Feb. 16, 1960 F. K. BECKER 2,925,467

ELECTROGRAPHIC TRANSMITTER

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FIG. 1

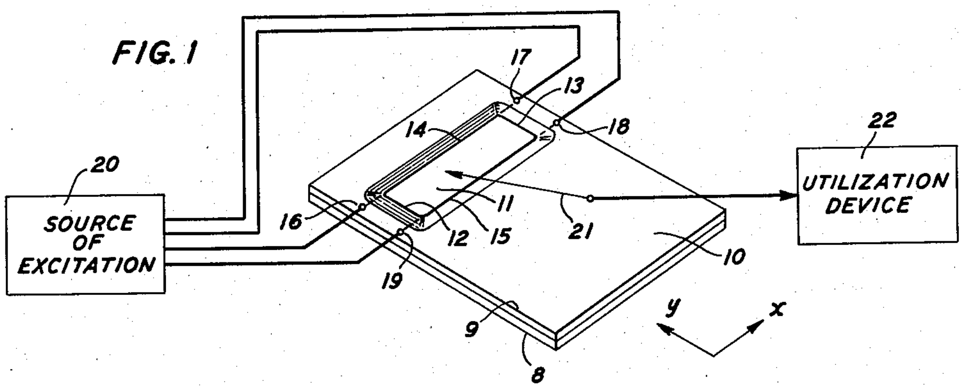

FIG. 2

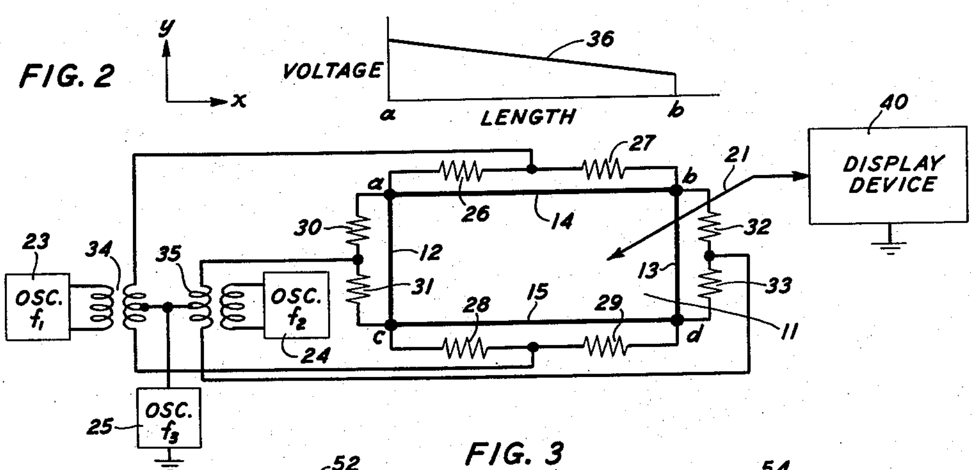

FIG. 3

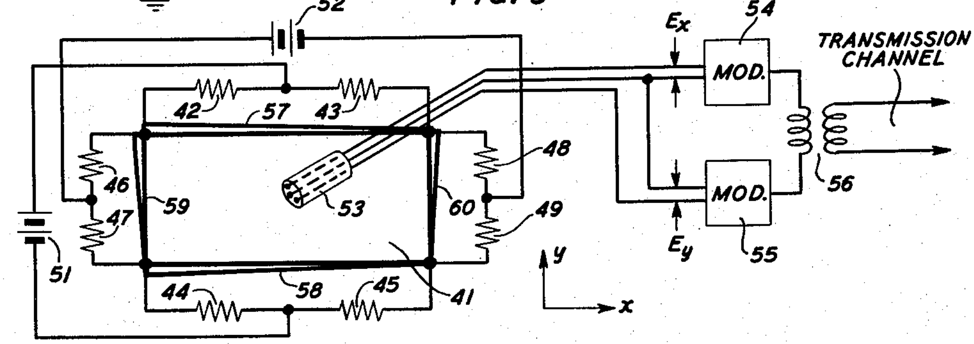

FIG. 4

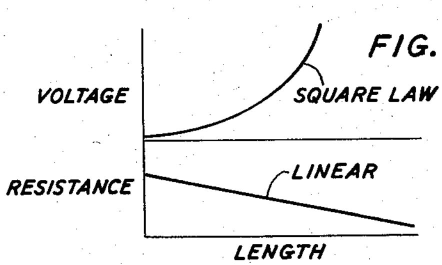

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FIG. 5

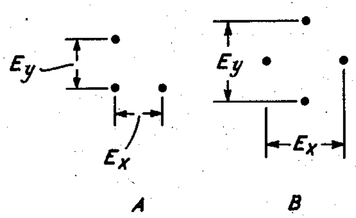


FIG. 6

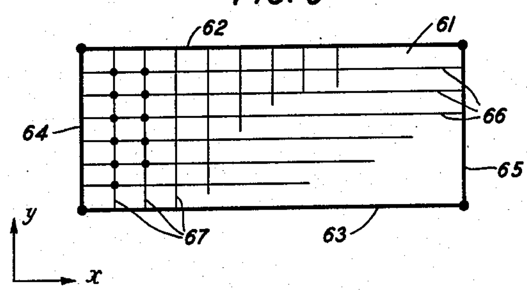


FIG. 8

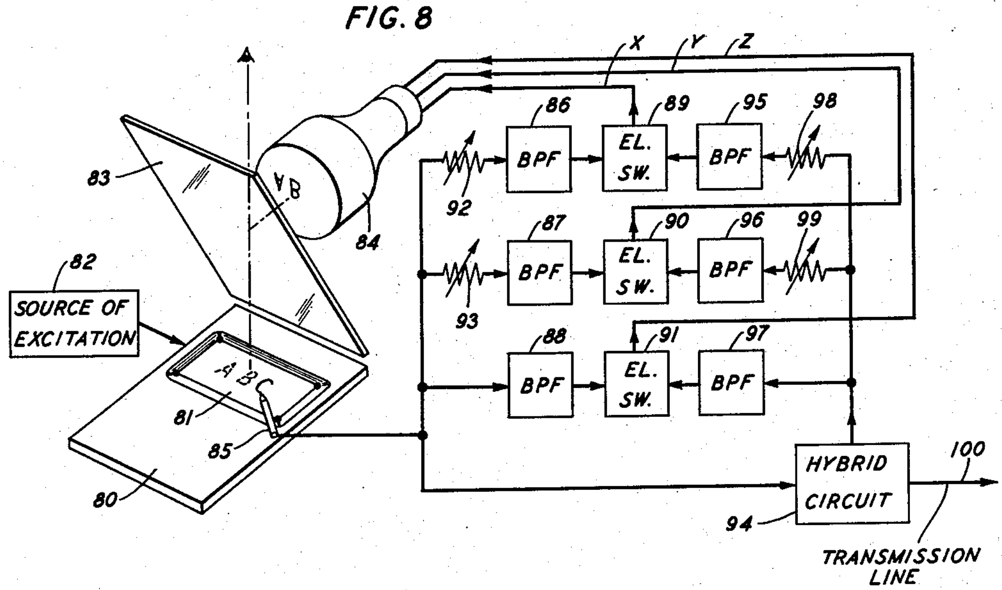
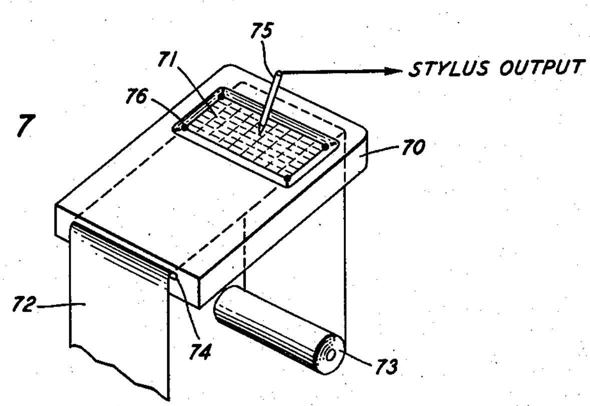


FIG. 7



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ELECTROGRAPHIC TRANSMITTER

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Application October 31, 1958, Serial No. 771,098

17 Claims. (Cl. 178—18)

This invention relates to the electrical transmission of graphic material from one station to another distant station and the instantaneous reproduction of the material at the distant station. More particularly, it relates to a two-parameter electrographic signal generator for instantaneously converting cursive writing and the like into an electrical signal, and has for its principal object the improvement of the faithfulness with which the conversion is effected.

Fully electrical telewriting generators, which have been developed to replace the mechanical telautograph with its pantograph and captive stylus arrangement, generally employ a resistive writing surface to support time or frequency separated orthogonal electric fields. Some form of unrestricted conductive stylus is provided to establish an electrically conductive path between selected points on the resistive surface and a reference potential thereby to generate a signal whose magnitude is a function of the coordinates of position of the selected points. However, extreme nonlinearity of the electrical fields developed in the writing surface, particularly near each edge of the surface, often reduces the usable writing area to a small fraction of the total writing surface. If, on the one hand, the writing surface is energized by voltages applied to elongated electrodes located at the edges of the surface, the resulting equipotential lines produced within the surface are uniformly distributed only in the center portion of the writing surface and are nonuniformly distributed at or near the edges. Consequently, the usable writing area is greatly reduced. If, on the other hand, the surface is energized at a number of independent terminals positioned along the periphery of the surface, and suitable field correcting voltages are employed to energize the surface, the nonlinearity is, to some extent reduced, but the overall useful area is, nevertheless, still somewhat smaller than desirable.

It is another object of the present invention to improve substantially the linearity of fields developed within a writing surface of an electrographic transducer thereby substantially to increase the usable writing area.

In accordance with the present invention, substantially linear fields are developed in a plane resistive writing surface by applying field generating potentials to electrodes which terminate the edges of the surface throughout their entire lengths and which support the same potential gradients as those developed in the surface itself. As a result, equipotential lines are developed within the surface which are uniformly distributed in straight line paths extending to the extreme edges of the writing surface. For use in a telewriting system as described above, a writing instrument, which may be a stylus or contact element adapted to provide an electrically conductive path between a point on the writing surface and a reference potential, is employed to derive from points in the writing surface, potentials whose magnitudes are functions of the coordinate positions of the writing instrument. Preferably, the stylus is completely independent of mechanical couplings and linkages and is free to contact any point

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in the writing surface at the discretion of an operator. Since field distortions are minimized, the entire area, from border to border, may be used.

The coordinate identifying potentials, developed as the stylus traces out a written message or other cursive design on the writing surface, are transmitted conveniently by conventional means to a distant receiving station and there employed to generate, instantaneously, a replica of the message. Since a record of the message is immediately available at both stations, a two-way telewriting conversation is readily accomplished. Although any form of reproducer is suitable for use in the practice of the invention, mechanical recorders on the one hand and cathode ray display devices on the other are particularly well suited to this use.

The invention will be fully apprenhended from the following detailed description of a preferred illustrative embodiment thereof taken in connection with the appended drawings in which:

Fig. 1 is a simplified diagrammatic representation of an electrographic transmission system in accordance with the present invention;

Fig. 2 is a diagram, partially in block schematic form, illustrating one form of energized resistive writing surface which may be employed in a practice of the invention;

Fig. 3 is a diagram, partially in block schematic form, illustrating another form of energized resistive writing surface useful in the practice of the invention;

Fig. 4 illustrates the voltage and resistance relationships which hold along one of the bounding electrodes and within the adjacent portion of the resistive writing surface illustrated in Fig. 3;

Fig. 5 is a graphic illustration helpful in the explanation of the embodiment of the invention shown in Fig. 3;

Fig. 6 is a diagram showing the structural details of another form of resistive writing surface in accordance with the invention;

Fig. 7 illustrates an alternative form of electrographic transmitter employing a resistive writing surface according to the invention; and

Fig. 8 illustrates a two-way telewriting system embodying the invention.

Referring now to Fig. 1, there is shown an electrographic signal generator which includes a base member **10** for supporting a resistive writing tablet **11**. The writing tablet **11** may comprise a sheet or layer of finely divided carbon granules in a suitable binder deposited on a fiber or other insulating backing material. Resistive sheets of this sort which exhibit a relatively high and uniform resistance per unit area are well known in the art and are known commercially as resistance "cards." Typically, the writing surface has a resistivity of approximately 500 ohms per unit area. The resistive sheet **11** may be physically supported, if desired, between two sheets of an insulating material, a base member **8** and a frame member **9** which together form base **10**. The writing surface is supplied with suitable excitation signals derived, for example, from generator **20** to establish a pair of mutually perpendicular fields within the resistive surface. The fields may be separated either in time, frequency or in space. A writing instrument, which may be a stylus or contact member **21** adapted to provide an electrically conductive path between a point on the writing surface and a reference potential point, is provided to derive from the writing surface potentials whose magnitudes are functions of the instantaneous coordinate position of the writing instrument. These potentials are supplied to a utilization device **22** which may, for example, include terminal equipment for transforming the signals into a form suitable for transmission to a distant station.

Since the potential at every point in the interior of a plane uniform resistance element is determined by the geometrical configuration of the edges and by the magnitude of the potential supplied to the edges of the surface, uniformly distributed potential gradients extending throughout the entire area of the surface are secured by effectively terminating the edges of the surface with an infinite number of terminals supplied with potentials which correspond exactly with those to be developed within the surface. This is accomplished in accordance with the present invention by completely bounding or framing the opposite sides of the resistive writing tablet 11 with parallel elongated electrodes. The resistivity per unit length of the electrodes is selected to be substantially lower than that of the writing surface. In particular, if the high resistance writing surface is selected to have a resistance of, for example, approximately 500 ohms per unit area, the electrodes which may be formed from Nichrome resistance wire, should have a resistance of approximately 50 ohms per unit length, i.e., the ratio of resistances should be on the order of ten to one.

By applying a voltage between the corner extremes of the electrodes bounding the opposite X dimension edges of the surface, the two electrodes bounding the opposite Y dimension edges are maintained at uniform potentials throughout their entire lengths. Thus, the IR drop in each of the individual Y dimension electrodes is zero and the two electrodes are held at different potentials corresponding respectively to the potentials of the opposite ends of the X dimension electrodes. Hence, a field is produced within the surface in the X direction. The potential of the tablet consequently is tapered in the X direction and parallel equipotential lines extend in the Y direction of the surface. The electrodes bounding the X dimension edges, to the contrary, being connected in series with the potential source, support a potential gradient identical to the one produced in the writing surface. Consequently, edge distortion or "scalloping" of the equipotential lines is avoided and a virtually distortionless field of constant force is produced in which linearity of the equipotential lines extend to the extreme edges of the surface. In like fashion, a Y direction field within the surface and congruent potential gradients in the Y dimension electrodes are produced by applying a voltage between the corner extremes of the electrodes bounding the opposite Y dimension edges of the surface.

By rapidly alternating the connections outlined above, the two pairs of parallel electrodes bounding the opposite sides of the writing surface alternately act as constant potential edges and as supports for a gradient potential congruent with the developed field to establish mutually perpendicular voltage gradients in the surface. Since the resistivity of each electrode is low as compared with the surface resistance, each pair of electrodes may assume both roles in the alternating cycles of operation. Accordingly, the ends of adjoining electrodes are connected electrically together and to suitable electrical terminals. Excitation signals are applied to the terminals.

Referring once again to Fig. 1, the surface 11 is bounded or framed by low resistance electrodes 12, 13, 14 and 15 which are firmly bonded together at each corner. The corners of the electrode frame are connected to terminals 16, 17, 18 and 19 which are conveniently mounted on the insulating surface of base 10. Equipotential lines within the surface extending in the X direction are produced by connecting a source of potential, for example, a battery, between terminals 16 and 19 and between terminals 17 and 18. With these connections, a potential gradient identical to the one supported by the writing surface is developed within the lengths of the electrodes 12 and 13. In like fashion, equipotential lines extending in the Y direction are produced by connecting the source of potential between terminals 16 and 17 and between terminals 18 and 19.

A more detailed schematic diagram of one form of the writing surface 11 and the means for energizing it are shown in Fig. 2. Frequency domain separation of the fields is illustrated by way of example. This form of excitation is, in many cases, preferred since the output signal derived from the surface by stylus 21 can be supplied immediately to a transmission line or the like without subsequent modulation of a carrier wave. In this embodiment of the invention, the writing surface 11, composed of a uniformly distributed high resistance material, is bounded by electrodes 12 through 15. Adjoining electrodes are electrically connected at the junctions *a*, *b*, *c* and *d*. Separate energizing signals for the X and Y directions are supplied by the constant current sources 23 and 24 which may comprise oscillators or the like operating at slightly different frequencies at any desired points in the spectrum. A convenient separation of two to three hundred cycles has been found to be desirable. Oscillator 23 operating at a first frequency f_1 is connected by means of coupling device 34 between the ends *a* and *c* and between the ends *b* and *d* of the electrodes 12 and 13, respectively. Serially connected resistors 26—27 and 28—29 connected between terminals *a* and *b* and between terminals *c* and *d* may be utilized to facilitate the energizing of the electrodes. With these connections, energy from source 23 at a frequency f_1 produces an electric field in the Y direction. The second source of oscillation 24, operating at a second frequency f_2, is coupled by means of device 35 to the mid-points of the serially connected resistors 30—31 and 32—33 to produce, in the writing surface, an electric field in the X direction. The fields are mutually exclusive. Since the electrodes effectively frame the writing surface, the voltages developed in the electrodes are uniformly distributed throughout their entire lengths. The voltage distribution in electrodes 14 and 15 is shown in curve 36. A similar gradient curve is applicable to electrodes 12 and 13.

A third source of oscillation 25, operating at a third and different frequency f_3, is connected effectively between the four corner terminals of the writing surface and a ground reference potential to establish a third or Z-axis gradient within the surface. This places an effective ground at the exact geometric center of the surface and provides an indication of stylus contact with the surface.

As the stylus 21 contacts any point of the surface 11, including the portions contiguous to the bounding electrodes, three separate signals are derived which are indicative of the X and Y coordinate positions of the stylus and the Z-axis or contact condition of the stylus. Since the voltage gradients developed along each length of the surface are separated in frequency, the amplitude of the derived signals of both frequencies indicate exactly the coordinate position of the stylus.

The three components may be transmitted over conventional facilities to a display device 40. In the device 40 simple selective filters centered about the frequencies f_1, f_2 and f_3 and associated envelope detectors are sufficient to detect the signals. The signals are preferably displayed on a direct view storage tube although they may, of course, be used to energize a mechanical telautograph writer or an x—y recorder.

Spatial separation may also be used to define accurately the coordinates of position of a stylus in accordance with the invention. Fig. 3 illustrates a form of electrographic generator which employs this form of separation. In accordance with this embodiment of the invention electric gradients proportional to the distance from a common neutral point positioned within the writing surface 41 are formed along the X and Y axes. Although there are several ways of accomplishing this, it has been found convenient to employ a writing tablet whose resistance is linearly tapered, together with bonding electrodes formed to exhibit the same resistance characteristic. Thus, for example, the electrodes **57**, **58**, **59** and **60** may be physically tapered so that their resistance per unit length is a linear function of the length of the electrodes. Alternatively, bonding electrodes whose resistance per unit length is a linear function of distance may be employed. As before, adjoining electrodes are electrically connected to each other and to external terminals. Physical tapering of the resistive surface **41** itself has been found to be a convenient way of providing the necessary tapering of the resistance of the surface.

With resistive tapering of this sort, a voltage proportional to the square of the distance of the stylus from the effective neutral point indicates the coordinate position of the stylus. Battery **51** connected to the surface through resistive dividers **42—43** and **44—45**, and battery **52** connected to the surface through dividers **46—47** and **48—49** produce simultaneously, orthogonal electric fields within the surface. A multitipped stylus **53** is utilized to detect the difference in potential between closely spaced points within the surface in both directions. This is equivalent to taking a first order derivative of the potential gradient at the point of contact with the surface. Higher order derivatives may also be employed, of course, to define the coordinates of the stylus position. This information, which unambiguously defines the coordinates of position of the stylus, is applied, for example, to modulators **54** and **55** wherein the amplitude or frequency characteristic of suitable carrier waves is altered. The modulated waves are combined in a mixing device **56** for transmission over a conventional channel.

Fig. 4 illustrates the voltage and resistance relationships existent in the writing surface **41** and its framing electrodes **57** through **60**. As shown, the resistance is a linear function of distance while the voltage developed within the surface and in the bonding electrodes follows a square law.

Fig. 5 illustrates two alternative configurations for the tips of the multitipped stylus **53**. The simple triangular array, shown at 5A, is sufficient to produce between a common corner tip the other tips, address voltages in both the X and in the Y directions. The four-tipped stylus arrangement, shown in Fig. 5B, is sufficient to produce two completely separated voltage components representative of the X and Y coordinates of position of the stylus.

Commercially available resistive "cards," employed as the writing surface in accordance with the invention, ordinarily possess reasonably good resistance uniformity in both coordinate directions. By means of the unique electrode framing arrangement employed to energize the card, linearity of the resulting equipotential lines within the card is insured to its very edges. However, if extremely large writing surface areas are employed, slight non-uniformities of the resistance card are more pronounced and may give rise to serious distortions in the surface fields. This difficulty is circumvented in accordance with the present invention by subdividing the area of the resistive surface into a number of small subelements, each of which effectively is a separate resistive card bounded on all four sides by low resistance conductive electrodes. Thus, the surface framing mechanism may be extended to form, effectively, a matrix of contiguous elemental writing surfaces, each independently energized. Consequently, small corrections are made as writing takes place and cumulative errors are avoided.

Fig. 6 illustrates one form of electrode matrix suitable for energizing a resistance card in a manner to insure uniformity throughout the surface. The card **61** is bonded at all four edges by the primary electrode, **62**, **63**, **64** and **65**, and is energized at its corners in the fashion heretofore explained. Within the confines of the outer bounding electrodes, parallel electrodes **66** are provided which extend in the X direction. Linearity of the equipotential lines in the Y direction is thus insured, and at the same time X direction fidelity is improved. A further improvement may be made by providing additional electrodes **67** extending in the Y direction. A firm electrical bond is provided at each intersection of the electrodes within the matrix.

An electrode matrix which is eminently suitable for use with commercially available resistance cards or the like, for improving the linearity of the card when used in telewriting applications, may be formed from so-called wire cloth or from conductive screen material. If this material is used, a frame and support arrangement of the sort illustrated in Fig. 1 is employed to provide a pressure contact at the outer edges of the writing surface between the wire cloth matrix and the resistance sheet. Alternatively, the matrix may be formed from individual low resistance wires bonded at each intersection or from individual conductive elements deposited together with the resistive granules on a printed circuit board. Conductive paper, placed over the wire matrix, provides both the electrical contact between the stylus and the resistance sheet and a permanent record of the written message.

Fig. 7 illustrates a telewriting generator in accordance with the invention which is particularly suitable for use in those systems in which a permanent record of the message is required. In this embodmient of the invention, writing surface **71** is provided with an electrode matrix of the sort described above in connection with Fig. 6. It is supported in a base **70** in a fashion such that the writing surface is exposed through a window **76**. A sheet of conductive paper **72** drawn from a roll **73** and passed through a slot **74** extending throughout the length of the base **70** covers the writing surface **71**. The paper is pressed into contact with the resistive surface **71** both by the edges of the window **76** and by the stylus **75** at the point of contact of the two. Although any form of conductive paper may be used, it has been found that absorbent paper of the type known commercially as "Teledeltos" is particularly well suited for use in this application. If this material or the like is used, the stylus member **75** is provided with a reservoir of conductive ink which both deposits a visible ink line on the paper as the stylus is drawn thereacross and renders the paper conductive. The resulting signal derived from the stylus **75** is indicative of the position of the stylus on the surface. Once a message is complete, the paper **72** may be pulled from the roll **73** through the base to renew the writing surface. The used portion may, of course, be removed and preserved as a permanent inked record of the correspondence.

A complete system employing the improved writing surface of the invention is illustrated in Fig. 8. Provision is made in this embodiment for a two-way telewriting conversation. Accordingly, the subscriber at each end of a transmission circuit is supplied with the equipment illustrated in Fig. 8. Each subscriber may visually observe both his own writing and an incoming signal at one and the same time. For example, the subscriber at one terminal may start a sentence, drawing, or equation and the subscriber at the other terminal may simultaneously contribute to the final writing.

In the apparatus of Fig. 8, a resistive writing surface **81**, energized from excitation source **82** in any of the fashions described heretofore or, indeed, by any other field separating means well known in the art, is mounted in a suitable base **80**. Signals derived by a stylus **85** and indicative of its coordinates of position are supplied by means of hybrid circuit **94** to a transmission line **100**. The stylus output signals are simultaneously supplied locally to a storage display tube **84**. The visual display appearing on the surface of the tube **84** is projected by means of a half-silvered mirror **83** so that it appears to originate on the resistive writing surface **81**. The details of operation of the storage tube and the projection system are not illustrated inasmuch as they are well known in the respective arts. Assuming frequency separated coordinate signals as an example, multi-frequency signals defining the position of the stylus are separated by applying them to band pass filters **86**, **87** and **88**, tuned respectively to the X, Y, and Z signals. Electronic switches **89**, **90** and **91** transfer these signals to the X, Y and Z input terminals of the tube **84**.

Incoming signals from transmission line **100** are routed by means of hybrid circuit **94** to the band pass filters **95**, **96** and **97**, which correspond to filters **86**, **87** and **88**, to effect their separation. Electronic switches **89**, **90** and **91** supply these signals to the corresponding input terminals of the tube **84** in alternation with the locally generated signals. Effective dual beam operation of the storage tube **84** is thus accomplished in a fashion well known in the communications art. Hence, the two signals, i.e., the locally generated signal and the remotely generated signal, are projected simultaneously on to the writing surface **81** to produce a display which appears to a viewer as a superimposition of the two individual signals.

To establish an initial alignment of the storage tube and to insure exact coincidence of both projected signals, attenuators **92** and **93** are connected in the X and Y signal circuits of the local monitor, and attenuators **98** and **99** are connected in the X and Y circuits of the receiving circuit. Assuming that the optical system is adjusted to produce a satisfactory image of locally generated material, electrical alignment is effected by touching the styli at both stations to the extreme corner or other suitable reference point on the respective writing surfaces. Under this condition the attenuators at both stations are adjusted to produce a coincidence of the locally generated and incoming line signals. The usual means for controlling the cathode writing beam of the storage tubes is also adjusted to produce the proper amplitude, orientation and intensity of the signals appearing on the surfaces of the tubes. With this procedure, exact superimposition of the two signals at both stations is established before the initial transmission. Occasional readjustment will insure exact coincidence during subsequent transmissions.

Once the written conversation has been terminated, the messages persist on both storage tube screens, and hence appear on both writing surfaces, until locally generated erase signals (not shown) are supplied to the storage tubes. Conventional x—y recorders or photographic means and the like may be employed to provide a permanent record of the message.

Although the invention has been described as relating to specific embodiments, the invention should not be deemed limited to the embodiments illustrated, since various modifications and other embodiments will readily occur to one skilled in the art.

What is claimed is:

1. An electrographic writing surface which comprises a substantially plane conductive tablet having a relatively high resistance per unit area, means for producing a flow of current through said surface in one coordinate direction to develop a potential gradient between the opposite edges of said surface, said gradient being represented by substantially straight equipotential lines extending from edge to edge, said means including a first pair of conductive electrodes having relatively low resistance per unit length connected in electrically conductive relationship with the opposite sides of said tablet, a second pair of conductive electrodes having relatively low resistance per unit length connected in electrically conductive relationship with the other edges of said tablet, and means for applying excitation signals between the ends of each of said first pair of electrodes thereby to develop within said pair of electrodes potential gradients congruent with said gradient developed within said surface, and for applying said excitation signals between said second pair of electrodes to maintain each of said second pair respectively at uniform potentials.

2. An electrographic writing surface which comprises a conductive tablet having a relatively high resistance per unit area, means for producing a flow of current through said surface in at least two coordinate directions to develop potential gradients therein between opposite parallel edges of said surface, said gradients being represented by substantially straight equipotential lines extending from edge to edge, said means including a plurality of electrically conductive electrodes having relatively low resistance per unit length connected in continuous electrically conductive relationship with opposite parallel sides of said tablet, means for electrically connecting adjoining ones of said electrodes to one another and to corresponding electrical terminals, and means for applying separately distinguishable excitation signals between the terminal ends of pairs of opposite parallel electrodes.

3. An electrographic writing surface as defined in claim 2 wherein said conductive tablet comprises a thin layer of carbon granules deposited on an insulating base and said electrodes comprise lengths of Nichrome resistance wire and wherein the ratio of the resistance of said tablet to said electrodes is approximately ten to one.

4. An electrographic transmitter comprising a writing surface having uniform resistance per unit area, means for producing within said surface at least two mutually perpendicular potential gradients, said means comprising a source of excitation, a conductive border electrode in continuous electrical contact with each edge of said surface, each of said electrodes being electrically connected at each end thereof with the ends of adjacent electrodes and having uniform resistance per unit length, said resistance being low with respect to the corresponding resistance of said surface, means for connecting said excitation signals to the junctions of adjacent bars, thereby to develop within each of said electrodes potential gradients congruent with the corresponding gradients within said surface, electrical conductive means for contacting discrete points in said surface, and means for translating each point of contact into potentials whose amplitudes are proportional to the coordinates of position of said electrical conductive means.

5. An electrographic transmitter as defined in claim 4, wherein said electrical conductive means comprises a freely movable conducting stylus connected to said translating means.

6. An electrographic transmitter as defined in claim 4 wherein said source of excitation comprises a source of direct current potential and said excitation signal connection means includes means for alternately applying said signal to first one pair of opposite electrodes and then to the other.

7. An electrographic transmitter as defined in claim 4 wherein said source of excitation comprises first, second and third constant current signal generators operating respectively at frequencies f_1, f_2 and f_3, and wherein said excitation signal connection means includes means for applying signals at frequency f_1 continuously to one pair of oppositely disposed electrodes, means for applying signals at frequency f_2 continuously to the other pair of oppositely disposed electrodes, and means for applying signals at frequency f_3 between a reference potential point and the effective geometrical center of said writing surface area.

8. An electrographic writing surface which comprises a conductive tablet having a relatively high resistance per unit area, the resistance of said tablet being tapered from edge to edge in at least two coordinate directions, means for producing a flow of current through said surface in at least two coordinate directions to develop nonlinear potential gradients between opposite parallel edges of said surface, said means including a plurality of electrically conductive electrodes having relatively low re-

sistance per unit length and tapered throughout their entire lengths, each one of said tapered electrodes being connected in electrically conductive relationship with a plurality of points along each side of said tablet, means for electrically connecting adjoining ones of said tapered electrodes to one another and to corresponding electrical terminals, and means for applying separately distinguishable excitation signals between the terminal ends of pairs of opposite parallel electrodes to establish in said electrodes nonlinear potential gradients congruent with said gradients developed within said tablet.

9. An electrographic transmitter which comprises in combination, a writing surface having linearly tapered resistance per unit area, means for producing within said surface at least two mutually perpendicular nonlinear potential gradients, said means comprising a source of potential, a conductive border strip in electrical contact with each edge of said surface, each of said border strips being electrically connected at each end thereof with the ends of adjacent strips, the resistance of said strips being low with respect to the corresponding resistance of said surface and opposite ones of said strips being tapered linearly to support a nonlinear potential gradient identical with the corresponding gradient produced within said surface, means for connecting selected components of said source of potential to the junctions of adjacent bars, and electrically conductive means for determining the relative potential difference between spatially separated points along each of said mutually perpendicular directions in said surface.

10. An electrographic transmitter as defined in claim 9 wherein said electrically conductive determining means comprises an insulating support member provided with a plurality of spatially distributed conductive styli, each electrically insulated one from another and connected to an external circuit.

11. An electrographic transmitter as defined in claim 10 wherein said support member contains one stylus connected in common with at least two independent circuits and at least one other stylus connected in each of said two independent circuits, said other styli being disposed along the locus of a pair of perpendicular lines intersecting said common stylus.

12. An electrographic transmitter as defined in claim 10 wherein said support member contains at least two pairs of styli, the styli of each pair being separated along mutually perpendicular loci, and in which each pair of styli is connected, respectively, to a separate circuit.

13. An electrographic writing surface which comprises a conductive tablet having a relatively high resistance per unit area, means for producing orthogonal electric fields within said tablet, said fields being represented by potential gradients within said tablet extending from edge to edge, and means including a closed frame of low resistance electrodes connected in continuous electrical conductive relationship with the perimeter of said tablet, a plurality of low resistance electrodes electrically connected between one pair of opposite sides of said frame, said plurality of electrodes being spaced apart from and positioned substantially parallel with one another, and means for applying separately distinguishable excitation signals to opposite pairs of electrodes whereby said potential gradients become substantially uniform from edge to edge.

14. An electrographic writing surface which comprises a conductive tablet having a relatively high resistance per unit area, means for producing orthogonal electric fields within said tablet, said fields being represented by potential gradients within said tablet extending from edge to edge, and means including a closed frame of low resistance electrodes connected in continuous electrical conductive relationship with the perimeter of said tablet, a plurality of low resistance electrodes electrically connected between both pairs of opposite sides of said frame, said plurality of electrodes between both pairs of sides being respectively spaced apart from and positioned substantially parallel with one another to form a matrix of crossed electrodes, the points of intersection of said crossed electrodes being electrically connected together, and means for applying separately distinguishable excitation signals to opposite pairs of said frame electrodes, whereby said potential gradients become substantially uniform from edge to edge.

15. An electrographic writing surface as defined in claim 14 in combination with electrically conductive means operatively associated with said surface for contacting discrete points in said surface, and means for translating each point of contact into potentials proportional to the coordinates of position of said electrically conductive means.

16. An electrographic writing surface as defined in claim 15 wherein said electrically conductive means comprises a sheet of electrically conductive paper juxtaposed with said surface, and stylus means provided with a reservoir of conductive ink for establishing an electrical contact between said conductive paper and said translating means.

17. In a two-way communication system including a first and a second substation, electrographic communication means at each substation for providing subscribers with a graphic display of instantaneous message signals, said electrographic communication means comprising transmitting and receiving means at both of said substations and a transmission link interconnecting the two, said transmitting and receiving means comprising a writing surface including a high resistance conductive tablet, means for producing orthogonal fields in said tablet, said means comprising a closed frame of low resistance electrodes connected in continuous conductive relationship around the perimeter of said tablet, means for applying separately distinguishable excitation signals between the end terminals of opposite pairs of the electrodes of said frame, and electrically conductive means for detecting the potentials appearing at selected discrete points in said tablet, the potentials so derived being representative of the coordinates of position of said selected points, means including said transmission link for transmitting said detected potentials to said second substation, means for separating said excitation signals detected by said electrical conductive means to produce a first set of control signals representative of the points selected by the subscriber at said first substation, means for separating the distinguishable signal components of message signals received from said second substation to produce a second set of control signals representative of the points selected by the subscriber at said second substation, a direct view storage tube, means for applying to said storage tube in alternation said first and said second sets of control signals to produce a composite visual display on said storage tube corresponding to the sequences of points selected by the subscribers at both said first and said second substations, and optical means for projecting said composite display on to said conductive tablet.

No references cited.