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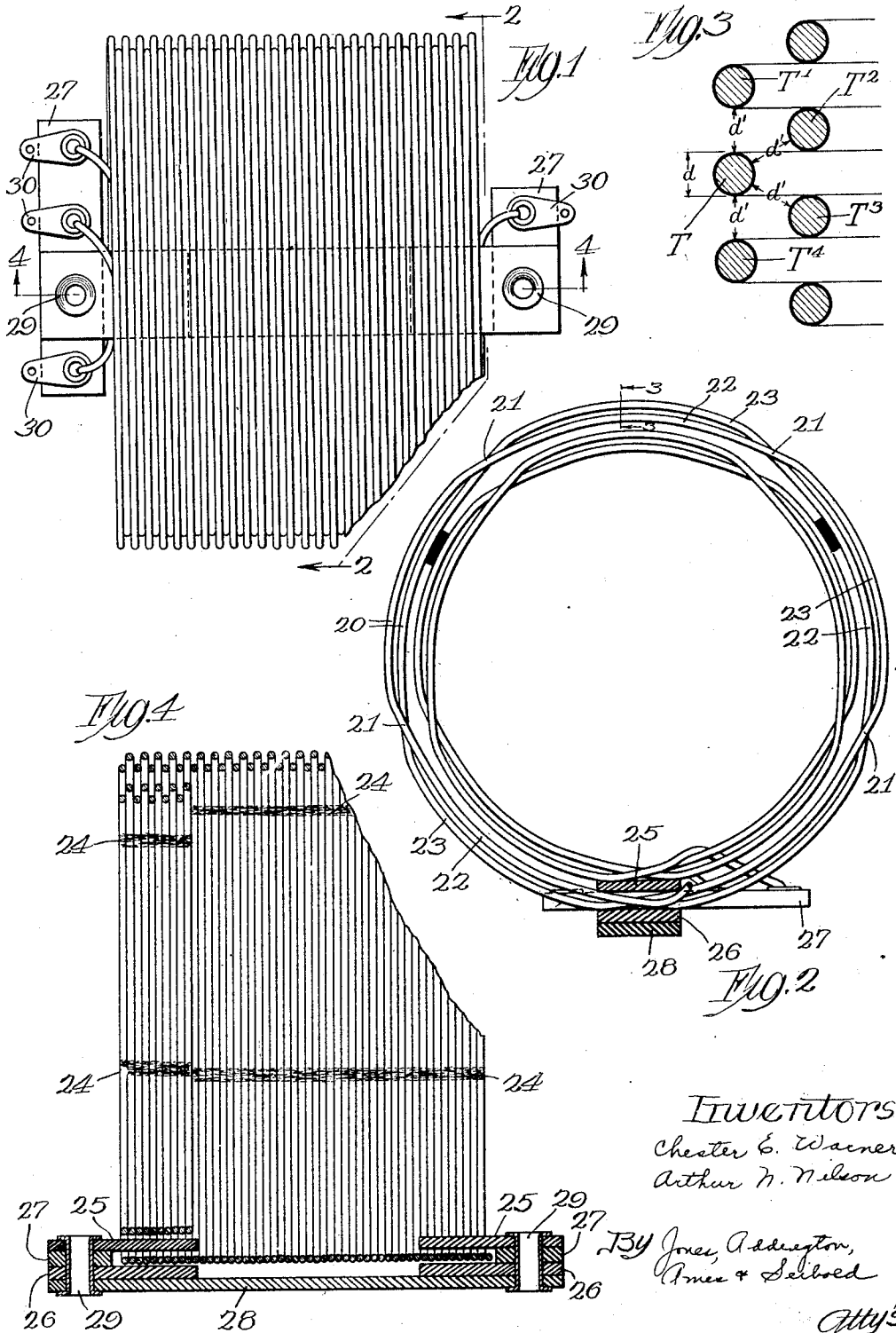
C. E. WARNER ET AL

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APPARATUS FOR AND METHOD OF FORMING COILS

Filed June 17, 1925

2 Sheets-Sheet 1



Inventors:
Chester E. Warner
Arthur H. Wilson

By Jones, Addington,
Ames & Selsted

Attys.

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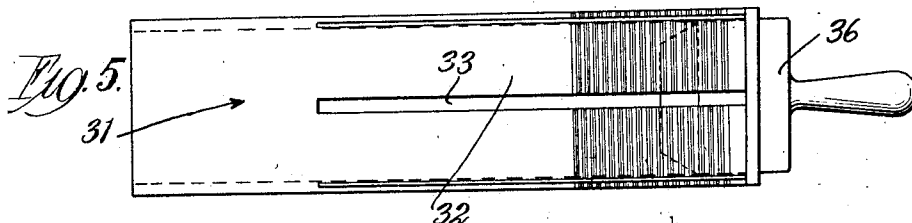
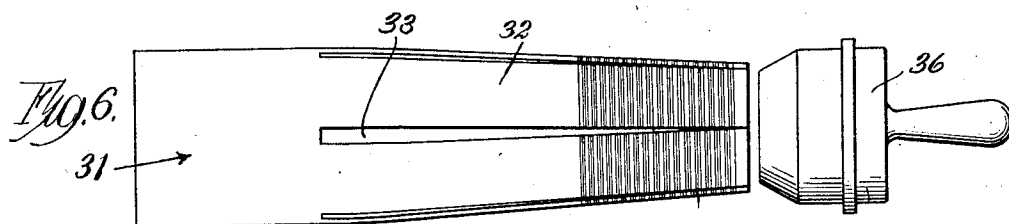
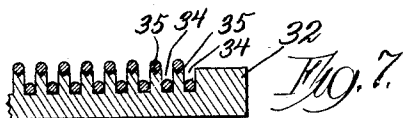
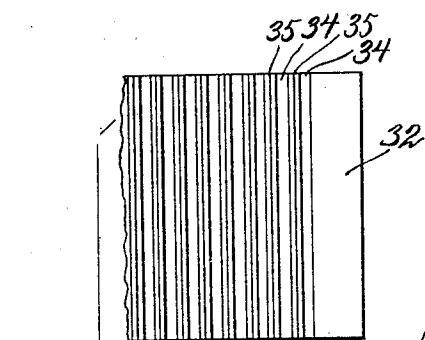
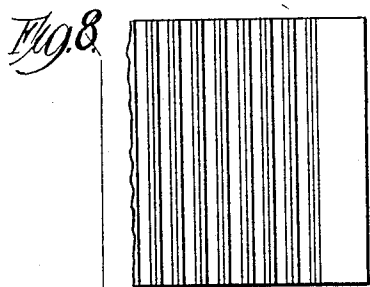
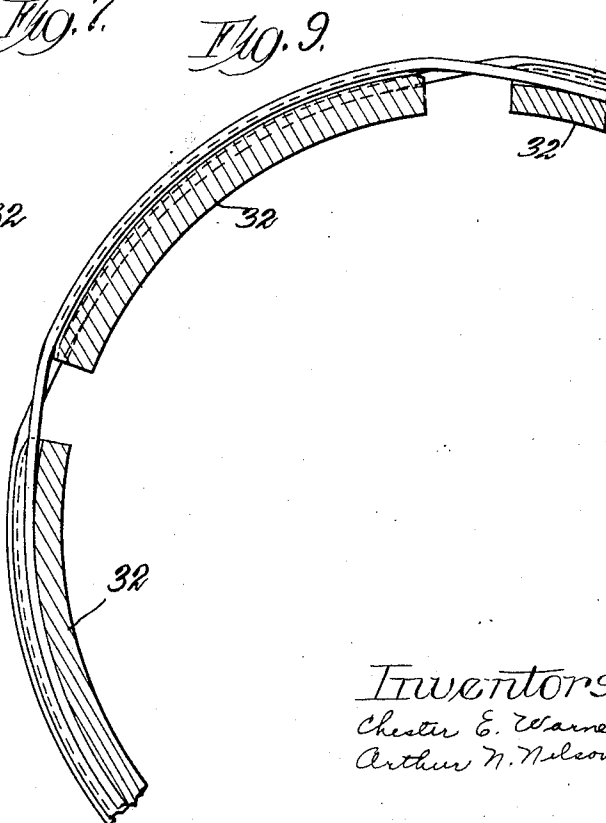
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APPARATUS FOR AND METHOD OF FORMING COILS

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2 Sheets-Sheet 2



Inventors:
Chester E. Warner
Arthur H. Nelson

By Jones, Oddington, Ames & Peabody
Attys

UNITED STATES PATENT OFFICE.

CHESTER E. WARNER AND ARTHUR N. NILSON, OF CHICAGO, ILLINOIS.

APPARATUS FOR AND METHOD OF FORMING COILS.

Application filed June 17, 1925. Serial No. 37,640.

This invention relates to electrical coils which are particularly adaptable for use with radio apparatus or in other high frequency current circuits.

One of the objects of this invention is to provide a coil having substantially minimum distributed capacity consistent with the maintenance of high inductive efficiency. Such coils are particularly desirable in radio circuits in order to permit of sharp tuning and in order to render it possible for circuits of desirable dimensions to be tuned over wide range of frequencies.

A further object of this invention is to provide an electrical coil having the above desirable properties and which is also of substantially circular cross section whereby a desirable distribution of magnetic flux is maintained.

Another object of the invention is to provide a self retaining coil of relatively durable construction but wound in a manner whereby only very small quantities of adhesive insulating material are necessary to retain together the successive turns.

Still another object of the invention is to provide a simple form of supporting and clamping structure for a coil of the above described type, which structure is so made and positioned as to permit of substantially no electrostatic losses therein.

Also among the objects of this invention may be included the provision of an efficient transformer for high frequency currents formed of a cooperating pair of coils having the above described properties.

Still other objects of this invention include the provision of very simple, durable and inexpensive constructions for the purposes desired, such constructions embodying substantially the minimum amount of necessary materials and parts but yet being dependable and certain in their operation.

Furthermore it is our object to produce a simple and efficient method of winding coils of the type above indicated as well as a simple form of mandrel upon which the coils may be wound.

Other objects of the invention will be ap-

parent from the following description and claims taken in connection with the accompanying drawing in which;

Fig. 1 is a side elevational view of a coil and supporting structure embodying the invention, the particular structure as shown comprising a high frequency current transformer with suitable wiring terminals.

Fig. 2 is a sectional view taken on the line 2—2 of Fig. 1.

Fig. 3 is an enlarged sectional view taken substantially on the line 3—3 of Fig. 2.

Fig. 4 is a sectional elevational view taken on the line 4—4 of Fig. 1.

Fig. 5 is a view of the winding mandrel upon which the coils of Fig. 1 may be wound. The mandrel being expanded ready to be used in the winding operation.

Fig. 6 is a view similar to Fig. 5 but showing the mandrel in collapsed condition to permit removal of a coil after having been wound thereon.

Fig. 7 is a detailed sectional view showing the form of thread on the mandrel of Fig. 5.

Fig. 8 is a developed view of a threaded portion of the mandrel of Fig. 5.

Fig. 9 is a cross sectional view of a part of the mandrel showing portions of a coil wound thereon.

The structure of Fig. 1 is made up of coils wound in a particular novel manner which is best illustrated in Figs. 2 and 3. Each coil comprises a plurality of turns as at 20 which are in contact with each other only at spaced points, as at 21, located around the coil, preferably at equal distances apart circumferentially. In the preferred form as illustrated five of such points are shown; however, the number may vary from one to a large number, depending upon the mechanical strength and electrical efficiency necessary in the finished coil. Intermediate of the points 21 it will be noted that the major portion of each turn is uniformly air-spaced from the neighboring turns. To accomplish this spacing each turn is alternately displaced inwardly and outwardly of the coil in radial directions to form the portions 22 and 23 respectively.

To accomplish such displacement the successive turns cross each other at their contacting points 21.

The relative displacement of the turns is indicated in the enlarged view of Fig. 3. As indicated a turn "T" having an over-all diameter of d is spaced by a uniform distance d^1 from each of the two preceding turns T^1 and T^2 and from the next two succeeding turns T^3 and T^4 . The distance d^1 may vary slightly in accordance with various mechanical considerations such, for example, as thickness of insulation used upon the wire. However, by trial we have discovered that the distance d^1 may be substantially equal to the wire diameter d to produce highly satisfactory electrical results and permitting simple manufacturing methods. Thus, it will be seen that each turn is very nearly in the same inductive relation to each of four other turns, yet the turns are so spaced as to eliminate objectionable distributed capacity between turns.

As appears in Fig. 2, the turn portions 22 and 23 conform very closely to arcs of circles and the completed coil is tubular and substantially cylindrical in form. Thus, it will be seen that although the turns are spaced to avoid undesirable capacity effects the efficient and conventional circular form of turn is substantially maintained. The crossing of the turns as shown is effected by bends following smooth curves thus avoiding sharp bends and their accompanying resistance to high frequency currents.

In order to render the coil self retaining, a band of adhesive insulation material as at 24 may be applied in liquid form along the crossing points 21 as indicated in Fig. 4. This material is preferably applied on the interior only of the coil thus leaving the insulation of uniform appearance exteriorly. Sufficient insulating material may be applied to form the band 24 and to produce a durable coil without forcing the material in between adjacent turns to any considerable extent. Increase of the capacity between turns by reason of the increased dielectric value of the adhesive material may thus be largely avoided. In the coil as above described the crossed arcuate portions 22 and 23 serve to brace each other and are held in a firm relationship by the adhesive insulating material.

As illustrated, two or more of the above described coils may be telescoped preferably concentrically to provide a high frequency current transformer. When two concentric coils are thus used as shown in Fig. 4, an efficient arrangement may be provided by locating opposite each other the outwardly and inwardly displaced portions respectively of the turns of the two coils. If the two coils are retained in such posi-

tion, a predetermined coupling relation may be easily maintained therebetween.

In order to provide a simple and efficient supporting and wiring terminal structure for the coils, the arrangement shown in Figs. 1 and 4 may be employed. Insulation clamps 25 and 26 formed of flat strips of relatively small area are shown embracing the coil edge at each end of the coil. Spacing strips 27 substantially equal to the total thickness of the wall of the coil may be provided. These members at opposite ends of the coil may be interconnected by a bar of insulating material 28 fixed at each end to the clamping strips by eyelets as at 29. It will be noted that the bar 28 throughout the major portion of its length is spaced a substantial distance from the coil thereby avoiding the possibility of electrostatic losses therein. Also to avoid the possibility of such losses the clamping strips 25 and 26 are preferably of relatively small area as indicated in Fig. 1. The spacing strips 27 may be extended at one or both sides of the clamping strips 25 to form lug portions to which wiring terminals as at 28 may be affixed. Suitable connections to the coil circuits may be applied to the terminals 30.

Although the coil as above described may be manufactured by other methods, we have found a method making use of the following described apparatus as illustrated in Figs. 5 through 9 to be preferable. A mandrel 31 is formed preferably with an odd number of spring fingers 32 extending longitudinally of the mandrel. The number of fingers used is equal to the desired number of crossing points 21 to be formed in the finished coil. The fingers are separated by slots 33 of suitable width to permit the fingers to normally collapse to a diameter smaller than that of the finished coil and as indicated in Fig. 6. As best shown in Fig. 7 each finger is formed with a series of deep grooves 34 comprising portions of a continuous spiral groove or thread formed around the entire mandrel. Intermediate the deep grooves 34, raised portions 35 are provided. The raised portions also having their outer edge grooved along lines following the same spiral thread as that of the grooves 34. The raised portions and deep grooves on adjacent spring fingers are staggered with respect to each other as indicated in the developed view of Fig. 8. In other words the deep grooves of one spring finger are in alignment with the raised portions of both the preceding and succeeding fingers.

To form a coil on the above described mandrel the fingers are first expanded by any suitable method such as by the insertion of a tapered plug 36 as indicated in Fig. 5. The mandrel may then be rotated in any suitable manner while a single layer

of wire is wound thereon. As the wire passes over succeeding spring fingers it will alternately engage the deep grooved and raised portions of the thread, thus producing the inward and outward displacement of the turn and accomplish the desired spacing of the wires. During or after this winding process the adhesive insulating material may be applied to the points 21 interiorly of the coil and thru the slots 33 of the mandrel. The mandrel may then be allowed to collapse whereupon the coil will be free for removal. If desired the adhesive insulating material may be applied during the removal of the coil from the mandrel.

While we have shown and described one specific embodiment of our invention it is understood that we do not desire to have any limitations imposed thereon except as specified in the appended claims or required by the prior art.

Having thus described our invention what we claim as new and desire to secure by Letters Patent of the United States is:

1. A method of winding a helicoidal wire coil, the adjacent turns of which cross each other at a plurality of points, and each turn of which lies substantially in a plane perpendicular to the axis of the coil which comprises causing the turns as they are wound to wind in and out in a substantially radial direction at intervals to cross the preceding turns, the in and out winding movement being in a general plane adjacent the general plane of the previously wound turn.

2. A method of winding a helicoidal wire coil, the adjacent turns of which meet each other at a plurality of points, and each turn of which lies substantially in a plane perpendicular to the axis of the coil which comprises causing the turns as they are wound to wind in and out in a substantially radial direction at intervals to meet the preceding turns, the in and out winding movement being in a general plane adjacent the general plane of the previously wound turn.

3. Apparatus for forming a coil comprising a series of helically arranged coil supporting members for engaging the inner side of the coil, said members being alternately raised and depressed, each turn having an odd number of coil supporting members whereby members lying alongside each other are alternately raised and depressed.

4. Apparatus for forming a coil comprising a plurality of fingers extending longitudinally of the axis of the coil, and surrounding said axis, said fingers collectively being provided with a series of helically arranged coil supporting members for engaging the inner side of the coil, said members being alternately raised and depressed, there being an odd number of said fingers where-

by the coil supporting members on the same finger are alternately raised and depressed.

5. Apparatus for forming a coil comprising a plurality of fingers extending longitudinally of the axis of the coil, and surrounding said axis, said fingers collectively being provided with a series of helically arranged coil supporting members for engaging the inner side of the coil, said members being alternately raised and depressed, there being an odd number of said fingers whereby the coil supporting members on the same finger are alternately raised and depressed, said fingers being collapsible toward the axis of the coil to permit the removal of the coil.

6. Apparatus for forming a coil comprising a series of helically arranged coil supporting members for engaging the inner side of the coil, the members of adjacent turns which lie alongside each other being alternately raised and depressed.

7. Apparatus for forming a coil comprising a series of helically arranged coil supporting members for engaging the inner side of the coil, the members of adjacent turns which lie alongside each other being alternately raised and depressed, said coil supporting members being grooved to receive the coil.

In witness whereof, we have hereunto subscribed our names.

CHESTER E. WARNER.
ARTHUR N. NILSON.

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