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GRIDS FOR ELECTRIC DISCHARGE DEVICES

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FIG. 1.

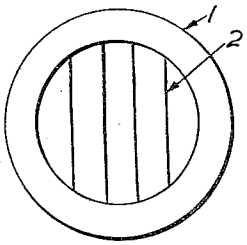


FIG. 2.

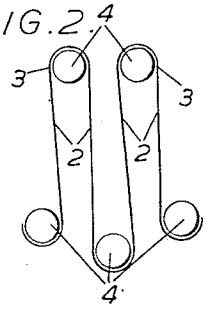


FIG. 3

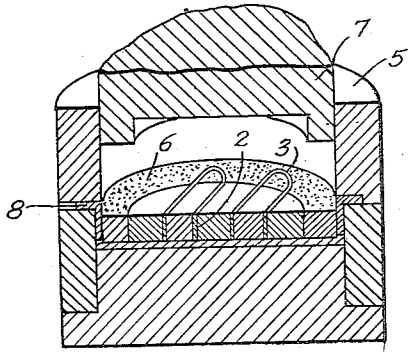


FIG. 4

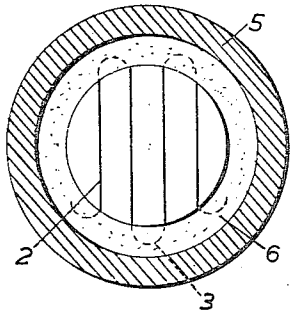
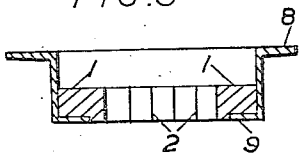


FIG. 5



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GRIDS FOR ELECTRIC DISCHARGE DEVICES

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4 Claims. (Cl. 313—348)

The present invention is concerned with grid constructions for use in electron discharge devices of the type employing substantially planar as opposed to coaxial electrode arrangements.

In electron velocity modulation tubes and similar devices wire or mesh grids are sometimes used to define the extent of a high frequency field traversed by an electron beam. In this way a larger effective area is available for the passage of the beam than is the case if a simple aperture be used, since the area of the latter is restricted by fringe effects of the electromagnetic field. A wire or mesh grid is usually operated at a positive potential and therefore intercepts electrons; hence, to distinguish them from apertured electrodes we call such grids interception grids.

Interception grids for use in high frequency apparatus are usually difficult to manufacture and to handle. The present invention simplifies the method of manufacture of a wire grid whether the wire be round or tape—by dispensing with the need for welding transverse wires onto a frame,

According to one aspect of the present invention there is provided an interception grid for use in an electron discharge device comprising a plurality of transverse metal wires embedded in a surrounding frame of sintered metal powder.

In an interception grid, the fraction of the current intercepted by the grid must be kept small for two reasons: the useful current is reduced at each interception and the grid is inherently poorly adapted for the dissipation of power.

Thus in a tube in which an electron beam crosses four grid planes as in a two resonator klystron amplifier or in a reflex klystron oscillator, if each grid intersects 10% of the beam current the final beam current is reduced by more than 25%. In general, in such tubes the interception factor must be kept less than 20% for a reasonable ratio of working current to electron gun current. Since, however, the interception factor to a first approximation is merely the ratio of the area occupied by the grid wires to the total area of the aperture over which the wires are stretched, this consideration leads to the use of very fine wires.

Round wires have the disadvantage that the area available for radiating power as heat is only twice the area intercepting current.

Similar considerations, of course, apply to interception grids in electron charge density modulation tubes. Although, in the present specification attention is directed primarily to grids for use in electron velocity modulation tubes, it will be evident that grids according to the invention will have applications in other types of electric discharge tube employing planar electrode structures.

According to another aspect of the present invention there is provided an interception grid for use in an electric discharge device comprising a substantially flat metallic frame and metallic strips stretched across the said

frame edgewise on to the major cross-sectional area bounded by the frame, the strips being embedded in the material of the frame to form an integral structure therewith.

From the point of view of manufacture, the present invention provides a method of manufacture of an interception grid for an electric discharge tube comprising bending wire to form a plurality of transverse members, securing the ends of the transverse members in an annular mass of powdered metal, compressing the powder to form a solid mass of the shape required for a frame supporting the said strips and firing the assembly to sinter the powder to form the assembly into a rigid integral unit.

The invention will now be described with reference to the accompanying drawings, in which:

Fig. 1 shows a plan view of a grid according to the invention.

Figs. 2 and 3 illustrate steps in the manufacture of a grid according to the invention.

Fig. 4 shows a cross-section through the plane 4—4 of Fig. 3.

Fig. 5 shows in section a grid incorporating in the unitary structure a surrounding piece part.

In the completed embodiment of Fig. 1 the grid comprises an annular substantially flat frame 1 of sintered metal across which is stretched a plurality of transverse metal members 2—in the present embodiment being edgewise-on strips—embedded in the material of the frame to form an integral structure therewith. The metal of the strips, depending on the operating temperature it is required to withstand, may be tungsten, molybdenum or nickel. In a typical grid the strip may occupy 10% of the total cross-sectional area within the frame.

In the manufacture of the grid a length of wire such as a tape 3, is wound back and forth upon a number of studs 4, as indicated in Fig. 2 to form the required plurality of transverse members 2 and is then heat treated in known manner to set it into the required shape. After it has been set into shape the wire is transferred to a slotted die 5, as shown in Figs. 3 and 4, the slots extending substantially the width of the transverse members. An annular recess corresponding in shape to the frame 1 is left around the slotted portion so that the bends of the wire are positioned therein. This recess is then filled with powdered metal 6, and a punch 7 is lowered into the die to compact the metal until it is compressed into a frame embedding the wire and can be removed from the die without fracture. The frame with its attached transverse members 2 is then fired to sinter the powder, after which the structure is substantially as strong as though the frame were of solid metal of the same dimensions. Since the wire extends well beyond the slots in the die the transverse members are solidly embedded in the metal and a very strong structure results.

If it be desired to mount the grid upon a piece part such as indicated at 8 in Fig. 5, the piece part may be loaded within the die before the metal is compressed, so that, after sintering, the transverse members 2, frame 1 and piece part 8 form a unitary structure with the grid in its final position. A lip 9 on the front edge of the piece part facilitates removal from the die. By choosing the right amount of powder, the grid tapes held by partially compressed powder may be forced into this lip, bringing the edge of the tapes to the front plane of the piece part. This procedure has the advantage that before sintering the grid can be handled by way of the metal piece part with less risk of breakage, the problem of securing the sintered frame 1 to another piece part after the sintering operation is eliminated and the strength of the piece part tends to eliminate distortions due to shrinkage

in firing particularly if the thermal expansions are correctly chosen.

By way of example we may quote the details relating to a particular grid having a circular frame with a 0.210 inch diameter central aperture. The wire used was 0.001 inch x 0.020 inch tungsten tape, the material of the frame being a mixture of equal parts of nickel and copper in a powder of 200 mesh size or smaller. A pressure of the order of 50 tons per square inch was used to compress the powder and the sintering operation was conducted in an atmosphere of hydrogen at a temperature of 940° C.

Nickel tape is easier to handle than tungsten but will not withstand such high temperatures; other compositions of powder, notably mixtures of tungsten with the 50:50 copper nickel mixture have been used.

The frame of the grid could of course, be rectangular or of any convenient shape other than circular if required. The shape of the transverse members inserted could also be varied, as by curving them, but when thin tape is used, the construction of the die becomes rather expensive unless a simple form be adopted.

While the principles of the invention have been described above in connection with specific embodiments and particular modifications thereof, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of the invention.

What we claim is:

1. An interception grid for use in an electric discharge device comprising a substantially flat annular metallic frame of sintered metal powder and a metallic strip stretched across said frame edgewise-on to the major cross-sectional area bounded by said frame and looped back and forth to provide a plurality of strips across the opening of said frame, the looped ends of said strips being embedded in the material of said frame to form an integral structure therewith and an annular metallic supporting cup integrally fastened to said frame externally thereof.

2. The method of manufacture of an interception grid for an electron discharge tube comprising arranging a wire tape in loops to form a plurality of transverse members, supporting said tape members intermediate their looped ends, placing the looped ends of the transverse members in an annular mass of powdered metal with the edges of said wire tape parallel with the axis of the annular mask, compressing the powder to form a solid mass of the shape required for a frame supporting said members and firing the assembly to sinter the powder to form the assembly into a rigid integral unit.

3. The method of manufacture according to claim 2, further comprising placing said annular mass in an annular metallic supporting cup prior to said compressing and sintering, whereby said frame and supporting cup are united to provide a readily handled grid unit.

4. The method of manufacture according to claim 2 wherein the wire tape is arranged by bending a single strand back and forth to form a plurality of transverse members.

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