

May 21, 1963

J. HENRY-BAUDOT

3,090,933

A.C. TRANSDUCERS AND VARIOMETERS

Filed Sept. 15, 1958

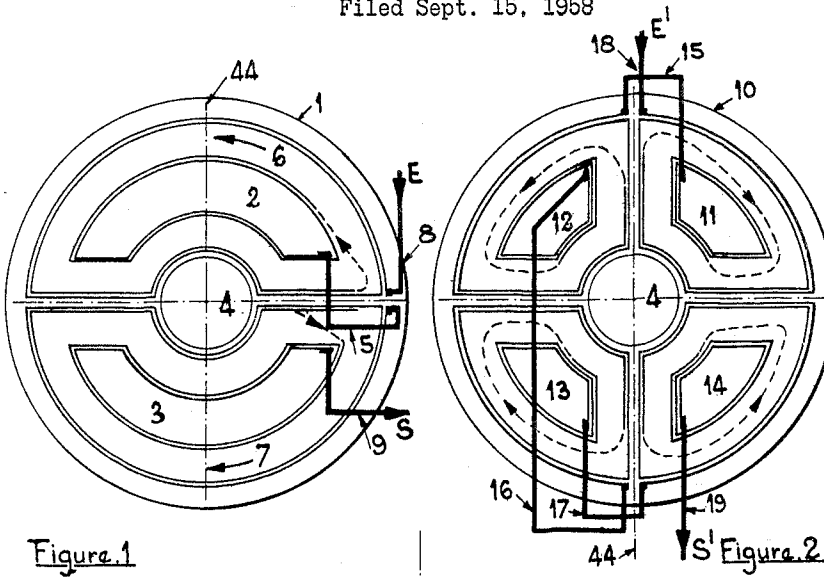


Figure 1

Figure 2

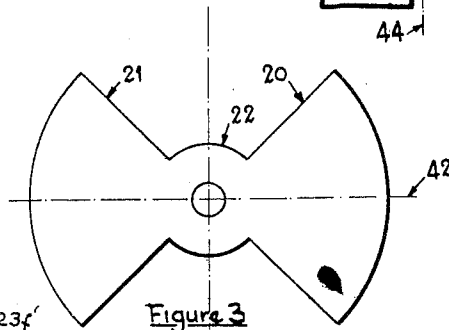


Figure 3

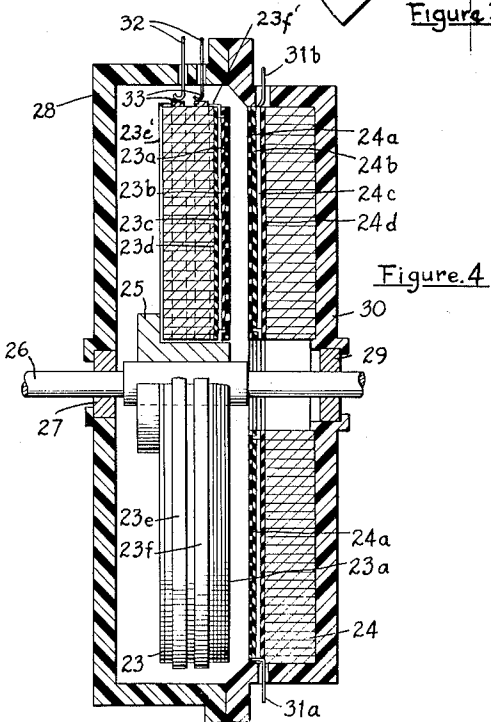


Figure 4

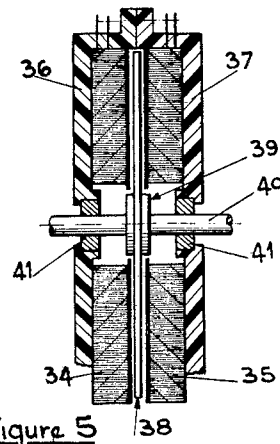


Figure 5

INVENTOR

Kernon, Palmer, Stuart & Estabrook

By

Ralph B. Stuart

Attorneys

1

3,090,933

A.C. TRANSDUCERS AND VARIOMETERS

Jacques Henry-Baudot, Antony, France, assignor, by mesne assignments, to Printed Motors, Inc., New York, N.Y.

Filed Sept. 15, 1958, Ser. No. 761,143

Claims priority, application France Nov. 13, 1957

5 Claims. (Cl. 336—120)

The present invention relates to improved A.C. transducers and variometers of the type including at least one primary winding supplied with an alternating current and at least one secondary winding supplying an alternating output current, and means for varying the inductive coupling between primary and secondary windings.

Such means may either act through the relative displacement of the windings or through the displacement of a diamagnetic screen movable in an air-gap separating the windings.

One of the objects of the invention, therefore, is to provide an A.C. transducer or variometer operative as a variable ratio transformer as well as a variable inductance device or what may be conveniently termed as a "magnetic potentiometer."

Another object of the invention is to incorporate in such A.C. transducers structural designs which are highly efficient even at relatively low frequencies of operation and relatively high power outputs without complicating manufacture and assembly of components.

As a further object of the invention, primary as well as secondary windings of such an A.C. transducer include at least one pair of substantially flat solenoidal coils of relatively opposite current direction, which are symmetrically formed over apex-opposed sectorial surfaces of a core member comprising a disc of magnetic material.

According to a further feature of the invention at least two such winding-bearing core discs are mounted in close proximity, one being connected to input supply terminals for the application of an A.C. current and the other being connected to output terminals for supplying the translated alternating current.

Still another object of the invention is to support at least one of the magnetic core discs or members to be rotatable with respect to the other.

Alternatively, a diamagnetic screen covering at least part of the area of one or both of these discs is inserted therebetween and rotatably supported with respect to one or both of the discs.

In a further embodiment of the invention, the discs may have an unequal number of sectorial coils, and in such case the number of coils on the second disc will be a multiple of the number of coils on the first disc.

These and other objects of the invention will be more fully disclosed with reference to the accompanying drawings.

FIG. 1 shows a front view of an A.C. transducer member bearing a two coil winding.

FIG. 2 shows a front view of an A.C. transducer member bearing a four coil winding.

FIG. 3 shows a diamagnetic screen for insertion into certain embodiments of an A.C. transducer according to the invention.

FIG. 4 shows a cross section view of an A.C. transducer according to the invention wherein one of the inductor members is rotatably supported with respect to the other; and

FIG. 5 shows a cross section view of an A.C. transducer according to the invention wherein the two inductor members are of fixed relative position and a rotatable screen is mounted between the inductor members.

Referring first to FIG. 1, an inductor member comprises

2

a disc or core of magnetic material 1 which is shown to consist, by way of example, of a spiralled magnetic iron or steel ribbon, as indicated by the laminated structure apparent from the cross sections shown in FIGS. 4 and 5, FIG. 4 being on a larger scale than FIG. 5.

One face of the spiralled ribbon is smoothened to provide a flat surface which carries a winding obtained, for instance, by one of the so-called "printed circuit" techniques.

Such winding consists of two flat coils spread out in the form of sectors 2 and 3, with only some of the turns indicated for clarity's sake, as shown in FIGS. 1 and 2. Each coil 2, 3 covers at least a substantial part of a 180° sector since the center part of disc 1 is cut out at 4 for the assembly of the member in the transducer device. Each turn then follows a pattern consisting of two circumferential arcs and two linear side portions parallel to the radii defining the sectorial surface covered by the coil.

As shown in the drawings, the preferred form for coils 2 and 3 is that of a single-layer coil with the turns thereof arranged in a flat-spiral to cover a sectorial area of the winding surface.

Lead 5 connects the two coils in series so that an alternating current applied to an input terminal E through a conductor 8 circulates first through coil 2, for example, in the direction of arrow 6, and then through coil 3 in the direction of arrow 7 which is opposite to that of 6, reaching through conductor 9 output terminal S. Conductors 5, 8 and 9 may be "printed" on the rear face of the magnetic disc 1 with interconnections for 8 and 9 passing through or along the periphery of disc 1.

Alternatively, these interconnections may be printed on the rear face of a thin dielectric film or sheet, the face of which has the two coil windings formed thereon. Such dielectric film or sheet is "glued" to the face of the magnetic disc 1. Such connection arrangements are well known per se in the technique of "printed circuitry."

The structure of the inductor member shown in FIG. 2 is now obvious, the only difference being in the number of sectorial coils "printed" on the magnetic core disc.

In FIG. 2, magnetic core disc 10 bears four sector coils 11, 12, 13 and 14 which may be formed in the same manner as coils 2 and 3 of FIG. 1. Each sector coil occupies a quadrantal sector, and all are serially connected from input E¹ to output S¹ for the circulation of the alternating current in the direction of the dotted-line arrows shown in FIG. 2. Connection leads 15 through 19, are similar to the leads 5, 8 and 9 of FIG. 1.

FIG. 3 shows a third member which is to be used in certain embodiments of the invention, and forms a diamagnetic screen, the shape of which is adapted to the sectorial distribution of the winding of FIG. 2.

In FIG. 3, the screen is shown to consist of two opposite fins 20 and 21 integral with a hub portion 22 having the diameter of the center cut-out 4 of discs 1 and 10 of FIGS. 1 and 2. Each fin 20, 21 covers substantially one quadrantal sector, i.e., an area equivalent to one coil in the member, if several coils are to be assembled in the final embodiment of the device.

Screen 20, 21, 22 is made from a flat sheet of desired diamagnetic material, e.g., copper.

It is of course feasible if required to provide still greater numbers of sectorial coils, preferably an even number thereof, each sectorial coil covering a corresponding area. A screen adapted to cooperate with such coils will have a correspondingly increased number of fins, i.e., half the number of the sectorial coils of the member (especially that having the higher number of sectorial coils) with which such a screen is designed to cooperate in the final assembly of the device.

3

In the assembly of FIG. 4, two inductor members 23 and 24 are arranged to define a narrow air-gap between their winding-bearing faces. Member 23, for example, is attached to a hub 25 of shaft 26 journaled on bearings 27 and 29 of casing sections 28 and 30. This permits member 23 to be turned about the axis of shaft 26. Member 24 is attached to casing section 30 and remains fixed.

In FIGURE 4 the lower half of the inductor member 23 and the parts carried thereon are shown in elevation, while the upper half is shown in section, the inductor member 24 being shown in section throughout. The printed circuit winding 23a mounted on the inner face of the inductor core 23 is formed on an insulating carrier 23b, and 23c indicates the winding crossing conductors arranged on the rear face of the insulating disc 23b. These conductors are insulated from the inductor member 23 by an insulating layer 23d.

The electrical terminals of the winding of member 23 are brought out to two peripheral rings 23e and 23f which may be "printed" for example on the periphery of the magnetic disc or part thereof. The ring 23e is connected to the inner terminal of the winding 23a by a connection 23e' passing from the ring 23e along the back face of the member 23 to the inner periphery of the member 23 and then across the inner periphery of this ring to the inner terminal of the winding 23a. The outer terminal of winding 23a is connected to the collector ring 23f by a connection 23f'. In this way, a pair of brushes or sliders, such as indicated at 33 attached to half-casing 28 ensure the connection of winding of 23 to an external circuit (not shown) connected to output terminals 32. The construction and arrangement of the winding 24a on the inductor member 24 is the same as for the winding 23a on the member 23, the insulating winding carrier being shown at 24b the crossing conductors on the rear face of the carrier at 24c and the insulating layer on the inner face of the member 24 being shown at 24d. The alternating current supply for the winding 24a is connected to the terminals 31a and 31b which, in turn, are connected by suitable ones of the conductors 24c to the winding ends.

In case both members 23, 24 are provided with windings of the type shown in FIG. 1, the device acts as a variable ratio transformer, the ratio being varied from 1 to 0, ratio 1 corresponding to a complete registration of the two windings; ratio 0 corresponds to a 90° displacement of member 23 with respect to the position of complete registration.

When the angular movement of 23 is reduced or restricted to a 90° maximum, rings 34 may also be reduced to a 90° peripheral extension.

In case one of the members 23, 24 has a winding of the type shown in FIG. 1 and the other has a winding of the type shown in FIG. 2, the device acts as a variable coupling inductance. When coils 2 and 3 of member 23 register, respectively, with pairs of coils 11-12 and 13-14 of member 24, the effective coupling is zero since the action of the magnetic fluxes oppose and cancel each other in the output circuit and no output is obtained. For a +90° angular displacement of member 23 from the zero coupling position, the magnetic fluxes add in one direction; they add in the reverse direction for a -90° displacement. Finally the coupling varies between two values of mutual inductance on either side of the zero coupling position.

Referring now to FIG. 5, two winding-bearing inductor members 34 and 35 are associated by being attached to sections 36 and 37 in spaced face-to-face relation, thereby defining a narrow air-gap between them and within which is inserted a screen 38 supported through hub 39 on rotatable shaft 40. Shaft 40 is journaled in bearings 41 of casing 36, 37.

Member 34, for example, may have a winding of the type shown in FIG. 1 and member 35 a winding of the

4

type shown in FIG. 2. Their axes 44 are shown in FIGURES 1 and 2 to be in register, and screen 38 is of the type shown in FIG. 3.

In the rest position of screen 38, its long transverse axis 42, shown in FIG. 3, registers with axes 44 of stationary members 34, 35. Then the coupling ratio is zero as the transferred magnetic fluxes balance out in the secondary member. The coupling ratio increases as the screen is rotated to either side of this rest position. It becomes a maximum at 90° on each side from this position, but of course, for 90° in one direction, the phase of the secondary voltage will be opposite to the phase of the same voltage for a 90° rotation in opposite direction.

From the above examples, any alternative arrangement or modification of A.C. transducer according to the invention may be provided without departing from the spirit and scope of this invention.

I claim:

1. An alternating current transducer device comprising: first and second magnetic core members, each having on one face thereof an annular surface consisting of a single flat plane, said core members being mounted with said annular surfaces in opposed parallel relation and on a common axis, said surfaces thus defining therebetween a narrow annular air gap; a first electric winding bonded flat to said annular surface of said first core member and including at least a pair of coils arranged on opposite sides of said common axis, each coil comprising a plurality of turns wound about a common coil axis and covering a separate sectorial portion of the annular surface of said first core member, adjacent coils being oppositely wound with respect to each other and all coils being serially connected; a second electric winding bonded flat to said annular surface of said second core member and including a plurality of coils equal in number to a multiple of the number of coils in said first winding, the coils of said second winding being equally distributed about said common axis and each comprising a plurality of turns wound about a common coil axis and covering a separate sectorial portion of the annular surface of said second core member, adjacent coils of said second winding being oppositely wound and all being serially connected in a common circuit and means for varying the coupling between said first and second windings.

2. A device according to claim 1, wherein said core members are of relatively fixed positions and a diamagnetic sectorial screen is mounted rotatable in the air-gap between said core members.

3. A device as defined by claim 2 wherein said sectorial screen is provided with sectorial fins, each fin being substantially coextensive with a coil of said second electric winding, the number of screen fins being one half the number of coils in said second winding.

4. A device according to claim 1, wherein at least one of said core members is a disc mounted to rotate with respect to the other, and includes slide rings printed along its periphery and connected to the terminals of the winding carried by said disc, and stationary brushes cooperating with said slide rings for deriving current from the winding on said rotary disc.

5. A device according to claim 4, wherein said rotary disc is formed as a spiral of magnetic ribbon and said slide rings are printed along the periphery of said spiral.

References Cited in the file of this patent

UNITED STATES PATENTS

2,468,126	Silver	Apr. 26, 1949
2,585,050	Simon	Feb. 12, 1952
2,609,531	Kirchner	Sept. 2, 1952
2,629,860	Chesus et al.	Feb. 24, 1953
2,630,529	Mann	Mar. 3, 1953
2,900,612	Tripp	Aug. 18, 1959
2,921,280	Litwin	Jan. 12, 1960
2,942,212	Mynall	June 21, 1960