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A. KRÜSSMANN
INDUCTIVE TRANSMITTER
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2,928,060

FIG. 1

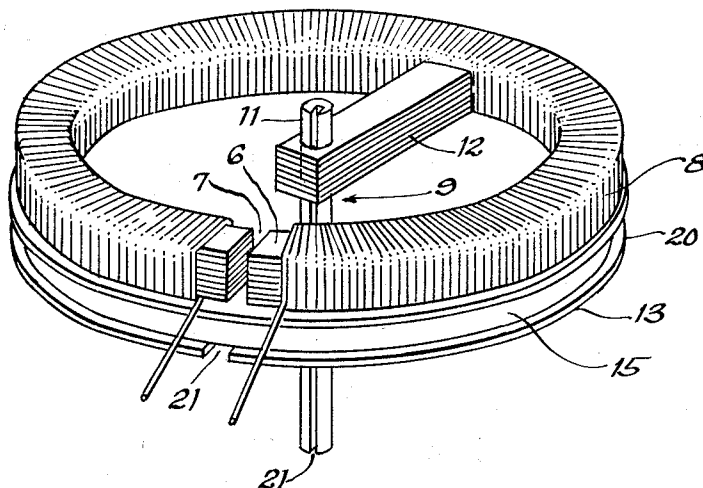


FIG. 2

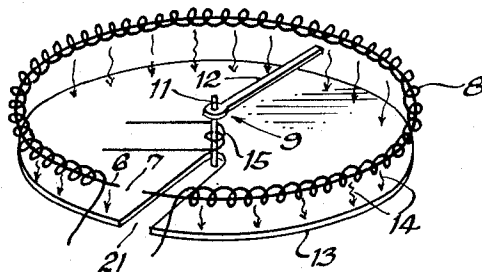
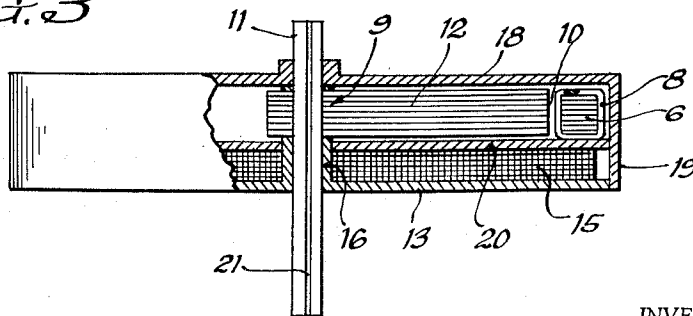


FIG. 3



INVENTOR.
Adolf Krüssmann
BY *[Signature]*
James E. Rye
Attorneys

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INDUCTIVE TRANSMITTER

Adolf Krüssmann, Minden, Westphalia, Germany, assignor to Schoppe & Faeser, G.m.b.H., Minden, Westphalia, Germany

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7 Claims. (Cl. 336—132)

The present invention relates to inductive transmitters, such as are used for developing an electrical voltage signal of amplitude corresponding to the sensed magnitude of a condition.

A primary object of the invention is provision of a device of the kind in question of novel arrangement productive of superior operating characteristics and practical utility as compared to the conventional arrangements heretofore used for similar purposes, such as transformers with relatively rotatable primary and secondary windings or wherein relatively fixed primary and secondary windings are variably coupled by a movable core piece.

The present invention is based on the primary concept of a transformer wherein the primary and secondary windings respectively are magnetically coupled to different core structures each of which has a pair of end surfaces as distinguished from endless or ring cores, and wherein an end surface of one core structure is movable along the surface of the other winding, in the directions of longitudinal extent of the core that is coupled to the latter winding, thereby varying the inductive intercoupling of the different electrical circuits provided by the two windings, and correspondingly varying amplitude of voltage induced in the secondary one of the windings. The invention also embraces a type of arrangement providing magnetic coupling between the two magnetic circuits that is highly and substantially uniformly efficient throughout the full range of relative movement of the two core structures.

As compared to the mentioned conventional devices of the prior art, the present invention very materially increases ranges of relative movement wherein variation of output voltage is linearly responsive to movements of the adjustable control member. As hereinafter disclosed, the invention may be embodied in a rotary form of device, thereby avoiding the restriction to linear motion encountered in movable core transformers, and the movable member of the disclosed device is operable throughout almost three hundred sixty angular degrees, with substantially linear response throughout the full movement range, thereby eliminating the restriction encountered in rotatable transformers to practical ranges of ninety or fewer angular degrees of positional adjustment of the relatively movable parts.

In the accompanying drawings:

Fig. 1 is a perspective view of the working parts of an assembly embodying the invention.

Fig. 2 is a schematic perspective showing the electrical and magnetic circuits of the device of Fig. 1.

Fig. 3 is an elevation, partly in median section of a complete unit embodying the invention and also in the specific arrangement of Figs. 1 and 2.

In the illustrated arrangement, the device comprises a first magnetic circuit provided by a first core 6 of high magnetic permeability, provided with a gap 7 and longitudinally formed annular. An electrically conductive winding 8 is magnetically coupled to core 6, preferably by the illustrated encirclement of the core by the turns of

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the winding, and the turns are distributed along core 6. For a linear response characteristic distribution of the turns of winding 8 is uniform and symmetrical relative to gap 7.

A second magnetic circuit is provided by a highly magnetically permeable core structure 9 that is provided with an end surface 10 positioned in facing adjacency to a lateral surface of winding 8, and that, by movement of structure 9, is adjustable along that lateral surface in the directions of longitudinal extent of core 6 and winding 8, so that arm portions of the electromagnetic circuit structure provided by core 6 and winding 8, which arm portions are defined by and lie respectively between opposite sides of core structure end surface 10, and gap 7, and each of which is returned to surface 10 through structure 9 as will appear, can be relatively and inversely varied by movement of surface 10.

To provide for adjusting movement of surface 10, core structure 9 comprises a rotatable shaft 11, a radial arm 12 projecting from that shaft toward winding 8 and the end of which constitutes surface 10, and a plate 13 a marginal portion of which is positioned laterally of core 6 for magnetic coupling therewith, as indicated by the arrows 14 of Fig. 2. Preferably plate 13 is spaced from one side of winding 8 and the second electrical winding 15 is located between plate 13 and the space occupied by electromagnetic circuit structure 6, 8 and arm 12, and in encircling relation to shaft 11. Plate 13 is of highly magnetically permeable material and is provided with bearing means 16 wherein shaft 11 is rotatable and closely engaged to minimize reluctance between it and the plate.

For linear response, facing surfaces of winding 8 and plate 13 should be parallel and spaced at a sufficient distance to insure uniform field distribution along the space between, and winding 8 and plate 13 should be parallel. For such purpose core 6 and the turns of winding 8 are preferably of the indicated rectangular sections with the facing surfaces of winding 8 and plate 13 disposed in parallel planes. Also for linear response shaft 11 should be concentric with the annulus formed by structure 6, 8, and for accuracy arm 12 preferably is of rectangular cross section substantially matching that of core 6 and with end surface 10 registered with the inner side thereof. It will be seen that non-linear response, if required, may be provided by varying one or more of such factors as distribution of turns of winding 8 along core 6, positional relationship of axis of rotation of shaft 11 to axis of the annulus defined by structure 6, 8, and spacings of various surface portions of plate 13 from corresponding facing surface portions of winding 8.

It will be seen that while surface 10 is so positioned that the arms of the magnetic circuit provided by structure 8, 9 and which respectively lie to opposite sides of surface 10, are symmetric, and with either winding 8 or winding 15 energized by alternating current, as a primary winding, equal and opposite magnetic forces will be developed in the magnetic paths respectively provided by the parts of core 6 lying to opposite sides of surface 10, extended across the space to plate 13 and thence through the common path arm provided by shaft 11 and arm 12. Consequently in that condition no voltage will be developed across the one of the windings that serves as the secondary. Upon upset of circuit-arm symmetry by displacement of surface 10, the opposite magnetic forces will become unbalanced and a resultant voltage will appear across the secondary winding. It is contemplated that winding 15 be used as the primary winding so that the secondary winding 8 effectively is divided, by surface 10, into secondary winding sections wherein opposed voltages are induced.

As shown in Fig. 3, a complete unit assembly may be arranged by providing a low permeability housing portion including an end plate 18 covering the end of the working assembly opposite plate 13, and a cylindrical sidewall 19 that surrounds structure 6, 8 and winding 15 and that is joined to the margin of plate 13. A low permeability plate 20 may be interposed between the assembly of arm 12 and structure 6, 8, and winding 8. To reduce eddy current losses shaft 11, plates 13 and 20 and housing elements 18, 19 may all be provided with slots 21.

From the foregoing, the concept of the invention, and its utility, and many advantages will be apparent as will be the possibilities of making many modifications, alterations and changes in the purely exemplary specific structural arrangement disclosed. Consequently it will be appreciated that the invention and its limits are defined and are to be ascertained solely by and from the appended claims.

I claim:

1. An inductive transmitter assembly comprising an elongate core of magnetically permeable material longitudinally formed to surround a space and provided with a gap, a first electrically conductive winding whereof the turns encircle said core and are distributed along it, a second core of magnetically permeable material located in the space enclosed by the first said core and spaced from said gap, and a second electrically conductive winding magnetically coupled with said second core, and magnetically permeable means extending to adjacent said second core from points on opposite sides of said gap and adjacent said elongate core.

2. An inductive transmitter assembly comprising a first electromagnetic circuit including an elongate core of magnetically permeable material longitudinally formed to enclose a space and provided with a gap, and an electrically conductive winding whereof the turns encircle said core and are distributed along it, and a second electromagnetic circuit including a first core piece of magnetically permeable material located in and extended axially of said space, a second core piece of magnetically permeable material attached to said first core piece and spaced from said gap, said second core piece, projecting radially from the first core piece and having a terminal surface located adjacent said elongate core, a second electrically conductive winding encircling one of said core pieces, and magnetically permeable means peripherally coextensive with said elongate core providing a flux path between said elongate core and said first core piece.

3. An inductive transmitter assembly comprising an annular first electromagnetic circuit structure including a magnetically permeable annular core having a gap and an electrical winding whereof the turns encircle and are distributed along said core, and a second electromagnetic circuit comprising magnetically permeable core means including a support portion disposed within said

core, an arm attached to and extended radially from said support portion toward said core and having an end adjacent the turns of said winding, and a plate extending from said support portion and projecting therefrom into adjacency to a side of said annular circuit structure to provide a flux path between said first circuit structure and said support portion, and a second electrical winding encircling said support portion.

4. An inductive transmitter assembly according to claim 3, wherein said annular circuit structure has a side extended substantially along a plane, said second winding is mounted outwardly of said plane, and said plate is located to the opposite side of said second winding from said plane.

5. An inductive transmitter assembly according to claim 3, wherein said plate is provided with bearing means rotatably penetrated by said support portion, and including a casing member of material of low magnetic permeability surrounding said annular circuit structure and arm and having a wall outwardly encircling the latter and attached to said plate.

6. An inductive transmitter assembly comprising a magnetically permeable annular core of rectangular cross section and having a transverse gap, a first electrical winding whereof the turns encircle and are distributed along said core, a rotatable magnetically permeable shaft concentric with said core, a radial arm of rectangular cross section attached to said shaft within and projecting into adjacency to inner surfaces of said winding turns, a casing of material of relatively low magnetic permeability enclosing said core winding and arm and including a spaced pair of walls respectively overlying the opposite sides of said winding and at least one of which is rotatably penetrated by said shaft, and a circular side wall surrounding the periphery of said winding and having a skirt portion projecting beyond one of said opposite sides, a second electrical winding located within said skirt portion, and outwardly of the adjacent one of said pair of walls and encircling said shaft, and a plate of magnetically permeable material located to the opposite side of said second winding and having a marginal portion that contacts said skirt portion, said plate being provided with bearing means rotatably penetrated by said shaft.

7. An inductive assembly according to claim 3, wherein said plate is provided with a slot extending radially from said first portion and in alignment with said gap of the annular core.

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