be readily understood that the removal of the taper provides not only an excess of metal strip material but also causes the development of a pressure between the butted longitudinal edges **49** and **51**. Hence, these desirable conditions enhance the securing of the longitudinal edges **49** and **51** by a weld upon energization of the electrodes **63** and **65**. As a result, the longitudinal edges **49** and **51** are continuously welded in a buttseam weld or at least are welded at a sufficient number of points along the longitudinal axis to provide a metallic mechanical joint having sufficient resistance to separation to permit the processing and operation thereof in an electron discharge device without deleterious distortion and variation in dimensions.

Following, the buttseam welded metal strip material blank is shaped to provide a desired configuration. More specifically, the strip material blank is disposed upon a mandrel of predetermined size and shape and pressure is applied to the exterior surfaces of the material blank by means of tools in an amount and manner such that the blank is formed to the shape of the mandrel and the tools.

For example, the substantially rectangular-shaped cathode sleeve structure of FIG. 1 would be formed from a buttseam welded metal strip material blank disposed upon a substantially rectangular mandrel having slightly rounded corners. Also, the tools for exerting pressure on the blank would have substantially parallel sides and very sharp corners. Since the blank would necessarily have to be larger than the mandrel whereon it is disposed, the tools are caused to strike the blank with sufficient force to cause the excess material to flow around the rounded corners of the mandrel forming the previously described desirable interior fillets as well as the desirable sharp exterior corners.

In this manner, there is provided a cathode sleeve structure having a substantially consistent and uniform exterior dimension even though the thickness of the metal strip material may vary. Also, the fillets of the cathode sleeve structure greatly enhance the rigidity and resistance to bowing of the structure. Further, the sharp exterior corners provide a maximum surface therebetween suitable for the deposition thereon of potentially emissive materials.

Additionally, numerous variations and refinements of the above-described process are applicable and appropriate. For example, a reducing atmosphere may be created in the vicinity of the welding area to reduce oxide formation and enhance the welding operation. Numerous means for creating such an atmosphere are well known in the art and a preferred technique is to apply a combined welding and lubricating fluid to the weld area prior to energization of the welding electrodes.

Further, one or a plurality of embossed or indented areas may be formed in the cathode sleeve structure either prior to, during, or after the shaping thereof. Preferably, the embossing or indenting of the cathode sleeve structure is carried out during the shaping operation in order to prevent distortion of the structure and a deleterious effect upon the desired uniformity of exterior dimensions.

As a specific example of the highly desirable results obtained with the above-described cathode sleeve structures a purchased sample of seamless cathode sleeves, suitable for use in a type 6EM7 receiving tube, was compared with a sample of buttwelded sleeves fabricated to the same specifications and of the same material in accordance with the above-described process. The purchased seamless sample and the buttwelded sample were both subjected to an identical bend test wherein the cathode sleeve was supported by a knife-edge at either end and a force exerted on the cathode sleeve at a point halfway between the supporting knife-edges. The collapse strength, which may be defined as the amount of weight applied at

the half-way point which causes the cathode sleeve to leave one of the knife-edges, was then compared. The collapse strength of the purchased seamless cathode sleeve sample averaged 516 grams as compared with an average value of 1084 grams for the buttwelded sample fabricated in accordance with the present invention.

Further, the purchased seamless cathode sleeve sample and the buttseam welded sample were both subjected to identical firing schedules. That is, both samples were fired in a dissociated ammonia atmosphere for 10 minutes at a temperature of about 1050° C. After firing, the seamless cathode sleeve sample has an average collapse strength value of 418 grams while the buttseam welded sample had an average collapse strength value of 607 grams. Obviously, such improved rigidity and strength greatly enhances the manufacture of electron discharge devices.

As a further comparison, a sample of purchased seamless cathode sleeves of substantially rectangular shape measuring 0.031 x 0.092 inch was compared with a sample of buttwelded cathode sleeves fabricated to the same exterior dimensions. As a result of the substantially sharp corners of the buttwelded cathode sleeve as compared with the rounded corners of the purchased seamless sleeves, it was found that the buttwelded cathode sleeve had an average of 10% greater surface area suitable for the application of potentially emissive materials. Since the usable surface area increases in percentage and significance as the size of the cathode sleeve decreases, the advantages of such a structure are readily understood.

Thus, there has been provided a unique cathode sleeve structure having numerous advantages which are believed to be unattainable in any cathode sleeve structure available in the art. The cathode sleeve structure has a unique uniformity and consistency of exterior dimensions, a rigidity and resistance to bowing, and a maximum surface area suitable for potentially emissive materials all of which are unavailable in any other known cathode sleeve structure. As a result, electron tube performance and reliability have been enhanced while such undesirable features as noise, microphonics, and a wide dispersion of electrical characteristics have been reduced.

Further, the unique process for fabricating such cathode sleeve structures is economical in both labor and materials and especially adapted to automated apparatus. Also, the process permits the utilization of thoroughly cleaned strip material, as compared with a die-type operation wherein lubricants are frequently used. Moreover, the enhanced process provides a product having a wide variety of accurately controlled shapes without folded seams which also lends itself to thorough cleaning and removal of contaminants.

Additionally, the process is ideally suited to a wide variety of materials which are available in strip form but unavailable in seamless form. More specifically, powdered metal materials are readily available in strip form but, as far as is known, unavailable in a form suitable for use in fabricating seamless cathode sleeve structures.

While there have been shown and described what are at present considered the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention as defined by the appended claims.

What is claimed is:

1. A cathode sleeve for an indirectly heated discharge device comprising: metal strip material having a longitudinal axis and a pair of edges along said strip being shaped to form an open-ended tube with an interior surface and an exterior surface and further having an abutting relationship of said edges and a weld intermediate to and securing said abutting edges to one another, said interior surface and said exterior surface of said sleeve being free of material overlapping adjacent portions of each of said surfaces at said abutting edge.

2. The cathode sleeve of claim 1 wherein said strip material is shaped to provide at least one interior angle having the sides thereof joined by a fillet of said strip material.

3. The cathode sleeve of claim 2 wherein said strip material is substantially rectangular-shaped having opposing substantially parallel sides with a fillet of strip material joining adjacent interior sides.

4. The cathode sleeve of claim 2 wherein said strip material is substantially triangular-shaped with a fillet of strip material joining adjacent interior sides.

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U.S. Cl. X.R.

29—25.17, 25.18, 477; 219—102, 104; 313—337