

Nov. 30, 1965

C. B. SANBORN, JR.
SIGNAL PRODUCING DEVICE AND COMBINATION
THEREOF WITH MASTER CONTROLLER

3,221,246

Filed July 27, 1961

2 Sheets-Sheet 1

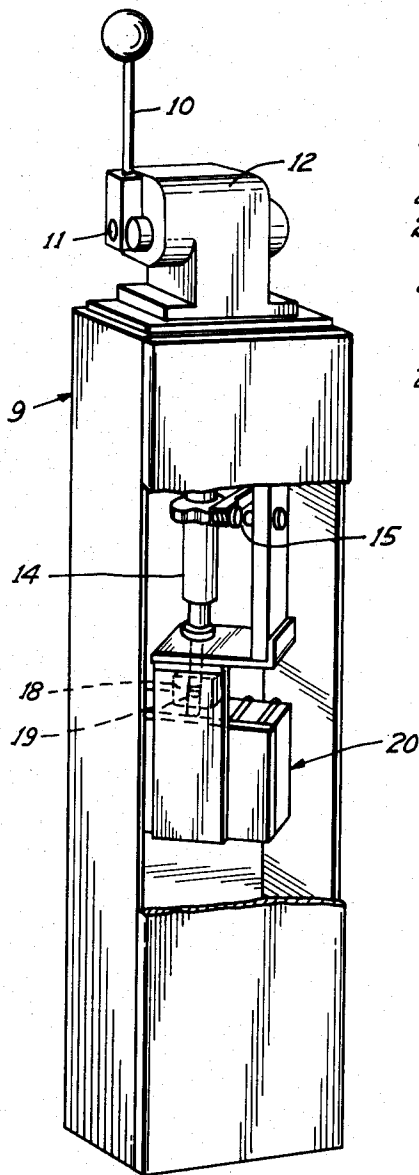


Fig. 1.

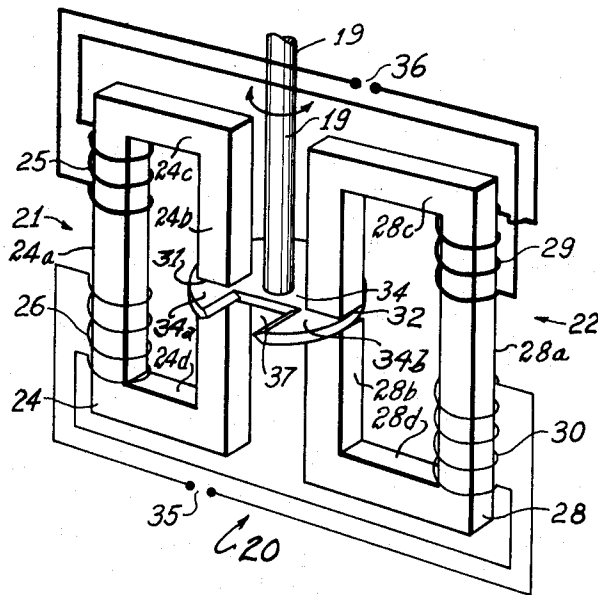


Fig. 2.

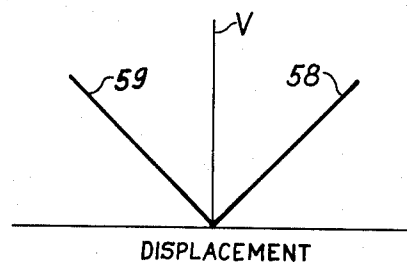


Fig. 5.

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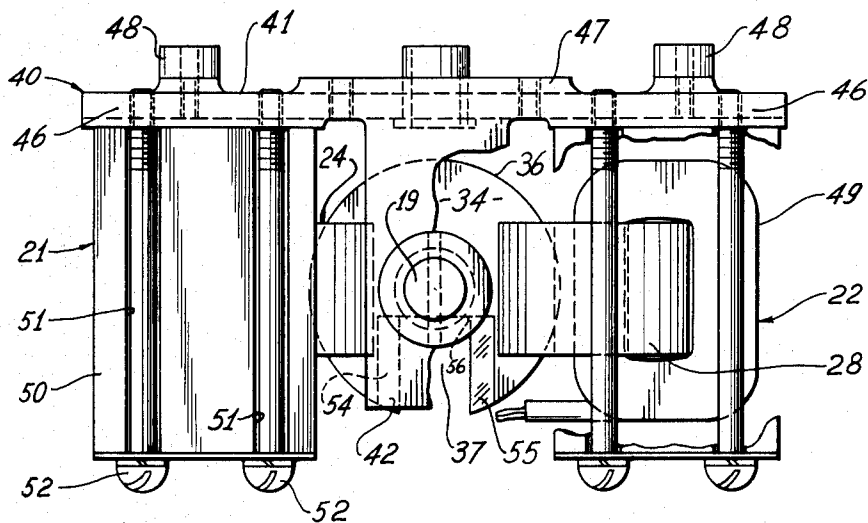


Fig. 3.

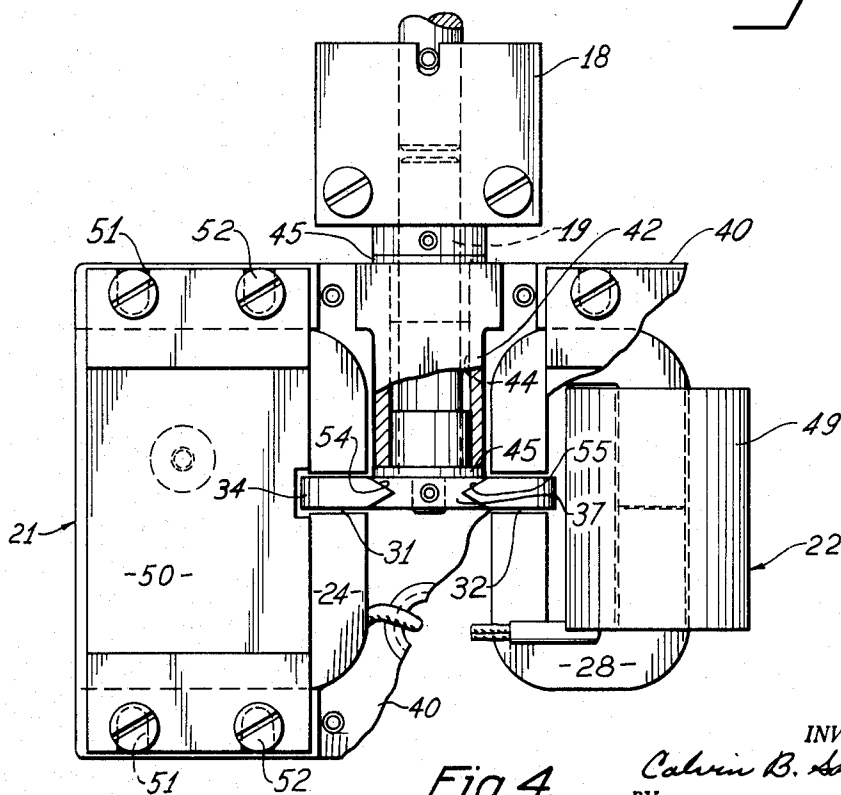


Fig. 4.

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SIGNAL PRODUCING DEVICE AND COMBINATION THEREOF WITH MASTER CONTROLLER
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5 Claims. (Cl. 323—51)

This invention relates to electrical signal producing devices and more particularly to a manually operable signal producing device suitable for use as a master control element for an electric motor controller.

For the control of electric motors supplied through, or otherwise controlled by, saturable inductors, grid controlled tubes, controlled semi-conductors, rectifiers, or the like, it is desirable to have a signal producing device which provides an output voltage variable in phase or polarity depending upon the direction of the displacement of a pivoted handle from a central position and proportional in magnitude to the extent of displacement of the handle from the central position.

A differential transformer has many advantages as a means to provide a variable voltage in such a device. Generally, however, in differential transformers of the moving core type, the core moves rectilinearly. In a master control element, it is desirable that the operation of the switch be effected by a pivotal motion of an operating handle. In order for such prior differential transformers to respond to the pivotal motion of an operating handle, a complex mechanical linkage or motion converter is required to change the pivotal motion of the handle to rectilinear motion of the core.

In accordance with the present invention, the need for such a motion converter is eliminated by providing a signal producing device including a differential transformer having a rotary core portion to which pivotal motion of a pivoted member, such as a pivoted operating handle of a master control element, can be transferred directly or through simple gearing.

An object of this invention is to provide such an improved signal producing device, the output voltage of which depends upon the rotated position of a rotatable core portion.

A more specific object is to provide an improved differential transformer having a rotatable core portion and suitable for use as a signal producing device in a master control element for an electric motor controller.

Another object is to provide an improved signal producing device which provides an output voltage proportional in magnitude to the rotary displacement of a pivoted operating member from a neutral position.

Another object is to provide an improved signal producing device which provides an output voltage variable in phase depending upon the direction of movement of a pivoted member from a central neutral position.

Another object is to provide an improved signal producing device having an output voltage proportional in magnitude to the extent of rotary movement of a pivoted member from a central neutral position and variable in phase depending upon the direction of movement of the member from the central neutral position.

A further object is to provide a signal producing device having an output voltage which is infinitely variable between two predetermined magnitudes of opposite phase relation upon rotary motion of a magnetic core.

Another specific object resides in the combination of

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the signal producing device with a master control element in a manner such that operation of the pivoted handle of the control element directly rotates the core of the device.

Another object is to provide a signal producing device that is of compact and rugged construction and adapted to be readily associated with a conventional contact-making master switch and operable directly by movement of the operating shaft of the master switch.

Other objects and advantages of the invention will be apparent from the following description wherein reference is made to the drawings in which:

FIG. 1 is a perspective view of a signal producing device in accordance with this invention operatively associated with a conventional contact-making master switch of the pivoted handle type;

FIG. 2 is a schematic representation of the signal producing device of FIG. 1;

FIG. 3 is a top plan view of the signal producing device of FIG. 1;

FIG. 4 is a front elevational view of the device of FIG. 1; and

FIG. 5 is a graph depicting the displacement-output characteristic of the device.

Referring to FIG. 1, a master control element, shown as a conventional master switch 9, of the type having a pivoted operating handle 10, is shown. The handle 10 is fixedly mounted on a horizontally disposed shaft 11 for pivotal movement in opposite directions about the shaft axis from the central position to predetermined limits, respectively. The shaft 11 enters a gear box 12 wherein it is connected to conventional gearing, not shown, by which rotary motion of the input shaft 11 imparts rotary motion to a vertically disposed output shaft 14. The shaft 14 may be arranged to operate a series of cam-operated contacts 15 of the master switch 9. The lower end of the shaft 14 is fixedly secured, as by a coupling 18, to a coaxial shaft 19 of a signal producing device 20 which is in the form of a differential transformer, in accordance with this invention, as best illustrated in FIG. 4.

Referring now to the schematic showing of FIG. 2, the signal producing device 20 includes a pair of transformers 21 and 22. The transformer 21 has a core 24, a primary winding 25, and a secondary winding 26. The transformer 22 has a core 28, a primary winding 29, and a secondary winding 30. The windings 25 and 26 are positioned on an outer leg 24a of the core 24 and the windings 29 and 30 are positioned on an outer leg 28a of the core 28. An inner leg 28b of the core 24 has an air gap 31 and an inner leg 28b of the core 28 has a similar air gap 32. The air gaps 31 and 32 are disposed in the same horizontal plane. The outer leg 24a and the inner leg 24b of the core 24 are joined by an upper yoke portion 24c and a lower yoke portion 24d. Similarly, the outer leg 28a and the inner leg 28b of the core 28 are joined by an upper yoke portion 28c and a lower yoke portion 28d. A horizontal vane member 34 is carried at the lower end portion of the vertical shaft 19 and is rotatable therewith about the shaft axis. The outer peripheral margin of the vane member 34 is receivable in the gaps 31 and 32 concurrently.

The primary windings 25 and 29 are shown as serially connected, but may be connected in parallel if desired. The secondary windings 26 and 30 are connected in series opposition to each other between a pair of output terminals 35.

With an alternating voltage applied at input terminals 36 of the primary windings 25 and 29 and the vane 34 in the position shown, the voltages across the secondary

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windings 26 and 30 are equal and opposite in phase and the voltage at the output terminals 35 is zero. The peripheral margin of the vane member is interrupted part-way of its circumferential extent by suitable means, such as at notch or cut-out 37.

Upon rotation of the shaft 19 clockwise from the position shown, the notch or recess 37 enters the air gap 31 causing the voltage across the secondary winding 26 to decrease. As a result, a differential voltage in phase with the voltage across the secondary winding 30 appears at the terminals 35.

Upon counterclockwise rotation of the shaft 19 from the position shown, the notch or recess 37 enters the air gap 32 and the voltage across the winding 30 decreases. As a result, a differential voltage in phase with the voltage across the secondary winding 26 appears at the terminals 35.

It will be noted that the vane has portions 34a and 34b on opposite sides of the slot 37. These portions are, in operative effect, separate vane means insertable into and retractable from the air gaps 31 and 32, respectively.

Referring now to FIGS. 3 and 4, a preferred construction of the signal producing device, depicted schematically in FIG. 2, comprises a support or base member 40 which carries the transformers 21 and 22. The base 40 is preferably an aluminum casting having a generally planar portion 41 with a central projection 42. The projection 42 has an opening 44 which receives upper and lower bushings 45 which, in turn, rotatably receive the shaft 19. The base 40 has a pair of thickened portions 46 at one face at opposite ends thereof with a plurality of tapped openings therein. A boss 47 is formed centrally at the other face of the base 40 and has an opening for passage of wires which may extend to a terminal board, not shown, carried on bosses 48.

Each of the cores 24 and 28 is in the form of a stack of generally U-shaped laminations to facilitate assembly of the windings 25, 26, 29, and 30 thereon. The windings 25 and 26 and the windings 29 and 30, indicated in FIG. 2, are wound one outside of the other, as indicated for the windings 29 and 30 at 49 in FIGS. 3 and 4. The cores 24 and 28 and assembled windings 25, 26, 29, and 30 are suitably potted in a body 50 of moldable insulating material. The body has slots 51 in its end portions which receive screws 52 which engage the tapped openings in the base 40 for fastening the transformers to the base. The vane 34 is carried on the end of the shaft 19 beyond the lowermost of the bushings 45.

As shown in FIG. 3, the notch 37 is defined by side walls 54 and 55 and a chordal inner wall 56.

From the foregoing, it is seen that the shaft 19 may be selectively rotated upon pivotal movement of the handle 10 to insert or withdraw the slot 37 from the air gaps 31 and 32, selectively.

The signal producing device of this invention thus constitutes a rotary differential transformer having a signal output of a magnitude proportional to the angular displacement of the rotatable vane member 34 from a pre-selected central or null point and of a phase relation dependent upon the direction of movement. In operation, the vane member 34 acts to complete the flux path for each of the transformers 21 and 22. Depending upon the direction of rotation, the slot 37 enters one or the other of the gaps 31 and 32, and thereby increases the reluctance of the flux path for the one of the transformers 21 and 22 associated with the particular gap while at the same time maintaining the reluctance of the other substantially constant. Variance in the reluctance of the flux path for a given transformer may be achieved by only partially filling its air gap. When the vane member 34 is positioned in the air gaps 31 and 32 so as to provide a flux-conducting path of equal reluctance for each of the transformers 21 and 22, the voltages at the secondary coil windings 26 and 30 are equal. Because the windings 26

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and 30 are connected in series opposition as shown in FIG. 2, there will then be no voltage output across the terminals 35. As described in connection with FIG. 2, movement of the vane causes one of the transformers to decrease its voltage while the voltage of the other remains substantially constant.

The shape of the notch or cut-out 37, defined by the walls 54, 55, and 56 in the illustrative example, is so related to the area of the cores and the axis of the shaft 19 that the output voltage at the terminals 35 of FIG. 2 varies as indicated by curves 58 and 59 in FIG. 5 wherein the output voltage is plotted as a function of the angular rotation or displacement of the shaft 19 on opposite sides of a null point. The curve 58 shows the resultant voltage of the terminals 35 when the vane 34 is turned in one direction and the curve 59 shows the voltage at the terminals 35 when the vane 34 is turned in the other direction. The voltages represented by the curves 58 and 59 are 180° out of phase with respect to each other and, as is well known, a full-wave rectification means can be connected in a well known manner to receive the signals from the windings 26 and 30 and can be used to give a D.C. output of opposite polarities, selectively.

By varying the shape of the notch or cut-out 37, the voltage characteristics, relative to displacement, can be altered. If desired, the cut-out may be in the form of a circular segment or sector, instead of the shape illustrated.

Having thus described my invention, I claim:

1. An apparatus comprising separate first and second transformers, cores for said transformers, respectively, each core having a first leg portion, a second leg portion, and a bottom yoke portion and a top yoke portion joining said leg portions, primary and secondary windings on each of said cores, each of said second leg portions having an air gap extending transversely thereof, said gaps being coplanar, a single flux conducting vane member rotatable about an axis normal to the plane of said gaps and common to said gaps and insertable into and retractable from said gaps successively, alternately, upon rotation of said vane member to different positions about said axis.

2. The structure according to claim 1 wherein said primary winding of said first and said second transformers are serially electrically connected and wherein said secondary windings of said first and said second transformers are serially connected in opposition so as to constitute a differential transformer device.

3. The structure according to claim 1 wherein said movable vane member is a relatively flat circular plate having a single cut-out portion therein eccentric to said axis.

4. A differential transformer device comprising two separate transformers, cores for said transformers, respectively, each core having an air gap, said air gaps being coplanar, a movable vane comprising a relatively flat circular plate member rotatable about an axis normal to the common plane of said air gaps and having a single cut-out therein, means for rotating said plate member selectively in opposite directions and said gaps being positioned for receiving portions of said plate member at opposite sides of said cut-out upon rotation of said plate member about said axis in opposite directions, selectively.

5. The combination with a master switch including contact making and breaking means, a shaft rotatable about a predetermined axis, means on said shaft for operating said contact making and breaking means consequent upon rotation of said shaft, an operating handle operatively connected to said shaft for rotation of said shaft upon operation of said handle, of a signal producing device including a vane, a vane supporting shaft coaxial with said first mentioned shaft, means connecting said shafts for co-rotation about said predetermined axis in fixed relation to each other, said vane being rotatable with said vane supporting shaft and differential transformer means responsive to the rotative position of said

vane to produce signals related to the position of said handle.

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