

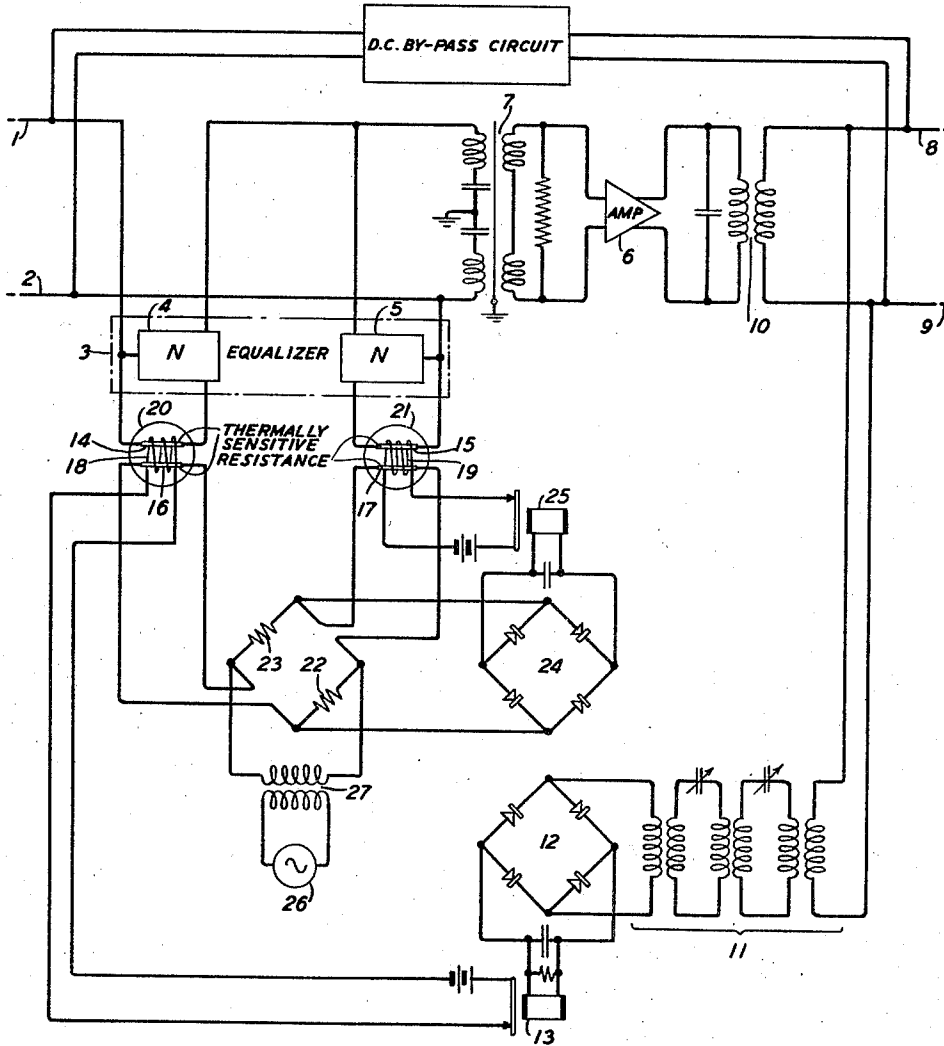
Aug. 9, 1938.

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2,126,529

TRANSMISSION SYSTEM.

Filed Sept. 16, 1936



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2,126,529

TRANSMISSION SYSTEM

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Application September 16, 1936, Serial No. 101,058

6 Claims. (Cl. 178-44)

This invention relates to communication systems and has for its object to improve transmission in such systems.

In transmission systems employing amplifiers, the transmission is often controlled by means of an equalizer in the input circuit which is in turn controlled by means of a pilot current which is taken from the output of the amplifier.

In such a variable equalizer as this, it is essential that the series and shunt resistances maintain a definite relation, so that the input impedance will remain nearly constant over the variable range of the equalizer characteristic and further keep the equalizer input impedance from being unduly sensitive to the termination used at the other end of the equalizer.

In accordance with the present invention an input equalizer is controlled through the medium of thermally sensitive elements, for example, particularly elements of silver sulphide or boron so arranged that whenever the series resistance is changed the shunt resistance is automatically changed to such a value that their product is held constant.

The attached drawing shows a specific embodiment of the invention in a pilot channel system of the general type shown in Patent 1,918,390 granted to E. I. Green on July 18, 1933. The amplifier may be of the type shown in Patent No. 2,075,975, granted to F. A. Brooks on April 6, 1937, while the equalizer may be of the type shown in Patent 1,606,817 granted November 16, 1926 to G. H. Stevenson or more specifically of the type shown in Patent No. 2,096,027, granted to H. W. Bode on October 19, 1937.

Current incoming over conductors 1 and 2 passes through equalizer 3 having a series element 4 and a shunt element 5. It is then fed to amplifier 6 through shielded transformer 7 and from the amplifier to the outgoing conductors 8 and 9 through transformer 10.

The pilot frequency is picked up from the outgoing conductors 8 and 9 by means of the band pass filter 11 and fed through the full wave rectifier 12 to relay 13.

In place of an adjustable resistance in the series element 4 of the equalizer, there is substituted a thermally sensitive resistance 14. Similarly a thermally sensitive resistance 15 is substituted for an adjustable resistance in the shunt element 5 of equalizer 3.

Resistance 14 is enclosed in an oven 20 in which is also included a second similar thermally sensitive resistance 16 and a heating element 18 which encloses both resistances 14 and

16. Resistance 15 is likewise associated with a second similar thermally sensitive resistance 17 and a heating element 19, all enclosed in an oven 21.

Thermal resistances 16 and 17 form opposite arms of a Wheatstone bridge of which resistances 22 and 23, which are unaffected by temperature, form the alternate arms. The bridge receives current from the alternating current generator 26 through transformer 27 and the diagonal of the bridge includes full wave rectifier 24 and relay 25. Relay 13 controls heater 18 and relay 25 controls heater 19.

According to the well-known Wheatstone bridge formula when the bridge is balanced

$$\frac{R_{23}}{R_{16}} = \frac{R_{17}}{R_{22}}$$

or

$$R_{16} \times R_{17} = R_{23} \times R_{22} = \text{a constant}$$

Since resistances 14 and 15 are similar to resistances 16 and 17, respectively, and are subjected to the same heat conditions, the product $R_{14} \times R_{15}$ is also a constant when the bridge is balanced.

Since silver sulphide has a high negative temperature-resistance coefficient, its resistance decreases rapidly with increase in temperature. Therefore, when the pilot frequency is below the desired value, relay 13 is released, the heating circuit of oven 20 is closed and the resistance of the elements 14 and 16 decreases, the decrease in resistance of element 14 causing the amplification to increase, which will be reflected by an increased volume for the pilot frequency until the desired point is reached and relay 13 operates to turn off the heat. The reduced resistance of element 16 unbalances the bridge, operating relay 25, which opens the heating circuit of oven 21, causing the temperature of that oven to fall and the resistance of elements 15 and 17 to increase until the balance is restored and the aforementioned relation of the resistances adjusted.

There are three conditions which may exist with regard to resistance 14 and therefore with regard to resistance 16. Namely, it may be constant, it may be increasing or it may be decreasing. If resistance 14 is constant and oven 21 is too hot, resistance 15 will be too low, the bridge will be unbalanced and relay 25 will operate, turning off the heat, cooling the oven 21, increasing the resistance 15 and bringing the bridge toward a balance. As the balance is approached relay 25 releases, heat is again supplied to oven

21, producing a too hot condition, which again turns off the heat and this cycle will continue as long as oven 20 is at a constant temperature.

Therefore, there are two requirements that must be met to make the system operative in this condition, namely: the heating current for oven 21 must be great enough to insure this oscillatory condition just described; and when heat is applied to oven 21 the resistance 15 must be able to assume a resistance value somewhat less than is required to balance the bridge.

When oven 20 is heating so that resistance 14 is decreasing, to balance the bridge, resistance 15 must increase and oven 21 must cool. Since oven 21 is normally too hot during operation, the decrease in resistance 14 lengthens the time that relay 25 remains operated to hold the heating circuit for oven 21 open.

When oven 20 is cooling so that resistance 14 is increasing, resistance 15 must decrease and therefore oven 21 must heat. In order for this to be true, oven 21 must be able to increase in temperature faster than oven 20 can decrease in temperature, which would naturally be the case. During the time that oven 20 is cooling, the oscillatory condition of oven 21 previously described continues, with the released periods of relay 25 increased in relative length in order to hold the temperature at a higher point.

This arrangement therefore provides a simple, stable means of maintaining the output of the amplifier constant while preserving the proper family of characteristics for equalizer 3 and at the same time preserving a good impedance looking into equalizer 3. For the specific embodiment described the reflection coefficient at the input to equalizer 3 referred to the resistance of the equalizer is better than that of the equalizer's termination, the improvement being equal to the amplification or current ratio corresponding to twice the insertion loss of the equalizer. For example, if the equalizer loss be 3 db, this improvement would be fourfold or in other words the reflection coefficient at the input would be $\frac{1}{4}$ that of the termination.

What is claimed is:

1. In a transmission system, an amplifier, an equalizer in the input of said amplifier having a series resistance and a shunt resistance, and means for maintaining the output of said amplifier constant, comprising means under the control of said output to vary said series and shunt resistances, while maintaining their product constant, said varying means including silver sulphide resistance units, and heating means for reciprocally varying the temperatures thereof.

2. In a transmission system, an amplifier, an equalizer in the input of said amplifier, having a series resistance element and a shunt resistance element, and means for maintaining the output of said amplifier constant, comprising means under the control of said output to vary the value of said series and shunt resistance elements, while maintaining their product constant, said varying means comprising auxiliary resistance units of large temperature coefficients of resistance in the opposite arms of a Wheatstone bridge.

3. In a transmission system, an amplifier, an

equalizer in the input of said amplifier having a series resistance and a shunt resistance, means for maintaining the output of said amplifier constant, comprising means under the control of said output to vary the series and shunt resistances of said equalizer, while maintaining their product constant, said varying means comprising silver sulphide resistance units in the opposite arms of a Wheatstone bridge, and means controlled by said Wheatstone bridge to control the relative temperatures of said silver sulphide resistance units.

4. In a transmission system, an amplifier, an equalizer in the input of said amplifier, said equalizer having a series element and a shunt element, and means for maintaining the output of said amplifier constant while preserving the proper characteristics for said equalizer comprising a temperature sensitive resistance in the series element of said equalizer, a temperature sensitive resistance in the shunt element of said equalizer, means under the control of the output of said amplifier to vary the temperature of said series temperature-sensitive resistance, a Wheatstone bridge associated with said series and shunt temperature sensitive resistances and means under the control of said bridge to vary the temperature of said shunt temperature sensitive resistance.

5. In a transmission system, an amplifier, an equalizer in the input of said amplifier, said equalizer having a series element and a shunt element, and means for maintaining the output of said amplifier constant while preserving the proper characteristics for said equalizer comprising a silver sulphide resistance in the series element of said equalizer, a silver sulphide resistance in the shunt element of said equalizer, means under the control of the output of said amplifier to vary the temperature of said series silver sulphide resistance, a Wheatstone bridge associated with said series and shunt silver sulphide resistances and means under the control of said bridge to reciprocally vary the temperature of said shunt silver sulphide resistance.

6. In a transmission system, an amplifier, an equalizer in the input of said amplifier, said equalizer having a series element and a shunt element, and means for maintaining the output of said amplifier constant while preserving the proper characteristics for said equalizer comprising a silver sulphide resistance in the series element of said equalizer, a silver sulphide resistance in the shunt element of said equalizer, said series silver sulphide resistance enclosed in an oven together with a first auxiliary silver sulphide resistance and a heater, said shunt silver sulphide resistance enclosed in a second oven together with a second auxiliary silver sulphide resistance and a second heater, means under the control of the output of said amplifier to vary the temperature of said first oven, a Wheatstone bridge including said first and second auxiliary silver sulphide resistances and means under the control of said bridge to vary the temperature of said second oven.

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