Dec. 1, 1953 E. J. WALSH 2,661,029

METHOD OF MAKING A FINE WIRE MESH

Filed Oct. 20, 1948

FIG. 1

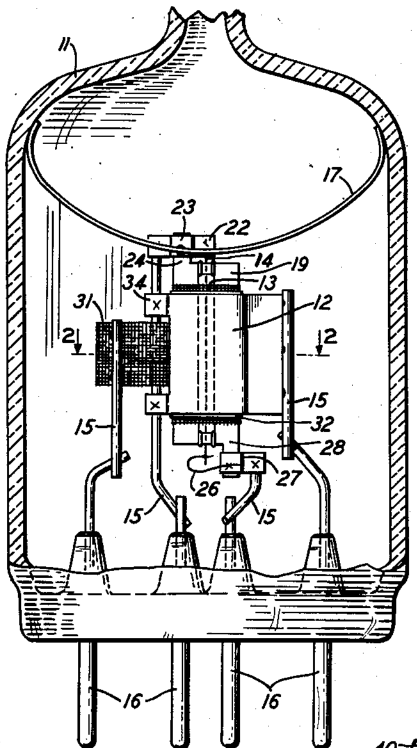


FIG. 3

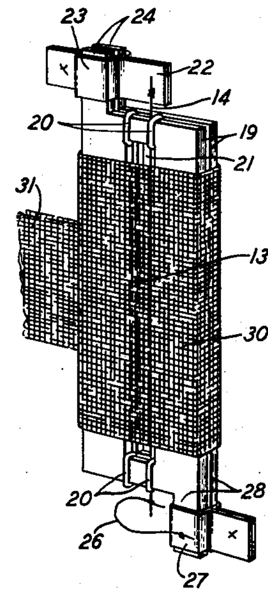


FIG. 4

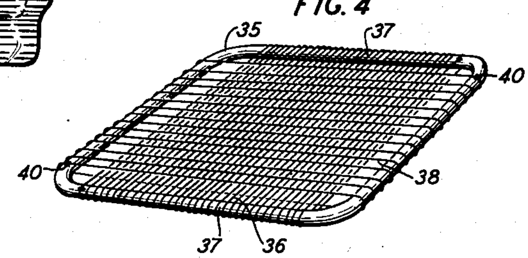


FIG. 2

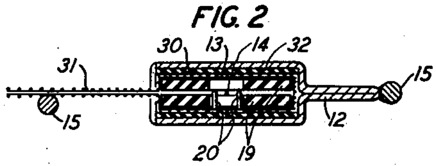
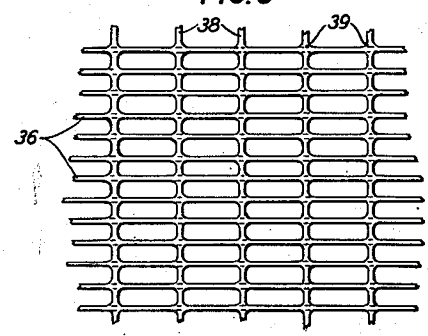


FIG. 5



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METHOD OF MAKING A FINE WIRE MESH

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3 Claims. (Cl. 140—71.5)

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This invention relates to a method of making a fine wire mesh and more particularly to a fine wire mesh for electrodes for electron discharge devices.

The main object of this invention is to obtain a finer wire mesh than heretofore available.

Another object is to simplify the method of manufacturing fine wire meshes.

The transconductance of electronic discharge devices depends on the spacing between the cathode, control grid, and screen grid, the diameter of the grid wire, the spacing thereof, the electrode area and the potentials applied to the electrodes. In order to attain a high transconductance certain factors must be incorporated in the grid structure including small diameter grid laterals, close spaced adjacent laterals, and mechanically stable laterals. When lateral diameters on the order of 0.0003 inch and less are employed in electrode structures, the advantages of the mechanical stability obtained by the mutual supporting effect of the intersecting laterals of a mesh electrode are obvious. However, the finest woven wire meshes heretofore commercially available have been limited to about 100 x 100 wires per inch using wires of about .0008 inch diameter. Such coarse meshes and such large diameters of the laterals have prevented the employment of mesh electrodes, particularly control electrodes, in tubes intended for the very high frequency ranges, since a poor transconductance is attained. Finer meshes have been formed by electrolytic processes. However, these meshes have had too large a closed area in relation to the open area to be employed in some applications in the construction of electron tubes.

According to this invention, meshes giving very satisfactory results as electrodes for high frequency tubes have been formed comprising a plurality of parallel lengths of fine wire all in a single plane which lie above and in contact with a second group of parallel lengths of fine wire which extends transverse to the first set and are also in a single plane which is parallel to the first plane. These wires are coated with a metal fusible below their fusing temperature and they are bonded together at their points of contact with each other by a fused joint of the metal coating. In the magnitudes to which this invention is particularly directed, that is, wires of 0.0005 inch and less diameter, it has been found that gold joints can be conveniently formed between the intersecting wires. In one method of manufacture gold is maintained adjacent the ends of wires and the mesh is subjected to a brazing temperature sufficient to melt the gold. The fluid gold flows out along the wires to coat them with a thin film of gold which fuses with the coating on the transverse wires to form a secure bond therebetween.

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A more complete explanation of the process of manufacturing the mesh of this invention and its application in a typical electrode structure will be forthcoming from the following detailed description when read in conjunction with the accompanying drawings in which:

Fig. 1 represents an elevation of a triode in which the mesh of this invention might be employed as one of the electrodes, portions of the envelope of the tube being cut away to more clearly set forth the relationship of the electrode structure;

Figure 2 is an enlarged cross-section of the electrode structure shown in Fig. 1 taken along the line 2—2 of Fig. 1;

Fig. 3 is a perspective of the electrode structure of the tube of Fig. 1 with the anode removed to show the relationship of the mesh to its support and to the filament;

Fig. 4 shows a perspective of the mesh and an associated frame on which it can readily be formed; and

Fig. 5 shows an enlarged portion of the mesh illustrating the joint formed by the flow of the metal coating at each intersection of the wires.

Referring now to the drawings, a triode employing a control grid formed from the mesh of this invention is disclosed in Fig. 1. The triode comprises a conventional envelope 11 housing an electrode structure including an anode 12, a mesh control electrode 13 and a filament 14. This electrode structure is supported in the envelope by the straps 15 extending from base pins 16 to the various electrodes and by the spring 17 secured to the upper portion of the electrode structure and frictionally engaging the inner walls of the envelope 11. The electrode structure proper comprises a filamentary cathode 14 mounted between a pair of frames 19 made up of a suitable insulating sheet material, such as a mica or a ceramic. These frames are assembled in a pile-up and are separated by quartz filament spacers 20 of slightly greater thickness than the filament. The filament is supported between these frames 19 and along the longitudinal axis of their windows 21 by a metal tab 22 formed from a portion of a strap 23 which is bound around extensions 24 on said frames. The other end of the filament is tensioned by a spring 26 welded to a strap 27 secured around an extension 28 on the lower end of the mica frame. A single sheet of wire mesh **30** is then wrapped around the frame to form an effective mesh grid surface **13** across the frame windows **21**, the grid being spaced from the filamentary cathode the thickness of the sheet material of the frame. The mesh **30** is cut, prior to its mounting on the frame **19**, so that integral tabs **31** extend from the side to provide an extension to which an electrical conductor, such as the strap **15**, may be secured. A second pair of frames **32**, each having a critical thickness which determines the grid to anode spacing, is then mounted over the mesh **30** with their windows aligned with those of the first frames. A sheet anode **12** is formed around the assembly and welded upon itself at its projecting tabs **34** to secure the completed electrode structure in its assembled relationship.

The mesh employed in the above-described tube is disclosed in Figs. 4 and 5. It comprises a plurality of coplanar parallel lengths of fine wire **36** parallel to and in contact with which is mounted a second group of coplanar parallel lengths of fine wire **38** transverse the first group. The wires are coated with a fine layer of a metal having a fusing temperature below that of the wires, the coating preferably being one of the noble metals, such as gold, when the mesh is to be employed as an electrode. This coating serves to braze the wires of the different groups together at their points of contact **39** with each other thereby stabilizing the mesh structure, and when this coating is of gold it also serves to prevent excessive primary emission when the mesh is employed as an electrode in vacuum tubes.

The following method has been employed in manufacturing a 500 x 700 gold brazed mesh of 0.0003 inch tungsten wire, such as might be employed in the tube of Fig. 1. A square frame is formed of tungsten wire, the ends of which are welded or brazed together at one corner. Tungsten is employed as the material of the frame in order to avoid any differential in the temperature coefficients of expansion of the wires of the mesh and frame. The frame faces are then ground down so that the upper and lower winding surfaces of each side of the square are coplanar with the upper and lower surfaces of the remaining sides. After cleaning, the frame is electroplated with gold, and is then placed in an oven and heated to about 1050° C. and held in that temperature range for a time sufficient to allow the gold to flow, thereby providing a microscopically smooth surface. This smoothing step is included in order to remove any small irregularities in the gold surface produced in the plating process which might throw off the position of the extremely fine wires of the mesh thereby causing variations in the spacing between adjacent wires. Next, the frame is mounted in a winding machine, for example, a machine employed for winding very high pitch grids for electronic discharge devices, and wound with fine wire to provide a group of parallel wires **36**, as disclosed in Fig. 4, extending over the sides **37** of the frame. A spot of reducible cement, such as nitrocellulose cement **40**, is applied to the ends of the winding to tack it to sides of the frame. Then the frame is removed from the winding machine and is placed in an oven containing a hydrogen or other non-oxidizing atmosphere and heated to about 1070° C. for a time sufficient to partially braze the wires to the frame with fused gold and evaporate the cement **40**. This operation also allows the gold to flow out along the fine wires thus preparing the way for the final joining of the second winding. A second winding **38** is then put on the frame, extending transverse to and over the first winding and secured thereto by cement **40**. The mesh and frame at this stage of construction appear as disclosed in Fig. 4. The mesh and frame are then placed in an oven containing a hydrogen or other non-oxidizing atmosphere and heated to about 1070° C. for a period sufficient to braze the second winding to the frame and complete the brazing of the first winding. It has been found that molten gold will flow along wires having diameters of less than 0.0005 inch. This phenomena is taken advantage of to cause the adherence of the wires of winding **36** to those of winding **38** at their intersections. The gold which is plated on the frame flows out on the wires of the windings and on cooling, the coating of one winding coheres to the coating of the other to provide a gold joint at their points of contact **39** as shown in Fig. 5. The mesh formed on the upper and lower surfaces of the frame **35** is cut away from the frame near its side and may be utilized in a structure such as the control electrode **13** shown in Figs. 1, 2 and 3.

A modification of the method of manufacturing this mesh includes the following steps. The frame is prepared as above but the plating step is omitted. Instead the wire to be used in the mesh is coated as by plating or evaporation with the metal it is desired to use as a bond. This coated wire is wound in two separate groups of transverse windings on the frame and is fired in a non-oxidizing atmosphere at a temperature sufficient to fuse the coating. The coatings of the wires at their points of contact adhere to each other on solidifying to bond the intersecting wires together. The mesh can then be cut away from the frame.

As many possible embodiments may be made of the above invention and as many changes might be made in the embodiment above set forth, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. The method of manufacturing a fine wire mesh which comprises winding a series of coplanar turns of fine wire on a gold-plated supporting member, winding a second coplanar series of turns of fine wire on said support transverse and in contact with said first series of turns, placing said support member and said windings in a non-oxidizing atmosphere, subjecting said windings and said support to a temperature sufficient to fuse said gold and permit it to flow along and coat said windings, and cooling said windings whereby the coating of one winding adheres to the coating of the other winding bonding the intersecting wires together.

2. The method of manufacturing fine wire mesh, comprising coating a support member with gold, heating said support member to cause the gold to form a smooth surface on said support member, winding a series of parallel turns of fine wire about said support member, winding a second series of parallel turns of fine wire over and at an angle to said first series of turns and in contact therewith, heating said support member and turns to the fusion temperature of gold in a reducing atmosphere, cooling said support member and turns to cause the gold to bond the wires at points of intersection, and removing the

resulting bonded meshes from said support member.

3. The method of manufacturing fine wire mesh comprising winding a series of turns of fine wire on a gold-coated frame, heating said frame and turns to the fusion temperature of gold, allowing the gold to flow over said turns, cooling said frame and turns, winding a second series of turns of fine wire transverse to said first series of turns and in contact therewith, heating said frame and turns to allow the gold on said first series of turns to bond with the second series of turns at the points of intersection, cooling said frame and removing the resulting mesh from said frame.

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