(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 644 571 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **94114353.9**

(51) Int. Cl.[6]: **H01J 29/07**

(22) Date of filing: **13.09.94**

(30) Priority: **21.09.93 US 124183**

(43) Date of publication of application: **22.03.95 Bulletin 95/12**

(84) Designated Contracting States: **DE GB**

(71) Applicant: **THOMSON CONSUMER ELECTRONICS, INC.**
10330 North Meridian St.
Indianapolis, IN 46206 (US)

(72) Inventor: **Keller, Raymond Edward**
2064 Laurel Hill Rd.
Clarks Summit,
PA 18411 (US)
Inventor: **Sies, Neil Edward**
86 Ridings Way
Lititz,
PA 17543 (US)
Inventor: **Piascinski, Joseph John**
305 Pleasant Valley Drive
Leola,
PA 17540 (US)

(74) Representative: **Wördemann, Hermes, Dipl.-Ing.**
Thomson Consumer Electronics Sales GmbH
Postfach 91 13 45
D-30433 Hannover (DE)

(54) Color picture tube having shadow mask-frame assembly support means.

(57) An improved color picture tube (8) includes an evacuated glass envelope (10) having a faceplate panel (12) with a cathodoluminescent screen (22) comprising different color-emitting phosphor elements disposed thereon. The panel includes a shadow mask-frame assembly (30) mounted therein by support means (34) located at peripherally spaced positions within the panel. The shadow mask (24) includes an apertured portion (25), the apertures of which are in register with the phosphor elements of the screen. The support means at each spaced position includes a stud (44) attached to the glass envelope, a spring (46) having an aperture (60) therein for engaging the stud, and a plate (48) welded between the spring and the mask-frame assembly. The improvement comprises mechanically joining the spring and the plate by extrusions interlocking the parts together at two-spaced apart locations (50, 51) along one edge (52) of the parts, whereby the spring and the plate are in contact along at least a portion of the facing surfaces thereof. The interlocking extrusions render the spring and plate resistant to shock induced movement, thereby minimizing misregister between apertures in the mask and the phosphor elements of the screen.

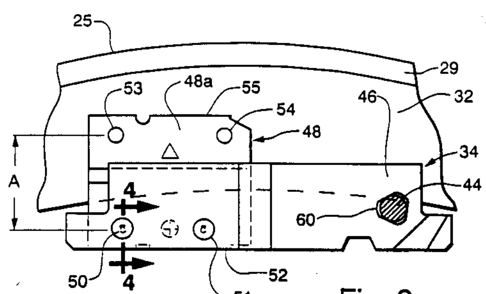


Fig. 3

EP 0 644 571 A2

This invention relates to color picture tubes of the type having a shadow mask attached to a peripheral frame which is suspended in relation to a cathodoluminescent screen comprising blue-emitting, green-emitting and red-emitting phosphor elements and, more particularly, to improved means for supporting a mask-frame assembly in such a tube so that electron beams, generated by an electron gun, impinge upon the proper phosphor elements.

In most current color picture tube types, a peripheral frame, supporting a shadow mask, is suspended in a faceplate panel by means of springs that are welded either directly to the frame or to plates which in turn are welded to the frame. In the directly welded version, the springs are usually made of bimetallic materials; and in the plate version, the plates are bimetallic. As the springs or plates become heated by transfer of heat from the mask through the frame, the bimetallic materials expand differently, thereby bending the springs or plates to cause movement of the mask-frame assembly toward a screen disposed on the panel. It is also known to use the geometric structure of the springs to cause this same motion towards the screen by action of the force of the expanding mask-frame assembly against the springs.

It is common to use either three or four springs to support a mask-frame assembly within a rectangular faceplate panel of a tube. In a three-spring support system, one spring is usually located at the upper center of the mask, and the other two springs are located along the sides of the tube between the centers of the sides of the mask and the lower two corners of the mask. In a four-spring support system, springs are usually located at the top and bottom centers of the mask and at the left and right centers of the mask. In both the three- and four-spring support systems, as described above, it is possible for the mask-frame assembly to twist slightly and shift relative to the faceplate, during tube manufacture and/or operation. A known means for minimizing twisting and shifting of a mask-frame assembly uses spring supports at the four corners of the frame.

A problem with the above-described structures for the plate version is that it is difficult to nondestructively evaluate the quality of the welds used to attach the springs to the plates, and the plates to the frame. Defective welds may fail due to thermal or mechanical shock, and the welding operation may generate weld splash, i.e., metal particles expelled from the weld area, because of improper contact between the parts to be joined together and the welding electrodes. The weld splash particles may become dislodged within the sealed tube and cause either cosmetic or electrical problems. Another weld-associated problem is that, if the parts to be joined are not flush, a weld nugget is formed between the parts and may act as a pivot point possibly causing weld failure or a relative rotation of the parts and the shadow mask under shock loading. Such a condition results in a misregister between the apertures in the shadow mask and the phosphor elements of the cathodoluminescent screen, thereby causing the electron beams to impinge upon areas of the screen other than the intended areas.

An improved color picture tube according to the present invention includes an evacuated glass envelope having a faceplate panel with a cathodoluminescent screen disposed thereon. The panel includes a color selection electrode assembly mounted therein by support means that are located at peripherally spaced positions within the panel. The support means at each of the spaced positions includes a stud attached to the glass envelope, a spring having an opening therein for engaging the stud, and a plate welded between the spring and the color selection electrode assembly. The improvement comprises mechanically joining the spring and the plate by extrusions interlocking the parts together at two spaced-apart locations along one edge of the parts.

In the drawings:

Fig. 1 (Sheet 1) is an axially sectional side view of a color picture tube embodying the present invention;

Fig. 2 (Sheet 2) is a schematic rear elevational view of a faceplate panel supporting a shadow mask assembly according to a preferred embodiment of the present invention;

Fig. 3 (Sheet 1) is a sectional view along lines 3-3 of Fig. 2, showing a portion of the shadow mask assembly and its support means;

Fig. 4 (Sheet 3) is a sectional view along lines 4-4 of Fig. 3, showing details of an interlocking extrusion of the support means;

Fig. 5 (Sheet 2) is a schematic rear elevational view of a quadrant of the faceplate panel and shadow mask assembly according to another preferred embodiment of the present invention;

Fig. 6 (Sheet 3) is a partial sectional view of a corner of the panel-shadow mask assembly of Fig. 5, and

Fig. 7 (Sheet 3) is a sectional view along lines 7-7 of Fig. 5, showing a corner support means.

Fig. 1 shows a rectangular color picture tube 8 having a glass envelope 10, comprising a rectangular faceplate panel 12 and a tubular neck 14 connected by a rectangular funnel 16. The panel 12 comprises a viewing faceplate 18 and a peripheral flange or sidewall 20 which is sealed to the funnel 16. The faceplate panel 12 includes two orthogonal axes: a major axis X-X, parallel to its wider dimension (usually horizontal), and a minor axis Y-Y, parallel to its narrower dimension (usually vertical). The major and minor axes are perpendicular to the central longitudinal axis Z-Z of the tube which passes through the center of the neck 14 and the center of the panel 12. A three-color phosphor screen 22, comprised of blue-, green-, and red-emitting phosphor elements, is carried by the inner surface of the faceplate 18. The screen preferably is a line screen with the phosphor lines extending substantially parallel to the minor axis Y-Y. Alternatively, the screen may be a dot screen. A multiapertured color selection electrode, or shadow mask, 24 is removably mounted, by improved means, in predetermined spaced relation to the screen 22. An electron gun 26 is centrally mounted within the neck 14, to generate and direct three electron beams along convergent paths through openings in a curved, apertured portion 25 of the mask 24, to the screen 22.

The tube of Fig. 1 is designed to be used with an external magnetic deflection yoke, such as the yoke 28, located in the neighborhood of the funnel-to-neck junction. When activated, the yoke 28 subjects the three beams to magnetic fields which cause the beams to scan horizontally and vertically in a rectangular raster over the screen 22.

The shadow mask 24 is part of a mask-frame assembly 30 that also includes a peripheral shadow mask frame 32. The mask-frame assembly 30 is shown positioned within the faceplate panel 12 in Figs. 1 and 2. The mask-frame assembly 30 is mounted to the panel 12 by four improved support means 34 shown in Figs. 2, 3 and 4.

The shadow mask 24 includes the curved apertured portion 25, an imperforate border portion 27 surrounding the apertured portion 25, and a skirt portion 29 bent back from the border portion 27 and extending away from the screen 22. The skirt portion 29 of the mask 24 is telescoped within or set inside the frame 32 and welded to the inside surface thereof.

The support means 34 are located at peripherally spaced positions of the mask-frame assembly 30 and the panel 12. Each support means 34 includes a stud 44, a spring 46 and a plate 48. Each stud 44 is a conically-shaped metal member that is attached to the panel sidewall 20, for example, along the major and minor axes in a 26V tube having a diagonal dimension of 66cm. An aperture 60 in the spring 46 engages the free end of the stud 44. The plate 48 is a bimetallic element comprising a first metal layer 48a and a second metal layer 48b laminated or otherwise bonded together in face-to-face relation. The spring 46 is in contact with and attached to the first metal layer 48a of the plate 48, and the second metal layer 48b is attached to the frame 32. The bimetal materials of the plate 48 are chosen so that, when heated, the plate moves toward the frame and displaces the mask-frame assembly 30 towards the screen 22. Thus, the coefficient of thermal expansion of the metal layer 48b next to the frame must be lower than the coefficient of expansion of the layer 48a attached to the spring. This temperature compensation structure is discussed in U.S. Pat. No. 3,803,436, issued to Morrell on Apr. 9, 1974.

Unlike in the prior art, the spring 46 is attached to the plate 48 not by welding, but by mechanically joining the components together using extrusions which interlock the components along facing surfaces. The extrusions are formed at two spaced apart locations 50 and 51 along one edge 52 of the joined parts. A cross section of an interlocking extrusion is shown in Fig. 4. In this embodiment, the centers of the extrusions are spaced about 19.05 mm (0.750 inch) apart and about 4.78 mm (0.188 inch) from the edge 52 of the joined parts. The other end of the plate 48 is attached to the frame 32 by conventional welding, or by utilizing extrusions of the type described. Attachment points 53, 54, shown in Fig. 3, are located about 25.4 mm (1.00 inch) apart and 4.78 mm (0.188 inch) from the opposite edge 55 of the plate 48. The lateral spacing, A, between the attachment locations 50, 51 and points 53, 54 is about 22.20 mm (0.874 inch), to provide adequate room for movement of the plate 48 to achieve temperature compensation.

The interlocking extrusions at locations 50, 51 may be formed using conventional clinching devices, such as are available from Tech-Line Engineering Co., Warren, Michigan or from BTM Corp., Marysville, Michigan.

The advantages of the interlocking extrusion over conventional attachment means, such as welding or riveting, are the elimination of weld splash, the ability to non-destructively inspect the quality of the closures, the high degree of accuracy of the location of the closures, the elimination of pre-forming holes for rivets, and the elimination of additional parts which are required by riveting. A drawback of the interlocking extrusion is that it possesses only about 70 percent of the strength of a "good" weld of equivalent nugget size; however, by slightly increasing the nugget size of the extrusion, comparable closure strength can be achieved.

An unexpected advantage of the interlocking extrusion is the improvement in shock test and static load test results for a panel having a shadow mask assembly mounted therein utilizing the novel interlocking extrusion for attaching together the associated springs 46 and plates 48. Shock tests were conducted on twelve test panel assemblies made with the interlocking extrusions at locations 50 and 51. The test assemblies were evaluated versus eight conventional (control) panel assemblies in which the springs were welded to the plates. Both the test and control assemblies had the plates welded to the frame of the shadow mask assembly.

The panels were prepared using a conventional matrix process such as that described in U.S. 4,049,452, issued to Nekut on Sept. 20, 1977. A photoresist solution, the solubility of which is altered when it is exposed to light, was deposited on the interior surface of the panel and dried. The shadow mask assembly was placed in the panel, and light from a lighthouse was projected through the apertures in the mask to expose selected areas of the photoresist. The lighthouse, in this instance, directed the light at an angle identical to the angle that the electron beams, which impinge on the green-emitting phosphor elements, would take. The mask assembly was removed from the panel, and the unexposed, more soluble portions of the photoresist were removed by washing. Then, a solution of light absorbing matrix material was deposited on the bare area of the panel and on the retained areas of exposed photoresist. The matrix solution was dried and then etched with a suitable etchant, which softened and removed the underlying retained areas of the photoresist and the overlying matrix material, leaving light absorbing matrix material on the majority of the panel, with clear windows formed in the locations previously occupied by the underlying retained areas of photoresist and overlying matrix material.

The windows in the matrix provide a way to measure register shift. When the shadow mask assembly is reinserted into the panel, with the windows formed as described above, light from the exposure lighthouse passes through the open windows, and the light location can be accurately read using a device called a matrix register reader. The panels were then shocked by a drop test that provided a 35G shock to the panel with the shadow mask assembly supported therein. G is the gravitational force. The panel assemblies were shocked with the panel in the usual viewing orientation, identified in TABLE 1 as "Y", and with the panel assembly face down, "FD", and also face up, "FU". Separate panels were used for each test. Prior to the shock test, the panel assemblies were thermally stress cycled by passing them through a stabilizing furnace operating at a temperature of 450±15°C. The thermal stress cycling was repeated five times for each panel to provide a "worst case" condition. The results of the drop test are recorded in TABLE 1. "C" identifies a control tube having a conventionally welded spring and plate, and "T" identifies a test tube having the spring and plate interlocked by the extrusions shown in Figs. 3 and 4. Register shift was measured in seven locations for each panel assembly: in the center (CTR); along each diagonal, about 25 mm from the edge of the screen (2D, 8D, 4D and 10D); and along the major axes (3:00 and 9:00). The recorded measurements were taken by projecting light from the same lighthouse, used for forming the windows in the matrix, through the mask assembly and windows, and then measuring the amount of displacement or "misregister" due to the 35G shock. The recorded values are in micrometers (μ); and the smaller the absolute value of the displacement, the lower the register shift. The plus (+) and minus (-) designations refer to shifts in one direction or the other.

TABLE 1

CHANGE AFTER 35G SHOCK TEST								
SAMPLE N	DROP	CTR	2D	3:00	4D	8D	9:00	10D
C2	Y	1	7	4	3	2	-4	-5
C3	Y	2	8	8	10	0	-4	-4
AVERAGE =	Y	1	7	6	6	1	-4	-4
C4	FU	1	11	13	12	-12	-12	-11
C5	FU	4	25	21	23	-6	-10	-16
C6	FU	1	16	13	13	-6	-8	-11
AVERAGE =	FU	2	17	16	16	-8	-10	-12
C7	FD	2	-27	-23	-19	29	34	35
C9	FD	4	-20	-15	-13	29	34	29
C10	FD	1	-24	-24	-31	31	30	30
AVERAGE =	FD	2	-23	-21	-21	30	32	31
T1	Y	2	2	0	1	6	1	-2
T2	Y	3	6	3	4	9	4	1
T3	Y	-1	3	2	-1	3	1	-2
AVERAGE =	Y	1	3	2	1	6	2	-1
T4	FU	-1	13	9	7	-12	-16	-18
T5	FU	3	13	13	15	-14	-14	-13
T6	FU	2	12	9	8	-8	-13	-13
T7	FU	1	11	9	11	-11	-12	-14
AVERAGE =	FU	1	12	10	10	-11	-13	-14
T8	FD	-2	-28	-36	-40	28	26	18
T9	FD	-2	-36	-40	-45	35	29	19
T10	FD	1	-30	-24	-22	21	29	29
T11	FD	1	-22	-28	-29	25	24	25
T12	FD	2	-21	-25	-26	27	27	23
AVERAGE =	FD	0	-27	-31	-32	27	27	22

A comparison of the register shifts for control and test panels dropped with the panel assembly in the usual viewing orientation (Y) reveals that, in the center, the test panels and the control panels had the same amount of misregister. But, at the 2D, 3:00, 4D, 9:00 and 10D locations, the absolute value of the misregister ranged from 2 to 5μ less for the test panels, while, at the 8D location, the average test panel had 5μ greater misregister than the controls. On average, the test panels experienced less overall misregister than did the control panels for the Y orientation shock test. In the face up (FU) position, the drop test results also favored the test panels, with less misregister in the center and at the 2D, 3:00 and 4D locations, but slightly greater misregister than the control panels at the 8D, 9:00 and 10D locations. In the face down test (FD), the test panels fared worse than the control panels, but all performed poorly.

Static load test results for two additional control tubes, made with conventional welds, and two test tubes, having the springs attached to the plates using the novel interlocking extrusions, are listed in TABLES 2 and 3, respectively.

TABLE 2

Sample C11						
LBS @ 2D	2D	3:00	4D	8D	9:00	10D
0	0	0	0	0	0	0
5	-1	1	1	2	1	0
10	0	0	1	3	1	0
15	-2	0	1	1	1	1
20	-3	0	-3	0	2	-1
25	-4	0	-3	1	2	-1
30	-8	-1	-2	-4	2	-4
35	-10	0	-3	0	0	-7
40	-17	-1	1	0	-1	-11
45	-27	-3	2	4	-2	-18
50	-37	-8	9	8	-2	-31
55	-47	-9	16	16	0	-35
Sample C12						
LBS @ 2D	2D	3:00	4D	8D	9:00	10D
0	0	0	0	0	0	0
5	1	0	-2	0	0	0
10	0	-2	-3	-1	-2	1
15	0	0	-2	-1	-2	0
20	-5	-1	-4	-2	-2	-3
25	-7	-1	-4	-2	-1	-2
30	-7	-1	-4	-2	-3	-3
35	-9	-2	-4	-2	-2	-8
40	-15	-3	-2	0	-2	-12
45	-25	-7	0	3	-5	-20
50	-35	-9	4	7	-6	-27
55	-49	-13	17	17	-6	-40

TABLE 3

Sample T13						
LBS @ 2D	2D	3:00	4D	8D	9:00	10D
0	0	0	0	0	0	0
5	-2	1	2	1	2	3
10	-2	1	0	0	2	6
15	-3	2	3	2	2	5
20	-7	0	0	-1	3	5
25	-11	-2	-1	-2	2	2
30	-15	-4	-3	-3	1	3
35	-21	-6	-6	-4	-2	-1
40	-22	-6	-7	-5	-3	-4
45	-27	-6	-3	-2	-3	-9
50	-34	-6	0	1	-4	-13
55	-43	-8	3	3	-2	-19
Sample T14						
LBS @ 2D	2D	3:00	4D	8D	9:00	10D
0	0	0	0	0	0	0
5	6	8	10	7	5	4
10	5	4	7	8	5	6
15	2	5	7	8	5	6
20	0	4	7	10	6	7
25	1	3	7	7	5	4
30	-4	2	7	7	5	5
35	-10	0	5	6	3	2
40	-15	-1	6	8	4	0
45	-19	-1	6	9	3	-4
50	-23	-1	11	12	4	-8
55	-37	-3	16	17	3	-13

In the static load test, a push was exerted against a corner of the frame, the 2D (2 o'clock) corner, and the displacement of the light source through the matrix openings was recorded at the corners (2D, 4D, 8D and 10D) and on the major axis (3:00 and 9:00). All readings were made about 25 mm from the edge of the screen. The pushing force was increased in 5 pound (2.268 kg) increments, and the corresponding displacements were recorded.

The plates and springs of the test tubes, T13 and T14, were mechanically joined by the novel extrusion interlocking the parts. The plates and springs of the control tubes, C11 and C12, were joined by conventional welding. The plates of both the test and control tubes were welded to the shadow mask frame, as described above for the shock test tubes. The interlocked plates and springs of test tubes T13 and T14 offered more resistance to displacement or misregister than did the welds of the control tubes. This is concluded by comparing the maximum displacements at a non-contacted corner (10D), as the static load is increased from 40 to 55 pounds at the 2D corner. A 45 pound test load simulates the forces on the mask-frame assembly, if the panel with the mask-frame assembly mounted thereon is mishandled during manufacturing and the mask frame is contacted.

With reference to TABLE 2, when a 40 pound load was applied to the 2D corner of the control tubes, the greatest displacement at a non-contacted corner occurred at the 10D corner of the control tubes, where the misregister was 11 and 12μ, respectively. However, as shown in TABLE 3, for the test tubes, an equivalent load of 40 pounds at the 2D corner resulted in displacements of 4 and 0μ, respectively, at the 10D corner. When the load at the 2D corner was increased to 55 pounds, the corresponding displacements at the 10D corner for the control tubes, were 35 and 40μ, as shown in Table 2; whereas, the displacements for the test tubes were only 19 and 13μ, respectively, as shown in TABLE 3.

While the invention has been described with respect to support means located on the major and minor axes of the panel and shadow mask-frame assembly, the support means also may be positioned at other locations on the panel and the mask-frame assembly. As shown in Figs. 5, 6 and 7, the support means 34' are included at each of the four corners of the mask-frame assembly 30' and panel 12'. Components that are similar to components in Figs. 1-4 are labelled with primes of the same number. Each support means 34' includes a stud 44', a spring 46' and a plate 48'. Each plate 48' is welded near one end at a truncated corner of the frame 32'. The welds may be conventional, or a pair of novel extrusions at points 53' and 54', which interlock the frame 32' to the plates 48', may be used. The spring 46' is attached at one of its ends to the other end of the plate 48' by extrusions at locations 50' and 51', which interlock the parts together in the manner shown in Fig. 4, for the first embodiment. The spring 46' includes an aperture 60' near its free end, which engages the conical portion of the stud 44'.

The plate 48' is of laminated bimetal construction, as shown in Fig. 6. One metal layer 48a', facing the frame 32', is a high thermal expansion material, and the other metal layer 48b', facing the spring 46', is a low thermal expansion material. The spring 46' and the plate 48' each provide a contribution to the compensation necessary to move the mask-frame assembly 30' relative to the screen, to compensate for thermal expansion of the mask 24' during tube operation. The extent of the contributions of the spring and the plate is described in U.S. Pat. No. 5,063,325, issued to Ragland, Jr. on Nov. 5, 1991.

Claims

1. A color picture tube including an evacuated glass envelope having a faceplate panel with a cathodoluminescent screen disposed on an interior surface of said panel, a color selection electrode assembly mounted in spaced relation to said screen, said assembly being secured to said panel by support means located at peripherally spaced positions, said support means at each of said spaced positions including a stud attached to said panel, a spring and a plate, said spring being attached to said plate, said spring having a stud-engaging opening therein, and said plate being secured to said frame; characterized by said spring (46, 46') and said plate (48, 48') being mechanically joined by extrusions interlocking said spring and said plate together at two spaced apart locations (50, 51, 50', 51') along one edge (52, 52') of said spring and said plate.

2. The tube as described in claim 1, characterized in that said faceplate panel (12) is rectangular and the peripherally spaced positions of said support means (34) are along oppositely disposed sides of said panel.

3. The tube as described in claim 1, characterized in that said faceplate panel (12') is rectangular and the peripherally spaced positions of said support means (34') are in the corners of said panel.

4. The tube as described in claim 1, characterized in that said plate (48, 48') is mechanically joined to said frame (32, 32') by extrusions interlocking said plate and said frame together at two spaced apart points (53, 54, 53', 54').

5. The tube as described in claim 4, characterized in that said spaced apart points (53, 54, 53', 54') are along an edge (55, 55') of said plate (48, 48') opposite the one edge (52, 52') attached to said spring (46, 46')

6. A color picture tube including an evacuated glass envelope having a rectangular panel with a viewing portion and a peripheral sidewall connected to said viewing portion, a cathodoluminescent screen comprising different color-emitting phosphor elements disposed on an interior surface of said viewing portion of said panel, a rectangular shadow mask assembly within said panel mounted in spaced relation to said screen, said shadow mask assembly including an apertured portion and a frame, the apertures in said apertured portion being in register with the phosphor elements of said screen, said assembly being mounted in said panel by support means located at peripherally spaced positions, said support means at each of said spaced positions including a stud attached to said sidewall of said panel, a spring and a bimetal plate having a first metal layer and a second metal layer in face-to-face relation, said metal layers having different coefficients of thermal expansion, said spring being in contact with and attached to said first metal layer of said plate, said spring having a stud-engaging opening therein, and said second metal layer of said plate being secured to said frame; characterized by said spring (46, 46') and said plate (48, 48') being mechanically joined together by extrusions interlocking said spring and said plate together at two spaced apart locations (50, 51, 50', 51') along one edge (52, 52') thereof, said extrusions extending from said plate into said spring, whereby said spring and said plate are in contact along the facing surfaces thereof, the interlocking extrusions rendering said spring and

said plate resistant to shock induced rotation, thereby minimizing misregister between the apertures of said shadow mask (24, 24') and said phosphor elements of said screen (22).

7. The tube as described in claim 6, characterized in that said peripherally spaced positions of said support means (34) are located on oppositely disposed sides of said panel (12).

8. The tube as described in claim 6, characterized in that said peripherally spaced positions of said support means (34') are located in the corners of said panel (12').

9. The tube as described in claim 6, characterized in that said plate (48, 48') is mechanically joined to said frame (32, 32') by extrusions interlocking said plate and said frame together at two spaced apart points (53, 54, 53', 54').

10. The tube as described in claim 7, characterized in that said spaced apart points (53, 54, 53', 54') are along an edge (55, 55') of said plate (48, 48') opposite the one edge (52, 52') attached to said spring (46, 46').

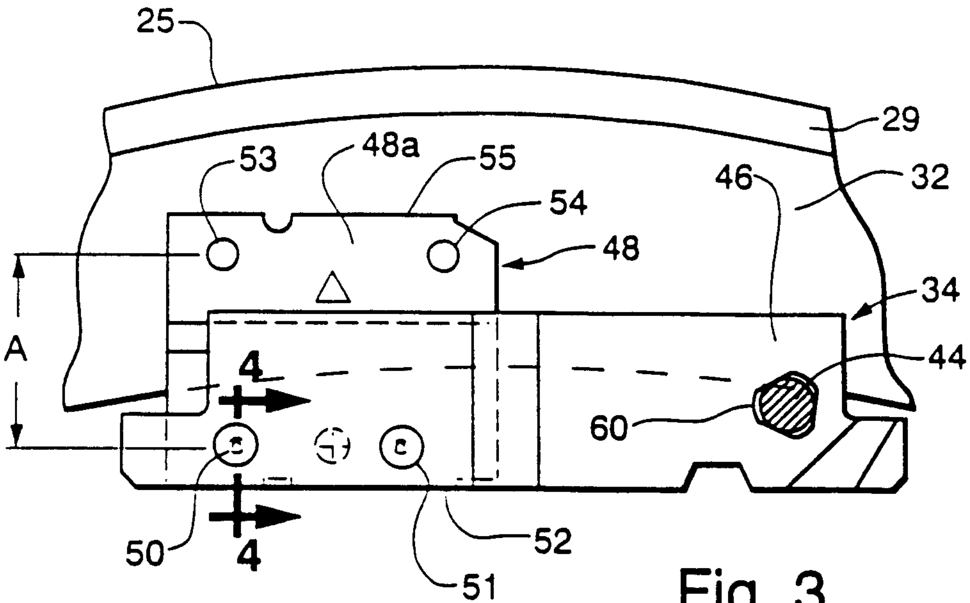

25
29
53
48a
55
54
48
46
32
34
A
4
44
60
50
4
52
51

Fig. 3

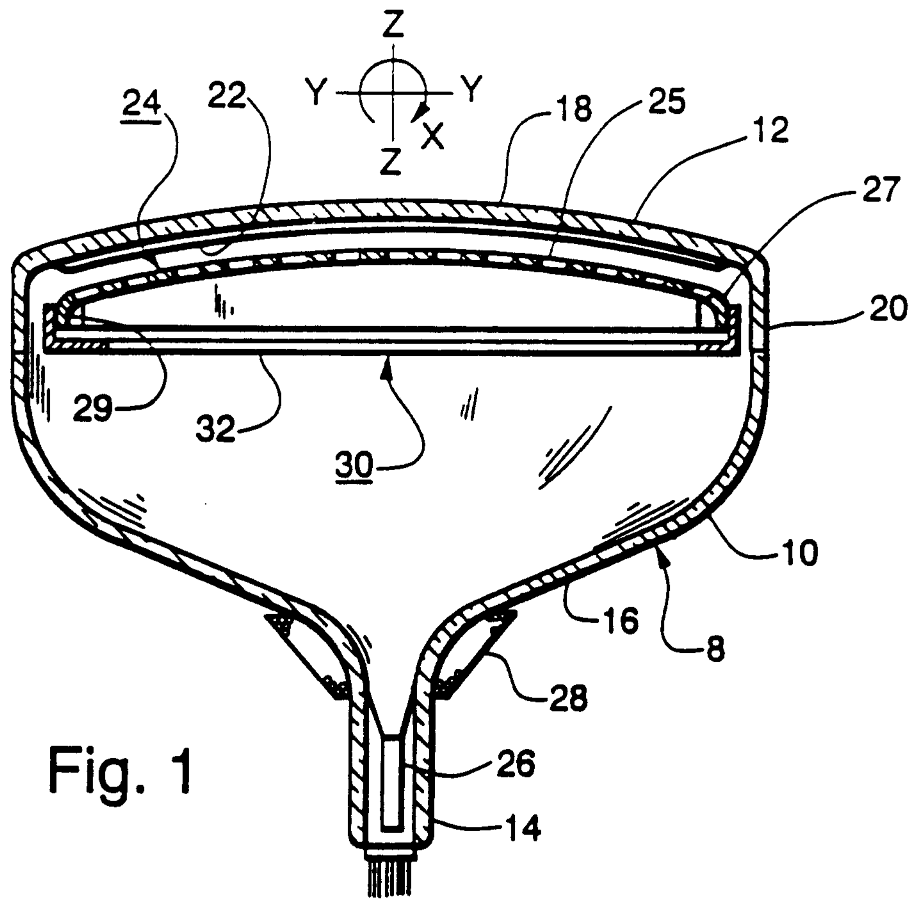

Z
Y
Y
X
Z
24
22
18
25
12
27
20
29
32
30
10
16
8
28
26
14

Fig. 1

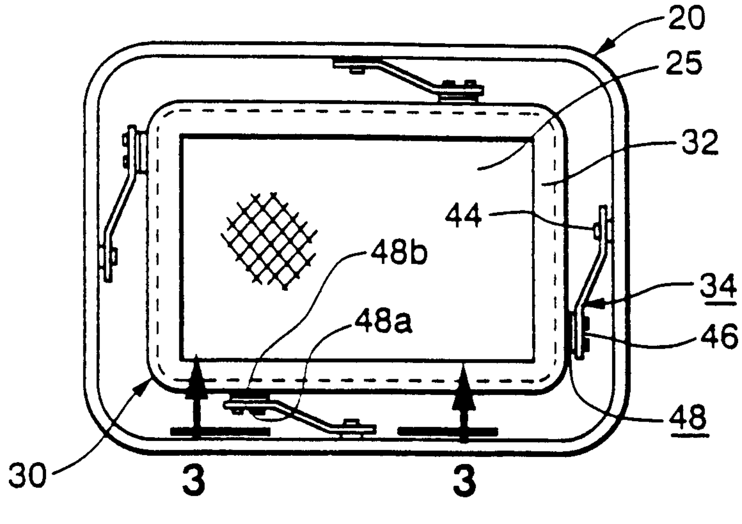


Fig. 2

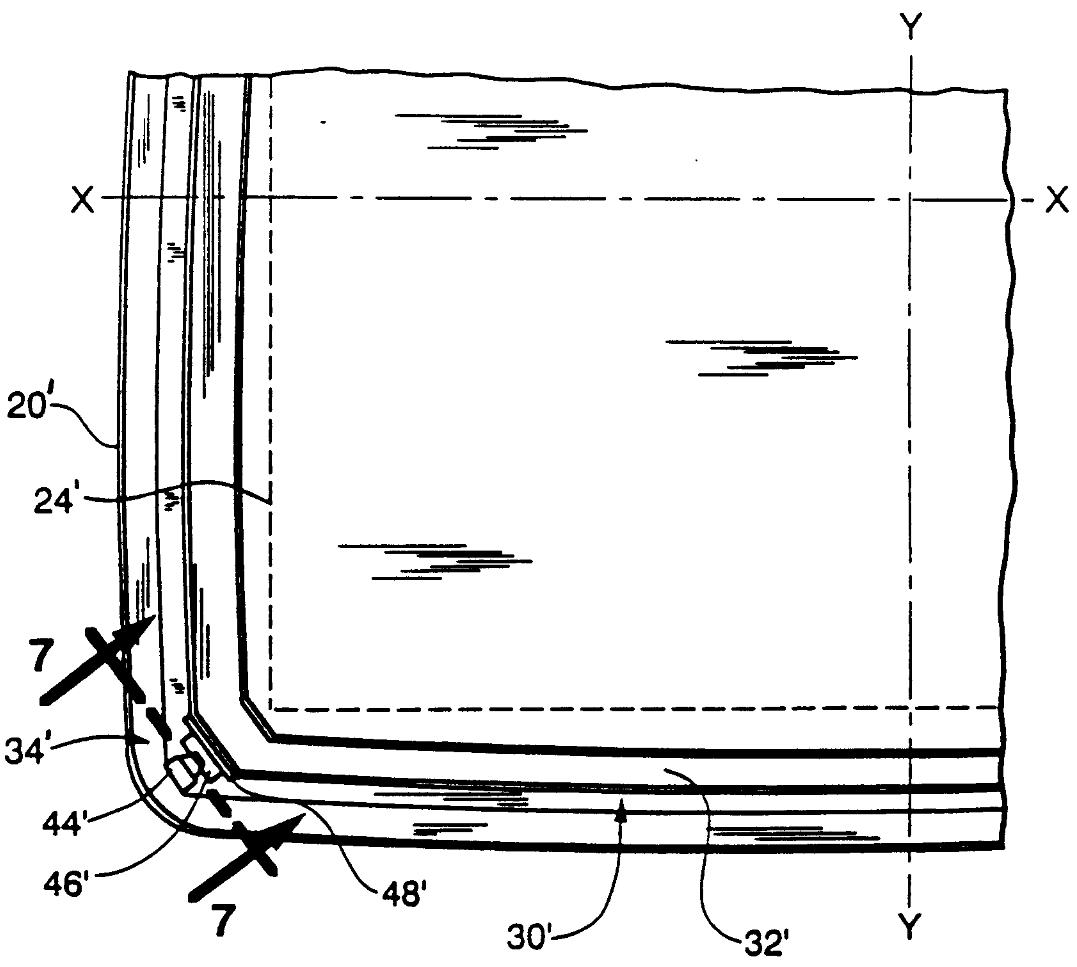
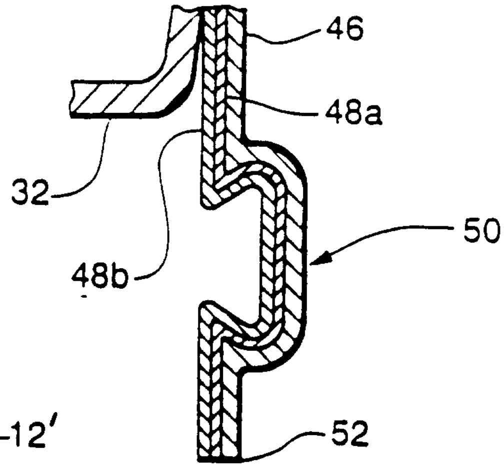


Fig. 5

Fig. 4



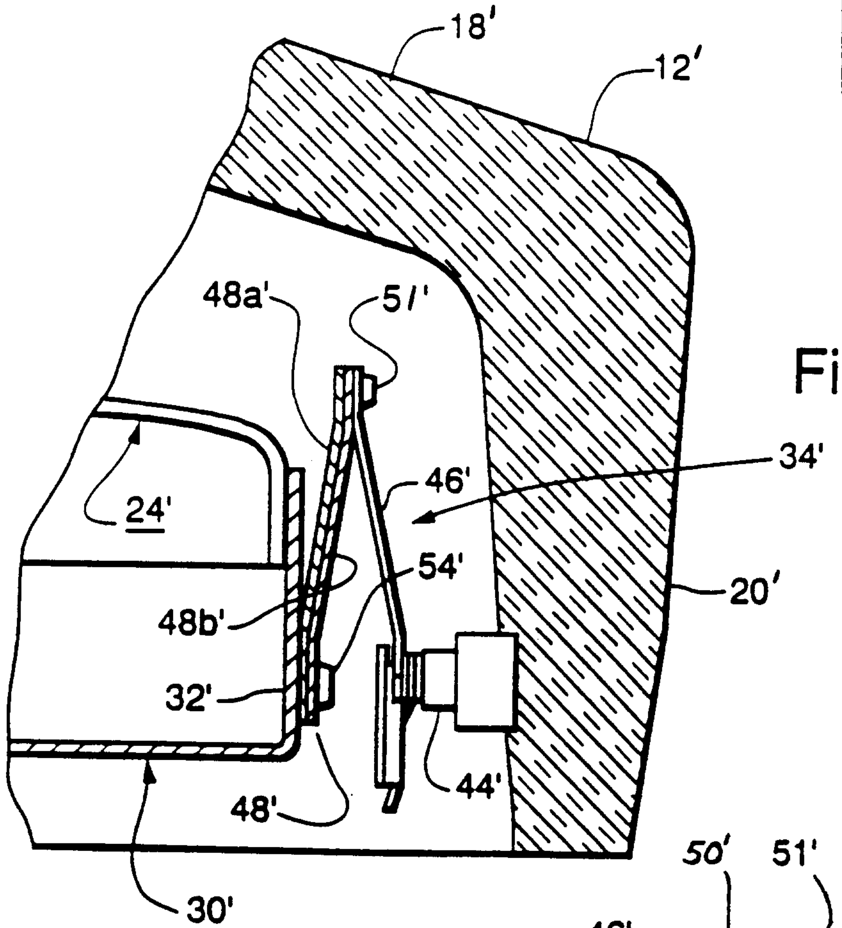


Fig. 6

Fig. 7