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SYSTEM FOR INDICATING TIME

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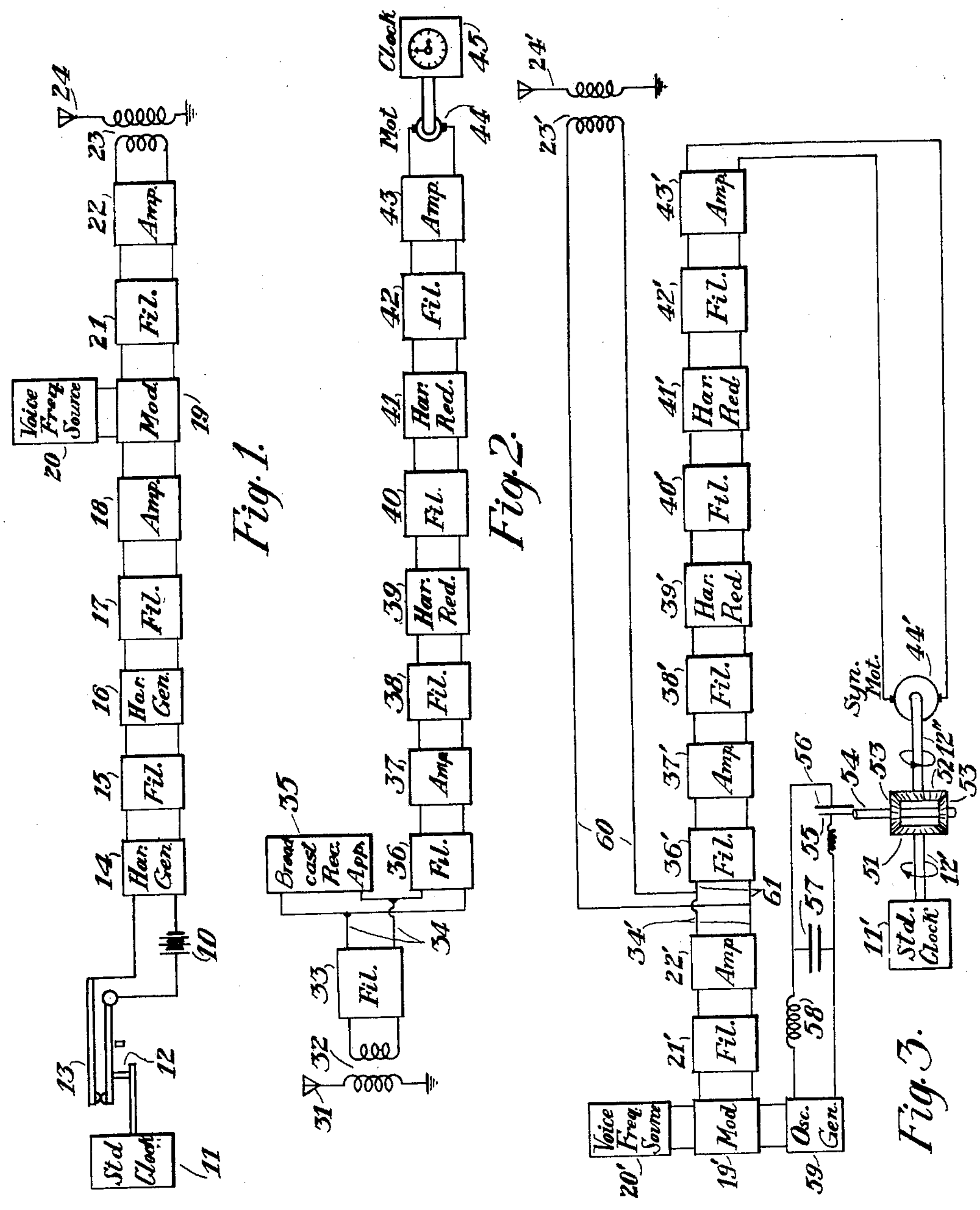

INVENTOR.

Arthur F. Poole

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SYSTEM FOR INDICATING TIME

Arthur F. Poole, Ithaca, N. Y.

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An object of my invention is to provide a new and improved system and method for indicating time at a distance from a standard clock and controlled thereby. Another object is to provide for distant control of a time indicator by suitable radio transmitting and receiving apparatus. Still another object is to provide for sending radio waves having a component of frequency determined by a time standard and actuating or controlling clocks at receiving stations in accordance with said component. A further object in this connection is to provide for getting this desired component at the receiving station with its frequency the same as determined by the time standard at the sending station. Another object of my invention is to provide for controlling the carrier frequency of a radio broadcast transmitting system by a standard clock, and at receiving stations employing the carrier frequency component of the received energy to control local clocks and keep them in synchronism with the standard clock. These and other objects of my invention will become apparent on consideration of a limited number of specific embodiments of the invention that I have chosen for disclosure in this specification. It will be understood that this disclosure relates principally to these particular examples of the invention, and that the scope of the invention will be indicated in the appended claims.

Referring to the drawing, these are diagrams in which Figure 1 shows a broadcast transmitting station with a carrier current of frequency stepped up in definite ratio from current impulses whose frequency is determined by a standard clock; Figure 2 shows a corresponding receiving station for the broadcast waves and for controlling a local clock from the carrier; and Figure 3 shows a modified broadcast transmitting station with special provision to enable the receiving station of Figure 2 to get the proper current frequency for clock control.

In the transmitting system of Figure 1, the standard clock 11 drives the wiper 12, which periodically closes the circuit of battery 10 at contacts 13. This circuit is the input circuit of the harmonic generator 14. This device 14, receiving a periodic current on its input side, delivers harmonics thereof on its output side to the filter 15, which passes one and only one of these harmonics of higher frequency to the next harmonic generator 16. Thus the combination of the harmonic generator 14 and the filter 15 constitutes a frequency multiplier. The combination 16—17 is another such frequency multiplier, and by as many such sets as needful the frequency of the current from the impulse sender 12—13 is stepped up to a proper frequency to be the carrier current of the radio broadcasting system. This current of carrier frequency is amplified at 18 and modulated at 19 from the voice frequency source 20. Thence the modulated current goes through the filter 21 and amplifier 22 to the transformer 23 from which its energy is delivered to be radiated on the antenna 24.

A corresponding receiving station is shown in Figure 2. The energy of the electric waves falling on the receiving antenna 31 is delivered through the transformer 32 as input current to the band pass filter 33. The output currents in the conductors 34 go by one branch conductor pair to the broadcast receiving apparatus 35, and by another branch conductor pair to the narrow band pass filter 36. This separates the carrier current from the side bands and passes the carrier current, which is amplified at 37, again filtered at 38, and applied to the harmonic reducer 39. This may be a three electrode vacuum tube oscillator having a natural frequency such that the frequency on its input side is very nearly a harmonic thereof; under this condition the oscillator will be forced to operate at precisely the fundamental rate of which its input is a harmonic. For example, if the input is at 1,000 kilocycles and the natural rate of the oscillator is very nearly 100 kilocycles, it will be receiving its tenth harmonic (counting the fundamental as first), and will operate at exactly the rate of 100 kilocycles. Thus from the filter 38 on the input side of the reducer 39 to the filter 40 on its output side, the frequency is stepped down once, and it may be stepped down again through another reducer 41 and corresponding filter 42, and the process may be repeated as many times as necessary to get a suitable frequency for the operation of the synchronous motor 44.

Harmonic frequency reducers such as shown at 39 and 41 are sometimes called multivibrators. Such devices may be caused by adjustment to yield any one of several distinct sub-multiple frequencies or harmonic frequencies. Thus suppose one of them gives a fundamental output for which the input is the tenth harmonic; it may be caused by adjustment to change this fundamental output so that the input will be its ninth harmonic. No such change of adjustment is contemplated in connection with the use of the devices as here described.

Eventually the current of reduced frequency from the last filter 42 goes to the amplifier 43, and the output therefrom is applied to drive the synchronous motor 44, which drives the clock indicator 45. Thus the local clock 45 is driven at a rate determined by the frequency of the received carrier current on the antenna, which as we have seen is determined at the sending station by the standard clock 11. Interfering radiation that may fall on the entenna 31 will be excluded for the most part by close tuning and filtering, and the clock 45 will operate exactly or very nearly in synchronism with the standard clock 11.

A modified transmitting station is shown in Figure 3, for cooperation with receiving stations such as shown in Figure 2. In the transmitting system of Figure 3, the standard clock 11′ drives the bevel gear wheel 51 in the direction of the arrow 12′, while the synchronous motor 44′ drives the matched bevel gear wheel 52 in the opposite direction as indicated by the arrow 12′′. The current supply for the motor 44′ will be discussed presently. The gear wheels 51 and 52 form part of a differential gear mechanism whose intermediate bevel pinions 53 are carried on the arm 54; this arm 54 will stand still when the rates of rotation indicated by the arrows 12′ and 12′′ are equal, but will be displaced one way or the other according as one such rotation is faster than the other.

The arm 54 carries one plate 55 of an adjustable condenser which has the fixed plate 56. This adjustable condenser 55—56 is of small capacity at any adjustment compared with the parallel condenser 57. These condensers in parallel, with the inductance 58, form the frequency determining circuit of the three electrode vacuum tube oscillation generator 59, whose output current goes as input to the modulator 19′, where it is modulated from the voice frequency source 20′. The modulated output current from the modulator 19′ goes through the filter 21′ and amplifier 22′ and on the conductor pair 34′, from which a branch conductor pair 60 goes to the transformer 23′ by which the energy of this current is applied for radiation from the antenna 24′.

By another branch conductor pair 61, the modulated current goes to the initial end of the sequence of elements of apparatus 36′ to 43′ and 44′. These need not be here described in detail, for they are made as nearly as possible like the sequence of elements 36 to 44 in Figure 2, which have been described heretofore. Accordingly, it will be understood that the sequence of apparatustus elements 36′ to 44′ operates to filter and pass only the component of current of the carrier frequency, to step it down in frequency, and to drive the synchronous motor 44′ thereby.

The proportions of design are such that the motor 44′ will drive the bevel gear wheel 52 at approximately the same speed of rotation as the clock 11′ drives the bevel gear wheel 51. If these speeds are exactly the same, the adjustable condenser 55—56 will remain fixed in its adjustment. Of course the speed of the standard clock 11′ remains constant, but the speed of the motor 44′ can change by a change in the frequency of the carrier current in the output 34′ and 61. If such a change occurs, the motor 44′ will be accelerated or retarded and will impart a differential movement to the arm 54 carrying the movable plate 55 of the adjustable condenser 55—56. If the change is an acceleration of the motor 44′, the capacity at 55—66 will be increased, the natural oscillation frequency will be increased in the circuit whose capacity lies in condensers 55—56 and 57 and whose inductance is 53, and thus a compensating adjustment will be effected by which the motor 44′ will be held at the proper speed the same as the speed of the standard clock 11′.

Comparing the transmitting station of Figure 3 and the receiving station of Figure 2, we see that in the respective conductor pairs 34′ and 34 there are present all the components of the modulated carrier current, including the current of the pure carrier frequency. At both stations alike this carrier component is separated and applied to drive the respective synchronous motors 44′ and 44. These motors are alike, and the sets of apparatus for getting the driving current for them are alike, and these motors must run at substantially the same speed. As we have seen, the motor 44′ at the transmitting station runs at the same speed as the standard clock 11′, therefore the motor 44 at the receiving station will run at that same speed, and will accordingly drive the local clock 45 in unison with the central standard clock 11′.

The reeciving system of Figure 2 can be used with any broadcasting station to ascertain its carrier frequency. Through the branch circuit from the conductor pair 34 to the filter 36, by careful filtering and tuning in the associated apparatus, the current of the carrier frequency may be selected and passed. The associated clock indicator 45 will in effect count the successive cycles of the carrier and give a cumulative measure thereof. By comparing this indication from time to time with a standard clock, the carrier frequency can be ascertained accurately, and it can be learned whether the corresponding transmitting station is holding properly to its assigned carrier frequency.

I claim:

1. In combination, a radio broadcast transmitting station, a standard clock, means to control the carrier frequency thereby, a corresponding broadcast receiving station, a clock, and means to control said clock by the carrier component of the energy received from said transmitting station.

2. In combination, a radio broadcast transmitting station for voice frequencies, a standard clock, means governed by said clock to control a certain component of the transmitted energy at a certain frequency, a corresponding receiving station, a clock associated therewith, and means to control said clock by the same component of the received energy.

3. In combination, a radio broadcast transmitting station for voice frequencies, a standard clock, means controlled by said clock to generate the carrier current at said station at a constant frequency, a corresponding receiving station for said voice frequencies, a clock at said receiving station, and means to control said clock by the carrier frequency at the receiving station.

4. In combination, a radio transmitting station adapted to generate a modulated carrier current and radiate it, a standard clock, means to control the frequency of said carrier current by said clock, a corresponding receiving station adapted to receive the radiated waves as currents and demodulate them, a local clock, and means to control said local clock by the carrier frequency component of the received currents.

5. In combination, a radio broadcast transmitting station, a standard clock, means to control the carrier frequency thereby, a corresponding broadcast receiving station, a local clock, means to separate the component of the received currents of the carrier frequency, means to step this frequency down in definite ratio, and a synchronous motor to drive the said local clock and be operated by the current of reduced frequency.

6. In combination in a radio broadcast system, an oscillation generator to generate carrier current, an inductance-capacity frequency determining circuit therefor, a voice frequency source to modulate this current, a radiating antenna, a cir-

cuit to deliver the modulated current thereto to be radiated, a branch circuit from said circuit, filtering means therein to pass only the component current of carrier frequency, a harmonic reducer to derive therefrom current of lower frequency in definite ratio, a synchronous motor to which the lower frequency current is applied, a standard clock, a differential gear mechanism driven on one side by said motor and on the other side by said clock, and a connection from the intermediate element of said mechanism to adjust the capacity in said frequency determining circuit, whereby this frequency is kept constant by the said clock.

7. In combination in a radio broadcast system, a transmitting station, a standard clock, means to control the carrier frequency thereby, a receiving antenna, a circuit for the received currents, broadcast receiving apparatus to which these currents are delivered, a branch circuit from said circuit, filtering means therewith to pass only the component current of carrier frequency, a harmonic reducer to derive therefrom current of lower frequency in definite ratio, a synchronous motor to which the current of lower frequency is applied, and a clock driven by said motor, whereby said clock is kept in synchronism with said standard clock.

8. The combination of claim 6, and in operative association therewith a receiving station comprising a receiving antenna, a circuit for the received currents, broadcast receiving apparatus to which these currents are delivered, a branch circuit from said circuit, filtering means therewith to pass only the component current of carrier frequency, a harmonic reducer to derive therefrom current of lower frequency in definite ratio, a synchronous motor to which the current of lower frequency is applied, and a clock driven by said motor, whereby said clock is kept in synchronism with the said standard clock mentioned in said claim 6.

9. The method of ascertaining the carrier frequency of a radio broadcasting system transmitting a carrier modulated by voice frequencies, which consists in receiving the modulated waves as corresponding currents, treating such currents to separate the carrier component from the side bands due to the modulation, and applying the said carrier component to control the rate of a clock-like device, thereby getting an indication from said device of the frequency of the carrier current.

10. In combination with a radio broadcast system at a receiving station thereof, means for ascertaining the carrier frequency, consisting of a branch circuit for the received modulated currents, filtering means therewith to pass only the component current of carrier frequency, a harmonic reducer to derive therefrom current of lower frequency in a definite ratio, a synchronous motor to which the current of lower frequency is applied, and a clock-like device driven by said motor, whereby said device in effect counts the cycles of the carrier current over any desired time-interval.

11. In combination with a radio broadcast transmitting station, a receiving station comprising a circuit for the received modulated currents, a synchronous motor, means to drive said motor at a definite rate in relation to the carrier frequency component of said currents, and means to count the turns of the motor and thereby in effect count the cycles of the carrier current over any desired time-interval.

12. In combination, a standard clock, an oscillation generator of a certain frequency, a device to compare the generator output frequency, with the clock rate, means controlled by said device to adjust the output frequency of said generator, means to modulate the output current from said generator according to a broadcast program and to radiate corresponding electric waves, a receiver to receive such waves, means at the receiver to demodulate the corresponding currents, means there to separate out the current component of said certain frequency, and a clock controlled thereby.

13. The combination a radio broadcast transmitting station, a standard clock, a carrier current generator and a transmitting antenna as a part of said station, means to take off current as it is delivered to the antenna, a chain of apparatus to step said current down in frequency, a motor driven by such stepped down current, means to compare the motor speed and the clock speed and thereby to adjust and regulate the frequency of said generator, a receiving antenna, a clock therewith and a chain of apparatus like that at the transmitting station between said receiving antenna and said clock therewith.

14. In combination, a radio broadcast transmitting station, a standard clock means to control the carrier frequency thereby, a corresponding broadcast receiving station, a clock and means to control said clock by the carrier component of the energy received from said transmitting station, both said means being like chains of apparatus elements with inputs at one end for currents of the radio frequency and with outputs at the other end for currents of relatively low frequency for application respectively to control the carrier frequency of the transmitting station and the clock of the receiving station.

15. The system of clock control in connection with a radio broadcasting system which comprises a generator of carrier current of a certain frequency, means to modulate it with currents of voice frequency range, an antenna to radiate energy corresponding to the modulated currents, a standard clock, means to control the generator frequency thereby, all the foregoing apparatus being at a transmitting station, and in combination the following apparatus at a receiving station, namely, means to demodulate received currents to get currents of voice frequency range, a clock, and means to separate current components of carrier frequency and apply them to control said clock.

16. The system of clock control in connection with a radio broadcasting system which comprises at a transmitting station a standard clock, a generator of carrier currents of a certain frequency, means to modulate said current with currents of voice frequency range, a radiating antenna, and at a corresponding receiving station, means to demodulate received current and thereby to get currents of voice frequency range, and at both stations means to separate out currents of approximate carrier frequency from the modulated currents, like synchronous motors to which these currents are applied, a clock at the receiving station driven by the motor there, and means at the transmitting station to adjust the generator frequency in accordance with the differential rates of the motor and the standard clock.

ARTHUR F. POOLE.