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FREQUENCY CONTROL METHOD AND SYSTEM

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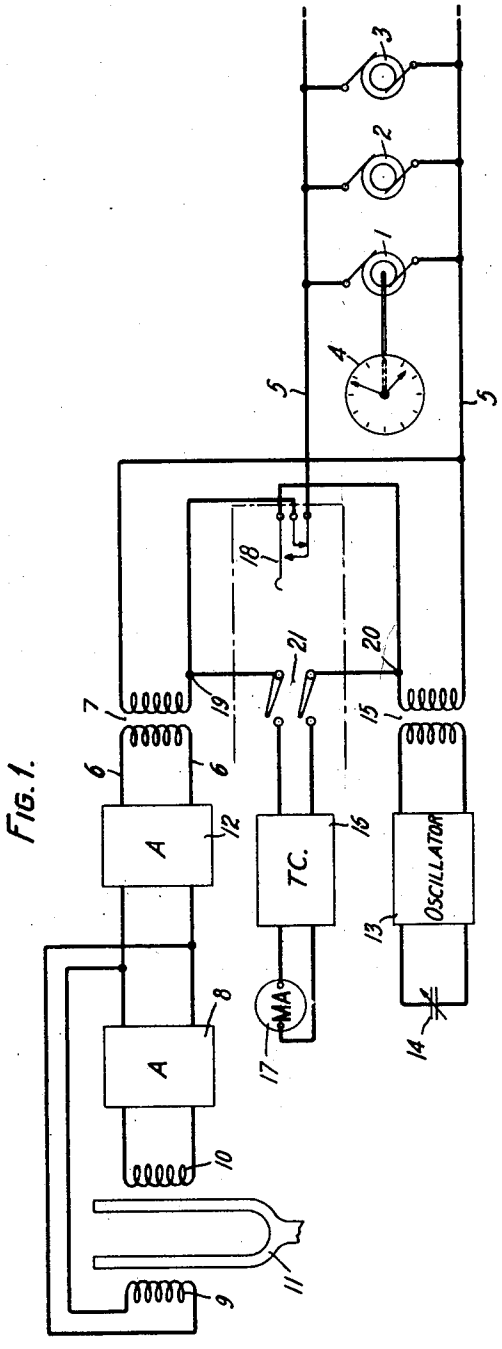

FIG. 1.

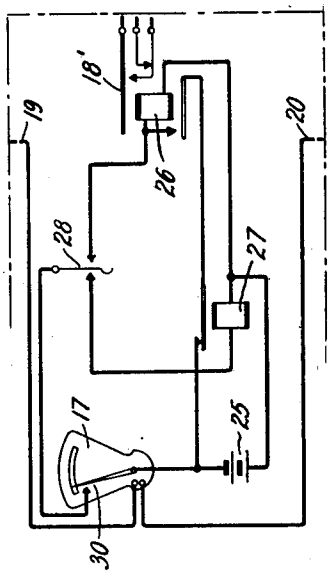

FIG. 2.

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FREQUENCY CONTROL METHOD AND SYSTEM

Application filed February 24, 1928, Serial No. 256,783. Renewed June 11, 1930.

The present invention relates to the generating, controlling and transmission of electrical currents or waves and particularly to provisions for securing desired flexibility of control of the frequency of such currents or waves.

The invention has particular application to systems operating at one or more frequencies that are nominally constant or that correspond to some fixed conditions. In such systems it is common to provide special means for securing and maintaining the required constancy of frequency or the required adherence of the frequency to the prescribed or fixed conditions. It frequently becomes necessary, however, in such systems to introduce a change in the frequency either by way of correction or for some control purpose contrary to the fixed conditions. Such changes might be made by altering the characteristics of the primary frequency control means, so that, for example, the system takes up a new frequency of operation. Where, however, special precautionary provisions have been made to hold the frequency rigidly to some fixed requirements it frequently becomes incompatible with such provisions to shift the frequency out of its prescribed course and into some other course.

It is an object of the invention to provide for readily introducing changes in the frequency of electrical control waves in a system to cause the system to depart from the normal or prescribed frequency relations.

A further object is to enable one voltage source to be substituted for another without introducing disturbances into the system.

The invention provides for introducing flexibility of control into a system even though the system in its normal operation may be made to obey rigidly a fixed law of operation as to frequency.

The invention will be more fully described in the following specification and in connection with the attached drawing forming a part thereof, in which drawing Fig. 1 is a schematic representation of a system of control in accordance with the invention with a normally fixed control frequency and with provision for quickly, but without occasioning disturbances, varying the frequency of the system at will and in any desired manner; and Fig. 2 shows a modified type of circuit for effecting a circuit change incidental to introducing the frequency variations as described. While the invention is applicable to transmission or control systems generally, including signaling, measuring or indicating and other systems, the application illustrated and described in detail herein is to a control system for operating clocks or similar apparatus.

Referring to Fig. 1 of the drawing, a number of synchronous motors 1, 2, 3, etc., may be connected to the line 5, one motor being shown as driving a clock 4. These motors are supplied with current of constant frequency from the circuit 6 through transformer 7. The source of constant frequency current may be of any suitable type but is illustrated as comprising an amplifier 8 having an output winding 9 coupled to an input winding 10 through the medium of a tuning fork 11 such that the fork is maintained in a continuous vibrating condition at its resonant frequency and, in vibrating, it maintains the electrical current in amplifier 8 at the same frequency. Such a source of constant frequency current is disclosed in my application for Letters Patent Serial No. 19,580, filed March 31, 1925, which issued as Patent No. 1,763,000, June 10, 1930, and to which reference may be made for a more detailed description, if desired. The frequency in the final output circuit 6 may be the frequency of the fork 11 or some multiple or sub-multiple thereof. A circuit for obtaining such sub-multiple frequencies is disclosed in an article by Horton and Marrison published in the Proceedings of the Institute of Radio Engineers for February, 1928, Volume 16, Number 2, pages 137 to 154.

In the normal operation of the system, the amplifier 8 in cooperation with fork 11 supplies a wave of constant frequency through a second or succeeding amplifiers 12 as may be desired, to output circuit 6, and thence through transformer 7 to distributing circuit 5, to which the devices to be operated (1, 2, 3 etc.) are connected.

If it is desired for any reason to exercise an independent control over motors 1, 2, 3 etc., such as to step them ahead or backwards to reset the clock 4 or for any other purpose, provision is made for transferring the control from circuit 6 to a substitute source of current 13, which may take the form of a vacuum tube oscillator such for example as that disclosed in U. S. patent to Hartley 1,356,763 granted October 26, 1920. The oscillator is provided with a variable condenser 14 to enable the frequency of the oscillations to be changed at will.

The transfer of circuit 5 from connection with the fork generator to connection with the source 13 is effected by make-before-break key 18 in a manner to be described. In order to make the transfer without introducing disturbances into the circuit 5, a meter 17 and thermocouple 16 are provided for connection between points 19 and 20 in the circuit by means of switch 21. The thermocouple is a form of modulating device giving a response in meter 17 equivalent to the beat or difference frequency, if any, existing between sources 6 and 13 when both sources are connected at the same time to the meter circuit. In other words, the elements 16 and 17 form a beat frequency indicator.

Assuming the switch 18 to be in the position indicated in the drawing, the motors 1, 2, 3 are being constantly driven under control of the fork-controlled generating circuit 8. If it is desired to step the motors ahead or back, the oscillator 13 is set into operation at approximately the frequency of the current in circuit 6, the switch 21 being closed to enable readings to be made on meter 17. If the currents from circuit 6 and source 13 were exactly of the same frequency and phase, then there would at all times be no potential difference between terminals 19 and 20, and the meter 17 would read zero. Ordinarily, however, even with careful adjustment of the condenser 14, there will be some slight difference in frequency of the two sources so that the needle of meter 17 will swing back and forth across its scale. By adjusting condenser 14, the movement of the pointer of meter 17 may be readily slowed down or held practically stationary. When the meter 17 gives a zero reading the operator knows that no potential difference exists across circuit 19, 20, that is, between the closed and the open points of key 18. This key is therefore depressed when meter 17 reads zero, and source 13 is substituted for source 8 without introducing any voltage change in circuit 5.

After the transfer of the circuit has been made in the manner described, the frequency of source 13 may be varied by adjusting condenser 14 and the motors 1, 2, 3, etc., may be accelerated or retarded as may be desired, since they are now under control of oscillator 13. After the desired change in setting has been made by the control thus exercised over motors 1, 2 and 3, the control is restored to the fork-controlled circuit by bringing oscillator 13 back to frequency and phase agreement with the fork circuit and key 18 is then released. The correspondence in frequency and phase between the two sources is indicated, as before, by the meter 17 at its zero reading.

Fig. 2 discloses a modified switching arrangement in which the actual cutting over of the circuits is under the joint control of a manual key and the meter 17. The elements in this figure are to be substituted for those within and to the left of the dotted line in Fig. 1. Conductors 19 and 20 lead to the meter 17 as in Fig. 1, while the three leads from key 18 of Fig. 1 are shown in Fig. 2 connected to the relay-actuated key 18′.

In the operation of the circuit according to Fig. 2, when it is desired to substitute oscillator 13 for the fork-controlled source, the frequency of the current from oscillator 13 is brought to approximately that of the fork circuit as determined by the pointer of meter 17 making very slow to-and-fro movements. Key 28 is then moved to close its right-hand contact. This may be done with the meter needle in any position and this modification relieves the operator from the necessity of watching the meter closely, all that is necessary being to have the frequencies of the two sources in fairly close agreement so that the meter swings slowly. In the modification being described, the meter 17 is provided with a contact 30 arranged to be closed at the zero position of the meter arm. As soon as contact 30 is closed by the meter, relay 26 is immediately operated by current from battery 25, and the circuit is cut over by movement of switch contacts 18′, the action of these contacts being as described in connection with Fig. 1. Relay 26 also closes a locking circuit for itself at its lower armature, independent of meter 17 and key 28, so that the key 28 may now be returned to its central or normal position and relay 26 holds the circuit in position to connect oscillator 13 to the load circuit.

After the necessary control of the load circuit from oscillator 13 has been effected, the load is returned to the fork-controlled source by moving key 28 to its left position, care being first taken to bring the source 13 back to such close frequency agreement with source 8 that meter 17 swings fairly slowly. Movement of key 28 to close its left contact causes, under control of contact 30, energization of relay 27 which breaks the holding circuit of relay 26 and restores the switch 18′ to its normal unoperated position.

It is, of course, to be understood that variations, substitutions and extensions as desired may be made within the scope of the

claims without departing from the spirit of the invention.

What is claimed is:

1. In a frequency control circuit, a source of alternating current of fixed frequency, a source of alternating current of adjustable frequency, a beat frequency indicator connected to both sources for indicating when said sources are in frequency and phase agreement, a load circuit, and means for connecting said load circuit at will to either of said sources of current.

2. In a control system including a mechanism to be driven at constant frequency, a source of alternating current normally connected thereto for continuously operating said mechanism, and means for stepping said mechanism to a new position with respect to its normal actuating current, comprising a source of alternating current of variable frequency, means to adjust the frequency of said second source to correspond to that of the first mentioned source, and means to substitute the second source for the first source at an instant when both sources are in phase agreement, whereby the control of said mechanism is transferred to said source of variable frequency.

3. In a system comprising a source of alternating current whose frequency is held to fixed predetermined adjustments, and a load supplied therefrom, the method of varying the frequency control of said load comprising substituting for said source a second source of waves of substantially the same frequency as said first mentioned source, varying at will the frequency of the second mentioned source, restoring after such variation the frequency of said second source to substantially that of the first source and again shifting the load to said first source from said second source.

4. In combination with a load circuit, a fixed frequency and a variable frequency source of alternating current, the first of said sources being normally connected to supply said load circuit, a beat frequency indicator for indicating when said sources are in synchronism and phase, means for substituting the variable frequency source for the fixed frequency source as the driving source for said load, means for adjusting the frequency of the second source about the frequency of said first source, to shift the relative phase position of the load with respect to the fixed frequency source, and means comprising said load to indicate the extent of that shift.

5. In combination with a member normally driven in synchronism with electrical waves of constant frequency and requiring a definite phase position with respect to time, means for temporarily applying to said member electrical waves of a variable frequency to adjust the relative phase position of said member, means for indicating when said mechanism has reached said required relative phase position, means indicating when said waves of variable frequency are in isochronism with said waves of constant frequency, and means for transferring said member to the control of said waves of constant frequency.

6. In combination with a mechanism normally operating under the control of electrical waves of constant frequency, a phase adjusting system comprising means for operating said mechanism under the control of waves of variable frequency to drive said mechanism to a proper phase position, means comprising said mechanism to indicate when said proper phase position has been reached, means indicating when said waves of variable frequency are in isochronism with said waves of constant frequency, and means for transferring said mechanism to the control of said first mentioned waves.

In witness whereof, I hereunto subscribe my name this 24 day of February, 1928.

WARREN A. MARRISON.