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G. WENNERBERG

2,885,645

ROTARY TRANSFORMER

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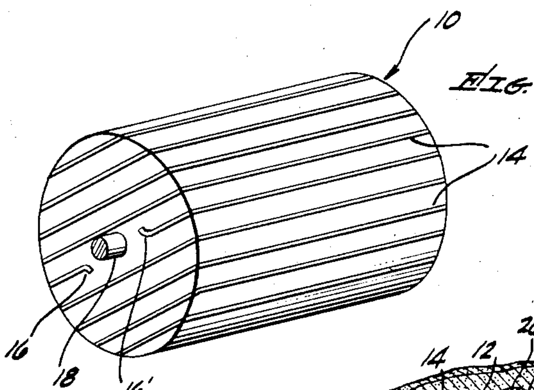


FIG. 1.

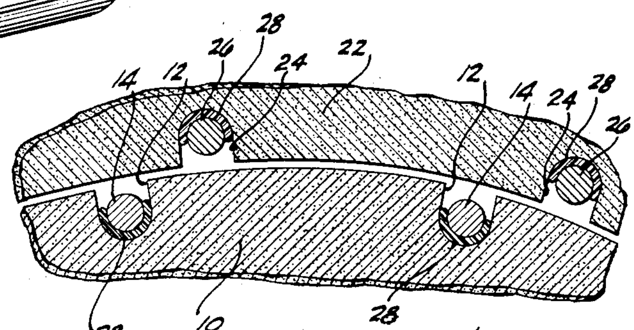


FIG. 3.

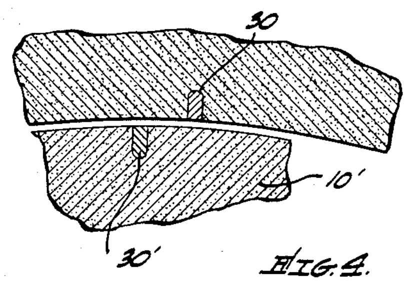
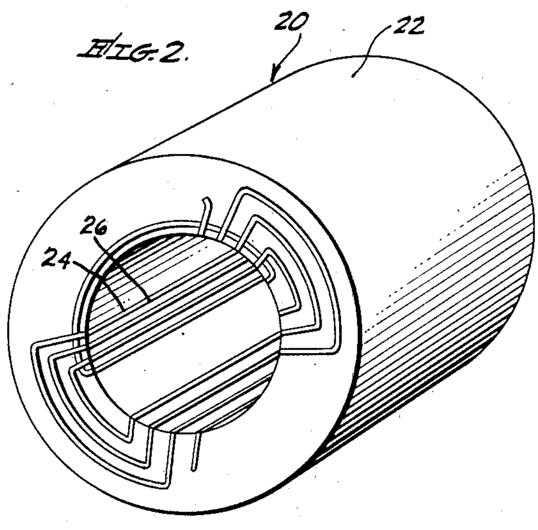


FIG. 4.

FIG. 2.



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ROTARY TRANSFORMER

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6 Claims. (Cl. 336—120)

This invention relates to rotary transformers such as synchro devices and the like, and more particularly to an improved rotor and stator structure and windings therefor.

As is well known, the leakage inductance of conventional rotary transformer devices is a limiting factor in using them with long transmission lines. Where stator windings are connected through long transmission lines to a source of high frequency signals, the leakage inductance results in phase shift at a predetermined frequency; particularly in installations such as aircraft automatic direction finders (ADF), where a goniometer may be connected between the antenna and the receiver, such phase shift would render the receiver indications unreliable at frequencies above that. If transmission lines are used, it is necessary to correct for the phase shift by means of a capacitance in series between the antenna and the stator windings of the goniometer. Also, since different lengths of transmission lines have different line capacitances, a different series capacitance would have to be selected for each length of transmission line. The amount of leakage inductance generally depends upon the air gap between the rotor and stator windings, and attempts to minimize this gap have heretofore been uniformly frustrated; to counteract the effects of leakage inductance, it has been necessary to employ large amounts of conductors for the windings, that is, numerous slots and winding turns. An additional problem which contributes to low quantity production of rotary transformers heretofore known resides in the forming of the rotor and stator slots. Slot configurations are arrived at after exhaustive analysis; they are generally complex in shape, requiring careful hand and machining operations for their formation, and generally require the use of slot wedges, e.g., lengths of stiff paper, to hold the conductors in place.

It is an object of this invention to provide an improved rotary transformer suitable for use with long transmission lines, and in which the leakage inductance is so low as to permit its use with long transmission lines without resorting to the use of series capacitance for the lines.

It is another object of this invention to provide an improved rotary transformer which can be used with long transmission lines to permit signals of higher frequency than heretofore possible to be passed through the line without being subject to phase shift.

It is a further object of this invention to provide an improved rotary transformer wherein complex slot configurations are dispensed with, wherein slot wedges are eliminated, and which can be reproduced in quantity with a minimum of hand and machining operations, and which in operation is characterized by minimum flux distortion and leakage inductance.

It is still another object of this invention to provide an improved rotary transformer device in which the rotor and stator are magnetic elements having simply formed slots with conductors secured therein and which is capable of handling high-frequency signals with much fewer

conductors without the effects of leakage inductance heretofore encountered.

It is another object of this invention to provide a rotary transformer comprising a minimum number of component parts of simple design, which can be assembled in less time and with fewer operations than prior art rotary transformers.

The above and other objects and advantages of this invention will become apparent from the following description, taken in conjunction with the accompanying drawing, in which a preferred embodiment is illustrated by way of example. The scope of the invention is pointed out in the appended claims. In the drawing,

Figs. 1 and 2 are perspective views of respective rotor and stator structures in accordance with this invention, and

Figs. 3 and 4 are partial sectional views of the rotor and stator of Figs. 1 and 2 assembled, showing different arrangements for supporting conductors, also in accordance with this invention.

Referring to the drawing, a rotor **10** of ferrite material is provided with a plurality of longitudinal grooves **12** on its lateral and end surface. A winding is formed with conductors **14** placed in slots **12** in a desired winding scheme. To provide a continuous winding between the end terminals **16, 16'**, the halves of the windings extend in opposite directions from such end terminals in substantially parallel turns of decreasing size, which of course requires that a portion of the winding (not shown) extend across the rear end surface, as is conventional in windings of this type. The end terminals **16, 16'** are connected to slip rings (not shown) placed on shaft **18** in a conventional manner.

The stator **20** (Fig. 2) comprises a housing **22** of ferrite material, the inner surface of which is provided with longitudinal grooves **24** in which are located conductors **26** forming a stator winding. The portions of the windings extending beyond the end faces of the stator are arranged adjacent the end faces in a conventional manner.

Thus far, aside from the fact that rotor **10** and stator housing **22** are of ferrite material, the structure described is generally well known in the art of rotating machinery. However, the slots **12, 24** formed in the ferrite rotor **10** and stator housing **20** are of the simplest possible shape, e.g., semicircular as shown, and of sufficient depth so that the conductors **14, 26** do not extend beyond the lateral surface thereof. The slots may be formed in the ferrite by any desired methods—grinding, acid etching, ultrasonic drilling. Conductors are secured in the slots by simple means, such as plastic or other adhesive material **28**.

Although ferrite is difficult to machine, the forming of grooves of the simple shape illustrated minimizes the difficulties heretofore encountered. Further, it has been found that for rotary transformer devices wherein high-frequency currents are induced, and in which the stator does not revolve at a high speed, this simple form of rotor and stator slots and simple manner of securing the conductors of the windings thereof has been found to be practical. Furthermore, the air gap between the rotor and stator surfaces can be made as small as desired, e.g., 0.005 inch.

Fig. 4 illustrates an arrangement wherein conventional longitudinally placed conductors are dispensed with. The rotor **10'** and stator housing **22'** are slotted, and a conductive material, e. g., silver or the like, is deposited in the grooves or slots as indicated at **30**. Where this arrangement is employed, conventional conductors to form the end turns of the respective rotor and stator windings are soldered to the ends of conductors **30** to form the desired winding scheme.

It will be appreciated that this invention is not limited to the winding scheme here described, the arrangement shown and described being illustrative only. For example, a second stator winding similar to that above described may be arranged in quadrature therewith to provide a goniometer. Such a goniometer has been used wherein, with conductors arranged as in Figs. 1–3, and an air gap of 0.005 inch, 95% coupling between the rotor and stator windings was realized. The goniometer has each stator winding connected through a transmission line to one winding of a loop antenna. It has been found that transmission lines as long as forty feet can be used with such a goniometer, to receive signals covering the entire aircraft broadcast range—up to 1.75 megacycles—without the phase shift above explained. Thus, not only is the rotary transformer structure of this invention easier to produce, but its utility is characterized by the use of transmission lines without phase correction means over a frequency range which has heretofore been impossible.

What is claimed is:

1. A rotary transformer device comprising a stator of ferrite material, a rotor element of ferrite material within said stator, said stator and rotor each having a plurality of longitudinal slots, each slot having its greatest width at the surface in which it is formed and having smooth contoured walls extending to a predetermined depth, a conductive material in each slot substantially filling the same, and said stator and rotor being of ferrite material.

2. A rotary transformer device in accordance with claim 1, wherein the conductive material comprises wire conductors, and a substance in each slot adhering to the ferrite material and to the wire conductor.

3. A rotary transformer device in accordance with claim 1, in which said conductive material comprises conductive metal, said metal adhering to the ferrite material and substantially filling the slot.

4. A rotary transformer device in accordance with claim 3, in which the turns of the windings are formed with wire conductors soldered to the conductive metal at the ends of the slots.

5. A rotary electro-mechanical device comprising rotor and stator elements of ferrite material, each of said elements having a plurality of longitudinal slots formed therein which taper gradually from the surface, wherein the widest portion of each slot is at the surface in which it is formed, a binder substance at the bottom of each slot and extending the length thereof, and at least one conductor in each slot being held in place by said binder substance.

6. A rotary electro-mechanical device comprising rotor and stator elements of ferrite material, each of said elements having a plurality of longitudinal slots formed therein, each of said slots having its greatest width at the surface of the associated element, a conductive metal deposited in each slot and adhering to the ferrite material, whereby wire conductors may be soldered to the ends of the conductive metal to provide desired rotor and stator winding schemes.

No references cited.