

May 18, 1948.

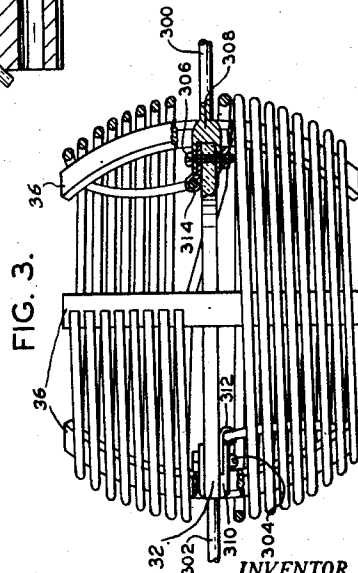
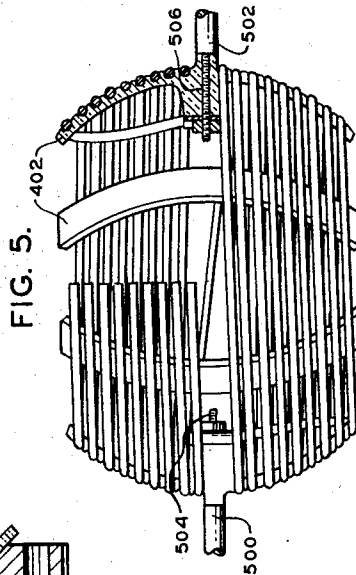
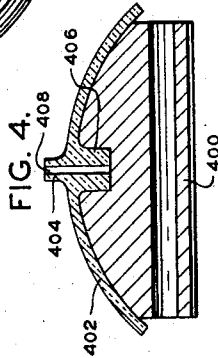
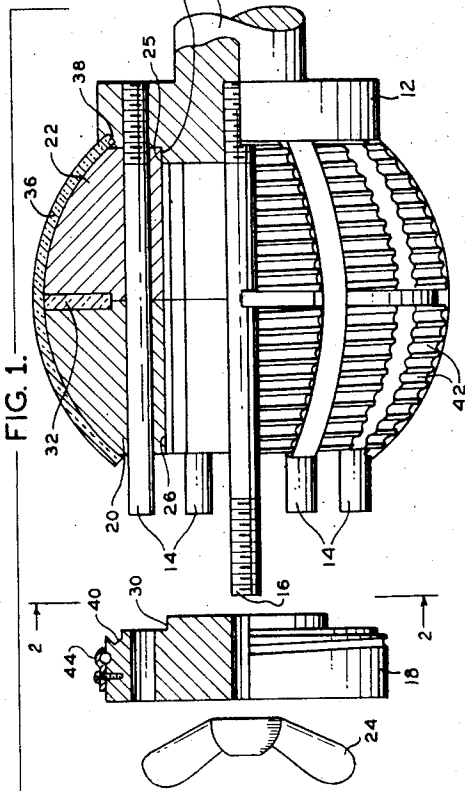
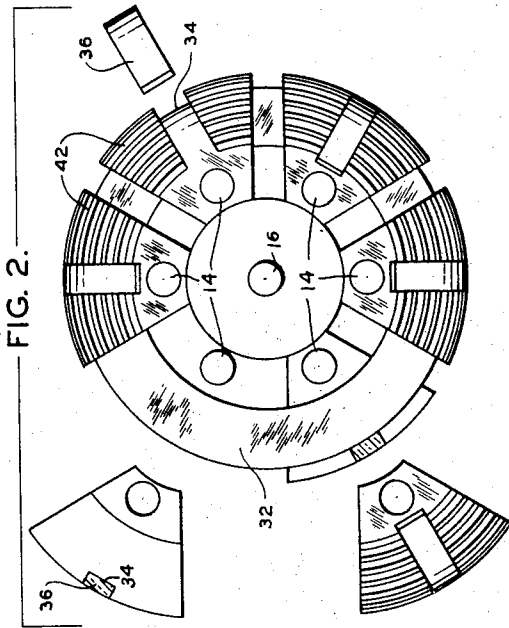
E. E. COMBS

2,441,564

SPHERICAL COIL FOR VARIOMETERS

Filed Sept. 6, 1944

2 Sheets-Sheet 1



INVENTOR.
EDWARD E. COMBS

BY *William D. Hall.*

ATTORNEY

May 18, 1948.

E. E. COMBS

2,441,564

SPHERICAL COIL FOR VARIOMETERS

Filed Sept. 6, 1944

2 Sheets-Sheet 2

FIG. 9.

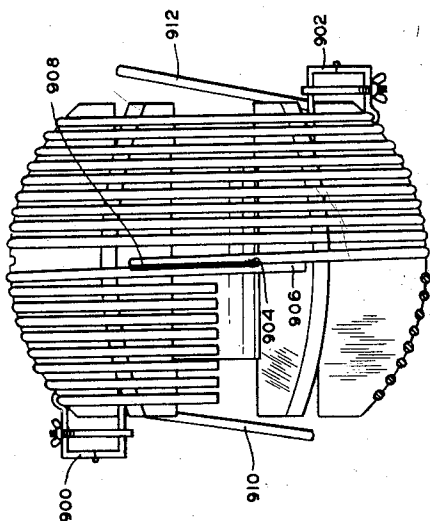


FIG. 6.

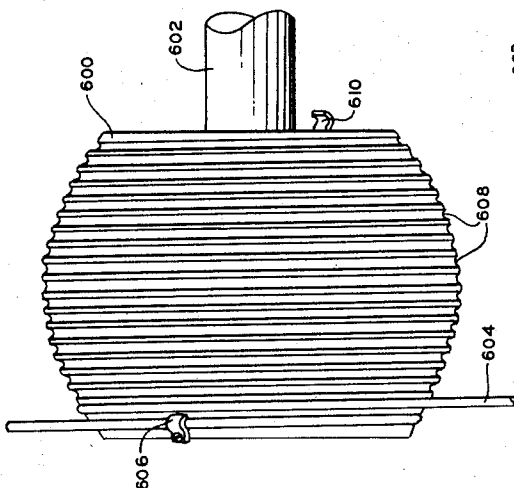


FIG. 7.

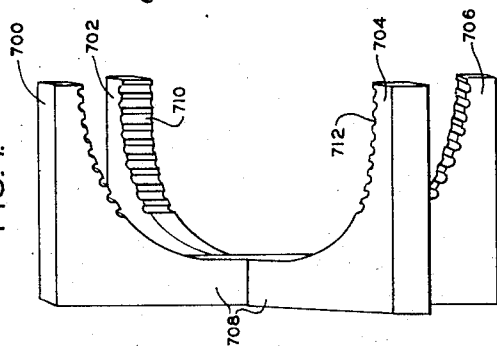
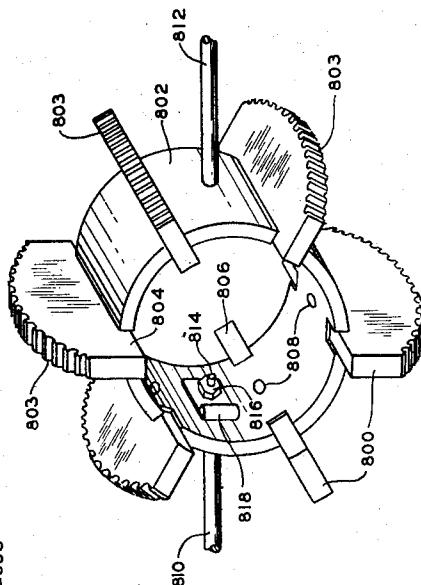


FIG. 8.



INVENTOR.
EDWARD E. COMBS

BY *William D. Hall.*

ATTORNEY

UNITED STATES PATENT OFFICE

2,441,564

SPHERICAL COIL FOR VARIOMETERS

Edward E. Combs, Long Branch, N. J.

Application September 6, 1944, Serial No. 552,859

7 Claims. (Cl. 242-9)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

1

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 of the spherical coils and the method of making them.

It is very well known in the radio art that the spherical coils when used in connection with 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 thus enabling one to span much wider frequency band with the variometers of this type, the combination being capable of replacing as many as six fixed R. F. coils. Although the advantages of the spherical coils are well known in the art, their use has been somewhat limited because no simple manufacturing methods were available, and, as a consequence, the majority of variometers used cylindrical rotors.

The invention discloses a simple method of making the spherical coils and a structure for supporting them after they are wound.

It is, therefore, an object of this invention to provide a simple jig for making spherical coils as well as to improve the structural and electrical features of the coils of this type.

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 drawings in which,

Fig. 1 is a side view of a jig used for making spherical coils,

Fig. 2 is an end view of Fig. 1,

Fig. 3 is a side view of a finished spherical coil,

Fig. 4 is a cross sectional view of an additional coil jig which may be also used for making spherical coils,

Fig. 5 is the side view of a finished spherical coil made in accordance with the method illustrated in Fig. 4,

Fig. 6 is a side view of a modified form of a jig,

Fig. 7 is a side view of a wire holder which is used for transferring the wound wire from the jig illustrated in Fig. 6 onto the coil frame illustrated in Fig. 8,

Fig. 8 is an isometric view of a frame equipped with ceramic pieces for supporting wire, the

2

ceramic pieces being mounted on a ring made of plastics material.

Fig. 9 is a side view of the coil illustrated in Fig. 8 with the wire wound upon it.

Referring now to Fig. 1 the jig for making the coil includes a shaft 10, which is ordinarily mounted in a lathe, enlarged at its outer end so as to form a ring 12, the ring being provided with a plurality of threaded pins 14 which are permanently mounted on the ring along a circle, as illustrated more clearly in Fig. 2. The center of this circle coincides with the longitudinal center-line of shaft 10. Ring 12 is also provided with a centrally mounted pin 16, the center line of pin 16 coinciding with the longitudinal center line of shaft 10. Pin 16 is threaded at both ends, and the right end of the pin is used for fixedly mounting pin 16 on ring 12 while the left end is used for holding an outer ring 18 against the truncated-sphere form-pieces 20 and 22 by means of a wing nut 24. The form-pieces 20 and 22 represent a plurality of pieces which, when mounted on the pins 14, the inner and outer corners 25 and 26 of these pieces rest on shoulders 28 and 30 provided for this purpose on the rings 12 and 18, thus forming a truncated sphere, as illustrated in Fig. 1. The form pieces are provided with a slot used for mounting a ring 32 made of any suitable insulating material such as Bakelite or polystyrene or any other non-conductive substance which does not introduce high radio frequency losses in the coil. The form pieces 20 and 22 are also provided with the longitudinal slots 34 (see Fig. 2), these slots being used for mounting the coil supporting ribs 36 made of the same material as ring 32. The ribs 36 are held in their slots 34 by rings 12 and 18 which are provided for this purpose with recesses 38 and 40, the ribs 36 protruding into these recesses.

The outer surfaces of the form pieces are provided with grooves 42 which are used for guiding the wire of the coil from one end of the form to the other during the winding operation. The grooves thus form an outer thread of the form, the number of turns in the coil being determined by the pitch of this outer thread.

The jig illustrated in the Figs. 1 and 2 is assembled and prepared for winding the coil upon it in the following manner: shaft 10 is mounted in a lathe and the form pieces 22 are slipped onto pins 14, corners 25 engaging shoulder 28 provided in ring 12. This aligns the form pieces 22 so that they form the right side of the form. Ring 32 is then placed in the recesses provided in the

3

pieces 22 and the form pieces 20 are then slipped into their proper position, ring 32 aligning the form pieces 20 with the pieces 22. When this is accomplished the preformed coil ribs 36 are placed into slots 34 (Fig. 2) and recesses 38, and the entire assembly is then rigidly clamped together by sliding ring 18 into engagement with the form pieces 20 and ribs 36, and by tightening the wing nut 24. The jig is now ready for use. The winding operation is performed by clamping the free end of the wire by means of a clamp 44 provided for this purpose on ring 18, and, upon fastening one end of the wire in this manner to the jig, the jig is rotated by the lathe. The wire is passed through a heater before it comes into contact with the form and is guided into the grooves 42 by hand or any suitable mechanical guide. One type of mechanical guide found to be suitable consists of a frame held by the compound rest of the carriage of the lathe, and a wire-guiding orifice supported by the frame. The orifice can be adjusted to introduce the desired degree of friction between the orifice and the wire, which in turn produces the desired degree of tension onto the wire during the winding operation. The wire is heated, preferably by electrical means, prior to its passage through the orifice, and is guided to follow the grooves 42 by sliding the carriage. Since the temperature of the wire has been raised by the heater, it imbeds itself in the polystyrene ribs 36 upon coming into contact with them. Winding operation is continued until the entire form has been covered with the wire whereupon the lathe is stopped and the wire is cut off from the wire spool. The wire is now held in place by the solidified polystyrene. In order to dismantle the jig wing nut 24 is unscrewed, ring 18 is removed from the pins and the entire coil form slid off pins 14 whereupon the form pieces 20 and 22 collapse and are removed from the coil, one form piece at a time. Ring 32 may be cemented to the ribs 36 either before winding of the wire or after the form pieces have been removed, the ring upon being cemented to the ribs, representing a centrally located rib-reinforcing ring imparting rigidity to the entire coil and holding ribs 36 in fixed relationship with respect to the coil. The only remaining operation to finish the coil resides in fastening coil shafts 300, 302 Fig. 3 with their bifurcated ends 308, 310 to the ring which is accomplished by means of bolts 304 and 306, the two ends of the wire are then connected to the shafts by means of lugs 312, 314, the shafts being made of conductive material.

Exceptionally rigid spherical coils are produced by the method illustrated in the Figs. 1 and 2, the coils having an additional advantage that only very limited amount of wire-supporting insulation is used for obtaining the desired result. Accordingly the coils of this type have small R. F. losses and high Q values.

Fig. 4 illustrates another coil form which may be used to accomplish the same result. In Fig. 1 two series of form pieces 20 and 22 are used for obtaining the spherical form, the form pieces being separated from each other in the middle. Split type structure is used since it is necessary to insert ring 32 between the form pieces which separates the form into two symmetrical halves. In Fig. 4 ring 32 has been completely eliminated, and as a consequence the form is made of a plurality of pieces 400 which are identical in all respects to the pieces 20 and 22 in Fig. 1 except that the recesses for ring 32 have been eliminated

4

and the sides joined together to form one piece 400. These pieces are slipped over pins 14 in the same manner as pieces 20 and 22 in Fig. 1, and the functioning of the entire assembly from then on is identical in all respects to the functioning of the assembly illustrated in Fig. 1. As in Fig. 1 ribs 402 are used for actually supporting the wire, these ribs being held in fixed position when the coil is wound in a manner similar to that illustrated in Fig. 1. Two of these ribs are provided with bushings 404 and 406 having a centrally located hole 408. These bushings are used for mounting coil shafts 500 and 502 as illustrated in Fig. 5.

The coil produced with the form illustrated in Fig. 4 is illustrated in Fig. 5. It does not differ markedly from the coil illustrated in Fig. 3 except that the centrally located ring 32 has been completely eliminated and the coil shafts instead of being mounted on ring 32 are now mounted on ribs 406 in a manner clearly illustrated in Fig. 5. The advantage of the coil illustrated in Fig. 5, as compared to the coil illustrated in Fig. 3, resides in the fact that a narrower spacing may be used between the central turns of the coil since shafts 500 and 502 are now equipped with threaded pins 504 and 506 which do not require as much clearance between the turns as the bifurcated joints 308 and 310 in Fig. 3.

Figs. 3 and 5 disclose that type of spherical coil which uses plastics, such as polystyrene, for supporting the wire. Uses of the variometer are encountered when the variometer is subjected to such heavy loads that the coils reach sufficiently high temperatures either to melt or carbonize the supports made of plastics. When such heavy usage is contemplated, it is obvious that the coils illustrated in Figs. 3 and 5 are unsuitable, and ceramic material must be used for supporting the wire of the coil.

Fig. 8 illustrates such coil where the wire supporting bridges 800 are made of ceramic material, the bridges being mounted on a ring 802 made of plastics. The outer surfaces 803 of the bridges are grooved for holding the wire, and are provided with extensions 804 and 806 which fit into the recesses provided for this purpose in ring 802. In order to stiffen the structure the ceramic bridges and the ring are provided with suitable holes 808 which are used for mounting plastic pins which act as additional elastic means for holding the ceramic bridges in elastic engagement with the ring. A two-piece shaft 810 and 812 of the coil is mounted in this instance on ring 802 by means of threaded ends 814 and nuts 816 (only one end is visible in the figure). The wound wire is connected to the shaft by means of lugs 818. The advantage of the structure illustrated in Fig. 8 resides in the fact that ring 802 is made of plastics thus providing a resilient base for the ceramic pieces, the resiliency of the ring and the resiliency of the connections between the ring and the bridges contributing markedly to the ability of the coil to absorb occasional severe shocks which are apt to take place when the equipment is subjected to unusually severe usage. In the prior art the entire coil supporting frame is made of ceramic material which results in a very brittle frame not capable of absorbing any mechanical shocks. This is not the case in Fig. 8 since the resiliencies of the ring and of the joints are so proportioned that they are capable of absorbing very severe shocks. When the variometer is in service, and is acci-

dently dropped, the shock is transmitted to the coil through shafts 810, 812, and since the shafts are mounted in the resilient ring 802, the shock is absorbed, in the main, by the ring and the bridge-ring pins, and is transmitted to the ceramic bridges only in a subdued form. When the ring is made of the ceramic material it ordinarily cracks resulting in the collapse of the entire coil.

In order to wind the coil frame illustrated in Fig. 8, a coil form 600 illustrated in Fig. 6 is used. It consists of a spherical metal form 600 slidably mounted on a mandrel 602, the mandrel being mounted in a lathe which revolves the form when a wire 604 is wound upon it. A clamp 606 is provided which is used for clamping the free end of the wire, and after the wire has been clamped, the form is rotated and the wire is wound on the form, the wire following grooves 608 provided for this purpose on the form. After the form has been completely wound the rotation of the form is stopped, and the opposite end of the wire is clamped by means of a clamp 610 similar to clamp 606. The wire is then cut off and the next step consists of transferring the wire wound on form 600 onto the frame illustrated in Fig. 8.

This transfer is accomplished by means of a wire holder illustrated in Fig. 7, which consists of four projections 700, 702, 704 and 706 joined together at 708, the inner surfaces of the projections being provided with grooves 710, 712 for holding the wire. Only one wire holder is illustrated in Fig. 7, but to accomplish the transfer of the wire from the form 600 onto the frame illustrated in Fig. 8, two wire holders are used simultaneously, the second holder being identical to the one illustrated in Fig. 7. After removing form 600 from the mandrel, the two holders are slipped over form 600, which they fit snugly, clamps 606, 610 are removed, and the wire is cut in the middle of the coil. Because of the springing action of the wire, it unwinds itself slightly, and this unwinding of the wire transfers it to the holders. The holders are then removed from form 600, and are placed on the frame illustrated in Fig. 8. The outer free ends 910 and 912 of the wire are then clamped to the ceramic bridges 800 by means of clamps 900, 902, as illustrated in Fig. 9, and after the outer ends have been thus secured to the ceramic bridges, the inner ends 906, 908 of the wire are pulled tightly against the bridges, thus transferring the wire from the holders onto the coil frame, and joined together by soldering as illustrated at 904. The outer ends 910 and 912 are then connected to the lugs 818 (only one lug is illustrated in Fig. 8). The clamps 900 and 902 are then removed and the coil is ready for its mounting in the variometer. In the majority of the cases the variometer structure may be such that connecting of the outer ends 910 and 912 to the lugs must be performed within the variometer after the spherical coil has been inserted into the stator. In either case the final connections are the same.

I claim:

1. A jig for winding a spherical wire coil for a variometer said jig including a shaft, a plurality of pins in fixed relationship with respect to said shaft, a plurality of truncated-sphere form-pieces in sliding engagement with said pins, said pieces, when mounted on said pins, forming a spherical form for winding said coil, and a clamping ring for rigidly holding said pieces during the winding operation of said coil.

2. A jig for winding a spherical coil as defined in claim 1 in which said form-pieces are so constructed and arranged as to form a collapsible structure removable from said coil upon completion of the winding operation of said coil and upon sliding of said form off said pins.

3. A jig for winding a spherical coil as defined in claim 1 in which said form pieces further include recesses for holding wire-supporting ribs for said coil.

4. A jig for winding a spherical coil as defined in claim 1 in which said form pieces further include recesses for holding wire-supporting ribs and a centrally mounted ring for centrally bracing said ribs upon removal of said form pieces.

5. A combination including a coil frame for winding a spherical wire-coil on said frame, said frame including a plurality of wire-supporting ribs, a plurality of form-pieces supporting said ribs, said ribs fitting into said form-pieces whereby the outer surfaces of said form-pieces and said ribs form a spherical wire-supporting surface during the winding operation of said coil, a shaft, a plurality of pins in fixed relationship with respect to said shaft, said form-pieces being slidably mounted on said pins, and a clamping ring for rigidly holding said form-pieces and said ribs against said shaft during the winding operation of said coil.

6. A combination as defined in claim 5 in which said ribs and said form-pieces are dimensioned so as to allow the removal of said form-pieces out of said spherical wire-coil upon the completion of the winding operation, removal of said clamping ring, and sliding of said form-pieces off said pins, said form-pieces thus acting as a collapsible wire-winding jig for said coil.

7. A combination as defined in claim 5 in which said ribs are made of thermoplastic material, said wire being partially embedded in and rigidly retained by said ribs.

EDWARD E. COMBS.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,640,821	Cocks	Aug. 30, 1927
1,853,148	Rigante	Apr. 12, 1932
1,888,541	Rigante	Nov. 22, 1932
1,965,330	Apple	July 3, 1934
2,013,764	Putnam	Sept. 30, 1935