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DIGITAL TO ANALOG TRANSLATOR

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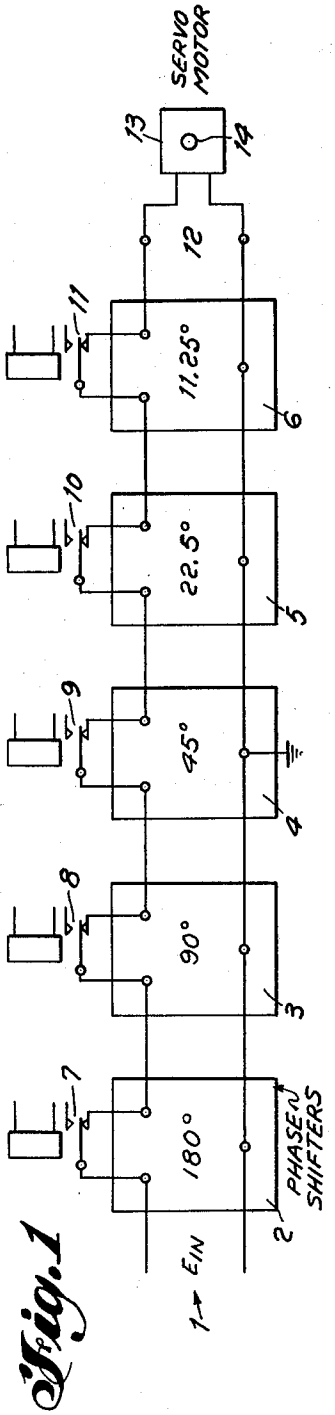


Fig. 1

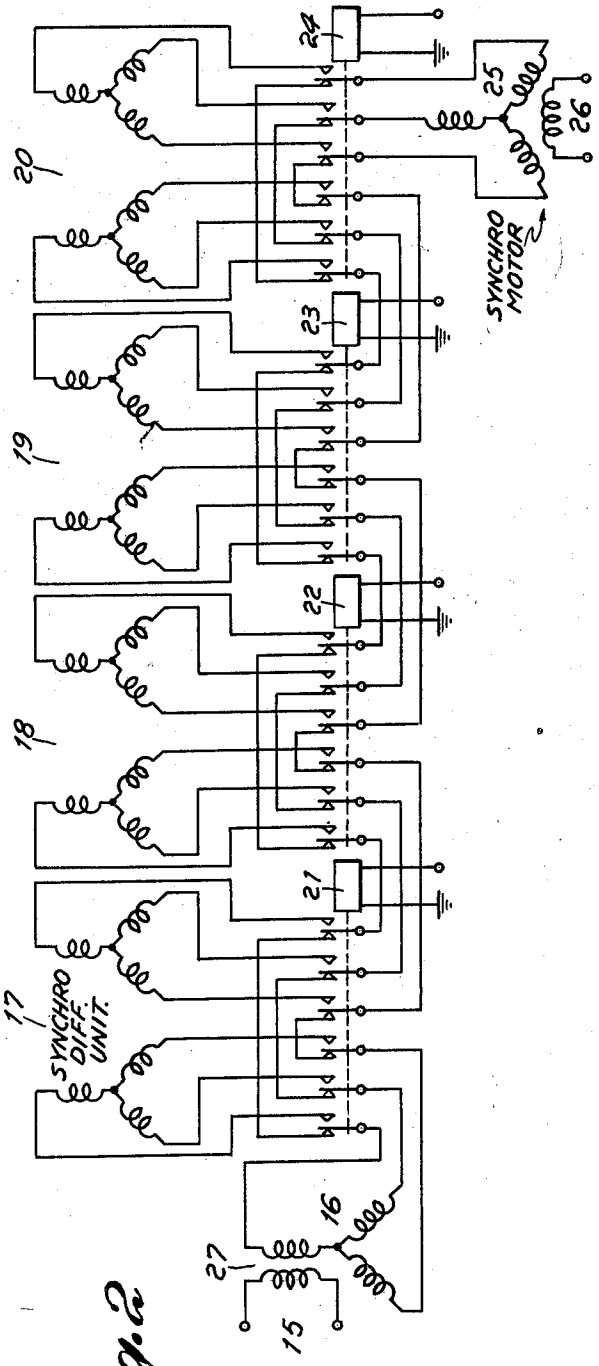


Fig. 2

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DIGITAL TO ANALOG TRANSLATOR

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7 Claims. (Cl. 340—347)

This invention relates to apparatus for translating information from a digital form into a representative shaft position and in particular for translating binary coded information into a representative shaft position.

There are numerous known methods for translating digital-to-analog information and the reverse analog-to-digital translation. Some of these systems are based on a principle of balancing a bridge, by coupling a potentiometer wiper to a shaft and comparing the potential developed in a circuit of components representing digital information against that of the potential found at the wiper position. Other systems known to the art use a series of cams and cam contacts with each cam being assigned a binary code weight. The shaft is operated when the camming circuits are introduced into the circuit through digital information controlled relays with the circuits causing the rotation being broken and/or held closed by the camming operation of the cam contacts. These systems have varying degrees of complexity with regard to electromechanical operations and components. A system for minimizing this complexity is therefore desirable.

An object of this invention is to provide a circuit which will translate digital information into a voltage vector form from which a shaft can be made to rotate proportionately with an economy of electromechanical complexity.

One of the features of this invention is the development of an output voltage whose voltage vector characteristic is determined as a function of digital information presented and is such as to cause a shaft to rotate in accordance with this voltage vector characteristic modification of the input voltage. This is accomplished by connecting in series a plurality of weighted devices for varying the voltage vector characteristic of an input voltage. In one embodiment of the system these devices each comprise a phase shifting network whose design causes the operation of a particular weighted voltage phase shift on the voltage presented thereto. Another embodiment employs for each device a weighted synchro differential transformer and features the series connection of these transformers, thereby developing a resultant voltage whose magnitude and polarity in each of the three legs of the stator of the conventional synchro motor causes the rotor of the motor to seek a single position null point.

The above-mentioned and other features and objects of this invention will become more apparent by reference to the following description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a block diagram of the phase shifting networks circuit.

Fig. 2 is a schematic of the differential transformer circuit.

In Fig. 1 there is an input voltage at **1**. The phase shifting networks **2, 3, 4, 5** and **6** can be connected in series or can be shorted out depending on the status of the relays. Relays **7, 8, 9, 10** and **11** are controlled by digital information. Assumming a "1" condition energizes a relay and a "0" condition does not energize a relay, then a number represented in a binary code by 10011 would energize relays **7, 10** and **11** while relays **8** and **9** would remain unenergized. This condition would create in the circuit a voltage phase shift of 180 degrees +22.5 degrees +11.25 degrees or 213.75 degrees which appears at output **12**. Such a voltage phase shift when applied to rotor device **13** causes the shaft **14** to rotate and change position proportionately to the number 10011. By way of illustration only, the networks were reduced by one half in each step although any weight could be assigned to the networks depending on the binary code and shaft rotation desired.

A second embodiment of the invention is shown in Fig. 2. This system as shown makes use of a series of synchro differential transformers in order to alter the input voltage in such a way as to develop an output voltage which when seen by the output synchro motor will cause the motor rotor-shaft to move itself into a position in accordance with the output voltage magnitude and polarity. The use of synchros and the synchro motor for a translation of a voltage value to a shaft movement is well known to the art. In effect, the relative physical orientation of the primary and secondary winding of the differential transformer varies the coupling such that the voltage magnitude and polarity in each leg stand in a relationship to each other which can differ from the reference or primary voltage as a function of the coupling. When the differentials are connected in series, the output of any secondary will become the reference of its following series adjacent primary; and therefore, the output of the series adjacent secondary will be an alteration of the output of the preceding adjacent series secondary reference. The relationship of the voltage magnitudes and polarities in the three legs is the rotor position determining factor so that a synchro differential transformer designed to move a rotor 45 degrees or change the voltage vector characteristic appearing at the stator will contribute a sufficient change to the overall output voltage to accomplish the 45-degree movement or the voltage vector characteristic change regardless of whether this differential unit operates on a reference as seen at a preceding adjacent secondary or the reference as seen at the original voltage input.

In Fig. 2 there is an input voltage at **15** which induces a voltage in the three legs of the secondary **16** of the synchro differential transformer **27**. Again assuming that relays **21, 22, 23** and **24** are energized by a "1" condition and not energized by a "0" condition, a binary number 1100 would cause relays **21** and **22** to be energized while relays **23** and **24** would remain unenergized. With relays **21** and **22** energized, the differential transformers **17** and **18** are connected in series and the output is shorted around differential transformers **19** and **20** to the output "Y" at **25**. The voltage at **25** will have three components and the voltage magnitude and polarity in each leg will be of such value that the rotor at **26** will seek a null point of which there is only one for the voltage relations in the three windings at **25**. The number of bits could be extended depending on the code or angular needs.

While I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of my invention as set forth in the objects thereof and in the accompanying claims.

I claim:

1. An electromechanical system for translating digital information into a voltage vector characteristic representing an angle between zero and 360° comprising an input voltage source, a source of digital information, a plu-

rality of phase shifting network devices for varying the voltage vector characteristic of said input voltage, each of said phase shifting devices adapted to vary said input voltage vector characteristic by a predetermined amount, means including switches for coupling said voltage vector varying devices into and out of circuit with said input voltage source and means to control said switches in accordance with the information received from said source of digital information.

2. An electromechanical system for translating digital information into a voltage vector characteristic representing an angle between zero and 360° comprising an input voltage source, a source of digital information, a plurality of synchro differential transformer devices for varying the voltage vector characteristic of said input voltage, each of said synchro transformer devices adapted to vary said input voltage vector characteristic by a predetermined amount, means including switches for coupling said voltage vector varying devices into and out of circuit with said input voltage source and means to control said switches in accordance with the information received from said source of digital information.

3. An electromechanical device for translating digital information into a representative shaft position comprising a plurality of phase shifting networks with each of said networks being assigned a binary code weight, a voltage summation circuit, digital information controlled means, circuitry means for coupling said voltage summation circuit to said phase shifting networks through said controlled means, an input voltage means coupled to said networks to provide an input voltage having a phase characteristic, and means including a shaft responsive to the output of said voltage summation circuit to rotate said shaft.

4. An electromechanical device for translating digital information into a representative shaft position comprising a plurality of phase shifting networks with each of said networks being assigned a binary code weight, a voltage summation circuit, a plurality of relays each of which is capable of shorting out a respective one of said networks, means to control said relays by digital information, circuitry means for coupling said voltage summation circuit to said phase shifting networks including said relays, an input voltage means coupled to said networks to provide an input voltage having a phase characteristic, and means including a shaft responsive to the output of said voltage summation circuit to rotate said shaft.

5. An electromechanical device for translating digital information into a representative shaft position comprising a plurality of synchro differential transformers, an input voltage means to provide an input voltage having a voltage vector characteristic, a plurality of relays to connect said transformers in series to said input means with said relays controlled by digital information, and a rotor shaft device responsive to the voltage vector characteristics of said series transformer circuit output.

6. An electromechanical device for translating digital information into a representative shaft position comprising a plurality of synchro differential transformers with each of said transformers being assigned a binary code weight, a plurality of relays which are digital information controlled, a voltage summation circuit, circuitry means to enable said relays in accordance with said digital information to respectively insert in series said differential transformers into said voltage summation circuit, an input voltage means connected through said relays to said voltage summation circuit to provide an input voltage having a voltage vector characteristic, a rotor shaft device whose position is responsive to the voltage vector characteristics of said voltage summation circuit output, and means to couple said output to said rotor shaft device.

7. An electromechanical device for translating digital information into a representative shaft position comprising a plurality of synchro differential transformers with each of said transformers being assigned a binary code weight, a plurality of digital information controlled relays, each of said transformers having associated therewith one of said relays, a voltage summation circuit coupling said transformers in series through said relays, a voltage input means coupled to said summation circuit to provide an input voltage having a voltage vector characteristic, and a synchro motor coupled to the output of said voltage summation circuit.

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