June 22, 1926. 1,589,416

E. J. NIELSEN

VARIABLE ELEMENT

Filed April 30, 1923 2 Sheets-Sheet 1

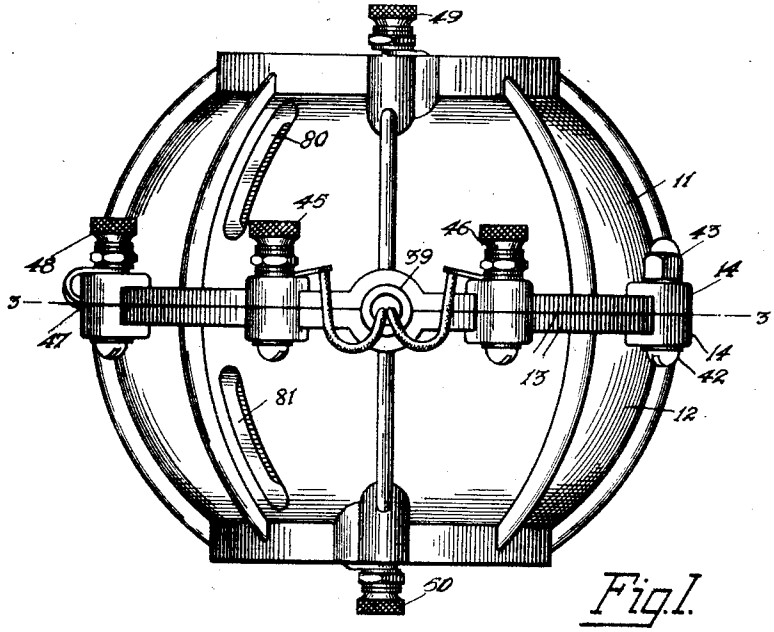

Fig. 1.

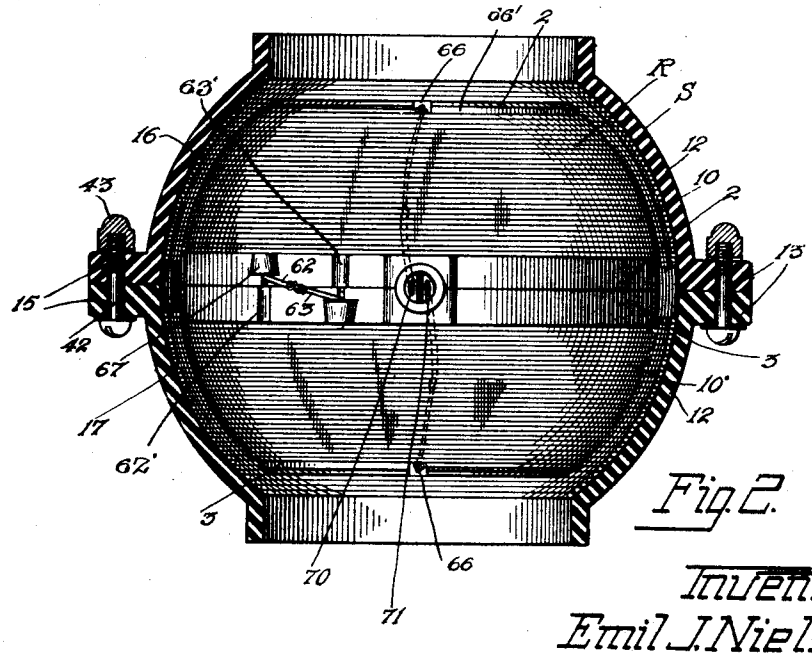

Fig. 2.

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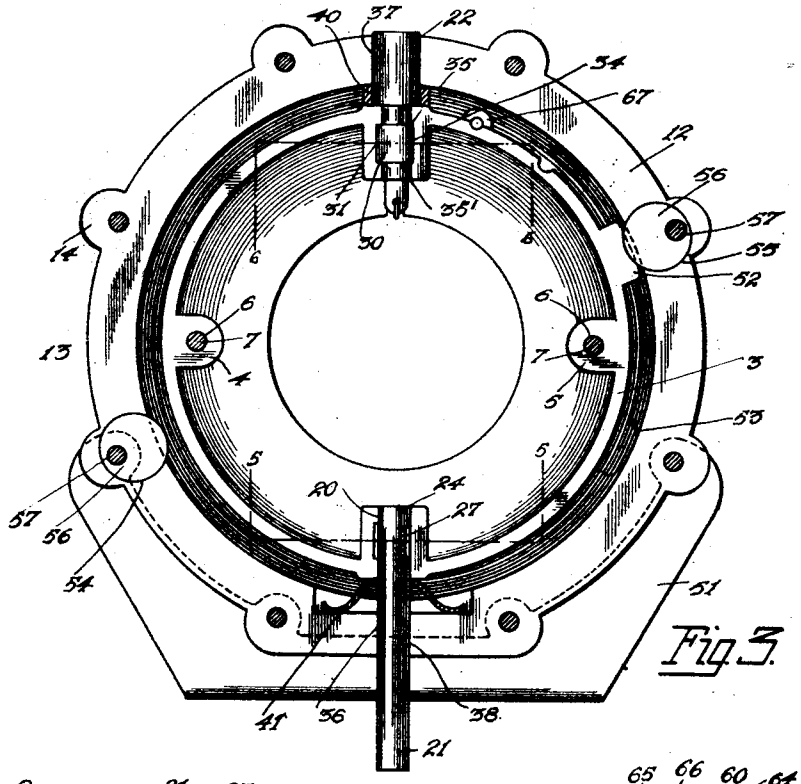

Fig. 3.

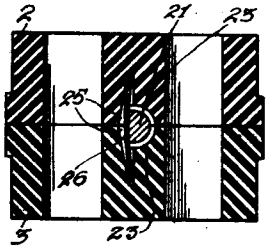

Fig. 5.

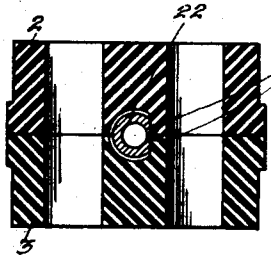

Fig. 6.

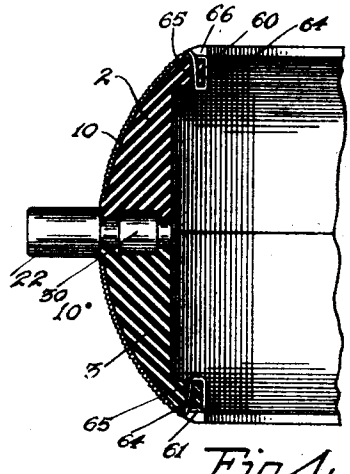

Fig. 4.

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Patented June 22, 1926. 1,589,416

UNITED STATES PATENT OFFICE.

EMIL J. NIELSEN, OF OAK PARK, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

VARIABLE ELEMENT.

Application filed April 30, 1923. Serial No. 635,414.

My invention relates to variable inductances and has to do more particularly with that type of inductance known in the art of radio telephony as a variometer in which a pair of coils or helices of wire, one stationary and the other rotatable, rotates inside of the stationary coil.

An object of my invention is the provision of an improved variometer which is provided with structural features which facilitate the assembly of a variometer of this type and at the same time provide an improved variometer structure which will be most efficient in its operation.

A variometer of the above type is provided with a stator spherical in form and comprises two halves which contain the stationary coil or winding and a rotor spherical in form which comprises two halves upon which the movable coil or winding is wound. This rotor element may be rotated within the stator which contains the stationary winding through a fixed degree of roation, through the medium of a pivoted shaft. Shafts of various types have been devised to pivotally support the rotor element and are more or less complicated in their construction and their method of securing them to the rotor element. In assembly of the rotor the two halves of the rotor are suitably secured together to form a spherical rotor element and the shaft for pivotally supporting the rotor is then secured in position by suitable means such as nuts or similar means. The shaft ends when in position in the rotor are inaccessible due to the spherical form of the rotor thus making the assembly of the shaft parts difficult. This manner of securing the shaft to the rotor is also objectional in that there is liability of the nuts which hold the shaft in position becoming loose and thereby permit the rotation of the shaft in the rotor without effecting the rotation of the rotor element as a whole.

In order to overcome the above objections to a shaft thus secured I have designed a shaft which dispenses with all nuts or set screw securing mean, and a feature of my invention is the provision of a spring member resting in suitable orifices in the rotor halves which cooperates with one section of the shaft when the rotor halves are secured together to prevent turning or longitudinal movement of the shaft.

Another feature of my invention is the provision of spring means which will permit the shaft held in position by means of the spring to yield slightly when the rotor element is moved to either of its extreme positions. This slight yielding of the shaft acts as a cushion to absorb the blow should the rotor be unduly forced to either of its extreme positions by the operator.

Another feature of my invention is the provision of novel means for securing the second section of the shaft in position against rotation.

Variometers of this type are also provided with various terminal connection means for the terminals of the winding of the rotor element so that they may be conducted to the external terminal connections provided for them. The rotor element which comprises two halves is also provided with suitable orifices to permit the insertion of two of the ends of each half of the rotor windings so they may be connected to the terminals provided for them. Orifices in each of the rotor halves are also provided which permit the other ends of the windings to be inserted therethrough into the interior of the rotor sphere so that they may be connected to form a continuous winding for said rotor element. Terminals provided on the rotor for the winding terminals as just described are practically inaccessible as they are usually located in the interior of the rotor sphere formed by the two halves thus making the connection of the winding terminals to the terminals provided therefor difficult to get at. The other winding end of the rotor windings are secured together to form a continuous winding and this connection is also made in the interior of the rotor sphere thus making this connection also difficult. A type of variometer provided with this method of terminal connection necessitates additional assembly of parts and tooling of the rotor halves for the orifices thus adding materially to the cost of manufacture.

To overcome these objections above cited I have designed novel means for eliminating these terminals, and another feature of my invention is the provision of a hollow shaft which permit the winding terminals of the rotor winding to be led to the external terminals without the use of additional terminals secured to the rotor. Still another

feature of my invention is the provision of securing means for the inner terminal ends of the rotor windings so that all connections and securing of the winding ends of the rotor element may be made externally on the stator.

The above named features as well as others, the combinations of which produce an improved variometer structure will be more fully described in the ensuing specification.

For a clearer understanding of my invention, reference may be had to the accompanying drawings in which like reference characters in the several views denote like parts and in which

Fig. 1 is a side elevation of the variometer of my invention;

Fig. 2 is a view similar to Fig. 1 with the stator element in section to more clearly illustrate the rotor element of the variometer;

Fig. 3 is a sectional view of the variometer along the line 3—3 of Fig. 1;

Fig. 4 is a fragmentary sectional view of the rotor element to more clearly illustrate the securing means of the outer ends of the rotor winding;

Fig. 5 is a sectional view along the line 5—5 of Fig. 3 to clearly illustrate the securing means of one of the rotor shafts, and

Fig. 6 is a sectional view along the line 6—6 of Fig. 3 to clearly illustrate the securing means of the other portion of the rotor shaft.

Referring now more in detail to my invention as illustrated in the accompanying drawings, it comprises a rotor R spherical in form and moulded in two halves 2 and 3 of suitable insulation material such as bakelite. Each half 2 and 3 of the rotor R has integrally formed therewith a pair of lugs 4 and 5 diametrically opposite each other, which have suitable openings 6 of a size to receive screws 7 which are adapted to receive suitable nuts to clamp the two halves 2 and 3 of the rotor R together. With this method of assembly of the two halves of the rotor R, a smooth spherical surface is presented for windings 10 and 10′ of the coil of the rotor R. Each half 2 and 3 is provided with a peripheral portion 66′ for receiving a portion of the rotor winding.

The stator S of the variometer is also spherical in form and moulded in two halves 11 and 12 of suitable insulation material such as bakelite. Each stator half 11 and 12 has integrally formed therewith a flange 13 and a plurality of offset portions 14 which are provided with orifices 15. A pair of coils or windings 16 and 17 are shaped to conform with the inner spherical surface of the halves 11 and 12, and rest therein and are held in position by means of suitable adhesive liquid, such as shellac, or collodion, which when dry permits the windings 16 and 17 to adhere to the inner surfaces of the stator halves 11 and 12 of the stator S.

A pair of shafts 21 and 22 are provided for rotatably supporting the rotor R as a whole inside of the stator S. The rotor halves 2 and 3 are provided with semi-circular recesses 20 which when the halves 2 and 3 are secured together form a circular orifice 23 to receive the end 24 of the shaft 21. A V shaped orifice 25 is provided in each of the recesses 20 and is of a size to receive a leaf spring 26 which rests in said orifices 25. End 24 of the shaft 21 which rests in the orifice 23 is provided with a notch 27 which cooperates with the spring 26 as will presently be described. In the assembly of the rotor halves 2 and 3 the leaf spring 26 is inserted in the V shaped orifice 25 of one of the rotor halves as 3 and the shaft 21 is then placed in the semi-circular recess 20 provided for it in the rotor half 3. The spring 26 when in position in the V shaped orifice 25 rests in the groove or notch 27 in the end portion 24 of the shaft 21 and when thus far assembled the other half as 2 of the rotor element R is placed upon the half 3. The V shaped orifice 25 of this half 2 registers with the V shaped orifice 25 of the half 3 and the protruding end of the spring 26 enters this V shaped orifice 25 and when in this position the two halves are clamped or secured together by means of screws 7 and nuts as before described. The spring 26 when the two rotor halves 2 and 3 are assembled to form the rotor element R rests in the notch 27 in the shaft 21 and prevents longitudinal movement of the shaft 21 and also prevents turning of the shaft 21 in the orifice 23 formed by the two semi-circular recesses 20 in the rotor halves 2 and 3 but the spring 26 although holding the shaft 21 against turning permits a slight movement of the shaft for purposes as will presently be described.

The shaft 22 which forms the other shaft support for the rotor element R is tubular in form and is also clamped between the two rotor halves 2 and 3 by the screws 7 and suitable nuts. A portion 30 of the shaft 22 rests in recesses 31 in the rotor halves 2 and 3, a portion of each of said recesses being provided with a flat face portion 33. A portion 30 of the shaft 22 which rests in the recesses 31 in provided with a face portion 34 which when the shaft 22 is in position engages the face portions 33 of the recesses 31 so that when the shaft 22 is in position as illustrated in Figs. 3 and 4 and the rotor halves 2 and 3 are clamped together, the shoulders 35 and 35′ formed by the portion 30 of the shaft 22 prevents longitudinal movement of the shaft 22 and

the faces 33 of the recesses 31 in the rotor halves 2 and 3 engaging the face 34 on the shaft 22 prevents turning of the shaft 22.

The stator halves 11 and 12 are provided with semi-circular recesses 36 and 37 diametrically opposite and the recesses 36 in each of the stator halves 11 and 12 form an orifice 38 of a size to permit the shaft 21 to extend through, the recesses 37 in each of the stator halves 11 and 12 form an orifice 39 of a size to permit the shaft 22 to extend through and the orifices 38 and 39 form bearings for the said rotor R when the same is rotated.

The rotor R is adapted to rotate within the assembled stator S and is supported upon the shafts 21 and 22 and held in concentric relation with the stator S by means of a spacer washer 40 which is placed upon the shaft 22 between the rotor R and the inner face of the stator S. A leaf spring 41 formed as illustrated in Fig. 3 is placed upon the shaft 21 and rests between the rotor R and inner face of the stator S to prevent longitudinal movement of the rotor R as a whole in its bearings 38 and 39, and also provides friction means for holding the rotor R in any of its adjusted positions. When the rotor R is in its position as illustrated in Fig. 3, the stator half 11 is placed in position and screws 42 pass through the orifices 15 in the flange 14 of the stator halves 11 and 12 and bolts 42 having screw-threaded engagement with the screws 43 clamp the stator halves 11 and 12 to form the spherical shaped stator S. Certain of said screws 42 are adapted to receive terminals 45 and 46 to which the winding terminals of the coil 10—10′ of the rotor R are soldered, as will presently be described. The inside terminals of the windings 16 and 17 of the stator halves 11 and 12 are brought out through a suitable opening 47 in the stator halves to the terminal on binding post 48 secured to one of the screws 42. The outer terminals of windings 16 and 17 of the stator halves 11 and 12 are brought through suitable orifices in the said halves 11 and 12 which are formed during the moulding of the stator as illustrated in Fig. 1 and connected to the external terminals 49 and 50 secured to the stator halves 11 and 12. Brackets 51 are secured to the stator halves 11 and 12 by means of the screws 42 and nuts 43 and permit the variometer as a whole to be secured to a panel.

As before stated, the rotor element R is adapted to be rotated within the stator element S through a fixed degree, which in practice is set at 180 degrees, and I provide novel stopping means for stopping the rotor R in its zero position and its extreme position, which is 180 degrees. The rotor half 2 is provided with a stop lug 52 integrally formed therewith, and the rotor half 3 is also provided with a stop lug 53, which lugs 52 and 53 when the rotor halves 2 and 3 are assembled are spaced 45 degrees apart. The stator half 11 is provided with a pair of circular depressions 54 and 55, whose centers are eccentrically displaced in relation to the centers of a pair of diametrically opposite orifices 15 in the flange 13 of the sector half 11. Discs 56 are provided and are of a size to rest in the depressions 54 and 55 and are provided with eccentrically displaced orifices 57 which register with the orifices 15. Now, when the stator half 12 is in place and the two stator halves 11 and 12 are secured together, the discs 56 are held in position. By referring to Fig. 3 it may be seen that when the rotor R is in the position illustrated in Fig. 3 the stop lug 52 of the rotor half 3 engages a disc 56 and thus limits the movement in a clockwise direction. Now, when the rotor R is turned in a counter-clockwise direction, the stop lug 53 on the rotor half 2 which is shown in dotted lines in Fig. 4, will engage the disc 56 diametrically opposite the disc 56 that was engaged by the stop lug 52 on the rotor half 2 when moved through 180 degrees of rotation in a counter-clockwise direction. When the rotor R is again turned in a clockwise direction, the stop lug 53 will again engage its associated disc 56.

From the above description it may be seen that I provide a novel stop arrangement for the rotor R which is simple in construction and does not necessitate a large number of parts.

I also provide novel means for securing in place the outer ends 60 and 61 of the windings 10 and 10′ of the rotor R and the inner ends 62 and 63 of the windings 10 and 10′ as will now be described. An individual lug 64 integrally formed with each rotor half 2 and 3 is provided with a suitable orifice 65.

The outer end 60 of winding 10 extends through a slot 66 formed in the peripheral portion 66′ and then passes through the orifice 65 in the lug 64 and is then looped around the portion of said winding 10 engaging the slot 66 and is then permitted to extend into the rotor R the said looped portion resting in the slot 66 molded in the peripheral portion 66′ of the rotor half 2 adjacent to the lug 64. A lug 67 integrally formed upon the rotor half 2 is provided with a suitable orifice through which the inner end 62 of the winding 10 extends. The outer end 61 of the winding 10′ of the rotor half 3 is also secured as above described in connection with the outer winding end 60 its end extending into the rotor R. The inner end 63 of the winding 10′ extends through the orifice in the lug 67 on the rotor half 3 and these two inner ends 62 and 63 of the windings 10 and 10′ may now be connected to-

gether to form the continuous rotor winding. Recesses or grooves 62′ and 63′ are provided in the rotor halves 3 and 2, respectively, and are situated so that when the said halves are clamped together the recess 62′ will be in alignment with the orifice in the lug 67 and the recess 63′ will be in alignment with the orifice in the other lug 67. The purpose of these recesses 62′ and 63′ will now be described. When the winding 10 has been placed upon the rotor half 2, the end 62 is run through the orifice in the lug 67 of the rotor half 2, and were it not for the provision of the recess 62′ only a very small portion of the end 62 would extend through the orifice in the lug 67 due to the fact that the end 62 would abut against the peripheral edge of the rotor half 3, thus making it very difficult to get at the protruding end 62. However, by the provision of the recess 62′, the end 62 may be inserted through the orifice in the lug 67 to such an extent that the same may be readily taken hold of by the hand of the assembler, thereby enabling the assembler to complete the assembly operation in less time than would otherwise be required. The provision of the recess 63′ serves for the same purpose relative to the end 63 of the winding 10′ as has just been described in connection with the recess 62′. Lead wires 70 and 71 covered with suitable sleeving pass through the hollow shaft 22 and are of a size so that when inserted through the orifice of the shaft 22 they form a force fit in the shaft 22. The two outer ends 60 and 61 of the windings 10 and 10′ are now connected to these lead wires 70 and 71 to carry these two ends to the external terminals 45 and 46. With this method of construction in which lugs 64 and 67 integrally formed with orifices for the securing of the outer ends 60 and 61 and inner ends 62 and 63 of the windings 10 and 10′ does away with added drilling operations to permit connections of the winding ends of the windings 10 and 10′ of the rotor R and the lugs 67 which are provided for the inner ends 62 and 63 of the windings 10 and 10′ of the R permits the said ends to be connected from the outside as are also the connections of the outer ends of the winding 10 and 10′ of the rotor R.

The shaft 21 which is held in position against longitudinal movement and turning by means of the leaf spring 26 has however a small latitude of movement in that the spring 26 which rests in the V shaped orifices 25 in the rotor halves 2 and 3 may be sprung against its normal tension due to the small space between the face of the spring 26 and the walls of the V shaped orifices 25 of the rotor halves 2 and 3, for purposes as will now be described. As previously described the rotor R moves through 180 degrees of rotation in a clockwise or counter clockwise direction, this movement being limited by means of the stops 52 and 53 as before described. Should the rotor R be turned to its 180 degree position with undue force the stop 52 will engage the stop 56 with a blow of considerable force which if the blow is strong enough will damage the stop. To overcome this I have constructed the V shaped orifices 25 in association with the spring 26 so that if the rotor R should be forced back with considerable force the spring 26 will yield slightly due to the space between the spring 26 and the walls of the V shaped orifices 25 and act as a cushion and absorb the blow. This slight turning of the shaft 21 will of course carry the dial beyond its 180 degrees of rotation but when the force is released the spring 26 will restore the dial to its correct position. When the rotor R is turned in the opposite direction the spring will have the same effect. In Fig. 1 I have ilustrated slots 80 and 81 in the face of the stator halves 11 and 12 which slots 80 and 81 are placed therein during the moulding operation of the same and provides means for using the same apparatus in building a vario coupler. The slots 80 and 81 permit the windings 16 and 17 of the stator element to be tapped as is well known in the construction of vario couplers.

While I have illustrated and described, a preferred embodiment of my invention it is to be understood that changes and modifications will readily suggest themselves to those skilled in the art, and I therefore do not wish to be limited to the exact structure, as shown but aim to cover all such changes and modifications as come within the spirit and scope of the appended claims.

Having described my invention what I claim as new and desire to secure by United States Letters Patent, is:

1. A device of the character described including a stator element and a rotor element shafts for said rotor element, a pair of hemispherically shaped members comprising said stator element, and a pair of hemispherically shaped members comprising said rotor element, semi-circular recesses in said rotor halves diametrically opposite forming orifices for said shafts when said rotor halves are secured together, orifices in two adjacent recesses, and spring means resting in said orifices for holding one of said shafts in position against displacement.

2. In a device of the character described including a stator element and a rotor element, a pair of hemispherically shaped members comprising said stator element, and a pair of hemispherically shaped members comprising said rotor element, shafts for said rotor bearings in said stator element for said shafts for rotatably supporting said rotor element inside said stator element,

semi-circular recesses in said rotor halves diametrically opposite forming orifices for said shafts when said rotor halves are secured together and orifices in two adjacent recesses, and spring means resting in said orifices for holding one of said shafts in position against movement.

3. In a device of the character described including a stator element and a rotor element, hemispherically shaped members comprising said stator halves and hemispherically shaped members comprising said rotor element, shafts for said rotor element, bearing in said stator element for said shafts for rotatably supporting said rotor element inside of said stator element, recesses in said rotor element forming orifices diametrically opposite for said shafts, orifices in two adjacent recesses, and spring means resting in said orifices for holding one of said shafts against displacement, face portions in two of said other adjacent orifices, and a face portion on said other shaft engaging said face portions of said two other recesses for holding said other shaft against movement.

4. In a device of the character described including a pair of hemispherically shaped members to form a stator element, and a pair of hemispherically shaped members to form a rotor element, shafts for said rotor element, bearings in said stator element for said shafts to rotatably support said rotor inside of said stator element, recesses in said rotor forming orifices diametrically opposite for said shafts, V shaped orifices in two adjacent recesses, a leaf spring resting in said orifices, a notch in one of said shafts in which said springs rests when said shaft is resting in said orifice formed by two adjacent recesses, said leaf spring holding said shaft against longitudinal movement and rotation in said orifice.

5. In a device of the character described including a pair of hemispherically shaped members to form a stator element and a pair of hemispherically shaped members to form a rotor element, shafts for said rotor element, bearings in said stator elements for rotatably supporting said rotor element inside of said stator element, recesses in said rotor halves forming orifices diametrically opposite for receiving said shafts, V shaped orifices in two adjacent recesses, a leaf spring resting in said V shaped orifices, and engaging a notch in one of said shafts resting in said orifices formed by said two adjacent recesses to hold said shaft in position, stops for said rotor element for limiting the movement of said rotor element in its clockwise or counter clockwise direction, said spring yielding a slight degree when said rotor engages its stops when moved to either of its limited positions.

6. In a device of the character described including a pair of hemispherically shaped members to form a stator element and a pair of hemispherically shaped members to form a rotor element, shafts for said rotor element, bearings in said stator element for rotatably supporting said rotor element inside of said stator element, recesses in said rotor halves forming orifices diametrically opposite for receiving said shafts, V shaped orifices in two adjacent recesses, a leaf spring resting in said V shaped orifices and engaging a notch in one of said shafts resting in said orifices formed by said two adjacent recesses to hold said shaft in position, stops for said rotor element for limiting the movement of said rotor element in its clockwise or counter clockwise direction, said spring yielding a slight degree when said rotor engages its stops when moved to either of its limited positions to permit the said shaft to be turned a limited degree after said rotor engages either of its stops.

7. In a device of the character described including a pair of hemispherically shaped members to form a stator element and a pair of hemispherically shaped members to form a rotor element, a winding for said rotor element, lugs integrally formed with said rotor elements, orifices in said lugs for receiving the outside terminal ends of said winding, slots in the peripheral edge of said rotors aligned with said lugs for receiving the looped ends of said winding to permit said terminals to extend into said rotor sphere element.

9. A device of the character described, including a pair of hemispherical shaped members to form a stator element and a pair of hemispherical shaped members to form a rotor element, a winding for said rotor element, lugs integrally formed upon the circumferential face of said rotor element and provided with orifices for receiving the inside terminal ends of said winding to permit said inside ends to be connected.

9. A device of the character described, comprising two members, each of said members having a recess, a shaft adapted to fit into said recesses, means for holding said members together, on said shaft, and a member adapted to fit into said recesses for cooperation with said shaft to prevent movement thereof.

10. A device of the character described, comprising two members, each of said members having a recess, a shaft adapted to fit into said recesses, means for holding said members together on said shaft, and a member adapted to cooperate with said shaft to prevent longitudinal displacement thereof.

11. A device of the character described, comprising two members, each of said members having a recess, a shaft adapted to fit into said recesses, means for holding said members together on said shaft, and a mem-

ber adapted to fit into said recesses for cooperation with said shaft to prevent longitudinal movement thereof and to substantially prevent rotary movement of said shaft relative to said members.

12. A device of the character described including a pair of members, a semi-circular orifice in each member, means for clamping said members together, said semi-circular orifices forming a circular orifice when said members are clamped together, a hollow shaft, adapted to fit in said circular orifice, and an enlarged intermediate portion for said shaft resting in a portion of said circular orifice to prevent longitudinal movement of said shaft in said circular orifice.

13. A device of the character described including a pair of members, a semi-circular orifice in each member, means for clamping said members together, said semi-circular orifices forming a circular orifice when said members are clamped together, a hollow shaft adapted to fit in said circular orifice, an intermediate enlarged portion for said shaft provided with a flat portion, cooperating with a flat surface in said circular orifice, to prevent rotary movement of said shaft relative to said members.

14. A device of the character described including a pair of members, a semi-circular orifice in each member, means for clamping said members together, said semi-circular orifices forming a circular orifice when said members are clamped together, a hollow shaft adapted to fit in said circular orifice, an enlarged intermediate portion for said shaft resting in a portion of said circular orifice to prevent longitudinal movement of said shaft in said orifice and a flat portion on said enlarged portion of said shaft cooperating with a flat surface in said circular orifice to prevent rotary movement of said shaft relative to said members.

15. A device of the character described including two halves adapted to be clamped together, windings adapted to be placed upon said halves, an orifice formed in one of said halves in which one terminal of one winding extends, and a recess formed in the other half aligning with the orifice in said first half, whereby the terminal of said one winding may be extended through said orifice into said recess.

16. A device of the character described, consisting of two members, adapted to be clamped together, one of said members having an enlarged peripheral portion, a winding adapted to be placed upon said member one of the convolutions of which engages said enlarged peripheral portion, a lug formed integrally with said member, a slot in said enlarged peripheral portion immediately above said lug, and an orifice through said lug, whereby one terminal of the winding may be brought through said slot and through the orifice formed in said lug.

17. A device of the character described including two members adapted to be clamped together, an enlarged peripheral portion for each of said members, a winding adapted to be placed upon each of said members, said windings being separated by said peripheral portions, lugs formed on the said peripheral portions of said members and provided with orifices, whereby the inner terminals of said windings may be extended through the orifices in said lugs and connected together, and the outer terminals of said windings extended through other orifices to the lead-out wires of the device.

18. A device of the character described including two members adapted to be clamped together, an enlarged peripheral portion for each of said members, a winding adapted to be placed upon each of said members, said windings being separated by said peripheral portions, lugs formed on the said peripheral portions of said members and provided with orifices, whereby the inner terminals of said windings may be extended through the orifices in said lugs and connected together, and the outer terminals of said windings extended through other orifices to the lead-out wires of the device, and a hollow shaft adapted to be clamped between said two members through which the lead-out wires extend.

Signed by me at Chicago, in the county of Cook, and State of Illinois, this 23rd day of April, 1923.

EMIL J. NIELSEN.