Oct. 20, 1959 C. F. MILLER ET AL 2,909,200

GRID ELECTRODES FOR ELECTRON DISCHARGE DEVICES

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Fig. 1.

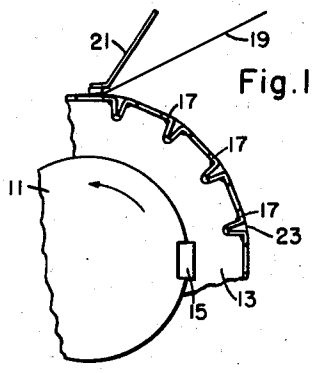


Fig. 3.

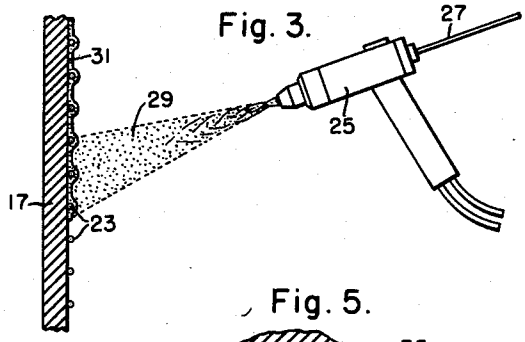


Fig. 2.

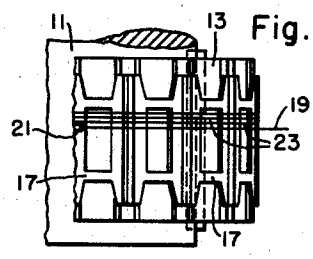


Fig. 5.

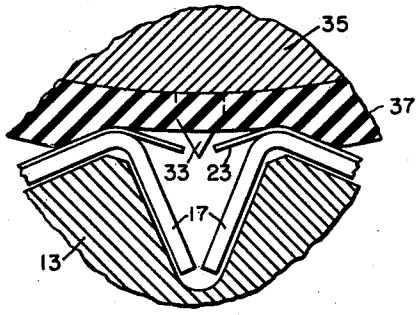
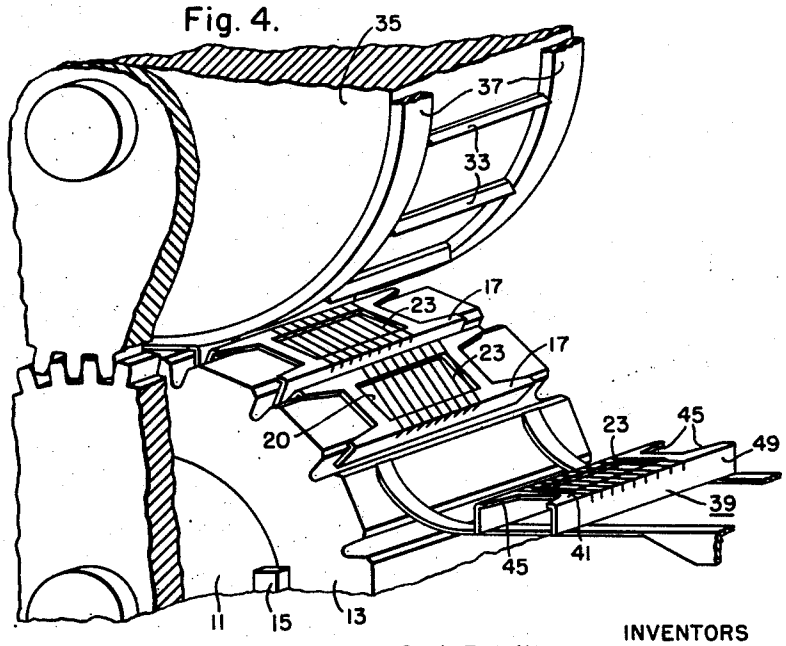


Fig. 4.



WITNESSES

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GRID ELECTRODES FOR ELECTRON DISCHARGE DEVICES

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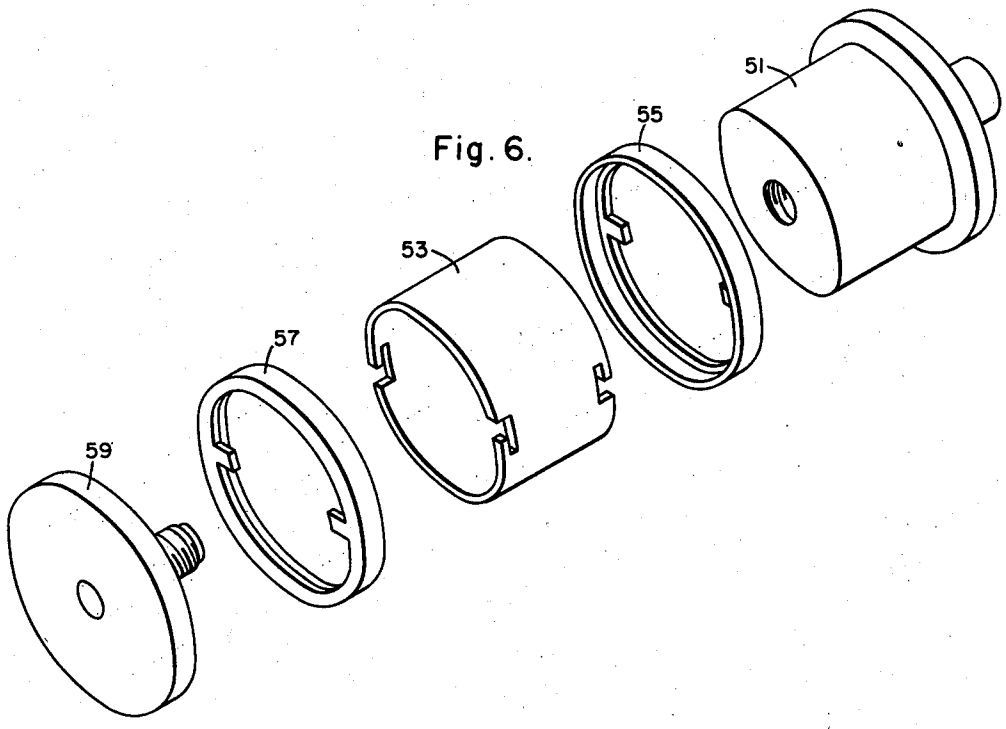
Fig. 6.



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GRID ELECTRODES FOR ELECTRON DISCHARGE DEVICES

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Application April 1, 1955, Serial No. 498,538

1 Claim. (Cl. 140—71.5)

This invention relates to electron discharge devices and more particularly to improvements in or relating to the construction of grid electrodes for use in said electron discharge devices.

In general, the present invention involves placing a number of grid frame members on a support member, winding wire material around the support member at any desired pitch, joining the wire material to the grid frame members at the intersections of the wire material and the grid frame members, and separating the completed grids from each other by cutting the wire material between adjacent grid frame members.

It is an object of this invention to provide a method of manufacturing grid electrodes for electron discharge devices.

It is another object to provide a method for manufacturing grid electrodes for electron discharge devices, which method is suitable for use in the automatic production of electronic parts.

It is an additional object to provide an improved grid electrode sturdy enough to be used in automatic production methods of manufacture.

It is a different object to provide a method of manufacturing grid electrodes for electron discharge devices, which method results in a lower percentage of rejected grids and, therefore, in higher efficiency in the manufacture of grid electrodes.

It is still another object to provide an improved method of attaching lateral grid wires to grid frames.

These and other objects of the invention will be apparent from the following description taken in accordance with the accompanying drawings which form a part of this application, and in which:

Figure 1 is a partial end view of the apparatus upon which the grid frame members are mounted during manufacture of the grid electrodes;

Fig. 2 is a top view of the apparatus of Fig. 1;

Fig. 3 is a view in elevation, partly in section, of a suitable method of joining grid wires to grid frame members;

Fig. 4 is a perspective view of the apparatus used to separate the completed grid electrodes from each other;

Fig. 5 is a cross sectional view of a part of Fig. 4 showing the cutting of the wires between the grid frame members; and

Fig. 6 is an exploded perspective view of another form of the apparatus upon which the grid frame members are mounted during manufacture of the grid electrodes.

In Fig. 1 there is shown a shaft member **11**, which may be rotatable, if desired, around which a mandrel member **13** is positioned. A key member **15** is used in positioning the mandrel member **13** on the shaft member **11**. Grid frame members **17** are attached to the mandrel member **13**. Suitable methods of attaching the grid frames **17** to the mandrel member **13** include providing the shaft member **11** and the mandrel member **13** with internal channels by which the grid frames **17** may be

held by vacuum to the mandrel member **13**. Another method is to utilize magnetic attraction to attach the grid frames **17** to the mandrel member **13**. Also the edges of the grid frames **17** can be held to the mandrel member **13** by a clip. Another suitable method is shown by Fig. 2. Wire material **19** is wound around the mandrel member **13** in such a manner as to cross the grid frames **17** a number of times. The spacing and the pitch of the wire **19** are guided by a guide member **21**. After the winding operation, if desired, the mandrel member **13** may be removed from the shaft member **11** and may be heated in a furnace during the brazing operation.

In Fig. 2 there is shown a top view of the apparatus of Fig. 1 including the shaft member **11**, the mandrel member **13**, the grid frame members **17**, the guide member **21** and lateral grid wires **23**.

In Fig. 3 there is shown a portion of a grid frame member **17**. A metal spray gun **25**, such as a Schoop spray gun, may be heated electrically or by means of gas or other combustible material and may be provided with a source of compressed gas to eject a spray of molten metal. The metal spray gun **25** is supplied with a rod **27** of a suitable metal to be used in joining the grid wires **23** to the grid frame **17**. In operation, the metal spray gun **25** creates a flame of intense heat in which the rod **27** is fused and is immediately subjected to a blast of air or gas whereby the molten metal is projected as a spray **29** of fused metal. The gas may be such as to prevent oxidation of the metal spray. In this way, a metal coating **31** is formed over the intersections of the lateral grid wires **23** and the grid frame members **17** so that the lateral grid wires **23** are bonded to the grid frame member **17**. Since it is possible to spray a large variety of metals by the Schoop process, a wide choice of metals are available for use in joining the grid wire **23** to the grid frame members **17**. Molybdenum has been found to be a suitable metal for use in the Schoop process, as have the brazing solder powders discussed below. Suitable masking to avoid metal deposition in undesirable locations may be used. Other methods which may be used to join the lateral grid wires **23** to the grid frame member **17** include cold welding, welding, notching and peening, and brazing.

In Fig. 4 there is shown the shaft member **11**, the mandrel member **13**, the key member **15**, the grid frame member **17** and the lateral cross wires **23**. Cutting members **33** are mounted on a cutting member support member **35** between rubber pads **37**. The cutting member support member **35** is geared to the shaft member **11** so that as the shaft member **11** is rotated, the cutting member support member **35** is rotated in such a manner as to position a cutting member **33** between each grid frame member **17** so that the wire material between the grid frames **17** is severed, thus separating the completed grid electrodes **39** from each other.

A suitable grid electrode is shown in Fig. 4 including a grid frame member **17** having a U-shaped cross section, a flat middle portion **41** and at least one aperture **20** in the flat middle portion **41**. Lateral grid wires **23** are positioned across the aperture **20** and joined to the grid frame member **17** by any of the methods discussed elsewhere in this application. The grid electrode **39** has tapered leg members **45** at the end portions. It is apparent, however, that the present invention is not necessarily limited to grid electrodes of the above configurations. The edge portions **49** of the grid frame member **17** may be positioned at any desired angle with respect to the flat middle portion **41** of the grid frame member **17** including perpendicular and coplanar configurations.

In Fig. 5 there is shown the actual cutting operation in which the cutting member **33** is severing the wires **23**

between the grid frames **17**. Also shown are parts of the mandrel member **13**, the support member **35** and the rubber pad **37**.

In Fig. 6 there is shown a mandrel member **53** upon which grid frames similar to the grid frame member **17** shown in Fig. 1 may be mounted. The grid frame members are held in position by collar members **55** and **57**. The mandrel member **53** with the grid frame members and collar members **55** and **57** attached is then fitted to the shaft member **51** and locked into position by screwing end member **59** into the shaft member **51**. After the winding operation the mandrel member **53** with the collar members **55** and **57** still attached may be removed from the shaft member **51** and brazed if desired. After the brazing operation, collar members **55** and **57** are removed from the mandrel member **53** before the grids are separated as is shown in Fig. 4. The mandrel members may have a smooth surface as shown by mandrel member **53** or a notched surface as shown by mandrel member **13** in Fig. 1.

Materials used for the grid frame members **17** and the lateral grid wires **23** must be chosen carefully. It is very important that the coefficients of thermal expansion of the grid frame members **17**, the lateral grid wires **23**, and any brazing materials used in joining the lateral grid wires **23** to the grid frame members **17**, be closely matched. A first combination of suitable materials would include grid frames **17** made of .015 inch sheet Kovar with lateral wires made of gold plated molybdenum of .002 inch diameter. In addition, if brazing is the method used to join the lateral wires **23** to the grid frame members **17**, a suitable solder powder is composed of 15% silver, 80% copper and 5% phosphorous, and is heated at 700° C. for three minutes. A second combination of suitable materials would include grid frames **17** made of .010 inch sheet steel of the type known in the trade under the designation SAE 1010 and lateral wires made of .002 inch diameter stainless steel. Again, if brazing is used as the method for joining the lateral wires **23** to the grid frames **17**, the preferred solder powder may be either one composed of 15% silver, 80% copper and 5% phosphorous which is heated at 700° C. for three minutes or a powder composed of 60% silver, 30% copper and 10% tin, which is heated at 750° C. for three minutes. In the brazing process methanol binders are suitable. Another suitable binder is polymerized methyl methacrylate, known under the trade name "Lucite."

This invention utilized a method suited for fully automatic grid manufacture procedures with a reduction of labor costs, improved efficiency and better control of tolerances. These grid electrodes may be made with from 100 to 400 lateral wires **23** per inch. The number of grid frame members **17** mounted on the mandrel member **13** or **53** may vary in number but groups of 2, 10 and 20 grid electrodes have been made at one time by this method. The wire **19** must be attached to the first grid by known methods such as spot welding or by the use of pins.

The mandrel member **13** or **53** may be of any desired shape or configuration but a cylindrical mandrel member is preferred because, using this shape, the circular winding speed is uniform which results in more uniform tension of the lateral grid wires **23**. After completing the winding, the wire **19** is fastened to the last grid frame member **17** in the same manner as it was first attached. Also, more than one mandrel member **13** may be supported on the same shaft member **11** allowing more grids to be manufactured in one operation.

While the present invention has been shown in a few preferred forms only, it will be obvious to those skilled in the art that it is not so limited but is susceptible of various changes and modifications without departing from the spirit thereof.

We claim as our invention:

A method of fabricating a plurality of frame grid members characterizing and having a planar support member with an aperture therein and lateral wires overlying and extending beyond said aperture, said method including the steps of providing a mandrel member, providing a plurality of positioning means on the surface of said mandrel for individually positioning a plurality of support members therein, securing said support members to the surface of said mandrel by magnetic attraction, winding wire material at equally spaced intervals across the apertures in said frames thereby providing a suitable number of lateral wires for each of said support members, spraying a molten metal onto said lateral wires and said support member to bond said lateral wires to said support member and separating the completed grid electrodes from each other and the mandrel to provide a plurality of individual frame grid electrode members.

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