Feb. 24, 1970 H. BOEING 3,497,745

ALIGNMENT MAGNET FOR CATHODE-RAY TUBE

Filed Feb. 20, 1967

FIG. 1

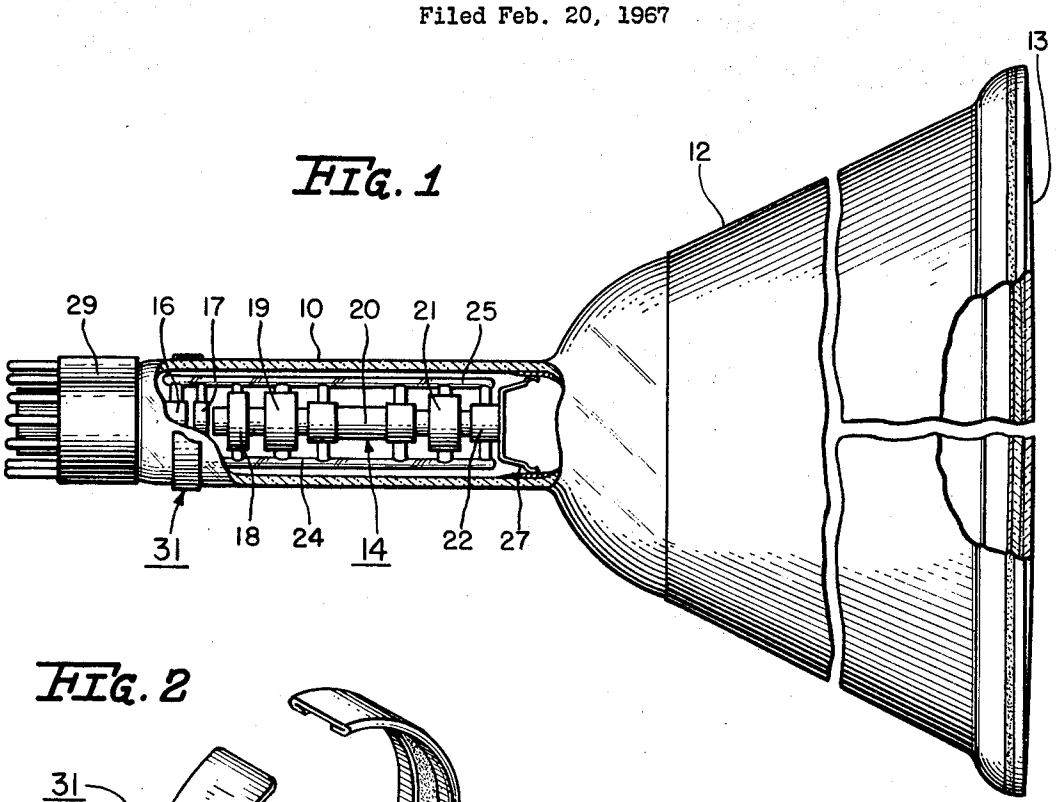
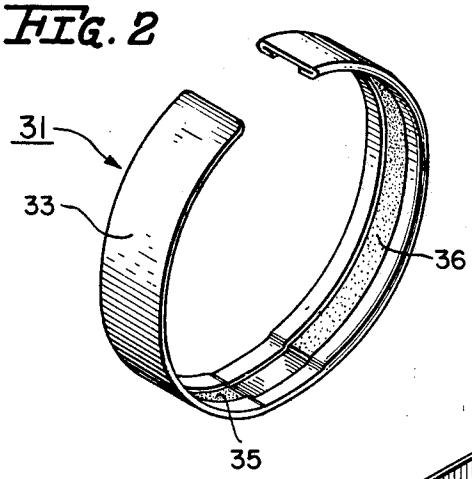


FIG. 2



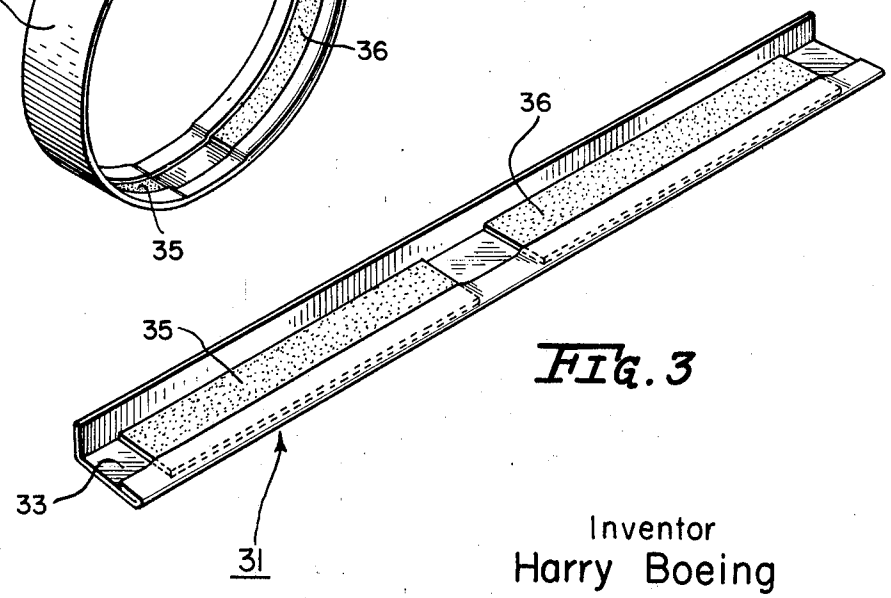


FIG. 3

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ALIGNMENT MAGNET FOR CATHODE-RAY TUBE

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ABSTRACT OF THE DISCLOSURE

A structure and method of compensating for misalignment of certain centrally apertured electrodes of an electron gun assembly of a cathode ray tube are disclosed. A thin ferromagnetic strip, readily conformable to the tube neck contour, is premagnetized along its longitudinal axis to a field strength appropriate to compensate for the misalignment and is held in proper position on the tube neck, with the magnetic field transverse to the direction of electron beam propagation, by retaining means. The strip and retaining means are sufficiently thin to avoid interference with installation or removal of other neck mounted elements.

BACKGROUND OF THE INVENTION

The present invention relates to cathode ray tubes and, more particularly, to an improved permanent magnet assembly and method of compensating for inadvertent misalignment of certain electrodes of the electron gun structure of a cathode ray tube.

In general, a cathode ray tube comprises a glass envelope having a narrowed cylindrical neck portion which is flared outwardly at one end to meet a transverse faceplate on which is formed the image screen for the tube. An electron gun structure is housed within the cylindrical tube neck and its function is, of course, to develop randomly directed electrons into a narrow and well defined beam and to project this beam toward the image screen. To this end, it is necessary that the several centrally apertured electrodes constituting the electron gun structure be coaxially aligned and great care is taken during manufacture in an effort to insure that such is the case. Unfortunately, there is often a slight misalignment between certain of the electrodes, especially those electrodes having extremely small central apertures. This condition results in part of the electron beam being intercepted by one or more of the grid structures, rather than entirely passing through the central apertures, and as a consequence, the electron spot formed on the screen suffers an astigmatic distortion.

It is known in the prior art to correct or compensate for such misalignment by use of a steady state magnetic field created either by an electric current or a permanent magnet arrangement. The use of an electrically created magnetic field, as by a DC current in the deflection coils, is inconvenient as it requires an adjustable DC current source and also interferes with proper operation of the deflection system. As to prmanent magnets, the prior art has heretofore proposed rather cumbersome constructions which are adjustable in field strength and are slidably positionable on the tube neck so that both position and filsd strength may be accommodated to the vagaries of the individual tube.

The latter type assemblies indeed function satisfactorily, however, cathode day tubes are usually sold absent the beam deflection yoke and other apparatus which is also slidably received on the tube neck forward of the aligning magnet; accordingly, factory location and adjustment of the magnet assembly are futile. Furthermore, even if the tube is sold as part of the complete

electrical unit, jarring of the unit may disturb this alignment and after each repair or replacement of a neck mounted element the alignment procedure must be repeated. The alignment procedure is not only an inconvenience to the consumer, but often he lacks the requisite skill and apparatus for making an optimum correction.

It is therefore an object of the present invention to provide a new and improved permanent magnet assembly to compensate for electrode misalignment which assembly overcomes the aforenoted disadvantages of the prior art.

It is a further object of the invention to provide such an assembly which suitably compensates the alignment deficiencies of different tubes but yet does not interfere with installation or removal of other apparatus from the neck of the cathode ray tube.

It is yet another object of the present invention to provide a new and improved method of compensating for misalignment of electrodes of an electron gun structure which method is readily accomplished at the factory and need never be repeated by the consumer.

SUMMARY OF THE INVENTION

Accordingly, the invention relates to a cathode ray tube having an image screen and having a neck portion housing an electron gun assembly, constituting a series of apertured electrodes, which develops and projects an electron beam onto the image screen. Specifically, the invention is directed to an improved permanent magnet assembly which corrects for misalignment of the apertured electrodes. This assembly comprises a thin strip of ferromagnetic material of a type readily conformable to the contour of the tube neck and premagnetized to a predetermined field strength. Retaining means are provided for fixedly locating the ferromagnetic strip at a predetermined axial and rotational position on the neck portion. The retaining means and ferromagnetic strip together do not substantially add to the outer diameter of the neck portion or interfere with installation or removal of other elements therefrom.

A further aspect of the invention is directed to a method of compensating for electrode misalignment. Specifically, a test signal is applied to a tube and a variable strength magnet located about the tube neck and adjusted positionally and in magnetic field strength to optimize resolution of the test pattern on the image screen. The adjustable magnet is removed and the field strength measured and a comparable magnetic field strength imparted to a thin strip of ferromagnetic material. The ferromagnetic strip is then permanently affixed to the neck portion in close conformity thereto and at the optimum resolution position.

BRIEF DESCRIPTION OF THE DRAWING

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing, in the several figures of which like reference numerals identify like elements, and in which:

FIGURE 1 is a side view, partly in section, of a cathode ray tube embodying the present invention;

FIGURE 2 is a perspective view of the permanent magnet band assembly shown in FIGURE 1; and

FIGURE 3 is a perspective view of the band of FIGURE 2 shown during one stage of its construction.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIGURE 1, the cathode ray tube there shown comprises an evacuated envelope having a neck portion **10**, a flared conical or funnel-like portion **12** and a round faceplate **13**, which bears a viewing or image screen on its interior surface. The image screen comprises a layer of phosphor having a smooth aluminum backing layer which reflects light outwardly to increase brightness of the image in a manner well-known in the art. A gun structure **14**, which in this case consists of a single electron gun, is located in the neck of the tube and is oriented to project a beam of electrons along a predetermined path toward viewing screen **13**. As is well understood in the art, the projected electron beam is made to scan the image screen in a predetermined pattern by a deflection system including a neck mounted magnetic deflection yoke (not shown).

The cathode ray tube here illustrated is of a high resolution type useful, for example, as a radar display device. Accordingly, neck portion **10** is relatively long to accommodate the unusually long and complex gun structure required by such a tube and funnel **12** is likewise of exceptional length due to the relatively limited deflection angle of this tube. Since the tube is specifically designed for high resolution, slight misalignments of gun electrodes are often limiting factors on resolution and must be properly compensated. The consumer is neither favorably disposed to aligning the tube, nor can it be done without some expertise and equipment. For example, a test signal generator as well as some mirror arrangement for observing the image screen while making adjustments to neck mounted compensating means are required in the present case.

The electron gun assembly includes a cathode (not shown), a modulating or control electrode **16**, an accelerating electrode **17** and a first anode **18**. Electrode **18** is followed by a series of four other electrodes respectively a first focus electrode **19**, a second anode **20**, a second focus electrode **21** and a third anode **22**. The individual gun elements are held in a fixed spatial relation relative to one another by individual mounting tabs which extend from opposite sides of each electrode and are secured in glass pillars **24** and **25**. The resultant unitary structure is centered in neck **10** by means of snubber springs **27** which are welded to the flange end of final electrode **22**. Springs **27** also establish a conductive connection between electrode **22** and the screen by contacting an internal conductive coating which is formed on the interior of funnel **12**. The various electrodes of the gun structure receive appropriate operating potentials from several lead pins which extend from an end cap **29** of the tube. The electrical potentials applied to the elements of the electron gun structure for proper operation as well as the theory of operation are well understood in the art and need not be discussed here.

As previously stated, an inadvertent misalignment of certain of the electrodes of the gun structure may unreasonably deteriorate image resolution. The source of misalignment of the gun is not significant to its correction but usually is assignable to failings in construction of the gun assembly, installation of the gun in the tube envelope, or to the effects of temperature cycling of the tube in final bake-out or other processing procedures. At any rate, compensation is afforded, in accordance with the invention, by provision of a thin strip of ferromagnetic material of a type which is readily conformable to the neck contour and is premagnetized along its longitudinal axis to a field strength appropriate to shift the electron beam the desired amount. The manner of ascertaining the proper field strength will be considered in detail later herein. Retaining means are provided for fixedly locating the ferromagnetic strip at a predetermined axial and rotational position on the tube neck to correct the misalignment.

In the illustrated and preferred embodiment, a band **31** carries a pair of magnetic strips premagnetized along their respective longitudinal axes to an appropriate field strength. The magnets are oriented in the band in an aiding relation, relative to one another, i.e., N–S, N–S. Band **31** is conformed to the tube neck with the magnets transverse to the direction of electron beam propagation and is permanently fixed in position by means of an epoxy resin or similar bonding agent. It is apparent from FIGURE 1 that band **31** does not materially increase the outer diameter of the tube neck nor, unlike prior art alignment structures, is it of physical dimensions to interfere with installation or removal of other elements from the tube neck. Furthermore, since the band is permanently positioned during the manufacturing procedure, the consumer is never faced with the alignment problem.

A clearer illustration of band **31** is provided in FIGURES 2 and 3. As shown, it comprises a brass sleeve **33** which is of a sufficient length to fully encompass the cylindrical neck of the cathode ray tube. Sleeve **33** is of a non-ferromagnetic material which is both malleable and ductile in a high degree to permit ease in handling and forming. The sleeve material must also possess a relatively high strength and ruggedness in the form of a relatively thin strip. It has been found that brass shim stock of three one-thousandths inch thickness satisfactorily meets the above requirements.

Sleeve **33** carries a pair of rectangular strips of ferromagnetic material **35** and **36**, which like the sleeve member, must be quite thin and readily conformable to the neck contour. The ferromagnetic sections **35** and **36** are similar in all respects and are physically spaced in the sleeve so as to create equal gaps between their opposed end portions. The use of two separate magnets, rather than a single magnet, has been found to provide a more uniform magnetic deflection field. It is further required that ferromagnetic strips **35** and **36** readily accept a magnetic field strength of from 1 to 10 gauss, as variously required to effect beam compensation, and retain the induced field strength over a very extended period of time. It has been found that a cobalt-iron alloy containing 3½% vanadium, 48½% colbalt, 1% miscellaneous elements and the remainder iron and which is available from the Westinghouse Corporation under the tradename "Remendur" is entirely satisfactory for the present application. In the preferred embodiment, ferromagnetic strips **35** and **36** are both composed of this material and are approximately 1¾ inches long ⅜ inch wide and four one-thousandths inch thick. Thus, band **31** is of a total thickness of one-hundredth inch which clearly does not interfere with locating of other neck mounted elements.

It is understood that the compensation required by different cathode ray tubes varies depending upon the character and extent of electrode misalignment. It is for this reason that the prior art has employed the more cumbersome magnet assemblies previously described. In accordance with the structure and method of the present invention such cumbersome assemblies are avoided while the necessary individual compensation is still provided. Specifically, the method of the invention contemplates applying a predetermined test signal to a fully assembled cathode ray tube which has also been found otherwise in compliance with specifications. Preferably, the test signal is delivered by a pulse source which provides a regular dot pattern on the image screen.

In the absence of misalignment, each dot is crisp and well defined while misalignment is readily visible to a trained technician by the presence of dots which are somewhat smeared. If misalignment is evident from viewing the test pattern, an adjustable magnet assembly, such as any of those known to the prior art, is placed about the tube neck and is physically positioned and adjusted

to a magnetic field strength appropriate to optimize resolution of the dots of the test pattern. The techniques for readily esablishing the correct position and magnetic field strength are generally understood in the art. When this has been accomplished, the physical position of the assembly is noted and it is removed from the tube neck and the magnetic field strength thereof is measured by a gauss meter.

A permanent magnetic field strength of the measured value is then imparted to ferromagnetic strips **35** and **36** by any suitable method known to the art. For instance, this may be done by passing a permanent magnet of relatively high strength over the ferromagnetic strips in the same direction on each of several passes. The band assembly **31** is then positioned on the tube neck at the desired point for providing optimum correction. This is empirically determined but is usually quite close to the physical position determined for the adjustable magnetic assembly. Once located the band is temporarily retained in position by a removable restraining strap or cinch (not shown). An epoxy resin or similar chemical bonding agent which is initially in a fluid state is injected beneath the band about its peripheral portion. The temporary restraining cinch is, of course, removed after the epoxy resin has set.

While particular embodiments of the invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects, and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim:

1. In a cathode-ray tube having an image screen and having a neck portion housing an electron gun assembly constituting a series of apertured electrodes for developing and projecting an electron beam onto said image screen, an improved permanent magnet assembly compensating for misalignment of said apertured electrodes comprising:

a thin narrow strip of ferromagnetic material of a type readily conformable along its longitudinal axis to the contour of said tube neck portion and premagnetized along said longitudinal axis to a predetermined field strength;

and retaining means for fixing said ferromagnetic strip at a predetermined axial position along said neck portion about the outer circumference of said portion comprising a thin sleeve member for carrying said strip conformably to the circumference of said neck and orienting said strip with said longitudinal axis substantially transverse to the axis of said neck portion so that its magnetic field is transverse to the direction of electron beam propagation, said sleeve member further being formed closely about said thin strip to thereby exhibit a thinness of cross-section small in relation to the outer diameter of said neck portion, so as not to substantially add to the outer diameter of said neck portion or interfere with installation or removal of other elements therefrom.

2. The combination according to claim **1**, which further includes a second ferromagnetic strip similar to said first strip, in which said thin sleeve member is formed closely about both said thin strips and carries both strips conformably to the circumference of said neck portion, and in which said sleeve fixedly maintains said strips in predetermined spaced relationship with their said longitudinal axes substantially in circumferential alignment and in end-to-end series orientation with aiding polarity, said strips being of a combined length substantially equal to the circumference of said neck portion.

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U.S. Cl. X.R.

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