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METHOD OF FABRICATING AND PROCESSING CATHODE RAY TUBES

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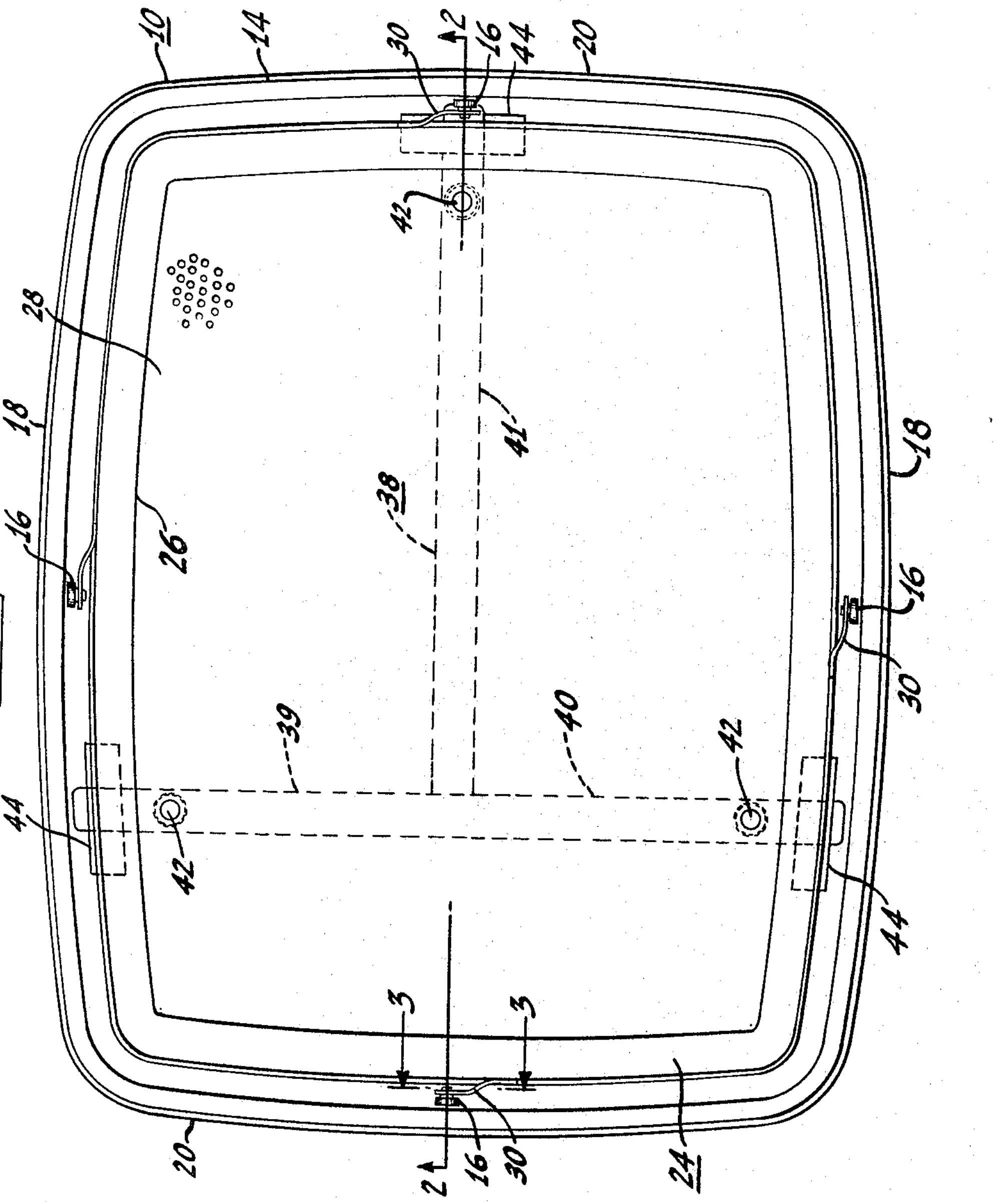

Fig. 1.

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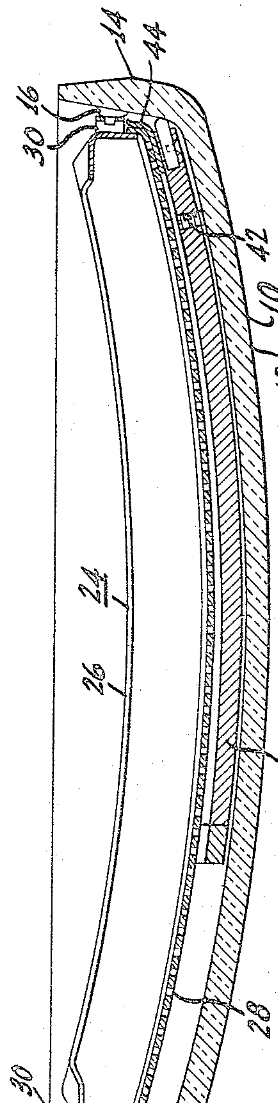

Fig. 2.

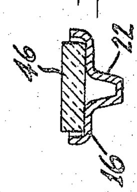

Fig. 5.

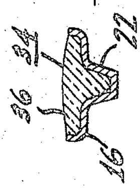

Fig. 4.

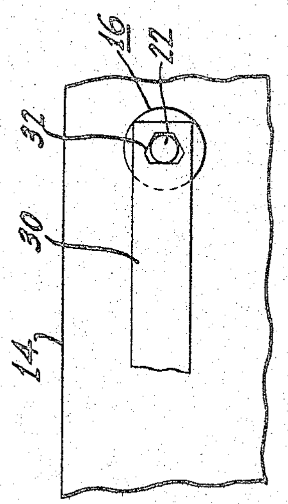

Fig. 3.

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METHOD OF FABRICATING AND PROCESSING CATHODE RAY TUBES

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7 Claims. (Cl. 29—25.13)

This invention relates to the manufacture of cathode ray tubes and particularly to the fabrication of faceplate panel assemblies therefor and to the processing of faceplate panel assemblies and electrodes mounted therein.

In some types of cathode ray tubes, an electrode of substantially the same size as the phosphor screen of the tube is mounted closely adjacent to the screen. For example, the shadow mask cathode ray tube for producing images in color includes a multiapertured masking electrode which may be spaced about ½-inch from a mosaic phosphor screen. The commercially available RCA 21FBP22 is such a tube.

The envelopes of tubes, which have an electrode mounted adjacent to the screen, usually include a shallow-bowl like glass faceplate panel sealed to a glass funnel member by a low temperature melting glass (frit) such as described in U.S. Patent 2,889,952 issued to S. A. Claypool on June 9, 1959. The faceplate panel comprises a curved faceplate portion on which the phosphor screen is disposed and a peripheral sidewall portion. A plurality of studs are sealed into or onto the internal surface of the panel, usually the side wall of the panel, and the mask electrode is removably mounted thereon by a plurality of spring support elements which are attached to the mask and which have apertured plate portions that fit over the studs.

It is an object of this invention to provide a novel method for providing an improved mounting of the electrode support studs onto a faceplate panel.

Another object of the invention is the provision of an improved heat treatment method of processing parts of a cathode ray tube.

It is also an object of this invention to provide an improved assembly of a faceplate panel and a shadow mask electrode for a cathode ray tube.

The invention disclosed herein may be practiced in the manufacture of a cathode ray tube having a mosaic screen comprising a multiplicity of elemental phosphor deposits critically positioned relative to the apertures of an apertured electrode which is to be mounted in a particular faceplate panel. In accordance with one feature of the invention, the electrode is provided with apertured support springs attached thereto and is positioned within the panel in a desired spatial relationship therewith. One or more studs, a portion thereof which may be precoated with a glass frit, are inserted into the apertures of the support springs so that the springs urge the studs against the interior surface of the panel. The assembly of panel, electrode, and studs is then subjected to a suitable treatment, such as a heating thereof, to secure the studs to the panel in locations precisely aligned with their associated spring apertures.

In accordance with another feature of the invention, either by this heating or by a separate heating, the electrode and/or panel are heat stabilized to relieve the stresses therein. Subsequent to the attachment of the studs and the heat stabilization of the electrode and panel, the elemental phosphor deposits of the mosaic screen are applied to the faceplate panel.

It is often the present practice in the industry in making shadow mask cathode ray tubes to attach the studs to a faceplate panel by the use of one jig and to attach the support springs to the mask electrode by the use of a

different but related jig. The resulting tolerance of fit of the mask on the studs and the tolerance of the mask-to-screen spacing is accordingly determined by the additive tolerances of the two jigs. The method of the present invention avoids the inaccuracies of such additive tolerances since the mask itself is used as the jig for securing the studs to the panel, thereby providing a custom fit between the mask electrode and studs.

The improved accuracy of fit between the mask electrode and the studs obtained by my method is especially advantageous in a four stud support arrangement such as has been proposed for a shadow mask cathode ray tube having a rectangular shaped faceplate and mask electrode.

With the general type of spring-stud arrangement described herein, a 3-spring mask can always be fited onto its 3-stud panel even though, due to manufacturing tolerances, the spring aperture array and the stud array are not identically disposed. This is because the mask can be shifted and rotated slightly until each of the three spring apertures is in alignment with its associated stud. Furthermore, the three springs will be received on the three studs with the mask in only one position relative to the panel. That is, a 3-point support arrangement of three springs on three studs determines a unique position of the mask with relation to the panel. This is true not only for a 3-stud support system but also for three of the four supports of a 4-stud support system. Thus, in a 4-stud system, the fourth spring and the fourth stud must be positioned so that they mate precisely with each other when the mask is in the unique position determined by the other three supports. Manufacturing tolerances of the prior art methods described above do not permit such precise positioning to be readily obtained.

When the studs are secured to the faceplate panel according to my method, both the mask electrode and the panel can be completely heat stabilized with respect to temperatures to which they will be subjected during subsequent processing and operation thereof. No such heat stabilization of the mask and panel is provided in accordance with practices of the prior art.

The advantage of a complete heat stabilization of both the mask electrode and faceplate panel may be explained as follows. In a wide angle deflection shadow mask cathode ray tube, a dot-like phosphor deposit of about 17 mils (1 mil=.001 inch) diameter may be excited by an electron stream which produces an electron spot of about 12 mils in diameter on the phosphor dot. Even when the electron spot is precisely centered on the phosphor dot there exists only a 2½ mil tolerance for spot-dot register. In practice, the electron spot may not be precisely centered on the phosphor dot. Thus, the tolerance for spot-dot register may be something less than 2½ mils, e.g., 1 mil. In prior art shadow mask cathode ray tubes, the mask electrode and faceplate panel are not completely heat-stabilized before deposition of the phosphor screen. The mask and screen then can shift relatively to each other during screen bake-out or during operation of the completed tube because of a heating and stress-relief effect which occurs then. Since this stress relief occurs after the phosphor screen has been deposited, there is a change of register between the phosphor dot and the electron spot. However, if the tube is heat stabilized as disclosed herein, there is little or no stress-relief effect to cause change of registry of phosphor dot and electron spot, and a product superior in use to the prior art product is attained.

In the drawing:

FIG. 1 is a plan view of a studded cathode ray tube faceplate panel and apertured mask electrode together with a spacing fixture utilized in securing the studs to the panel;

FIG. 2 is a sectional view taken along line 2—2 of FIG. 1;

FIG. 3 is an enlarged elevation view of a portion of the device of FIG. 1 taken along line 3—3 thereof; and

FIGS. 4 and 5 are sectional views of one of the mask mounting studs of FIG. 1 illustrating different process modifications and stages thereof in the securing of the studs to the panel.

With reference to the drawing, a cathode ray tube glass faceplate panel **10** comprises a generally rectangular faceplate **12** and a side wall **14** extending from the periphery of the faceplate. The faceplate **12** is preferably curved, e.g., with an approximately spherical contour, as is known in the art. A plurality of electrode mounting studs **16** are attached to the interior surface of the panel side wall **14**, preferably one near the mid-point of each of the two long sides **18** and the two short sides **20**. As best shown in FIGS. 3, 4, and 5, each stud **16** comprises a hollow circular cup-shaped element having a tapered circular tip **22** forming the bottom of the cup.

A shadow mask electrode **24**, mounted within the faceplate panel **10**, includes a frame member **26**, a masking member **28**, and a plurality of support leaf springs **30**. The frame **26** comprises a closed, generally rectangular rim having an L-shaped cross section. The masking member **28** comprises a shallow bowl-like multiapertured sheet of metal mounted across the frame **26**. The mask member **28** has a surface contour which approximately matches the surface contour of the faceplate **12**, for example, as described in U.S. Patent 3,109,116 issued to D. W. Epstein et al., on October 29, 1963. Each of the leaf springs **30** (see particularly FIG. 1) has one of its ends attached to the side of the frame-mask assembly **26–28** and an opposite end off-set radially outwardly from the side of the frame-mask assembly and provided with an aperture **32**. The aperture **32** is preferably of a generally triangular shape (FIG. 3), and the springs are so located that the apertures **32** receive the round tapered tips **22** of the studs **16** in a three point contact (or three small area contacts) therewith.

Before attaching the studs **16** to the panel side wall **14**, the studs are preferably prepared by providing them with a precoating of a bonding agent such as a devitrifiable glass frit. In accordance with a preferred practice, the cup shaped stud **16** is filled with a slurry of glass frit suspended in a binder such as nitrocellulose. The stud **16** and frit slurry are then heated to a temperature sufficient to volatize the binder and soften the frit to thereby cause it to glaze, or adhere to, the inner wall of the stud **16**. As shown in FIG. 4, the frit **34** is of such a quantity that when glazed to the stud **16** it substantially fills the large cup portion of the stud **16** and protrudes very slightly beyond the open end of the stud in a shallow mound **36**.

The shadow mask electrode **24**, including the frame **26**, the masking member **28**, and the support springs **30** are provided as a unit and positioned on top of a spacer device **38** within a studless faceplate panel **10**. Such method of positioning provides an extremely accurate strain-free spacing. The panel may be oriented open-end-up as shown in FIG. 2 so that gravity urges the mask electrode **24** against the spacer **38** and the spacer against the panel **10**. The spacer device **38** includes a T-shaped member whose three arms **39, 40, 41** extend to points adjacent to the panel side wall **14**. Spacer pads **42** are provided near the ends of the arms **39, 40, 41** and extend therefrom to contact the faceplate **12**. Mask-support brackets **44** are attached to the ends of the spacer arms **39, 40, 41** for receiving the mask electrode **24** in desired spaced relationship with the faceplate **12**.

If desired the assembly of the panel **10**, spacer **38**, and mask electrode **24** may be inverted with the mask electrode being supported and the panel resting thereupon.

With the mask electrode **24** in position within the faceplate panel **10**, the frit coated studs **16** (as shown in FIG. 4) are inserted between the support springs **30** and the

panel side wall **14**, with the tapered tips **22** received within the apertures **32** of the support springs and with the frit mounds **36** in contact with the interior surface of the panel side wall **14**. In such an arrangement, the frit coated studs **16** are urged by the support springs **30** against the panel side wall **14**.

The entire assembly of faceplate panel **10**, mask electrode **24**, and studs **16** is then heated to resoften the frit coating on the studs **16**. The particular time and temperature schedule to produce a softening of the frit is dependent upon the particular type of frit used. After the frit has become softened and the studs **16** pressed into place against the panel side wall **14**, the frit is allowed to solidify and permanently secure the studs to the panel side wall. In the case of a devitrifiable frit such as that marketed by the Corning Glass Company and identified by them as 7572, the solidification of the frit may occur at an elevated temperature. Such a devitrifiable frit is preferred because of its subsequent resistance to high temperature treatment during later processing of the cathode ray tube. In the case of a non-devitrifiable frit, the assembly of faceplate panel, mask electrode, and studs is cooled to produce a solidification of the frit.

The above-described method of attaching the studs **16** to the panel **10** may be used to secure either all of the studs or any partial number of them, to a faceplate panel. For example, in a 4-stud panel, three of the studs may be sealed into the panel by a prior art method, and the mask electrode may be provided with its four support springs. Then the mask may be supported within the panel with three of the support springs mounted on the three existing studs, and the fourth stud may then be frit sealed to the panel as hereinbefore described. In such a fabrication procedure, the spacing device **38** may be dispensed with since the mask can be supported in place within the panel on the three existing studs during sealing-in of the fourth stud.

When one or more studs are frit sealed to the panel as described above, both the mask **24** and the panel **10** can be conveniently heated simultaneously to a heat-stabilizing temperature as high as or higher than that to which they will be heated in subsequent processing or operation of the tube. This heat-stabilizing heating causes stresses in the mask and panel to be relieved and results in a relaxing and attendant minute reshaping of the mask and panel. Subsequent heatings of the mask and panel cause no significant additional stress relief and no reshaping of the mask and panel, as long as the subsequent heating does not raise the mask or panel to a temperature higher than the previous heat-stabilizing temperature. The mask and panel may be considered to be completely heat-stabilized for subsequent normal processing and operation.

As an alternative to heat stabilizing the mask and panel together, they may be heat stabilized by separate hetaings. For example, it may be desirable and/or convenient for the glass panel to be heat stabilized by the manufacturer of the panel. In any event such a separate heat-stabilizing treatment of the panel should be at a temperature at least as high as the highest temperature to which it will be subsequently subjected by the tube manufacturer.

In attaching the studs to the panel, it may not be desirable to use a temperature equal to or greater than all subsequently encountered temperatures. In such cases, a separate heating of the mask and panel should be employed before application of the phosphor screen so as to raise the mask and panel to a suitable heat-stabilizing temperature as described above. The lack of accurate spot-dot register which may result from heating of the mask and panel in later use or processing is thus prevented.

If desired, the frit **34** may be provided as a pellet **46** as shown in FIG. 5. The pellet **46** may be inserted into a cup-shaped stud **16** a the time the stud is inserted in the apertures **32** a support spring **30**. The first pellets are then held in place within the studs by the spring pressure urging them against the panel side wall **14**. The bonding, or glazing, of the frit thus occurs simultaneously to both the stud **16** and the side wall **14** when the assembly is heated. Alternatively, the frit pellet **46** may be heated in its stud prior to assembly of the stud within the spring aperture to preglaze the frit of the pellet to the stud as shown in FIG. 4.

As another alternative, the frit may be applied to the panel sidewall **14**. The studs, with or without a coating of frit, are then pressed against the fritted areas of the side-wall. In such case it may be preferred to use a solid stud or a stud having a closed, flush end adjacent to the side wall **14**. In this alternative, the frit may be provided in the form of an adhesive-backed tape comprising frit suspended in a solidified organic binder such as nitrocellulose. Furthermore, whether the frit is provided as a tape or otherwise, it may be applied to the panel side wall **14** over an area considerably larger than the stud. Such a large-area application of frit may serve to advantageously reduce stress concentration at the seal between the stud and panel.

In accordance with one practice of the invention, the faceplate panel **10** may comprise a glass marketed by the Corning Glass Company and identified by them as 9019. The studs **16** may comprise industry standard N71 stainless steel, an alloy of principally nickel and iron, and the frit may comprise the devitrifiable 7572 frit referred to above. The precoating of the studs **16** with the frit may be performed at 340°–400° C. and the subsequent softening and devitrifying of the frit coating on the stud performed at a temperature of 445° C.

This invention has been disclosed by way of example, as embodying a particular design of multiapertured shadow mask electrode including a particular support spring design and a particular design of mask mounting studs. However, other designs of these elements may be used.

Furthermore, means other than a glass frit as herein disclosed may be used to bond the studs to the faceplace panel. For example, other bonding materials such as Sauereisen cement may be used. Alternatively, a selected area of the faceplate panel may be metalized and the studs soldered thereto.

What is claimed is:

1. In the manufacture of cathode ray tubes of the type comprising a faceplate panel having a plurality of studs attached thereto by heat-sealing which are received within the apertures of a plurality of spring supports attached to a mask electrode, the method of attaching said studs to said faceplate panel, said method comprising the steps of:

(a) disposing said mask and said panel in a desired spatial relationship with each other,

(b) positioning said studs in the apertures of said spring supports so that said studs are pressed against said panel by the spring action of said spring support elements, and

(c) then heating the assembly of said panel, mask electrode, and studs to as high a temperature above the heat-sealing temperature as the highest temperature to which said assembly is to be subjected during subsequent processing and operation to secure said studs to said panel in locations corresponding precisely to the locations of said spring supports and to heat stabilize said mask electrode and said panel so that stresses therein are substantially relieved when the said electrode is subsequently supported on said studs and said tube is operated.

2. In the manufacture of a cathode ray tube of the type having an electrode to which are attached a plurality of apertured support elements which are received on respectively different mounting studs secured by heat-sealing to the internal surface of the side wall of a shallow bowl-shaped faceplate panel, the method of mounting asid electrode in said panel comprising the steps of:

(a) coating a portion of one of said studs with glass frit,

(b) inserting said stud in the aperture of one of said support elements,

(c) assembling said electrode and stud within said panel with said electrode in a given spatial relationship with said panel and with the frit on said stud in contact with the side wall of said panel,

(d) then heating the assembly of said electrode and panel to as high a temperature above the heat-sealing temperature as the highest temperature to which said assembly is to be subjected during subsequent processing and operation to heat stabilize said electrode and said panel and to soften said frit, and

(e) hardening said frit to secure said stud to said panel.

3. In the manufacture of a cathode ray tube of the type comprising a multiapertured sheet metal mask electrode which includes a plurality of apertured support springs at the periphery thereof, a shallow bowl-shaped faceplate panel including a face-plate portion and a peripheral side wall portion, and a plurality of cup-shaped mounting studs secured to the internal surface of said side wall and received in the apertures of said support springs, the method of mounting said mask in said panel which method comprises the steps of:

(a) depositing quantities of devitrifiable glass frit in said cup-shaped studs and glazing said frit thereto so that said frit protrudes slightly from the open ends of said studs,

(b) inserting said studs in the apertures of said support springs, disposing said electrode within said panel and urging said electrode with said studs in the support springs thereof toward said panel with a spacer device disposed between said electrode and the internal surface of said faceplate portion, with the frit on said studs being pressed into contact with said side wall by said support springs,

(d) then heating the assembly of said electrode, studs, and panel to as high a temperature as the highest temperature to which said assembly is to be subjected during subsequent processing and operation to heat stabilize said mask and said panel and soften said frit, and

(e) devitrifying said frit to secure said studs to said panel at locations corresponding to the locations of said support springs.

4. In the manufacture of a cathode ray tube of the type having a multiapertured shadow mask electrode to which are attached a plurality of apertured support springs received on respectively different mounting studs secured by heat-sealing to the internal surface of the side wall of a shallow bowl-shaped faceplate panel on which is provided a mosaic screen including a multiplicity of dot-like phosphor deposits critically positioned relative to the apertures of said mask, the method of mounting said mask in said panel and simultaneously heat stabilizing said mask and panel comprising the steps of:

(a) coating a portion of each of said studs with glass frit,

(b) inserting said studs in the apertures of said support elements,

(c) assembling said electrode and studs within said panel with said electrode in a given spatial relationship with said panel and with the frit on said studs in contact with the side wall of said panel,

(d) then heating the assembly of said electrode and panel to a temperature above the heat-sealing temperature as high as the highest temperature to which said mask and panel will be subjected during subsequent processing and operation thereof, whereby to heat-stabilize said mask and panel assembly and to soften said frit,

(e) hardening said frit to secure said studs to said panel, and then

(f) applying the dot-like phosphor deposits of said mosaic screen onto the heat-stabilized faceplate panel.

5. In the manufacture of cathode ray tubes of the type comprising a faceplate panel and a multi-apertured mask electrode mounted on said panel in a predetermined spaced relation thereto, said panel including a mosaic phosphor screen comprising a multiplicity of elemental phosphor deposits critically positioned relative to the apertures of said mask electrode; the method comprising the steps of:

(a) mounting said mask electrode on said panel in said predetermined relation;

(b) then heating the assembly of said panel and mask electrode to as high a temperature as the highest temperature to which said panel and mask electrode will be subjected during subsequent processing and operation thereof to relieve the stresses therein and thus heat stabilize said assembly, and

(c) then depositing the elemental phosphor deposits of said mosaic screen on said panel.

6. The method of claim 5, wherein said mask electrode is removably mounted on said panel in step (a) by

means of a plurality of spring supports secured to said mask electrode and having apertures engaging a like plurality of studs secured to said panel.

7. The method of claim 5, wherein said assembly is heated to a temperature of at least 445° C., in step (b).

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