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H. NYQUIST

ELECTRICAL MEASURING SYSTEM

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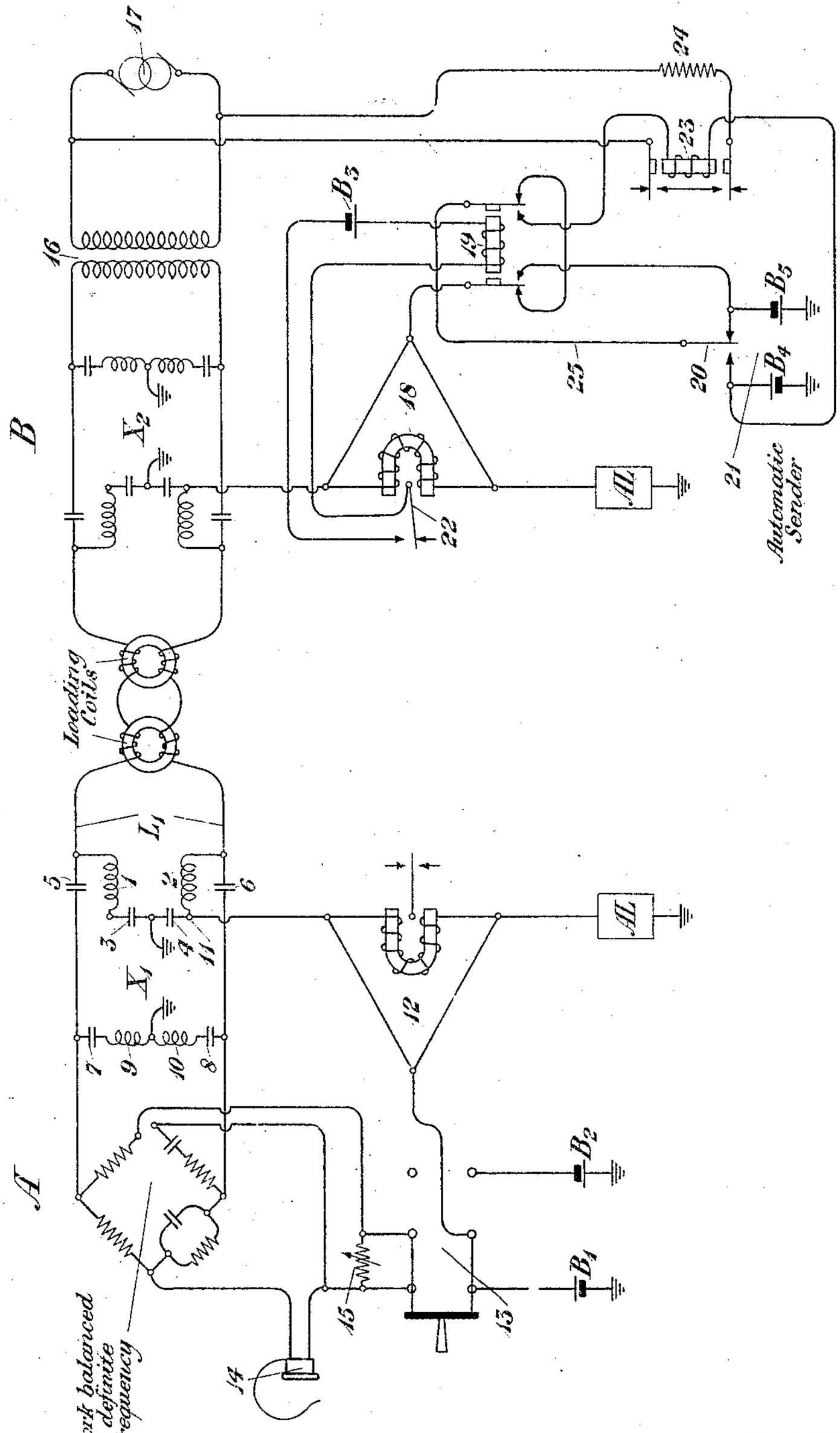

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ELECTRICAL MEASURING SYSTEM.

Application filed October 28, 1921. Serial No. 511,004.

To all whom it may concern:

Be it known that I, HARRY NYQUIST, residing at Elmhurst, in the county of Queens and State of New York, have invented certain Improvements in Electrical Measuring Systems, of which the following is a specification.

This invention relates to electrical measuring systems and particularly to an arrangement for determining the magnitude of flutter effect produced in a loaded signaling circuit adapted for the simultaneous transmission of telephone and telegraph currents.

When telegraph impulses are transmitted over a loaded signaling circuit simultaneously with the transmission thereover of voice currents, an effect is produced upon the voice currents which is commonly designated as "flutter." This effect is produced by the action of the direct current telegraph impulses upon the loading coils. The action which the telegraph impulses produce in the loading coils causes a reaction upon the voice currents traversing the said coils, this reaction tending to diminish the amplitude of the voice waves. This manifests itself in the received voice currents in a momentary diminution in the strength of the said received current, thereby giving rise to an effect which has been designated flutter.

It is the object of the applicant's invention to provide an arrangement for measuring the relative magnitude of flutter effect.

This invention will be better understood from the following description when read in connection with the attached drawing, which shows a form of embodiment of the invention.

In the drawing, L_1 represents a signal transmission circuit adapted for the simultaneous transmission of telephone and telegraph currents, and extending between two stations A and B. Connected to the line L_1 at stations A and B are the composite sets X_1 and X_2 respectively. These sets, which are of the well known type, comprise the inductances 1 and 2 connected in series to ground with the condensers 3 and 4 respectively. Connected in series with the sides of the line L_1 are the condensers 5 and 6, which serve to prevent the transmission to the terminal telephone apparatus of any telegraph impulses that might pass by the point at which the telegraph terminal apparatus is connected with the line circuit. Another shunt path to ground to prevent the effect of telegraph impulses on the terminal telephone apparatus is provided by means of the condensers 7 and 8 in series to ground with the inductances 9 and 10 respectively. The telegraph terminal apparatus herein represented by the bridge polar duplex arrangement 12 is connected to the junction point 11 between the condenser 4 and the inductance 2 of the composite set X_1. The arrangement of the composite set X_2 is similar to X_1 and needs no further explanation. The midpoint of the bridge arms of the telegraph terminal apparatus is connected with one of the movable arms of the double pole double throw switch 13, which when operated to the left, as shown in the figure, is adapted to apply a positive impulse from the battery B_1 to one side of the line L_1, and when operated to the right to apply a negative impulse from the battery B_2 to the same side of the said line.

Bridged across the line L_1 at the station A is a network similar to that shown in Fig. 1 of my copending application, Serial No. 511,003, filed Oct. 28, 1921. As described in the said application, such network is designed to be balanced for a definite frequency and therefore will not transmit current at that frequency. If, however, other frequencies are applied thereto current will be transmitted through the said bridge to a receiver 14, connected across opposite terminals of the said bridge network. The variable resistance 15 will be connected into one of the arms of the said bridge network whenever the switch 13 is open, but will be short circuited when the switch is in the position shown in the figure. Connected effectively across the line L_1 at the station B by means of the transformer 16 is a source of sinusoidal oscillations 17, of a predetermined frequency. A bridge polar duplex telegraph set 18 is connected with the composite set X_2, the midpoint of the bridge arms being connected through the contacts of relay 19 with the tongue 20 of the automatic telegraph sender 21. The tongue of the receiving relay 22 is adapted to control the operation of the relay 19 in a manner which will hereinafter be made clear. The relay 23, which is controlled by

the operation of relay 19 and the automatic sender 21, is adapted to connect an impedance 24 across the output side of the source of sinusoidal oscillations 17, thereby modulating the said oscillations and producing harmonics necessary in the making of the flutter measurement.

Having in mind the foregoing description of the circuit and also the apparatus connected therewith, this invention will be clear from the following description of the mode of operation of the circuit.

When the switch 13 is in the position shown in the drawing, current will flow from the positive battery B_1 to the midpoint of the bridge arms, where it will divide, part of the current flowing through the artificial line to ground and the remainder flowing through the inductance 2 over the lower side of the line L_1 through a corresponding inductance of the composite set X_2, thence through the winding of the receiving relay of the terminal apparatus 18 to ground, which will cause the tongue of the receiving relay to be in the position shown in the drawing. The circuit of the winding of the relay 19 will be open and consequently the relay will not be energized. The automatic sender 21, which is adapted to move the tongue 20 between its contacts, will transmit positive and negative impulses over conductor 25 through the contacts of relay 19 to the midpoint of the bridge arms of the telegraph receiving set, where the current will divide, part passing through the artificial line to ground and the remainder being transmitted over the lower side of the line L_1 through the inductance 2 of the set X_1, and through the relay of the set 12 to ground. Simultaneous with the transmission over one side of the line L_2 of the telegraphic impulses by the automatic sender, current of a predetermined frequency will be transmitted from the source 17 over the said line to the bridge network connected at station A. Due to the action of the telegraph impulses upon the loading coils connected with the line L_1, the current arriving at station A from the source 17 will contain not only the fundamental frequency transmitted by the said source, but also harmonics produced by the action of the telegraph impulses upon the loading coils. Further, it will contain frequencies slightly higher and slightly lower than the fundamental, due to modulating action of the telegraph wave. Since the bridge network at station A is balanced for the fundamental frequency, current of that frequency will not pass through to the receiver 14, but the harmonics of that frequency caused by the effect of the telegraphic impulses upon the loading coils together with the modulation products will pass through and be detected by the receiver 14.

The switch 13 should then be thrown to the right, thereby connecting the negative battery B_2 to the midpoint of the bridge arms of the telegraph terminal set 12. The current from this source will divide, part passing through the artificial line to ground and the remainder traversing the lower side of the line L_1 and the telegraph receiving relay of the set 18, which causes the tongue 22 of the relay to close its contact. Relay 19 will thereby be energized by current from the battery B_3, thereby moving its armatures from their outer to their inner contacts. With the tongue of the automatic sender in the position shown in the drawing, current will flow from the positive battery B_4 through the winding of relay 23, the inner contact of the right-hand armature of relay 29 to the negative battery B_5 thereby energizing relay 23.

By the operation of relay 23, the impedance 24 will be connected across the source of the sinusoidal oscillations 17, thereby producing modulation products. The fundamental frequency and its modulation frequencies will be transmitted over the line L_1 and will be impressed across the network at station A. The network at station A is no longer balanced for the reason that when the switch 13 is operated toward the right the variable resistance 15 is effectively connected into one of the arms of the said network. Consequently, the current arriving over the line L_1 and impressed across the network at A will be transmitted through the said network to the receiver 14. By varying the magnitude of the resistance 15, the intensity of the sound produced in the receiver 14 can be varied. By throwing the switch 13 alternately to the right and the left, and by adjusting the resistance 15 the point will be reached where the sound produced in the receiver 14 for the two positions of the said switch will be approximately of equal intensity. The setting of the variable resistance 15 will then be a measure of the flutter.

Although in the drawing I have shown only the form of balanced network shown in Fig. 1 of my copending application, Serial No. 511,003, filed Oct. 28, 1921, it is to be understood that any of the forms shown in the said application may be used in connection with the circuit in which this invention is embodied without varying the nature or scope of this invention.

It will be seen from the foregoing description that this invention embodies simple and effective means for determining the magnitude of flutter effect produced upon telephone currents by the simultaneous transmission therewith of telegraph impulses over the same loaded line circuit. Since the amplitude of the steady part of a fluttered wave is great in comparison with the un-

steady part of the same wave, by balancing the network for the steady part, its transmission therethrough to the current investigating apparatus is prevented which greatly increases the accuracy of investigation and measurement of the unsteady part of the said wave, which are of much smaller amplitude.

Although this invention has been disclosed in a definite form and arrangement of parts, it is to be understood that it is capable of embodiment in other and different forms without departing from the spirit and scope of the appended claims.

What I claim is:

1. In a loaded circuit characterized by the simultaneous transmission of a plurality of currents, the method of investigating flutter which consists in suppressing the larger steady part of a fluttered wave and transmitting and investigating the unsteady part of smaller amplitude.

2. In a loaded circuit characterized by the simultaneous transmission of a plurality of currents, the method of investigating flutter which consists in suppressing the larger steady part of a fluttered wave and transmitting the remaining unsteady part of the fluttered wave, producing and transmitting a standard variable wave, and comparing the unsteady part of the fluttered wave to the standard wave.

3. In a loaded circuit characterized by the simultaneous transmission of a plurality of currents, the method of investigating flutter which consists in suppressing the larger steady part of a fluttered wave and transmitting the remaining unsteady part, transmitting a standard variable wave produced by varying the output wave generated by the source of the originally fluttered wave, and comparing the unsteady part of the fluttered wave to the standard wave.

4. In a loaded circuit characterized by the simultaneous transmission of a plurality of currents, the method of investigating flutter which consists in suppressing the larger steady part of a fluttered wave and transmitting the remaining unsteady part, transmitting a standard variable wave produced by varying the output wave generated by the source of the originally fluttered wave and obtaining a certain fraction of the larger steady part of said wave, and comparing the said unsteady part of the fluttered wave to the standard wave.

5. In a flutter measuring circuit, the combination with a loaded line circuit adapted for the simultaneous transmission of telephone and telegraph currents of a source of sinusoidal waves of a definite frequency, a source of telegraphic impulses, a network connected with the said line circuit balanced for the fundamental frequency of the sinusoidal oscillations, current detecting means connected with the said network, and circuit controlling means associated with the said detecting means whereby the source of telegraphic impulses may be caused either to transmit over the said line or to modulate the said sinusoidal oscillations at the source.

6. In a flutter measuring circuit, the combination with a loaded line circuit of composite sets connected across each end thereof, telegraph transmitting and receiving circuits connected with the said composite sets, a source of sinusoidal oscillations also connected across one end of said loaded circuit, a Wheatstone bridge network balanced for a definite frequency connected across the other end of the said circuit and having current detecting means connected therewith, and circuit controlling means connected with one of the said telegraph transmitting and receiving circuits adapted to control the operation of the other of said telegraph transmitting and receiving circuits in such a manner that the said latter circuit may be caused to transmit telegraph signals over the said line circuit or to modulate the sinusoidal oscillations at their source.

7. In a flutter measuring circuit, the combination with a loaded line circuit adapted for the simultaneous transmission of telephone and telegraph currents of a source of sinusoidal waves of a definite frequency, a source of telegraphic impulses, a current indicating device connected with the line circuit and normally balanced for the fundamental frequency transmitted by the source of sinusoidal waves, and means to control the said source of telegraphic impulses in such a manner that the said latter source may be caused to transmit telegraphic signals over the said line circuit or to modulate the sinusoidal oscillations at their source.

8. In a flutter measuring circuit, the combination with a loaded line circuit of a source of sinusoidal voltage, a source of direct current impulses, a network connected with the said line circuit having a current indicating device normally balanced for a particular frequency, and means connected with the said source of sinusoidal voltage and controlled by the said source of direct current impulses in such a manner that the sinusoidal voltage wave may be modulated by the said direct current impulses.

In testimony whereof, I have signed my name to this specification this 26th day of October, 1921.

HARRY NYQUIST.