Nov. 11, 1958 D. C. LANGWORTHY 2,860,328

SHIELD FOR CATHODE RAY TUBES AND PROCESS OF MAKING THE SAME

Filed Nov. 18, 1953

2 Sheets-Sheet 1

FIG. 1.

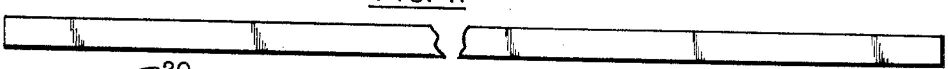


FIG. 2.

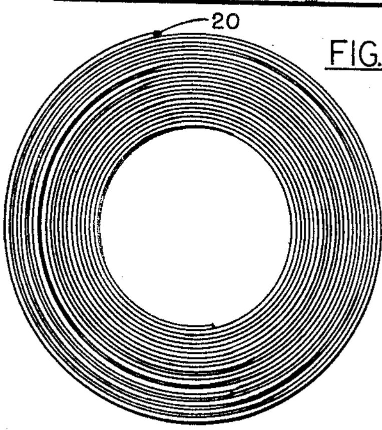


FIG. 3.

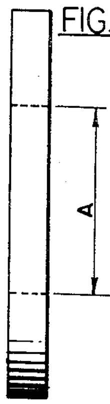


FIG. 4.

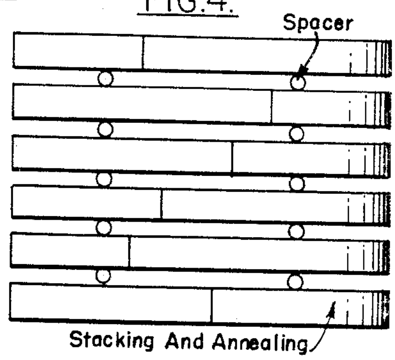


FIG. 5.

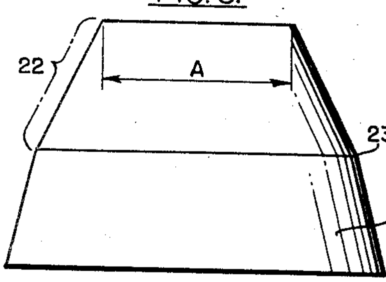


FIG. 6.

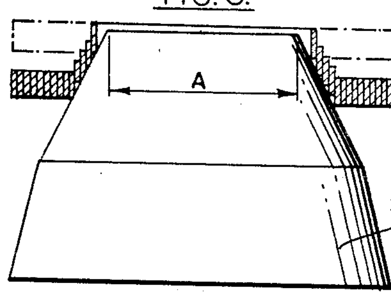


FIG. 7.

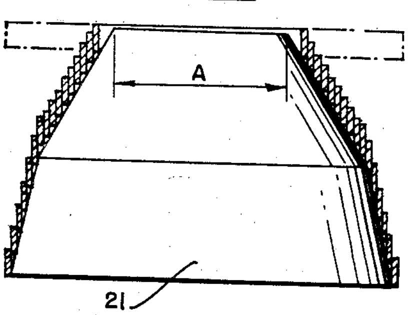
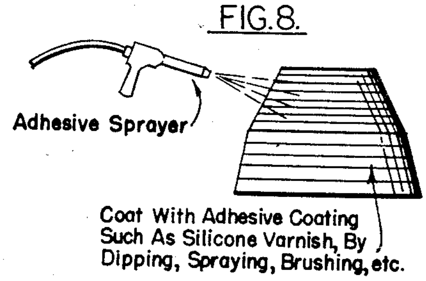


FIG. 8.



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2 Sheets-Sheet 2

FIG. 9.

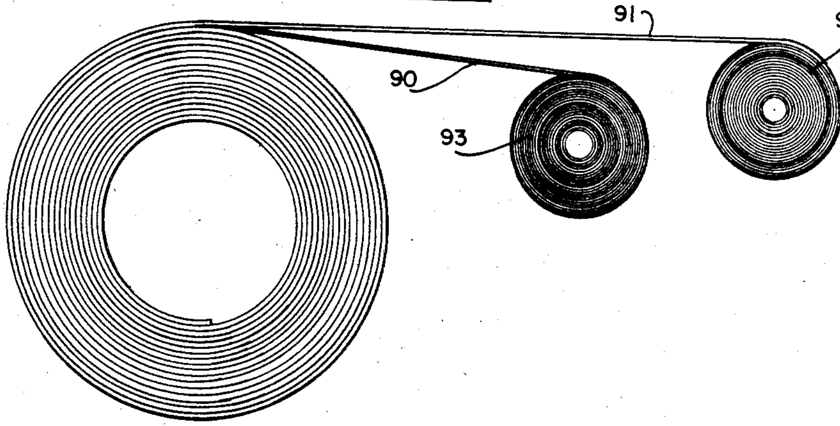


FIG. 10.

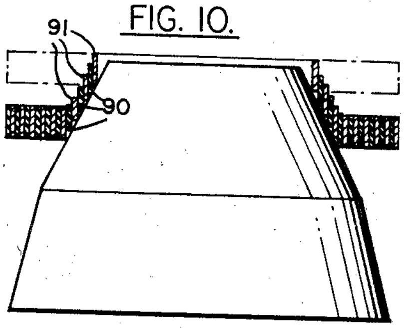


FIG. 11.

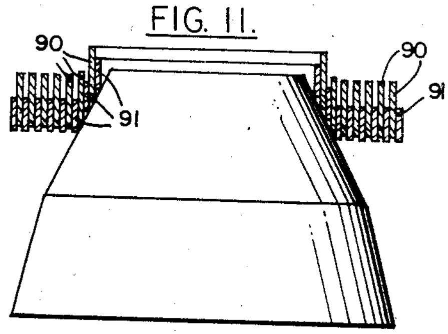


FIG. 12.

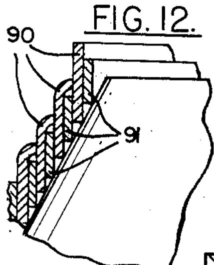


FIG. 13.

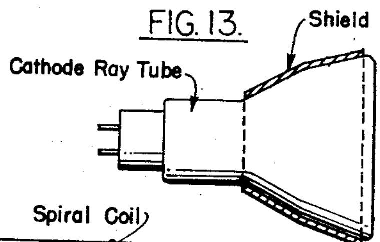
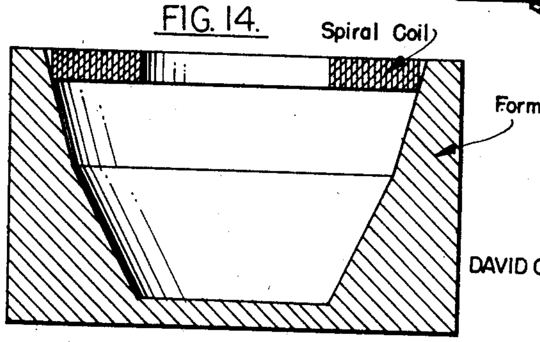


FIG. 14.



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SHIELD FOR CATHODE RAY TUBES AND PROCESS OF MAKING THE SAME

David C. Langworthy, Narberth, Pa., assignor to Magnetic Metals Company, a corporation of New Jersey

Application November 18, 1953, Serial No. 392,925

22 Claims. (Cl. 340—367)

This invention relates to shields and more particularly to shields for cathode ray tubes. It also relates to processes for making shields.

Heretofore shields for cathode ray tubes have been necessary in some situations in order to prevent weak stray magnetic fields from deflecting the beam. These stray fields often include the earth's magnetic field, direct current fields, fields varying at sixty or one hundred twenty cycles, and higher frequency fields. Such shields have been made of expensive nickel-iron alloys which must be spun or otherwise fabricated into the proper shape. In making such a shield there is often about 40% waste because of the shape of the shield. Since, the material is very expensive this waste is very serious. It would be possible to use lower cost silicon-iron alloys, except that they are very brittle and therefore hard to fabricate. One object of this invention is to provide a shield of silicon-iron alloy and a process of making the same which is effective yet inexpensive.

Another object of the invention is to provide an improved shield for cathode ray tubes.

Still another object of the invention is to provide a shield in which the effectiveness of the shield may be improved at critical areas.

Yet another object of the invention is to provide, in a single shield, two different shielding materials that give two different desired effects.

It is also an object of the invention to provide a process of manufacturing shields in which the space in the furnace required for annealing is reduced.

A further object of the invention is to provide a shield that, when made of any well known magnetic material, has lower cost than conventional shields made of the same magnetic material, whatever that may be.

The preferred way of making my improved shield is briefly as follows. A strip of high silicon steel (2 to 5 percent silicon) which is preferably wider than one-fourth inch and preferably between 0.002 and 0.020 inch thick is wound in the form of a spiral coil. Preferred dimensions for the strip are given later in this specification, and it is understood that the broader claims are not limited in the matter of dimensions. The final shield will have a shape generally the same as the frustum of a cone. The inside diameter of the spiral coil will be about the same as the diameter of the smaller end of the frustum and the outside diameter of the spiral coil will be about the same as the diameter of the larger end of said frustum. A form having the shape of the shield to be fabricated is employed. The hole in the spiral coil is placed around the small end of the form. The turns of the spiral coil are one after another pressed downwardly parallel to the axis of the coil (as well as parallel to the axis of the form) until the turns touch the form. This procedure is followed starting with the inner turns of the coil and continuing outward until finally all of the turns have been pressed into contact with the form. There results a helical coil the turns of which overlap and become of larger and

larger diameter. Then an adhesive is applied to secure all of the turns together and to form a self-contained self-supporting shield. There are a number of additional features and details which are hereinafter described in more detail and claimed.

In the drawings:

Figure 1 is a strip of magnetic material suitable for use in this process.

Figure 2 illustrates the second step in the process, namely a spiral coil produced by winding the strip of Figure 1.

Figure 3 is an end view of the coil of Figure 2.

Figure 4 illustrates the next step in the process, which is stacking a plurality of coils like those of Figure 1 and annealing them.

Figure 5 illustrates a form on which the shield may be shaped.

Figure 6 illustrates how the spiral coil is fitted onto the form of Figure 5.

Figure 7 illustrates the spiral coil after it has been fully formed on the form of Figure 5.

Figure 8 illustrates the next step of the process, namely applying adhesive to the formed spiral coil.

Figure 9 illustrates apparatus for making a spiral coil using two strips of material.

Figure 10 illustrates a modified form of shield produced with the aid of the apparatus of Figure 9 and having layers of paper between layers of the magnetic material.

Figure 11 shows a modified shield in which wide copper strips are between adjacent turns of the magnetic material.

Figure 12 shows another modified shield in which the upper edges of the copper are spun together.

Figure 13 shows a cathode ray tube with my improved shield thereon.

Figure 14 is a cross-section of a modified type of form which may replace the form of Figure 5.

In Figure 1 there is shown a strip of high silicon steel (preferably having 3 to 4 percent silicon) of a thickness of preferably 0.012 inch and a width of preferably 5/16 inch. This strip is then wound in a spiral coil as shown in Figure 2. The outer turn is welded or otherwise fastened to the next turn at point **20** adjacent the free end of the spiral. The spiral coil is then stacked along with other similar coils like pancakes as shown in Figure 4, and annealed at a suitable temperature (for example 1250 to 1500 degrees F. in the case of silicon steel) in a suitable medium. However, the annealing may be omitted when a thin strip of annealed material is employed at the start of the process. One advantage of this process is that the space required during the annealing operation is reduced since the material is in a compact coiled form during the annealing step.

A form **21** of rigid solid material as shown in Figure 5 has the shape of that part of the cathode ray tube which is to be shielded. The annealed spiral coils have an opening A which fits snugly onto the small end of the form, as shown in dotted lines in Figure 6. The spiral coil is then pressed downwardly as shown in Figure 6 to lower and lower levels until finally the strip takes the shape of a helix, the turns of which have progressively increasing diameter. The innermost turns are pressed downwardly at first and then the larger and larger turns are pressed down until finally they all have been so pressed as shown in Figure 7. The helix accurately fits over the outside of the form. Finally, the helical coil is coated with a penetrating adhesive such as silicone varnish by dipping, spraying, brushing, etc., all as shown in Figure 8. The form **21** is then removed from the shield and a self-supporting self-contained shield for the cathode ray tube results.

In a cathode ray tube, a given stray field will cause a given angular deflection of the beam. Obviously, therefore, stray fields near the electron gun will cause a greater deflection of the spot (on the face of the screen) than stray fields near the face of the tube. It is, therefore, desirable to have greater shielding near the neck of the tube than near the face. One advantage of the new shield is that the strip (which forms the helix) may have a greater overlap on the neck portion **22** of the tube than below the bend **23**.

This is possible with this process since the overlaps of the turns increase when the angle between the side wall of the form and the axis of spiral coil increases.

Most silicon alloys have better magnetic properties in thin than in thicker gauges. This is true since rolling of the silicon alloy improves the grain orientation and thus improves the magnetic properties. Therefore, several layers of thin silicon material form a much better shield than a single sheet having the same overall thickness. Consequently, the shield produced by the above process has a greater shielding effect than a solid piece of the same configuration.

It would be expensive to produce silicon shields of the desired configuration due to the extreme brittleness of the material. Even if it were commercially practical to produce such shields, it would be necessary to anneal them after any machining of the same in order to restore the desired magnetic properties to the shield. In carrying out such an anneal the space required in the annealing furnace would be much greater than in the case of this invention.

The strip of Figure 1 was slit in the direction of the grain of the material, hence all transverse fields that intersect the shield do so in a with-grain direction. Therefore, maximum shielding results. Explaining this in more detail it might be said that the permeability is greatest in the direction of the grain. Harmful magnetic fields are transverse to the cathode ray tube and are best diverted from the tube itself when the grain orientation is longitudinal of the strip.

It is understood that the drawings are for purposes of illustration only since it is impractical to make drawings in proper proportions and still follow conventional Patent Office drafting practices. In actual devices the strip is much thinner and some narrower, in proportion to the size of the form, than is shown. In actual devices built according to the invention there is much more overlap than is shown in the drawing. In one typical coil built according to the invention, the strip was 0.004 inch thick and was 7⁄16 inch wide and on the part **22** of the tube above bend **23** the overlap was about 6⁄16 inch, meaning that each turn of the coil was displaced about 1⁄16 inch below the previous one. The coil was over six inches in diameter at its small end (dimension A of Figures 3 and 5) and about fifteen inches in diameter at its large end. It is apparent that the length of strip forming the smallest turn was about twenty inches. A lateral displacement of 1⁄16 inch where the strip is twenty inches long is insufficient to counteract or impair the effect of the annealing step. Moreover, it is obvious that the shield was about six layers thick at the small end of the tube and about four layers thick at the large end.

Figures 9 and 10 illustrate a modified form of the invention in which a layer of paper **90** is fed into the spiral coil between layers of the silicon steel **91**. Two rolls, one, **93** of paper, and one **92**, of silicon steel strip are employed as shown. The process is otherwise the same as stated in connection with Figures 1 to 8. When the annealing step is omitted, ordinary paper may be used but when the material is annealed a special grade of paper (such as asbestos paper) should be used. The final product, therefore, has layers of paper between adjacent turns of the helical silicon steel strip. One advantage of using the paper is that the silicon steel strip **91** may be somewhat wider without actually requiring an increase in the weight of silicon steel used. The wider strip effects a sturdier construction. Moreover, the magnetic properties of the shield are improved since the shield is composed of spaced magnetic strips. It has been found that the shielding is improved when the shield is composed of spaced parallel sheets or strips as in the case of Figure 10.

When the cathode ray tube is liable to be used in either a weak field or a strong one, it has been considered desirable to employ a combination of two different shields. For example, molybdenum Permalloy is a desirable shielding material for very weak fields and silicon steel is a desirable shielding material for stronger fields. In order to effectively shield the tube against penetration of either of these fields, the two rolls **92** and **93** of Figure 9 could respectively feed silicon steel strip **91** and molybdenum Permalloy strip **90** into the spiral coil of Figure 9. Otherwise, the process is the same as described in connection with Figures 1 to 10 and results in a shield in which alternate layers are of the two different materials, and respectively primarily shield against the two aforesaid types of fields. The final shield would be the same as that of Figures 7 and 8 so far as external appearance is concerned.

From the foregoing it is apparent that the present invention may achieve in one shield what previously required two.

If a shield is constructed according to the teachings of Figures 1 to 8 inclusive, it will have high shielding efficiency only at low frequencies. If it is desired to extend the frequency range to the higher audio and to radio frequencies, alternate layers of copper and silicon steel may be used. Referring again to Figure 9, a coil of strip silicon steel **92** would be employed. Preferably in this case the copper strip **90** is wider than the strip **91** and results in a construction shown in Figure 11. The upper ends of the copper strips **90** may if desired be brought together in conducting relationship in any suitable manner such as by spinning the shield and thus forcing adjacent upstanding free ends into contact as shown in Figure 12. Hence, there is a layer of good conducting material outside of the magnetic shield.

While silicon steel is hard to form to a conical shape there are other materials which may be spun or otherwise formed to the proper shape. However, those which give effective shielding are very expensive. It is, therefore, desirable to employ the teachings of this invention, using silicon steel, in order to obtain an inexpensive yet effective shield. The invention, in its broader aspects, is not limited to silicon steel or to specific thicknesses thereof. Other materials that may be used include the various nickel-iron alloys and in fact any magnetic material that can be rolled into strip form. Moreover, if exceptionally good shielding is required for a certain part of the tube, a strip of very high permeability material may be spliced into the strip of Figure 1 to form a section thereof which will cover the critical area involved. For example, if it is desired to have a very excellent shield along neck **22** (Figure 5) the inner turns of the spiral coil (Figure 2) would be composed of Permalloy and the outer turns composed of the less expensive silicon steel. A similar result could be obtained if the strip (Figure 1) were wider where it will cover the critical area.

While particular reference has been made to conical shapes, the same process can be employed if the cathode ray tube has a rectangular cross section in which event the coil of Figure 2 would be rectangular.

Instead of employing the process of Figures 2 to 7, it would be possible within the broadest aspects of my process to wind the spiral coil directly on the form.

Figure 14 illustrates a modified type of form, which may be referred to as a female form. The outside diameter of the spiral coil to be formed is the same as the opening at the top of the form. To fit the coil to the form the turns near the outside are pressed down first. Progressively thereafter the turns of smaller and smaller diameter are pressed down against the form.

In Figure 10 is illustrated alternate layers of paper and magnetic material. This was formed by winding the two materials into a single spiral coil. An alternate way of producing a spiral coil having alternate layers of paper and magnetic material is to wind a coil solely of magnetic material with the diameter A of the central opening somewhat larger than desired. Then the inner turn of the spiral coil is rotated (counterclockwise in the case of Figure 3) to cause the turns of the spiral to become separated from each other. The paper may then be threaded between the turns of the spiral coil. In like manner it is possible to thread a thin piece of copper between the turns of the coil to produce the shield of Figure 11. Likewise another magnetic material may be threaded in the coil to give a shield composed of two different magnetic materials.

I claim to have invented:

1. The process of shielding a cathode ray tube comprising winding a spiral coil of strip magnetic material in which the diameter of the coil is perpendicular to the face of the strip, the coil having an opening therein, annealing said coil to improve its magnetic properties and then allowing the coil to cool, displacing the turns of said annealed coil in a direction parallel to the axis of the coil to form a helical shield of progressively increasing diameter the turns of which overlap, said displacement of the coil turns to form said helix including such a limited bending of said magnetic material as not to impair substantially the effect of the annealing on said material, and thereafter slipping said helical shield over the neck of said cathode ray tube.

2. The process of claim 1 in which the turns of the helix are positioned with greater overlap near the end of the shield of smaller diameter than near the end thereof of greater diameter.

3. A shield for cathode ray tubes comprising a coil of strip magnetic material the inside dimensions of which conform to outer dimensions of the cathode ray tube to be shielded adjacent turns of the coil being in overlapping relation, said coil including insulating means located between adjacent turns thereof.

4. The process of making a shield which includes winding a strip of silicon steel having 2 to 5% silicon into a spiral coil having an opening in its center, the thickness of said strip being between 0.002 and 0.020 inch, annealing said coil and thereafter allowing the coil to cool, and displacing each turn of the annealed coil a progressively larger amount more than the previous one in a direction parallel to the axis of the coil to form a coil having the general shape of a helix of varying cross-section, said displacement being of such a small extent as not to alter the magnetic characteristics of said coil resulting from said annealing, the displacement of each turn being less than one-third the width of said strip whereby the resulting shield is several strip layers thick at each point along the same.

5. The process of claim 4 in which the turns of the coil are secured together after being displaced to their final position.

6. In combination, a cathode ray tube and a strip of magnetic material in the general shape of a helix around the outside of the tube to shield it, adjacent turns of said strip overlapping each other, and insulating material interposed between adjacent turns of said strip.

7. The process of making a shield which includes winding a coil of two different strip materials one of which is a magnetic material and the other of which is an insulating material, the layers of the coil alternating between the two materials, and displacing the turns of the coil in a direction parallel to the axis of the coil to form a helix of progressively increasing diameter and the turns of which overlap.

8. In combination, a cathode ray tube and a shield thereon produced by the process of: winding a strip of silicon steel into a spiral coil, annealing the coil to improve the magnetic properties thereof, allowing the coil to cool, thereafter displacing the turns of the coil to form a shield in the general shape of a helix the turns of which overlap and have progressively larger diameter so as to fit the cathode ray tube, applying an adhesive to secure the turns of the helix together, and placing the shield onto the cathode ray tube, the step of displacing the turns of the coil into the general shape of a helix being limited to such small displacements that the magnetic properties of the strip resulting from the annealing are not affected.

9. The process of claim 7 in which the permeability of the magnetic material is improved by an annealing step after the material has been wound into a coil and before the turns of the coil are displaced, the displacement of the turns of the coil being of such limited extent that the improvement in the permeability due to the annealing step is preserved.

10. A shield as defined in claim 3 in which the magnetic material is silicon steel.

11. The combination of claim 6 in which the magnetic material is silicon steel.

12. A magnetic shield comprising a coil of strip magnetic material in which the face of the strip is parallel to the axis of the coil and in which the diameter of the coil decreases from one end to the other, the turns of the coil overlapping each other to such an extent that generally the shield is at least three layers of strip thick at each point, there being a strip of insulating material extending between the layers of magnetic material and which spaces each turn from the turns adjacent to it.

13. The process of making a shield which includes making a coil of two different strip materials one of which is a magnetic material and the other of which is an insulating material, the layers of the coil alternating between the two materials, the magnetic material being of a type that its magnetic properties will be impaired if the material is bent beyond a limit, and displacing the turns of the coil, without bending said magnetic material beyond said limit, in a direction parallel to the axis of the coil to form a helix of progressively increasing diameter and having an insulating layer separating adjacent layers of magnetic material, each of said turns being displaced more than the preceding one but generally not greater than one-third of the width of the strip more than the displacement of the preceding one; whereby the shield is generally at least three layers of magnetic material thick.

14. The process of making a shield which includes making a coil of two different strip materials one of which is a high permeability magnetic material and the other of which is an insulating material, the layers of the coil alternating between the two materials, the magnetic material being of a type that its magnetic properties will be impaired if the material is bent beyond a limit, and displacing the turns of the coil, without bending said magnetic material beyond said limit, in a direction parallel to the axis of the coil to form a helix of progressively increasing diameter and having an insulating layer separating adjacent layers of magnetic material, each of said turns being displaced more than the preceding one but generally not greater than one-third of the width of the strip more than the displacement of the preceding one; whereby the shield is generally at least three layers of magnetic material thick.

15. In combination, a cathode ray tube, a strip of magnetic material in the general shape of a helix disposed around the outside of said tube to shield it, adjacent turns of said strip overlapping each other, said overlapping strip turns extending closely adjacent the envelope walls of said cathode ray tube over substantially the entire area between the neck and picture face of said tube, and an additional strip of material inter-

posed between adjacent turns of said magnetic strip, said additional strip of material being different in composition and electrical characteristics from said magnetic material.

16. The combination of claim 15 wherein said additional strip of material comprises a non-magnetic strip of electrically conductive material.

17. The combination of claim 15 wherein said additional strip of material comprises a further strip of magnetic material having a different magnetic composition from that of said first mentioned magnetic material.

18. In combination, a cathode ray picture tube, a magnetic shield structure extending adjacent to the envelope of said tube over substantially the entire envelope area between the neck and picture face thereof, said magnetic shield structure comprising an elongated substantially flat strip of magnetic material having a width which is small in relation to the distance between the neck and picture face of said tube, said strip having a wound configuration comprising a large plurality of overlapping turns forming a helix having a progressively increasing diameter between said neck and picture face of said tube, whereby the adjacent turns of said helix are each disposed closely adjacent to the envelope of said cathode ray tube.

19. The combination of claim 18 wherein the amount of overlap of adjacent ones of said turns decreases from the neck to the picture face of said tube, whereby the shielding effect of said helical strip is greater adjacent the neck of said tube than it is adjacent said picture face.

20. In combination, a cathode ray picture tube, a magnetic shield structure around the envelope of said tube between the neck and picture face thereof, said shield structure comprising a relatively narrow strip of magnetic material having a wound configuration comprising a large plurality of overlapping turns whereby said wound strip forms a continuous helix the adjacent overlapping turns of which are each disposed closely adjacent the envelope of said picture tube, the amount of overlap between adjacent ones of said turns comprising a substantial portion of the strip width whereby substantially all points on the shielded portion of said envelope are shielded by a plurality of overlapping strip portions.

21. In combination, a cathode ray picture tube, a magnetic shield structure extending adjacent to the envelope of said tube between the neck and picture face thereof, said magnetic shield structure comprising an elongated strip of magnetic material wound in a large plurality of respectively overlapping turns thereby to form a substantially continuous helical magnetic surface of progressively increasing diameter between said neck and picture face of said tube, the adjacent turns of said helix each being disposed closely adjacent to the envelope of said cathode ray tube, the amount of overlap between adjacent ones of said turns being sufficiently large that substantially all points on the shielded portion of said envelope are shielded by a plurality of overlapping strip portions.

22. In combination, a cathode ray tube, a magnetic shield structure around the envelope of said tube, said shield structure comprising a substantially flat strip of magnetic material wound in a plurality of overlapping turns thereby to form a continuous helix having overlapping turns disposed closely adjacent to the envelope of said tube, the amount of overlap between adjacent ones of said turns comprising a substantial portion of the strip width whereby substantially all points on the shielded portion of said envelope are shielded by at least three overlapping strip portions.

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