United States Patent

[11] 3,599,026

[72] Inventors **Asahide Tsuneta**
Kawasaki-shi;
Shinichi Sawagata, Tokyo; Mikio Noguchi,
Kawasaki-shi, all of, Japan

[21] Appl. No. **852,625**
[22] Filed **Aug. 25, 1969**
[45] Patented **Aug. 10, 1971**
[73] Assignee **Tokyo Shibarua Electric Co., Ltd.**
Kawasaki-shi, Japan
[32] Priority **Aug. 28, 1968, Aug. 31, 1968, Aug. 31, 1968**
[33] **Japan**
[31] **61272/68, 62252/68 and 75009/68**

[54] **PROJECTION TUBE WITH ROTATABLE COOLED DISPLAY SCREEN**
7 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** **313/92,** 313/149, 313/30
[51] **Int. Cl.** **H01j 29/02,** H01j 1/42, H01j 21/22
[50] **Field of Search** 313/146, 149, 30, 92

[56] **References Cited**

UNITED STATES PATENTS

2,241,974	5/1941	Anderson et al.	313/92 X
2,417,621	3/1947	Traub	178/5.4 RCF
2,422,937	6/1947	Szegho	313/92 X
2,569,872	10/1951	Skehan et al.	313/92 X
3,306,975	2/1967	Donnay	313/13 X
3,331,978	7/1967	Brown et al.	313/30 X

FOREIGN PATENTS

60,847	4/1943	Denmark	313/92
109,821	2/1940	Australia	313/92

Primary Examiner—Robert Segal
Attorney—Flynn & Frishauf

ABSTRACT: A projection picture tube comprises a vacuum vessel, an anode support member received in said vessel, a fluorescent film coated on the upper surface of said anode member and an electron gun assembly for ejecting electron beams on said fluorescent film, said anode member consisting of a hollow metal body through which a cooling fluid is caused to flow.

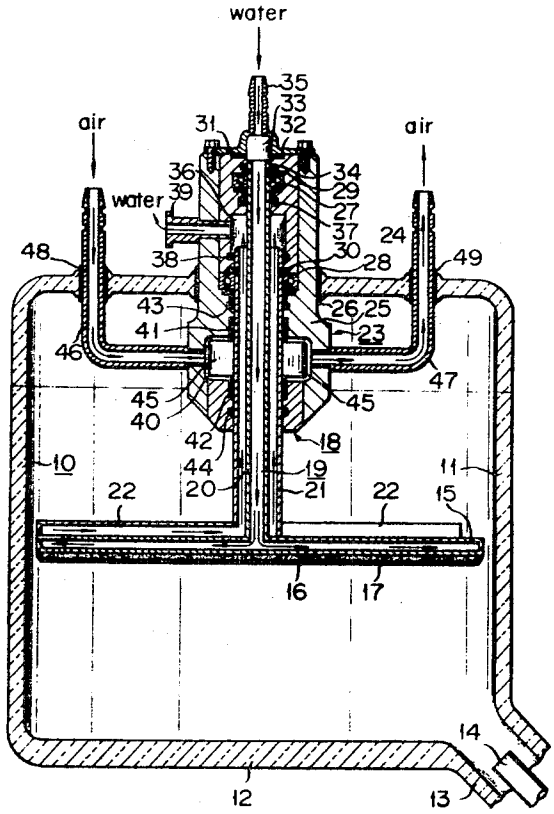


FIG. 1

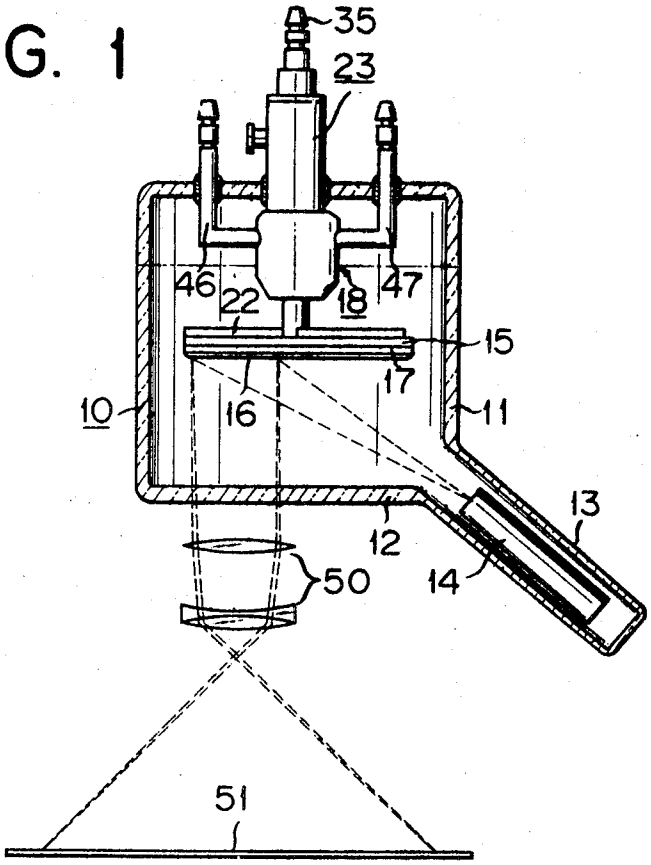

35
23
46
22
18
47
15
17
10
16
11
13
12
14
50
51

FIG. 4

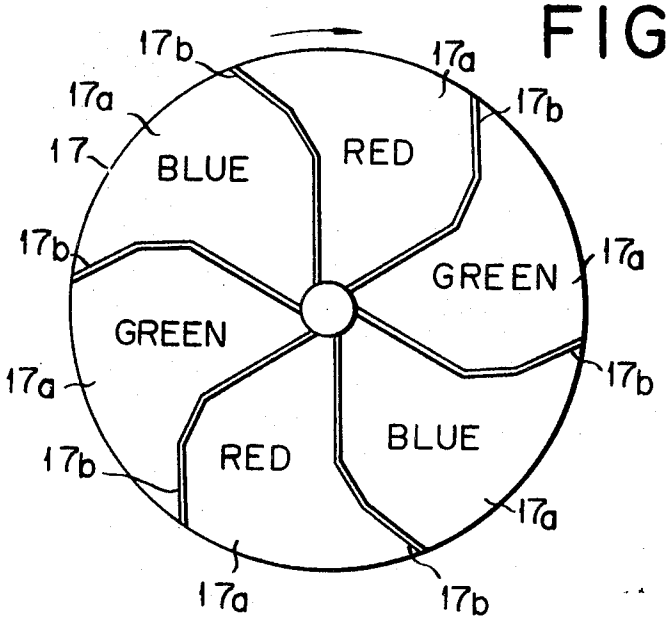

17b
17a
17a
17b
17
BLUE
RED
17b
GREEN
17a
GREEN
17a
17b
17b
RED
BLUE
17a
17a
17b

FIG. 2

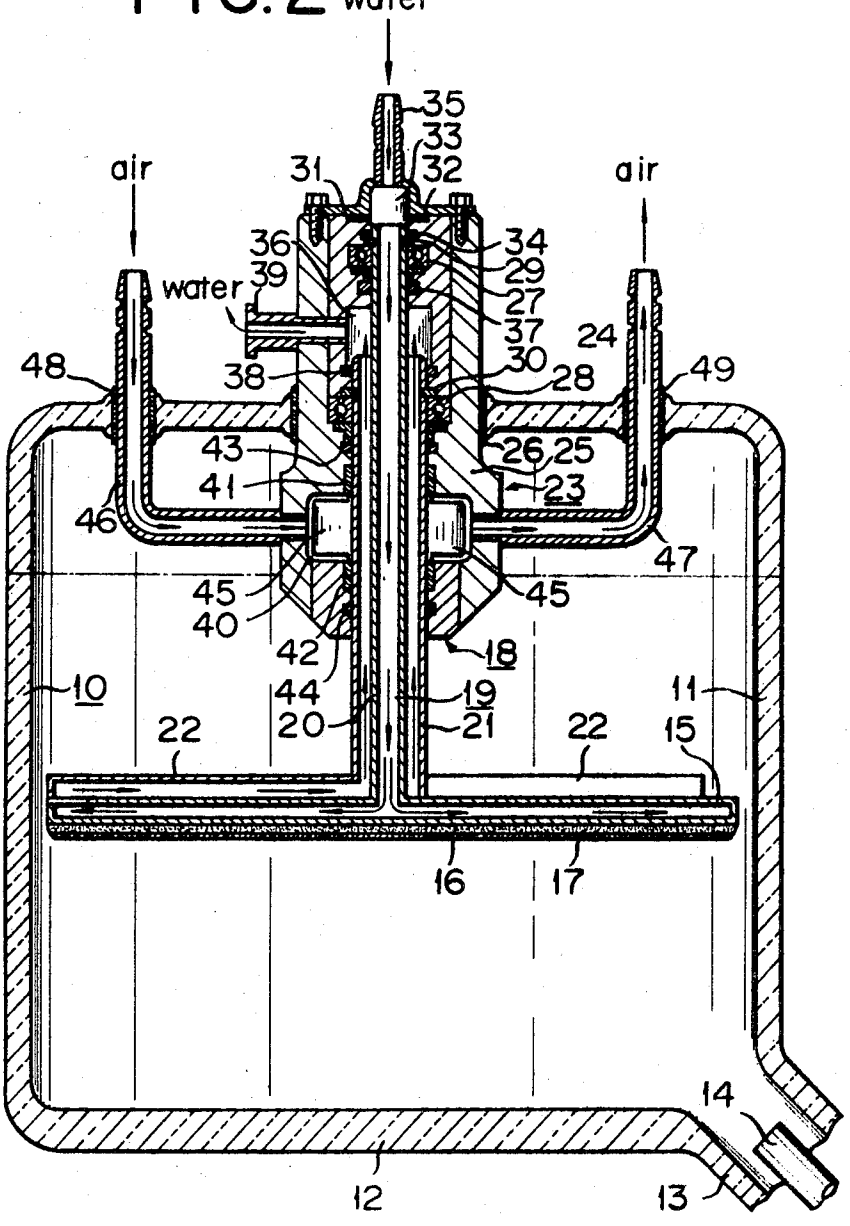

water
35
33
air
31
32
air
36
34
39
water
29
27
37
24
48
38
30
28
49
43
26
25
41
23
46
47
45
45
40
42
18
10
44
19
11
22
20
21
22
15
16
17
14
12
13

FIG. 3

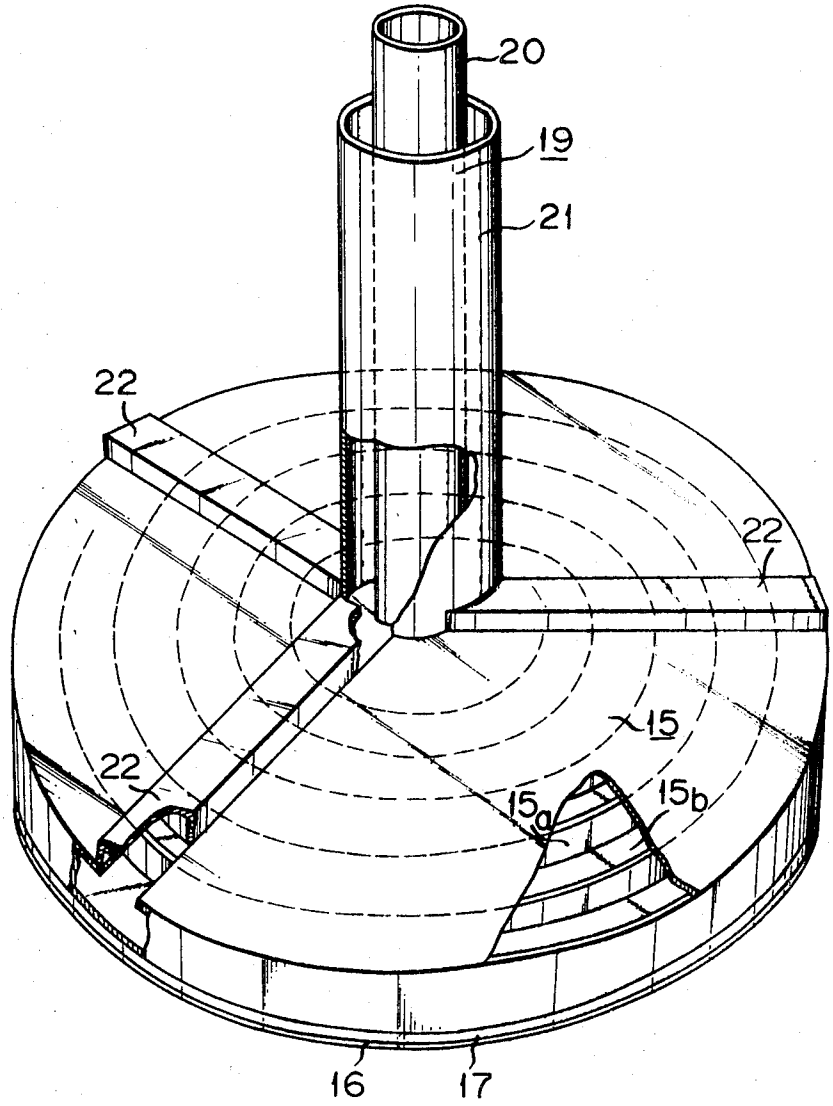


FIG. 5

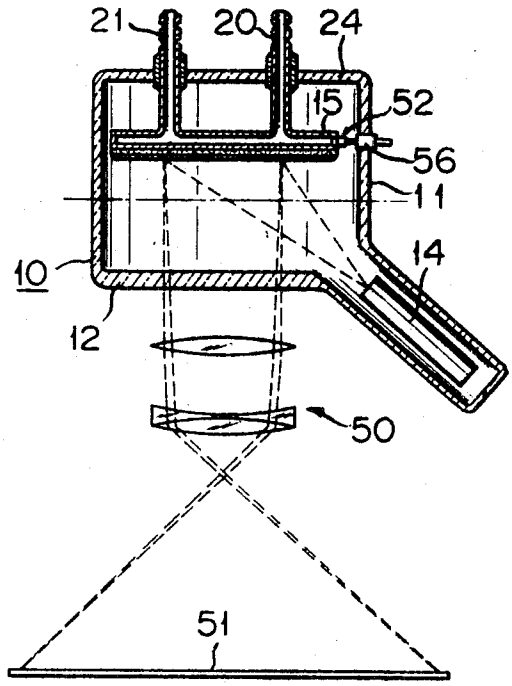
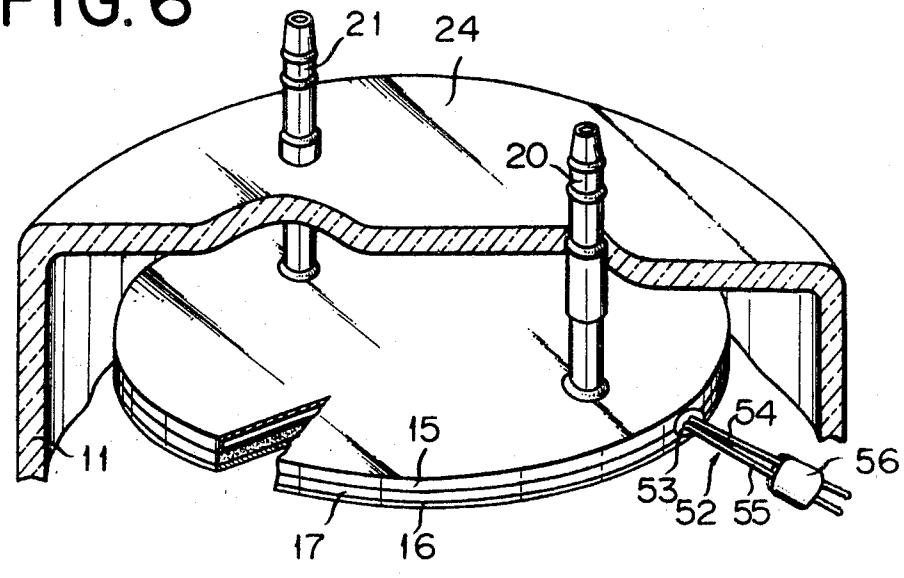


FIG. 6



PROJECTION TUBE WITH ROTATABLE COOLED DISPLAY SCREEN

BACKGROUND OF THE INVENTION

The present invention relates to a special type of picture tube, and particularly to a picture tube of the projection type capable of producing an enlarged image.

As is generally known, the projection picture tube is a type which projects an enlarged picture on a screen and allows a large number of people to see, for example, telecast pictures at the same time. Though not much different from other types, this projection picture tube particularly requires an optical system for compensating and enlarging a picture to be produced. To this end, said picture tube is required to display a picture with far greater intensity and resolving power than is demanded of an ordinary type. For this purpose, the prior art projection picture tube ejected electron beams on the fluorescent surface at an extremely accelerated speed. However, this led to high temperatures, short life and deterioration of the fluorescent surface, and thus failing to obtain a picture of desired high intensity and resolution. With the view of preventing the temperature of the fluorescent surface from unduly rising, there has heretofore been proposed a picture tube fitted with a blower for supplying cooling air. With such apparatus, however, the blower used unavoidably became bulky, failing to attain the aforesaid object. Moreover, since the fluorescent surface could not be effectively cooled unless other unnecessary parts of said picture tube were first cooled, the apparatus as a whole had a low efficiency due to poor cooling effect.

SUMMARY OF THE INVENTION

The projection picture tube of the present invention comprises a vacuum tube, an anode support member received in said vessel, a fluorescent film coated on the upper surface of said member and an electron gun assembly for ejecting electron beams on said film. The support member consists of a hollow metal body through which there is allowed a cooling fluid to travel. A double pipe means is provided for circulating the cooling fluid. Since the fluorescent surface is unfailingly cooled even when it is impinged by considerably accelerated electron beams, it is saved from becoming unduly hot, thus enabling a picture of high intensity and resolution to be projected.

BRIEF EXPLANATION OF THE DRAWINGS

FIG. 1 is a schematic sectional view of the entire projection picture tube according to an embodiment of the present invention;

FIG. 2 is an enlarged sectional view of the cooling device of the picture tube of FIG. 1;

FIG. 3 is a perspective view, with part broken away, of a modification of the anode support member of FIG. 2;

FIG. 4 is a plan view of a color television fluorescent film coated on the upper surface of said anode support member of FIG. 3;

FIG. 5 is a sectional view of a projection picture tube according to another embodiment of the invention; and

FIG. 6 is a fractional enlarged perspective view, with part broken away, of the picture tube of FIG. 5.

DETAILED DESCRIPTION OF THE INVENTION

There will now be described by reference to FIGS. 1 and 2 a projection picture tube according to an embodiment of the present invention. Said projection tube includes an envelope made of transparent glass as indicated by the numeral 10. The envelope 10 comprises a cylindrical body 11, one end face of which constitutes a face plate 12 and a neck portion 13 disposed at a point at which the face plate 12 and side plane of the cylindrical body 11 intersect each other and outwardly extending at an angle of 45° with respect to the central axis of the cylindrical body 11. The envelope of the aforesaid arrangement is evacuated by the known method. In the neck portion 13 is disposed an electron gun assembly 14 concentrically therewith in a manner to face the cylindrical body 11 (said electron gun assembly may consist of an ordinary type and description and illustration thereof are omitted). In the cylindrical body 11 is positioned coaxially therewith the later described hollow anode disk member 15 made of nonmagnetic material such as stainless steel. That side of said disk member 15 which faces the aforesaid face plate 12 is entirely coated with a fluorescent film 17. This film 17 is formed of fluorescent material consisting of, for example, P_4(ZnS : Ag+(Zn, Cd)S : Ag). That portion of the upper surface of the fluorescent film 17 which is positioned on the left side from the center is impinged by electron beams ejected by the electron gun assembly 14 at an incidence angle of about 45° to produce fluorescent light corresponding to the picture. While it is not always necessary to coat said fluorescent film 17 with any extra material, it is preferred that there be vapor deposited a very thin aluminum film 16 on said fluorescent film 17 for keeping off ion spots.

At the back side of the disk member 15, namely, that side which is not coated with the fluorescent film, is positioned a mechanism 18 for cooling and rotating said disk member 15. Said mechanism 18 comprises a double tube 19 formed coaxially with the disk member 15 in a manner to protrude perpendicularly from the backside thereof, said double tube consisting of a feed pipe 20 disposed inside and a drain pipe 21 so positioned as to surround it. Said feed pipe 20 communicates with the center of the hollow interior of the disk member 15, and the drain pipe 21 communicates with the center of an assembly of three drain ducts 22 formed on the backside of the disk member 15 and radially extending from the center of said member 15 at an equal angle. The outermost end of the respective drain ducts 22 lies on the periphery of the hollow disk member 15 to allow a cooling fluid introduced into the feed pipe 20 to be conducted to the periphery from the center of said disk member 15 and then through said drain ducts 22 into the drain pipe 21.

The double tube 19 and consequently the disk member 15 are rotated about the central axis thereof by a drive device 23. Further, the disk member 15 is connected to the anode of an external power source (not shown). The drive device 23 comprises a cylindrical casing 25 penetrating the upper wall 24 of the envelope 11 and a seal metal 26 interposed between said casing 25 and upper wall 24 to effect their tight attachment. Into the hollow area of the casing 25 is inserted the aforesaid double tube 19 in a manner to rotate by ball bearings 27 and 28 and which is fixed in the axial direction by stop rings 29 and 30. The upper end face of the casing 25 is covered by means of packing 32 with a cap member 31 whose central portion projects outward so that a water chamber 33 is formed therebetween. The water chamber 33 is kept airtight by a shield ring 34 interposed between the double tube 19 and casing 25. The upper end of said water chamber 33 communicates with a water inlet pipe 35 penetrating the cap member 31.

In the center of the casing 25 is formed a drain chamber 36 which is kept airtight by a pair of shield rings 37 and 38 interposed between the casing 25 and double tube 19. With said drain chamber 36 communicates a drain outlet pipe 39 penetrating the casing 25. The upper end of the feed pipe 20 terminates with the water chamber 33 and that of the drain pipe 21 with the drain chamber 36. In the lower interior part of the casing 25 is formed a rotary blade chamber 40, which is kept airtight by a pair of bushes 41 and 42 and a pair of shield rings 43 and 44 interposed between the inner wall of the casing 25 and the outer wall of the double tube 19. Said chamber 40 contains a plurality of rotary blades 45 radially projecting from the sidewall of the double tube 19. With said rotary blade chamber 40 communicate air inlet and outlet pipes 46 and 47 which are fixed to the upper wall 24 of the envelope 11 and

casing 25 in a manner to penetrate them. These inlet and outlet pipes 46 and 47 are connected to a blower (not shown) and particularly the inlet pipe 46 is connected thereto through a pressure adjuster (not shown). The fitting of both pipes 46 and 47 to the upper wall 24 of the envelope 11 is effected by seal metals 48 and 49 respectively.

Outside of the envelope 11 at a point opposite to the faceplate 12 is positioned an ordinary optical system, for example, a Schlieren optical system 50. Further, outside of said optical system 50 is provided a screen 51.

With the projection picture tube of the present invention having the aforementioned arrangement, the fluorescent film is scanned by electron beams ejected by the electron gun assembly which contain prescribed signals, such as television signals so as to produce an image corresponding to said signals, which is projected on the screen after being compensated and enlarged by said optical system. During the electron beam scanning, there is introduced through the double tube a cooling fluid, for example, water into the hollow disk member 15 to cool the fluorescent film, and the disk member 15 itself is rotated by said drive device 23.

The rotation of the disk member adopted in the aforesaid embodiment of the present invention is intended to prevent electron beams from being concentrated on one part of the fluorescent film and allow the cooling fluid introduced through the feed pipe to be uniformly distributed over the inner surface of the hollow disk member.

According to said embodiment, the hollow disk member contains nothing. For effective utilization of the cooling medium, however, it is advisable to provide the arrangement shown in FIG. 3. Namely, in the hollow interior of the disk member 15 there is formed a spiral partition wall 15*a* to form a spiral feed passage 15*b*. The center of said passage 15*b* agrees with that of the disk member, with which there communicates the feed pipe 20 of the double tube 19. To the periphery of the feed passage 15*b* are open the ends on one side of the three drain ducts 22, and the ends on the other side thereof communicate with the drain pipe 21. The numerals 16 and 17 represent the aluminum film and fluorescent film respectively.

In the foregoing embodiment, the fluorescent film fitted to the rotary disk consisted of one kind (or a monochromatic type) of fluorescent material. However, if said film is prepared from the later described fluorescent materials of three colors, it can be used in a color television projection picture tube. The fluorescent film is divided into six sections 17*a* of the same area separated from each other by a partition band 17*b* as indicated by the numeral 17 of FIG. 4. Said six sections are formed, as indicated, into two groups, each of which comprises three sections prepared from fluorescent materials producing blue, red and green colors and arranged in the order mentioned. Said sections 17*a* may be formed in various shapes or by different processes. However, preferable is the following process, for example. Namely, on the upper surface of the rotary disk member (on which there is to be formed a fluorescent film 17, though not shown) there is formed by the ordinary selective etching process six depressed segments separated by six protruding bands. These protruding bands extend substantially radially from the center of the rotary disk member at an equal angle, and include second and third portions which are bent at angles of 30° and 50° respectively opposite to the rotating direction of the disk member indicated by the arrow. The second portion accounts for 15 percent and the third portion 30 percent of the entire length of each band. It is generally preferred that the depressed segment be 0.05 to 0.08 mm. deep, the surface roughness be of the order of 2 to 5 microns and the protruding band be 0.3 to 0.5 mm. wide. If the angular portion defined by the sidewall of the protruding band and the top plane of the depressed segment which intersect each other is previously designed to form a curved plane having a curvature corresponding to the meniscus or crescent shape appearing on the edge of a fluorescent film deposited on said segment by ordinary means, then the upper surface of the film will become completely flush with that of the protruding band. The disk member preferably consists of a nonmagnetic metal material having a magnetic permeability of less than 1.005 microns, for example, stainless steel of the Cr16–Ni14 type. On the entire upper surface of the disk member is first coated by the precipitation process a fluorescent material of one color, for example, red. Thereafter only those portions of said material which will later constitute the red color sections of the fluorescent film are exposed to light for baking and all the other portions are washed off. The same operation is conducted with respect to the other blue and green sections of the fluorescent film, obtaining the three-color fluorescent plane shown in FIG. 4.

A picture tube using a fluorescent film thus prepared is operated, for example, in the following manner. To a device for rotating the disk member (said device consists of an air motor in the aforesaid embodiment) is connected a 144 c/s power source exactly synchronizing with the vertical synchronizing pulse of an image signal. The disk member is rotated 1,440 times per minute and the fluorescent plane is scanned by electron beams at the rate of 144 fields per second, obtaining a color television picture.

There will now be described another embodiment of the present invention. The same parts of this embodiment as those of the preceding one are denoted by the same numerals and description thereof is omitted.

To the top wall of the cylindrical envelope 11 consisting of a glass envelope or bulb 10 are fitted by means of seal metals a feed pipe 20 and drain pipe 21 in a manner to penetrate said wall. The ends of the feed pipe 20 and drain pipe 21 are connected to the back side of the disk member at a prescribed spacing from each other and a cooling fluid introduced through the feed pipe 20 is discharged from the drain pipe 21 through the disk member 15. On that plane of the disk member 15 which is opposite to its surface or faceplate 12 are superposed a fluorescent film 17 and aluminum film 16 in turn. Further in the bulb 10 is provided a means 52 for detecting the temperature of the fluorescent film 17. Said means 52 comprises a thermoelectric converting element 53 fitted to the circumferential wall of the disk member 15, which is made of thermocouple material, for example, alumel-chromel material used in determining temperatures of from zero to about 1,200° C. To said thermoelectric converting element 53 are connected two detecting lead lines 54 and 55 consisting of positive pole copper and negative pole copper alloy which are drawn out of the bulb 10 to the outside through a seal metal 56. If the temperature of the fluorescent film is continuously detected by said temperature detecting means 52 and the amount and temperature of a coolant introduced into the disk member 15 are adjusted according to said detected temperature of the fluorescent film 17, then said film will always be able to display a constant intensity. Also at a prescribed point in the bulb 10 is positioned an electron gun assembly 14 for impinging electron beams on the fluorescent film 17 at a prescribed angle of incidence. Outside of the body 11 are disposed a Schmidt lens 50 and screen 51 in a manner to face the faceplate 12 of said bulb 10.

There will be described particularly by reference to FIG. 6 the method of manufacturing the hollow disk member 15 and fluorescent film 17.

The hollow disk member 15 consists of stainless steel of the Cr16–Ni14 type having a magnetic permeability of less then 1.005 microns. The stainless steel plates used have a thickness of 1 to 1.5 mm., and are welded together in a manner to prevent any leak in preparing a hollow disk member having a thickness of about 5 mm. On one side of the disk member 15 are vertically set up two ducts 20 and 21 similarly made of stainless steel which are fixed in a prescribed position by brazing material. That part of said ducts 20 and 21 which penetrates the top wall 24 of the bulb 10 is preferably surrounded by a suitable seal metal according to the material of said bulb 10. On the other side of the disk member 15 is deposited a fluorescent film 17 by any of the known processes, i.e. precipitation, spraying electrodeposition, floating centrifugal separation.

The hollow disk member thus prepared is sealed in that part of the envelope **10** which is cut off at a position indicated by a dot-dash line of FIG. **5** in a manner illustrated in FIG. **6**. Namely, the disk member **15** is enclosed airtight in the bulb **10** by melting the seal metal of the ducts **20** and **21** to the top wall of said cutoff part of the bulb **10**. After the disk member is thus sealed, the assembly is placed in an annealing furnace to eliminate any deformation and the cutoff parts of the top and bottom walls of the bulb **10** are respectively fused together by a burner. After the electron gun assembly **14** is sealed in the neck portion of the bulb **10**, the whole of it is evacuated.

If, in each of the aforementioned embodiments, the seal metal consists of SNC material or Sylvania No. **4** material where the bulb **10** is made of soft glass, and KOV (29 percent Ni and 17 percent Co) in case of hard glass and said seal metal is heat treated to form an oxide film thereof, then there will be obtained a better effect of sealing.

As mentioned above, the present invention allows a cooling fluid, for example, cold water to be supplied to the hollow disk member through the feed pipe to cool said disk member and in consequence the fluorescent film. Accordingly, even when electron beams ejected from the electron gun assembly are accelerated with high voltage, the fluorescent film will not have an elevated temperature, thus enabling the resultant picture tube to display high intensity and resolving power.

The foregoing embodiments involved such type of electron gun device as ejecting only one flux of electron beams. But there may be used two electron gun members to eject two fluxes of electron beams to obtain two images by scanning different parts of the fluorescent film or one composite image by scanning the same part thereof at the same time.

We claim:

1. A projection picture tube comprising:

an evacuated envelope having a transparent faceplate;

a hollow metal anode plate member disposed in the envelope;

a fluorescent film coated on one side of the hollow metal anode plate member which faces the faceplate;

a double pipe means for circulating cooling fluid into the hollow metal anode plate member extending from the other side of the hollow metal anode plate member, said double pipe means being rotatably and airtightly mounted at least partially within a casing extending through said evacuated envelope and including a coaxially arranged drain pipe and feed pipe coupling said cooling fluid into the hollow metal anode plate member;

drive means for rotating said hollow metal anode plate member about its central axis, said drive means including a fluid driven motor having a plurality of rotary blades projecting substantially radially from the outer wall of the double pipe means and a blast pipe for supplying propulsive fluid to the rotary blades;

an electron gun assembly disposed in the envelope for ejecting electron beams on the fluorescent film; and

an optical system for enlarging the image produced on the fluorescent film by electron beams.

2. The tube according to claim **1** wherein said feed pipe is the inner of said coaxial pipes and said drain pipe is the outer of said coaxially arranged pipes.

3. The tube according to claim **1** wherein the anode plate member includes a disk member having a spiral passage therein for allowing the cooling fluid to flow in eddy currents.

4. The tube according to claim **3** comprising a drain duct coupling the spiral passage to said drain pipe.

5. The tube according to claim **1** wherein the upper surface of the fluorescent film which is impinged by electron beams is coated with an aluminum film.

6. The tube according to claim **1** wherein said fluorescent film is a color fluorescent film.

7. The tube according to claim **6** wherein the fluorescent film is divided into six sections of equal area separated by partition bands extending substantially radially at equal angles from the center of said film, and said six sections being formed into two groups, each group comprising three sections prepared from fluorescent materials projecting blue, red and green light beams and arranged in the order mentioned.