Oct. 16, 1934. J. C. SNELL 1,976,895

COIL AND METHOD OF MAKING THE SAME

Filed March 7, 1932

Fig. 1

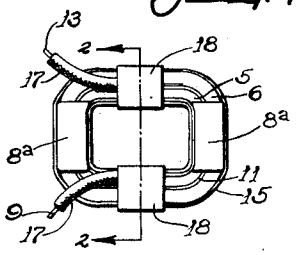


Fig. 2

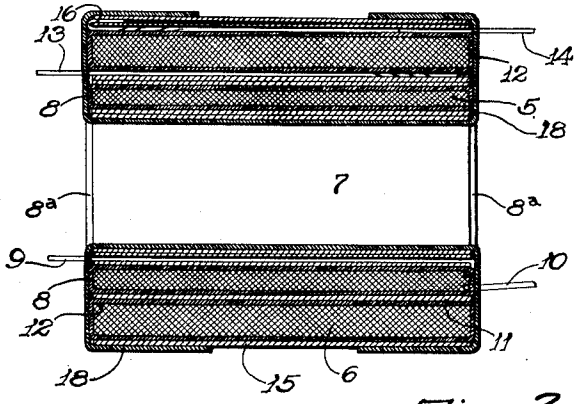


Fig. 3

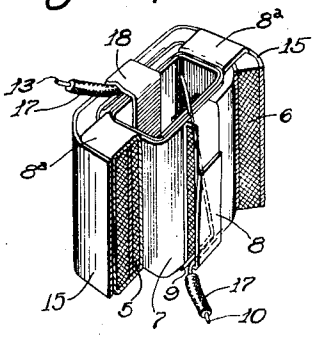
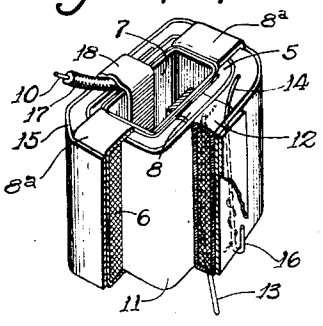


Fig. 4



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COIL AND METHOD OF MAKING THE SAME

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15 Claims. (Cl. 175—359)

This invention relates to coils generally and more particularly to coils having a plurality of windings such as the coils employed in radio loud-speaker transformers.

Radio loud-speaker transformers are generally constructed with a shell-type core and with the primary and secondary windings formed into a single coil mounted on the central leg of the core. The axial length and the radial thickness of the coil thus directly determine the length of the legs and the spacing of the outer legs of the core from the central leg, thereby controlling the overall size of the core. If, then, the coil is unduly large not only does a bulky and cumbersome transformer result, but the cost is raised because of the increased amount of steel required, and the length of the flux path is increased.

Necessarily the transformer must have a certain capacity and a fairly constant ratio of transformation which thus requires a minimum number of turns in the primary and secondary windings. Where the coils are wound on automatic or semi-automatic machines they are wound on a long preformed core, later severed between each coil. Because of the amount of time required to set up and adjust an automatic machine preparatory to a winding operation only the high impedance winding, which is composed of hundreds of turns, is wound on such an automatic machine. The low impedance winding is later wound over the high impedance winding on a manual machine and after the core has been severed. Moreover, to avoid cutting any turns of the coil in the severing of the core, the core is permitted to project beyond the windings a substantial distance at both ends thereby increasing the length of the coil. The radial thickness of the coil is increased because of the fact that machine wound coils depend upon the rigidity of the coil to retain the end turns in position, which rigidity is obtained by the insertion of a sheet of paper or the like between each layer of turns of the winding. It is thus apparent that much of the coil so constructed is electrically ineffective and serves only to increase the size of the coil with the consequent disadvantages pointed out above. The necessity of applying the windings on separate machines is also a material disadvantage.

With the foregoing in view, it is an object of my invention to effect a reduction in the size of a transformer coil of given capacity, by a novel arrangement and construction of the windings and body structure of the coil.

Another object of the invention is the provision of a novel body structure for the coil, which so facilitates the winding operation of the coil on a manual machine as to place such manner of production substantially on a competitive basis with automatic machine production of the former coils.

More particularly it is an object of the invention to provide a novel and compact coil which may be constructed on a single machine in a continuous series of operations, of which the formation of the core is the first.

Resulting directly from the ability to produce manually wound coils on a commercial basis, is a coil having the low impedance winding on the inside and the high impedance winding on the outside which construction also constitutes an object of the invention.

A further object is the provision in a coil of the character described of novel means for securing and bringing out the leads from the windings.

Other objects and advantages will become apparent from the following description taken in connection with the accompanying drawing, in which:

Figure 1 is an end elevational view of a coil embodying the features of the invention.

Fig. 2 is an enlarged vertical sectional view taken along line 2—2 of Fig. 1.

Fig. 3 is a perspective view of the coil of Fig. 1 partially broken away to show the manner of securing and bringing out the leads of the inner winding.

Fig. 4 is a perspective view showing the manner of securing and bringing out the leads of the outer winding.

For purposes of illustration the invention is herein shown embodied in a coil adapted for use in a radio speaker transformer. The coil comprises generally a low impedance winding 5 having a comparatively small number of turns and generally constituting the secondary winding of the transformer, a high impedance winding 6 having a large number of turns and constituting the primary, and a body structure which supports and binds the windings in position and in which the leads for the windings are secured. The coil is herein shown with the low impedance winding 5 on the inside of the coil, which is the preferred construction, but it is to be understood that the coil may as readily be constructed with the position of the windings interchanged.

Constituting a part of the body structure is a hollow core 7 made substantially rectangular in outline so as to fit closely about the rectangular leg of the core of the transformer upon which the coil is mounted. The core 7 is not a preformed

and cured core, as commonly employed in the winding of coils on automatic machines, but is formed on the mandrel of a manual winding machine by the operator as the first step in the building up of the coil. This insures that the core 7 is the proper size and that it has not shrunk from too long exposure to the atmosphere before use.

The core 7 is formed from a strip of gummed insulating paper, known to the trade as gumcraft, or any other suitable gummed material such as armite. This strip corresponds in width to the length of the coil to be constructed, and is of such length that when wound about the mandrel it will produce a core composed of a pluraiity of layers of paper, thus lending stiffness and rigidity to the core. The strip so cut to the desired length and width, is moistened by the operator and then tightly wound about the mandrel of the winding machine. In order that the core so formed may be as nearly rectangular as possible, the paper is creased at the corners of the core in a manner such as to cause the sides of the core to hug the mandrel closely. Herein the core is shown as composed of two layers of the gummed paper except for one side which has a third layer formed by the outer end of the strip (see Figs. 2 and 3). This small number of layers is possible because the rigidity of the core 7 is increased by a construction presently to be described. The core so formed from the gummed strip is immediately employed in the construction of a coil without first subjecting it to the usual steps of baking, drying, etc., involved in the curing process. In addition to eliminating the steps of the curing process, the use of an uncured core also has the advantages that it facilitates the construction of the coil and eliminates the waste due to the unequal shrinkage of the core and other uncertainties of the curing process.

Pasted to the outer sides of the core 7 substantially in the middle of each of its long sides and extending axially thereof, is a strip of gummed paper 8 while a strip 8^a is similarly attached to each of the short sides. The strips 8 and 8^a are substantially longer than the core 7 and form a skeleton structure binding the windings of the coil. In addition to constituting a means for binding the windings, the strips 8 and 8^a are made of heavy material and thus also serve to strengthen and make more rigid the sides of the core 7 thereby preventing a wrinkling of the sides by the pressure of the windings. The strips attached to the core 7 on those sides thereof whose end edges abut the core of the transformer when the coil is mounted thereon, herein the strips 8^a, are made substantially wider than the sides of the core 7 to which they are pasted in order to insulate the windings from the core of the transformer as will hereinafter more clearly appear.

Upon the core 7 and the strips 8 and 8^a so assembled, the low impedance winding 5 is formed. The low impedance winding 5 as well as the high impedance winding 6 are solidly wound, that is, each winding is composed entirely and only of turns of wire with successive turns and turns of adjacent layers in bodily contact, and does not have paper strips interposed between successive layers of turns. A winding so formed is very compact and requires very little skill in winding because no high degree of exactness or uniformity in the positioning of the successive turns is required. In a winding so formed the outer turns of the winding may be flush with the end of the core, thereby making the winding coextensive with the core and eliminating the unused length of core common in present constructions and which only causes waste space when the coil is mounted on a transformer. The end turns are retained on the core 7 during the winding operation in any suitable way as by means of side plates (not shown) positioned on the mandrel at the ends of the core. The side plates have circumferentially spaced slots formed therein through which the ends of the strips 8 and 8^a project.

The winding 5, being composed of a wire of substantial size and having substantial tensile strength, is secured at its inner and outer ends 9 and 10 respectively which ends are brought out from the coil to form leads therefor. To secure the inner end 9 of the winding 5, it is placed axially of the core between the second and third layers thereof and with a portion projecting from one end to form a lead (see Figs. 2 and 3). The end of the winding is thus securely anchored especially against being pulled out by force applied to the portion projecting from the coil. The end thus held also facilitates bending of the winding over the third layer of the core (see Figs. 2 and 3), and at right angles to the portion secured in the core to form the first turn of the winding. As the turns of the winding increase, the end becomes more and more securely held by the pressure of the winding.

The outer end 10 of the winding is bent to project from the end of the coil opposite that from which the end 9 projects and is secured by one of the strips 8 which is wrapped around the winding 5 to bind it to the core 7 and to retain the end turns in position. The other of the strips 8 is also wrapped around the winding 5 thus securely binding the winding on opposite sides. The strips 8 are of sufficient length that when wrapped around the winding 5, the ends overlap and may thus be securely pasted together. If desired, the strips 8^a may also be wrapped around the winding 5 but the preferred construction is to wrap only the strips 8, as here shown.

With the low impedance or secondary winding mounted next to the core 7, a shorter mean length of turn is obtained, thereby materially decreasing the direct current resistance, which constitutes a substantial proportion of the total impedance of the winding because of the comparitively few turns. This reduction in resistance may be taken advantage of by employing a smaller wire and increasing the number of turns up to the limit of total resistance permissible, which additional turns, because of the smaller wire, require no additional space.

Wound over the winding 5 and the overlapped strips 8 is a circumferential strip 11, also of gummed paper, further binding the winding 5 and insulating it from the primary winding 6 which is to be wound thereover. The strip 11 corresponds in width to the length of the coil and may be wound about the winding 5 any desired number of times. Herein, one turn is shown which is ample to insulate the windings from one another. This strip 11 also has secured to it skeleton strips 12 on the long sides of the coil.

On the foundation so formed the primary 6 of the coil is wound in the manner previously described. The primary being a high impedance winding composed of extremely fine wire requires its ends to be brought out from the coil by special leads of heavier wire with which the ends of the winding have an electrical connection. In se-

curing the leads for the high impedance winding, the body structure of the coil is again employed in a unique manner to effect the anchoring of the leads. The inner end of the winding 6 is soldered (indicated in the drawing as wound about the heavier wire) to a lead 13 which extends axially of the coil between the strip 11 and one of the skeleton strips 12. Preferably the lead 13 is located on the side of the coil opposite the side in which the ends of the secondary winding 5 are anchored. The lead 13 is completely covered by the strip 12 and thus prevents the lead or the solder thereon from rupturing the thin insulating coat of varnish on the wire composing the winding. Though the portion of the lead 13 secured in the coil is straight, the pressure of the winding 6 securely retains the lead against normal force tending to withdraw the same.

When the winding 6 so secured at its inner end is completely wound, the strips 12 are wrapped tightly about the winding to bind it securely and to retain the end turns in position. Like the strips 8, the strips 12 are of sufficient length that when wrapped about the high impedance winding 6 their ends overlap to permit them to be tightly pasted together. The ends of the strip 12 so overlapped also form an insulating strip extending across the entire winding for protecting the winding from short circuit by a lead 14 having electrical connection with the outer end of the winding 6 and conveniently placed on the strip 12. The lead 14 is positioned to project from the end of the coil opposite that from which the lead 13 projects.

The strips 8^a, previously secured to the outside of the core 7 so as to lie beneath even the secondary winding 5, are now also wrapped around the windings and the overlapping ends pasted together thereby binding both the primary and secondary winding to the core. It will also be seen that the strips 8^a when so wrapped about the windings and because of their width positively prevent contact between the core of the transformer and the end turns of the windings. The strips 8^a are, therefore, of a comparatively thick stock so as to protect the windings against abrasion by the core of the transformer and to effectively insulate the windings therefrom. The strips 8^a thus serve the threefold purpose of adding rigidity to the core, binding the windings, and insulating the end turns of the windings from the metallic core of the transformer.

To retain the lead 14 in position on the strip 12 and to form a protecting means for the high impedance winding 6, a cover strip 15 is wound about the coil circumferentially thereof. The strip 15 is wide enough to cover completely the entire length of the coil and thus protects the surface of the primary winding 6 from injury. One thickness of the strip 15, when formed from comparatively heavy stock is sufficient for all practical purposes. The lead 14 is further anchored against being pulled out of the coil by a hook 16 which is formed on its inner end and which engages the strip 15. The hook 16 is preferably concealed by an overlapping end portion of the outer covering strip 15.

The substantially complete coil is then removed from the mandrel and insulating sleeves 17 threaded over the leads 13 and 14 and the ends 9 and 10 of the secondary winding. These sleeves are retained on the leads and the coil further bound together by a third set of skeleton strips 18 pasted to the inside of the core 7 on the long sides thereof and wrapped around the entire coil.

Since the rigidity of the coil is not relied upon to retain the end turns of the respective windings in position, such turns being positively retained by the skeleton strips, the insertion of strips of paper between the successive layers of turns necessary in former constructions is entirely avoided with a consequent decrease in radial thickness of the coil. The construction described also obviates the necessity of winding the coil with the high degree of precision and accuracy required where paper strips are inserted between successive layers of turns. With each coil individually and substantially completely formed on a single core and the same machine, the turns of the windings may extend to the very edge of the core 7, where they are retained by the side plates on the mandrel while in the machine and by the skeleton strips which form bands encircling the winding when completed. Thus the radial thickness as well as the length of the coil is reduced.

I claim as my invention:

1. A coil comprising, in combination, an uncured core composed of a circumferentially wound strip of gummed paper, and a winding formed on said core, the inner end of said winding extending axially of said core between the turns thereof and projecting from the end thereof.

2. In a transformer coil having primary and secondary windings, a core composed of a circumferentially wound strip upon which said windings are mounted in superimposed relationship, one end of the winding mounted next to said core projecting from the core and extending axially between the layers thereof to be thus secured, and means for binding said windings to said core.

3. In a transformer coil having a high and a low impedance winding, a core upon which the windings are mounted in radially spaced relation composed of a circumferentially wound strip, the low impedance winding being mounted next to said core and having its inner end projecting from said core and extending axially between the layers thereof to be secured thereby, a skeleton strip secured to said core and binding the outer end of the winding also projecting from the coil, and means binding said high impedance winding.

4. In a transformer coil having solidly wound primary and secondary windings in superimposed relationship, a body structure for the coil comprising a core, a set of skeleton strips pasted to the core to extend axially thereof and binding one winding onto the core, a circumferential strip, interposed between the windings, a set of skeleton strips pasted to said circumferential strip and binding the other winding, and an outer circumferential strip and leads extending axially of the coil between said skeleton strips and circumferential strips to be thereby secured in said body structure and electrically connected to the ends of the outer one of said windings.

5. A transformer coil comprising, in combination, a core, a low impedance winding formed on said core, a circumferential strip wound about said winding, a skeleton strip secured to said circumferential strip to extend axially of the coil, a high impedance winding formed on said circumferential strip and bound by said skeleton strip, and a lead electrically connected with the inner end of said high impedance winding and extending axially of the coil between said circumferential strip and said skeleton strip.

6. A transformer coil comprising, in combination, a core, a low impedance winding formed on said core, a high impedance winding formed over said low impedance winding, a circumferential

strip interposed between said windings, a skeleton strip secured to said circumferential strip and encircling said high impedance winding to bind the same, a cover strip wound around the coil, and a lead having electrical connection with the outer end of said high impedance winding and extending axially of the coil between said cover and said skeleton strip, said lead having a hook at one end engaging said cover.

7. A coil comprising a gummed paper core substantially rectangular in outline, a solidly wound winding on said core, and strips of gummed paper pasted to the sides of said core to extend axially thereof and adapted to be wrapped about said winding to bind the same, one of said strips being wider than the side of the core to which it is pasted.

8. In a transformer coil having primary and secondary windings mounted in superimposed relationship, a body structure of insulating material comprising a core substantially rectangular in transverse cross-section, a skeleton strip secured to each of two opposite sides of said core and binding the inner one of said windings and a skeleton strip secured to the remaining sides of said core and binding both of said windings, said last mentioned strips being wider than the sides of the core to which they are secured.

9. In a transformer coil having primary and secondary windings mounted in radially spaced relationship, a body structure of insulating material comprising a core substantially rectangular in transverse cross-section, a skeleton strip pasted to each side of the core to extend axially thereof, said strips being adapted to encircle at least one winding to bind the winding to said core, a circumferential strip interposed between the windings, skeleton strips pasted to said circumferential strip and adapted to bind the outer one of the windings, a cover strip encircling the coil, and skeleton strips secured within the core and extending around to bind the cover strip.

10. A coil comprising an uncured core composed of a strip of gummed paper wound to form a plurality of layers, and a winding on said core having its inner end portion interposed between adjacent layers of the core and projecting from one end of the core to form a lead.

11. A coil comprising an uncured core composed of a strip of gummed paper of a width substantially equal to the length of the coil to be formed and of a length adapted when wound upon a mandrel to form a plurality of layers, a plurality of gummed paper binding strips pasted on the outer sides of said core and of a length substantially greater than the length of the core, said strips serving to stiffen the core, and a winding having its inner end portion anchored to the core and projecting from one end thereof to form a lead, said winding being composed of a wire wound upon the core with successive turns forming a plurality of directly superimposed layers, and said binding strips having their end portions wrapped about the ends of the winding and secured together to bind the winding onto the core.

12. The method of making coils which comprises wrapping on a mandrel a strip of gummed paper of a width substantially equal to the length of the coil to be formed and of a length adapted to form a core having a plurality of layers, pasting on the outer sides of the core while still on the mandrel a plurality of binding strips extending axially of the core and having opposite end portions projecting beyond the ends of the core, inserting one end portion of a wire beneath the outermost layer of the core and then winding the wire on the core over said binding strips to form a coil, and wrapping the ends of the binding strips around the ends of the coil to bind them onto the core.

13. The method of making coils which comprises wrapping on a mandrel a strip of gummed paper of a width substantially equal to the length of the coil to be formed and of a length adapted to form a core having a plurality of layers, pasting on the outer sides of the core while still on the mandrel a plurality of gummed paper binding strips extending axially of the core and having opposite end portions projecting beyond the ends of the core, winding on said core over the binding strips a plurality of turns of wire to form a coil with the inner end portion of the wire projecting from one end of the core to form a lead, and wrapping the ends of the binding strips around the coil to bind it onto the core.

14. In a transformer coil having a winding of extremely fine wire and a winding of substantially heavier wire arranged in radially superimposed relationship with the winding of heavier wire innermost, a body structure for the coil comprising an uncured core composed of a plurality of layers of gummed paper, a circumferential strip encircling the outer winding, axial skeleton strips pasted to the core and the circumferential strip and binding the windings, the ends of the heavy winding projecting from the coil to form leads with the inner end of the winding secured between the layers of the core, and lead wires secured by the circumferential and skeleton strips and connected to the ends of the fine wire winding.

15. A transformer coil comprising, in combination, a core, a winding on said core, circumferentially spaced skeleton strips secured to said core and encircling said winding to bind the same onto said core, a cover strip wound around the winding, a lead having electrical connection with the outer end of said winding and extending axially of the coil between the cover strip and a skeleton strip, and a hook formed on one end of the lead and engaging one of the strips between which it is positioned.

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