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SYNCHRONIZING SYSTEM

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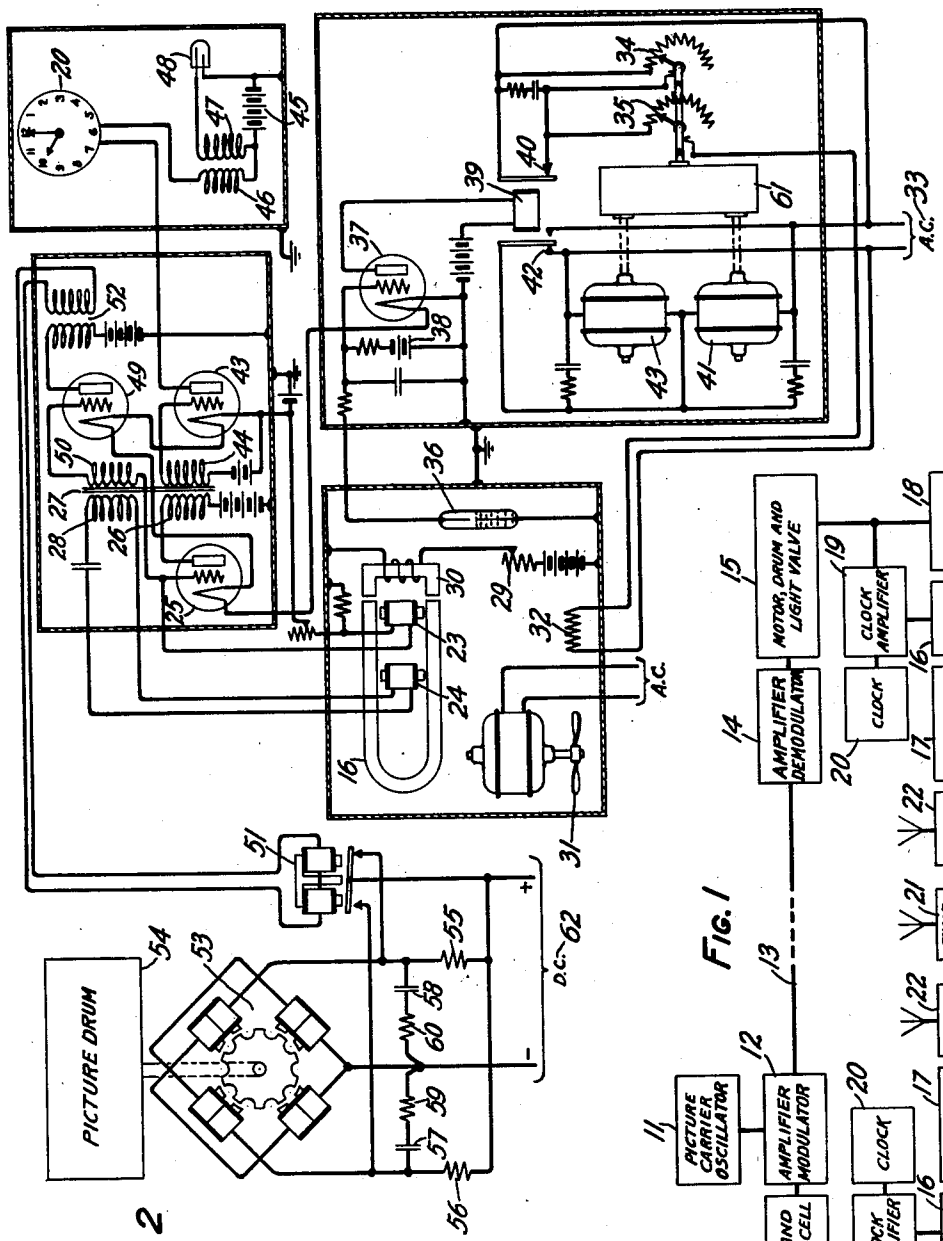

FIG. 2

FIG. 1

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SYNCHRONIZING SYSTEM

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This invention relates to synchronizing systems and particularly to methods of and apparatus for maintaining the movable elements of an electrical image transmission system in synchronism.

An object of the invention is to control the movement of elements, such as are employed at different stations of an electrical image producing system, by means of independent sources of substantially constant frequency energy at the different stations.

A further object is to check the frequency of the constant frequency energy sources over long periods against the same chronometer and to correct for any small deviation from the constant frequency which may be indicated.

In a specific embodiment of the invention, hereinafter described in detail, there is provided at each of a plurality of stations of a picture transmission system, a constant frequency current generator which comprises a vacuum tube circuit and a tuning fork for controlling the electromotive force applied to the input of the vacuum tube circuit. The current from this source actuates a relay which controls the energization of a La Cour motor to which the picture drum is mechanically coupled. The tuning fork is automatically maintained at a constant temperature so as to prevent changes in its natural period due to temperature variations. There is also associated with the constant frequency current source an electrically driven clock or similar mechanism whose movement over a period of time is dependent upon the frequency of the constant frequency source. This mechanism is calibrated in hours, minutes and seconds so that it may be checked over long periods, perhaps of the order of a day, against a source of standard time, as for example, the time signals sent out each day over a radio channel.

Fig. 1 shows schematically the general arrangement of the parts of a picture transmission system constructed in accordance with the present invention and Fig. 2 shows in detail a portion of the system shown in Fig. 1.

That portion of the system which is employed for producing and transmitting a carrier current modulated in accordance with the tone values of successively scanned elemental areas of a picture and for utilizing this modulated current for controlling the reproduction of a picture is disclosed in detail in Patent No. 1,606,227, issued November 9, 1926, to J. W. Horton, H. E. Ives and M. B. Long, and reference is made thereto for a detailed disclosure thereof.

Referring now to Fig. 1 of the drawings, the apparatus 10 which is employed for scanning a picture comprises a drum on which the picture film is mounted and a motor for driving the drum to rotate it and at the same time move it in the direction of its axis. A stationary source of light which is focused upon the film is provided for illuminating its elemental areas in succession in accordance with the movement of the drum and the light which is transmitted through or reflected from the picture film is directed upon the light sensitive surface of a photoelectric cell for modifying the photoelectric current in the cell in accordance with the tone values of the successively scanned elemental areas of the picture. The photoelectric current and a carrier current generated by the picture carrier oscillator 11 is impressed on the amplifier modulator 12 to produce a carrier current which is modulated in accordance with the tone values of the successively scanned elemental areas of the picture. This modulated carrier current is transmitted over a suitable transmission channel 13 to the picture reproducing station where it is amplified and demodulated by the apparatus 14. The apparatus 15 comprising a motor, a picture drum and a light valve is employed for reproducing the picture. The demodulated picture current is impressed upon the light valve which controls the amount of light reaching a light sensitive sheet mounted on the picture drum. The motor drives this drum in synchronism with the drum at the transmitting station so as to permit the exposure of successive elemental areas of the light sensitive sheet in accordance with the operation of the light valve.

At the transmitting and receiving stations independent sets of apparatus are employed for driving the picture drums at a speed of such constancy that the drums are maintained in synchronism without speed correction over long periods of time and without the transmission of synchronizing current from one station to the other. Each of these sets of apparatus comprises a master tuning fork 16, which is automatically maintained at a constant temperature by the apparatus 17. The master fork controls a relay 18 which in turn controls the current supplied to the picture drum driving motor. The master fork also controls an amplifier 19 which supplies power to an electric clock 20. The movement of this clock is determined by the number of vibrations made by the master fork over a period of time. This clock is preferably calibrated in time units so that a check can be made over long periods of time against the source of standard time, an indication of which may be transmitted from a distant station 21 and received by the apparatus 22 located at each picture transmitting and picture receiving station.

Referring to Fig. 2 of the drawings, the master tuning fork 16 after being started in vibration is maintained in vibration through the action of the pick-up coil 23 and the driving electromagnet 24. Due to the vibration of the tines of the tuning fork, the reluctance of the magnetic circuit associated with the coil 23 is changed, thus inducing a correspondingly varying electromotive force in the coil 23 which is impressed on the control electrode of the electric discharge device or vacuum tube 25. This varying electromotive force causes corresponding current variations in the winding 26 of transformer 27 connected in the anode circuit of vacuum tube 25, which variations, in turn, cause corresponding current variations in the circuit comprising the transformer winding 28 and the driving electromagnet 24. Such an arrangement for driving a tuning fork and for producing a current having a frequency determined by the rate of vibration of the fork is disclosed in Patent 1,560,056 granted to J. W. Horton, November 3, 1925. It is thus seen that the thermionic tube generator 25 produces in the transformer winding 26 a current whose frequency is controlled by the master fork 16. The frequency of vibration of the fork may be controlled by varying the resistance element 29 for changing the current through the winding on the electromagnetic damping element 30.

To prevent frequency variations of the fork with changes in room temperature, the fork is maintained in a bath the temperature of which is automatically maintained constant by means of apparatus similar to that disclosed in Patent No. 1,757,727, to W. A. Marrison, May 6, 1930. The bath is agitated by the motor driven stirring element 31. The heater resistance element 32 which is in circuit with a source of current 33 and variable resistance elements or rheostats 34 and 35 supplies heat to the bath. When the temperature of the bath is low and the thermostat control element 36 is open, the control electrode of vacuum tube 37 is biased negatively by the potential of battery 38 and the anode current of vacuum tube 36 flowing through the winding of relay 39 is at a low value. Rheostat 34 having comparatively low resistance with respect to the resistance in rheostat 35 is short-circuited through the relay contact 40 and the motor 41 is supplied with power through relay contact 42 and drives the arms of rheostats 34 and 35 through the differential gears 61 in such direction as to decrease the effective portion of the resistance of rheostats 34 and 35. When the temperature of the bath increases and causes the closure of the contacts of the thermostat control element 36, the negative bias on the control electrode of the vacuum tube 37 is reduced to a low value, thus increasing the anode current to a sufficiently high value to cause the operation of relay 39. As a result the short circuit is removed from the rheostat 34 due to the opening of contact 40 and the motor 43 drives the arms of rheostats 34 and 35 through the differential gears 61 in such a direction as to increase the effective resistance of the rheostats 34 and 35 thus decreasing the current through the heater resistance element 32. The temperature of the bath is thus maintained substantially constant.

The current variations produced in winding 26 of transformer 27 due to the vibration of the tuning fork 16 are impressed on the control electrode of vacuum tube 43 through the winding 44 of transformer 27. The anode current for vacuum tube 43 is supplied from the source 45 through transformer winding 46 and the driving motor of clock 20. The anode current variations thus drive the clock 20 and these current variations are also impressed through transformer winding 47 upon the glow discharge lamp 48. In starting the system, light from the glow discharge lamp is directed upon the armature of the motor which drives the clock 20 to give a stroboscopic effect to aid in bringing the clock motor up to speed. The clock is then set to the correct time. However, after the constant speed apparatus at the different stations have once been correctly adjusted, the tuning forks at the different stations will remain in synchronism over long periods of time and no further use is made of the stroboscopic effect until the system is again shut down and subsequently started. The movement of the

clock 20 is proportional to the number of vibrations made by the tuning fork 16 over a period of time and when the fork is running at the correct speed the clock indication will check exactly with the standard time signals received from the time signal transmitting station 21. When the tuning fork is running slightly fast or slow, this will be indicated by the clock 20 and the speed of the tuning fork can be corrected by means of the variable resistance element 29. The tuning forks at different stations therefore are maintained in close synchronism without the necessity of transmitting synchronizing impulses from one station to another. If desired, of course, the source of standard time may be maintained at each station against which the clock at that station is checked.

The current variations produced in transformer winding 26 due to the vibration of the tuning fork 16, are impressed on the control electrode of vacuum tube 49 through a transformer winding 50. The varying current in the anode circuit of vacuum tube 49 is impressed on a relay 51 through a transformer 52. Due to the closure of the contacts of relay 51 and the resulting periodic short-circuiting of resistance elements 55 and 56, current impulses from the direct current source 62 are impressed on the windings of the La Cour motor 53 for driving it at a speed determined by the rate of vibration of the armature of relay 51 which in turn is determined by the frequency of vibration of the master fork 16. The condenser elements 57 and 58 and resistance elements 59 and 60 are provided for preventing sparking at the contacts of relay 51. The La Cour motor 53 drives the picture drum 54. By providing a vacuum tube amplifier and the relay 51 between the master fork 16 and the driving motor 53, instead of driving the motor directly from contacts associated with the master fork, the fork may be maintained more accurately at a constant speed.

What is claimed is:

1. The method of synchronizing moving mechanisms, such as are employed in electrical image producing systems, comprising motive means at each station for causing the movement of corresponding parts of the apparatus, which method comprises independently generating at each station fluctuating energy of substantially constant frequency for controlling said motive means at that station, obtaining an indication at each station proportional to the exact time required for the generation of at least several million cycles of energy from said source at said station, and checking the indication at each station against the same source of time measure.

2. In combination, a plurality of elements to be maintained in synchronism and located at different stations, respectively, of a system such as employed for the electrical transmission of images, similar apparatus at each of said stations for generating a current of the same frequency, means for driving said elements at each station by means of said current at a speed determined by its frequency, an electric clock at each station responsive to said current, the time indication of said clock being determined by the frequency of said current, means at each station for indicating standard time, and means for adjusting said current generating means at each station to vary its frequency in accordance with the difference between the reading of said electric clock and said indication of standard time.

3. In an electrical image producing system, transmitting and receiving stations, means including a rotatable element at said transmitting station, for scanning a picture or other object to produce an image current, means for transmitting said image current, means including a rotatable element at said receiving station for producing an image of said picture or object in accordance with the characteristics of said transmitted image current, similar means including a tuning fork and an electric discharge device at each station for producing a current of substantially the same constant frequency, means for automatically maintaining said tuning fork at a constant temperature to prevent frequency changes of the fork due to temperature variations, a clock, means responsive to said constant frequency current for controlling the movement of said clock, which is calibrated in time units, to indicate the frequency of said tuning fork, an electromagnetic relay, means responsive to said constant frequency current for controlling the movement of said electromagnetic relay, a motor for driving said rotatable element, means including said electromagnetic relay for driving said motor at a speed determined by the frequency of vibration of said tuning fork, means at each station for indicating standard time, and means for changing the frequency of said tuning fork in accordance with the deviation between the reading of said clock and said indication of standard time.

4. The method of synchronizing moving mechanisms, such as are employed in electro-optical image producing systems, comprising motive means at each station for causing the movement of corresponding parts of the apparatus, which method comprises independently generating at each station fluctuating energy of substantially constant frequency for controlling said motive means at that station, obtaining an indication at each station proportional to the exact time required for the generation of a large number of cycles of energy from said

source at said station, and making an adjustment of the frequency at that station in accordance with said indication and without reference to the frequency of the current generated at the other of said stations.

5. Apparatus for synchronizing moving mechanisms, such as are employed in electro-optical image producing systems, comprising motive means at each station for causing the movement of corresponding parts of the apparatus, means for independently generating at each station fluctuating energy of substantially constant frequency for controlling said motive means at that station, means for obtaining an indication at each station proportional to the exact time required for the generation of a large number of cycles of energy from said source at said station, and means for checking the indication at each station against the same source of time measure.

6. Apparatus for synchronizing moving mechanisms, such as are employed in electro-optical image producing systems, comprising motive means at each station for causing the movement of corresponding parts of the apparatus, means for independently generating at each station fluctuating energy of substantially constant frequency for controlling said motive means at that station, means for obtaining an indication at each station proportional to the exact time required for the generation of a large number of cycles of energy from said source at said station, means for checking the indication at each station against the same source of time measure, and means for making an adjustment of the frequency at each station independently of the other.

In witness whereof, I hereunto subscribe my name this 27 day of March, 1929.

JOSEPH W. HORTON.