

PATENT SPECIFICATION

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(54) METHOD OF WINDING DEFLECTION COILS FOR CATHODE-RAY DISPLAY TUBES

(71) We, PHILIPS ELECTRONIC AND ASSOCIATED INDUSTRIES LIMITED, of Abacus House, 33 Gutter Lane, London, E.C.2., a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

10 THE INVENTION relates to a method of winding a saddle-shaped deflection coil for a cathode ray display tube, and to a method of manufacturing a plurality of such coils. Coils of the type to which the invention relates are flared longitudinally from rear to front between the rear end and the front end, and the turns of such a coil are distributed over a number of electrically series-arranged and successively-wound sections.

20 Deflection coils for cathode-ray display tubes generally have a flared saddle shape which accurately fits the neck and the adjoining trumpet-shaped widening part of the tube. One pair of these coils is used for the line deflection and one pair is used for the field deflection.

30 Particularly for tubes having large deflection angles, especially for colour television, it is required that the distribution of the magnetic flux generated by each of the coils deviates only very little from an optimum distribution. The coils are wound to their desired shape on an automatic winding machine. In this case all kinds of circumstances which are difficult to control may cause small variations in the distribution of the turns on the coils so that it is found later that some of the coils wound on the machine do not meet these stringent requirements.

40 It has been proposed in German patent specification 1,274,249 to present a correction possibility by providing a multi-filarly wound coil with tappings in some areas so that the coil is divided into a

number of sections. The jointly wound wires of some sections are arranged in parallel and those of other sections are arranged in series. By varying the numbers of turns per section the distribution of the flux generated by the coil may be influenced.

A drawback of this method is that soldered joints have to be made afterwards on the tappings so as to achieve the correct arrangement of the different sections. This is time-consuming and hence expensive while in addition there is a risk of incorrect connections being made. Another drawback is that asymmetries occurring in a coil cannot be corrected or can only be corrected with difficulty in this manner.

60 According to the invention there is provided a method of winding a saddle-shaped deflection coil for a cathode ray display tube, comprising forming a coil which is flared longitudinally from rear to front between its rear and front ends as a continuous winding of turns of wire with at least two electrically series-arranged successively-wound sections, and including the steps of:—

- (i) winding a number of turns of wire to form a section of the coil,
- (ii) Continuing winding a further number of turns of wire to form a further section and forming between these sections at least one space, the or each space being near to one end of pair of longitudinal boundaries between the further section and its preceding section, the turns of the further section being wound about the preceding section and the space or spaces so that these sections have mutual boundaries including their longitudinal boundaries except at the spaces, and
- (iii) if desired repeating step (ii).

The or each space may be formed by positioning a pin outside the preceding section near an end of a longitudinal

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boundary and winding the turns of the subsequent section about the preceding section and the pin. After winding each section, except the last, two pins may be positioned outside that section, one near to an end of a first longitudinal boundary of the section at one end of the coil and the other near to an end of a second longitudinal boundary at the same end of the coil. After winding a first section a first pin may be positioned near to an end of a first longitudinal boundary of the said first section near one end of the coil, a second section being wound about the said first section and first pin, a second pin being positioned near to an end of a second longitudinal boundary of the said second section at the same end of the coil, the first and second longitudinal boundaries being on opposite sides of the plane of symmetry extending between the ends of the coil, and a third section is wound about the said second section and second pin. The two pins may be located in symmetrical positions in relation to the plane of symmetry extending between the ends of the coil.

The space or spaces may be formed near to the front end of the coil whilst at least one additional space may be formed near the rear end of the coil.

The invention also provides a method of manufacturing a plurality of saddle-shaped deflection coils for cathode ray display tubes, each coil being flared from rear to front between its rear and front ends, comprising forming each coil by a method of the invention, periodically selecting a wound coil and testing the operational distribution of its magnetic flux, and compensating in the winding of subsequent coils for deviations detected in the tested coil from a desired operational flux distribution by altering the number of turns which are wound in one or more sections of the subsequent coils.

With this method a coil from time to time is tested, in order to find out whether a change has occurred in the operational distribution of the flux of the coils coming from the winding machine. Dependent on the result of the testing of these samples, the number of turns in one or more sections is varied as necessary. The number of coils to be tested in proportion to the total production of the machine depends on the rate at which variations are found to occur during the process and on the permitted tolerances. Optionally, measuring and re-adjusting may be automated.

The invention additionally provides a saddle-shaped deflection coil by either of the above methods.

In order that the invention may be readily carried into effect, some embodiments thereof will now be described in

detail by way of example with reference to the accompanying diagrammatic drawing in which:

Figures 1 and 2 show a deflection coil according to the invention in a cross-sectional view and a plan view and

Figure 3 shows a detail of the coil of Figure 1 on a larger scale in a rear view during winding.

The saddle coil shown in Figures 1 and 2 consists of a central portion 1, a front coil end 3 and a rear coil end 5, and is flared longitudinally from rear to front between its rear and front ends. The central portion 1 has a trumpet-shaped widening and follows the surface of a cathode-ray display tube (not shown) whose gun is located behind the rear coil end 5 and whose display screen is located in front of the front coil end 3. The conductors comprising the turns of the coil extend in the central portion 1 between the rear coil end and the front coil end. The magnetic field which is generated by the central portion 1 of the coil provides the most important contribution to the deflection of the electron beam generated in the tube. It will be seen that the conductors in the coil ends 3 and 5 are approximately at right angles to the conductors in the central portion 1. The coil ends 3 and 5 are bent away from the surface of the tube so that the magnetic field generated in the coil ends exerts only little influence on the electron beam.

A window 7 is provided in the centre of the central portion 1. As is shown by the hatching in Figure 1 the thickness of the coil increases progressively with the distance from this window. The purpose thereof is to roughly distribute the magnetic flux generated by the coil in a desired manner.

In order to be able to influence this flux distribution also during winding, the turns of the coil are distributed over a number of sections. Figure 3 shows how this distribution during winding is established. The Figure is a rear view of a part of the front coil end 3 with the adjoining part of the central portion 1. The coil consists of three sections 9, 11 and 13 the mutual boundaries 15 and 17 of which are denoted by broken lines. During winding the inner section 9 is wound first, for example, around a mandrel 19. As soon as the number of turns required for section 9 is obtained, a pin 21 located substantially at right angles to the plane of the turns is positioned outside section 9 near one end of the longitudinal boundary 15'. A second pin 21 (not shown) is located in a complementary position (not shown) to the left of the symmetry plane 23 of the coil located at right angles to the plane of the drawing

and extending longitudinally between the ends of the coil.

The first turn of the next section 11 is wound around section 9 and the pins 21 so that open spaces 25 are created in the vicinity of these pins. The spaces formed by the pins 21 and the open spaces 25 are bounded by the outer turns of section 9 and the inner turns of section 11. The turns of sections 9 and 11 adjoin each other at some distance from the pins 21 so that the longitudinal boundaries of the respective sections become mutual and the boundary 15-15' is invisible or hardly visible at that area. The second pin 21 may be positioned simultaneously with the first pin so that the boundary 15 on either side of the symmetry plane 23 varies symmetrically, but alternatively a number of turns can be provided after one of the pins 21 has been positioned, whereafter the second pin 21 is positioned. In this case the coil becomes asymmetrical so that asymmetries created in a different manner may be compensated for. Then, as it were, a small number of turns constitutes an extra section between section 9 and section 11.

After the required number of turns of the section 11 is reached, two pins 27 which are substantially at right angles to the turns are positioned in an analogous manner.

The turns of section 13 are wound around section 11 and the two pins 27. Thus again open spaces 29 are created between the outer turns of section 11 and the inner turns of section 13.

In the embodiment described the open spaces 25 and 29 are present on the front side of the central section 1 near the front coil end 3. The open spaces may of course alternatively be provided at other areas, for example, near the rear coil end 5. Likewise more than two open spaces per section may be provided, for example, two spaces near the front coil end and two near the rear coil end.

The region chosen for the open spaces shown in the drawing is, however, particularly favourable because the central portion 1 of the coil fans out (it is flared) in the forward direction so that the density of the turns near the front coil end 3 is considerably smaller than that near the rear coil end 5. The result thereof is that small local variations in, for example, the distribution of the turns at the front end of the central portion 1 exert a much greater influence on the distribution of the operational magnetic flux than the same variations do at the rear end of the central portion. Therefore it is important to have a correction possibility for the front end of the central portion 1, which possibility consists in the variation of the number of turns in each of the three sections 9, 11 and 13.

WHAT WE CLAIM IS:—

1. A method of winding a saddle-shaped deflection coil for a cathode ray display tube, comprising forming a coil which is flared longitudinally from rear to front between its rear and front ends as a continuous winding of turns of wire with at least two electrically series-arranged successively-wound sections, and including the steps of:

- (i) winding a number of turns of wire to form a section of the coil,
- (ii) Continuing winding a further number of turns of wire to form a further section and forming between these sections at least one space, the or each space being near to one end of a pair of longitudinal boundaries between the further section and its preceding section, the turns of the further section being wound about the preceding section and the space or spaces so that these sections have mutual boundaries including their longitudinal boundaries except at the spaces, and
- (iii) if desired repeating step (ii).

2. A method as claimed in Claim 1, in which the or each space is formed by positioning a pin outside the preceding section near an end of a longitudinal boundary and winding the turns of the subsequent section about the preceding section and the pin.

3. A method as claimed in Claim 2, in which after winding each section, except the last, two pins are positioned outside that section, one near to an end of a first longitudinal boundary of the section at one end of the coil and the other near to an end of a second longitudinal boundary at the same end of the coil.

4. A method as claimed in Claim 2, in which after winding a first section a first pin is positioned near to an end of a first longitudinal boundary of the said first section near one end of the coil, a second section is wound about the said first section and first pin, a second pin is positioned near to an end of a second longitudinal boundary of the said second section at the same end of the coil, the first and second longitudinal boundaries being on opposite sides of the plane of symmetry extending between the ends of the coil, and a third section is wound about the said second section and second pin.

5. A method as claimed in Claim 3 or Claim 4, in which the two pins are located in symmetrical positions in relation to the plane of symmetry extending between the ends of the coil.

6. A method as claimed in any preceding claim, in which at least one space is formed near to the front end of the coil.

and extending longitudinally between the ends of the coil.

The first turn of the next section 11 is wound around section 9 and the pins 21 so that open spaces 25 are created in the vicinity of these pins. The spaces formed by the pins 21 and the open spaces 25 are bounded by the outer turns of section 9 and the inner turns of section 11. The turns of sections 9 and 11 adjoin each other at some distance from the pins 21 so that the longitudinal boundaries of the respective sections become mutual and the boundary 15-15' is invisible or hardly visible at that area. The second pin 21 may be positioned simultaneously with the first pin so that the boundary 15 on either side of the symmetry plane 23 varies symmetrically, but alternatively a number of turns can be provided after one of the pins 21 has been positioned, whereafter the second pin 21 is positioned. In this case the coil becomes asymmetrical so that asymmetries created in a different manner may be compensated for. Then, as it were, a small number of turns constitutes an extra section between section 9 and section 11.

After the required number of turns of the section 11 is reached, two pins 27 which are substantially at right angles to the turns are positioned in an analogous manner.

The turns of section 13 are wound around section 11 and the two pins 27. Thus again open spaces 29 are created between the outer turns of section 11 and the inner turns of section 13.

In the embodiment described the open spaces 25 and 29 are present on the front side of the central section 1 near the front coil end 3. The open spaces may of course alternatively be provided at other areas, for example, near the rear coil end 5. Likewise more than two open spaces per section may be provided, for example, two spaces near the front coil end and two near the rear coil end.

The region chosen for the open spaces shown in the drawing is, however, particularly favourable because the central portion 1 of the coil fans out (it is flared) in the forward direction so that the density of the turns near the front coil end 3 is considerably smaller than that near the rear coil end 5. The result thereof is that small local variations in, for example, the distribution of the turns at the front end of the central portion 1 exert a much greater influence on the distribution of the operational magnetic flux than the same variations do at the rear end of the central portion. Therefore it is important to have a correction possibility for the front end of the central portion 1, which possibility consists in the variation of the number of turns in each of the three sections 9, 11 and 13.

WHAT WE CLAIM IS:—

1. A method of winding a saddle-shaped deflection coil for a cathode ray display tube, comprising forming a coil which is flared longitudinally from rear to front between its rear and front ends as a continuous winding of turns of wire with at least two electrically series-arranged successively-wound sections, and including the steps of:

- (i) winding a number of turns of wire to form a section of the coil,
- (ii) Continuing winding a further number of turns of wire to form a further section and forming between these sections at least one space, the or each space being near to one end of a pair of longitudinal boundaries between the further section and its preceding section, the turns of the further section being wound about the preceding section and the space or spaces so that these sections have mutual boundaries including their longitudinal boundaries except at the spaces, and
- (iii) if desired repeating step (ii).

2. A method as claimed in Claim 1, in which the or each space is formed by positioning a pin outside the preceding section near an end of a longitudinal boundary and winding the turns of the subsequent section about the preceding section and the pin.

3. A method as claimed in Claim 2, in which after winding each section, except the last, two pins are positioned outside that section, one near to an end of a first longitudinal boundary of the section at one end of the coil and the other near to an end of a second longitudinal boundary at the same end of the coil.

4. A method as claimed in Claim 2, in which after winding a first section a first pin is positioned near to an end of a first longitudinal boundary of the said first section near one end of the coil, a second section is wound about the said first section and first pin, a second pin is positioned near to an end of a second longitudinal boundary of the said second section at the same end of the coil, the first and second longitudinal boundaries being on opposite sides of the plane of symmetry extending between the ends of the coil, and a third section is wound about the said second section and second pin.

5. A method as claimed in Claim 3 or Claim 4, in which the two pins are located in symmetrical positions in relation to the plane of symmetry extending between the ends of the coil.

6. A method as claimed in any preceding claim, in which at least one space is formed near to the front end of the coil.



7. A method as claimed in Claim 6, in which at least one additional space is formed near the rear end of the coil.
8. A method of manufacturing a plurality of saddle-shaped deflection coils for cathode ray display tubes, each coil being flared from rear to front between its rear and front ends, comprising forming each coil by a method as claimed in any of the preceding claims, periodically selecting a wound coil and testing the operational distribution of its magnetic flux, and compensating in the winding of subsequent coils for deviations detected in the tested coil from a desired operational flux distribution by altering the number of turns which are wound in one or more sections of the subsequent coils.
9. A saddle-shaped deflection coil wound by a method as claimed in any of the preceding claims.
10. A deflection coil as claimed in Claim 9 when read in conjunction with any of Claims 1 to 6, or 8, in which the space or spaces are located in parts of the coil where the average density of the turns is at a minimum.
11. A method of manufacturing a plurality of saddle-shaped deflection coils for cathode ray display tubes, substantially as hereinbefore described with reference to the accompanying drawing.
12. A method of winding a saddle-shaped deflection coil for a cathode ray display tube, substantially as hereinbefore described with reference to the accompanying drawings.
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