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

(11) EP 0 410 965 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
10.07.2002 Bulletin 2002/28

(21) Application number: **89900503.7**

(22) Date of filing: **15.11.1988**

(51) Int Cl.[7]: **H01J 29/07**, H01J 9/20

(86) International application number:
PCT/US88/04075

(87) International publication number:
WO 89/05513 (15.06.1989 Gazette 1989/13)

(54) **MATERIAL AND PROCESS FOR THE MANUFACTURE OF TENSION MASKS FOR CATHODE RAY TUBES**

STOFF UND VERFAHREN ZUR HERSTELLUNG VON GESPANNTEN SCHATTENMASKEN FÜR KATHODENSTRAHLRÖHREN

MATERIAU ET PROCEDE SERVANT A LA FABRICATION DE MASQUES DE TENSION POUR TUBES A RAYONS CATHODIQUES

(84) Designated Contracting States:
DE FR GB NL

(30) Priority: **02.12.1987 US 127724**

(43) Date of publication of application:
06.02.1991 Bulletin 1991/06

(73) Proprietor: **LG ELECTRONICS INC.**
Seoul 150-721 (KR)

(72) Inventors:
- **LIVSHULTZ, Michael**
Skokie, IL 60077 (US)
- **TONG, Hua-Sou**
Mundelein, IL 60060 (US)

(74) Representative: **Molyneaux, Martyn William et al**
Langner Parry
52-54 High Holborn
London WC1V 6RR (GB)

(56) References cited:
EP-A- 0 121 628
EP-A- 0 175 370
DE-A- 2 217 280
GB-A- 2 183 903

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 0 410 965 B1

Description

[0001] This invention relates generally to tensioned foil color cathode ray tubes, and more particularly to a tensioned foil shadow mask formed from an improved alloy as well as to a process for the manufacture of such tubes, including the heat treating of nickel-iron alloys to provide a desired combination of mechanical and magnetic properties necessary for effective operation of tensioned foil shadow masks. Also disclosed is a front assembly containing such a mask.

[0002] Cathode ray tubes having flat faceplates and correspondingly flat tensioned foil shadow masks are known to provide many advantages over conventional cathode ray tubes having a curved faceplate and a curved shadow mask. A chief advantage of a flat faceplate cathode ray tube with tensioned mask is a greater electron beam power-handling capability, a capability which can provide greater picture brightness. The power-handling capability of tubes having the conventional curved mask is limited due to the thickness of the mask (5 to 7 mils), and the fact that it is not mounted under tension. As a result, the mask tends to expand or "dome" in picture areas of high brightness where the intensity of electron beam bombardment, and consequently the heat, is greatest. Color impurities result when the mask expands toward the faceplate and the beam-passing apertures in the mask move out of registration with their associated phosphor dots or lines on the faceplate.

[0003] A tensioned foil mask when heated acts in a manner quite different from a curved, untensioned mask. For example, if the entire mask is heated uniformly, the mask expands and relaxes the tension. The mask remains planar and there is no doming and no distortion until the mask has expanded to the point that tension is completely lost. Just before all tension is lost, wrinkling may occur in the corners. When small areas of a tensioned foil mask are differentially heated, the heated areas expand and the unheated areas correspondingly contract, resulting in only small displacements within the plane of the mask. However, the mask remains planar and properly spaced from the faceplate and, consequently, any color impurities are unnoticeable.

[0004] The mask must be supported in tension in order to maintain the mask in a planar state during operation of the cathode ray tube. The amount of tension required will depend upon how much the mask material expands upon heating during operation of the cathode ray tube. Materials with very low thermal coefficients of expansion need only a low tension. Generally, however, the tension should be as high as possible because the higher the tension, the greater the heat incurred, and the greater the electron beam current that can be handled. There is a limit to mask tension, however, as too great a tension can cause the mask to tear.

[0005] The foil mask may be tensioned in accordance with known practices. A convenient method is to thermally expand the mask by means of heated platens applied to both sides of the foil mask. The expanded mask is then clamped in a fixture and, upon cooling, remains under tension. The mask may also be expanded by exposure to infrared radiation, by electrical resistance heating, or by stretching through the application of mechanical forces to its edges.

[0006] In addition to having the composition as described herein, after heat treatment and slow cooling according to the invention, a foil formed from the alloys will have a unique combination of mechanical, thermal and magnetic properties that makes it uniquely suited for use as a tensioned foil shadow mask. The alloy, in as-cast or in treated form, must have adequate ductility to permit it to be hot or cold rolled to a foil having a thickness of less than 2 mils, preferably to a thickness of 1 mil, or even as thin as 0.5 mil. A 1 mil thick foil when rolled will typically have a reduction in area of at least 0.8 percent and preferably at least 1.0 percent elongation. To withstand the forces incident to the tensing operation, the mask material should have a yield strength above about 80 ksi and preferably above about 100 ksi (0.2 percent offset). The mask material should also be able to withstand a tension load of at least about 25 Newton/centimeter, preferably at least about 65 Newton/centimeter. The mask material should also have a thermal coefficient of expansion that is not substantially less than that of the glass of the faceplate.

[0007] In addition to the mechanical properties described, the mask material must have a particular combination of magnetic properties. In this connection, it is important that the mask material have as high a permeability as is possible while maintaining the necessary mechanical properties. The permeability should be at least about 6,000, preferably at least about 10,000, and most desirably in excess of 60,000. A maximum coercivity is desirably below about 1.0 oersted and preferably is below about 0.5 oersted.

[0008] It is well known in the manufacture of standard color cathode ray tubes of the curved-mask, curved-screen type to heat-treat the shadow masks prior to their being formed into a domed shape. Conventional (non-tensioned) shadow masks are typically delivered to cathode ray tube manufacturers in a work-hardened state due to the multiple rolling operations which are performed on the steel to reduce it to the specified thickness, typically about 6 mils. In order that the masks may be stamped into a domed shape, they must be softened by use of an annealing heat treatment--typically to temperatures on the order of 700-800 degrees C. Annealing also enhances the magnetic coercivity of the masks, a desirable property from the standpoint of magnetic shielding of the electron beams. After stamping, and the consequent moderate work hardening of the mask which may result from the stamping operation, it is known in the prior art to again anneal the masks while in their domed shape to further enhance their magnetic shielding properties.

[0009] Foils intended for use as tensioned masks are

also delivered in a hardened state--in fact, much harder than standard masks in order to provide the very high tensile strength needed to sustain the necessary high tension levels; for example, 30,000 psi, or greater. The prior art annealing process, with its relatively high annealing temperatures, would be absolutely unacceptable if applied to flat tension masks, as any extensive softening or reduction of tensile strength of the mask resulting from the process would make the material unsuited for use as a tension mask.

[0010] GB-A-2 183 903 discloses a process of manufacture of a foil shadow mask and a cathode ray tube including the foil shadow mask. The cathode ray tube includes a flat faceplate and the foil shadow mask mounted thereon in tension, the mask being formed from an iron alloy comprising between 41,0 and 43,5% nickel. The alloy has a coefficient of expansion that is not less than about that of the faceplate of the cathode ray tube.

[0011] U.S. Patent No. 4,210,843 to Avedani, sets forth an improved method of making a conventional color cathode ray tube shadow mask; that is, a curved shadow mask having a thickness of about 6 mils, and designed for use with a correlatively curved faceplate. The method comprises providing a plurality of shadow mask blanks composed of an interstitial-free steel, each with a pattern of apertures photo-etched therein, which blanks have been cut from a foil of steel, precision cold-rolled to a full hard condition, and with a thickness of from 6 to 8 mils. A stack of blanks is subjected to a limited annealing operation carried out at a relatively low maximum temperature, and for a relatively brief period sufficient only to achieve recrystallization of the material without causing significant grain growth. Each blank is clamped and drawn to form a dished shadow mask without the imposition of vibration or roller leveling operations, and thus avoids undesired creasing, roller marking, denting, tearing or work-hardening of the blank normally associated with these operations. The end-product shadow mask, due to the use of the interstitial free steel material, has an aperture pattern of improved definition as a result of more uniform stretching of the mask blank. The annealing operation has little effect on the magnetic properties of this type of steel, and the coercivity of the material, after forming, is above 2.0 oersteds.

[0012] Prior to the present invention, there was no foil mask material available having the desired combination of mechanical and magnetic properties described herein. One material used in tensioned foil shadow mask applications in flat faceplate cathode ray tubes has been aluminum-killed, AISI 1005 cold-rolled capped steel, generally referred to as "AK-steel." AK steel, has a composition of 0.04 percent silicon, 0.16 percent manganese, 0.028 percent carbon, 0.020 percent phosphorus, 0.018 percent sulfur, and 0.04 percent aluminum, with the balance iron and incidental impurities.

[0013] (Throughout the specification and claims, all percentages are considered weight-percentages, unless otherwise indicated.)

[0014] Invar, which has a nominal composition of 36 percent nickel, balance iron, has also been suggested as a possible material for tensioned foil shadow masks. Invar however has a thermal coefficient of expansion far lower than that of the glass commonly used cathode ray tube faceplates and so is considered generally unacceptable.

[0015] AK steel, while it can be formed into a fairly acceptable foil shadow mask, is deficient in certain important properties. For example, the yield strength of AK steel foil one mil thick is typically in the range of 75-80 ksi. This makes it only marginally acceptable from a strength standpoint. More importantly, AK steel has a permeability that is much lower than desired, for example, 5,000 in a 1 mil foil. Since the ability of a material to carry magnetic flux decreases with decreasing cross-section, cathode ray tubes having masks made of AK steel thinner than about 1 mil may require both internal and external magnetic shielding. With internal shielding only, the beam landing misregistration due to the earth's magnetic field, i.e. the change in beam landing position upon reversal of the axial field component, is typically 1.7 mils, which is much greater than the maximum of about 1 mil that is generally considered tolerable.

[0016] In addition, AK steel is metallurgically dirty, having inclusions, defects and dislocations which interfere with both the foil rolling process and the photo resist etching of the apertures in the foil resulting in higher scrap rates and consequently lower yields.

[0017] Another significant disadvantage of an AK steel tensioned foil shadow mask is the fact that as the tension applied is increased, the permeability decreases and coercivity increases. Translated into picture performance, this means that as the tension of the AK-steel foil shadow mask is increased in order to permit increased beam current and, therefore, greater picture brightness, its ability to shield the electron beams from the earth's magnetic field deteriorates, resulting in increased beam misregistration.

[0018] Finally, AK steel rusts and thus requires greater care in storage and possibly the application of rust inhibitors. If rust does appear, it must be removed in a separate production operation, and without altering the size or shape of the apertures, or the thickness of the mask material.

[0019] In general, the invention aims to provide an improved shadow mask material for use in color cathode ray tubes having a tensioned foil shadow mask.

[0020] According to a first aspect of this invention there is provided a cathode ray tube as claimed in claim 1 herein.

[0021] Another general aspect of the invention is to provide an improved process for manufacturing cathode ray tubes containing tensioned foil masks having improved mechanical and magnetic properties.

[0022] According to a second aspect of this invention

there is provided a process as claimed in claim 8 herein.

[0023] Further features and advantages of the present invention may best be understood by reference to the following description of preferred embodiments of the invention taken in conjunction with the accompanying drawings (not to scale), in the several figures of which like reference numerals identify like elements, and in which:

Figure 1 is a side view in perspective of a color cathode ray tube having a flat faceplate and a tensioned foil shadow mask, with cut-away sections that indicate the location and relation of the faceplate and tensioned foil shadow mask to other major tube components;

Figure 2 is a plan view of an in-process foil shadow mask;

Figure 3 is a plan view of an in-process flat glass faceplate showing a phosphor screening area and a foil shadow mask support structure secured thereto;

Figure 4 is a perspective view of a funnel referencing and fritting fixture, with a funnel and the faceplate to which it is to be attached shown as being mounted on the fixture; and

Figure 5 is partial detail view in section and in elevation depicting the attachment of a funnel to a faceplate.

[0024] To facilitate understanding of the process and material according to the invention and their relation to the manufacture of a color cathode ray tube having a tensioned foil shadow mask, a brief description of a tube of this type and its major components is offered in the following paragraphs.

[0025] A color cathode ray tube 20 having a tensioned foil shadow mask is depicted in Figure 1. The faceplate assembly 22 essentially comprises a flat faceplate and a tensioned flat foil shadow mask mounted adjacent thereto. Faceplate 24, indicated as being rectangular, is shown as having on its inner surface 26 a centrally located phosphor screen 28 depicted diagrammatically as having a pattern of phosphors thereon. A film of aluminum 30 is indicated as covering the pattern of phosphors. A funnel 34 is represented as being attached to faceplate assembly 22 at their interfaces 35, the funnel sealing surface 36 of faceplate 24 is indicated as being peripheral to screen 28. A frame-like shadow mask support structure 48 is indicated as being located on opposed sides of the screen between funnel sealing surface 36 and screen 28, and mounted adjacent to faceplate 24. Support structure 48 provides a surface for receiving and mounting in tension a metal foil shadow mask 50 a Q-distance away from the screen 28. The pattern of phosphors corresponds to the pattern of apertures in mask 50. The apertures depicted are greatly exaggerated for purposes of illustration, in a high-resolution color tube for example, the mask has as as many as such 750,000 apertures, with aperture diameter being on the average about 5 mils. As is well-known in the art, the foil shadow mask acts as a color-selection electrode, or "parallax barrier" which ensures that each of the beamlets formed by the three beams lands only on its assigned phosphor deposits on the screen.

[0026] The anterior-posterior axis of tube 20 is indicated by reference number 56. A magnetic shield 58 is shown as being enclosed within funnel 34. High voltage for tube operation is indicated as being applied to a conductive coating 60 on the inner surface of funnel 34 by way of an anode button 62 connected in turn to a high-voltage conductor 64.

[0027] The neck 66 of tube 20 is represented as enclosing an in-line electron gun 68 depicted as providing three discrete in-line electron beams 70, 72, and 74 for exciting respective red-light-emitting, green-light-emitting, and blue-light-emitting phosphor elements deposited on screen 28. Yoke 76 receives scanning signals and provides for the scanning of beams 70, 72 and 74 across screen 28. An electrical conductor 78 is located in an opening in shield 58 and is in contact with conductive coating 60 to provide a high-voltage connection between the coating 60, the screen 28, and shadow mask 50.

[0028] Two of the major components, designated as being "in-process," are depicted and described as follows. One is a shadow mask indicated diagrammatically in Figure 2. In-process shadow mask 86 includes a central area 104 of apertures corresponding to the pattern of phosphors that is photo-deposited on the screen of the faceplate by using the mask as an optical stencil. Center field 104 is indicated as being surrounded by an unperforated section 106, the periphery of which is engaged by a tensing frame during the mask tensing and clamping process, and which is removed in a later procedure.

[0029] An in-process faceplate 108 is depicted diagrammatically in Figure 3 as having on its inner surface 110 a centrally located screening area 112 for receiving a predetermined phosphor pattern in an ensuing operation. A funnel sealing surface 113 is indicated as being peripheral to screen 112. A frame-like shadow mask support structure 114 is depicted as being secured on opposed sides of screen 112, the structure provides a surface 115 for receiving and mounting a foil shadow mask under tension a Q-distance from the screen.

[0030] A process according to one aspect of the invention essentially comprises providing an apertured foil shadow mask 86 characterized by being composed of a nickel-iron alloy, and securing the mask 86 to the mask-support structure 114 of the faceplate 108 while under tension, and in registration with the phosphor screen. The process is further characterized by subjecting the mask 86 to a thermal cycle to partially anneal the mask to a state in which the mask has favorable magnetic and mechanical properties.

[0031] According to the present invention, a class of

nickel-iron alloys, desirably containing minor additions of certain alloying agents, when heat-treated and cooled under controlled conditions, yield a material which, when fabricated into a thin foil, have mechanical and magnetic properties not found in known alloys that make them uniquely suited for use as tensioned foil shadow masks.

[0032] The desired properties achieved by the inventive process are as follows: The alloy foil should have a yield strength (0.2 percent offset) of at least about 80 ksi, preferably at least about 100 ksi and most desirably at least about 150 ksi in order to be able to withstand the tension loading applied to the foil when used as a tensioned foil shadow mask. This yield strength should be combined with the magnetic properties of high permeability and low coercivity. The permeability should be in excess of about 6,000 preferably in excess of about 10,000 and most desirably in excess of 100,000. The coercivity should not exceed about 2.5 oersteds, and is preferably below about 0.5 oersted.

[0033] A specific example of an alloy responsive to the heat treatment according to the invention, and fabrication into a tensioned foil shadow mask, is the known nickel-iron-molybdenum alloy sold under the tradenames HyMu80,YeP-C, and Moly-Permalloy. This alloy contains about 80 percent nickel, 4 percent molybdenum, with balance iron and incidental impurities. In the as-rolled, fully hardened condition, and 80Ni-4Mo-Fe foil has a high yield strength, typically 155-160 ksi, but poor magnetic properties, e.g., a permeability of less than 3,000. To impart good magnetic properties, as for use in tape recorder heads, the material is conventionally annealed at 1120 degrees C. for two to four hours followed by furnace cooling to 600 degrees C. The fully annealed alloy foil has excellent magnetic properties but poor mechanical properties. The permeability may be as high as 300,000. However, the yield strength is in the range of 20-40 ksi, making this alloy, when fully annealed, clearly unsuited for use as a tensioned foil shadow mask.

[0034] However, when the 80Ni-4Mo-Fe alloy foil is partially annealed according to the inventive process, it unexpectedly displays properties which make it superior as a material for the fabrication of tensioned foil shadow masks. As a result of this cycle of heating and cooling according to the invention, the mechanical properties of the alloy are substantially retained while its magnetic properties are improved to a degree necessary for use as a foil shadow mask.

[0035] Surprisingly, it has been found that the magnetic properties of the 80Ni-4Mo-Fe foil, when treated in accordance with this invention, actually improve, and improve very significantly, when the foil is placed under tension. For example, after heat treating and conditioning according to the invention, an untensioned 80Ni-4Mo-Fe foil having a thickness of 1 mil has a permeability of 60,000. When that same foil is placed under a tension of about 60 Newton/centimeter, its permeability is increased to 100,000. It is to be noted that the same material exhibits no significant permeability change under tension when in its conventional full hard state. As a result of the increased permeability, the amount of beam misregistration due to the earth's magnetic field of an 80Ni-4Mo-Fe foil 1 mil thick, when processed according to the invention, is far less than that of an AK-steel foil of 1 mil thickness.

[0036] With regard to the alloy composition, a nickel-iron alloy is provided comprising between about 30 and about 85 weight-percent of nickel, between about 0 and 5 weight-percent of molybdenum, between 0 and 2 weight-percent of one or more of vanadium, titanium, hafnium, and niobium, with the balance iron and incidental impurities; e.g., carbon, chromium, silicon, sulfur, copper and manganese. Typically, the incidental impurities combined do not exceed 1.0 percent. Preferably, the alloy may comprise between about 75 and 85 weight-percent of nickel, between about 3 and 5 weight-percent of molybdenum, with the balance iron and incidental impurities. In one specific example, the alloy may comprise about 80 weight-percent nickel, about 4 weight-percent molybdenum, with the balance iron and incidental impurities.

[0037] A partial anneal of the preferred material may be accomplished according to a further aspect of the invention as a discrete step prior to installing the mask on the mask support structure secured to the faceplate. To achieve the desired combination of mechanical and magnetic properties, the foil must be subjected to a specified procedure of heat treating and slow cooling according to the invention to provide a foil having the desired combination of magnetic and mechanical properties.

[0038] In a typical process according to the invention, a group of 12 full-hard, apertured masks of the configuration shown by Figure 2 are stacked for insertion into an oven. The process according to the invention is characterized by subjecting each of the stacked masks to a thermal cycle to partially anneal the mask to produce favorable magnetic and mechanical properties, comprising heating the mask to a temperature above about 400 degrees C. and below that temperature at which the mask alloy substantially forms a solid solution for a period of at least about 30 minutes, preferably about at least 45 minutes, and slowly cooling the mask from that temperature to the temperature at which the alloy from which the mask is formed is substantially recrystallized at a cooling rate of less than about 5 degrees C. per minute, and preferably less than about 3 degrees C. per minute; and then securing the mask to a mask support structure affixed to or integral with the faceplate while the mask is under tension and in registration with the phosphor screen. For example, the mask may be heated to a temperature of between about 400 degrees C. and 700 degrees C. for a period between about 30 minutes and about 60 minutes. The mask is then slowly cooled from that temperature to the temperature at

which the material of the masks is substantially recrystallized at cooling rate of less than about 5 degrees C. per minute, preferably less than 3 degrees C. per minute, and most desirably at a rate of between about 2 degrees C. and about 3 degrees C. per minute. Longer heat treatments are permissible but do not appear to result in an improvement in properties. Heat treating at the indicated temperatures followed by air cooling or cooling at rates above 5 degrees C. per minute resulted in foils having undesirably poor mechanical properties. While not wishing to be bound by any particular theory, it is believed that the disclosed heat treatment, which is at temperatures well below annealing temperatures, followed by slow cooling, results in the long range ordering of Ni_3Fe as intergranular and intergranular precipitates.

[0039] The heating of the assembly and the foil, and the slow rate of cooling of the assembly and the foil according to the invention, is effective to partially anneal the foil mask and produce a yield strength in excess of 80 ksi, a permeability above about 6,000, a coercivity below about 2.5 oersteds, and a thermal coefficient of expansion that is not less than about that of the faceplate (glass). Following the process as described, the mask may well have a yield strength above about 150 ksi, a permeability above about 10,000, and a coercivity below about 1.0. The foil is able to withstand tension loads in excess of about 65 Newton/centimeters, and possibly above 75 Newton/centimeter.

[0040] The heat treatment and slow cooling treatment of the masks described in following paragraphs closely approximates the processing steps in frit sealing cathode ray tube, and the sealing of the funnel and faceplate in the manufacturing process.

[0041] Subsequent to the initial implementation of the inventive process, it was determined that the heating and cooling conditions to which the tensioned mask is subjected during a frit cycle are such that a substantial improvement in the properties of the described alloy is obtained without requiring the separate heat treatment and slow cooling process described in the foregoing. The properties of the tensioned foil mask are not as good as those obtained when the mask material is heated to the more desirable temperature of 500-600 degrees C. However, where the brightness and resolution demanded of the cathode ray tube are not as high, it has been determined that the slow heating of an in-place 80Ni-4Mo-Fe tensioned mask to about 435 degrees C. in the frit cycle, followed by slow cooling at a rate of less than about 5 degrees C. per minute, preferably between about 2 degrees and about 3 degrees C. per minute, which is the cooling rate in the frit cycle, provides a finished mask having the desired mechanical and magnetic properties.

[0042] For example, when untreated tensioned foil masks are placed under a tension of 30 Newton/centimeter, and run through the frit cycle, a yield strength of between about 150 ksi and about 160 ksi and a permeability of between about 60,000 and about 100,000, and a coercivity of below about 0.4 oersted, is obtained. The beam misregistration is somewhat higher than that obtained when the foil is separately heat treated, but still below the desired limit.

[0043] So a partial anneal according to the invention may also be accomplished during, and as a result of, a thermal cycle in the process of sealing the tube. The process is described in the following paragraphs.

[0044] As indicated in Figure 3, a shadow mask support structure 114 is secured on the inner surface 110 of faceplate 108 between the peripheral sealing area, noted as being the funnel sealing surface 113, and the screening area 112. The mask support structure 114 provides a surface 115 for receiving and supporting foil shadow mask in tension. The mask support structure 114 may comprise, by way of example, a stainless steel metal alloy. Attachment of the support structure is preferably by means of a devitrifying frit.

[0045] A nickel iron alloy is provided comprising between about 30 and about 85 weight-percent of nickel, between about 0 and 5 weight-percent of molybdenum, between 0 and 2 weight-percent of one or more of vanadium, titanium, hafnium, and niobium, with the balance iron and incidental impurities; e.g., carbon, chromium, silicon, sulfur, copper and manganese. Typically, the incidental impurities combined do not exceed 1.0 percent. Alternately and according to the invention, the alloy may comprise between about 75 and 85 weight-percent of nickel, between about 3 and 5 weight-percent of molybdenum, with the balance iron and incidental impurities. Preferably, the alloy may comprise about 80 weight-percent nickel, about 4 weight-percent molybdenum, with the balance iron and incidental impurities.

[0046] The alloy according to the invention is formed into a foil having a thickness of about 0.001 inch or less.

[0047] A central area 112 of the foil is apertured to form a foil mask 108 consonant in dimensions with the screening area 112 for color selection. Aperturing of the mask can be accomplished by a photo-etching process in which a light-sensitive resist is applied to the foil. The resist is hardened by exposure to light except in those areas where apertures are defined. The exposed metal defining the apertures is then etched way.

[0048] The foil mask is then tensed in a tensing frame to a tension of at least about 25 Newton/centimeters. In essence, the foil may be expanded by enclosing it between two platens heated to 360 degrees C for one minute, clamped in the tensing frame, and air cooled it to provide a tensioned foil having a greater length and width than the faceplate to which it will be secured. A pattern of red-light-emitting, green-light-emitting, and blue-light-emitting phosphor deposits are sequentially photo-screened on screening area 112. The photo-screening process includes repetitively registering the foil of the phosphor screening area by registering the tensing frame with the faceplate.

[0049] The foil comprising the mask 86 is secured to the mask support structure 114, with the apertures of

the mask in registration with the pattern of phosphor deposits on screening area 112. The means of securement of the mask to the mask support structure may be by welding with a laser beam, with the excess mask material removed by the same beam. Inasmuch as the faceplate 108 and the tensioned foil shadow mask 86 are rigidly interconnected by their mutual attachment to the mask support structure, the thermal coefficient of expansion of the alloy foil must approximate that of the faceplate, which is typically a glass having a coefficient of expansion of between about 12 x 10^{-6} and about 14 x 10^{-6} in/in/degrees C. This is necessary due to the relatively high temperatures to which the faceplate and mask are subjected during the cathode ray tube manufacturing process. A coefficient of expansion somewhat greater than that of the faceplate can be tolerated, but a coefficient of expansion substantially less than that of the faceplate is to be avoided as this may lead to mask failure during the manufacturing process.

[0050] Figures 4 and 5 depict the use of a funnel referencing and fritting fixture 186 for mating of a faceplate 108 with a funnel 188 to form a faceplate-funnel assembly. Faceplate 108 is indicated as being installed face down on the surface 190 of fixture 186. Funnel 188 is depicted as being positioned thereon and in contact with funnel sealing surface 113, noted as being peripheral to screening area 112 on which is deposited a pattern of phosphors 187 as a result of the preceding screening operation. With reference to Figure 4, three posts 192, 193 and 194 are indicated as providing for alignment of the funnel and faceplate. Figure 5 depicts details of the interface between post 194, the faceplate 108, and funnel 188. Flat 117c on faceplate 108 is shown as being in alignment with reference area "c" on funnel 188. Shadow mask 86, noted as being in tension, is preferably depicted as being mounted on shadow mask support structure 114.

[0051] Post 194 is shown as having two reference points 196 and 198 for locating the funnel 188 with reference to the faceplate 108. The reference points preferably comprise buttons of carbon as they must be immune to the effects of the elevated oven temperature incurred during the frit cycle.

[0052] A devitrifiable frit in paste form is applied to the peripheral sealing area of the faceplate 108, noted as being funnel sealing area 113, for receiving funnel 188. The faceplate 108 is then mated with the funnel 188 to form a faceplate-funnel assembly. The frit, which is indicated by reference No. 200 in Figure 5, may for example comprise frit No. CV-130, manufactured by Owens-Illinois, Inc. of Toledo, Ohio.

[0053] The faceplate-funnel assembly is then heated to a temperature effective to devitrify the frit and permanently attach the funnel to the faceplate, after which the assembly is cooled. The process of fusing of the funnel to the faceplate is generally carried out under conditions referred to as the frit cycle. In a typical frit cycle, the faceplate, to which the tensioned foil mask is adhered, and funnel are slowly heated to 435 degrees C., then cooled to room temperature or slightly thereabove over a period of three to three-and-one-half hours. The foil must be cooled to the temperature at which the alloy is substantially recrystallized at a cooling rate of less than about 5 degrees C. per minute, preferably less than about 3 degrees C. per minute and most desirably at a rate of between about 2 degrees C. and about 3 degrees C. per minute.

[0054] The heating of the assembly and the foil, and the slow rate of cooling of the assembly and the foil according to the invention and during the frit cycle, is effective to partially anneal the foil mask and produce the desired mechanical and magnetic properties set forth in the foregoing.

[0055] Test results in support of the concept according to the invention are summarized by the following examples.

Example I

[0056] An 80Ni-4Mo-Fe cold-rolled foil is 1 mil thick. In the as-received condition, the foil has a permeability of 3,000, a coercivity of 2.2 oersteds and a yield strength of 156 ksi.

[0057] The foil is heat treated in a dry hydrogen atmosphere at 500 degrees C. for 60 minutes and is then cooled to 200 degrees C. at a cooling rate of 3 degrees C. per minute. The heat treatment results in a foil having a yield strength of 192 ksi, a permeability of 60,000, a coercivity of 0.31 oersteds, and a coefficient of expansion of 13x10^{-6} in/in/degrees C.

Example II

[0058] A 42Ni-Fe cold-rolled foil 1 mil thick may be used. In the as-received condition, the foil will have a permeability of 3,000, coercivity of 4.0 oersteds and yield of 110 ksi.

[0059] The foil may be heat treated at 600 degrees C. in a dry hydrogen furnace for two hours and cooled to below 200 degrees C. at a cooling rate of 2 degrees C. per minute. The heat-treated and slow-cooled foil will have a permeability of 9,000, a coercivity of 1.1 oersteds and a yield strength of 80 ksi.

Example III

[0060] A 49Ni-Fe foil 1 mil thick in the as-received condition, will have a permeability of 3,200, a coercivity of 4.2 oersteds and a yield strength of 115 ksi. After heat treatment and slow cooling in accordance with Example I, the foil will have a permeability of 10,000, a coercivity of 0.4 oersteds and a yield strength of 85 ksi.

Example IV

[0061] A 49Ni-4Mo-Fe foil 1 mil thick in the as-re-

ceived condition will have physical and magnetic properties similar to the foil of Example I. After heat treating and slow cooling, in accordance with Example I, the foil will have a permeability of 20,000, a coercivity of 0.3 oersteds and a yield strength of 160 ksi.

Example V

[0062] A 79Ni-2Mo-IV-Fe foil 1 mil thick in the as-received condition will be expected to have physical and magnetic properties similar to the foil of Example I. The foil may be heat-treated and slow cooled in accordance with Example I. After heat treatment and slow cooling, the foil will be expected to have permeability of 30,000, a coercivity of 0.30 oersteds and yield strength of 160 ksi.

Example VI

[0063] A 79Ni-2V-1Ti-Fe foil 1 mil thick in the as-received condition will be expected to have physical and magnetic properties similar to the foil of Example I. The foil may be heat-treated and slow cooled in accordance with Example I, after which the foil will be expected to have a permeability above 30,000, a coercivity of 0.30 oersteds, and a yield strength of 170 ksi.

Example VII

[0064] A 79Ni-4Mo-Fe foil 1 mil thick in the as-received condition will be expected to have physical and magnetic properties similar to the foil of Example I, after heat-treating and slow cooling through the conventional frit cycle. The frit cycle comprises an open furnace with a peak temperature of about 435 degrees C. The total time duration for the sample to pass through from the entry of the furnace to the outlet is about 3-1/2 hours. The foil is expected to have a permeability of about 60,000, coercivity of about 0.4 oersteds, and a yield strength of about 155 ksi.

[0065] A foil shadow mask according to the invention for use in a tensioned foil color cathode ray tube, or a faceplate assembly for such a tube, is preferably formed from an alloy comprising between about 30 and about 85 weight-percent nickel, between about 0 and 5 weight-percent molybdenum, between 0 and 2 weight-percent of one or more of vanadium, titanium, hafnium, and niobium, the alloy having a yield strength in excess of 80 ksi, a permeability above about 6,000, coercivity below about 2.5 oersteds and a thermal coefficient of expansion that is not less than about that of the faceplate. Further, the mask may be under a tension of at least about 25 Newton/centimeters when the tube is at ambient temperature. The alloy according to the invention may have a yield strength above about 150 ksi, a permeability above about 10,000, and a coercivity below about 1.0. Further with regard to the content of the alloy of the mask, the content may comprise between about 75 weight-percent and about 85 weight-percent of nickel, between about 3 weight-percent and about 5 weight-percent of molybdenum, with the balance iron and incidental impurities; and preferably, the content may comprise about 80 weight-percent of nickel, about 4 weight-percent of molybdenum, with the balance iron and incidental impurities.

Claims

1. A cathode ray tube (20) including a flat faceplate (24) and a foil shadow mask (50) mounted thereon in tension, said mask (50) being formed from an alloy comprising between about 30 and about 85 weight-percent nickel, between 0 and about 5 weight-percent molybdenum, between 0 and about 2 weight-percent of an alloying agent selected from the group consisting of vanadium, titanium, hafnium, niobium and mixtures thereof, balance iron and incidental impurities, said alloy having a coefficient of expansion that is not less than about that of the associated faceplate of the cathode ray tube, **characterized in that** said alloy comprises between about 75 weight-percent and about 85 weight-percent of nickel, between about 3 weight-percent and about 5 weight-percent of molybdenum.

2. The tube of claim 1, **characterized in that** said alloy has a yield strength in excess of about 552 N/mm^2 (80 ksi), a permeability above about 6,000, a coercivity below about 199 A/m (2.5 oersteds).

3. The tube of claim 1 or 2, wherein said mask is under a tension of at least about 25 Newton/centimeters when said tube is at ambient temperature.

4. The tube of claim 1 or 2, wherein said alloy of said mask has a yield strength above about 1033 N/mm^2 (150 ksi), a permeability above about 10,000, and a coercivity below about 80 A/m (1.0 oersted).

5. The tube have of claim 1 or 2, wherein said alloy comprises about 80 weight-percent of nickel, about 4 weight-percent of molybdenum, with the balance iron and incidental impurities.

6. The tube of any of the preceding claims including a cathode ray tube front assembly comprising said flat faceplate with the shadow foil mask mounted adjacent to the flat faceplate.

7. The tube of claim 2, wherein said alloy also has a thermal coefficient of expansion that is not less than about that of said faceplate.

8. A process for the manufacture of a foil shadow mask (50) for a tension mask color cathode ray tube

(20) which includes a faceplate (24) having on its inner surface (26) a phosphor screen (28) and a support structure (48) for supporting a tensioned foil shadow mask (50) adjacent thereto, the process **characterized by** including the steps of providing a hardened nickel-iron alloy foil containing between about 75 and about 85 weight-percent nickel and at least one of the following in the indicated weight-percent:

molybdenum 0 and about 5%; vanadium 0 and about 2%; titanium 0 and about 2%; hafnium 0 and about 2%; niobium 0 and about 2%, balance iron and incidental impurities, heat treating said hardened foil under conditions which achieve favorable magnetic shielding properties while maintaining strength properties of the hardened material sufficient to withstand normal operating mask tension levels, including heat treating said foil at a temperature above about 400°C and below that temperature at which the alloy forms a solid solution for a period of at least about 30 minutes and controlling the cooling rate of said foil from said temperature to the temperature at which said alloy is substantially recrystallized to provide a foil having a yield strength in excess of 552 N/mm^2 (80 ksi), a permeability in excess of 6000 and a coercivity of 199 A/m (2.5 oersteds) or below, applying tension to said foil, and securing said foil to said support structure while under tension.

9. The process of claim 8, wherein said mask comprises between about 75 and 85 weight-percent nickel, preferably about 80 weight-percent nickel, between about 3 and 5 weight-percent molybdenum, preferably about 4 weight-percent molybdenum, with the balance iron and incidental impurities.

10. The process of claim 8 or 9, wherein the cooling rate is less than 5°C per minute, preferably less than 3°C per minute.

11. The process of claim 8, 9 or 10, wherein the foil is placed under a tension of at least 25 Newton/centimeters.

12. The process of claim 8 or 9, wherein the faceplate has on its inner surface a centrally disposed phosphor screening area embraced by a peripheral sealing area adapted to mate with a funnel, and the shadow mask is secured in tension to a frame-like shadow mask-support structure on said faceplate inner surface between said peripheral sealing area and said screening area; said process including the steps of forming said alloy into a foil, aperturing a central area of said foil to form a foil mask consonant in dimensions with said screening area for color selection, tensing said foil to a tension of at least about 25 Newton/centimeters, sequentially photo-screening a pattern of red-light-emitting, green-light-emitting, a blue-light-emitting phosphor deposits on said screening area, including repetitively registering said foil with said phosphor screening area by registering said tensing frame with said faceplate, applying tension to said foil mask, securing said foil mask to said mask-support structure with said apertures in registration with said pattern of phosphor deposits, applying a devitrifable frit in paste form to said peripheral sealing area for receiving a funnel, mating said faceplate with said funnel to form a faceplate funnel assembly, heating said assembly to a temperature effective to devitrify said frit and permanently attach said funnel to said faceplate, and cooling said assembly at a cooling rate of less than about 3 to 5 degrees C. per minute, the heating of said assembly and said foil and the slow rate of cooling of said assembly and said foil being effective to partially anneal said foil mask and produce a yield strength in excess of 552 N/mm^2 (80 ksi), a permeability above 6,000, a coercivity below about 199 A/m (2.5 oersteds), and a thermal coefficient of expansion that is not less than about that of said faceplate.

13. The process of claim 12, wherein said foil mask is tensed by heating said foil mask to a temperature above 400 degrees C. and below that temperature at which the alloy forms a solid solution for a period of at least about 30 minutes and thereafter cooling said foil to ambient temperature at a cooling rate of less than about 3 to 5 degrees C. per minute.

14. The process of claim 12 or 13, wherein said foil mask has a yield strength above about 1033 N/mm^2 (150 ksi), a permeability above about 10,000, and a coercivity below about 80 A/m (1.0 oersted).

Patentansprüche

1. Kathodenstrahlröhre (20) mit einer flachen Frontplatte (24) und einer unter Spannung darauf montierten Schattenmaske (50) aus Folie, wobei die Maske (50) aus einer Legierung besteht, die zwischen etwa 30 und etwa 85 Gewichtsprozent Nikkel, zwischen 0 und etwa 5 Gewichtsprozent Molybdän, zwischen 0 und etwa 2 Gewichtsprozent eines Legierungselements, das aus der aus Vanadium, Titan, Hafnium, Niobium und Mischungen derselben bestehenden Gruppe ausgewählt ist, Rest Eisen und zufällige Verunreinigungen enthält, wobei die Legierung einen Ausdehnungskoeffizienten hat, der nicht kleiner ist als etwa der der zugehörigen Frontplatte der Kathodenstrahlröhre, **dadurch gekennzeichnet, daß** die Legierung zwischen et-

wa 75 Gewichtsprozent und etwa 85 Gewichtsprozent Nickel und zwischen etwa 3 Gewichtsprozent und etwa 5 Gewichtsprozent Molybdän enthält.

2. Röhre nach Anspruch 1, **dadurch gekennzeichnet, daß** die Legierung eine Streckfestigkeit von mehr als etwa 552 N/mm^2 (80 ksi), eine Permeabilität über etwa 6.000 und eine Koerzitivkraft unter etwa 199 A/m (2,5 Oersted) hat.

3. Röhre nach Anspruch 1 oder 2, bei der die Maske unter einer Spannung von mindestens etwa 25 Newton/Zentimeter steht, wenn die Röhre Umgebungstemperatur hat.

4. Röhre nach Anspruch 1 oder 2, bei der die Legierung der Maske eine Streckfestigkeit über etwa 1.033 N/mm^2 (150 ksi), eine Permeabilität über etwa 10.000 und eine Koerzitivkraft unter etwa 80 A/m (1,0 Oersted) hat.

5. Röhre nach Anspruch 1 oder 2, bei der die Legierung etwa 80 Gewichtsprozent Nickel, etwa 4 Gewichtsprozent Molybdän und als Rest Eisen und zufällige Verunreinigungen enthält.

6. Röhre nach einem der vorhergehenden Ansprüche mit einem Vorderteil der Kathodenstrahlröhre bestehend aus der flachen Frontplatte und der angrenzend an die flache Frontplatte montierten Schattenmaske aus Folie.

7. Röhre nach Anspruch 2, bei der die Legierung außerdem einen Wärmeausdehnungskoeffizienten hat, der nicht kleiner ist als etwa der der Frontplatte.

8. Verfahren zur Herstellung einer Schattenmaske (50) aus Folie für eine Farbkathodenstrahlröhre (20) mit Spannmaske, die eine Frontplatte (24) umfaßt, die auf ihrer Innenseite (26) einen Leuchtschirm (28) und eine Haltevorrichtung (48) aufweist, die daran angrenzend eine gespannte Schattenmaske (50) aus Folie festhält, wobei das Verfahren **dadurch gekennzeichnet ist, daß** es die folgenden Schritte umfaßt: Bereitstellen einer Folie aus einer gehärteten Nickel-Eisen-Legierung, die zwischen etwa 75 und etwa 85 Gewichtsprozent Nickel und mindestens eines der folgenden Elemente in den angegebenen Gewichtsprozent enthält: Molybdän zwischen 0 und etwa 5 %; Vanadium zwischen 0 und etwa 2 %; Titan zwischen 0 und etwa 2 %; Hafnium zwischen 0 und etwa 2 %; Niobium zwischen 0 und etwa 2 %, Rest Eisen und zufällige Verunreinigungen; Wärmebehandeln der gehärteten Folie unter Bedingungen, bei denen eine günstige magnetische Abschirmung erzielt wird, während gleichzeitig Festigkeitseigenschaften des gehärteten Materials aufrechterhalten werden, die ausreichen, um den normalen Spannungen beim Betrieb der Maske standzuhalten, einschließlich Wärmebehandeln der Folie für die Dauer von mindestens etwa 30 Minuten bei einer Temperatur über etwa 400°C und unter der Temperatur, bei der die Legierung eine feste Lösung bildet, und Regeln der Abkühlgeschwindigkeit der Folie von dieser Temperatur auf die Temperatur, bei der die Legierung im wesentlichen wieder auskristallisiert, um eine Folie mit einer Streckfestigkeit über 552 N/mm^2 (80 ksi), einer Permeabilität über 6.000 und einer Koerzitivkraft von 199 A/m (2,5 oersted) oder darunter zu liefern, die Folie unter Spannung setzen und die Folie an der Haltevorrichtung befestigen, während sie unter Spannung steht.

9. Verfahren nach Anspruch 8, bei dem die Maske zwischen etwa 75 und 85 Gewichtsprozent Nickel, vorzugsweise etwa 80 Gewichtsprozent Nickel, zwischen etwa 3 und 5 Gewichtsprozent Molybdän, vorzugsweise etwa 4 Gewichtsprozent Molybdän, und als Rest Eisen und zufällige Verunreinigungen enthält.

10. Verfahren nach Anspruch 8 oder 9, bei dem die Abkühlgeschwindigkeit weniger als 5°C pro Minute beträgt, vorzugsweise weniger als 3°C pro Minute.

11. Verfahren nach Anspruch 8, 9 oder 10, bei dem die Folie unter eine Spannung von mindestens 25 Newton/Zentimeter gesetzt wird.

12. Verfahren nach Anspruch 8 oder 9, bei dem die Frontplatte auf ihrer Innenseite einen mittig angeordneten Leuchtschirmbereich hat, der am Umfang von einem Dichtungsbereich umschlossen wird, der mit einem Trichter zusammenpaßt, und bei dem die Schattenmaske unter Spannung an einer rahmenartigen Schattenmaskenhaltevorrichtung auf der Innenseite der Frontplatte zwischen dem am Umfang angeordneten Dichtungsbereich und dem Schirmbereich befestigt ist; wobei das Verfahren die folgenden Schritte umfaßt: aus der Legierung eine Folie herstellen, einen mittigen Bereich der Folie mit einer Öffnung versehen, um eine Folienmaske zu bilden, die zur Farbauswahl in ihren Abmessungen mit dem Schirmbereich übereinstimmt, Spannen der Folie auf eine Spannung von mindestens etwa 25 Newton/Zentimeter, nacheinander ein Muster aus rotes Licht emittierenden, grünes Licht emittierenden und blaues Licht emittierenden Leuchtstoffen auf den Schirmbereich aufbringen und die Folie wiederholt mit dem Leuchtschirmbereich ausrichten, indem der Spannrahmen mit der Frontplatte ausgerichtet wird, die Folienmaske unter Spannung setzen, die Folienmaske an der Maskenhaltevorrichtung so befestigen, daß die öffnungen mit dem Muster aus Leuchtstoffen übereinstim-

men, Aufbringen einer entglasbaren Fritte in Pastenform auf den am Umfang befindlichen Dichtungsbereich zur Aufnahme eines Trichters, die Frontplatte auf den Trichter passen, um eine Baugruppe aus Frontplatte und Trichter zu bilden, Erwärmen der Baugruppe auf eine Temperatur, die das Entglasen der Fritte bewirkt, und den Trichter dauerhaft an der Frontplatte befestigen und die Baugruppe mit einer Abkühlgeschwindigkeit von weniger als etwa 3 bis 5°C pro Minute abkühlen, wobei das Erwärmen der Baugruppe und der Folie und die langsame Abkühlgeschwindigkeit der Baugruppe und der Folie bewirken, daß die Folienmaske teilweise gehärtet wird und daß eine Streckfestigkeit über 552 N/mm^2 (80 ksi), eine Permeabilität über 6.000, eine Koerzitivkraft unter etwa 199 A/m (2,5 Oersted) und ein Wärmeausdehnungskoeffizient erzeugt wird, der nicht kleiner ist als der der Frontplatte.

13. Verfahren nach Anspruch 12, bei dem die Folienmaske gespannt wird durch Erwärmen der Folienmaske für eine Dauer von mindestens etwa 30 Minuten auf eine Temperatur über 400°C und unter der Temperatur, bei der die Legierung eine feste Lösung bildet, und danach Abkühlen der Folie auf Umgebungstemperatur mit einer Abkühlgeschwindigkeit von weniger als etwa 3 bis 5°C pro Minute.

14. Verfahren nach Anspruch 12 oder 13, bei dem die Folienmaske eine Streckfestigkeit über etwa 1.033 N/mm^2 (150 ksi), eine Permeabilität von etwa 10.000 und eine Koerzitivkraft unter etwa 80 A/m (1,0 Oersted) hat.

Revendications

1. Tube à rayons cathodiques (20) comprenant une dalle plate (24) et un masque de feuille de rhodium (50) monté sur celle en tension, ledit masque (50) étant formé à partir d'un alliage comprenant entre environ 30 et environ 85 pour cent en poids de nickel, entre 0 et environ 5 pour cent en poids de molybdène, entre 0 et environ 2 pour cent en poids d'un agent d'alliage sélectionné à partir du groupe se composant de vanadium, titane, hafnium, niobium et des mélanges de ceux-ci, des impuretés de fer et incidentes pour le reste, ledit alliage ayant un coefficient de dilatation qui n'est pas inférieur environ à celui de la dalle plate associée du tube à rayons cathodiques, **caractérisé en ce que** ledit alliage comprend entre environ 75 pour cent en poids et environ 85 pour cent en poids de nickel, entre environ 3 pour cent en poids et environ 5 pour cent en poids de molybdène.

2. Tube selon la revendication 1, **caractérisé en ce que** ledit alliage a une résistance à la déformation supérieure à environ 552 N/mm^2 (80 ksi), une perméabilité supérieure à environ 6000, et une coercivité inférieure à 199 A/m (2,5 oersteds).

3. Tube selon la revendication 1 ou 2, dans lequel ledit masque est sous une tension d'au moins environ 25 Newton/centimètre lorsque ledit tube est à la température ambiante.

4. Tube selon la revendication 1 ou 2, dans lequel ledit alliage dudit masque possède une résistance à la déformation supérieure à 1033 N/mm2 (150 ksi), une perméabilité supérieure à 10000, et une coercivité inférieure à 80 A/m (1,0 oersted).

5. Tube selon la revendication 1 ou 2, dans lequel ledit alliage comprend environ 80 pour cent en poids de nickel, environ 4 pour cent de molybdène, avec des impuretés de fer et incidentes pour le reste.

6. Tube selon l'une quelconque des revendications précédentes comprenant un assemblage avant de tube à rayons cathodiques comprenant ladite dalle plate avec un masque perforé monté de façon adjacente à ladite dalle plate.

7. Tube selon la revendication 2, dans lequel ledit alliage possède aussi un coefficient de dilatation thermique qui n'est pas inférieur environ à celui de ladite dalle plate.

8. Procédé pour fabriquer le masque perforé (50) pour un tube à rayons cathodiques en couleur de masque de tension (20) qui comprend une dalle plate (24) ayant sur sa surface interne (26) un écran luminophore (28) et une structure de support (48) pour supporter un masque perforé sous tension (50) adjacent à celui-ci, le traitement étant **caractérisé en ce qu'**il comprend les étapes de fourniture d'une feuille d'alliage nickel-fer durcie contenant entre environ 75 et environ 85 pour cent en poids de nickel et au moins un des éléments suivants dans le pourcentage de poids indiqué : molybdène entre 0 et environ 5%, vanadium entre 0 et environ 2%, titane entre 0 et environ 2%, hafnium entre 0 et environ 2%, niobium entre 0 et environ 2%, impuretés de fer et incidentes pour le reste, de traitement thermiquement de ladite feuille durcie dans les conditions qui réalisent des propriétés de blindage magnétique favorable tout en maintenant des propriétés de résistance du matériau durci suffisantes pour résister à des niveaux de tension de masque en fonctionnement normal, y compris en traitant thermiquement ladite feuille à une température supérieure à environ 400°C et sous la température à laquelle l'alliage forme une solution solide pendant une période d'au moins environ 30 minutes et

commandant la vitesse de refroidissement de ladite feuille à partir de ladite température à la température à laquelle ledit alliage est substantiellement recristallisé pour fournir une feuille ayant une résistance à la déformation supérieure à 552 N/mm2 (80 ksi), une perméabilité supérieure à 6000, et une coercivité inférieure à 199 A/m (2,5 oersteds) ou moins, application de la tension à ladite feuille, et fixation de ladite feuille à ladite structure de support tout en étant sous tension.

9. Traitement selon la revendication 8, dans lequel ledit masque comprend entre environ 75 et 85 pour cent en poids de nickel, préférablement environ 80 pour cent en poids de nickel, entre environ 3 et 5 pour cent en poids de molybdène, préférablement environ 4 pour cent en poids de molybdène, avec des impuretés de fer et incidentes pour le reste.

10. Traitement selon la revendication 8 ou 9, dans lequel la vitesse de refroidissement est inférieure à 5°C par minute, préférablement à 3°C par minute.

11. Traitement selon la revendication 8, 9 ou 10, dans lequel la feuille est placée sous une tension d'au moins 25 Newtons/centimètre.

12. Traitement selon la revendication 8 ou 9, dans lequel la dalle plate possède sur sa surface interne une zone d'écran luminophore disposée centralement englobée par une zone d'étanchéité périphérique adaptée pour accoupler un cône, et le masque perforé est fixé en tension à la structure de support de masque perforé ressemblant à un cadre sur ladite surface interne de dalle plate entre ladite zone d'étanchéité périphérique et ladite zone d'écran ; ledit traitement comprenant les étapes de formation dudit alliage dans une feuille, d'ouverture d'une zone centrale de ladite feuille pour former un masque de feuille en accord en dimensions avec ladite zone d'écran pour la sélection de couleurs, une tension de ladite feuille à une tension d'au moins environ 25 Newtons/centimètre, d'effet d'écran par photographie séquentiellement d'un motif de dépôts luminophore d'émission de lumière rouge, d'émission de lumière verte, d'émission de lumière bleue sur ladite zone d'effet d'écran, comprenant répétitivement la mise en registre de ladite feuille avec ladite zone d'écran luminophore mettant en registre ledit cadre de tension avec ladite dalle plate, application de la tension audit masque de feuille, fixation dudit masque de feuille à ladite structure de support de masque avec lesdites ouvertures enregistre avec ledit motif de dépôts luminophore, application d'une matière dévitrifiable sous forme de pâte sur ladite zone d'étanchéité périphérique pour recevoir un cône, accouplement de ladite dalle plate avec ledit cône pour former un assemblage de dalle plate-cône, chauffage dudit assemblage à une température efficace pour dévitrifier ladite matière et fixer de façon permanente ledit cône à ladite dalle plate, et refroidissement dudit assemblage à une vitesse de refroidissement inférieure à environ 3 à 5 degrés C par minute, le chauffage dudit assemblage et de ladite feuille et la vitesse lente de refroidissement dudit assemblage et de ladite feuille étant efficace pour recuire partiellement ledit masque de feuille et produire une résistance à la déformation supérieure à 552 N/mm2 (80 ksi), une perméabilité supérieure 6000, une coercivité en dessous d'environ 199 A/m (2,5 oersteds), et un coefficient de dilatation thermique qui n'est pas inférieur à environ de celui de ladite dalle plate.

13. Traitement selon la revendication 12, dans lequel ledit masque de feuille étendu en chauffant ledit masque de feuille à une température supérieure à 400°C et en dessous de la température à laquelle l'alliage forme une solution solide pendant une période d'au moins environ 30 minutes et ensuite refroidissement de ladite feuille à la température ambiante à une vitesse de refroidissement inférieure à environ 3 à 5 degrés C par minute.

14. Traitement selon la revendication 12 ou 13, dans lequel ledit masque en feuille possède une résistance à la déformation supérieure à environ 1033 N/mm2 (150 ksi), une perméabilité supérieure à environ 10000, et une coercivité en dessous d'environ 80 A/m (1,0 oersted).

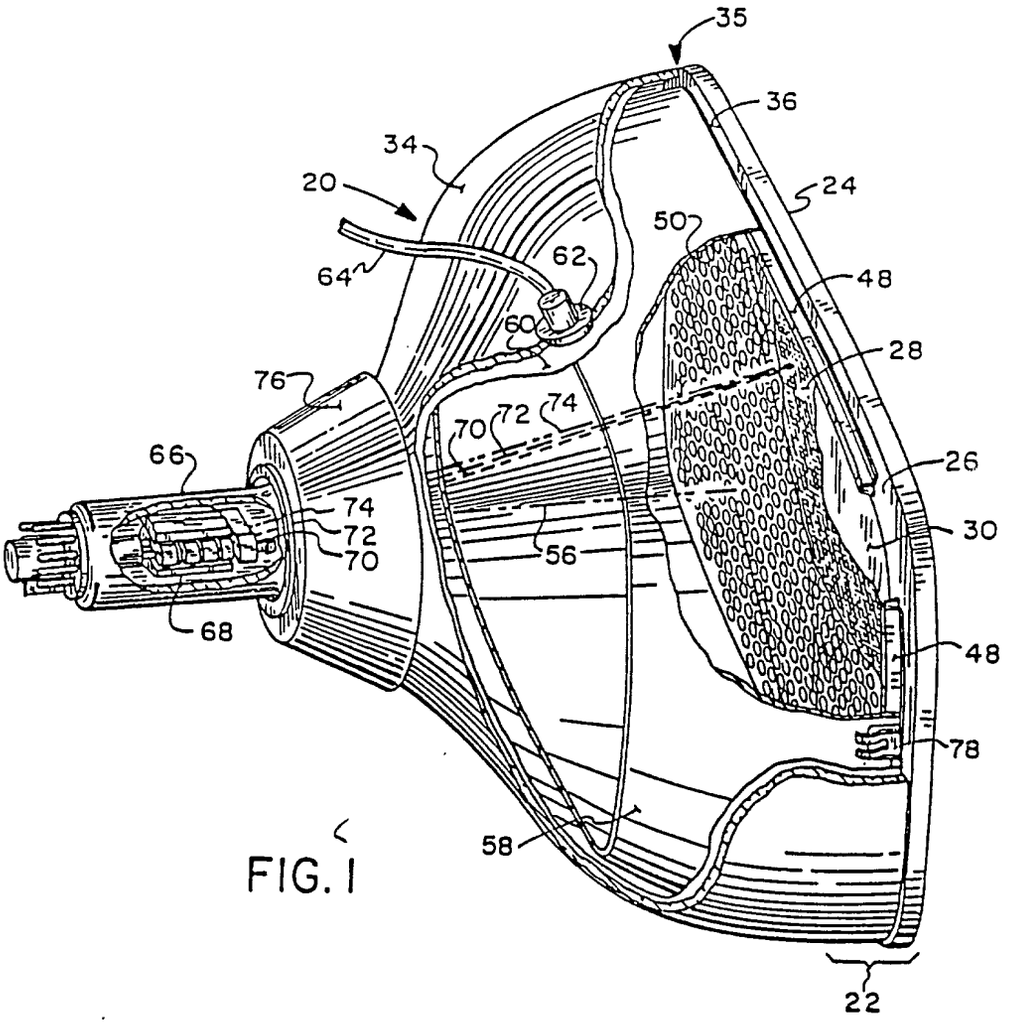


FIG. 1

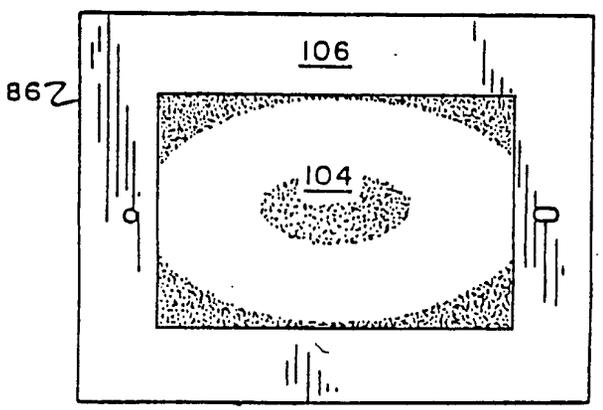


FIG. 2

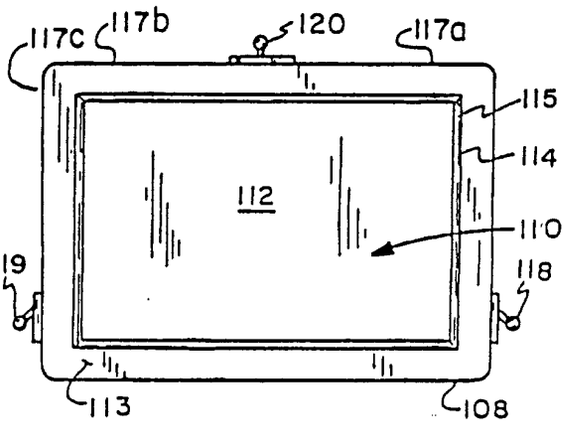


FIG. 3

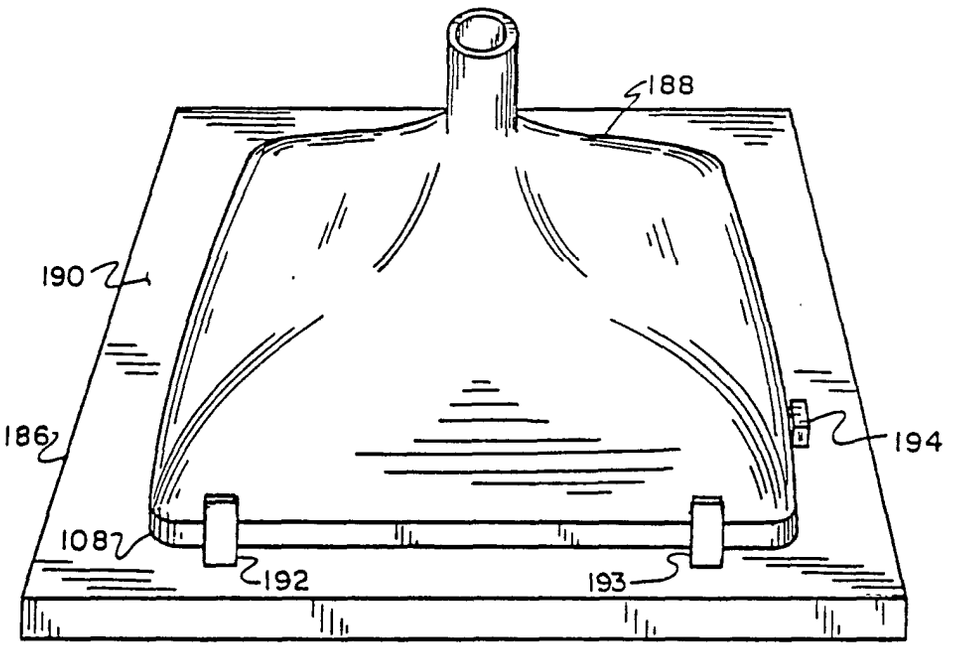

188
190
186
194
108
192
193

FIG. 4

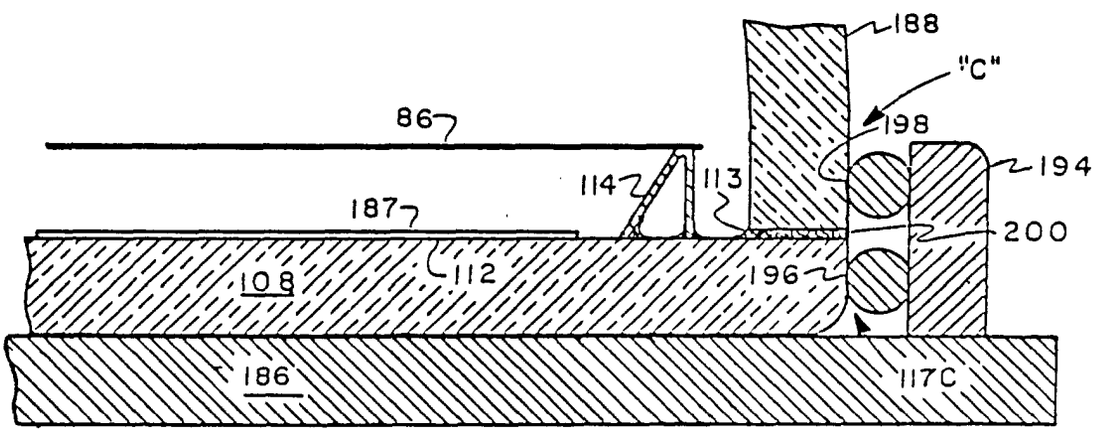

188
"C"
198
86
194
114
113
187
200
108
112
196
186
117C

FIG. 5