

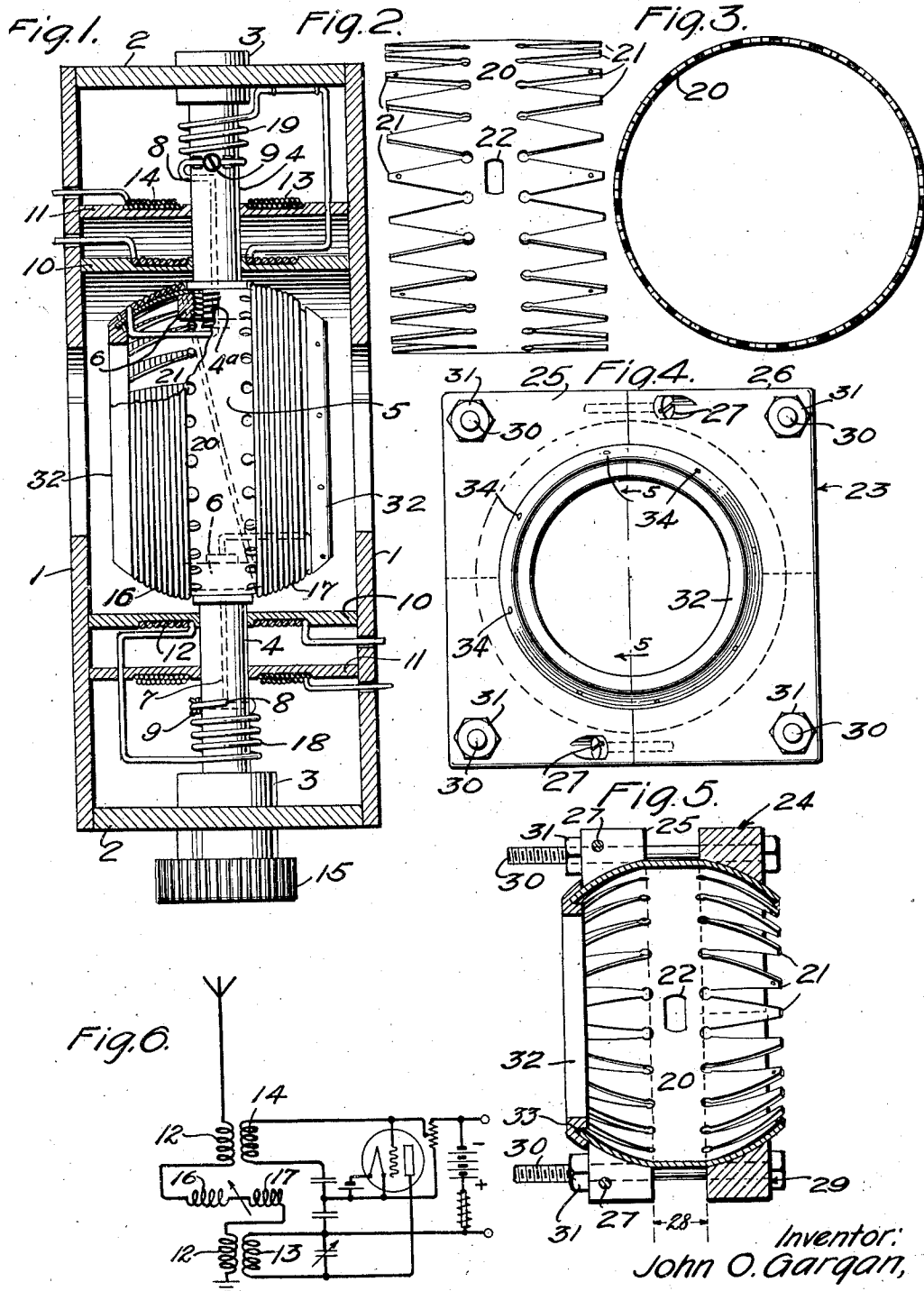
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VARIABLE INDUCTIVE DEVICE

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## UNITED STATES PATENT OFFICE.

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## VARIABLE INDUCTIVE DEVICE.

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This invention relates to a variable inductive device having relatively movable coil sections which is adapted for use in high frequency circuits and more particularly to a method of making an insulating support for the movable coil section.

As is well-known the presence of metallic parts in proximity to conductors carrying high frequency current of appreciable value results in the production of large eddy currents in the metal and hence the development of a considerable amount of heat. Aside from the fact that the energy thus transformed into heat is wasted, it has been found difficult and in some cases impossible to dissipate this heat at a sufficiently rapid rate to prevent overheating these parts. This causes rapid deterioration of the apparatus and in time its destruction would result, due to the temperature of the metallic parts being excessive. This is especially true when the power transmitted is relatively large and the frequency of the electrical waves is exceptionally high, as, for instance, in the case of a 100 watt transmitter radiating waves of from 500,000 to 1,000,000 cycles.

The present invention is directed to an inductive device comprising a stationary coil mounted on a cylindrical insulating support and a movable coil wound upon a core of insulating material which is substantially ball shaped or spheriodal and is carried by an insulating shaft coaxial with respect to the stationary coil support. It is further directed to a method of and a means for making the ball shaped or spheriodal core for the movable coil.

One object of this invention is to provide a variable inductive device which is substantially free from metallic parts. Another object is to provide a movable coil support having ventilating openings or passages. Still another object is to provide a spheriodal core mounting for a movable coil which is strong, durable and inexpensive to manufacture.

The invention itself as to its organization and the operation of its various parts will be clear from the following description read in connection with the attached drawing in which Fig. 1 shows an inductometer which involves the invention; Figs. 2 and 3 show a side and end view respectively of a partially completed core body for the movable coil; Fig. 4 shows an end view of a

mould used for shaping the coil body; Fig. 5 is a section on line 5—5 of Fig. 4, and Fig. 6 illustrates one form of apparatus with which the inductometer may be used.

Referring to Fig. 1 there is shown a frame of insulating material comprising the sides 1 and ends 2 provided with bearings 3. Mounted in the bearings 3 are stub shafts 4 of insulating material adapted to be secured to the core body 5 by nuts 6 engaging the screw threaded ends 4<sup>a</sup> of the shafts. These nuts are also of insulating material. the shafts 4 may be hollow but in any case each shaft is provided with a duct 7 extending from its inner end along part of the length of the shaft and then laterally through the side thereof at 8. Binding posts 9 are mounted on or are secured to the shafts adjacent the openings 8. Secured in the frame are a plurality of cylinders 10 and 11 of insulating material upon which stationary coils 12, 13 and 14, adapted to cooperate with the coil carried by the movable core, are mounted. A knob or handle 15 secured to one of the shafts 4 is provided, whereby the adjustment of the movable core may be effected.

The winding of the movable coil consists of two sections 16 and 17, the terminal wires of which are threaded through the ducts 7, lateral openings 8 and secured to the binding posts 9. The fixed portion of the winding of the inductive device or inductometer, namely the coil 12, is wound in two sections on the insulating support 10. One section is wound upon the left-hand cylinder, and an end portion of the conductor constituting the winding, after being wrapped around the lower shaft 4 as shown at 18, is then secured to the binding post 9. The other section is similarly wound on the right-hand cylinder 10. An end portion of the conductor constituting this winding is coiled about the upper shaft 4, as shown at 19, is secured to the other binding post 9. Thus, the two sections of the stationary winding 12 and the movable coils 16, 17 are connected in series circuit. As shown these coils are also mutually coupled, so that the inductive effect of the complete device comprises the algebraic sum of the self-inductances of the separate coils and the mutual inductance between them. In one extreme position of the core 5, the self-inductance of the several windings and the

mutual inductance between them will be additive and hence the reactive effect of the device will be a maximum. By rotating the coil through 180°, however, the inductances of the several coil sections will oppose one another by virtue of the fact that the current flow in the coupled sections is oppositely directed and the total inductive effect of the device will thereby be reduced to a minimum.

The core upon which the movable coil is wound is a shell having two end sections which are zones of spheres and a medial section of cylindrical form. As shown in Fig. 2 a cylinder of insulating fibre 20 has portions cut away to form tooth shaped projections or arms 21 extending from the outer limits of the cylindrical center portion to its ends. Each of the arms 21 is adapted to be bent into the form of a sector of a sphere, the center of which lies on the longitudinal axis of the cylinder and in the plane passing through the outer limit of the cylindrical portion thereof. In order that the arms may be bent into spherical sectors, the material of which the cylinder is composed must have a relatively high degree of flexibility and, since the dielectric in the field of the coil should be a minimum, in order to maintain the capacity of the coil as low as possible, its material should be as thin as possible consistent with mechanical strength. One insulating material which is readily available and has been used for this purpose is phenol fibre, though any other material which meets these requirements may be used.

The cylindrical portion of the core is provided with two slots or openings 22 having straight sides into which correspondingly shaped portions of the shafts 4 are seated and held by the nuts 6. By this means, the shafts and core are securely connected together so that the core and hence the movable winding will be adjusted to any desired position upon the actuation of the knob 15.

By designing the arms 21 so that they have uniform flexure throughout their length and breadth, each group of arms may be simultaneously shaped by applying a properly designed mould to their outer extremities and forcing it home. By providing an annular mould having its maximum internal diameter equal to that of the fibre cylinder, its interior surface that of the zone of a sphere of the desired dimensions the several arms constituting one group will be shaped in accordance with inner surfaces of the mould and be properly centered therein when the mould, having been applied to the outer extremities of the arms 21, is forced inwardly as far as possible.

An apparatus for effecting the deformation of the end sections of the core as described above is shown in Figs. 4 and 5. In

these figures a pair of moulds 23 and 24 are shown, each consisting of two sections 25 and 26 connected together by screws or bolts 27 which may be applied as shown in Figure 4 or may extend completely through these sections. The internal surfaces of each mould correspond to the zone of a sphere, the diameter of the mould in the plane 28 is the same as that of the cylinder while its diameter in the plane 29 is equal to that of the smallest winding section used and the thickness of each mould is equal to the width of the winding section. When the moulds are applied to the extremities of the core body and drawn toward one another by the bolts 30 and nuts 31 until the surfaces 28 are in line with the inner extremity of the slots in the tube, each arm will lie in intimate contact with the inner surface of the mould throughout its whole extent and hence each group of arms will constitute a zone of a sphere.

The length of the arms 21 should be somewhat greater than the width of the winding space used, so that when the moulds are in final position the ends of these arms will project a short distance beyond the ends of the moulds, whereby an insulating ring 32 may be secured to the projecting ends of each group of arms 21 to complete the core structure. As shown the rings 32 are each provided with a circular groove 33 into which the projecting ends of the arms 21 are inserted and secured, this being effected by gluing or cementing these parts together or by insertion of insulating pins 34 projecting through perforations provided in the rings and arms. In fact both methods of fastening the rings and arms together may be used in the same structure. These rings serve to retain the arms 21 deformed and the windings 16 and 17 upon the end sections of the core 5. Having secured rings 32 in place the bolts 27 are removed and the mould sections 25 and 26 are then withdrawn in a direction transverse to the core body 5.

In Fig. 6 there is shown a radio transmitting system having an oscillator comprising an electric discharge device, the plate circuit of which includes the coil 13 and is coupled in feed back relation to the grid circuit, which includes the coil 14, by the antenna circuit having the coils 12, 16, 17 and 12 in series. The frequency of the oscillations radiated will be largely determined by the constants of the antenna circuit. By rotating the coils 16 and 17, which as shown in Fig. 1 are carried by the movable core, the tuning of the antenna circuit and its coupling with the plate and grid circuit coils 13 and 14 will be simultaneously varied.

From the preceding description it will be seen that the inductometer herein described possesses the advantage over constructions

heretofore suggested that all of the parts with which the windings are associated are of insulating material. An additional feature of the present construction is that, due to the removal of portions of the end sections of the core 5, the area of the coils 16 and 17 wound upon these sections which is exposed to the atmosphere is greatly increased. As is clear from Fig. 1, wherein the core body is shown broken away to expose its interior, a considerable part of the internal surface of these coils is exposed to the atmosphere and hence the heat developed therein due to the high frequency and large amplitude of the current flow through the coils will be readily dissipated. Again, it will be apparent that the ball shaped or spheroidal body is made of a material which is readily available in the open market and that the complete body consists of only three parts. The method of preparing and shaping the core body consists of simple steps and requires the use of but simple apparatus. Hence the apparatus itself, as well as the equipment required to manufacture it, is both simple and inexpensive.

While in the preceding description certain specific arrangement, details, and one application of the invention have been set forth, it is to be understood that this invention is not to be limited by these disclosures but only by the scope of the attached claims.

What is claimed is:

1. A method of making a support for the movable coil of an inductive device from a cylinder of insulating material which comprises slotting the end portions of the cylinder, deforming the end sections to constitute spaces for coil windings having ventilating openings, and maintaining the end portions deformed.

2. A method of making a support for the movable coil of an inductive device from a cylinder of fibrous material which comprises slotting the end sections of the cylinder, deforming each end section to constitute the zone of a sphere, and maintaining the end sections deformed.

3. A method of producing a movable coil support for a variable inductive device from a cylinder of fibrous insulating material which comprises slotting the end sections of the cylinder to produce arms each of uniform flexibility, shaping the arms into sectors of a sphere, and connecting the outer extremities of the arms of each section together to constitute a zone of a sphere.

4. A method of producing a movable coil support for a variable inductive device from an insulating fibrous material which comprises cutting away end portions of the cylinder to form groups of arms, moulding the groups of arms to constitute zones of spheres of the same diameter, and connecting the ends of the respective groups of arms to-

gether to maintain the spheroidal form of the end portions.

5. An inductometer including a cylindrical portion, a spheroidal slotted end portion, and a winding secured to said end portion.

6. An inductometer including a hollow core having a spheroidal slotted portion, with an open end and a winding secured to said portion.

7. An inductometer including a movable element comprising a core having a hollow cylindrical body portion, a deformed cylindrical slotted portion projecting from and integral with said body portion, and a winding mounted upon said slotted portion.

8. An inductometer including a movable element comprising a core having a hollow cylindrical body portion, a spheroidal slotted portion at each side of said body portion, said spheroidal slotted portions being open at the ends thereof, and windings mounted upon said slotted portions.

9. An inductometer including a movable element comprising a core having a hollow cylindrical body portion, a plurality of deformed cylindrical slotted portions projecting therefrom, and windings mounted upon said slotted portions.

10. An inductometer including a movable element comprising a core having a cylindrical body portion; a plurality of spheroidal slotted portions projecting from said body portion, and windings mounted upon said slotted portions.

11. An inductometer including a movable element comprising a core having a cylindrical body portion, a spheroidal slotted portion at each side of said cylindrical portion, and windings mounted upon said slotted portions.

12. A support and a winding thereupon, said support comprising a cylindrical body portion, a plurality of finger-like projections extending from each edge of said body portion, said finger-like projections forming a somewhat rounded frusto-conical surface connected to each edge, said winding having turns wound upon said surface.

13. A support for an inductance coil winding comprising a cylindrical body portion and a plurality of spaced apart flexible projections extending from each edge of said body portion.

14. A support for an inductance coil winding comprising an approximately cylindrical element of insulation material having a plurality of slots in each end of said cylinder with fingers projecting between each slot, each of said slots terminating at its base in an opening with rounded walls.

15. A support for an inductance winding comprising an approximately cylindrical portion of insulating material, and a complete ring of finger-like projections upon an end of said portion.

16. A support for an inductance winding comprising an approximately cylindrical portion of insulating material, and a complete ring of uniformly curved finger-like projections upon the end of said portion.
17. A support for an inductance winding comprising an approximately cylindrical portion of insulating material, a ring of relatively flexible finger-like projections extending from an end thereof, said projections being engaged in and held relatively rigidly by an end retaining member.
18. A support for inductance coil windings comprising a relatively thin walled cylinder of insulation material having a series of approximately triangular notches around an edge thereof.
19. A support for inductance coil windings comprising a relatively thin sheet of insulation material having a series of approximately triangular notches around an edge thereof with rounded openings at the bottom of each of said notches.
- In witness whereof, I hereunto subscribe my name this 22nd day of December A. D., 1921.

JOHN O. GARGAN.