

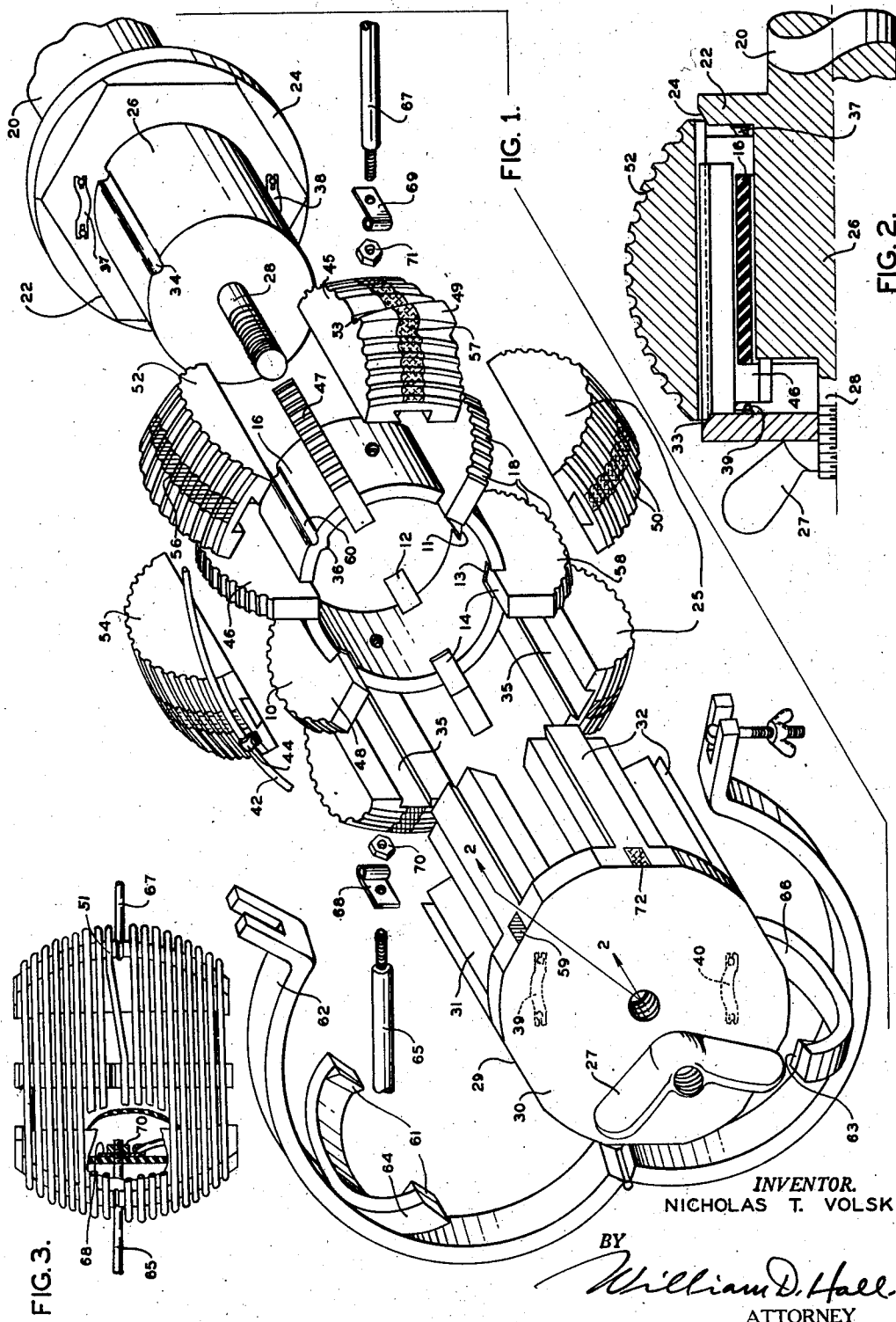
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JIG FOR WINDING SPHERICAL COILS

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JIG FOR WINDING SPHERICAL COILS

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as represented by the Secretary of War

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to spherical coils used in radio tuning circuits. The invention discloses the structure and the method of making the spherical coils.

It is well known in the radio art that the spherical coils when used in connection with the variometers are much more effective than the cylindrical coils because the spherical coil rotor may be coupled much closer to the cylindrical stator of the variometer, enabling one to span wider frequency band with the variometers of this type. Although this advantage of the spherical coils has been recognized, their use has been somewhat limited because no simple manufacturing methods were available, and, as a consequence, the majority of variometers use either cylindrical rotors, or rotors which only attempt to approach the surface defined by a perfect sphere.

The invention discloses a simple method of making the spherical coils, an auxiliary jig used for winding the coils, and a coil form which may be used with the jig.

In the prior art, the spherical coils were wound either directly on the coil forms or on jigs which required subsequent cutting of wire for removal of the coil wire from the jig. The latter method is disclosed in an application for patent of Edward E. Combs, 552,859 filed September 6, 1944. When the coils are wound directly on the coil forms because of the limited number of wire supports provided along the spherical surface of the coil, the wire does not follow the spherical surface but instead bends at the supports and follows a path of a cord forming the two adjacent supports. Coils of this type cannot be coupled closely to the outside cylindrical coil of the variometer because they do not possess the desired spherical form. In the second method of winding coils, i. e., with the aid of a jig and subsequent cutting of wire, the process is rather laborious, requires soldering of the wires, and the soldered joints produce spurious radiations at U. H. F. increasing the losses encountered in the coils.

The invention discloses a method and apparatus for winding a coil possessing a substantially spherical surface and without any soldered joints. The method of winding the coil may be considered an improvement on the method disclosed in the previously mentioned application of Combs. The disclosed invention eliminates transferring, cutting, and subsequent soldering of the wire taught

by Combs; the elimination of these steps obviously simplifying the procedure of winding the coils and improving the final product because there are no soldered joints on the coil.

It is, therefore, an object of this invention to provide a jig for winding spherical coils directly on the coil forms, the wire forming a portion of a substantially perfect sphere.

Another object of this invention is to provide a coil form with identical wire-supporting bridges disposed along a helix, the helical path corresponding to the pitch of the coil.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with the objects and advantages thereof, may best be understood in connection with the following description and accompanying drawing in which,

Fig. 1 is an exploded perspective view of a jig for winding the coil, and a perspective view of the coil form used for supporting the wire.

Fig. 2 is a cross-sectional view of the jig taken along line 2—2 illustrated in Figure 1.

Fig. 3 is a plan view of the wound coil.

Referring to Figure 1, the coil form consists of a plurality of ceramic bridges 10 with arched and grooved wire-supporting surfaces 18 and projecting teeth 12, 14, which fit into recesses 11, 13, etc., in a ring 16. The ring is preferably made of plastic material offering low radio frequency loss. The bridges 10 are identical to each other, and in order to obtain the desired wire-pitch the recesses 11 and 13 are disposed along a helical path corresponding to the pitch desired in the coil. The use of the supports with the identically positioned grooves 18 results in minor distortion of the coil surface; however, the departure of the produced surface from a perfect sphere is so insignificant that the advantages gained by having identical ceramic pieces become more important than the created distortion of the surface. The coil form having ceramic bridges and a ring made of plastics produces a coil form which can withstand mechanical shocks better than the coil forms made completely of ceramics, while the ceramic bridges resist high temperature encountered at heavy electrical loads. The jig may be used nevertheless with all ceramic coil forms, or forms made of any other suitable material.

The jig includes a mandrel 20 held by a chuck of a lathe for turning it; a wedge plate 22 integral with the mandrel and having a plurality of chamfered or beveled wedge-forming surfaces 24; a

drum 26 used for holding ring 16 in sliding engagement with the drum; and a threaded rod 28 provided with a wing nut 27. A spider 29, consisting of a wedge plate 30 and a plurality of legs 31, with oblong cross-sections and equipped with the projecting dovetails 32 on the outer surfaces of the legs, is used for holding six wire supports 25 between the wedge plates 22 and 30. The wire supports hold the wire during the wire-winding operation and fit into the recesses between the bridges 10. The form is assembled by sliding ring 16 over drum 26. In order to facilitate proper alignment of the drum with the ring, the drum and the ring are provided with an aligning groove 34, and a wedge 36 respectively. The wedge plates 22 and 30 are provided with flat springs 37, 38, 39 and 40 which automatically align the bridges with respect to the wire supports 25, as it will be explained presently. Upon sliding the coil form over drum 26, spider 29 is slipped over ring 16 with the wire supports 25 mounted on the dovetails 32 prior to its placement over ring 16, as is illustrated more fully in Figure 2. The wire supports, as well as the legs, are so dimensioned that the supports engage the beveled portions 24 and 33 of the wedge plates and the beveled portions of the dovetails 32 when the wing nut 27 is tightened. The dovetail joint between the dovetail projections 32, and the dovetail recesses 35 in the wire supports are dimensioned so as to form a relatively loose joint for allowing the beveled portions 24 and 33 of the wedge plates to raise the wire supports slightly above the surfaces of bridges 10 when wing nut 29 is tightened. A positive, rigid engagement joint between spider 29 and the wedge plate 22 is thus obtained. The spacing between the wedge plates at this instant is such that the bridges 10 do not engage either of the wedge plates directly, but are positioned in the desired relationship with respect to the wire supports by means of the previously mentioned flat springs 37 through 40, as illustrated more clearly in Figure 2. The entire jig is now ready for winding the coil. The winding process is started by clamping the starting end of the coil wire 42 by means of a clamp 44, and starting the lathe.

The reason for providing a recess 34 and a wedge 36 for positioning the coil form always in the indicated relationship with respect to the wedge plates is as follows: since all bridges are identical, the pitch is obtained, as mentioned previously, by shifting the position of the successive bridges on ring 16, for example: the upper bridge 46 may occupy the extreme left position on ring 16, and bridge 48 the extreme right position. All wire supports 25 are provided with grooves 50 which also have proper pitch, and, therefore, are not identical to each other, but are made with a continuous groove, following a helical path along the surface of the supports so that the wire, after it has been clamped by clamp 44, will follow the properly pitched, continuous, helical path. This being the case, the spherical supports must be placed in a predetermined order of rotation with respect to the coil form in order to match its pitch. Thus the wire support 52 must be positioned between the bridges 46 and 47; the wire support 54 must be positioned between the bridges 48 and 46, etc. To facilitate proper orientation of the wire supports with respect to the coil form the supports are provided with color combinations, illustrated as cross-hatched strips 56 and 57, etc. which match the corresponding strips 59, 72, etc. on the spider. Strip 56 which may be,

for example, of red color, is always aligned with red strip 59, wedge 36, and indentation 60 on the ring, etc. Accordingly, the proper procedure of assembling the jig consists of mounting the coil form on the drum, dovetailing the wire supports onto the spider with the color combinations on the wire supports matching the color combinations on the spider, slipping the spider with the wire supports upon it over the coil form, with the red color strip 56 fitting over groove 60 of the coil, and tightening nut 29 thereafter. Since the lateral positions of the bridges between the wedge plates are all different, proper alignment of the grooves may be obtained only when the coil form and the wire supports are placed according to the previously described order. Proper alignment of the elements may be improved still further by providing a wedge on the lower portion of leg 31 having red mark 59, this wedge matching groove 60 on the ring 16. The flat springs 37 through 40 engage the bridges 46 and 58 and hold the coil form in an elastically adjustable relationship with respect to the wire supports to take care of minor misalignment differences that may exist because of the variations in the dimensions in the bridges and the rings due to the manufacturing tolerances. When the wire is wound on the jig, the coil form is thus free to adjust itself with respect to the jig should the grooves in some particular bridge be slightly out of alignment with the grooves in the wire supports.

The center portion of wire support 45 is provided with a projection 49 for introducing a bend 51, Fig. 3 in the wire of the coil; which is necessary for providing clearance between the wire and shaft 67 of the coil. Projection 49 is provided at its base with a cross-groove 53 which increases the pitch of the wire path for the length of the projection, this increase being such as to transfer the wire when it reaches the center-turn to the next groove 18 on the ceramic support 10 thus separating the wire path into two spaced symmetrical halves and enlarging the separation between the two adjacent center-turns of the coil.

Upon winding of the wire, it is clamped down by means of a clamp 62, the arcuate metal strips 64 and 66 of which are equipped with rubber pads 61, 63, the pads fitting tightly over the diametrically opposite, outer turns of the wire, and holding them tightly against the bridges which prevents any loosening of the wire during any subsequent operations.

The separation of the jig from the coil is accomplished by unscrewing the wing nut 27 which results in sliding of the wire supports along the beveled surfaces 24 and 33, thus relieving the pressure exerted by the wire on the wire supports and transferring this pressure to the bridges. Since the wire supports are now only in loose engagement with the spider, the spider may be slipped out from under the supports.

The wire supports may now be slipped out of engagement with the coil frame and the wire by sliding them either to the left or to the right on the ring, and by turning them around the outer edges of the ring. The axial dimension of the ring is so proportioned that the wire supports may pass through the openings formed between the outer turns of the coil and the upper edges of the ring when the supports are turned or rotated around these edges. When the wire supports are removed, the two ends of the wire are connected to metal shafts 65, 67 by means of lugs 68, 69 and nuts 70, 71, as illustrated more clearly in Figure 3, which completes the winding process of the coil.

From the description of the jig and of the coil form, it follows that all stresses occurring during the winding operation are imposed directly on the wire supports, rather than the coil form, the coil form floating within the jig at this time. In some instances, when the wire is especially heavy, this may be a very desirable feature since lighter coil forms may be used for supporting the wire after the winding operation has been completed. Once the wire has been preformed by means of the jig, it may be held in fixed position by a very light coil form since the main stresses obviously occur during the winding operation. Besides reducing the total weight of the variometer, the light coil forms reduce the radio frequency loss introduced by the variometer.

The wire support is illustrated as a segment of a sphere truncated on four sides so as to form a solid having an oblong base, and four flat sides perpendicular to the base topped by a spherical surface, the center of which is on a line perpendicular to the base at the geometric center of said base. It is obvious that the spherical surface with one exception must be retained in all cases, but all the remaining surfaces may have different shape and relationship with respect to each other than that illustrated in the drawing. The remaining surfaces must satisfy only one requirement: they should hold the coil form in a sufficiently fixed relationship with respect to the wire supports during the winding operation of the coil, and should be easily removable during the dismantling operation of the jig. Where the pitch of the wire is very large, the departure of the bridges from a perfectly spherical surface may be such as to warrant a corresponding distortion of the supports from the spherical surface for matching the two surfaces more closely; this corresponds to the previously mentioned exception.

The drawing also illustrates the use of drum 26. This is a matter of convenience rather than necessity, and supporting of the coil form may be performed altogether by means of the spider and of the wire supports with the drum in the latter case being completely eliminated.

It is believed that the construction and operation of the jig and of the coil form will be apparent from the foregoing description. It should be understood, nevertheless, that while the invention has been shown and described in one preferred form, reasonable modification may be made without departing from the spirit of the invention as sought to be defined in the following claims.

I claim:

1. A jig for winding spherical radio coils including two spaced opposing wedge plates, a plurality of wire supports positioned between said wedged plates, one surface of each of said supports being a portion of a spherical surface, and a corresponding plurality of legs for said supports, said legs being attached to one of said plates and extending towards the other plate for holding said wire supports between said plates so as to form an approximately spherically-shaped wire-supporting surface during the winding operation of said coils.

2. A jig for winding spherical coils as defined in claim 1 which further includes wedging surfaces between said wedge plates and said wire supports, and mechanical instrumentalities for making rigid wedging engagement between said plates and said supports.

3. A jig for winding spherical coils as defined in claim 1 in which each of said wedge plates is

provided with a beveled surface at the inner edge of the periphery of the plate, and means for wedging said supports against said surface.

4. A jig for winding spherical radio coils as defined in claim 1 in which each of said wedge plates is provided with a plurality of beveled surfaces located at the inner edge of the periphery of said plates, the number of said surfaces on each plate corresponding to the number of said supports, and means for wedging said supports against said surfaces.

5. A jig for winding spherical radio coils as defined in claim 1, which further includes beveled surfaces on said wedge plates, a longitudinally sliding joint having a limited radial play between each wire support and the leg holding it, and means for wedging said supports against said surfaces and for taking up said radial play.

6. A jig for winding spherical radio coils as defined in claim 1 in which each of said wire supports comprise a flat, oblong base; four sides perpendicular to the base and to each other; and a sixth side, said sixth side being a part of a spherical surface whose center lies along the line normal to said base and passing through the geometric center point of said base.

7. A jig for winding spherical radio coils as defined in claim 1, which further includes a dovetail joint having a limited radial play between each wire support and the leg holding said support.

8. A jig for winding spherical radio coils as defined in claim 1 in which said wire supports include a groove following a helical path corresponding to the pitch of said coils, and a cross-groove crossing the center portion of one of said supports at an angle greater than said pitch for separating said path into two spaced symmetrical halves, and for enlarging the separation between the two adjacent center-turns of said coil.

9. A jig for winding spherical radio coils as defined in claim 1, which further includes a coil form fitting into said jig during the winding operation of said form, said form comprising a hollow cylinder and a plurality of uniformly spaced bridges fastened to said cylinder and extending outwardly and radially therefrom, said legs and said wire supports fitting into the spaces between said bridges substantially to supplement said approximately spherically-shaped wire-supporting surface.

10. A jig for winding spherical radio coils as defined in claim 1, which further includes a coil form fitting into said jig during the winding operation of said form, said form comprising a hollow cylinder and a plurality of uniformly spaced bridges fastened to said cylinder and extending outwardly and radially therefrom, said legs and said wire supports fitting into the spaces between said bridges to form said spherically-shaped wire-supporting surface, and means for rigidly clamping said wire supports against said plates during the wire winding operation of said coil form, and for separating said plates during the dismantling operation of said jig whereby said plates, legs, and wire supports may be separated from said coil form, thereby transferring the wire wound on said jig to said coil form.

11. A jig for winding wire for a spherical radio coil including two spaced opposing wedge plates, a plurality of removable wire supports each having at least two plane surfaces bound by a spherical surface having a curvature equal to that of said coil, said supports being held by said plates

so as to form spaced spherical portions of a single, substantially spherical surface corresponding to the surface of said coil, a plurality of pitched grooves on the spherical surface of said supports whereby said supports act as bending, guiding and supporting means for said wire during the winding operation of said coil, a coil form fitting between said plates and said wire supports, said plates supporting and aligning said form with respect to said supports during said winding operation, and a clamping means connected to said plates for rigidly holding said plates and said supports with respect to each other during said operation, said means, when unclamped upon completion of said winding operation, enabling the separation of said plates and of said wire supports from said coil form, and lowering of said wire from said supports onto said coil form.

12. A jig for winding wire for a spherical radio coil as defined in claim 11 which further includes sliding joints between one of said plates and said

5 supports with a limited radial play, said joints allowing the positioning of said supports in such a radial relationship with respect to said coil form upon tightening of said clamping means so as to transfer the greater part of the stresses due to said bending, guiding and supporting of said wire during said winding operation away from said coil form and onto said jig.

10 13. A coil form for supporting a wire of a spherical rotor of a variometer including a hollow cylinder, a plurality of uniformly spaced and identically shaped arcuate bridges fastened to said cylinder and extending outwardly and radially therefrom, a plurality of identically positioned grooves on the arcuate portions of said bridges for supporting said wire, and a plurality of helically disposed surfaces on said cylinder for positioning said bridges along the helical path defined by said surfaces, whereby said grooves

15 20 form a pitched path for said wire.

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