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[33] **Japan**
[31] **43/75008 and 43/90232**

[54] **PROJECTION PICTURE TUBE WITH ROTATING FLUORESCENT SCREEN**
6 Claims, 4 Drawing Figs.

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[51] **Int. Cl.** **H01j 1/44,** H01j 29/02, H01j 7/24
[50] **Field of Search** 313/146, 149, 30, 92

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ABSTRACT: A projection picture tube comprising an evacuated envelope, an electron gun assembly disposed therein, a metal target member with a fluorescent film thereon which is to be scanned by electron beams emitted by the electron gun assembly, a motor for rotating the target member without causing the electron beams to be affected by an external magnetic field, and an optical system for enlarging the image produced on the fluorescent film.

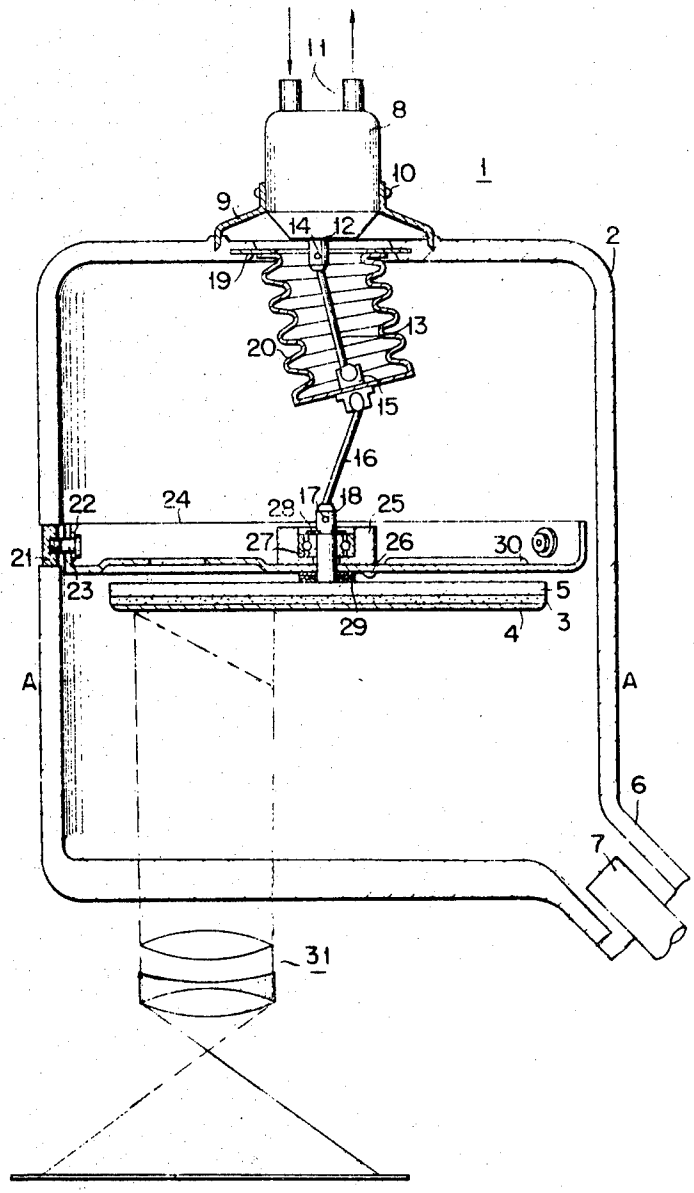
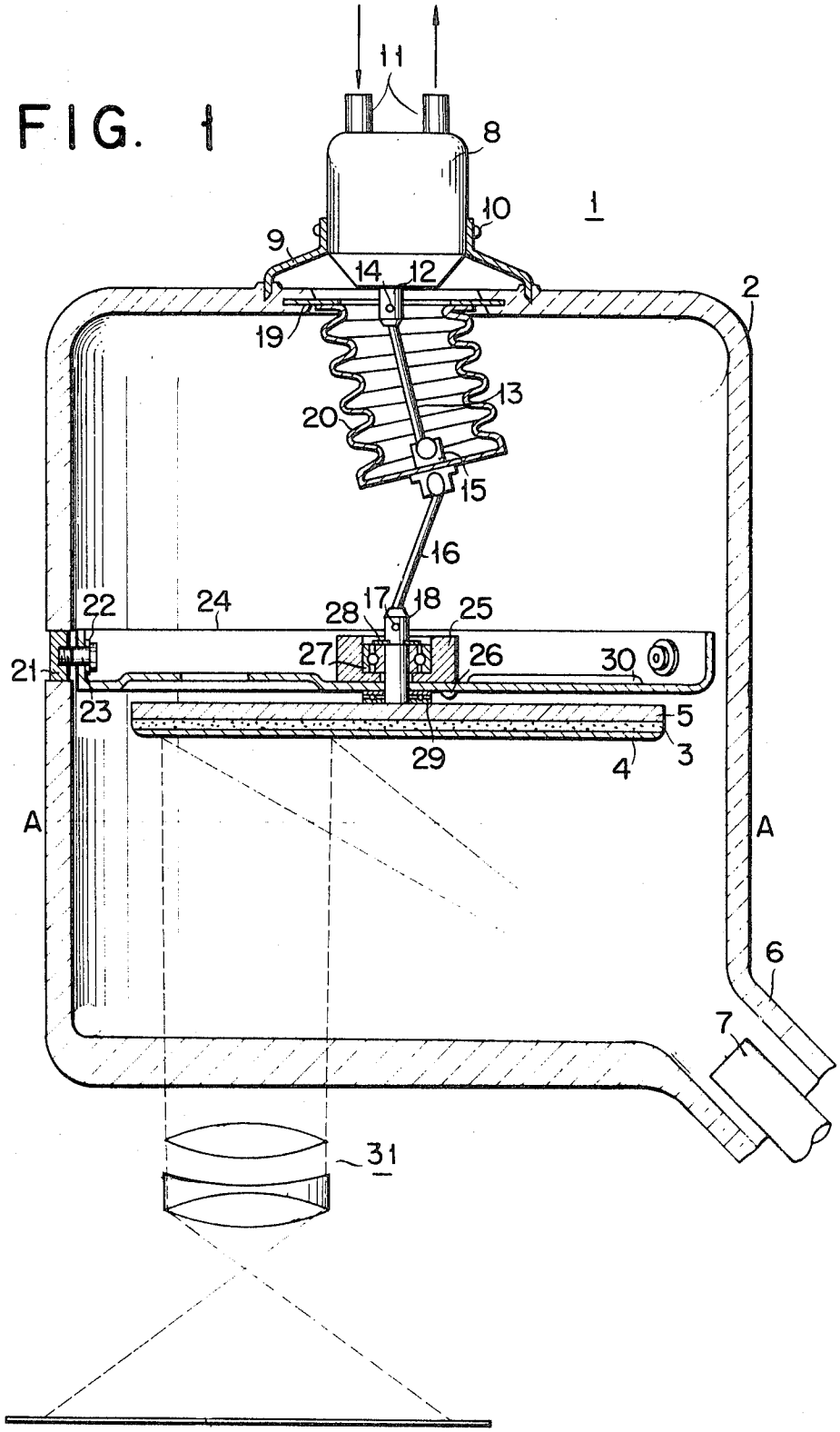


FIG. 1


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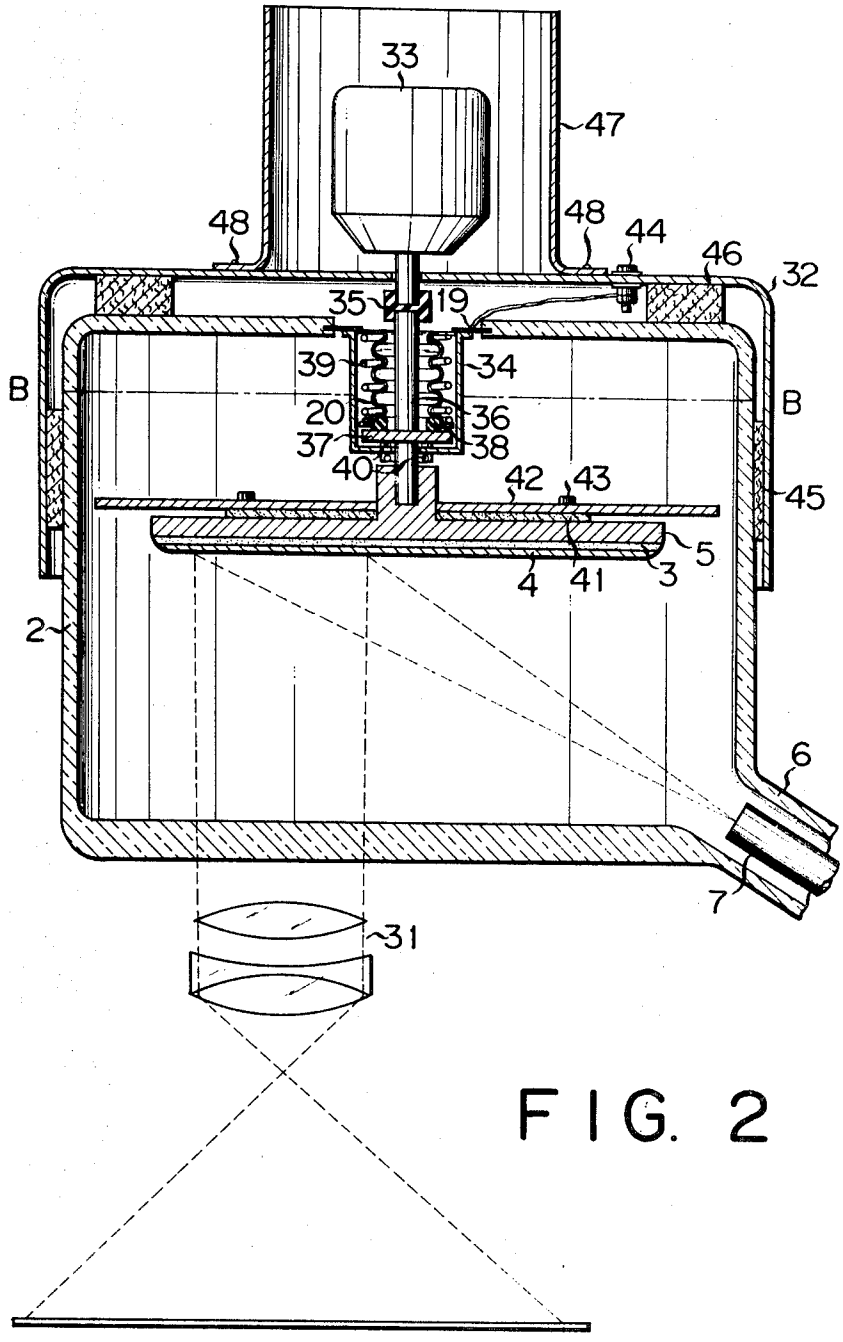
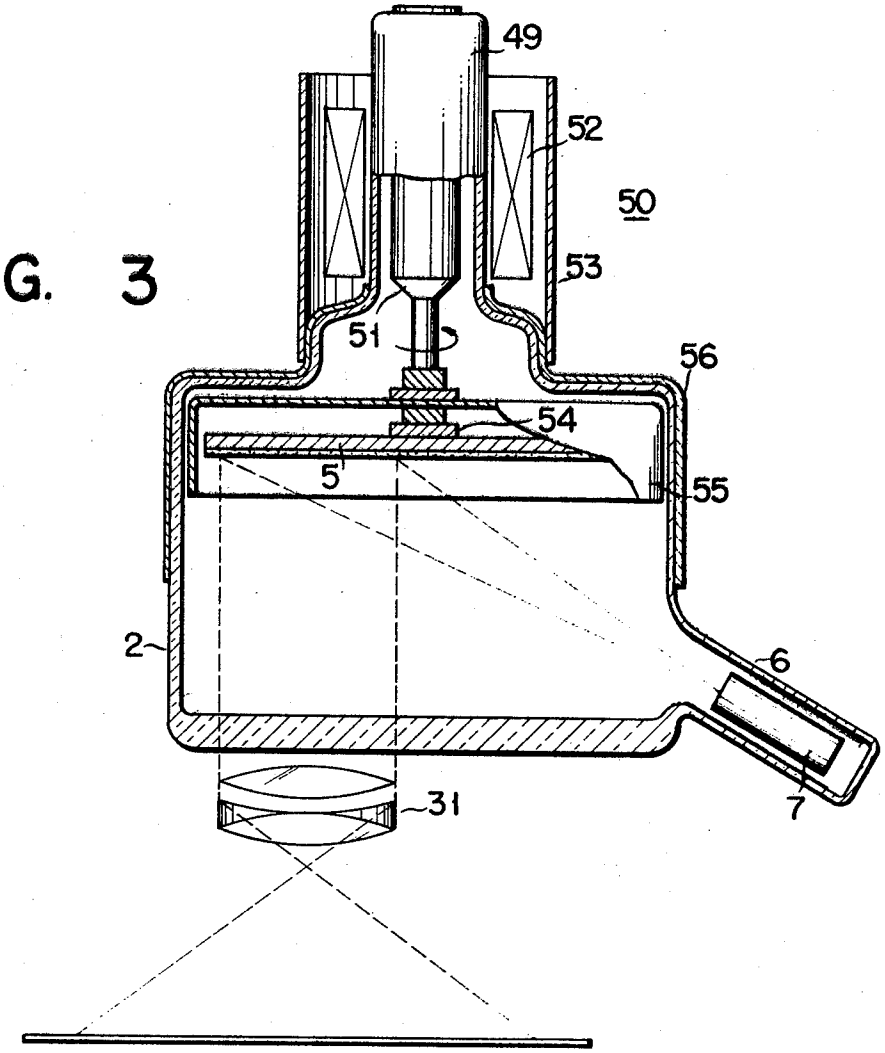

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FIG. 2

FIG. 3



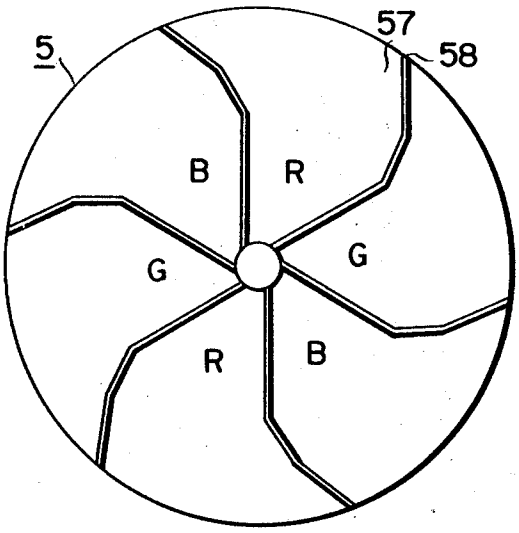


FIG. 4

PROJECTION PICTURE TUBE WITH ROTATING FLUORESCENT SCREEN

BACKGROUND OF THE INVENTION

The present invention relates to picture tubes, and more particularly to a projection picture tube.

The projection picture tube is intended optically to optically enlarge the image produced on the fluorescent film or plane by electron beams from the electron gun assembly and project the enlarged image on a screen. It is used, for example, by a theater or broadcasting station to allow a large number of people to see television images at the same time.

Since the projection picture tube is required to produce pictures of high intensity, the fluorescent film is impinged by particularly accelerated electron beams. Impingement of accelerated electron beams on the fluorescent film results in its increased temperature, reducing the amount of light beams or intensity generated therefrom.

According to the prior art, the fluorescent film is generally deposited on a glass envelope. Since the glass envelope has poor heat release characteristics, the temperature rise of the fluorescent film is unavoidable, imposing a limitation on the increase of intensity and in consequence failing to produce an image of desired clearness.

SUMMARY OF THE INVENTION

It is accordingly the object of the present invention to provide a projection picture tube wherein a substrate on which there is mounted a fluorescent film consists of metal to improve heat release from the film, and the substrate is rotated without affecting the electron beams by a magnetic field, to prevent the same part of the film from being continuously impinged by electron beams, thereby preventing the temperature rise of the film and increasing the intensity of an image produced thereon.

BRIEF EXPLANATION OF THE DRAWINGS

FIG. 1 is a sectional view of a projection picture tube according to the embodiment of the present invention, wherein the drive means consists of an air motor;

FIG. 2 is a sectional view of a projection picture tube according to another embodiment of the invention, wherein the drive means consists of an electric motor;

FIG. 3 is a section view of a projection picture tube according to still another embodiment of the invention, particularly adapted to project color television images; and

FIG. 4 is a plan view of the arrangement of a plurality of sections representing the three primary colors of the fluorescent film disposed on the rotary member involved in the projection picture tube.

DETAILED DESCRIPTION OF THE INVENTION

In the embodiment shown in FIG. 1 of a projection picture tube 1, there is contained in a cylindrical envelope 2 a metal rotary member 5 prepared by coating a fluorescent film 3 and vapor depositing thereon an aluminum film 4. The envelope comprises a transparent face plate and a blind cylindrical member made of glass. At the corner of the faceplate of the envelope 2 is formed a projecting neck portion 6, in which there is sealed an electron gun assembly for ejecting electron beams at an angle of 45° with respect to the central axis of the rotary member 5. An air motor 8 for driving the rotary member 5 is fixed by rivets 10 to a support frame 9 formed on the periphery of an opening perforated at the central part of the backwall of the envelope 2. The driving source of said air motor 8 is constant pressure air supplied at one end of a duct 11 and discharged at the other. Said air rotates a plurality of rotary vanes projecting from a movable vane shaft 12. To the movable vane shaft 12 is rotatably fitted one end of a crankshaft 13 by a pin 14. Said crankshaft consists of a rod made of insulating material, for example, Bakelite. The other

end of the crankshaft 13 is connected to one end of another crankshaft 16 made of metal, for example, stainless steel by means of a universal joint 15. The other end of the metal crankshaft 16 is rotatably connected to the central shaft 18 of the rotary member 5 by a pin 17. To finish up the aforesaid connecting mechanism, there is provided a washer type flange plate 19 at the opening in the back plate of the envelope 2. Said opening is sealed airtight with bellows 20 made of metal, for example, stainless steel which extends from the universal joint 15 to the flange plate 19 in a manner to cover the crankshaft 13. The flange plate 19 consists of seal metal, such as SNC (Sylvania No. 4) or KOV, which is selected according to the material of the envelope used. On the periphery of the envelope 2 are arranged at equal spacings a plurality of (three in this embodiment) bearings 21 concurrently acting as terminals. To these bearings are securely fixed from the interior of the envelope 2 a cylindrical bearing frame by means of a spring washer 22 and stainless steel bolt 23. The bolt 23 is effected by inserting a driver through a hole perforated in said bearing frame. To the central part of the bearing frame 24 is fixed a bearing frame 25 by a pin 26. The bearing frame 25 contains a stainless steel ball bearing 27. The central shaft 18 of the rotary member 5 is inserted into the ball bearing 27 and stopped by a stopper 28 disposed at the top of said bearing 27 to be prevented from being urged in the axial direction. Between the rotary member 5 and the bottom of the bearing frame 24 is interposed a thrust bearing 29 in a manner to surround the central shaft 18. Said thrust bearing 29 allows the rotary member 5 smoothly to rotate in a horizontal plane. On the bottom wall of the bearing frame 24 are radially formed a plurality of beads 30 to increase its mechanical strength and prevent its vibration thereby to ensure the smooth rotation of the rotary member by the force of the air motor 8. When, under such arrangement, the air motor 8 is operated, the rotary member 5 is rotated by the gyroscopic motion generated collectively by the crankshafts 13 and 16, universal joint 15 and bellows 20. With the view of preventing to some extent the temperature rise of the fluorescent film 4 resulting from scanning by accelerated electron beams, the rotary member has a thickness adapted to absorb and expel the heat generated in said film 4, for example, 5 mm. in this embodiment. The rotary member is preferably formed on nonmagnetic metal having a magnetic permeability of less than 1.005μ, for example stainless steel of the Cr16 percent—nil14 percent type. With a projection picture tube of ordinary size, a rotary member 5 mm. thick weighs about 0.3 to 0.8 kg. and can rotate most stably at a speed of 60 to 1200 r.p.m.

For impingement of accelerated electron beams on the fluorescent film 4, the rotary member 5 is impressed with high voltage. Said voltage is supplied through one of the aforesaid plurality of bearings 21 concurrently acting as terminals which are disposed on the sidewall of the envelope 2. Since the crankshaft 13 is made of insulating material, the voltage is not conducted to the upper part of the envelope 2. Though said voltage is supplied up to the universal joint 15, the support frame 9 serves as a safety cover, so that there is absolutely no danger of the high voltage section being contacted from the outside.

Outside of the envelope 2 is positioned an optical system 31, for example, a Schlieren optical system, in a manner to face the face plate of said envelope 2 or the fluorescent film 3.

Before the necessary parts are fitted to the interior of the envelope 2, said envelope 2 is cut on the indicated broken line A–A in upper and lower portions. After said fitting is complete, the divided parts are sealed together to finish a projection picture tube by a known process.

There will now be described the operation of a projection picture tube according to the present invention. Air having a constant pressure adjusted by a pneumatic pressure adjuster is introduced at one end of the duct 11 of the air motor 8 to rotate it and in consequence the rotary member 5 at a prescribed speed. Then the bearings 21 are impressed with a prescribed high voltage to energize the electron gun assembly

7 disposed in the neck portion 6 and scan the fluorescent film 4 mounted on the rotary member 5 with electron beams, obtaining a television image. Said image is enlarged by an enlarging optical system 31 provided outside of the picture tube and projected on a screen. The apparatus of the aforementioned embodiment involves an air motor and needs no magnetic shielding means as is required when there is used an electric motor.

There will now be described by reference to FIG. 2 a projection picture tube according to another embodiment of the invention. In the cylindrical envelope 2 is disposed a rotary member 5. On one side of the rotary member 5 is mounted a fluorescent film 3 on which there is superposed an aluminum film by vapor deposition. In the lower corner of the envelope 2 or at the end portion of the face plate is formed a projective neck portion 6 at an angle of 45° with respect to the central axis of the rotary member 5. To the interior of the neck portion 6 is fitted an electron gun assembly 7 for ejecting electron beams. A motor for driving the rotary member 5 is fitted to the upper portion of a cylindrical shield 32 so formed as to cover the back plate of the envelope 2. Said motor is of an induction or pulse type 33. The rotary shaft of the motor 33 is connected through an annular member 35 made of insulating material to the shaft 36 fitted to the central part of the rotary member 5. Said shaft 36 has a floating rotary plate 37 coaxially fitted to the center thereof. Further, said shaft 36 is supported by a cylindrical bearing stand 34 welded to a flange plate 19 sealed to the periphery of an opening in the envelope 2. To that side of the bearing stand 34 which faces the flange plate 19 is welded airtight one end of bellows 20. To the other end of the bellows 20 is sealed a packing 38 made of tetrafluoro resin or silicon rubber. Said packing 38 is slidably attached to the floating rotary plate 37 by means of a spring 39 concentrically disposed between the bearing stand 34 and bellows 20, thereby keeping the interior of the envelope 2 airtight. Between the floating rotary plate 37 and bearing stand 34, as well as between said bearing stand 34 and rotary member 5 are positioned a pair of thrust bearing 40 to ensure the smooth rotation of the rotary member 5. Said member 5 is fixed by bolt 43 to a shield plate 42 made of stainless steel or permalloy with a ceramic spacer 41 lying therebetween. Said shield plate 42 is supplementally intended unfailingly to shut off a floating magnetic field introduced from the outside. For the purpose of the present invention, it is preferred that all metal materials excluding the seal metal be of a nonmagnetic type having a magnetic permeability of less than 1.005μ, for example, Cr16percent—Nil14percent stainless steel. The required high voltage is supplied at a terminal 44 drawn out of the flange plate 19. The motor 33 is insulated from a source of said high voltage by the annular insulating member 35 interposed between said motor and shaft 36.

Since the motor 33 involves a great deal of magnetic material, it is necessary to shield said magnetic field. To this end, there is fitted a cylindrical magnetic shield 32 over the peripheral surface of the envelope 2 with spacers 45 and 46 interposed therebetween. Said cylindrical magnetic shield 32 consists of metals, for example, permalloy which have a great magnetic shielding effect to an external field. Said cylindrical magnetic shield 32 is so positioned as to cover the upper surface of the envelope 2 at a space of 10 to 15 mm. from the rotary member 5. Referring to the intervening spacers 45 and 46, there will be obtained a good effect if the side spacer 45 is 3 mm. thick and the upper spacer 46 is 10 mm. thick.

There is further provided another cylindrical magnetic shield 47 in a manner to surround the peripheral area of the motor 33, which is fixed to the aforesaid cylindrical magnetic shield 32 by rivets 48. When parts are assembled to manufacture the subject picture tube, the envelope 2 is cut on line B–B before the fitting of the cylindrical magnetic shields 32 and 47. After said assembly, the cut apart parts of the envelope 2 are welded or sealed together. A projection picture tube thus assembled is finished up by the known method.

The aforementioned arrangement enables a magnetic field to be fully shielded even when there is used an ordinary electric motor like an induction or pulse type which involves large amounts of magnetic material, and in consequence a satisfactory television picture to be projected.

The preceding two embodiments relate to an apparatus for monochromatic television pictures. If, however, the rotary member is fitted with a fluorescent film producing three primary colors, there will be obtained a picture tube for use in color television. There will now be described a color television picture tube by reference to FIGS. 3 and 4.

In FIG. 3, the envelope 2 is prepared from a cylindrical form of glass, in which there is disposed a rotary member 5. On one flat plane of the envelope 2 is concentrically formed a projecting portion 49. At the end part of the faceplate is formed a neck portion 6 at an angle of 45° with respect to the central axis of said rotary member 5. To the interior of the neck portion 6 is fitted an electron gun assembly 7. A motor 50 for driving the rotary member 5 comprises a rotor 51 rotatably disposed in the projecting portion 49 and a field coil 52 formed around the projecting portion 49. Around the field coil 52 is provided a cover 53. The shaft of the rotor 51 is connected to the rotary member 5 by a metal stopper 54. The field coil 52 is supplied with a revolving magnetic field. To avoid the effect of the revolving magnetic field of the field coil 52, there is fitted to the shaft of the rotor 51 a blind magnetic shielding member 55 in a manner to cover the back and side of the rotary member 5. Further, there is provided a magnetic shield 56 in a manner to surround the upper peripheral portion of the envelope 2.

The surface of the rotary member 5 is divided into six equal sections. In these sections are formed two groups of fluorescent films each of which involves three sections representing three primary colors of blue, red and green and arranged in the order mentioned as viewed in the rotating direction of said member 5. On the surface of the rotary member 5 are formed by the known etching process, as shown in FIG. 4, six depressed areas 57 0.05 to 0.08 mm. deep progressively broadening radially from the center to the periphery of the rotary member 5, so as to allow the aforesaid six fluorescent films to be deposited thereon. These depressed areas 57 are separated from each other by six projecting partition band 58 0.3 to 0.5 mm. wide which were left unprocessed during the etching operation. In this case, the partition bands 58 are bent in two stages opposite to the rotating direction of the rotary member 5. That portion of each band which accounts for 55 percent of the entire length thereof extending from the center to the periphery is formed along the radial line. The second portion of the band accounting for 15 percent of the entire length extends at an angle of 30° with respect to the radial line, and the last portion reaches the periphery of the rotary member at an angle of 50° with respect to the radial line. Considering requirements for the bonded strength of a fluorescent film and the resolution grade of the image produced, it is preferred that the surface of the depressed area 58 be finished with a roughness of 2 to 5 microns. Further, the angular portion defined by the side plane of the projecting partition band and the top plane of the depressed area which intersect each other is formed into a curved plane having a curvature corresponding to the meniscus or crescent shape appearing on the edge of a fluorescent film when it is disposed in said depressed area, in order to make the surface of said film completely flush with the surface of the projecting band. The rotary member 5 is made of metals, for example, Cr16 percent—Nil14 percent stainless steel which have a magnetic permeability of less than 1.005μ and consequently are most preferable in respect of electrical and physical properties. As described above, on the six depressed areas of the rotary member 5 are deposited two groups of fluorescent films, each of which comprises three sections representing three primary colors of blue, red and green and arranged in the order mentioned as viewed in the rotating direction of the rotary member 5. The formation of fluorescent films of three primary

colors is carried out, for example, in the following manner. First, over the entire surface of the rotary member 5 is applied a fluorescent material displaying one color, for example, red. Only the prescribed portion of said fluorescent material which will later constitute the red section is exposed to light for baking and other unnecessary unexposed portions are washed off. Such operation is repeated three times, namely, each time a fluorescent material representing one of the three primary colors is coated.

Electron beams from the electron gun assembly 7 scan at an angle of 45° the different fluorescent sections of blue, red and green in turn, according as the fluorescent plane travels due to the rotation of the rotary member 5, thereby presenting a color television picture.

The projection picture tube of the present invention having the aforesaid arrangement enables a color television picture to be projected on a screen with high intensity and resolution. To the field coil of said projection picture tube used as a drive means is connected a 144c/s source exactly synchronizing with the vertical synchronizing pulse of image signals. And the rotor or rotary member 5 is rotated at a speed of 1440 r.p.m. At this time electron beams from the electron gun assembly scan the fluorescent sections of blue, red and green at the rate of 144 fields per second, producing a color television picture on the fluorescent plane.

The rotating speed of the rotary member and the fluorescent sections have a certain relationship. That is, the number of the fluorescent sections is defined by an integral multiple of three, and the rotating speed of the rotary member is chosen according to said number.

In the projection picture tube described in the aforesaid three embodiments of the present invention, the electron gun assembly is intended to generate a single flux of electron beams or a single image. However, there may be used a plurality of such assemblies to produce a plurality of images on the fluorescent plane by supplying them with different image signals. Thus it is possible to enlarge these images separately for projection or combine them to form a composite picture. To this end, To is also possible to incorporate a plurality of electron guns into an assembly at such different angles to the fluorescent plane as produce divergent fluxes of electron beams or different images.

As mentioned above, the present invention allows the substrate of a fluorescent film or a rotary member to be made of metal, thus releasing heat effectively. Further, the rotation of said rotary member permits the parts of the fluorescent film scanned by electron beams to be constantly shifted in position, thereby preventing the undue local temperature rise of said film. Accordingly, the present invention has an advantageous effect of protecting the fluorescent film to improve its light producing efficiency and projecting a distinct enlarged image on a screen due to increased intensity. Experiments show that the life of a projection picture tube according to the present invention has been doubled as compared with that of the prior art type because the fluorescent film is prevented from being deteriorated.

Moreover, the fluorescent film is deposited on a disk substrate made of metal, for example, stainless steel. This eliminates the generation and transmission of X-rays as is observed in the case where there is formed a fluorescent film on the surface of glass material used in the conventional picture tube. Also there do not occur other drawbacks, for example, that the glass surface turns brown with the resultant low intensity and resolution and dark images.

What we claim is:

1. A projection picture tube comprising an evacuated envelope having a transparent faceplate, a bearing member fixed in the envelope, a rotary anode member rotatably coupled to the bearing member and having a central shaft, a motor disposed on the back portion of the envelope, coupling means airtightly coupling the motor and the central shaft of the anode member, said coupling means including an insulating crankshaft member coupled to the motor, a second crankshaft member coupled to the central shaft of the anode member, a universal joint coupling the crankshafts together, and bellows disposed airtightly on the back side of the envelope and surrounding the insulating crankshaft member, a fluorescent film formed on the surface of the rotary member which faces the faceplate, an electron gun assembly received in the envelope for impinging electron beams on the fluorescent film, and an optical system for enlarging and projecting an image produced on the fluorescent film by electron beam impingement.

2. The projection picture tube according to claim 1 wherein said fluorescent film is a color fluorescent film.

3. The projection picture tube according to claim 2 wherein said fluorescent film includes a plurality of fluorescent areas formed from fluorescent materials displaying three primary colors, those of said areas which are associated with the same color being arranged at equal spacings, the boundary between adjacent areas being bent at intermediate points in a direction opposite to the rotating direction of the rotary member, so that each of said areas has a shape progressively broadening from the center to the periphery of the rotary member.

4. The projection picture tube according to claim 1 comprising an aluminum film on the fluorescent film.

5. The projection picture tube according to claim 1 wherein said motor is an air motor.

6. The projection picture tube according to claim 5 wherein said second crankshaft member is metal and said bellows is metal.