

June 22, 1943.

D. MITCHELL

2,322,653

TELAUTOGRAPHIC DEVICE

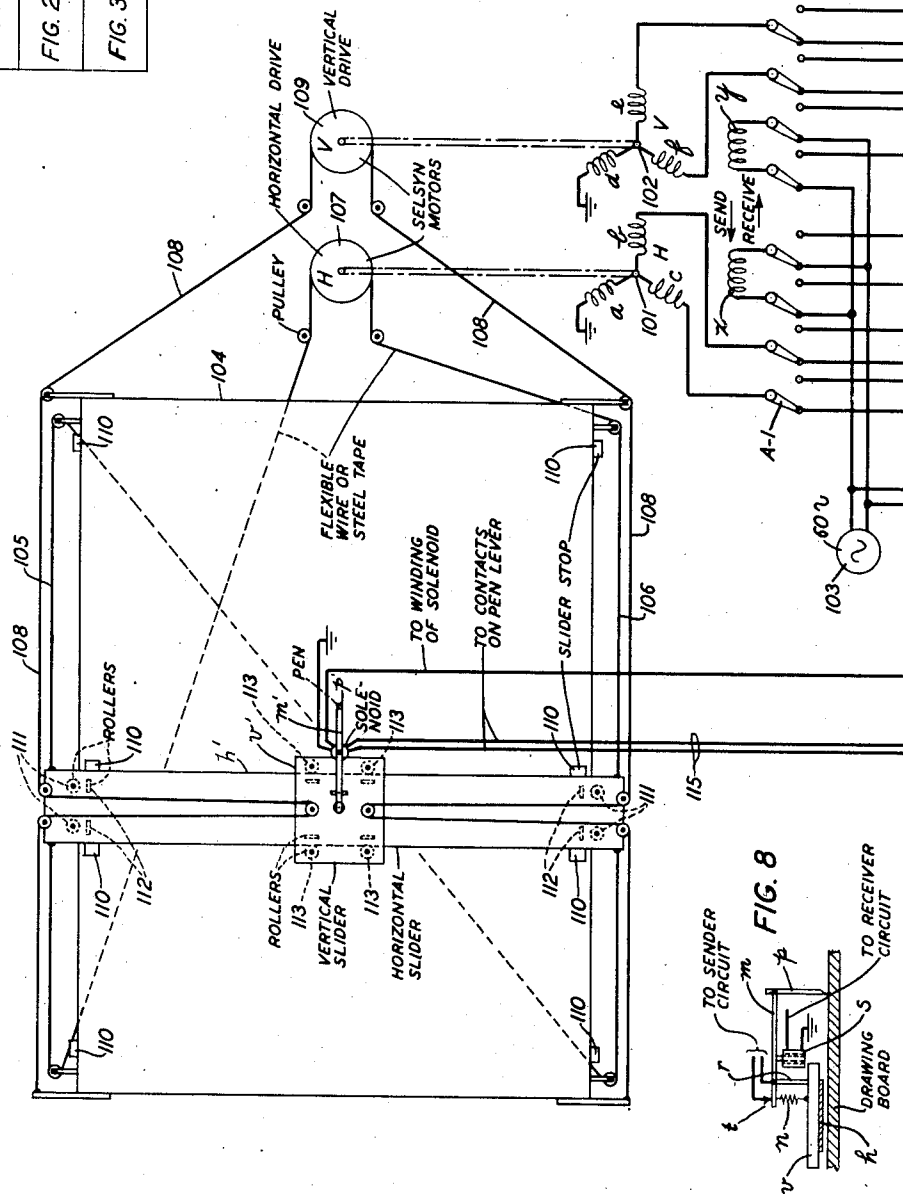
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6 Sheets-Sheet 1

FIG. 1	FIG. 4
FIG. 2	FIG. 5
FIG. 3	FIG. 6

FIG. 7

FIG. 1



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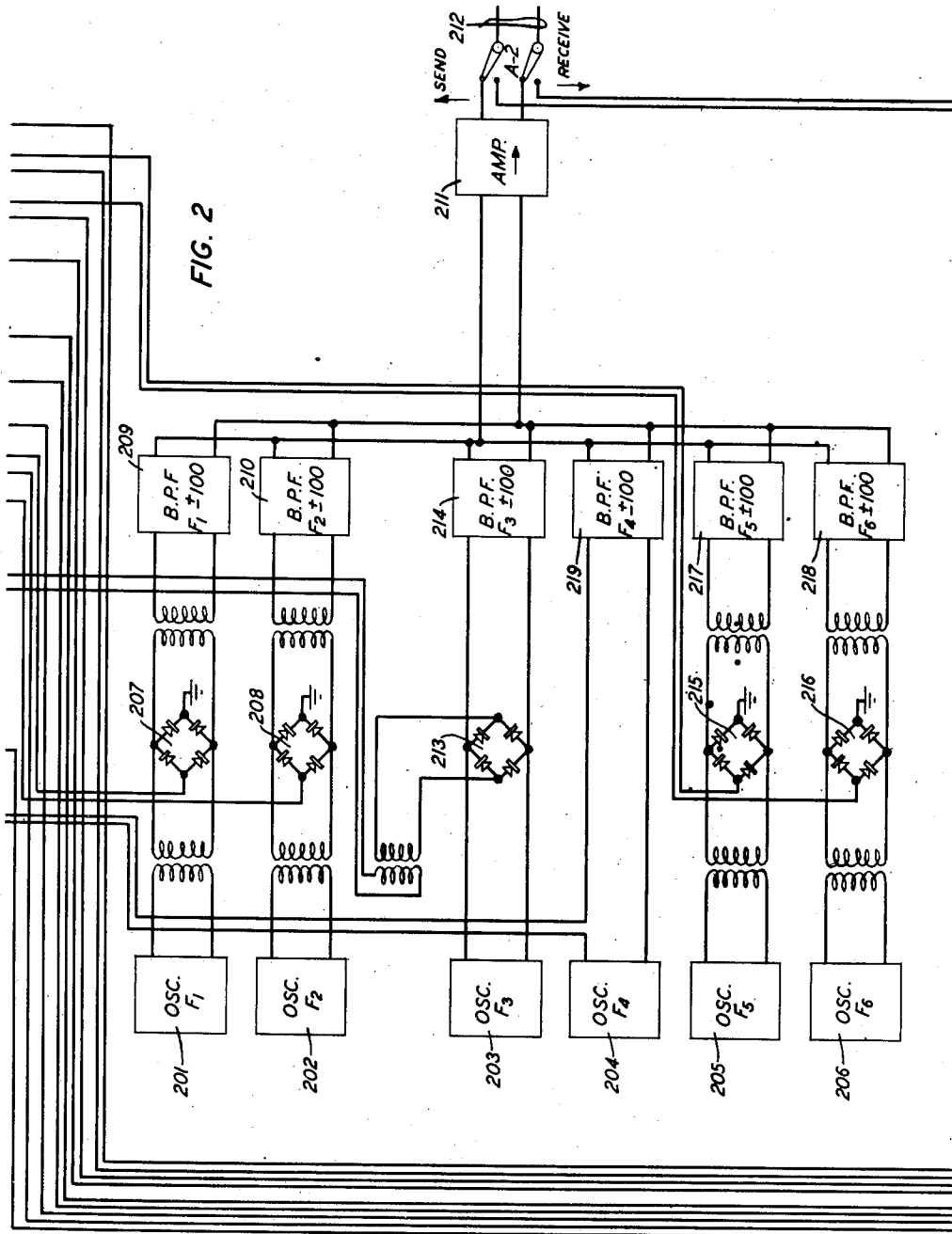
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6 Sheets-Sheet 2



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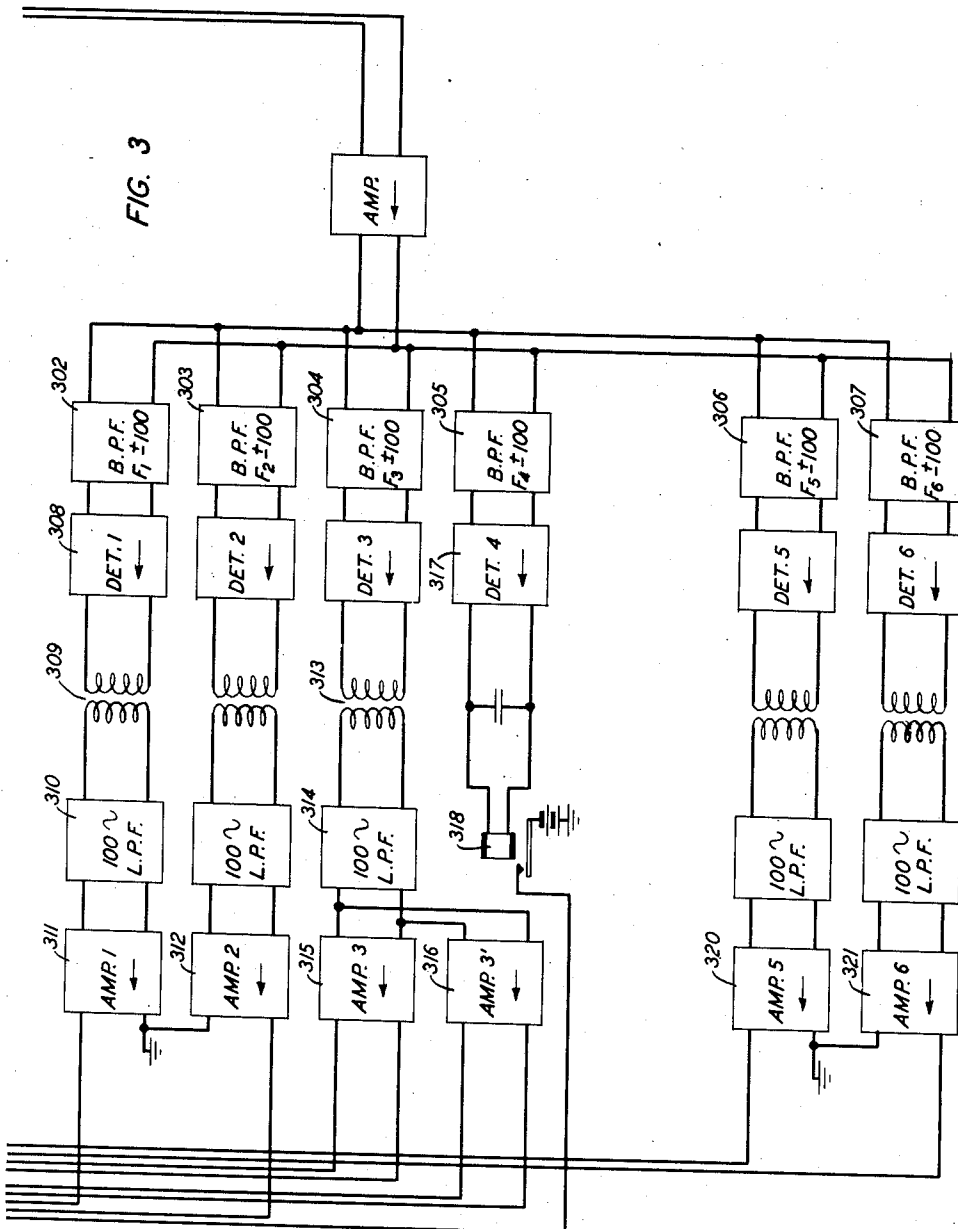
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6 Sheets-Sheet 3



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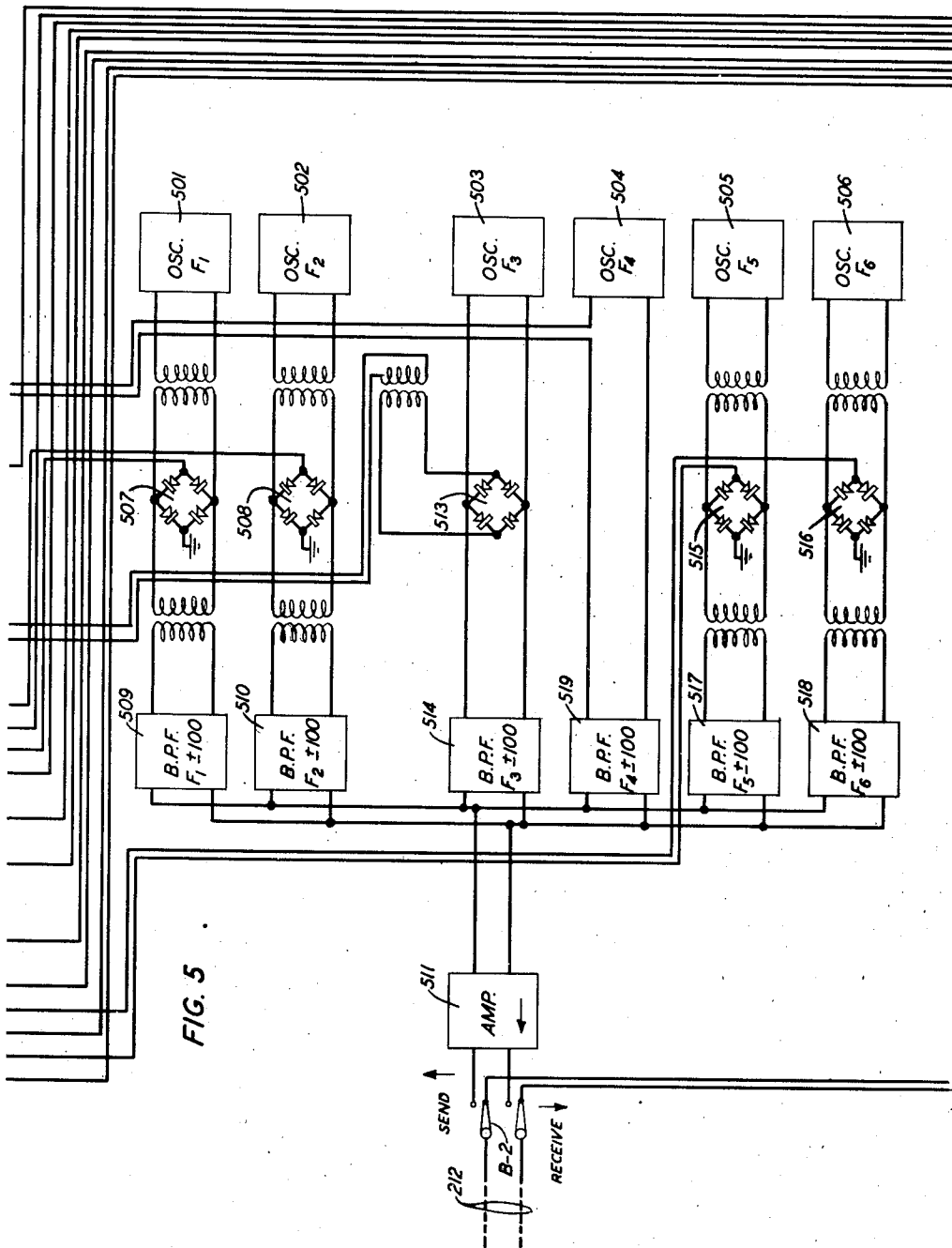
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6 Sheets-Sheet 5



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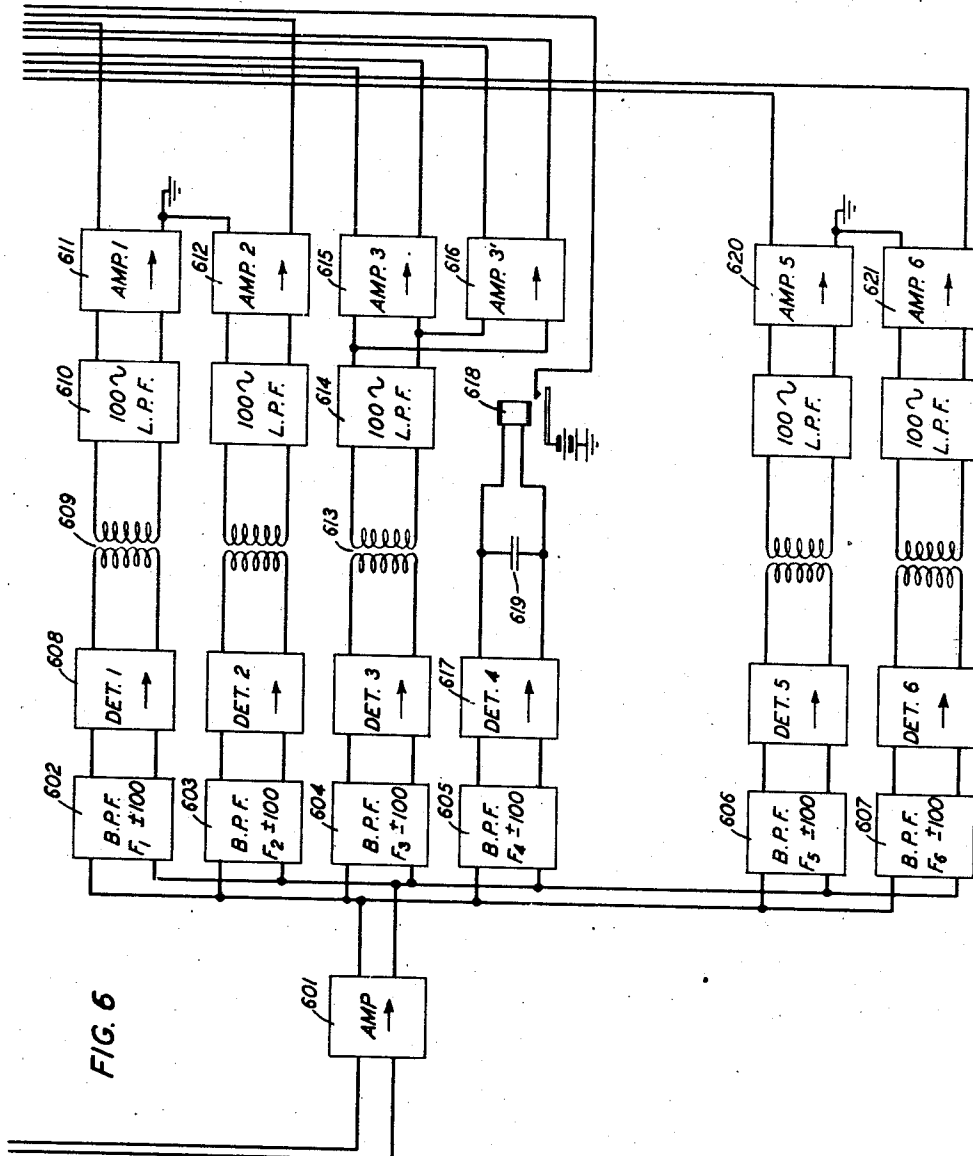
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TELAUTOGRAPHIC DEVICE

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6 Sheets-Sheet 6



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UNITED STATES PATENT OFFICE

2,322,653

TELAUTOGRAPHIC DEVICE

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Application January 5, 1940, Serial No. 312,472

7 Claims. (Cl. 178—19)

This invention relates to systems for transmission of intelligence over a transmission circuit and particularly to a telegraph system in which the movements of a stylus, or writing pen, at a transmitting station, are recorded in facsimile at a distant receiving station.

An object of the invention is to reproduce at a distant station sketches, in facsimile, simultaneously with the drawing of them at the local station.

Heretofore, in systems of this type, commonly referred to as telautograph systems, the movement of a directing, or writing, point at a transmitting station was resolved into two component motions which in one case varied the strength of current transmitted over a transmission circuit, in another case varied the phase angle of an ordinary current voltage applied to a transmission circuit, and, in another case, varied the frequencies of two signal currents being simultaneously transmitted over a transmission circuit.

According to the present invention, the movement of the directing, or writing, point at the transmitting station is resolved into two component motions which vary the phase and amplitude of a 60-cycle wave by means of two self-synchronous multiphase winding machines. The machines are used for both sending and receiving and the current and phase changes produced by two machines, positioned for sending at one end, are sent over an ordinary telephone line by modulating carrier currents with them. At the far end these carriers are separated by filters and detected in the usual manner and the sidebands are then applied to two other self-synchronous multiphase winding machines positioned for receiving, to reproduce the motion of the writing point as made at the sending station.

A feature of the invention is that the system is particularly adapted for design work in that it is capable of working equally well at any part of the useful surface of a drawing.

Another feature of the invention is that net loss variations in the transmission line do not affect the accuracy of the system.

Another feature of the invention is that its accuracy will not be affected by any ordinary amount of noise non-linearity or delay distortion which is present in telephone lines.

In the drawings:

Figs. 1, 2 and 3 illustrate the equipment at station A and Figs. 4, 5 and 6 the equipment at station B of a telautograph system which, more specifically, may be termed a telineator system in

that it appears to have several fundamental advantages with respect to design work, as compared with the telautograph as generally known.

Fig. 1 shows the drawing-board and the mechanical arrangement affixed for converting horizontal or vertical mechanical motion on the drawing-board into circular motion of two multiphase machines, or vice versa. The multiphase machines are shown and described herein with three-phase windings.

Fig. 2 shows the transmitting equipment at station A.

Fig. 3 shows the receiving equipment at station A.

Fig. 4 shows the drawing-board and mechanical arrangement affixed similar to that shown in Fig. 1.

Fig. 5 shows the transmitting equipment at station B.

Fig. 6 shows the receiving equipment at station B.

Fig. 7 shows the relative arrangement of Figs. 1 to 6.

Fig. 8 shows in detail the elevation view of the writing pen at the drawing-board shown in Figs. 1 and 4.

When the system is arranged to send from station A to station B, switches A—1 in Fig. 1 and A—2 in Fig. 2, B—1 in Fig. 4 and B—2 in Fig. 5 are in the position shown. When the direction of transmission is to be reversed the switches are operated to their alternate positions.

It will be noted that the parts at station B other than those also shown in Fig. 8, have the same reference characters as their corresponding parts at station A, except that the numeral prefixes indicate the figure in which they are located.

In Fig. 1 two rotors 101 and 102 are provided at station A and in Fig. 4 two other rotors 401 and 402 are provided at station B. Rotors 101, 102, 401 and 402 represent armatures of self-synchronizing remote control three-phase winding machines. The stator elements respectively associated with rotors 101 and 102 are windings x and y , and the stator elements respectively associated with rotors 401 and 402 are x' and y' . The complete unit including rotor 101 is herein designated H and the complete unit including rotor 102 is herein designated V. Similarly, the complete unit respectively including rotors 401 and 402 at station B are herein designated H' and V'. The stator windings x and y are the exciting elements for the machines H and V and are supplied with current from a single phase alternating current source 103 usually of a stand-

ard frequency, such as 60 cycles. Likewise, the stator windings x' and y' are the exciting elements of machines H' and V' at station B and are supplied with current, when station B is arranged for sending, from a single phase alternating current source 403, also of 60 cycles. Each of the rotors 101, 102, 401 and 402 serve as a three-phase armature winding, its associated stator elements as hereinbefore stated being in effect the exciting windings. By connecting the elements a , b and c on rotor 101 and d , e and f of rotor 102 with corresponding elements of rotors 401 and 402, respectively, at a remote point, such as a station B, by means of switches A-1, A-2, B-1 and B-2, any angular movement imparted to either or both of rotors 101 and 102 at station A is very quickly duplicated by the corresponding rotor element at station B, rotor 401 duplicating the movement of rotor 101 and rotor 402 duplicating that of rotor 102, and vice versa. In other words, the action between the machines at opposite ends on the system is self-synchronous. These self-synchronous remote control machines are used as an electrical means for transmitting accurate angular motion between two or more remote devices which cannot conveniently be mechanically interconnected. The accuracy of the motion transmitted varies with the amount of torque required by the load, the size of machines used, and the acceleration and operating speed of the system. Each machine is mechanically a miniature bipolar rotating-field three-phase alternator. The stator is wound with a single phase concentrated winding, the rotor, with a three-circuit distributed Y-connected winding. Electrically, in normal operation the machine acts as a transformer and voltages and currents existing therein are all single phase. By transformer action, voltages are induced in the three elements, such as those designated a , b and c in rotor 101, the magnitude depending upon the angular position of the rotor with respect to its associated stator. Rotors 101 and 102, respectively, control rotors 401 and 402 and vice versa, depending upon the direction of transmission. Assuming that these rotors are free to turn, they will take such positions that the voltages induced in the elements of rotors 101 and 102 at station A are of balanced magnitude and displacement with rotors 401 and 402, respectively, at station B. Under the condition of rotor voltage balance between two interconnected machines at separated stations, there is no circulating current in the rotor windings. Now, if the rotor of one machine is displaced by a certain angle and the rotor of the other machine is held in its original position, the rotor voltage balance is altered and a circulating current will flow in the windings. This circulating current reacting on the excitation flux provides a torque tending to turn the rotor of the machine to a position where the induced rotor voltages are again equal and opposite. Thus with both rotors unrestrained, any motion given to the rotor of one machine will be transmitted to and duplicated by the rotor of the second machine, and the system therefore becomes one of electrically transmitted mechanical motion. The phase relation must be kept so exact in such a system that even a difference of, say, a tenth of a cycle between the two power sources would result in a noticeable continuous motion of the receiving machine (one revolution every ten seconds), even though the transmitting was kept at rest. Thus, by modulating the local power upon a carrier the receiving end is able

to resupply this frequency at exactly the correct frequency and in a constant phase relation.

The invention will now be described with an assumption that transmission is from station A to station B, whereby switches A-1, A-2, B-2 and B-1 are in the positions shown. Referring to Fig. 1, a drawing-board 104 is shown equipped with a two-dimensional slider system so that a large area of the board can be covered with a writing pen p' , when moved. The pen p' and its associated parts, shown in detail in Fig. 8, are also shown in Fig. 1 wherein the component parts are designated with reference characters having prime markings whereby they may be identified with their corresponding parts in Fig. 8. Each of the sliders h' and v' is coupled by a system of wires and pulleys to one of the synchronous machines at station A. Rotor 101 is rotated when pen p' is moved in a horizontal direction, thus moving slider h' and rotor 102 is rotated when pen p' is moved in a vertical direction, thus moving slider v' . In addition, there is a contact provided with the lever m' on which the pen p' is mounted which makes contact when the pen p' is pressed down to meet the paper that is affixed to the drawing-board. When pen p' is in position to receive, a solenoid controlled by relay 318 of the receiving equipment in Fig. 3, is provided that will bring the pen p' down to meet the paper.

Assume that slider h' is moved from left to right. The wire 105 which is connected to it at the top will then move from left to right but due to the reversing type of linkage shown, the motion will be transmitted to the bottom wire 106 as a motion from left to right also. This will then cause the horizontal drive 107 to turn in a counter-clockwise direction. Similarly, if the pen p' is being used for receiving as the horizontal drive 107 turns in a counter-clockwise direction the horizontal slider h' will move from left to right.

Motion of the horizontal slider in either direction will cause the flexible wire 108 associated with the vertical slider v' to feed in and out through the system of pulleys shown but will not cause any relative motion of this wire at the vertical drive 109. If we assume that the vertical slider v' is moved upward from the bottom, a compensating slackening will take place at the top of the slider v' and the net result will be to turn the vertical drive 109 in a clockwise direction. If the vertical drive turns, due to applied power, it will convey this motion to the vertical slider v' for receiving.

As hereinbefore stated, it is the property of the synchronous machines employed in the applicant's device that they tend to keep in step but that it is possible for one to get 180 degrees out of phase with the other and to then lock in this new position. In order to prevent any difficulty due to this effect, it is provided that the system be made with some slippage between the flexible wires and the machine drives 107 and 109 and with stops 110 as shown at the top and the bottom of the h' slider and at the left- and right-hand sides of the drawing-board. In this way, just before a sketch is to be reproduced at the remote station the pen p' would first be moved as far as possible to the upper right-hand corner at the sending end and then as far as possible to the lower left-hand corner. This would cause the receiving machine to drive its slider as close as possible to the upper right-hand corner, but if either receiving machine had gotten 180 degrees ahead in phase from the transmitting

machine, the slider would stop at this point and the rest of the motion of the receiving machine would be taken up in slippage. Any error in phase of the two receiving machines in the other direction would be removed in a similar manner when the pen p' of the sending machine was moved to the lower left-hand corner.

The roller system shown on the sliders should allow them to operate freely. Thus one set 111 of rollers on slider h' rolls along the top and the bottom edge of the drawing-board 104 thereby presenting vertical motion of slider h' . The other set 112 of rollers rolls along the top and bottom of drawing-board 104 thereby preventing friction which might make it difficult to move the slider h' . A similar system of rollers is used with slider v' which will allow it to be moved upward and downward with as little skew motion and friction as possible, the two sets being designated 113 and 114. It is within the scope of the invention to have rollers associated with slider v' but underneath slider h' in order to prevent any rocking motion.

The transmitting equipment located at station A and shown in Fig. 2 comprises six oscillators 201 to 206, all of which are sources of different carrier current frequencies. Likewise, the transmitting equipment located at station B and shown in Fig. 5 comprises six oscillators 501 to 506 which also are sources of different carrier frequencies. The corresponding oscillators of stations A and B may be sources of similar frequency. It was hereinbefore mentioned that the frequency of the current in the exciting elements x and y at station A and x' and y' at station B are the same, that is 60 cycles, since in order to make certain that the 60-cycle current at the receiving end of the transmission line is sufficiently accurate, the 60-cycle source at the sending station is impressed on the transmission line. The transmission of the 60-cycle frequency to the receiving station may not be necessary if the 60-cycle power at both stations A and B were known to be in practically absolute synchronism. Even an extremely small difference between the two sources of 60-cycle current, however, would cause the receiving machine to continuously creep one way or the other.

The resulting action of the exciting voltages in stator element x and any movement at this time of rotor 101 of the horizontal machine H causes variations in the voltages, or information, transmitted to station B. The voltages between rotor elements a and b and a and c are impressed through copper-oxide modulators 207 and 208, respectively, on the carrier current frequency f_1 and f_2 of oscillators 201 and 202 as shown in Fig. 2. The outputs of the modulators 207 and 208 are passed through suitable band-pass filters 209 and 210, respectively, and then through an amplifier 211 and switch A-2 in its sending position onto the transmission line 212. The local 60-cycle voltage is also modulated through modulator 213 directly on to the frequency f_3 from oscillator 203 and then passes through another suitable band-pass filter 214 to line 212. The voltage and phase of the 60 cycles modulated on frequencies f_1 and f_2 depend on the position of the rotor 101 of horizontal machine H. It is apparent that the voltage between rotor elements b and c is definitely determined by the voltage between rotor elements a and b and a and c .

Likewise, the resulting action of the exciting voltage in stator element y and any movement at this time or rotor 102 of the vertical machine

V causes variations in the voltages, or information, transmitted to station B. The voltage between rotor elements d and e and d and f is impressed through copper-oxide modulators 215 and 216 respectively on the carrier current frequencies f_4 and f_5 of oscillators 205 and 206 as shown in Fig. 2. The outputs of modulators 215 and 216 are passed through suitable band-pass filters 217 and 218, respectively, and then through amplifier 211. The voltage and phase of the 60-cycle modulators on frequencies f_4 and f_5 depend on the position of the rotor 102 of vertical machine V. It is apparent, as stated above for the horizontal machine H that the voltage between rotor elements e and f is definitely determined by the voltages between rotor elements d and e and d and f .

In Fig. 8 the pen circuit is indicated schematically. As indicated, when the pen p is pressed down, the left side of lever m rises because the lever is pivotally supported at point r . Contacts t engage each other and close a circuit extending over conductors 115 thereby impressing the frequency f_4 of oscillator 204 on the line 212 through an appropriate band-pass filter 219 and amplifier 211. The filter 219 is necessary since otherwise whenever the pen p is pressed down or released a very wide side-band would be momentarily produced which would splash into the other channels and probably cause jerks to appear in the line drawn at the receiving station.

Frequency f_4 of oscillator 204, together with the modulated frequencies f_1 , f_2 , f_3 , f_4 and f_5 of oscillators 201, 202, 203, 205 and 206, respectively, are impressed over their respective channels on to line 212 and thus sufficient information is transmitted to cause rotor 401 of horizontal machine H' and rotor 402 of vertical machine V' to follow the movement of corresponding rotors 101 and 102 at the transmitting station. The informative energy incoming over line 212 is received over switch B-2 in a received position at station B and directed through amplifier 601 shown at Fig. 6. The output of amplifier 601 is divided by means of band-pass filters into channels corresponding in frequencies to the respective bands passing through filters 209, 210, 214, 219, 217 and 218. Filter 602 passes frequency $f_1 \pm 100$ cycles which corresponds to the output of filter 209 at station A and the output of filter 602 is detected by detector 608 and then passed through a repeating coil 609 and a 100-cycle low-pass filter 610. The repeating coil removes the direct current component from the output of detector 608 and the low-pass filter 610 removes the higher order products which might cause trouble in the operation. The output of filter 610 then represents a 60-cycle wave whose phase and amplitude correspond to that of the similar waves passed through filter 209 at station A. The output of filter 610 is then amplified by amplifier 611 and impressed on elements a' and b' of rotor 401 on the horizontal machine H' at station B. Similarly, the output of filter 210 at station A is demodulated by the circuit path controlled by filter 603 and the resulting 60-cycle wave is impressed between elements a' and c' of rotor 401 of the horizontal machine H'. Thus, 60-cycle current with the same relative amplitude and phase relation is impressed on the three-phase winding of the horizontal machine H' when arranged for receiving, as was produced by horizontal machine H when arranged for sending. It is of interest to note that by increasing the amplification of amplifiers 611 and 612, the torque

produced in the horizontal machine H' when arranged for receiving, can be increased by any desired amount up to the limit of the capacity of the amplifier or the ability of the winding of the machine to withstand burning.

Filter 604 passes frequency $f \pm 100$ cycles which corresponds to the output of filter 214 at station A and its output is detected and passed through repeating coil 613, low-pass filter 614 to amplifiers 615 and 616. The output of these amplifiers then represents, with great precision as to frequency, the original 60-cycle wave present at the send station, all harmonics and other disturbing influences being removed by the terminating equipment. The output of amplifier 616 is impressed on stator element x' of horizontal machine H' and that of amplifier 615 is impressed on stator element y' of vertical machine V'. The two amplifiers 615 and 616 are used so as to insure that there is no interaction between the horizontal machine H' and the vertical machine V'.

Filter 605 passes frequency $f \pm 100$ cycles which corresponds to the output of filter 219 and its output is then detected by detector 617 and passed through the winding of relay 618, condenser 619 serving to permit the direct current component only of the output of detector 617 to pass through the winding of relay 618. Relay 618 operates to close a circuit extending through solenoid s' in Fig. 4. Solenoid s' operates to cause writing pen p' to move down as desired into engagement with the paper affixed drawing-board 414.

Filter 606 passes frequency $f \pm 100$ cycles which corresponds to the output of filter 217 and filter 607 passes frequency $f \pm 100$ cycles which corresponds to the output of filter 218. Each of the outputs of filters 606 and 607 is, over separate paths, detected, passed through a repeating coil, a low-pass filter to an amplifier. Amplifiers 620 and 621 respectively amplify the output of the two paths. The output of amplifier 620 is impressed on element d' and e' of rotor 402 on vertical machine V' at station B and the output of amplifier 621 is impressed on elements d' and f' of the same rotor 402. Thus in a similar manner as hereinbefore stated for the horizontal machine H' the 60-cycle voltage with the same relative amplitude and phase relation is impressed on the three-phase winding of the vertical machine V' when arranged for receiving, as was produced by the vertical machine V at station A when arranged for sending.

The writing, or directing, pen p'' at station B, under the influence of the three-phase winding machine H' and V', is caused to be actuated over the paper affixed drawing-board 404 through the same motions as the pen p' at station A and therefore reproduces any sketch, design, or other information that may be drawn, traced or written on the paper affixed drawing-board 104.

Transmission from station B to station A

When transmitting from station B to station A the switches A-1, A-2, B-1 and B-2 are operated to positions opposite to those shown in the drawings. The source 403 of a standard frequency, such as 60 cycles, is now connected to the exciting windings x' and y' of machines H' and V', respectively, and the rotor elements b' and c' of machine H' and the rotor elements e' and f' of machine V' are connected to the

sending equipment of Fig. 5 in a manner similar to that of the rotor elements of machines H and V at station A being previously connected to the sending equipment of Fig. 2 as hereinbefore described. The sending equipment of Fig. 5 is now connected by means of switch B-2 to transmission line 212 and the line 212, by means of switch A-1, is now connected to the receiving equipment of Fig. 3. The receiving equipment of Fig. 3 is by means of switch A-1 connected to exciting stator windings x and y and rotor elements b, c, e and f of the machine at station A. The writing, or directing, pen p' at station A, under the influence of the three-phase winding machines H and V, is caused to be actuated over the paper affixed drawing-board 104 through the same motions as pen p'' at station B to reproduce any delineation described by pen p'' on drawing-board 404.

It is within the scope of the invention to make the exciting windings of the machines the rotary elements and the three-phase windings the stationary elements.

Because of the broad scope of usage to which the present invention may be adapted, no attempt has been made to furnish a detailed design of the mechanical or electrical arrangements that may be employed. However, where it is desired to use, say an 8" x 10" drawing, the self-synchronizing three-phase winding machines may be a typical moderate size Selsyn motor which produces a torque of 10 gram centimeters when a displacement of 5 degrees is made. If considerable care were taken to make the sliders as small as possible and of very lightweight material and to keep the rollers and wire linkages very free running, this should be somewhere near the amount of force required to operate the device assuming that the pulleys respectively adjacent to horizontal and the vertical drives were one centimeter in radius. Thus, there would be a 10 gram pull exerted by a displacement of 5 degrees.

A displacement of 5 degrees would then amount to about .033 inch or approximately $\frac{1}{30}$ inch on the paper. This means that the resolution of the system would be within about $\frac{1}{30}$ inch. This appears to be a fairly practical value to use on, for instance, an 8" x 10" drawing. It is considerably better than the present commercial telautograph which, in addition, only covers a space of 3" x 5".

It is obvious that the proposed scheme has the same resolution for any position on the drawing-board since a given displacement in degrees of one of the three-phase winding machines causes the same horizontal or vertical displacement for any position on the board. This is a fundamental advantage of a coordinate type linkage system as opposed to a polar type linkage which is used in the commercial telautograph. The resolution of any polar type system depends to some degree on the position on the board which is being used since a given displacement will cause different angular displacements depending on the position.

In making sketches on an ordinary piece of paper of about 8" x 10" in area, a travel time across the long dimension of about $\frac{1}{2}$ second seems to be as fast as is ordinarily used. This means that the speed of travel is about 50 centimeters per second, and if a one centimeter pulley radius were used, as hereinbefore assumed, this would mean a machine, or motor, speed of about 7 revolutions per second, or 420 revolutions per

minute. This also is within the limits of possibility, as present Selsyn type machine are fairly good up to speeds of about 500 or 600 revolutions per minute.

Assuming a constant speed across the paper as hereinbefore stated, the 60 cycles from the power source might be raised by 7 cycles to a value of 67 cycles. Some extra band width seems desirable, however, to take care of acceleration. It appears probable that the ± 100 cycle bands assumed as shown on the drawings should be sufficiently wide.

The mechanical inertia of the system might be considerable of a problem with speeds such as hereinbefore assumed. It is probable that it would be desirable to attempt to provide mechanical resistance and stiffness in any number of ways, depending on the system in which the invention is employed, to either effectively match mechanical resistance or to make the system aperiodic in any desirable way. The rather obvious solution at the receiving end is to merely increase the power applied to the receiving machines so that not only would the receiving machine follow after the motion of the transmitting machine but the braking motion would be very large when the transmitting machines were slowed down and the receiving machines tended to overrun. It is believed that these matters could best be studied by setting up a simple arrangement with only two machines and an amplifier between them and trying out various arrangements of mass, stiffness and resistance on the receiving machine.

In addition to the constant revolution over different parts of the drawing-board which has been hereinbefore discussed, the present arrangement is largely independent of net loss variations and could be made even more so by a certain amount of automatic volume control. Thus, if net loss should increase considerably between the transmitting and the receiving machines, the currents applied to the three-phase windings and the single winding of the horizontal machine would also be reduced. The relative phases and amplitudes, however, would not be changed and thus the position of the horizontal machine would not be changed.

Severe twist does not change the phase relations but would change the relative amplitudes to some extent. If this change in relative amplitude were large enough to be serious, it would be possible to place some very simple automatic volume control arrangements at the outputs of each of the receiving band-pass filters except those designated 305 at station A and 605 at station B, so that the detected current would always be of the proper value. These arrangements would not interfere with phase relations in any way. Such automatic volume control arrangements might easily be made a part of the output circuits, and preferably so, of each of detectors connected to band-pass filters 302, 303, 304, 306 and 307 at station A and band-pass filters 602, 603, 604, 606 and 607 at station B in any one of the well-known manners. The use of an automatic volume control arrangement is merely to improve the efficiency of the system.

What is claimed is:

1. In a telautograph system, a transmission circuit, a writing point capable of moving in a plurality of directions in a system of coordinates, a pair of electric inductive machines, each having rotatable elements and a fixed element, a

source of alternating current for energizing said fixed elements whereby said rotatable elements of said machines are electrically excited, linkages whereby movement of said point in one direction varies the position of the rotatable elements of one of said machines with respect to the position of their associated fixed element, and in another direction varies the position of the rotatable element of the other of said machines with respect to the position of their associated fixed element, and means for transmitting from each of said machines over said transmission circuit currents of various magnitudes which correspond to the movements of said point.

2. In a telautograph system, a transmission line, a writing point capable of moving vertically and horizontally, a pair of electric inductive machines each having rotatable elements and a fixed element, a source of alternating current for energizing said fixed elements whereby said rotatable elements of said machines are electrically excited, linkages whereby movement of said point in a vertical direction varies the positions of the rotatable elements of one of said machines with respect to the position of their associated fixed element, and in a horizontal direction varies the positions of the rotatable elements of the other of said machines with respect to the position of their associated fixed element, and means for transmitting from each of said machines, over said transmission line, currents of varying magnitudes which correspond to the movements of said point.

3. In a telautograph system, a circuit comprising a plurality of transmission channels, a transmitter, a plurality of alternating current sources of different frequencies, a plurality of electric voltage machines having rotatable elements and responsive to the operation of said transmitter, a source of standard alternating current frequency, means controlled by the rotatable elements of said machines for modulating the current of certain of said sources of alternating current, means controlled by said source of standard alternating current for modulating the current of another of said sources of alternating current, means directly controlled by the operation of said transmitter for actuating another of said sources of alternating current and means for impressing on each of said transmission channels of said circuit a distinctive band of modulated frequencies from said certain sources and one of said other sources and unmodulated frequencies from the other of said sources.

4. A telautograph device, a sending station, a receiving station, a transmission circuit interconnecting said stations, a plurality of oscillators of different current frequencies at said sending station, means at each of said stations including multiphase machines, an alternating current source therefor, a manually and automatically operated member for respectively modulating a current from said oscillators when said member is operated manually, a plurality of channels each including selecting means for selecting a particular side-band of current frequencies of each of said modulated currents for simultaneous transmission over said circuit, a second plurality of channels corresponding in number to the first-mentioned plurality of channels, a selecting means, a detecting means, and a demodulating means in each of said second plurality of channels for first, selecting a particular side-band of current frequency, secondly, repeating half of the selected side-band and thirdly, de-

modulating said half side-band of current frequency to automatically operate said multiphase machines and said manually and automatically operated member to reproduce at the receiving station the motion of said manually and automatically operated member at said sending station when the latter is operated manually.

5. A telautographic device comprising a sending station, a receiving station, a transmission circuit interconnecting said stations, a drawing-board at each of said stations, three-phase winding machines at each of said stations, an alternating current source for said machines at each of said stations, manually and automatically operated means at said stations, said means at said sending station being manually operated for converting the horizontal and vertical motion on the drawing-board at said sending station into circular motion of the three-phase machines respectively at said sending station, oscillating means for generating currents of different frequencies and arranged so that their respective frequency currents may be modulated separately by the differences in voltages of said three-phase machines at said sending stations, means in said receiving stations for selecting, detecting and demodulating, in turn, the frequency currents for transmission over separate channels to operate said machines and said manually and automatically operated means at said receiving station to reproduce on the drawing-board at said receiving station corresponding horizontal and vertical motion produced on the drawing-board at said sending station.

6. A telautographic device for transmitting sketches comprising a sending station, a receiving station, a transmission circuit interconnecting said stations, a drawing-board at each of said stations, three-phase winding machines at both sending and receiving stations, an alternating current source for said machines at each of said stations, oscillators for generating currents of different adjustable frequencies, manually and automatically operated means at said sending station for converting horizontal and vertical mo-

tion on the drawing-board at said sending station into circular motion of the three-phase machines, respectively, at said sending station, means for impressing varying voltages respectively produced by the circular motions of said machines at said sending station as modulated carrier current of different frequency bands, other means for impressing varying voltages produced by said alternating current source at said sending station as modulated carrier current of another frequency band and still other means for impressing varying voltages produced by the manually and automatically operated means at said sending station as an unmodulated carrier current of another frequency band for transmission over said transmission circuit, means at the receiving station for separating, detecting and demodulating the currents of different frequency bands and means for applying the demodulated frequency bands to their respective terminations to reproduce on said drawing-board of said receiving station, the corresponding horizontal and vertical motion that was produced on the drawing-board at said sending station.

7. In a telautographic device, a transmitter comprising a drawing-board, a horizontal and a vertical slider in engageable relation with each other, a movable writing pen mounted on one of said sliders and arranged in engageable relation with said drawing-board, a plurality of rotatable multiphase electric machines, a source of alternating current for magnetically energizing said machines, means interconnecting said sliders and said machines for rotating said machines in a magnetically energized field, a transmission circuit, a plurality of current sources of different frequencies connected to said transmission circuit, and means for modulating the currents from said frequency sources with the variations in voltages received from said machine for transmission over said transmission circuit, said variations in voltage received from said machines corresponding to the movement of said writing pen.

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