

[54] **DRY, IMPULSE-RESISTANT IMPLOSION PROTECTION SYSTEM FOR LARGE SCREEN CATHODE RAY TUBES**

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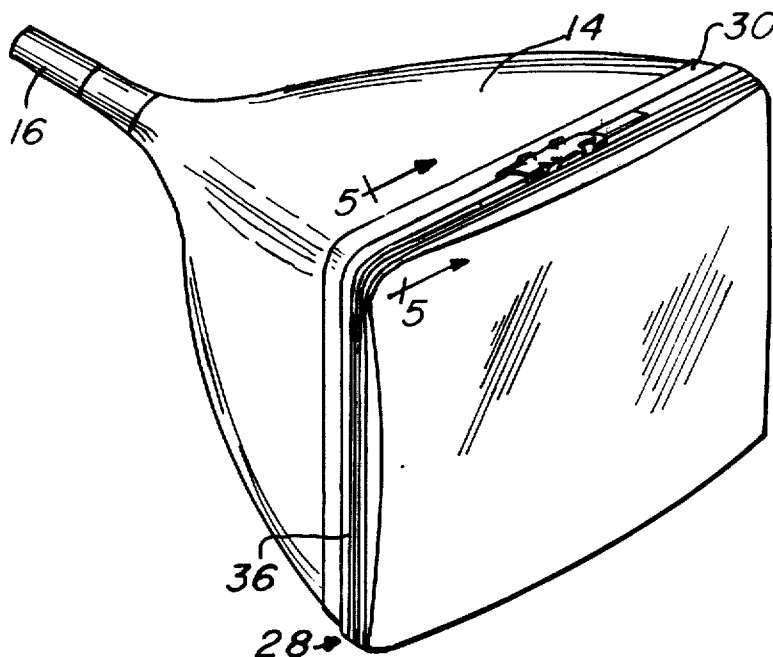
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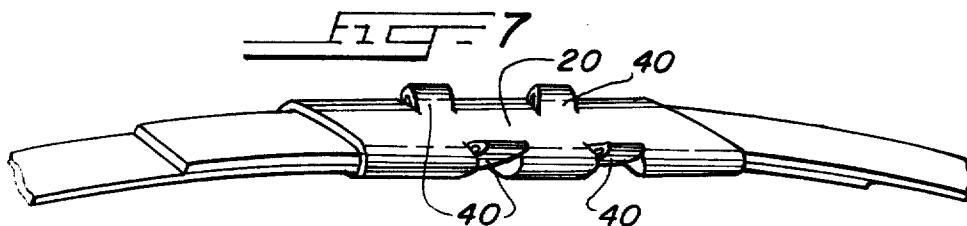
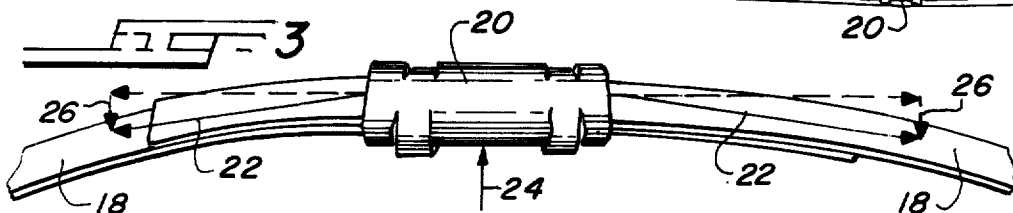
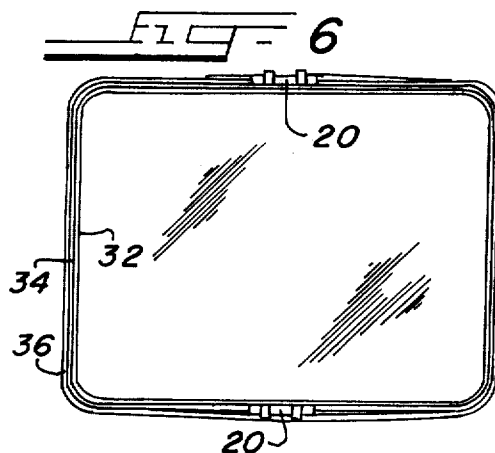
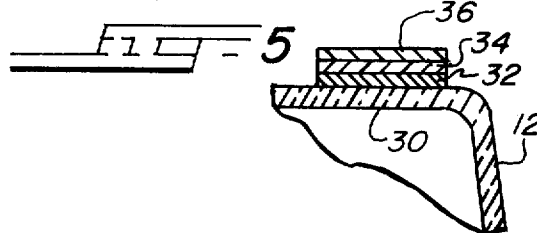
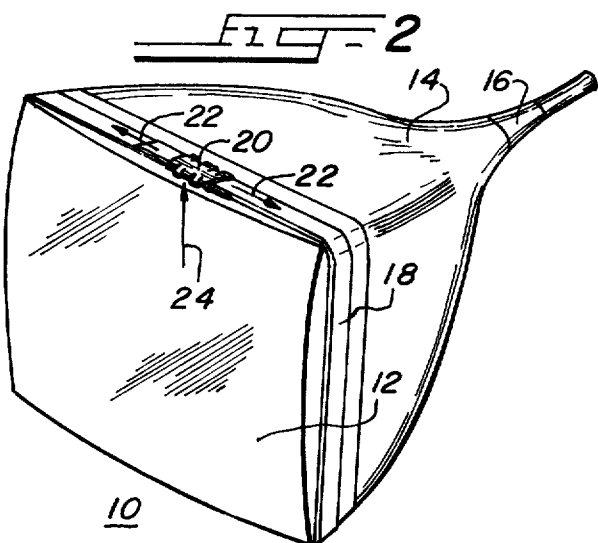
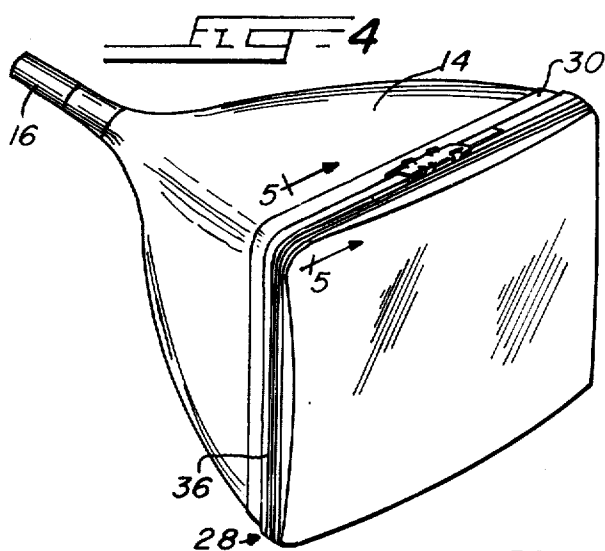
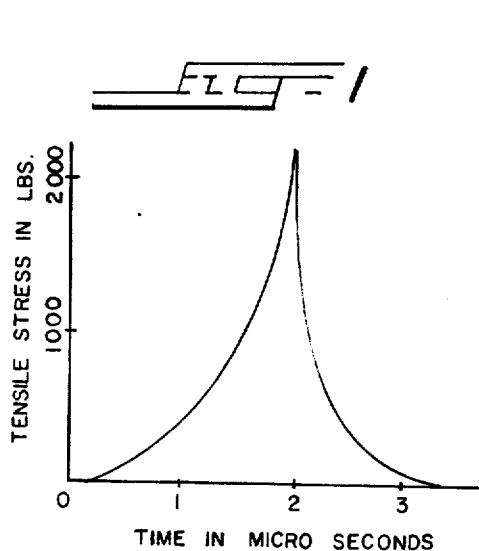
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[57] **ABSTRACT**

A dry impulse-resistant implosion protection system for large screen cathode ray tubes. The system includes a strip of relatively incompressible tape secured to and encircling the cathode ray tube front panel, a first steel tension band placed directly over the tape and tensed to provide hoop compression on the front panel, and a second steel tension band placed directly over the first band and also tensed to provide hoop compression on the front panel. The tension bands are tensed so as to provide a relatively high cumulative compression on the front panel. In addition, the tension bands have a rigidity and are so tightly secured in place on the front panel that, when a fracture of the front panel occurs, the resulting elongation in each band is small enough to inhibit the propagation of the fracture to the funnel or neck areas of the tube so that the bulb may substantially devacuate through the front panel fracture.

5 Claims, 7 Drawing Figures





DRY, IMPULSION-RESISTANT IMPLOSION PROTECTION SYSTEM FOR LARGE SCREEN CATHODE RAY TUBES

BACKGROUND OF THE INVENTION

This invention is related to large screen cathode ray tubes (CRT's) and their manufacture. It is specifically directed toward an improved system of implosion protection for such tubes.

Cathode ray tubes are evacuated glass bulbs containing a number of electrodes for converting applied electronic signals into a visible pattern of information on a viewing screen. Since each tube is evacuated, any sudden rupture or fracture of a CRT glass envelope will cause a sudden rush of air into the tube (devacuation). Should the tube devacuate through a fracture near the tube neck, the force of the devacuation can possibly sever the neck from the tube and throw it forward through the tube in the direction of a viewer. Therefore, every effort is made to insure that, should devacuation occur, it will happen from the front of the tube so that any glass fragments generated are propelled inwardly away from the viewer.

It should be pointed out that devacuation of the bulb can occur from the rear of the bulb even if the initial bulb fracture occurs in the faceplate. Because the faceplate of the tube is made of very thick glass, a fracture there will not necessarily result in an immediate devacuation through the faceplate. Rather, the fracture may rapidly propagate rearwardly toward the weaker funnel and neck sections of the bulb where a violent implosion might occur.

In the past, most attempts to control the devacuation of cathode ray tubes have involved the application of a compressive force around the envelope and near the faceplate. By keeping the front part of the envelope under compression, fractures which occur in the faceplate may be confined to the forward area of the tube instead of spreading rearwardly to the weaker funnel and neck areas where a sudden devacuation is most undesirable. This method of controlling the devacuation of cathode ray tubes is usually accomplished by placing a reinforcing metal sheath or "rim-band" around the tube near the faceplate. This rim-band is made of steel and is contoured to fit the tube envelope. A thermosetting adhesive such as an epoxy resin material is used to bond the rim-band to the tube. Finally, a steel tension band is placed over the rim-band and tensed to approximately 1,000 pounds. See U.S. Pat. No. 3,220,593, issued to Powell et al. Such a system is referred to herein after as a "wet" system because of its use of a bonding agent. By bonding the tension band to the bulb, the bulb is greatly reinforced and able to contain the fracture within the forward area of the bulb.

More recent developments in CRT implosion protection are commonly referred to as "T-band" (tension band) systems in which a pressure-adhesive cloth tape is wrapped around a forward part of the bulb near the faceplate. A steel tension band is then positioned over the tape and tensed to approximately 800 pounds of permanent tension to provide hoop compression around the forward part of the bulb. Such a system has found wide acceptance in the manufacture of small screen cathode ray tubes (i.e., screens smaller than 19 inch). The beauty of the system is that it is "dry"; that is, it does not involve the use of a bonding agent such as an epoxy resin material. The advantages of a dry sys-

tem are that it is much easier to apply in the factory than the messier wet systems; it is a cheaper system and is more quickly completed than the wet system. Further, CRT bulbs incorporating a dry system are much easier to "delam," i.e., remove the implosion protection and reopen the bulbs of imperfect CRT's for salvage purposes.

However advantageous the use of a dry system may be, it has never found commercial use in the production of large screen (19 inches and larger) CRT's even when two tension bands were used. The problem which the large screen CRT's encountered with the dry system was that they were unable to pass the UL (Underwriters' Laboratories) implosion safety tests.

As a result of the failure of the larger size CRT's to obtain UL approval with dry implosion protection systems, efforts were made to improve on existing wet implosion protection systems. For example, see U.S. Pat. No. 3,697,686, issued to Hildebrants on Oct. 10, 1972.

Today virtually every U.S. manufacturer of television CRT's uses a wet epoxy bonding system as described above for their large screen CRT's. The present wet bonding system includes a two section rim-band epoxy-bonded around the tube envelope near the faceplate. The rim-band is made of thin-walled steel, generally about 4 inches wide. A steel band is positioned around the rim-band and placed under a permanent tension of about one thousand pounds. Opposite ends of the tension band are secured together by means of a mechanical seal.

Although the wet bonding system described immediately above works well as far as implosion protection is concerned, it nevertheless has all the undesirable characteristics of a wet bonded system. It is expensive. It is difficult to manage in production quantities in a factory, lending itself poorly to both assembly line processing and process control. Moreover, the reclamation of imperfect bulbs using such a wet-bonded system is difficult, time consuming, expensive and very often ineffective. In many cases, removing the epoxy-bonded rim-band during the delaming process pulls chunks of glass away from the envelope and results in many rejected and useless bulbs.

One method of delaming wet bonded bulbs involves soaking the bulbs in a hot (200°F) soapy bath for 50 minutes. The hot water soaking tends to degrade and undercut the epoxy bond and, in some cases, permit the rim-band to be peeled off. However, peeling the rim-band off is and always has been a relatively dangerous operation for the person doing it. Sometimes pieces of glass are pulled away from the bulb along with the rim-band, thus weakening the bulb and occasionally resulting in an implosion. In any event, such a bulb cannot be reused if the glass is damaged during the delaming.

Accordingly, this invention is directed toward avoiding the above-described undesirable characteristics of present large screen implosion protection systems.

OBJECTS OF THE INVENTION

It is a general object of this invention to provide a greatly improved implosion protection system for large screen cathode ray tubes.

It is a more specific object of this invention to provide a dry implosion protection system for large screen cathode ray tubes which is less expensive and easier to install than present wet implosion protection systems.

It is another object of this invention to provide an improved implosion protection system for large screen cathode ray tubes which renders their reclamation and salvage easier, safer and less expensive.

It is yet another object of this invention to provide an implosion protection system with the above-mentioned characteristics which is capable of passing all UL tests for implosion protection safety.

It is a further object of this invention to provide a dry implosion protection system for large screen cathode ray tubes which is unyielding to the impact of a fracture impulse generated by a fracture of the cathode ray tube front panel.

PRIOR ART

U.S. Pat. No. 3,220,593, issued to Powell et al.;

U.S. Pat. No. 3,456,076, issued to Greswald et al.;

U.S. Pat. No. 3,697,686, issued to Hildebrants.

BRIEF DESCRIPTION OF THE DRAWINGS

The features of the 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, however, by reference to the following description taken in conjunction with the accompanying drawings in which:

FIG. 1 illustrates a representative fracture impulse of the type occurring in fractured CRT's;

FIG. 2 is a schematic illustration of a CRT implosion protection system which is useful in understanding the principles of this invention;

FIG. 3 is an enlarged and fragmentary view of a portion of the implosion protection system shown in FIG. 2, together with force vectors illustrating the forces present in such a system when a CRT fracture occurs;

FIG. 4 illustrates a large screen CRT having an implosion protection system in accordance with this invention;

FIG. 5 is a fragmentary sectional view taken along section lines 5—5 of FIG. 4;

FIG. 6 is a front view of the FIG. 4 implosion protection system which illustrates more clearly the preferred embodiment of this invention; and

FIG. 7 illustrates a preferred means for joining and securing opposite ends of a tension band in accordance with this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As discussed above, most large screen CRT's now in production use a wet-bonded implosion protection system with all the attendant problems of such a system. Up until now, no dry T-band system for large screen CRT's has been able to pass the rigorous UL tests for implosion safety. This disclosure will point out why previous attempts to use a dry T-band implosion system for large screen CRT's have failed and how this invention, recognizing the problem which was overlooked in the prior art, meets that problem squarely and provides a truly dry and safe implosion protection system for large screen CRT's which meets every UL test for implosion safety.

As with so many other inventions a recognition of the exact nature of an underlying problem or need is critical to a solution of the problem or satisfaction of the need. That is precisely the case here. Therefore, a brief explanation of what the problem has been with prior

dry implosion protection systems for large screen CRT's will be discussed before describing the preferred embodiment of this invention.

If a heavy missile strikes the front panel of a CRT, the front panel itself may literally bend inwardly under the impact. If the missile is massive enough and strikes the panel with a great enough velocity (as in UL implosion tests) a fracture or fractures will occur in the front panel and will allow the pressure of the atmosphere to force the panel inwardly. The reaction of the front panel to the impact happens so quickly that the resultant force on the glass can be characterized as a traveling fracture impulse, i.e., a very short-lived and high energy expansive tensile stress, which travels through the glass. Such an impulse is shown diagrammatically in FIG. 1. Note that the pulse amplitude rises and falls quickly.

The impulse propagates along a path of least resistance toward the funnel and neck areas of the bulb at a speed that will allow it to transmit its energy to those vulnerable sections of the bulb even before the fracturing of the front panel has been completed and before the bulb has had an opportunity to devacuate through the fracture in the front panel.

If the traveling impulse is not inhibited from reaching the funnel or neck areas of the bulb, it may eventually cause fractures in one of those areas since the glass there is much thinner than the glass found in the forward area of the bulb near the front panel. In that case, the bulb may implode from the rear and propel glass from the funnel and neck of the tube forwardly, perhaps even through the fracture in the front panel and toward a viewer.

As has been ably pointed out in the prior art on this subject, the application of a compressive force around the bulb near the front panel can possibly contain the fracture. What has not been pointed out, however, is exactly why a dry implosion system, even those using two tension bands, one on top of the other, has not been able to consistently prevent front panel fractures from resulting in implodings in the neck or funnel areas of large screen CRT's.

It has been discovered that the fracture impulse generated in large screen CRT's contains considerably more energy than similar impulses in the small size tubes. This is due to the fact that large screen CRT's present a much greater surface area upon which the pressure of the atmosphere can bear. When a fracture occurs, the greater total force bearing on the surface of the bulb is translated into a higher energy impulse. It is as though the larger bulbs contain an amount of potential energy which is directly related to their greater size, and that that potential energy is released as an impulse when the front panel is fractured.

The effect which an impulse can have on a tube and on its implosion protection system will now be discussed with reference to FIG. 2. As shown, a cathode ray tube 10 has a faceplate 12, a funnel section 14 and a neck section 16. For clarity and ease of explanation, the implosion protection system for the FIG. 2 CRT has been reduced to a single tension band 18 tensed around the forward part of the tube 10 and joined by a mechanical seal 20. Tension band 18 provides the hoop compression which is intended to inhibit a fracture of the front panel 12 from traveling rearwardly to either the funnel portion 14 or the neck section 16. Normally, an underlying layer of tape is affixed to the bulb to pro-

tect the glass from mechanical abrasion damage by the steel tension band. The tension band is then laid directly over the tape, placed under tension and secured by means of mechanical seal 20.

Vectors 22 represent the internal forces acting on tension band 18 and seal 20 due to the tension of the band. Vector 24 represents the force associated with a fracture impulse traveling in the faceplate 12 of the tube. It is assumed that the impulse is aimed directly at seal 20; experience has shown this to be the worst case condition for restraining a fracture.

If the only forces operating on tension band 18 and seal 20 are those represented by the vectors 22 and 24, band 18 will have to move in the direction of impulse vector 24 until vertical counteracting forces can be developed in tension band 18. When the sum of the downwardly directed forces in tension band 18 is equal to the magnitude of the force represented by impulse vector 24, tension band 18 will be in equilibrium and will not expand any farther.

As tension band 18 first begins to yield to an impulse, it will rise somewhat and allow vectors 22 to change their directions so that they contain vertical components which tend to counteract impulse vector 24.

FIG. 3 is a fragmentary and enlarged view of tension band 18 and seal 20. Tension band 18 is shown as having risen somewhat under the influence of vector 24. This rise has, of course, been exaggerated in order to more clearly demonstrate the principles under discussion. Vectors 22 have been resolved into their horizontal and vertical components. When the vertical components of vectors 22, represented by dashed vectors 26, are equal in magnitude to the force represented by vector 24, the tension band will remain stationary. Of course, the sum of all the vertical forces acting on tension band 18 must be equal to zero or it will continue to move upwardly in order to resolve a greater portion of vectors 22 into vertical components to counteract vector 24.

In the past, building an implosion protection system capable of containing a fracture without breaking apart has not been a problem. High strength tension bands have been available for quite some time which can easily withstand the forces resulting from a fracture. What prior art dry implosion protection systems did not account for is that, while their tension bands were flexing and yielding to generate the internal forces required to withstand and counteract an impulse, their tension band yield was so great that the very brief impulse was, in a manner of speaking, permitted to escape under the yielding tension band and to propagate rearwardly toward the CRT neck. The usual result was an implosion collapsing the rear of the tube.

This undesirable yield in prior implosion protection systems could have been due to momentary stretching of the tension band itself, yielding of the mechanical seal, or compression of the underlying layer of tape. It must be emphasized, therefore, that a high breaking strength alone in a tension band is not enough. Prior art large screen dry implosion protection systems failed, it is believed, chiefly because the problem of momentary yielding in such experimental systems was not recognized and corrected. The key to success in dry implosion protection systems for large screen CRT's and the essence of this invention is in fabricating a system which is so unyielding to the fracture impulse that the propagation of the impulse is inhibited while the

devacuation of the tube occurs through the already fractured faceplate. The inhibition of the traveling impulse can be achieved only when every element of an implosion protecting system is so unyielding to the initial impulse shock that the system, as a whole, functions as an impulse barrier. Just as a weak link can determine the strength of a chain, so also can one yielding element in an implosion protection system determine the effectiveness of that system.

Keeping in mind the above described requirements of a successful dry implosion protection system, the preferred embodiment of this invention will now be described. FIG. 4 illustrates a large screen CRT having a dry implosion protection system constructed in accordance with this invention. The CRT has the usual neck section 16, funnel section 14 and front panel 28. The front panel consists of a faceplate 12 whose inner surface is coated with red-emissive, blue-emissive and green-emissive phosphor elements, and a flange or skirt 30 wrapped around the faceplate and protruding rearwardly therefrom. Skirt 30 and funnel 14 are frit-sealed together to form an airtight envelope.

The implosion protection provided for the FIG. 4 CRT includes a pressure-adhesive strip of tape encircling the panel skirt 30 and situated on the forward part of the skirt near the faceplate 12. The tape cannot be readily seen in FIG. 4 but will be described more fully in the discussion to follow.

A first steel tension band is placed directly over the tape and tensed to approximately 1,500 pounds to provide hoop compression on the front panel. A second steel tension band 36, also tensed to approximately 1,500 pounds, is placed directly over the first steel band to provide additional hoop compression on the front panel. Since the hoop compression provided by the two tension bands is additive, the front panel will be under total compression of approximately 3,000 pounds. Placing one band directly over the other, each under tension, has an effect similar to using one large, strong band which is tensed to the cumulative tension of two smaller bands, one on top of the other.

The opposite ends of each tension band are joined together by a mechanical seal 20, more fully described hereinafter.

Referring now to FIG. 5 there is shown a cut-away view taken along section lines 5-5 of FIG. 4. The tape 32 is the layer flush with skirt 30. The first tension band 34 and the second tension band 36 are placed directly over tape 32 as shown. The tape and the two tension bands in the preferred embodiment are approximately three-fourths inch wide.

The tape found to be most suitable for this application is a relatively hard, plastic-impregnated cloth tape having a pressure adhesive on one side and a relatively smooth surface on the opposite side, for example, Permacel No. 672, a trademarked product of Permacel, New Brunswick, N.J. The smooth surface of the tape over which the first tension band is placed acts to enhance the distribution of the hoop compression of the bands and to prevent point loading of the bulb, particularly at the corners thereof. This tends to more evenly distribute the compression provided by the tension bands. The tape itself is relatively hard throughout in order to remain relatively incompressible in the presence of a bulb fracture so that a traveling fracture impulse in the bulb will not be able to compress the tape a significant amount, but will be transmitted by the tape

to the tension bands. Should a soft or compressible tape be used, such a tape might compress under the impact of an impulse to such an extent that the fracture would be able to escape beneath the tension bands and propagate to the rear of the tube. In that case, the breaking strength of the tension bands and their seals would be immaterial since the tape itself would be the weak link which would destroy the usefulness of the implosion protection system.

Tension bands 34 and 36 are conveniently made of the same high tensile strength steel. In a system constructed and successfully tested, the bands 34, 36 were approximately $\frac{3}{4}$ inch wide by 31 mils thick. The Young's modulus of the steel was approximately 30×10^6 pounds per square inch. A tension band as described is quite rigid and will tend to elongate very little under the impact of a high energy fracture impulse. Each tension band preferably has a breaking tensile strength of approximately 135,000 pounds per square inch.

FIG. 6 indicates how the tension bands are most conveniently secured around the bulb. As shown, the first tension band 34 is positioned directly over the tape 32 and has its opposite ends secured by a mechanical seal 20 at the top of the bulb. The second tension band 36 is placed directly over the first tension band and sealed at the bottom of the bulb. Each seal 20 is of the heavy duty type and is heavily notched into its associated tension band to form a notch joint having a joint strength of about 2,500 pounds. The seal is made from 22 gauge steel, having a thickness of 0.028 inch and a length of $2\frac{1}{4}$ inches.

FIG. 7 shows a tension band and the manner in which it is notch-joined to seal 20. Four notches 40, each $\frac{5}{16}$ inch wide and $\frac{5}{32}$ inch deep, are made in the seal and underlying tension band. Note that each notch 40 is turned upwardly and away from its associated band so that the pointed edges of the notched seal will not point load the panel at points where the notches would otherwise bear on the panel. The turned up notches also form a convenient cradle for holding the outermost tension band in place directly over the seal. This prevents the outermost band from slipping out of place.

The tension bands 34, 36 can conveniently be tensed by means of commercially available tensioners such as the N134TV tensioner made by Signode Corp. The seals may be notched by the usual commercial sealers such as the Signode Model RCN 3435.

The manner in which the tension bands are secured is perhaps the most critical element in a large screen implosion protection system. Should the tension bands be permitted to pull apart a small amount, even momentarily under the impact of the impulse, the protection may be completely lost. For this reason, the rigidity of each of the tension bands and the strength of the notched joints in the bands must be such that, when a fracture of the front panel occurs, the resulting tensile strain in each band is small enough to inhibit the propagation of a fracture impulse so as to substantially confine bulb devacuation to the front panel. By tensile strain is meant the elongation of a band divided by its original length; that is, $L_1 - L_0 / L_0$ where L_1 is the elongated length of a band and L_0 is the original length of the band. As used herein, the term "tensile strain" is meant to include not only the elongation of the tension band itself, but whatever yield occurs in the joint or seal which secures opposite ends of the band. Should

that joint yield or slip even momentarily under the impact of a fracture impulse, the fracture is likely to propagate right under the tension band and rearwardly toward the neck of the tube. In the case of the tension bands and seals used in the above described preferred embodiment, the total tensile strain of the bands was less than 0.5% for tensile stresses less than their elastic limit stress.

The fact that the tension band and its joint are strong enough to bounce back or recover from the impact is small consolation once the impulse has caused a funnel or neck implosion in the tube. It becomes evident that while the strength of the tension bands and the strength of their joints is important, it is just as important that their resistance to the initial impact or shock of a fracture impulse be great enough to inhibit the propagation of a fracture so that the tube can devacuate from the front panel before the fracture reaches the weaker neck and funnel sections of the tube.

An implosion protection system according to this invention which includes a relatively incompressible tape, rigid tension bands and strong, non-yielding tension band joints, all as described above, is an economical, safe and practical approach to protecting large screen CRT's. This approach is adaptable to CRT's of sizes at least as great as 25 inches and also to smaller sizes. In fact, it may be possible to limit the 19 inches CRT to a single tension band if the teachings of this invention with regard to choosing the elements of the system for their impulse resistant characteristics is followed.

While the invention has been described in terms of a specific embodiment thereof, it is evident that many alterations, modifications and variations will be apparent to those skilled in the art in light of the disclosure above. For example, the tension bands may be secured by means other than the mechanical seal used in the preferred embodiment as long as said means does not yield under the impact of a fracture impulse. Such a variation does not depart from the essence of this invention. Accordingly, it is intended to embrace all such alterations, modifications and variations which fall within the spirit and scope of this invention as defined by the following claims.

We claim:

1. A large screen cathode ray tube having an improved dry, impulse-resistant implosion protection system, comprising:

a glass bulb consisting of a front panel having a faceplate whose inner surface is coated with red-emissive, blue-emissive and green-emissive phosphor elements, and a funnel section terminating in a neck in which one or more electron guns are situated for generating electron beams to illuminate said phosphor elements, said front panel and funnel section being joined together to form an air-tight envelope;

a strip of relatively incompressible tape secured to and encircling the bulb and situated on the forward part of the bulb near the faceplate;

a first steel tension band placed directly over the tape and tensed to provide hoop compression on the bulb, the opposite ends of said tension band being secured together to prevent relative motion thereof;

a second steel tension band placed directly over the first band and also tensed to provide hoop com-

pression on the bulb, the opposite ends of said second tension band being secured together to prevent relative motion thereof, said first and second tension bands being tensed to provide a relatively high cumulative compression on the front panel while having a rigidity and being so tightly secured at their respective ends that when a fracture of the front panel occurs, the resulting tensile strain in each band is small enough to inhibit the propagation of a fracture impulse so as to substantially confine bulb devacuation to the front panel, thus ensuring that a front panel fracture impulse will not propagate to the weaker funnel or neck portions of the bulb until the bulb has been substantially devacuated.

2. A cathode ray tube as set forth in claim 1 wherein said tape is a relatively hard plastic-impregnated cloth tape having a smooth surface over which said first tension band is placed, said smooth surface acting to enhance the distribution of the hoop compression of the bands and to prevent point loading of the bulb, particularly at the corners thereof, and wherein said tape is relatively hard throughout in order to remain incompressible in the presence of a bulb fracture so that a traveling fracture impulse in the bulb will not be able to compress the tape but will be transmitted by the tape to the tension bands.

3. A cathode ray tube as set forth in claim 1 wherein each of said tension bands is secured with a heavy duty steel seal for notch-joining their opposite ends to form a non-slip notched joint having a joint strength of approximately 2,500 pounds, thus ensuring a non-yielding, non-slip, joint between opposite ends of each tension band to prevent relative slipping and expansion of the bands during a glass fracture and thereby inhibiting the glass beneath the bands from expanding and transmitting the fracture impulse.

4. A large screen cathode ray tube having an improved dry impulse-resistant implosion protection system, comprising:

- a front panel having a faceplate whose inner surface is coated with red-emissive, blue-emissive and green-emissive phosphor elements, and having a flange consisting of a wrap-around skirt protruding rearwardly from the faceplate;
- a funnel section terminating in a neck in which one or more electron guns are situated for generating electron beams to illuminate said phosphor elements, said front panel and funnel section being joined together to form an airtight envelope;
- a pressure-adhesive strip of tape encircling the panel skirt and situated on the forward part of the skirt

near the faceplate;

a first steel tension band placed directly over the tape and tensed to approximately 1,500 pounds so as to provide a hoop compression on the front panel, said band having a breaking tensile strength of approximately 135,000 pounds per square inch and a rigidity which limits the tensile strain of the band to no more than 0.5 percent;

a first heavy duty steel seal for notch-joining opposite ends of said first steel tension band to form a notched joint having a joint strength of approximately 2,500 pounds, to thereby prevent relative movement of said tension band ends;

a second steel tension band having the aforesaid physical characteristics of said first tension band, tensed to approximately 1,500 pounds, and placed directly over said first steel tension band to provide additional hoop compression on the front panel;

a second heavy duty steel seal for notch joining opposite ends of said second steel tension band to form a notched joint having a joint strength of approximately 2,500 pounds to thereby prevent relative movement of the ends of said second tension band, the rigidity of said first and second tension bands and the strength of the notch joints in the bands being such that, when a fracture of the front panel occurs, the resulting tensile strain in each band is small enough to inhibit the propagation of a fracture impulse so as to substantially confine bulb devacuation to the front panel, thus ensuring that a front panel fracture impulse will not propagate to the weaker funnel or neck portions of the bulb until the bulb has been substantially devacuated.

5. A cathode ray tube as set forth in claim 4, wherein said tape is an approximately $\frac{3}{4}$ inch wide by 14 mils thick cloth tape impregnated with plastic to present a relatively hard, smooth surface over which said first tension band may be placed in order to enhance the distribution of the hoop compression of the bands and to prevent point loading of the bulb, particularly at the corners thereof;

wherein said tape is relatively hard throughout in order to remain substantially incompressible in the presence of a fracture of the front panel so that a traveling fracture impulse in the front panel will not be able to compress the tape, but will be transmitted by the tape to the tension bands;

and wherein said steel tension bands are made of high tensile strength steel having a Young's modulus of approximately 30×10^6 pounds per square inch and are approximately $\frac{3}{4}$ inch wide by 31 mils thick.

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