Nov. 14, 1967 J. P. FIORE 3,351,996

METHOD OF MAKING A RECTANGULAR-MASK ASSEMBLY FOR A SHADOW-MASK TYPE OF COLOR TUBE

Filed March 29, 1965 2 Sheets-Sheet 1

FIG. 1

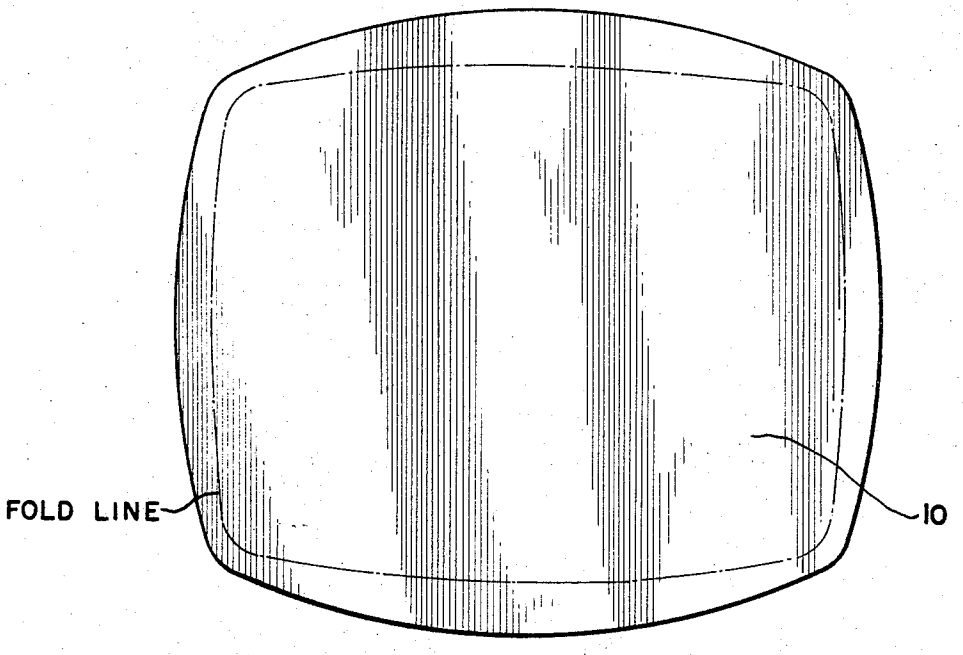



FIG. 2

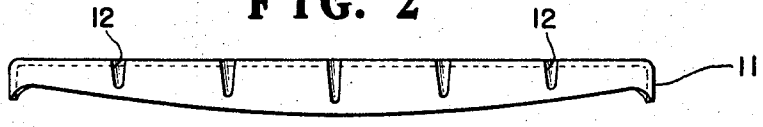
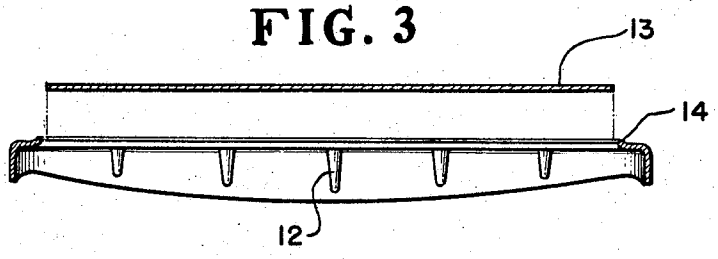



FIG. 3

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Nov. 14, 1967 J. P. FIORE 3,351,996

METHOD OF MAKING A RECTANGULAR-MASK ASSEMBLY FOR A SHADOW-MASK TYPE OF COLOR TUBE

Filed March 29, 1965 2 Sheets-Sheet 2

FIG. 4

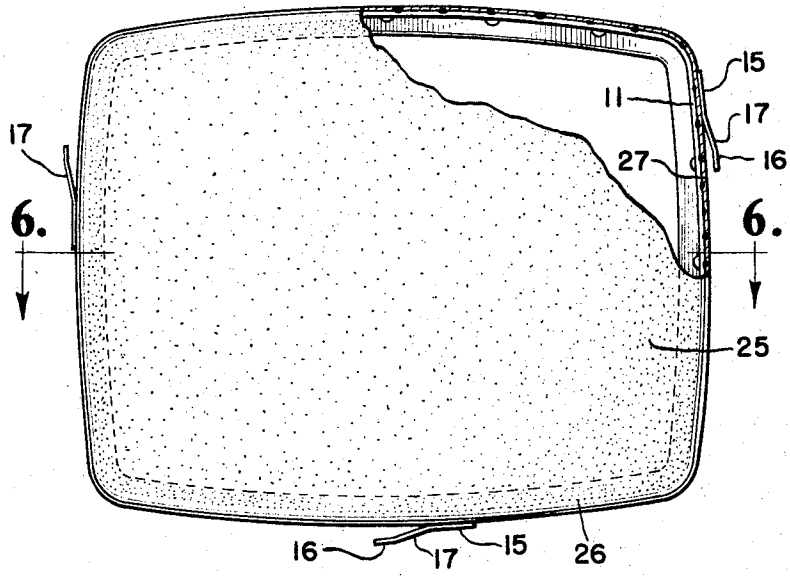



FIG. 5

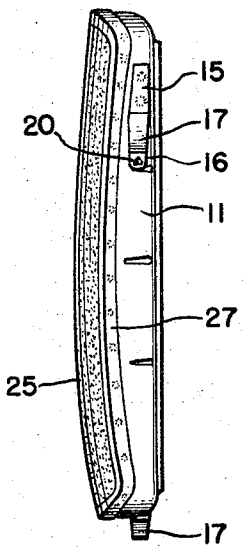



FIG. 6

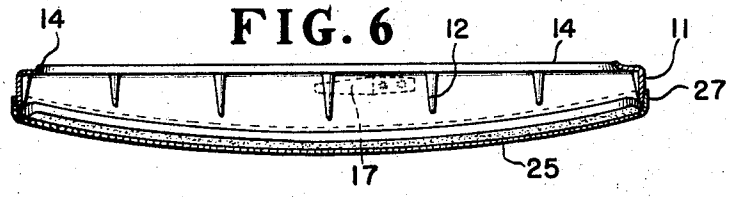



FIG. 7

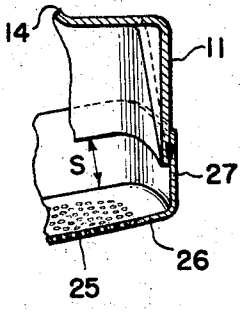



FIG. 9

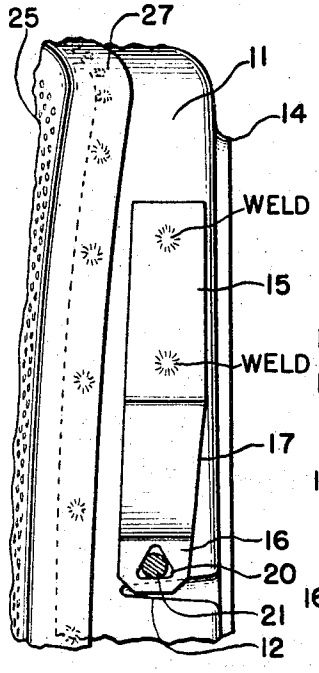
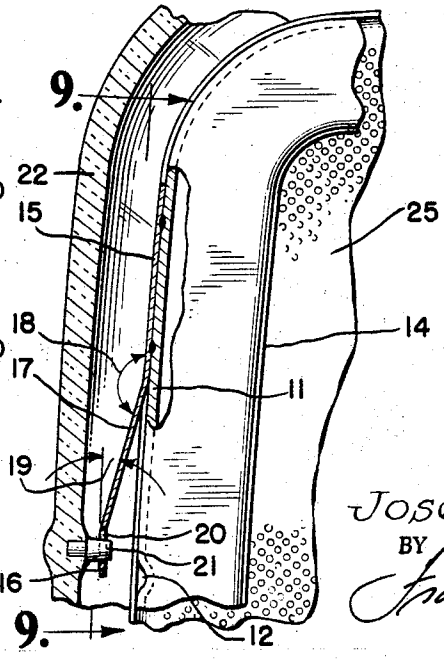



FIG. 8

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United States Patent Office

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3,351,996

# METHOD OF MAKING A RECTANGULAR-MASK ASSEMBLY FOR A SHADOW-MASK TYPE OF COLOR TUBE

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Filed Mar. 29, 1965, Ser. No. 443,467
8 Claims. (Cl. 29—25.13)

The present invention is directed to a method of forming a rectangular mask assembly for a shadow-mask type of color tube.

The shadow mask of such a tube is the means by which color selection is attained. It has a pattern of apertures disposed in a field which corresponds to the configuration of the image screen of the tube and is positioned between the screen and the three guns typically employed in a three-color simultaneous system. The arrangement is such that the electron beam from any gun, in reaching the screen through the apertures of the shadow mask, is permitted to impinge upon only those screen elements which emit light of the particular color to which that gun has been assigned, that is to say, where the screen is comprised of phosphor dots arranged in clusters of red, blue and green elements, the green gun is permitted to see only the green dots. In performing this function, the shadow mask intercepts a significant portion of the electron beam and, in the operation of the tube, it dissipates a considerable quantity of heat. It is not uncommon for the mask to attain a temperature of 125° C. during the operation of the tube.

The mask is made from thin metal stock and necessarily expands when subjected to such a high operating temperature. The expansion of the mask tends to displace the apertures within the aperture field and may result in misregistration. This will be evident when it is recognized that the phosphor dots are generally established on the screen through a photographic technique in which the mask of the tube is employed to establish the phosphor dot pattern. Necessarily, subsequent distortion of the aperture pattern due to heat or otherwise results in misregistration or an error in the beam landings relative to the phosphor dots over the image raster.

A unique mask structure that minimizes misregistration in spite of the heat dissipation is the subject of Patent 2,897,392, issued July 28, 1959 in the name of Joseph P. Fiore and assigned to the assignee of the present invention. That structure features an annular supporting frame for the shadow mask characterized by an L-shaped cross section with one leg disposed transversely of the tube axis and the other extending parallel to the tube axis in the direction of the screen. The leading edge of that leg has the same contour as the periphery of the shadow mask and it is welded to a mounting skirt extending from the mask parallel to the tube axis. The described structure has a generally rectangular configuration and the portion of the mask which has the aperture pattern is further shaped to conform essentially to the sector of a sphere. As explained in the patent, expansion of this structure in the presence of high ambient temperature causes the aperture mask to become more dome shaped, effectively to have a sharper radius. It is found that the increase in mask curvature maintains the registration of the electron beams with the phosphor dots because the displacement of the mask apertures is along a radial direction. This is in sharp contract with antecedent structures wherein the apertures of the mask tend to be displaced traversely of the tube axis with subsequent and substantial misregistration of the beams.

The present invention addresses itself to a process of forming such a mask assembly. It perfects the tube structure by eliminating other possible causes of misregistration even with a mask assembly of the type described in the Fiore patent. In particular, it minimizes distortions of the mask assembly which would otherwise be encountered in those process steps of the tube manufacture in which very high temperatures are encountered, for example in frit sealing and bakeout, which tend to introduce distortion in the mask supporting frame. Another source of difficulty which benefits from the invention is the series of leaf springs through which the frame is supported from studs projecting from the tube envelope and which may likewise be distorted by high processing temperatures. If that occurs, the springs may fail to engage their mounting studs with the proper orientation in which case the whole mask assembly suffers rotational displacement and consequent misregistration.



Accordingly, it is an object of the invention to provide a novel method of making a rectangular mask assembly for a shadow mask type of color tube.

It is a particular object of the invention to provide a method of making such a mask assembly which minimizes the possibility of distortion and misregistration due to the high processing temperatures of the shadow mask tube.

It is another particular object of the invention to improve the method of fabricating a rectangular mask assembly to achieve a high degree of thermal stability in the structure.

The method of the invention for making a rectangular mask assembly for a shadow-mask type of color tube comprises forming a rectangularly shaped mask with a pattern of apertures uniformly disposed over a substantially spherical section, which section is bordered by a mounting skirt disposed about the periphery of and extending normally to that section. The method also contemplates stamping from a sheet of metal, having a thickness many times that of the mask, a rectangularly shaped annular frame having principal dimensions large compared with those of the spherical section and having an outer edge contoured to correspond to the peripheral contour of the spherical section. The outer edge of the annular frame is folded normal to the plane of the frame to provide a mounting skirt of rectangular shape having predetermined dimensions for telescoping with the mounting skirt of the mask. The mask frame is heated to a temperature that is high compared to the operating temperature of the frame when included within an operating color tube in order to stress relieve the frame. Thereafter, the frame is restruck to restore its predetermined dimensions. The mask and frame are then assembled with their mounting skirts in telescoping relation and the skirts are mechanically secured, preferably by numerous welds spaced along their periphery.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings, in the several figures of which like reference numerals identify like elements, and in which:

FIGURES 1–3 are views used in explaining the formation of the frame component of the mask assembly;

FIGURE 4 is a view, partially in cross section, of a shadow-mask assembly constructed in accordance with the present invention;

FIGURE 5 is an end view of the assembly of FIGURE 4;

FIGURE 6 is a sectional view taken along line 6—6 of FIGURE 1;

FIGURE 7 is an enlarged detail view showing the telescoping relation of mounting skirts in the assembly of FIGURE 4; and

FIGURES 8 and 9 are enlarged views showing a mounting spring securing the assembly of FIGURE 4 to the envelope of a color cathode-ray tube.

The two major components of the mask assembly are formed individually and then assembled. These, of course, are the mask and its frame. For convenience, the formation of the mask will be considered first.

The mask is a very thin sheet of steel which has a multiplicity of apertures uniformly spaced in a rectangular field bordered by a strip of metal which is imperforate except for three spaced recesses used for positioning the sheet in a die press. The stock used in practicing the invention may, for example, be 5 mils in thickness and preferably it is drape drawn to the desired configuration, following the procedure described and claimed in applicant's copending application, Ser. No. 391,986, filed Aug. 25, 1964, now patent No. 3,296,850.

Specifically, the mask blank is initially clamped between a draw ring and a pressure ring dimensioned to engage the border strip at a distance from the aperture field that is many times the diameter of the mask apertures. The draw ring and pressure ring have spherical die surfaces, assuming that the portion of the mask containing the aperture pattern is to be shaped as a spherical section. Clamping of the sheet between the rings is a preforming step after which the rings are concurrently lowered to drape draw the mask blank over a punch having a spherical contour corresponding to that required of the mask. It is usually preferred that the ring dies be shaped to constitute extensions of the sphere of the punch. The descent of the clamp dies is then continued to draw a fillet or radius over the punch to preserve a uniform center-to-center spacing of the mask apertures throughout the aperture field. Thereafter, the pressure ring is released and the draw ring continues its downward stroke which wipes the preformed periphery of the mask blank into a mounting skirt disposed about the periphery of the spherical section of the mask and extending generally normally to that section. The mounting skirt is of uniform depth and the periphery of the spherical mask section corresponds to the curved surface obtained by the projection of a rectangle upon a spherical section. The mask is now completely formed and is ready for assembling with the frame, the construction of which will now be considered with particular reference to FIGURES 1–3.

The mask frame is stamped from a sheet of metal such as cold rolled steel having a thickness many times that of the mask in order that the frame may constitute a massive structure compared with the mask. Satisfactory results have been obtained with 93 mil stock for the frame as a support structure for a mask formed of 5 mil stock. It is distinctly preferable that the material of the frame be worked as little as necessary in achieving the structure required to support the mask. While an annular frame of rectangular shape is the ultimate configuration to be achieved, the first step is to stamp a planar blank or piece from the sheet or stock of the frame metal having principal dimensions, length and width, large compared to the corresponding dimensions of the spherical section of the mask and having an outer edge contoured to correspond to the peripheral contour of the spherical section of the mask. Such a frame blank **10** is illustrated in FIGURE 1 wherein the construction line designated "fold line" represents the approximate dimensions of the mask. After this frame blank has been struck from the sheet of stock, its outer edge is folded normal to the plane of the blank to provide a mounting skirt **11** (FIGURE 2) for the frame. That skirt has a rectangular shape and closely controlled dimensions as required for telescoping with the mounting skirt formed on the mask. In particular, the outside dimensions of mounting skirt **11** of the frame are essentially the same as the inside dimensions of the mounting skirt of the mask so that they may telescope with the frame received within the skirt of the mask.



The die employed in folding the frame to form a mounting skirt may also be used to strike gussets **12** in the folded-over portion of the frame spaced along the four sides of the frame. The gussets add to the strength of the frame and are desirable for masks employed in 25 inch tubes although they may not be required in smaller tube sizes such as 16 inch and 19 inch.

The central portion **13** (FIGURE 3) of the mask is now cut out, leaving an annular frame of generally rectangular shape having overall dimensions closely corresponding to those of the mask and having a mounting skirt **11** the leading or free edge of which has essentially the same configuration as the peripheral portion of the spherical section of the mask. The material **13** to be removed from the frame blank may, of course, be cut out by a simple die operation and at the same time, a rib **14** may be struck from the internal faces of the frame, extending at approximately 45° to the plane of the base of the frame. Such a rib adds mechanical strength to resist tortional or twist distortion in the face of high ambient temperatures encountered in the processing of the cathode-ray tube.

The frame has now been formed with appropriate configuration and dimensions through work forming processes which introduce a minimum of stress. Nevertheless, in view of the exacting requirements imposed on the mask assembly if significant misregistration is to be avoided, the frame is heated to a temperature that is very high compared to the operating temperature of the frame when included as a component of an operating color tube in order to accomplish stress relief. The heat treatment for stress relieving may be conducted at a high temperature with a short time cycle or at a relatively low temperature but with a considerably longer time cycle. For example, for frame material which has an annealing temperature of about 1600° F., stress relieving may be achieved by heating the frame to approximately 1400° F. for a period of approximately 20 minutes. Alternatively, heat treating the structure to approximately 450° for about two hours will accomplish stress relieving. The lower temperature, longer cycle is preferred although the high temperature, short cycle is acceptable for mass production.

It is found that where the high temperature process is employed for stress relieving, some distortion of the frame may be encountered and, therefore, stress relieving is followed by restriking the frame to restore its desired dimensions. In restriking, a die or form member corresponding to the required inner configuration of the frame is positioned within the space defined by the mounting skirt and cam dies are brought against the sides of the skirt as well as the base or bottom flange of the frame. If this form is slightly smaller in dimension than that desired of the frame, striking the cam dies may restore precise dimensions to the frame. The frame structure it self is now complete and is thermally stable but it is necessary to assemble the mask to the frame and to provide leaf springs by means of which the mask assembly may be supported within the color tube. It is preferred that the leaf springs be affixed first.

Three such springs are employed. They are made of stainless steel and are full hardened. As indicated in FIGURES 8 and 9, each of these springs has a base or frame mounting portion **15** at one end, an apertured stud receiving portion **16** at the opposite end and an intermediate portion **17** which defines a hinge with base **15** and at the same time supports stud receiving portion **16** at an appropriate angle. In an illustrative embodiment, the hinge angle **18** is approximately 13° and the angle **19** of the stud receiving portion **16** relative to the base is approximately 7°. The aperture **20** of the leaf spring is triangular and is dimensioned to fit over a mounting stud **21** which projects inwardly of the cap section **22** of the color tube. For optimum conditions, stud receiving portion **16** should be normal to the axis of mounting stud **21** of the envelope. Since there are three mounting springs and three envelope studs **21**, there will be at least six points of contact

between springs and mounting studs, assuring firm mechanical support for the mask assembly.

Each spring is secured to the mask frame by means of two spot welds at its base portion **15** and the welds (FIGURE 9) are preferably spaced as far as practicable in the direction of the base from the hinge angle. This localizes the heat of the weld and avoids undesired changes in the angles formed in the spring. As affixed to the frame, all three springs face in the same direction (FIGURE 4).

While the springs are full hardened after the described angles have been formed in them, they are stress relieved before being assembled onto the frame. They may be stress relieved to a condition of ¼ to ½ hard by being heated to approximately 1250° F. for about 15 minutes. A distinct advantage ensues from his heat treatment of the springs. It is found that if the angle between intermediate portion **17** and stud receiving portion **16** should change, for example as a consequence of the extreme temperatures to which the springs are subjected in the complete processing of the tube, the spring is no longer in its desired normal or perpendicular relation to the axis of mounting stud **21**. As a result a torque is applied which tends to rotate the whole frame assembly in one direction if the angle should increase and in the opposite direction if the angle should decrease. In either case, misregistration may be expected and this source of rejection is obviated by heat processing the springs as described.

With the springs in place, it is convenient accurately to position the frame mask in a welding fixture in order to affix the mask to the frame. These components are assembled with their mounting skirts in telescoping relation and with a uniform spacing or separation between the leading edge of mounting skirt of the frame and the spherical section of the mask. FIGURES 4–6 show the mask assembled to its frame and illustrate the aperture pattern **25** surrounded by an imperforate border strip **26**, a portion of which is folded over to constitute a mounting skirt **27**. The detail of FIGURE 7 shows the telescoping relation of mounting skirts **11** and **27** and the separation S of the free edge of skirt **11** from border strip **26** of the mask. This separation is maintained uniform throughout by spot welds spaced approximately ½ inch around the periphery. The described process permits the mask and frame mounting skirts to nest closely and avoids distortions that otherwise ensue from stretching or expanding one or the other of these skirts to effect their being united by welding. Accordingly, the assembly has a minimum of stress and is thermally stable.

The mask assembly is now complete but a further processing step is desirable. As indicated above, the mask intercepts a significant portion of the electron beams of the color tube and experiences a substantial increase in temperature. It may, for example dissipate as much as 25 watts and heat dissipation is facilitated by blackening the assembly to give it the radiation properties of a black body. A variety of processes are known for thermal blackening some of which involved elevated temperatures while others are carried out at relatively low temperatures. In the interest of imparting still further thermal stability to the structure, the high temperature technique is preferred. This is referred to as a batch type of blackening in which the structure is heated to 600° F., and the oxygen of the oven is then purged and replaced by steam. The temperature is then increased to 1000° F. to oxidize or blacken the structure.

The completed and blackened mask assembly is readily positioned within the screen or cap section of the color tube by means of the leaf springs and their engagement with the mounting studs of the tube. The massive base of the assembly holds the periphery of the mask fixed and the increase in temperature experienced in the operation of the tube, but more particularly in the further processing of the tube itself, results in dome-type expansion of the mask but no significant physical movement of the structure otherwise because of the thermal stability attained through the aforedescribed process. Expansion of the mask is manifest in further doming or in an increase in the curvature of the spherical section which accommodates expansion without introducing misregistration of the beam with respect to the phosphor dots of the screen. Accordingly, the exactness of precision necessary to maintain the proper beam landings throughout the scanning field is satisfied by the structure preformed in accordance with the described process.

While particular embodiments of the invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects, and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim:

**1.** The method of making a rectangular-mask assembly for a shadow-mask type of color tube which comprises:

forming a rectangularly shaped mask which has a pattern of apertures disposed over a substantially spherical section bordered by a mounting skirt disposed about the periphery of and extending normal to said spherical section;

stamping from a sheet of metal, having a thickness many times that of said mask, a rectangularly shaped annular frame having principal dimensions large compared to said spherical section and having an outer edge contoured to correspond to the peripheral contour of said spherical section;

folding said outer edge normal to the plane of said frame to provide a mounting skirt of rectangular shape having predetermined dimensions for telescoping with said mounting skirt of said mask;

heating said frame to a temperature that is high compared to the operating temperature of said frame when included within an operating color tube to stress relieve said frame;

restriking said frame to restore said predetermined dimensions;

assembling said mask to said stress-relieved and restruck frame with said mounting skirts in telescoping relation;

and mechanically securing said skirts to one another.

**2.** The method of making a rectangular-mask assembly for a shadow-mask type of color tube which comprises:

forming a rectangularly shaped mask which has a pattern of apertures disposed over a substantially spherical section bordered by a mounting skirt disposed about the periphery of and extending normal to said spherical section;

stamping from a sheet of metal, having a thickness many times that of said mask, a rectangularly shaped annular frame having principal dimensions large compared to said spherical section and having an outer edge contoured to correspond to the peripheral contour of said spherical section;

folding said outer edge normal to the plane of said frame to provide a mounting skirt of rectangular shape having predetermined dimensions for telescoping with said mounting skirt of said mask;

heating said frame to a temperature that is lower than the annealing temperature of said frame metal but high compared to the operating temperature of said frame when included within an operating color tube to stress relieve said frame;

restriking said frame to restore said predetermined dimensions;

assembling said mask to said stress-relieved and restruck frame with said mounting skirts in telescoping relation;

and mechanically securing said skirts to one another.

3. The method of making a rectangular-mask assembly for a shadow-mask type of color tube which comprises:

forming a rectangularly shaped mask which has a pattern of apertures disposed over a substantially spherical section bordered by a mounting skirt disposed about the periphery of and extending normal to said spherical section;

stamping from a sheet of metal, having an annealing temperature of approximately 1600° F. and a thickness many times that of said mask, a rectangularly shaped annular frame having principal dimensions large compared to said spherical section and having an outer edge contoured to correspond to the peripheral contour of said spherical section;

folding said outer edge normal to the plane of said frame to provide a mounting skirt of rectangular shape having predetermined dimensions for telescoping with said mounting skirt of said mask;

heating said frame to a temperature of approximately 1400° F. for about 20 minutes to stress relieve said frame;

restriking said frame to restore said predetermined dimensions;

assembling said mask to said stress-relieved and restruck frame with said mounting skirts in telescoping relation;

and mechanically securing said skirts to one another.

4. The method of making a rectangular-mask assembly for a shadow-mask type of color tube which comprises:

forming a rectangularly shaped mask which has a pattern of apertures disposed over a substantially spherical section bordered by a mounting skirt disposed about the periphery of and extending normal to said spherical section;

stamping from a sheet of metal, having an annealing temperature of approximately 1600° F. and a thickness many times that of said mask, a rectangularly shaped annular frame having principal dimensions large compared to said spherical section and having an outer edge contoured to correspond to the peripheral contour of said spherical section;

folding said outer edge normal to the plane of said frame to provide a mounting skirt of rectangular shape having predetermined dimensions for telescoping with said mounting skirt of said mask;

heating said frame to a temperature of approximately 450° F. for about 2 hours to stress relieve said frame;

assembling said mask to said stress-relieved frame with said mounting skirts in telescoping relation;

and mechanically securing said skirts to one another.

5. The method of making a rectangular-mask assembly for a shadow-mask type of color tube having three mounting studs for supporting the assembly, which method comprises:

forming a rectangularly shaped mask which has a pattern of apertures disposed over a substantially spherical section bordered by a mounting skirt disposed about the periphery of and extending normal to said spherical section;

stamping from a sheet of metal, having a thickness many times that of said mask, a rectangularly shaped annular frame having principal dimensions large compared to said spherical section and having an outer edge contoured to correspond to the peripheral contour of said spherical section;

folding said outer edge normal to the plane of said frame to provide a mounting skirt of rectangular shape having predetermined dimensions for telescoping with said mounting skirt of said mask;

heating said frame to a temperature that is high compared to the operating temperature of said frame when included within an operating color tube to stress relieve said frame;



forming three similar, hardened, metallic leaf springs individually having a frame-mounting portion at one end, an apertured stud-receiving portion at the opposite end and an intermediate portion defining a hinge with said frame-mounting portion and supporting said stud-receiving portion at such an angle that the aperture thereof is normal to the axis of an assigned one of said studs when the mask assembly is supported by said studs;

heat treating said left springs to stress relieve said springs;

affixing said mounting portions of said springs to said frame with said springs facing in the same direction and with said apertures thereof positioned to receive said studs;

assembling said mask to said stress-relieved frame with said mounting skirts in telescoping relation;

and mechanically securing said skirts to one another.

6. The method of making a rectangular-mask assembly for a shadow-mask type of color tube having three mounting studs for supporting the assembly, which method comprises:

forming a rectangularly shaped mask which has a pattern of apertures disposed over a substantially spherical section bordered by a mounting skirt disposed about the periphery of and extending normal to said spherical section;

stamping from a sheet of metal, having a thickness many times that of said mask, a rectangularly shaped annular frame having principal dimensions large compared to said spherical section and having an outer edge contoured to correspond to the peripheral contour of said spherical section;

folding said outer edge normal to the plane of said frame to provide a mounting skirt of rectangular shape having predetermined dimensions for telescoping with said mounting skirt of said mask;

heating said frame to a temperature that is high compared to the operating temperature of said frame when included within an operating color tube to stress relieve said frame;

forming three similar, full hardened, metallic leaf springs individually having a frame-mounting portion at the opposite end and an intermediate portion defining a hinge with said frame-mounting portion and supporting said stud-receiving portion at such an angle that the aperture thereof is normal to the axis of an assigned one of said studs when the mask assembly is supported by said studs;

heating said springs to approximately 1200° F. for about 15 minutes to stress relieve said springs;

affixing said mounting portions of said springs to said frame with said springs facing in the same direction and with said apertures thereof positioned to receive said studs;

assembling said mask to said stress-relieved frame with said mounting skirts in telescoping relation;

and mechanically securing said skirts to one another.

7. The method of making a rectangular-mask assembly for a shadow-mask type of color tube having three mounting studs for supporting the assembly, which method comprises:

forming a rectangularly shaped mask which has a pattern of apertures disposed over a substantially spherical section bordered by a mounting skirt disposed about the periphery of and extending normal to said spherical section;

stamping from a sheet of metal, having a thickness many times that of said mask, a rectangularly shaped annular frame having principal dimensions large compared to said spherical section and having an outer edge contoured to correspond to the peripheral contour of said spherical section;

folding said outer edge normal to the plane of said frame to provide a mounting skirt of rectangular

shape having predetermined dimensions for telescoping with said mounting skirt of said mask;

heating said frame to a temperature that is high compared to the operating temperature of said frame when included within an operating color tube to stress relieve said frame;

restriking said frame to restore said predetermined dimensions;

forming three similar, hardened, metallic leaf springs individually having a frame-mounting portion at one end, an apertured stud-receiving portion at the opposite end and an intermediate portion defining a hinge with said frame-mounting portion and supporting said stud-receiving portion at such an angle that the aperture thereof is normal to the axis of an assigned one of said studs when the mask assembly is supported by said studs;

heat treating said left springs to stress relieve said springs;

affixing said mounting portions of said springs to said frame with said springs facing in the same direction and with said apertures thereof positioned to receive said studs;

assembling said mask to said stress-relieved and restruck frame with said mounting skirts in telescoping relation;

mechanically securing said skirts to one another;

and oxidizing the assembly at a temperature high compared to the operating temperature of said frame when included within an operating color tube to accomplish thermal blackening of said assembly.

8. The method of making a rectangular-mask assembly for a shadow-mask type of color tube having three mounting studs for supporting the assembly, which method comprises:

forming a rectangularly shaped mask which has a pattern of apertures disposed over a substantially spherical section bordered by a mounting skirt disposed about the periphery of and extending normal to said spherical section;

stamping from a sheet of metal, having an annealing temperature of approximately 1600° F. and a thickness many times that of said mask, a rectangularly shaped annular frame having principal dimensions large compared to said spherical section and having



an outer edge contoured to correspond to the peripheral contour of said spherical section;

folding said outer edge normal to the plane of said frame to provide a mounting skirt of rectangular shape having predetermined dimensions for telescoping with said mounting skirt of said mask;

heating said frame to a temperature that is of approximately 1400° F. for about 20 minutes to stress relieve said frame;

restriking said frame to restore said predetermined dimensions;

forming three similar, hardened, metallic leaf springs individually having a frame-mounting portion at one end, an apertured stud-receiving portion at the opposite end and an intermediate portion defining a hinge with said frame-mounting portion and supporting said stud-receiving portion at such an angle that the aperture thereof is normal to the axis of an assigned one of said studs when the mask assembly is supported by said studs;

heating said springs to approximately 1200° F. for about 15 minutes to stress relieve said springs;

affixing said mounting portions of said springs to said frame with said springs facing in the same direction and with said apertures thereof positioned to receive said studs;

assembling said mask to said stress-relieved and restruck frame with said mounting skirts in telescoping relation and with a uniform spacing from the leading edge of said mounting skirt of said frame to the base of said mounting skirt of said mask;

mechanically securing said skirt to one another;

and oxidizing the assembly at a temperature of approximately 1000° F. to accomplish thermal blackening of said assembly.


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