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TELAUTOGRAPH SYSTEM
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FIG. 1

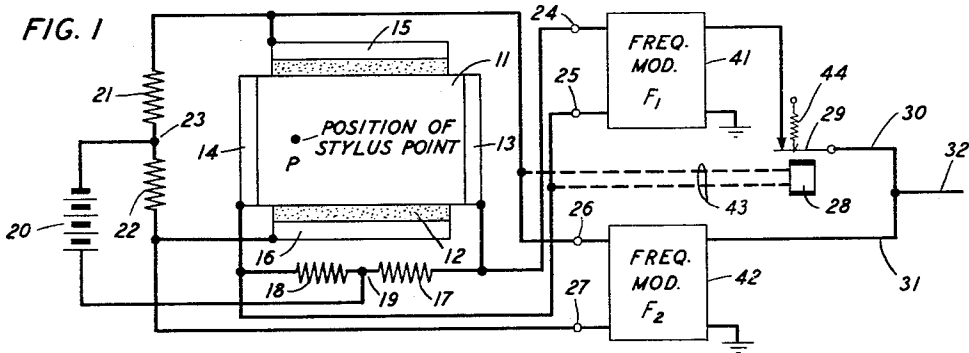


FIG. 2

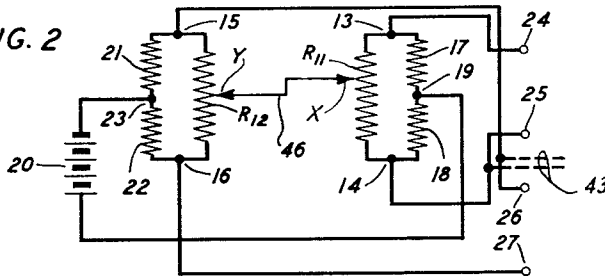
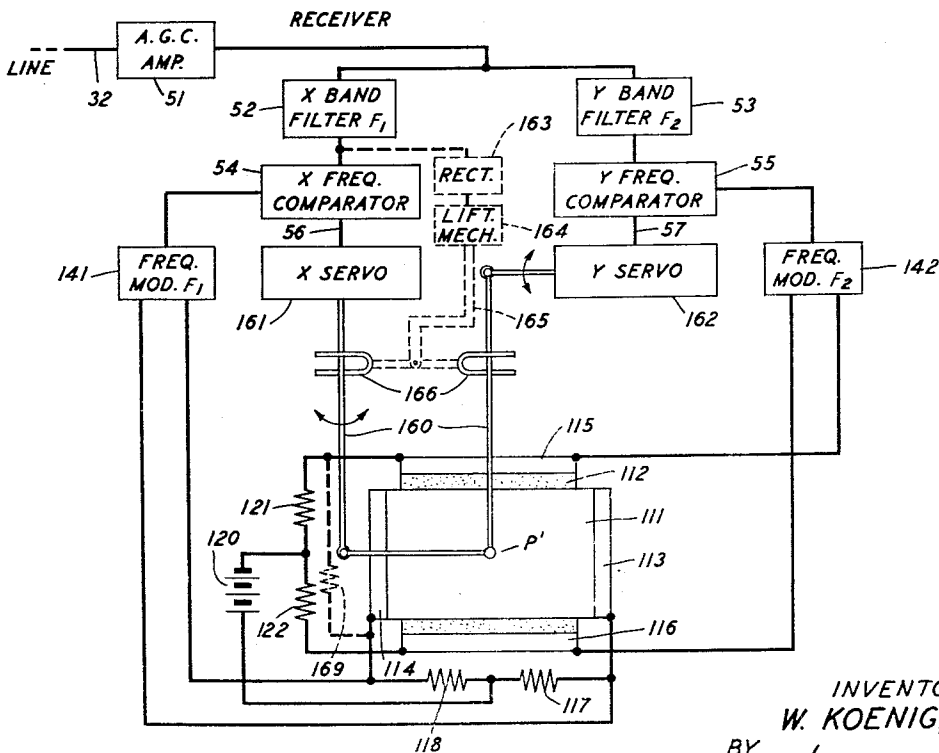


FIG. 3



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TELAUTOGRAPH SYSTEM

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1 Claim. (Cl. 178-20)

This invention relates to telautograph systems and particularly to those suitable for reproducing drawings, diagrams, or script of relatively large dimensions.

As is well known in the art, the typical telautograph systems employ at the transmitter a stylus such as a pen or pencil which is connected either mechanically or electrically to other portions of the apparatus. Such an arrangement obviously restrains the freedom of movement of the operator and consequently has certain disadvantages, particularly in systems for reproducing drawings and the like. In addition the mechanical or electrical intricacy of such apparatus is not advantageous from a manufacturing or maintenance standpoint.

One object of the present invention is to overcome such disadvantages by providing a telautograph transmitter operable with a free stylus.

Another object of the invention is to provide telautograph apparatus readily suitable for two-way operation.

In a telautograph system in accordance with the present invention voltages representative of the coordinates of the position of a stylus, which may be an ordinary pen or pencil, are obtained solely from the effect of the pressure of the said pen or pencil upon the writing or drawing surface. This is achieved by forming the writing surface from two superimposed sheets of material at least the upper of which is flexible and at least the adjacent surfaces of which are composed of resistive material preferably having a substantially uniform resistance per unit area. The sheets are arranged so that normally their adjacent resistive faces are not in intimate contact. The effect of the pressure of the stylus on the upper sheet is to establish intimate contact between the resistive surfaces of the two sheets at the point at which the stylus pressure is established. Circuit arrangements are provided for establishing flow of electric current through the resistive material of the two sheets, preferably from a single source, so that each sheet acts as a voltage divider. As a result the position of the stylus, and consequently the point of intimate contact between the resistive surfaces of each sheet, will produce two voltages at appropriate points in the circuit, for example, across the respective sheets. These voltages will be representative of the coordinates of the stylus position. The resulting coordinate voltages may be utilized directly for reproducing the stylus position and consequently the pattern produced by its movement at a distance directly by the use of telautograph receivers known in the art. Clearly, the coordinate voltages may be transmitted to the receiving position over separate lines or by the use of multiplex channels such as frequency modulated carriers or the like.

In accordance with another feature of the invention the telautograph receiver employs two crossed sheets of resistance material like that used in the transmitter, as just described. Such a receiver has two fundamental advantages. First, because of the symmetry of the receiver arrangement with respect to that of the transmitter any inherent nonlinear relation of the coordinate voltages to the coordinate positions due to interdependency of the two voltages will be inherently compensated. Second, the use of such a receiver makes the system readily adaptable for two-way transmission.

In accordance with a subsidiary feature of the invention the circuit of the transmitter is so arranged that when the stylus is lifted from the writing surface there is produced a

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voltage change which may be utilized, for example, to interrupt the carrier of one of the coordinate voltages. This operation may be employed at the receiver to cause the recording stylus to be lifted from its writing surface.

This invention will be more readily understood by reference to the following detailed description in connection with the accompanying drawings, in which:

FIG. 1 is a block circuit diagram of a telautograph transmitter in accordance with the invention;

FIG. 2 is an equivalent schematic circuit diagram of the transmitter of FIG. 1; and

FIG. 3 is a schematic circuit diagram of a telautograph receiver suitable for use with the transmitter of FIG. 1.

In the transmitter of FIG. 1 the writing surface is provided by the intersecting area of two rectangular sheets of material 11 and 12, preferably of insulating material. The adjacent surfaces of the sheets 11 and 12 are uniformly coated with electrically resistive material, for example, deposited carbon such as is used in coating resistors. The coating is preferably made in such a manner that the sheets have a substantially uniform resistance per unit area. The upper sheet 11 is preferably nonconducting on its upper or exposed surface and is of thin and flexible material so that in its normal condition there is no intimate contact between the adjacent resistive surfaces of the two sheets. The lower sheet 12 may be of rigid or flexible material as is found suitable.

The writing paper is placed over the intersecting area of the two sheets 11 and 12. It may be either a single sheet or in the form of a roll and in the latter case it may be stepped forward area-by-area or line-by-line if the latter type of transmission is desired. The stylus (not shown) is preferably a pencil or ball point pen so as not only to mark on the writing surface but also to have sufficient rigidity to bring about an intimate contact between the resistive surfaces of the two sheets 11 and 12 at the point of its contact on the writing surface. One such point is indicated between point P in the drawing.

The narrow ends 13-14 and 15-16 of the sheets 11 and 12 respectively are coated with highly conductive material such as metallic foil to form terminals for the resistive surfaces of the respective sheets. These terminals are provided for making electrical connections to the external circuits which will next be described.

Attached to the terminal strips 13 and 14 of the sheet 11 are two equal resistors 17 and 18, each of which has a high resistance with respect to the terminal-to-terminal resistance of the resistive coating of the sheet 11. The other terminals of the resistors 17 and 18 are connected together at a point 19 which is in turn connected to one terminal of the battery 20. Resistors 21 and 22, the resistance of which is similarly related to the resistance of the resistive coating of the sheet 12, are connected to the terminal strips 15 and 16 and from their junction 23 to the other terminal of the battery 20.

As will be explained in detail by reference to the equivalent circuit of FIG. 2 the movement of the stylus over the writing surface and consequently the movement of the point P of intimate contact between the resistive surfaces of the sheets 11 and 12 will produce across the respective sheets voltages representative of the orthogonal coordinates of the position of the point P. These voltages are brought out from the sheet 11 to the terminals 24-25 and from the sheet 12 to the terminals 26-27 by means of connections to the respective conducting strips 13, 14, 15 and 16. The direct current voltages appearing across the terminals 24-25 and 26-27 may be transmitted by direct wire connections or other communication channels to a receiving point where they can be utilized for reproducing the movement of the stylus (point P) and the resulting intelligence displayed on the writing sheet.

One method of transmitting the coordinate voltages by means of multiplex channels particularly suitable to the present system is by the use of frequency modulation and is illustrated in the drawing. For this purpose there are provided two frequency modulators 41 and 42 operating at normal or center frequencies F_1 and F_2 respectively. As is well understood in the art, the frequencies F_1 and F_2 are sufficiently separated that any variations therein produced by the modulating direct current voltages applied to the modulators will not bring the resulting frequencies into the same range. The X coordinate voltages produced between the contact strips 13 and 14 of the sheet 11 are impressed on the frequency modulator 41 from the output terminals 24 and 25. Similarly the Y coordinate voltages produced between the conducting strips 15 and 16 of the sheet 12 are impressed on the frequency modulator 42 from the terminals 26 and 27. The outputs of the frequency modulators 41 and 42 appearing in the respective connections 30 and 31 are combined in the transmission line 32 for transmission to the receiving station, for example as shown in FIG. 3.

If desired the transmitter of FIG. 1 may be provided with facilities for transmitting to the receiving station an indication that the stylus is lifted from the paper, which indication can be used at the receiver for producing a similar lifting of the recording stylus from its recording surface. For this purpose there is provided a relay including a solenoid 28, an armature 29, and a biasing spring 44 normally holding the armature 29 in its contact position. The armature 29 and its associated contact are connected in series in the output lead 30 from the frequency modulator 41. The solenoid 28 is connected through the dashed connections 43 to the conducting strips 14 of the sheet 11 and 15 of the sheet 12. As will be clear from a consideration of the equivalent circuit of FIG. 2 in connection with the description thereof, when the stylus is removed from the writing surface a substantial voltage will be developed between the conducting strips 15 and 14 which can be utilized to operate the relay armature 29 and interrupt the transmission of carrier from the frequency modulator 41 over the line 32. When the stylus is pressed against the writing surface the consequent connection between the resistive surfaces of the sheets 11 and 12 at any point P will cause a reduction in the voltage impressed upon the solenoid 28. This will cause the release of the armature 29 and reestablish the connection from the frequency modulator 41 to the line 32. Since the voltage impressed upon the solenoid 28 will vary somewhat, dependent upon the location of the contact of the pressure point P, the bias spring 44 for the relay armature is so chosen as to prevent the operation of the relay for any such variations in voltage. The relay will only be operated by that variation in voltage produced when the stylus is removed from the writing surface.

FIG. 2 shows an equivalent schematic circuit diagram of the telautograph transmitter of FIG. 1, illustrating similar circuit elements with the same reference characters. The resistive surfaces of the sheets 11 and 12 respectively are represented by the resistors R_{11} and R_{12} respectively. The effect of the contact point established by the pressure of the stylus is represented by a flexible connection 46 between the slider X on the resistor R_{11} and the slider Y on the resistor R_{12} . (X and Y are used to indicate that the sliders produce voltages representing the respective X and Y coordinates of the pressure point.) As previously pointed out, the resistances of each of the feed resistors 17, 18, 21 and 22 are high compared to the resistance R_{11} and R_{12} of the resistive sheets.

An examination of the equivalent circuit of FIG. 2 will readily show that when the pressure exerted by the stylus affords connection to the two sheet resistors R_{11} and R_{12} they will each act as a voltage divider. As a result there will be produced across each resistor a voltage dependent on the position of the respective slider

contact (pressure point). Thus with the contact Y established at about the center of the resistor R_{12} (vertical midline of sheet 12) the voltage across R_{11} will vary from the value of substantially zero when the contact X is at the midpoint of the resistance (horizontal halfway point on sheet 11) negatively or positively as the contact point X is moved laterally from the mid position. Similarly the voltage between the contact strips 15 and 16 of the sheet 12 will vary from the substantially zero value with the contact Y at the midpoint of resistor 12 in the negative and positive direction as the contact Y is moved vertically on the resistor R_{12} .

It will be observed that the voltage between either the contact strips 13 and 14 or 15 and 16, while mainly dependent upon the position of the respective contact X or Y, is to some extent also dependent upon the position of the other contact point Y or X. As a result the coordinate voltages applied to the output set of terminals 24—25 and 26—27 are not entirely linearly related to the XY coordinates of the position of the stylus point. However, in the usual case this lack of linearity is not material to an adequate reproduction at the receiver. Furthermore in the particular receiver shown in FIG. 3 the use of cross resistor sheets similar to those used at the transmitter will compensate for the nonlinear relation between the coordinate voltages and the coordinate positions with the result that the reproduced diagram will accurately correspond to that drawn at the transmitter.

In the receiver of FIG. 3 the frequency modulated signals transmitted over the line 32 from the transmitter of FIG. 1 are first amplified in an amplifier 51, preferably provided with automatic gain control. Subsequently they are supplied to the X band and Y band filters 52 and 53 having pass bands centered about the respective frequencies F_1 and F_2 . The outputs of the filters 52 and 53 are supplied to the X and Y frequency comparators 54 and 55 respectively.

Like the drawing surface for the transmitter, the drawing surface for the receiver is provided by two crossed sheets 111 and 112. These sheets are essentially identical to the sheets 11 and 12 utilized in the transmitter and are connected in a similar circuit arrangement to a battery 120 through the resistors 117, 118, 121, and 122. The received positional intelligence is recorded on paper or other stylus sensitive material (not shown) placed over the intersecting area of the sheets 111 and 112. The stylus P' which reproduces the diagram or writing is driven by a mechanism including the arms 160 controlled by the X servo mechanism 161 and Y servo mechanism 162.

Just as in the case of the cross sheets of the transmitter, the effect of the pressure of the recording stylus P' on the cross sheets 111 and 112 will produce voltages between the contact strips 113—114 and 115—116 respectively. These voltages are respectively proportional to the X and Y coordinates of the position of the recording stylus P'. The X coordinate voltage between the strips 113 and 114 is supplied to a frequency modulator 141 similar to the frequency modulator 41 of the transmitter to produce an output varying about the frequency F_1 and depending upon the X coordinate voltage. This frequency modulator output is supplied to the X frequency comparator 54 to be compared with the frequency modulated signal received from the transmitter through the X band filter 52. The resulting error voltage is supplied through the connection 56 to the X servo mechanism 161 to control the position of the stylus P'. When the horizontal position becomes coordinated with the position at the transmitter the error voltage becomes zero and horizontal movement of the stylus P' is interrupted.

Similarly the Y coordinate voltage developed between the contact strips 115 and 116 is applied to the Y frequency modulator 142 operating about the center frequency F_2 . The output of this modulator is supplied to the Y frequency comparator 55 to produce an error voltage which is supplied through the connection 57 to the Y

servo mechanism 162. This controls the vertical movement of the recording stylus P'.

Since the voltages between the respective sets of contact strips 113—114 and 115—116 are interdependent in the same sense that the voltage between the sets of contact strips 13—14 and 15—16 of the transmitter are interdependent, the receiver of FIG. 3 will operate to accurately reproduce the transmitted drawing or writing. In addition to compensating for this inherent nonlinearity of the transmitting apparatus, the use of the receiver of FIG. 3 provides the advantages of being readily adaptable for two-way transmission. Thus, to transmit from the system of FIG. 3 the recording stylus P' may be pushed out of range of the paper and a free stylus used thereon in the same way as one is used in the receiver of FIG. 1. This would produce frequency modulation coordinate signals in the outputs of the frequency modulators 141 and 142 which, by use of simple transfer switches, could be transmitted back over the line 32. Thus with two or more stations equipped as shown in FIG. 3 and with the additional transfer switches, two-way telautograph operation can be readily effected.

If the stylus lifting feature provided by the connections 43 and the relay 28 of FIG. 1 is used, additional equipment shown by the dotted lines in FIG. 3 may be provided. This equipment includes a rectifier 163 having its input connected to the output of the X band filter 52 and having its output connected to control a lifting mechanism 164 which is connected through a mechanical linkage 165 to the lifting forks 166. In the presence of a carrier in the output of the filter 52 the rectifier 163 will supply a voltage to the lifting mechanism 164 which will inhibit its operation. When there is no signal in the band of the filter 52, the inhibiting voltage will be removed from the lifting mechanism 164 and it will operate to lift the recording stylus P' from the recording paper. This will be in response to the lifting of the transmitting stylus at the transmitter of FIG. 1 which, as previously described, operates the relay 28 to interrupt the transmission of the output of the frequency modulator 41 over the line 32. The raising and lowering of the stylus from the recording surface is accomplished by a mechanism similar to that disclosed in United States Patent 2,186,252 to D. G. Little, January 9, 1940, to which reference is made for a more detailed description of the mechanism.

With the use of the stylus lifting feature in both the transmitter and receiver, it is desirable to provide in the circuit of the receiver a circuit element to compensate for the current drawn by the relay 28 at the transmitter. For this purpose a resistor 169 of resistance substantially equal to that of the solenoid 28 is connected between the strips 115 and 114. In this way the circuits of the receiver and transmitter are kept alike to provide for accurate reproduction of the drawings.

In FIG. 3 of the drawing the stylus P' is shown as providing both the function of recording and bringing the sheets 111 and 112 into contact with each other. It may be desirable to do the recording on the paper with a lighter pressure. In this case a blunt point may be used to produce the necessary pressure between the two resistor sheets and a pencil or ball point pen mounted immediately adjacent thereto to ride lightly on the recording surface can be used to make the actual record. The apparatus is also adaptable to other variations. For example, it may be desired to make the voltages on the two coordinate sheets entirely independent. In this case a thin, flexible conducting sheet connected to ground may be inserted between the two resistive sheets and separate battery voltages applied each sheet. In this case the two coordinate voltages will be entirely independent of each other. Additionally the apparatus is readily adaptable to the use of polar instead of rectangular coordinates.

What is claimed is:

In a telautograph system, a transmitting station including a crossed pair of overlapping sheets, the adjacent faces thereof being of resistive material and normally out of contact with each other and a movable stylus for pressing said sheets together, means for deriving two signals representative of the position at which said stylus presses said sheets together, means responsive to said derived signals for causing two carriers to be modulated and transmitted to a receiving station, means actuated when said sheets are out of contact with each other for interrupting at least one of said two carriers, means for receiving and separating said two carriers at a receiving station, means for positioning a second stylus on a coordinate surface at said receiver in response to said two carriers, and means at said receiver responsive to said interruption of said one carrier for mechanically lifting said second stylus from contact with said coordinate surface at said receiver.

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