

Nov. 16, 1954

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2,694,797

ANGLE TRANSMITTER FOR GUN CONTROL DEVICES

Filed March 15, 1951

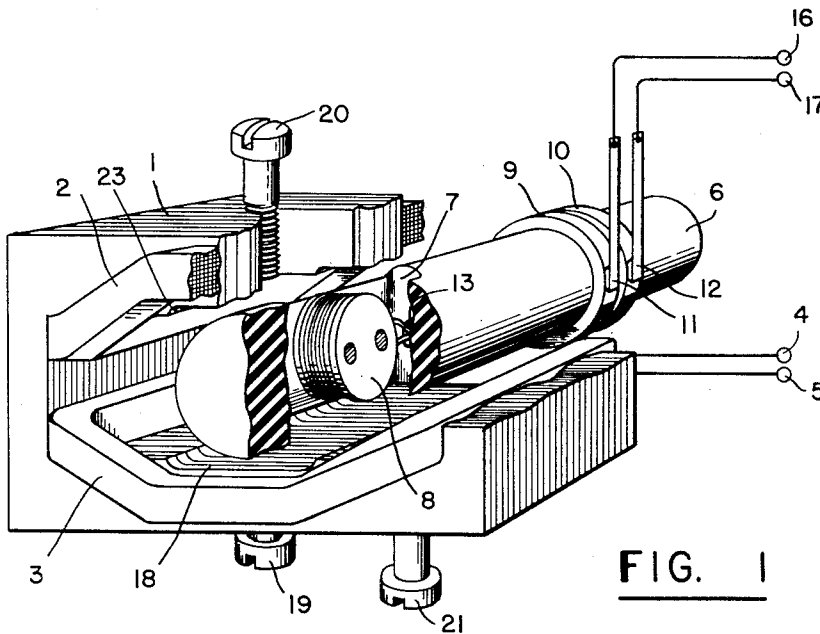


FIG. 1

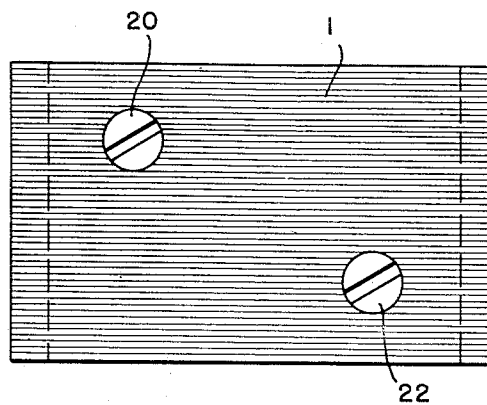


FIG. 2

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ANGLE TRANSMITTER FOR GUN CONTROL DEVICES

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Application March 15, 1951, Serial No. 215,821

Claims priority, application Sweden March 21, 1950.

10 Claims. (Cl. 336-117)

This invention relates to electric follow-up systems in which a variation of one magnitude is reflected by a corresponding change in another magnitude. More particularly, the invention relates to transmitters of the type including a stator and a rotor and in which the voltage output of the rotor is a function of the rotational angle of the rotor so that the voltage at the rotor terminals is indicative of the angular position of the rotor. Hence, if the magnitude to be transmitted is caused to control the angular position of the rotor, the resulting voltage appearing at the rotor terminals can be employed to place a second magnitude in a corresponding position.

Angle transmitters of the general type, above referred to, are useful for various purposes. A now preferred and particularly advantageous field of application of angle transmitters is as components of control mechanisms for the vertical and lateral aiming of a gun. Gun control mechanisms of the type to which reference is made herein are more fully described for instance in the co-pending patent application Ser. No. 207,950 filed on January 26, 1951, now abandoned.

With angle transmitters of the aforesaid type, an induced alternating voltage or an envelope of the induced voltage is obtained at the rotor terminals when the stator field is excited and the rotor is rotated. This output voltage is usually not of a pure sine form but includes some harmonics. For the purpose for which angle transmitters of the aforesaid type are often employed, particularly when used as components of a gun control mechanism, the presence of harmonics is undesirable and it is preferable that output voltage or the envelope thereof be as nearly sine-shaped or sinusoidal as possible.

Accordingly, the principal object of the present invention is to provide novel and improved means by which the harmonic components of the rotor output voltage are substantially eliminated in a simple and efficient manner.

Another more specific object of the invention is to provide novel and improved physical means (as distinguished from circuit means) capable of substantially eliminating the aforesaid undesirable harmonics.

A still more specific object of the invention is to provide physical means having components which can be independently adjusted for altering selected harmonics of the output voltage of the rotor.

Other and further objects, features and advantages of the invention will be pointed out hereinafter and set forth in the appended claims forming part of the application.

According to a now preferred exemplification of the invention these aforesaid physical means comprise one or more adjustably mounted magnetizable members, the position of which relative to the mass of the stator and the rotor can be varied and/or one or more grooves in the portion of the stator body facing the rotor, the position and configuration of the said grooves being determined by mathematical calculations or analysis of the A.-C. output voltage of the rotor well understood in the art for the purpose here in question.

In the accompanying drawing a now preferred embodiment of the invention is shown by way of illustration and not by way of limitation.

In the drawing:

Fig. 1 is a fragmentary perspective view, partly in section, of an angle transmitter according to the invention, and

Fig. 2 is a plan view of Fig. 1, the rotor being omitted.

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Referring now to the figures in detail, the transmitter according to the invention is exemplified as a transformer having a stator shown as comprising a stator body 1 of substantially rectangular outer shape and formed with an opening therein within which the field windings and the rotor are mounted. The stator body is illustrated as being of the laminated type composed of a number of magnetizable plates separated by insulation spacer plates.

The stator is provided with two field windings 2 and 3 which are disposed as can best be seen on Fig. 1 and terminate in primary input terminals 4 and 5. The stator windings are so connected that the stator fields aid each other when the field windings are excited with a D.-C. and A.-C. voltage respectively or an A.-C. voltage only. In the exemplification an A.-C. voltage is supplied.

The rotor is shown as a cylindrical body 6 made of insulation material and having an axial slot 7 therethrough. This slot serves to house a rotor winding 8, the terminals of which are connected through an axial bore 13 in cylinder 6 to slip-rings 9 and 10 respectively. These slip-rings are slidably engaged by brushes 11 and 12 respectively which in turn are connected to secondary output terminals 16 and 17. In other words, the output voltage of the rotor is available at terminals 16 and 17, assuming the field windings of the stator be excited and rotor 6 be rotated relative to the stator field.

For the purpose of reducing or eliminating the harmonics of the output voltage of the rotor one or more magnetic members are provided which are mounted adjustably relative to the mass of the stator and to the rotor winding. These adjustable magnetic members can take various shapes and the adjustability of the members can be accomplished by various means suitable for this purpose. It has been found that the desired purpose can be attained in a convenient and efficient manner by providing two pairs of screws 19, 20 and 21, 22 made of magnetizable or magnetic material such as iron or an iron alloy.

As will be noted, screws 20 and 22 are threaded in the upper wall portion of the stator body 1 and screws 19 and 21 in the lower portion of the stator body. Furthermore, screws 19 and 20 are disposed in alignment across the rotor as are also screws 21 and 22.

As is well known, the output voltage or the envelope of the output voltage which appears at terminals 16 and 17 can be expressed by the following equation:

$$E = b_1 \sin \beta + b_2 \sin 2\beta + b_3 \sin 3\beta + \dots + a_1 \cos \beta + a_2 \cos 2\beta + a_3 \cos 3\beta + \dots$$

wherein β is the turning angle or the rotational angle of the rotor.

It has been found that adjustment of the screws permits to eliminate or at least to reduce the components of the rotor output voltage and of the envelope of the voltage which are multiples other than the multiple one of the turning angle of the rotor, in other words, the components which are harmonics. More specifically, it has been found that a simultaneous screwing in of the screws 20 and 22 or of the screws 19 and 21 results in a reduction of the component $b_3 \sin 3\beta$. Simultaneous screwing in of the screws 20 and 21 causes an increase of the component $a_3 \cos 3\beta$ and simultaneous screwing in of the screws 19 and 22 results in a decrease of the same component.

For further reducing the harmonic components of the output voltage of the rotor, a groove 18 in the lower inner wall portion of the stator body and a groove 23 in the upper inner wall portion of the stator body are provided. As will be noted, the two grooves have the same configuration and are in transverse alignment across the rotor as is clearly shown on Fig. 1. The specific shape of the grooves, which are shown here as shallow and wide grooves, can be determined by mathematical calculations known for such purpose or more conveniently by a frequency analyzer also known for the purpose. Such analyzer permits to analyze the envelope of the output voltage, and the analysis thus obtained serves to determine the configuration of the grooves and the disposition thereof. Inasmuch as the specific configuration of the grooves is not claimed herein, it is believed that a detailed description of the known methods or

means by which the specific configuration of the grooves can be ascertained is not essential for the understanding of the invention. The grooves do not necessarily have the illustrated configuration. Furthermore, several pairs of grooves may be found to be advisable. It has been found that the grooves serve to eliminate nearly completely the component $b_3 \sin 3\beta$ of the voltage or the envelope thereof.

While the invention has been described in detail with respect to a certain now preferred example and embodiment of the invention it will be understood by those skilled in the art after understanding the invention, that various changes and modifications may be made without departing from the spirit and scope of the invention, and it is intended, therefore, to cover all such changes and modifications in the appended claims.

What is claimed as new and desired to be secured by Letters Patent is:

I claim:

1. Means for suppressing harmonics in an A.-C. angle transmitter in form of a transformer having a stator including a magnetic core with pole faces and a field winding thereon adapted to be connected with a source of voltage, and a rotor including a non-magnetic core and a winding thereon, the said rotor being disposed concentrically with the pole faces of the stator core, the A.-C. voltage output of said rotor winding in response to a rotation of the rotor being a function of the angular position of the rotor and containing harmonics, the said suppressing means comprising at least one member of magnetizable material mounted in the stator core adjustable in position relative to the mass thereof and disposed transversely to the axis of the rotor, adjustment of the position of the said member affecting the harmonics of the voltage output of the rotor for the purpose aforesaid.

2. Means for suppressing harmonics in an A.-C. angle transmitter in form of a transformer having a stator including a magnetic core with pole faces and a field winding thereon adapted to be connected with a source of voltage, and a rotor including a non-magnetic core and a winding thereof, the said rotor being disposed concentrically with the pole faces of the stator core, the voltage output of said rotor winding in response to a rotation of the rotor being a function of the angular position of the rotor and containing harmonics, the said suppressing means comprising at least one recess in a portion of the stator core facing said rotor winding, the said recess effecting a reduction of the harmonics of the voltage output of the rotor.

3. Means for suppressing harmonics in an A.-C. angle transmitter in form of a transformer having a stator including a magnetic core with pole faces and a field winding thereon adapted to be connected with a source of voltage, and a rotor including a non-magnetic core and a winding thereon, the said rotor being disposed concentrically with the pole faces of the stator core, the A.-C. voltage output of said rotor winding in response to a rotation of the rotor being a function of the angular position of the rotor and containing harmonics, the said suppressing means comprising at least one member of magnetizable material mounted on the stator adjustable relative to the mass of the stator core and disposed transversely to the axis of the rotor core, adjustment of the position of the said member affecting the harmonics of the voltage output of the rotor for the purpose aforesaid, and further comprising at least one recess in a portion of the stator core facing said rotor winding, the configuration and position of the said recess reducing the harmonics of the voltage output of the rotor for the purpose aforesaid.

4. Means for suppressing harmonics in an A.-C. angle transmitter in form of a transformer and having a stator including a magnetic core of generally rectangular cross-section and formed with pole faces, the said core having an opening therein, a field winding mounted within said opening of the stator core, and a rotor including a non-magnetic core and a winding thereon and rotatably mounted within the stator opening, the said rotor being disposed concentrically with the pole faces of the stator core, and A.-C. voltage output of said rotor winding in response to a rotation of the rotor being a function of the angular position of the rotor and containing harmonics, the said suppressing means comprising at least one member of magnetizable material, the said stator core being formed with a second opening disposed trans-

versely to the rotor axis, and the said magnetizable member being fitted in said second opening adjustable relative to the mass of the stator and disposed transversely to the axis of the rotor, adjustment of said member relative to the stator core and the axis of the rotor affecting the harmonics of the voltage output of the rotor for the purpose aforesaid.

5. Means for suppressing harmonics in an A.-C. angle transmitter in form of a transformer having a stator including a magnetic core of substantially rectangular cross-section and formed with pole faces, the said core having an opening therein, a field winding mounted within said opening of the stator core, and a rotor including a non-magnetic core and a winding thereon, the said rotor being rotatably mounted within the opening of the stator core, the said rotor being disposed concentrically with the pole faces of the stator, the A.-C. voltage output of said rotor winding in response to a rotation of the rotor being a function of the angular position of the rotor and containing harmonics, the said suppressing means comprising a pair of magnetizable members, the said stator core being formed with two additional openings extending transversely through the mass of the core, each of the said magnetizable members being fitted in a respective one of said transverse stator openings adjustable relative to the mass of the stator core and the axis of the rotor, adjustment of the positions of said members relative to each other and to the mass of the stator core and the rotor core affecting the harmonics of the voltage output of the rotor for the purpose aforesaid.

6. Suppressing means according to claim 5, wherein the said two magnetizable members are mounted in wall portions of the stator core situated diametrically opposite to the rotor axis.

7. Suppressing means according to claim 5, wherein two pairs of said magnetizable members are provided, the two members of each pair being disposed in opposite wall portions of the stator core in diametrical alignment one with the other, displacement of said members of each pair varying the distance of the respective members relative to each other and to the mass of the stator and the rotor.

8. Suppressing means according to claim 4, wherein said magnetizable member comprises a screw member threaded in said second opening of the stator core.

9. Means for suppressing harmonics in an A.-C. angle transmitter in form of a transformer having a stator including a magnetic core with pole faces and of substantially rectangular cross-section and formed with an opening therein, a stator field winding mounted within said opening of the stator core, and a rotor including a non-magnetic core and a winding thereon and rotatably mounted within the stator, the said rotor being disposed concentrically with the pole faces of the stator core, the A.-C. voltage output of said rotor winding in response to a rotation of the rotor being a function of the angular position of the rotor and containing harmonics, the said suppressing means comprising at least one pair of shallow grooves disposed in diametrically opposite inner wall portions of the stator core defining said opening and facing the rotor, the configuration and position of the said grooves reducing the harmonics of the voltage output of the rotor for the purpose aforesaid.

10. Means for suppressing harmonics in an A.-C. angle transmitter in form of a transformer having a stator including a magnetic core with pole faces and of substantially rectangular cross-section and formed with an opening therein, a field winding mounted within said opening of the stator core, and a rotor including a non-magnetic core and a winding thereon, the said rotor being rotatably mounted within the opening of the stator core and disposed concentrically with the pole faces of the stator, the A.-C. voltage output of said rotor winding in response to a rotation of the rotor being a function of the angular position of the rotor and containing harmonics, the said suppressing means comprising a pair of magnetizable members, the two members of said pair being mounted in alignment in two wall portions of the stator core situated diametrically opposite to the rotor axis and transversely adjustable relative to the mass of the stator and to the axis of the rotor, adjustment of the position of said members relative to the stator core and to each other affecting the harmonics of the voltage output of the rotor for the purpose aforesaid, and further comprising at least one pair of shallow grooves in diametrically opposite inner

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wall portions of the stator core defining said stator opening and facing the rotor, opposite grooves facing each other in alignment across the axis of the rotor, the configuration and position of said grooves reducing the harmonics of the voltage output of the rotor.

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