

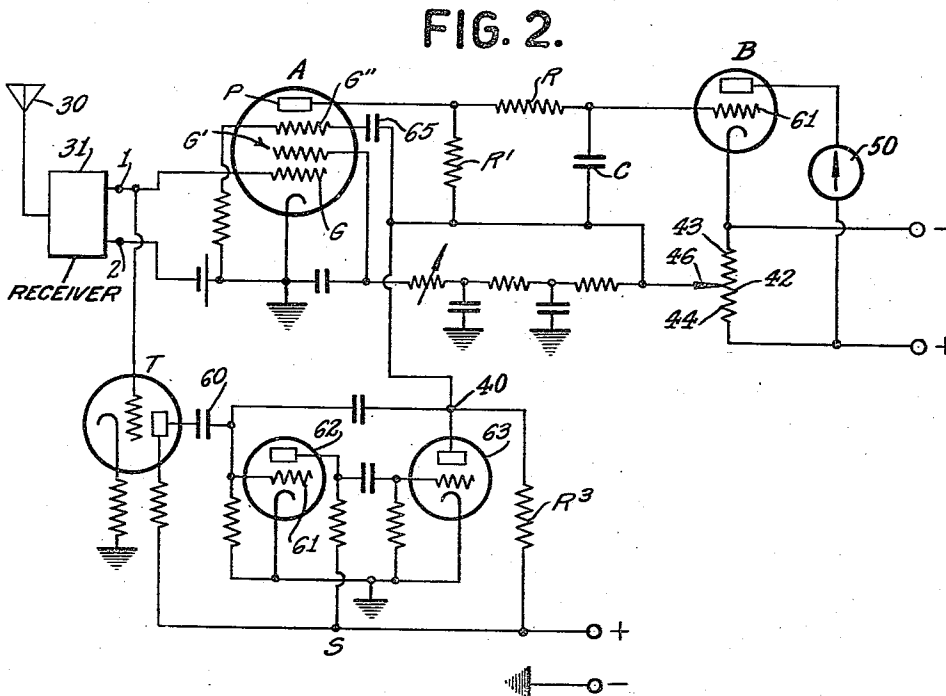
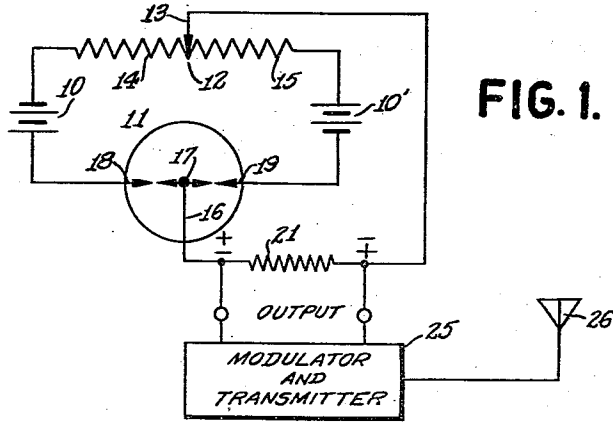
Oct. 15, 1946.

N. L. HAIGHT

2,409,560

DATA TRANSMITTER

Filed Jan. 18, 1944



INVENTOR.

NORMAN L. HAIGHT

BY

Joseph H. Lipschutz

ATTORNEY

UNITED STATES PATENT OFFICE

2,409,560

DATA TRANSMITTER

Norman L. Haight, Hoboken, N. J., assignor to
Sperry Products, Inc., Hoboken, N. J., a corpo-
ration of New York

Application January 18, 1944, Serial No. 518,770

4 Claims. (Cl. 177—351)

1

2

This invention relates to a method and means for transmitting data between two points, either through land wires or by radio, and is a continuation in part of my co-pending patent application, Ser. No. 452,932, filed July 30, 1942. Furthermore, the invention relates to the type of transmission wherein a relation of values of a plurality of impedances is transmitted, thereby obtaining a transmission system which is unaffected by such variables as will act upon the individual impedances simultaneously.

Prior devices generated a current flowing in one direction in response to one value and another current flowing in the opposite direction in response to the other value, the magnitudes of said currents being a function of said values. This required wire connections because the system depended upon alternating the direction of the current flow. In the present case each value to be transmitted is caused to modulate a carrier wave so that each value controls a block of waves. These blocks travel in succession along the transmission system either by wire or by radio, and their magnitudes are independent of the direction of current flow, and therefore no wires are needed. This enables the relative values to be transmitted by radio.

In prior devices each time the current changed through an indicating meter at the receiving station, the quantity of current in one direction averaged with the quantity of current in the other direction. If the current pulses were the same the currents cancelled each other at the receiving station, and a zero reading was obtained. In the present case no such averaging is effected. The receiver of the modulated carrier generates uni-directional pulses in response to the blocks of waves which are a function of the values transmitted, so that if the original pulses are equal, a certain peak output is nevertheless obtained. As one value becomes larger or smaller relative to the other value, the peak output changes, but is always of the same sign.

Further objects and advantages of this invention will become apparent in the following detailed description thereof.

In the accompanying drawing,

Fig. 1 is a wiring diagram illustrating one form of transmitter.

Fig. 2 is a wiring diagram illustrating one form of receiver.

Referring to Fig. 1 it will be seen that at the transmitting station I may operate from a D. C. source such as batteries 10, 10' which supply current to a bridge network 11 which includes a po-

tentiometer 12 from which operates a potential contact arm 13 to divide the potentiometer circuit into branches or impedances 14 and 15. The network 11 also includes a vibrator 16 comprising a double armature 17 designed to make contact at 18 and 19 with branch 14 and branch 15, respectively, of the network. The details of the vibrator are not shown since it may be of any known type and, if desired, may be replaced by a thermionic device. The remainder of the circuit from vibrator 16 includes an impedance which may take the form of a resistance 21. Thus, the vibrator will first close the circuit at 18 through the branch 14 of the potentiometer so that current will pass by way of battery 10, branch 14, contact arm 13, impedance 21 and back to the battery 10. In the other position of the vibrator the circuit is closed at 19 and extends from battery 10', branch 15 of the potentiometer to contact arm 13, to the impedance 21, and back to battery 10'. As the circuit is closed and broken at 18, a pulse in one direction is generated, and as the circuit is made and broken at 19 a pulse in the opposite direction is generated, and the amplitudes of these pulses determine the outputs from the impedance 21. If the resistances of branches 14 and 15 of the potentiometer are equal, the outputs in both directions will be equal, and thus a unity relation is transmitted; but if one branch or the other is greater, then the unity relation will be upset in one direction or the other and a different relation will be transmitted.

Heretofore these current pulses constituting the output of impedance 21 and generated in response to the values 14 and 15 were transmitted as positive and negative current pulses through a meter where the pulses were averaged. Thus, if the two current pulses were of equal magnitude the meter read zero, whereas if one or the other of values 14 and 15 predominated, the meter would give an indication in one direction or the other. This system however, limited the device to a wire transmission system because wires are necessary when direction of current is an essential element. In the present invention, however, the transmission is independent of direction of current pulses, and therefore transmission may be effected either by wire or by radio.

Fundamentally, therefore, the present invention differs from the prior devices in the respect that instead of relying upon direction of current, this invention relies upon the amplitudes of blocks of radio waves which may be transmitted in succession, the amplitude of each block being a function of the value 14 or 15. Since the direction of

current is not depended upon in the transmission, wires are unnecessary and the relative values 14 and 15 may be transmitted either by wire or by radio waves.

To accomplish the above described method, the outputs from impedance 21 are caused to modulate a carrier frequency at the modulator and transmitter 25. Each current pulse generated as a function of value 14 and value 15 therefore, modulates a carrier wave to vary the amplitude of the wave, irrespective of the direction of the current pulse.

Referring to Fig. 1, assuming that battery 10 applies -1.0 volt while battery 10' applies +1.0 volt, with 13 at the extreme left position, resistance 21 is subjected to a pulse of one volt when 16 goes left, the left end being plus. When 16 goes right, 21 is subjected to a pulse of something less than 1 volt since part of the drop is taken by resistance 15, and this pulse is in the reverse direction. In all positions of 13, the input to the modulator consists of alternate pulses of opposite direction, of different relative lengths depending upon the position of 13. The reversal of polarity at the input does not reverse the effect on the carrier wave. In other words, starting with the left end of 21 at one volt plus, decreasing the voltage decreases the amplitude of the carrier. If the potential changes to one volt minus, the carrier is simply still further reduced in amplitude. Reversal of polarity at the input of the modulation does not reverse the direction of the effect on the carrier, but continues to carry it further in the same direction.

The modulated carrier may be transmitted either by wire or by radio to a receiver 31. If transmitted by radio, the output of modulator and transmitter 25 may be applied to an antenna 26 and the resulting radio waves received by antenna 30, and led to receiver 31. The outputs from receiver 31 are passed through a tube A by applying the output to grid G. The output from tube A is taken off plate P and is applied to the grid G₁ of tube B, the output from which may be led to a meter 50. It will be understood that the radio waves received at the receiver 31 will, after passing through tube A, be in the form of substantially uni-directional pulses because the receiving unit 31 and the tube A act to rectify the incoming waves to yield the substantially unidirectional pulses. Without modulation the carrier will come through receiver 31 as a series of uni-directional impulses of constant amplitude. When modulated, this amplitude is increased and decreased by the values corresponding to impedances 14 and 15.

If the values 14 and 15 are equal, each block of waves will be similarly modulated so that equal successive uni-directional pulses will be obtained from tube A, and therefore a uniform peak output will be obtained as indicated on meter 50. When, however, values 14 and 15 differ from one another, then the successive blocks of waves will have different amplitudes, and large and small pulses (all in the same direction, however) will be obtained from tube A. Ordinarily the large and small pulses would average to give substantially the same peak values as when 14 and 15 are equal; and this would not give an indication of the relative changes which have taken place between said values. Therefore the system is made responsive to the peak values because the peak, that is, the value of the large pulse, will change when there is a change in the relative values of 14 and 15. To make the system respon-

sive to the peak values of the output from tube A there is introduced between the plate P of tube A and the grid G₁ of tube B, a coupling resistance R and a capacity C, in addition to the plate resistance R'. The peak values will charge the capacity C, but the smaller values, tending to discharge, will be retarded by the resistances R and R'. Thus, the system will be more responsive to the peak values than to the small values, and meter 50 will change substantially in response to peak values only.

The mid-point of meter 50 is arbitrarily marked zero and the pointer is caused to indicate zero when the values 14 and 15 are equal. In this way when value 14 predominates the pointer will move in one direction away from zero and when the value 15 predominates the pointer will move in the other direction from zero. There is, of course, no reversal of current, since, as hereinbefore described, the variation on the grid G₁ of the tube B is continuous as the contact 13 is moved from the extreme left end of resistor 12 to the extreme right end. In order to position the pointer at the zero mid-point of meter 50, the voltage normally placed on grid G₁ of tube B is such that when equal unit directional pulses are coming out of tube A the meter 50 will read zero. This potential on grid G₁ may be obtained from a potentiometer 42 over which operates potentiometer contact 46 to apply the voltage from a D. C. voltage source to the grid G₁, the contact 46 being adjusted to bring the needle to the mid-point on meter 50 which has arbitrarily been chosen as zero. The parts 43, 44 of the potentiometer 42 may be so designed that when values 14 and 15 are equal, branches 43 and 44 are equal and the voltage applied on grid G₁ at this time is such as to cause the meter 50 to read zero. As value 14 or value 15 predominates, the pointer will move in one direction or the other with respect to the zero point.

When operating the device by radio, it will be seen that interference from extraneous sources may be picked up by antenna 30 and caused to affect the output of receiver 31 and tube A, and thus give an incorrect reading on the meter 50. To reduce the amount of error due to extraneous interfering waves I may employ a switch which may take the form of an oscillatory system which will render the tube A ineffective in the intervals between received pulses from the transmitter, and will render the tube A effective for the time interval during which the pulse is being received. Thus, while the interference cannot be fully eliminated while the pulses are actually being received, nevertheless, by rendering tube A ineffective in the intervals between pulses, interference during these intervals is cut out and thus the total amount of interference is reduced.

For this purpose it will be apparent that an oscillatory system must be devised which has a frequency which is the same as the frequency of the transmitted pulses, or a multiple thereof, in order that the oscillatory system shall render tube A effective when a pulse comes in, and ineffective when the pulse ends. That is to say, the oscillatory period of the oscillatory system must synchronize with the period of the received pulses. For this purpose there is shown an oscillatory system S which may be of well-known design and theory as described fully in various text books, see for instance, "Theory and Applications of Electron Tubes" by Reich, page 360, published by McGraw-Hill Book Company, New York, New York. Such an oscillatory system

5

may be caused to oscillate by a trip or trigger controlled by the input signal. Thus, a portion of each pulse coming out of receiver 31 may be applied to the grid of trigger tube T, the output of which is applied to a condenser 60, which controls the input to grid G₁ of one tube 62 of the oscillator S. When a charge builds up to a predetermined magnitude on condenser 60 in response to a pulse coming out of receiver 31, this will place a positive bias on grid 61, which will cause tube 63 to be cut off because only one tube can conduct at a time. This causes a decrease in the voltage drop across R³, and hence an increase of voltage at point 40, and thereby a large positive voltage is applied to plate P which makes tube A conductive to allow the signal from receiver 31 to flow to the meter 50. In addition to increasing the positive charge on plate P through resistance R' to make tube A conductive, there may also be employed condenser 65 which takes this positive pulse output at 40 and impresses it through condenser 65 on suppressor grid G'' to make the tube more highly conductive. The latter system is well known. When the signal stops, the input on tube T is removed, and hence, the input on grid 61 is removed to make tube 62 non-conductive and tube 63 conductive, thereby causing an increase in voltage drop across R₃ sufficiently large to make the potential at point 40 substantially zero or small enough to make tube A non-conductive. Any interfering waves which now are received by antenna 30 in the interval between the end of the pulse just received and the succeeding pulse will have no effect on meter 50 because tube A has been rendered ineffective until the next pulse is received to place a bias on the grid of tube T to render tube 62 conductive and tube 63 non-conductive. In other words, in the interval when no signal is being received by receiver 31, the tube A, and hence the indicator 50 is rendered ineffective so that extraneous and foreign signals will not affect the indicator and introduce an error; but when a signal is being received, the oscillator renders the tube A, and hence the indicator effective to permit the signal to pass. The frequency of oscillator S is adjusted to the frequency of the incoming signal or a multiple thereof.

The oscillator will not be operated by the carrier, but only by the pulse frequency. This is true since the resistive and capacitive elements associated with tubes 62 and 63 are such as to form an effective rejection circuit to all frequencies except those near the natural frequency of the multi-vibrator, which, in this case, is the pulse frequency.

While the potentiometer 12 has been shown as employing a movable contact arm 13 for varying the amount of resistance in branches 14 and 15, the said contact 13 may be stationary and the resistances of branches 14 and 15 caused to vary in response to certain variables which it is desired to indicate or measure. Thus, for instance, in the transmission of weather data from balloons which rise to great altitudes, one branch, such as 14, may be made of material having zero temperature coefficient while the other branch 15 may be made of material having a high temperature coefficient, so that the difference in resistances between the two parts of the potentiometer would then be a direct measure of the temperature. Similarly, one of the parts, such as 15, of the potentiometer can be made responsive to other factors such as barometric

6

pressure, humidity, etc., while the other part 14 is made non-responsive to such factors, in which case the ratio transmitted will be a direct measure of the factor involved.

In accordance with the provisions of the patent statutes, I have herein described the principle and operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof, but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other equivalent means. Also, while it is designed to use the various features and elements in the combination and relations described, some of these may be altered and others omitted without interfering with the more general results outlined, and the invention extends to such use.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. A system for transmitting the relative values of a pair of impedances, comprising a circuit including said impedances and a source of energy, means for generating a carrier, means whereby the voltage drop across said impedances alternately modulates said carrier so that the average modulation increases continuously from minimum to maximum as one impedance increases from zero to maximum while the other impedance correspondingly decreases from maximum to zero, means for transforming the carrier into the modulation components, means responsive to the peak values of said modulation components, indicating means actuated by the output from said responsive means, means whereby said indicating means is caused to give a predetermined indication when there is a predetermined output from said responsive means corresponding to a predetermined relationship of said impedances and whereby said indicating means is caused to be actuated in one direction or the other in response to change in one direction or the other, respectively, in said predetermined relationship.

2. A system for transmitting the relative values of a pair of impedances, comprising a circuit including said impedances and a source of energy, means for generating a carrier, means whereby the voltage drop across said impedances alternately modulates said carrier so that the average modulation increases continuously from minimum to maximum as one impedance increases from zero to maximum while the other impedance correspondingly decreases from maximum to zero, means for transforming the carrier into the modulation components, means responsive to the peak values of said modulation components, indicating means actuated by the output from said responsive means, means for generating a component equal and opposite to the output from said responsive means when said impedances are in predetermined relationship to cause said indicating means to give a predetermined indication, whereby said indicating means will be actuated in one direction or the other in response to change in one direction or the other, respectively, in said predetermined relationship.

3. A system for transmitting the relative values of a pair of impedances, comprising a circuit including said impedances and a source of energy, means for generating a carrier, means whereby the voltage drop across said impedances alternately modulates said carrier so that the average modulation increases continuously from minimum to maximum as one impedance increases from zero to maximum while the other impedance correspondingly decreases from maximum

to zero, means for transforming the carrier into the modulation components, means responsive to the peak values of said modulation components, indicating means actuated by the output from said responsive means, means whereby said indicating means is caused to give a predetermined indication when there is a predetermined output from said responsive means corresponding to equality of said impedances and whereby said indicating means is caused to be actuated in one direction or the other, respectively, when said impedances become unequal.

4. A system for transmitting the relative values of a pair of impedances, comprising a circuit including said impedances and a source of energy, means for generating a carrier, means whereby the voltage drop across said impedances alternately modulates said carrier so that the

average modulation increases continuously from minimum to maximum as one impedance increases from zero to maximum while the other impedance correspondingly decreases from maximum to zero, means for transforming the carrier into the modulation components, means responsive to the peak values of said modulation components, indicating means actuated by the output from said responsive means, means for generating a component equal and opposite to the output from said responsive means when said impedances are equal so that said indicating means gives a predetermined indication in response to said relationship, whereby said indicating means will be actuated in one direction or the other, respectively, when said impedances become unequal.

NORMAN L. HAIGHT.