

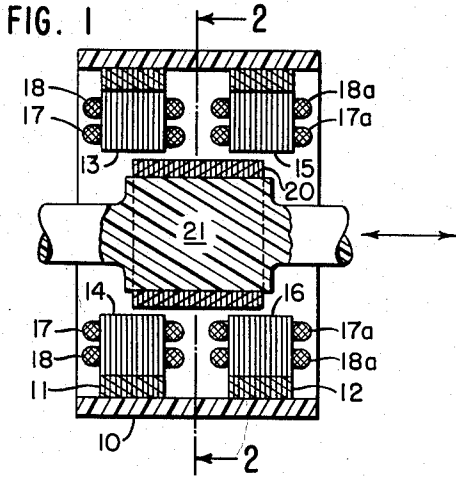
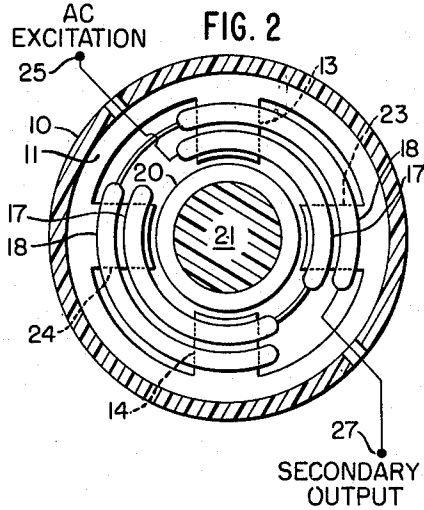
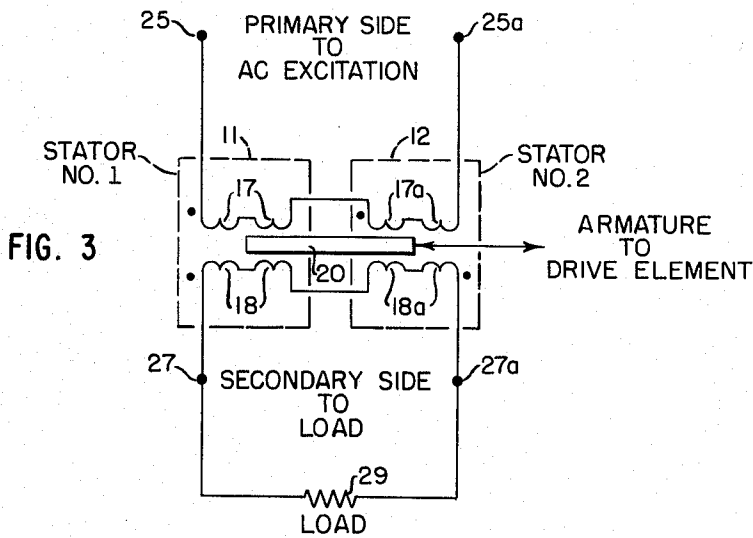
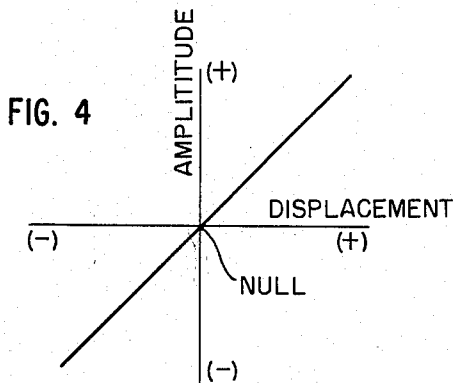
April 7, 1964

E. W. JOHNSON ET AL

3,128,441

VARIABLE DYNAMO TRANSFORMER HAVING LINEARLY MOVABLE ARMATURE

Filed June 30, 1960



INVENTORS
 ERNEST W. JOHNSON
 HENRY PACKARD
 BY
 KENWAY, JENNEY, WITTER & HILDRETH
 ATTORNEYS

1

3,128,441

VARIABLE DYNAMO TRANSFORMER HAVING LINEARLY MOVABLE ARMATURE

Ernest W. Johnson, Randolph, and Henry Packard, Norwood, Mass., assignors to Northrop Corporation, Beverly Hills, Calif., a corporation of California

Filed June 30, 1960, Ser. No. 39,883

4 Claims. (Cl. 336—30)

This invention relates in general to electromagnetic transducers and in particular to dynamo transformers.

Perhaps the best known type of dynamo transformer is the microsyn. The microsyn pick-off is commonly used in a variety of applications where an electrical signal proportional or otherwise related to the position of the rotor or armature of the device is desired. Usually, it is rotary displacement of the rotor which modifies the output signal, but there are other devices in which the armature is displaced in a different fashion to vary the output signal. However, the most successful and widely known device of the type under consideration is the microsyn with a rotor whose angular displacement provides output signal modification.

Although a definite need exists and has existed for a dynamo transformer in which signal modification may be attained by linear rather than rotary motion, most of the devices that have been proposed have certain inherent faults. Not the least of these faults is the sensitivity of the devices to motion other than that which is designed to provide significant modification of the output signal. By way of example, there have been proposed devices in which an armature in the form of a magnetic slug moves arcuately in the area of an E-shaped stator. However, this device in common with others designed for signal modification in response to translational rather than rotary armature motion has failed to win acceptance. The faults have been many, but the worst is probably that which gives rise to an erroneous output; namely the tendency of movement of the armature in directions other than that intended.

Conventional microsyn pick-offs are also favored by system designers because of their size and physical outline. Devices such as that described above are undesirable in the guidance of missiles or in any other aerial or space application simply because their size and weight usually exceed that of conventional microsyn by far. Obviously, every ounce of weight must be conserved and every cubic inch of volume must be efficiently utilized in such applications.

It is, therefore, a primary object of the present invention to increase the accuracy and the efficiency of utilization of size and weight in microsyn of the type which is sensitive to translational movement.

It is another object of the present invention to eliminate from microsyns errors arising from armature movement in directions other than that intended.

It is a further object of this invention to produce a microsyn responsive to translational movement which is similar in size and in weight to conventional microsyns.

In general, the invention is organized about components which are in many respects similar to those which make up a conventional microsyn. However, in the conventional microsyn having a four-pole stator, each primary or excitation winding is wound about a separate pair of adjacent poles and each secondary or output winding is wound about a pair of adjacent poles which includes one pole from each of the pairs about which the primary coils are wound. In other words, conventional microsyns have a staggered winding arrangement. The microsyn of the invention, when the invention is embodied in a four-pole device, has its primary and secondary windings about

2

the same pairs of adjacent poles. Moreover, a double stator is utilized with both stator members being coaxially aligned.

The armature of the present invention also differs from that of the conventional microsyn. In the conventional microsyn, the armature or rotor has circular end portions, but has inwardly relieved arcuate side portions. The rotor of the conventional microsyn is mounted for rotary displacement. The armature of the present invention is annular in cross-section and is mounted for displacement from a central null position along the axis of the double stator members.

The primary windings on one stator member may be either in series-adding or series-opposing relationship to the primary windings on the other stator member. The same is true of the secondary windings. However, the secondaries should be like-poled with oppositely poled primaries and oppositely poled with like-poled primaries. In either case, with displacement of the armature to opposite sides of null, the output from the secondaries is in phase opposition. The amplitude of the output signal varies with the degree of armature extension within a given stator member. For a better understanding of the present invention, together with other and further objects, features and advantages, reference should be made to the following specification which should be read in conjunction with the appended drawing in which:

FIG. 1 is an idealized cross-section of a microsyn built in accordance with the invention,

FIG. 2 is a cross-section of the embodiment in FIG. 1, taken along the line 2—2,

FIG. 3 is an electrical schematic of the same embodiment, and

FIG. 4 is a graphical representation of electrical performance of the device.

In FIG. 1 a cylindrical housing 10 of non-magnetic material may be seen. Within the housing there are fixed in coaxial relationship two stator members 11 and 12. The metallic parts of the stator members may actually be stators taken from conventional microsyns. These are usually laminated stacks of magnetic material, generally annular in cross-section, and are provided with an even number of inwardly directed radially disposed poles. The poles are arrayed symmetrically about the stator and their inner surfaces are arcuately formed into pole faces which define arcs of a circle having its axis at the center of the structure.

Considering the section of FIG. 1 to be taken through oppositely disposed stator poles, a pair of poles 13 and 14 of the stator 11 are visible. Similarly, a pair of poles 15 and 16 of the stator 12 may be seen. A set of primary or excitation windings 17 which actually includes two series-connected coils is shown in the manner in which it is associated with the first stator member. A second set of series-connected coils 17a serves as the input to the second stator member. Similarly arranged sets of secondary or output windings 18 and 18a are also shown in the preferred manner in which they are formed about the poles of the two stator members. The disposition and electrical interconnection of all eight coils is more amply illustrated in FIGS. 2 and 3 of the drawing.

An armature 20, preferably composed of a laminated stack of rings of soft iron or other magnetic material, is disposed centrally in the unit. The armature 20 may be mounted upon a central support 21 which is of non-magnetic material. The support 21 is then mounted for limited axial motion within the stator members. The armature 20 and its support may be retained by end-bells or similar structure (not shown), associated with the housing 10 to permit the desired degree of axial movement and to maintain coaxial alignment with the stator members 11 and 12.

The armature 20, in distinction from conventional microsyn rotors, is circular in outline. Its outer surface lies in a circle concentric with that outlined by the arcuate stator pole faces. The armature 20 is shown in its null position in FIG. 1. Its capacity for limited rectilinear or axial sliding motion is indicated by the double-ended arrow.

FIG. 2 is a section taken in such a manner that the cylindrical housing 10 may be seen as it retains the stator member 11, the outer surface of that stator member matching the inner housing wall. The other stator member 12 is not visible in this view, but it is in all respects similar to the stator member 11. The armature 20 and its support 21 are plainly shown in the central area of the unit.

Each stator member includes two series-connected primaries and two series-connected secondaries as has been noted above. In FIG. 2, the arrangement of the halves of the coils 17 and 18 associated with the stator member 11 may be seen. These coils, the two which form half of the primary (legended 17), and the two which form half of the secondary (legended 18) are duplicated in connection with the stator member 12, but differ electrically as shown below. They are, in each case, connected in series, and an input terminal 25 and an output terminal 27 are shown connected to an end of the primary and the secondary coils respectively. The other stator member 12 of course carries coils connected to corresponding input and output terminals.

It will be noted that one primary and one secondary winding are wrapped about the pair of poles 13 and 23. The other windings associated with the stator member 11 are similarly wrapped about the pair of poles 14 and 24. All coils are arcuately shaped to conform to the generally cylindrical outline of the unit and its components.

In FIG. 3, the electrical hook-up of the device is schematically illustrated. In this figure the interconnection of the windings between the stator members and the polarity or winding direction of the coils may be seen. Polarity is, of course, indicated by the dot convention. The input terminals 25 and 25a are connected to the ends of the coils 17 and 17a associated with the stator members 11 and 12, respectively. These coils are like-poled to achieve a series-adding relationship. The secondary coils 18 and 18a associated with the stator members 11 and 12 respectively are illustrated also by the dot convention as being in series-opposing relationship. The ends of the secondary coils are connected to the output terminals 27 and 27a to which there is shown a load 29 connected.

In FIG. 4 a graphic showing of output signal amplitude versus armature displacement may be seen. The amplitude of the output is zero when the armature is centered in a null position between the two stator members. As the armature is displaced to the left, the phase of the output signal changes, and amplitude increases in a negative direction. Conversely, as the armature is displaced to the right, the phase of the output signal is reversed, and the amplitude increases in the positive sense. This result comes about because of the poling of the excitation coils and of the secondary coils. The output signal is actually a resultant of the adding of the signal and the first and second secondaries. With the armature at a null position, the signals induced in the two stator secondaries are of equal magnitude and opposite phase providing a zero output. As the armature is displaced in a given direction, the coupling into the secondary on the stator which the armature approaches increases linearly while the coupling into the other secondary from which the armature is retracted decreases similarly. Since the phase of the signal in one secondary is opposite to that of the signal in the other secondary, adding of the two signals gives a resultant of the same phase as the larger output signal. The magnitude of the output signal is, of course, reduced by the

magnitude of the out-of-phase component in the bucking secondary.

As has been indicated previously, it is not necessary that the various windings be poled in the exact manner shown. The operation of the device may be the same with oppositely poled primaries and like poled secondaries. Furthermore, although an armature of annular cross-section has been described, any symmetrical configuration such as a circular or other geometrical shape may be utilized.

In the actual operation of the device, the armature is moved in response to some change of physical condition. That change would then be translated into a change of output signal from the unit. By varying physical components, the output need not be linear with the movement of the armature, but might be made to correspond to any desired function. Although a device having four poles is preferred, any even number of poles may be incorporated in the stator with suitable changes of wiring. The winding of primary and secondary coils need not be about pairs of poles of the stator, but might be varied in numerous ways as long as primary and secondary windings are both similar.

The output of the device is in all respects similar to that of a conventional microsyn having a rotating armature or rotor. However, devices built in accordance with the invention are inherently insensitive to rotary motion because of the symmetrical cross-section of the armature. Only a slight additional volume is required to accommodate the device of the invention as compared to that required for a conventional microsyn.

Although a preferred embodiment of the invention has been described and illustrated, many modifications will suggest themselves to those skilled in the art upon their reading the foregoing specification. Such modifications are believed to be within the purview of the present invention which should be limited only by the spirit and scope of the appended claims.

What is claimed is:

1. In a variable dynamo transformer, the combination of first and second adjacent stator members spaced apart along a common axis, an armature composed of a homogeneous length of magnetic material and of annular cross-section disposed coaxially within said stator members such that its peripheral area may be projected upon said stator members, the projected area of said armature upon said first stator member being normally substantially equal to the projected area of said armature upon said second stator member, means for displacing said armature in either direction along said axis, an input coil having a first winding on said first stator member and a second winding on said second stator member connected in series, and an output coil having a first winding on said first stator member and a second winding on said second stator member, the windings of one of said coils being like-poled and the windings of the other of said coils being oppositely poled.

2. Apparatus as defined in claim 1 wherein each of said stator members includes an even number of poles, said first input windings and said first output winding both being looped about a first plurality of said poles, said second input winding and said second output winding both being looped about a second plurality of said poles.

3. In a variable dynamo transformer, the combination of first and second stator members spaced apart along a common axis, a cylindrical armature composed of a homogeneous length of magnetic material and disposed coaxially within said stator members, said stator members having inwardly directed poles, the faces of said poles lying in arcs of a circle concentric with that defined by the outer surface of said cylindrical armature, an input coil composed of windings about a first plurality of the poles of said first stator member connected in series with windings about corresponding poles of said second stator member, an output coil composed of windings about a

5

second plurality of the poles of said first stator member connected in series with windings about corresponding poles of said second stator member, the windings of one of said coils being like-poled and the windings of the other of said coils being oppositely-poled, means for applying signals to said input coil, and means for moving said armature through a limited distance along said axis to provide signals in said output coil modified in accordance with the position of said armature.

4. In a variable dynamo transformer, a first stator member of generally annular cross-section having an even number of inwardly-directed radially-extending poles. said poles terminating in arcuate pole faces, said pole faces defining a circle the center of which lies on the axis of said stator member, a second stator member similar to, disposed coaxially with said first stator member and spaced therefrom, a generally annular armature composed of a homogeneous length of magnetic material and disposed within, coaxially with, and normally uniformly spaced relative to corresponding points of said first and second stator members such that its peripheral area may be projected upon said stator members, the projected area of said armature upon said first stator member being

6

normally equal to the projected area of said armature upon said second stator member, an input coil composed of a first winding upon a first plurality of adjacent pairs of poles of said first stator member and a second winding upon corresponding pairs of poles of said second stator member, an output coil composed of first and second windings similarly wound upon the same poles of said first and second stator members respectively, the windings of one of said coils being similarly poled and the windings of the other of said coils being oppositely poled, means for applying a signal to said input coil, and means for moving said armature along said common axis to provide a signal in said output coils which is related to said signal applied to said input coil, but is modified in phase and amplitude in accordance with the instantaneous position of said armature.

References Cited in the file of this patent

UNITED STATES PATENTS

2,870,422 Gindes ----- Jan. 20, 1959

FOREIGN PATENTS

214,158 Australia ----- Mar. 26, 1958