Oct. 31, 1933. N. M. RUST 1,932,640

ELECTRICAL COIL

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Fig. 1

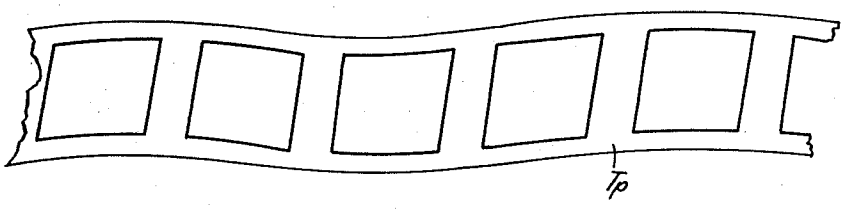


Fig. 2

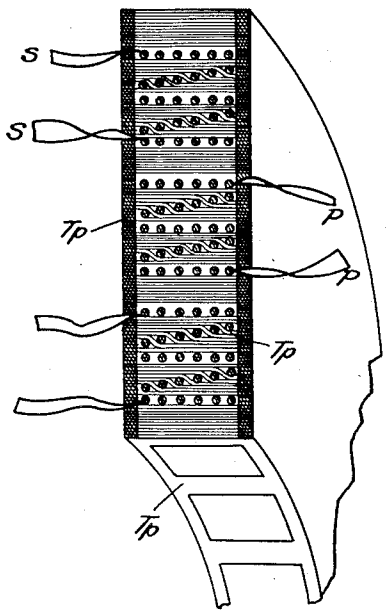
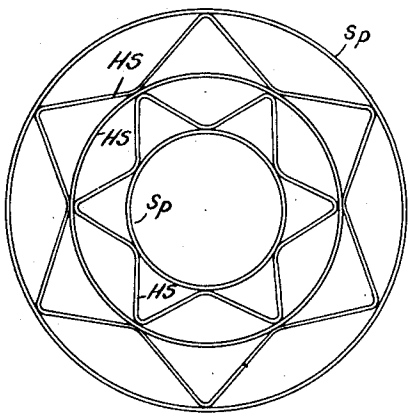


Fig. 7



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Fig. 3

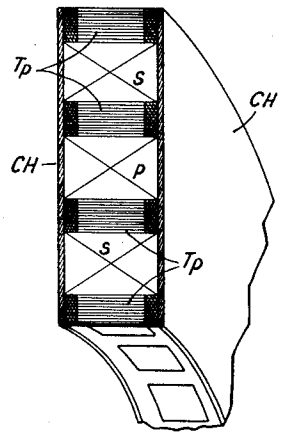


Fig. 4

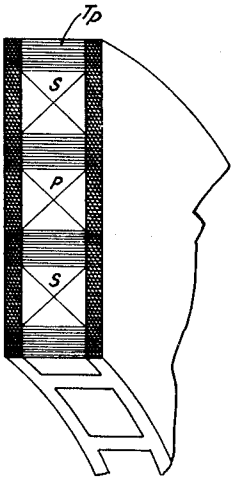


Fig. 5

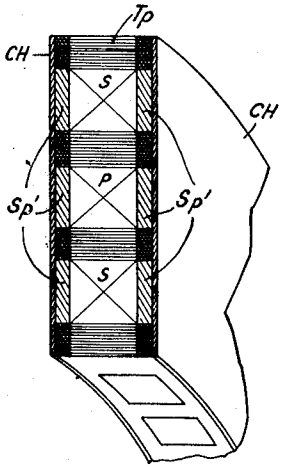


Fig. 6

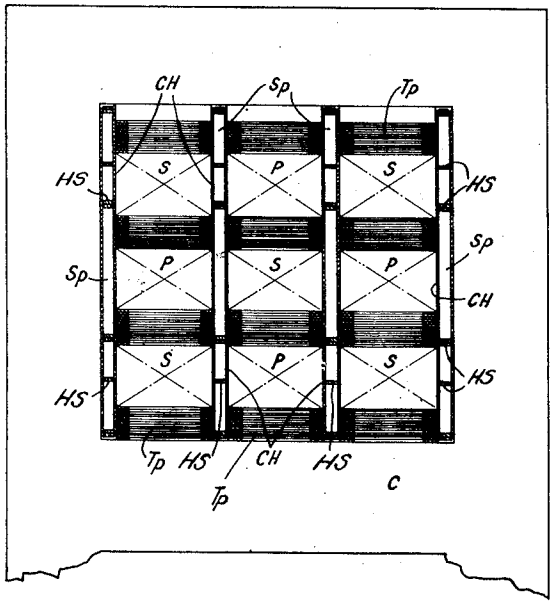
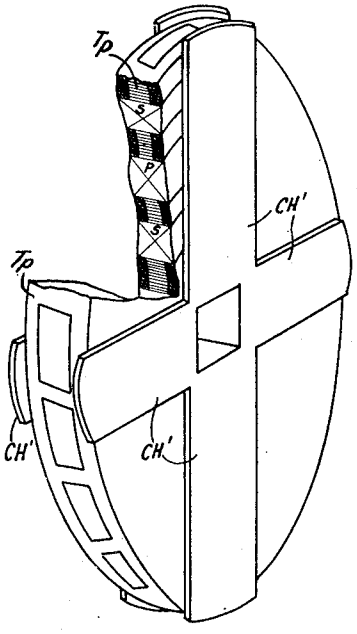


Fig. 8



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ELECTRICAL COIL

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Application September 16, 1931, Serial No. 563,108, and in Great Britain October 20, 1930

11 Claims. (Cl. 175—21)

This invention relates to electrical coils and more particularly, though not exclusively, to radio frequency, audio frequency and other transformers in which the winding capacities are of considerable design importance.

As is well known it is often desired in connection with transformers for use in radio and other high frequency circuits to obtain transformer coil structures in which there shall be a high mutual inductance between windings and at the same time a low mutual capacity and capacity to earth.

Similarly in the case of audio frequency transformers winding capacity is of paramount design importance. In the design of audio frequency transformers a high co-efficient of magnetic coupling between primary and secondary windings is one of the requirements necessary for obtaining a long level frequency-characteristic curve. Such high coupling and low leakage is generally obtained by sub-dividing the various windings into sections and inter-leaving the sections, but of course such inter-leaving involves an increase of capacity effects and in practice this consideration imposes a limit in design. It will therefore be of considerable advantage to employ windings in which there is a minimum amount of insulating material between elements which fluctuate in potential relative to one another and the principal object of the present invention is to provide a coil structure or arrangement to enable this to be achieved.

According to this invention the conductor or conductors of a transformer or similar winding structure are wound upon a foundation consisting of a plurality of superimposed layers of thin flexible paper or similar tape which has been blanked or otherwise cut out so as to be of skeleton form between its edges.

Where it is desired to separate different windings in the structure a further plurality of layers of tape may be wound on and also where desired the tape may be wound on with each turn of the conductor.

The various coils or transformer winding structures and details are shown in the accompanying drawings. In the drawings like reference characters refer to similar parts throughout the several views, in which—

Fig. 1 is a detailed showing of a length of paper strip which may be utilized in coils constructed according to this invention;

Fig. 2 is a cross sectional view of a coil wherein the individual turns of the conductors are wound together with the thin flexible paper strip shown in Fig. 1. This Fig. 2 is not a strictly accurate cross sectional view, it having been assumed for the sake of simplifying the drawings that all the blanked out portions of the paper strip are accurately superimposed, i. e., register with one another throughout the thickness of the coil. This is, of course, an inaccurate assumption since the blanked out portions of the paper are of uniform size and uniformly spaced throughout the winding for the reason that the radius of the winding layers is constantly changing. Therefore, the blanked out portions are changing in relationship with each successive layer;

Fig. 3 is a cross sectional view of a modification of a transformer coil construction wherein a primary winding or section is interposed between two secondary windings contained within a pair of solid insulated end disks;

Fig. 4 is a cross sectional view of another modification of a transformer coil construction wherein the windings of the primary and secondary coils are wound with the cross members removed from the ladder-shaped strip, as shown in Fig. 1;

Fig. 5 is another modification combining the features shown in Figs. 3 and 4;

Fig. 6 illustrates a coil comprising a plurality of coils as shown in Fig. 3, and assembled in a core window of an audio frequency transformer;

Fig. 7 is an elevation of a spacing arrangement between the groups of coils as shown in Fig. 6;

Fig. 8 is a perspective view of a coil as shown in Fig. 3, with the exception that the solid disk end members are replaced by a cross-shaped end member or cheek.

In one way of carrying out the invention as applied to a transformer winding structure a paper tape Tp of suitable electrical properties and of width equal to the over-all length of the required coil structure is blanked out so as to leave rectangular holes in such manner that the blanked out tape is of ladder-like formation as shown in Fig. 1. A plurality of layers of blanked out tape is wound upon a wooden or other former of the correct shape to correspond with the core (if any) of the transformer and if desired this operation may be facilitated by providing cheeks between which the paper is wound. The edges of the paper are treated with bakelite or other cementing varnish of good insulating property to act as an adhesive so that when the said tape is wound a foundation for the coil is obtained. When a foundation of

the required thickness has been wound on, a layer of wire is wound on over a winding length preferably equal to the width of the blanked out rectangles as shown in Figs. 2, 4 and 5. The paper and wire are then wound on together over a desired number of layers so that there is a paper separation between each turn of wire in these layers as shown in Fig. 2. Another layer of wire is then wound on followed by further layers of paper and wire wound together as may be desired. This process is continued until a complete secondary winding of desired size is obtained as indicated by the crossed lines. Further layers of paper are then wound on to separate the primary and secondary windings. The primary winding is then wound on, said primary winding being similar in general arrangement to the secondary winding. The leads to the windings are brought out sideways from the coil structure preferably by means of thin copper strip as shown in Fig. 2. Throughout the winding process the paper tape used has its edges treated with bakelite or similar varnish. The coil structure may be finished off with further protecting layers of paper tape. When the structure is completed it may be "bakelised" solid or otherwise treated in manner known per se with a suitable insulating and sealing compound.

One form of coil structure in accordance with the invention and suitable for use as a radio frequency transformer is illustrated in section in Figure 2 of the drawings, Figure 1 showing a length of paper strip such as is employed in the structure illustrated in Figure 2. As will be seen Figure 2 shows a transformer coil structure consisting of three winding sections the secondary winding being interposed between two independent primary windings and the tape Tp is shown as wound on with the conductors, thus separating at intervals the conductor turns. It should of course be understood that the separating distances between the various parts of the winding structure, the number of turns, the shape of the blanked out portions in the paper strip and so forth will depend upon design requirements.

In the construction shown in Figure 3 end cheeks CH are employed, the coil sections indicated by the crossed lines being wound upon foundations constituted by wrapped-on layers of tape as shown in Figure 1 indicated by Tp. In Figure 4, end cheeks are dispensed with their function being served by the superimposed "side portions" of the tape, the "rungs" of the ladder-like tape being cut away for the depths of coil where the windings are situated and indicated by the crossed lines.

The construction shown in Figure 5 differs from that shown in Figure 3 in that spacers Sp^1 are employed between the foundations of tape upon which the coil sections are wound the said coil sections indicated by the crossed line being wound only over that width of tape occupied by the "rungs." The coil structure shown in Figure 5 is of such a nature that such structures may be advantageously assembled in direct side by side contact. For example, in employing structures as shown in Figure 5 in a transformer assembly as shown in Figure 6 the spacers Sp would be dispensed with the necessary inter-coil spacing being obtained by virtue of the end cheeks CH and the spacer Sp^1. Figure 8 shows a coil structure generally similar to that of Figure 3 except that the solid disc end cheeks CH of Figure 3 are replaced by cross shaped end cheeks CH'.

As was mentioned above, Fig. 7 is an elevation of a novel spacing arrangement between the groups of coils as shown in Fig. 6. This novel spacing arrangement is necessary in order to provide a rugged mechanical structure for the group as a whole, and it will be noted in Fig. 6 that there is a substantial air space at the ends and between the groups of coils, which is desirable in order to keep down the amount of spacing material and still provide a low mutual capacity between the group. This spacing is accomplished by narrow strips of relatively heavy paper HS which are arranged in star-like formation as shown by Fig. 7, the narrow strips of heavy paper being interposed between the end cheek CH at the ends of the group of coils S. P. S. Furthermore, with both ends of the group of coils covered with the heavy end paper disc CH, there is provided a solid and rugged appearing group of coils.

It will be seen that the present invention enables a considerable reduction in self and inter-winding capacities by reason of the fact that the majority of the centre portion of the tape is blanked away. Further the practical advantage is obtained that as the wire is wound on it tends to "bed" itself into the blanked out tape in such manner as to relieve winding strain so that, more especially in the case of fine wire coils, the coil obtained is less susceptible to break down due to winding strains.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A transformer winding structure in which the conductors are wound upon a foundation consisting of a plurality of superimposed layers of thin flexible paper which has been blanked out to be of skeleton form between its sides or edges substantially as described.

2. A low capacity coil comprising a winding form composed of paper coiled in a helical manner wherein adjacent turns are arranged to lie close to one another, said paper having a plurality of central open spaces forming a ladder-like tape, and a coil winding wound upon the said paper.

3. A low capacity transformer coil comprising a plurality of winding forms composed of paper coiled in a helical manner wherein adjacent turns are arranged to lie close to one another, said paper having a plurality of central open spaces, forming a ladder-like tape and a coil winding having a plurality of single conductor turns wound upon the said ladder-like paper tape.

4. A low capacity coil comprising a winding form composed of a plurality of turns of flexible insulation having a substantial portion of its central area removed to form a continuous outer strip of insulation on each side of said coil and a plurality of cross members retaining said outer strips, the width of said cross members being substantially equal to one-third of the width of the removed central area, and a plurality of single conductor turns wound over said insulation to form said coil.

5. A low capacity transformer coil comprising coils whose conductors are wound upon an insulated tape, said tape having a ladder-like form.

6. A low capacity transformer comprising a

plurality of coils whose individual conductor turns are wound upon and spaced from each other by an insulated strip having a ladder-like form.

7. A low capacity transformer comprising a plurality of conductor coil windings, whose conductors are wound upon a plurality of superimposed layers of thin flexible insulation, a substantial portion of which has its central area removed to form a ladder-like strip, and a portion of said insulation having its central cross members cut away where the said conductor coil windings are situated, the side members of the said insulation forming cheeks for retaining said coil windings.

8. A transformer comprising a plurality of coil windings, whose conductors are wound upon a plurality of superimposed layers of flexible insulation, having a substantial portion of its central area removed to form a ladder-like strip, said coil windings extending over the full width of said insulation, and a relatively narrow spacing strip of insulation to provide substantial air spaces at each side of said coils to space the coils from each other.

9. A transformer comprising a plurality of coil windings, whose conductors are wound upon a plurality of superimposed layers of flexible insulation, having a substantial portion of its central area removed to form a ladder-like strip, said coil windings extending over the full width of said insulation, and a relatively narrow spacing strip of insulation arranged in a star-like pattern at each side of said coils, to space the coils from each other.

10. A transformer comprising a plurality of coil windings, whose conductors are wound upon a plurality of superimposed layers of flexible insulation, having a substantial portion of its central area removed to form a ladder-like strip, said coil windings extending over the full width of said superimposed layers of flexible insulation, and an open network of relatively narrow spacing strips of insulation at each side of said coils, to space the coils from each other.

11. A transformer comprising a plurality of coil windings, whose conductors are wound upon a plurality of superimposed layers of flexible insulation having a substantial portion of its central area removed to form a ladder-like strip, said coil windings extending over the full width of said superimposed layers of flexible insulation, and a cross-shaped spacing member of insulating material arranged at each side of said coils and interposed between said coils to space the coils from each other.

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