June 25, 1940. C. H. KEHM 2,205,531

RADIO AUTOGRAPH

Filed Dec. 31, 1937 3 Sheets-Sheet 1

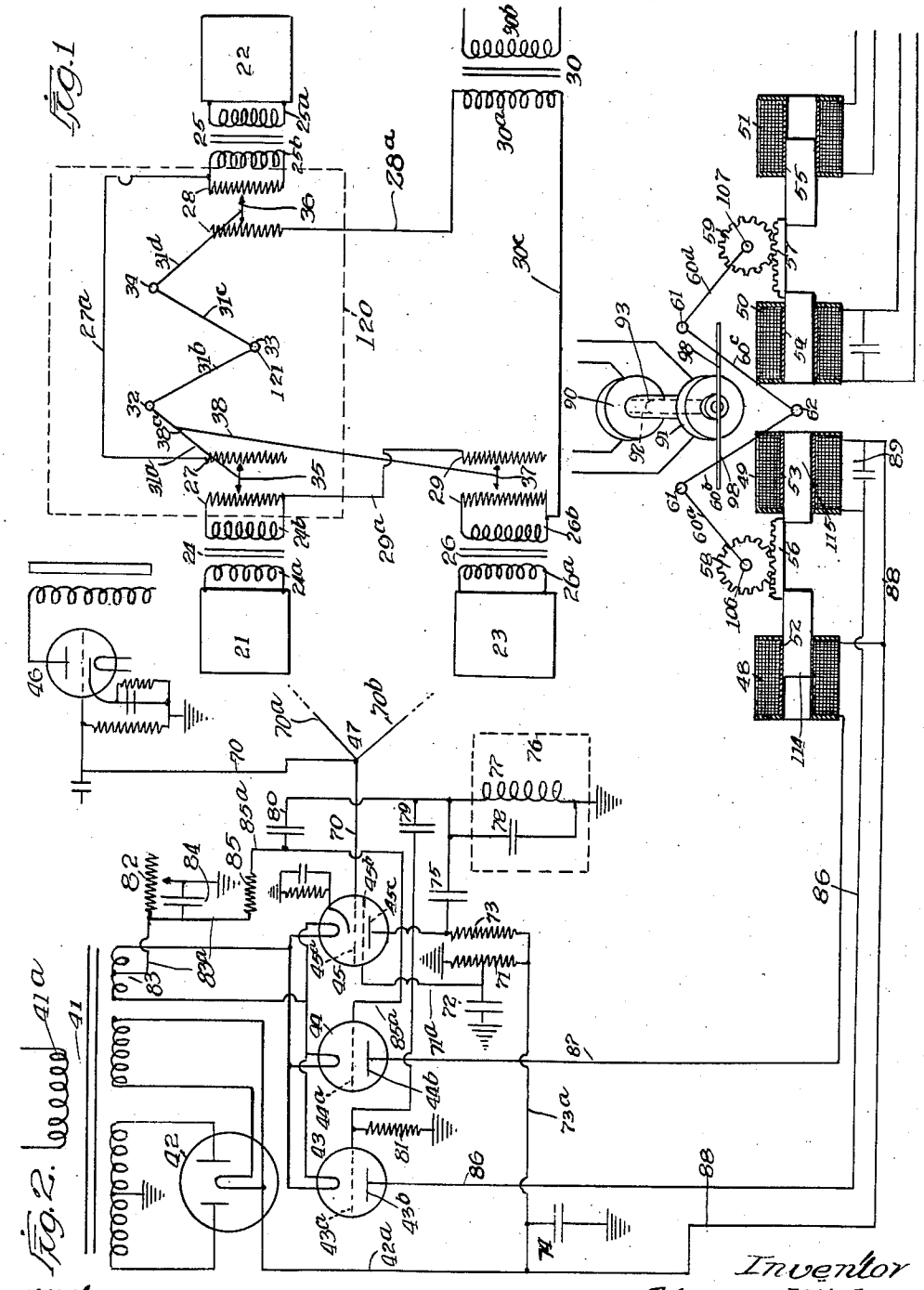


Fig. 1

Fig. 2.

Witness:
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Fig. 3

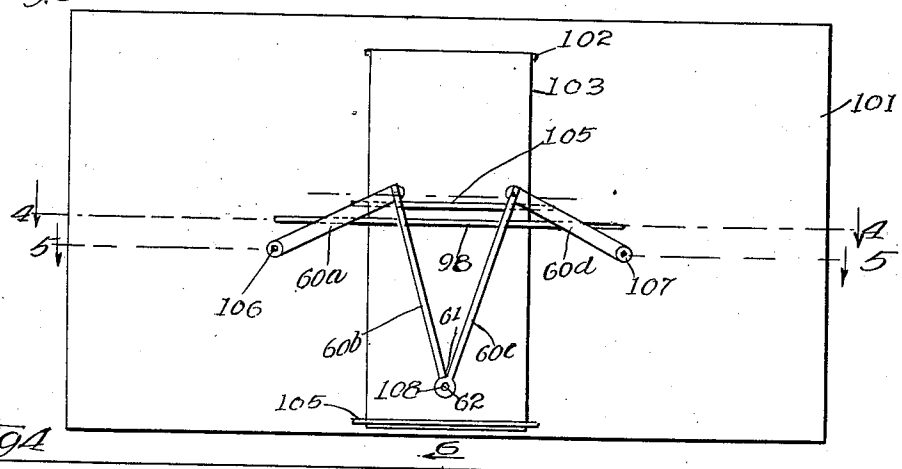


Fig. 4

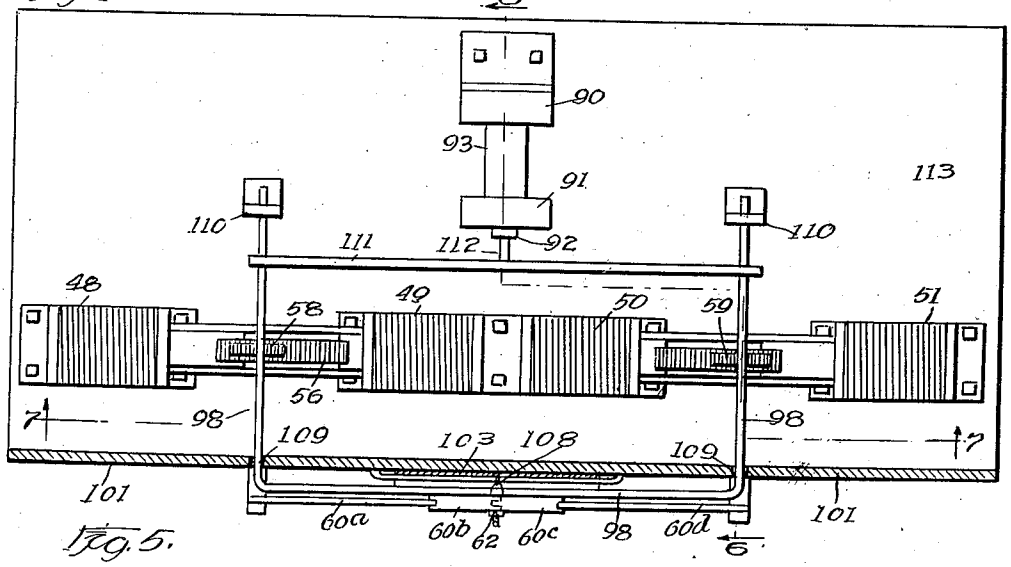
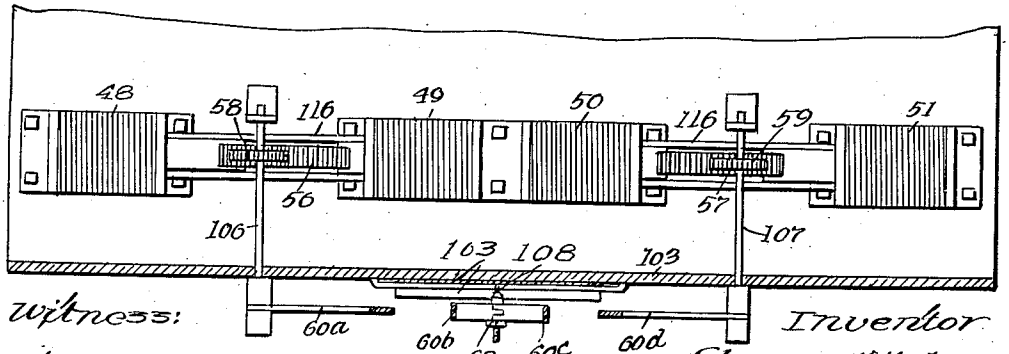


Fig. 5.



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Fig. 12.

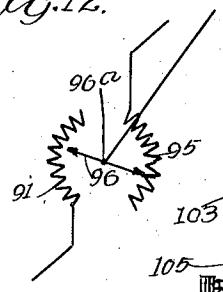


Fig. 6.

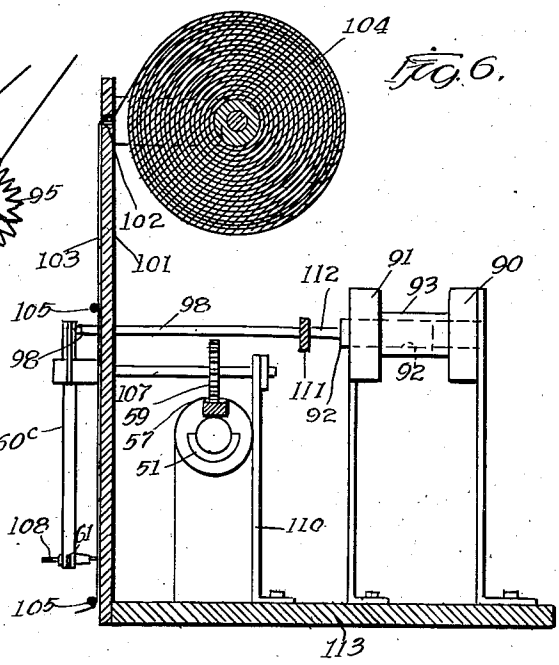


Fig. 10

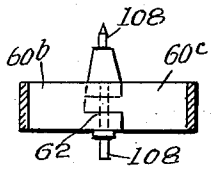


Fig. 11.

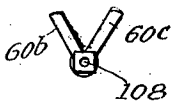


Fig. 7.

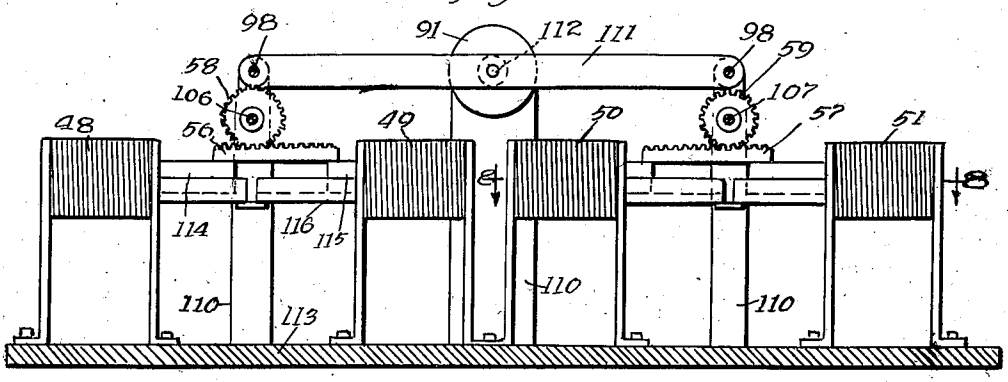


Fig. 8.

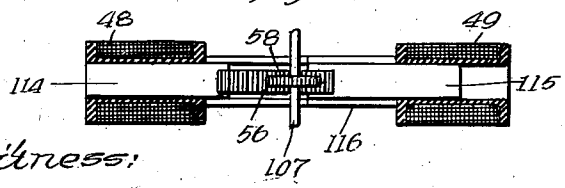
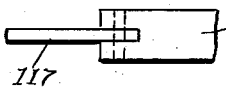


Fig. 9.



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UNITED STATES PATENT OFFICE

2,205,531

RADIO AUTOGRAPH

Clarence H. Kehm, Chicago, Ill.

Application December 31, 1937, Serial No. 182,719

12 Claims. (Cl. 178—19)

This invention relates in general to the method and apparatus for simultaneously transmitting and receiving writings, drawings, and the like, by means of radio apparatus.

The transmission of messages, drawings, and the like, by means of wire connected circuits, has been in practice for many years, but systems of this kind are limited as to distance, are usually carried on between two stations, and depend upon the maintenance of continuous circuits between the instruments.

The present invention depends upon a plurality of definite audio-frequencies of a radio apparatus and by varying the intensity of these frequencies.

An important object of the present invention is therefore in the provision of sending and receiving sets actuated by a radio broadcasting station by a plurality of definite audio-frequencies, in the provision of means for varying the intensity of those frequencies, and in the provision in the receiving units of means for converting the audio-frequencies into mechanical movement by means of a set of levers to which a pen, pencil, or stylus is attached.

Another important object of the invention is in the provision of suitable cooperating radio, electrical and mechanical apparatus for carrying out the principles of this invention, producing a variation of audio-frequency by mechanical movement, and reversely converting audio-frequencies into mechanical movement of the sending and receiving apparatus.

Other objects of the invention will appear hereinafter, the principal features and the preferred embodiment of the invention being illustrated in the accompanying drawings in which:

Fig. 1 is a diagrammatic drawing of a transmission set or system;

Fig. 2 is a diagrammatic drawing including a wiring diagram for a receiving unit;

Fig. 3 is a front view of a receiving unit showing paper or a surface to be written upon;

Fig. 4 is a top view of the receiving unit as taken on the line 4—4 of Fig. 3;

Fig. 5 is a top view as taken on the line 5—5 of Fig. 3;

Fig. 6 is a side view of a receiving unit;

Fig. 7 is a front view of a receiving unit with the front panel removed;

Fig. 8 is a detail of the armature and gear connections;

Fig. 9 is a detail of the armature mounting;

Fig. 10 and Fig. 11 are top and side views respectively showing the connection of a pen or pencil on the pivoted lever system; and

Fig. 12 is a detail view showing a constant impedance and network resistor.

In carrying out this invention a plurality of frequencies are set up in a sending station which are varied electrically by the operation of a pencil or stylus carried by a system of levers and these varying frequencies are broadcast and received by radio, the receiving sets being also equipped with a set of levers carrying a pencil or stylus and actuated by the audio-frequencies to reproduce any writing or drawing made by the pencil at the sending station.

Referring now more particularly to Figure 1 of the drawings, which diagrammatically illustrates a sending or transmitting station, a plurality of electrical audio-frequency oscillators 21, 22 and 23 are shown as having impedance matching transformers 24, 25 and 26 respectively with their primary windings 24*a*, 25*a* and 26*a* connected to the oscillators 21, 22 and 23. The secondary windings 24*b*, 25*b* and 26*b* are connected to a constant impedance network having units 27, 28 and 29 corresponding therewith and connected in series by conductors 27*a*, 28*a*, 29*a* and 30*c* to form a network with a primary winding 30*a* of a transformer 30, the secondary winding 30*b* of which is used as an input to a radio broadcasting station.

It is very necessary to have the several oscillators connected in series and by means of a constant impedance networks to the input transformer of the transmitting station. Other methods will cause distortion due to the change in inductance of the input transformer caused by the variation of the amplitude controlling resistances.

Each unit 27, 28 and 29 is represented as having two spaced constant impedances connected and varied by movable contacts 35, 36 and 37. A simple rotary form of this unit is preferably used and is also illustrated in Fig. 12 having curved impedances 94 and 95 with a double contact arm 96 rotatable at its center 96*a* between them and operative to increase the impedance in one coil as the impedance in the other coil is decreased.

A system of arms 31*a*, 31*b*, 31*c* and 31*d* have pivots 32, 33 and 34 connecting them together and the end arms 31*a* and 31*d* are connected to the movable contacts 35 and 36 of impedance units 27 and 28 respectively so that any movement of these levers will vary the intensity of the oscillators 21 and 22 thereby causing a plu-

rality of different frequencies and of varying intensities to be broadcast. A pen, pencil or stylus may be placed at the pivot 33 and by writing, drawing or moving the pencil or stylus over a plain surface, the variation of the oscillators is effected.

An arm 38 is also connected at one end by a pivotal connection 38a on one of the arms 31a and at the other end to the movable contact 37 of network 29 so that if the arm connected to the pencil is raised, as when the pencil is lifted from the paper, this action will cause a change in intensity of the oscillator 23. This is for the purpose of lifting the pencil or stylus of any receiver unit when no writing is desired.

A receiving unit for this system is diagrammatically illustrated in Fig. 2 having a power supply transformer 41 with a primary winding 41a, a rectifier tube 42 and radio tubes 43, 44 and 45 all receiving power from the transformer. Three identical sections are provided having different filter values but for the sake of brevity only one such section is shown. The diagram 46 represents the output tube of an ordinary radio set connected by a conductor 70 to a common terminal 47 to which two other identical sets are connected by conductors 70a and 70b. It is preferable to tap off or make a connection from the grid of output tube 46 rather than from the anode, as the output transformer usually does not have a uniform response. The average receiving set usually has a resistance coupling until the output of its final stage, and the resistance coupling having very good audio-frequency response, it is best to make a connection from this point.

Each receiving unit comprises two pairs of solenoid electro-magnets 48 and 49, 50 and 51 with connected armatures 52 and 53, 54 and 55 arranged to slide into and out of the cores of their respective magnets. Connecting and secured to each pair of armatures are gear racks 56 and 57 and engaging each rack are gears 58 and 59 respectively. Connected to the shafts of gears 58 and 59 is a system of arms 60a, 60b, 60c and 60d with loose pivots 61 connecting the arms to each other and a pencil or stylus pivotally mounted at 62, the pivot point between the two middle arms 60b and 60c. The gears 58 and 59 are rotatable, the arms 60a and 60d are secured thereto, and the gears are relatively fixed in position or spacing so that the movement of the gears by their magnets will cause a corresponding movement of the connected system of arms and consequently a movement of the stylus or pencil at 62.

A received signal is fed to the grid 45a of radio tube 45 from the grid of tube 46 by a conductor 70. Tube 45 and its companion tubes in the other sections (not shown) which are connected at points 70a and 70b serve as an amplifier and also as an isolating tube, for isolating the separate corresponding filter sections 76. The screen grid 45b of tube 45 receives voltage from a voltage divider 71 filtered by a condenser 72 through a conductor 71a. The plate 45c of the tube 45 receives voltage through resistance 73 from the rectifier tube 42 through conductors 42a and 73a. This voltage is filtered from conductor 73a by a condenser 74 to the ground.

The signal from the plate 45c of tube 45 is fed through a blocking condenser 75 to a filter unit 76. This filter unit consists of a predetermined inductance 77 connected in parallel to a predetermined capacity 78 so that the filter is resonant at only one audio-frequency, the other end of the filter is grounded. Thus when a signal resonant with this filter is received, the filter acts as a high reactance, allowing the signal to reach the grids 43a and 44a of tubes 43 and 44 through blocking condensers 79 and 80 respectively. At all other frequencies this filter acts as a short circuit, shorting the signal to the ground. The grid 43a of tube 43 has a high bias from a high resistance 81 to the ground.

With respect to the filament winding 83 of the transformer 41 the ground is negative because of a variable resister 82 by-passed by a condenser 84 which causes a voltage drop. The grid 44a of tube 44 is connected through a high resistance 85 directly to filament winding 83 of the transformer 41 by conductors 85a and 83a, therefore the grid 44a of tube 44 has no bias.

The plate 43b of tube 43 is connected by a conductor 86 to the winding of electro-magnet 49 and the plate 44b of tube 44 is connected by a conductor 87 to the winding of electro-magnet 48. A conductor 88 connected to conductor 42a supplies current from the rectifier tube 42 to the other ends of these magnet windings 48 and 49. One of the magnet windings, as 49, has a condenser 89 shunting its terminals but the electro-magnet 48 has no such capacity across it.

The action of this system is that when no signal is received by the grids of tubes 43 and 44, the magnet winding 48 has a high current flowing through it due to the grid 44a of tube 44 to which it is connected being without negative bias. The magnet winding 49 has little current flowing through it as the grid of its tube 43 has a high negative bias. With no alternating current signal tube 44 draws appreciable plate current since it has no grid bias. The plate current of tube 44 passes through resister 82, the ground terminal being common with the ground terminal of high voltage winding of transformer 41. This causes considerable negative bias on the grid of tube 43 and therefore less plate current flows in tube 43.

There is therefore a class B condition in tube 43 and with an increase in grid excitation due to the resonant alternating current signal, the plate current of that tube increases, since plate current flows during the positive peaks of the grid signal, and the condenser 89 holds up the average value. This is normal class B operation.

As the grid of tube 44 is receiving increased excitation when tube 43 does, its plate current is reduced as it is in class C operation, and an increased signal on the grid of tube 44 causes an increased grid bias due to grid current. This is normal class C operation.

However, since the plate current of tube 44 flows through the biasing resister of tube 43, the reduction in plate current of tube 44 causes a reduction in the bias on the grid of tube 43, and a consequent rise in plate current in tube 43. Thus the reaction of tube 44 through the biasing resister of tube 43 causes a reduction in the plate current of tube 43 in addition to the reduction that took place due to the increased excitation on the grid of tube 43. In other words there can be a greater change in the plate current of tube 43, with a given change in excitation, when it is working in conjunction with tube 44 than when it works alone.

Ordinarily it would not be possible for a self-biased tube to be at cut-off or below cut-off as is true in the case of tube 43. When no plate current flows in tube 43, that is, at no grid signal

condition, cut-off is obtained by the bias furnished by the voltage drop in resistor 82 due to the plate current of tube 44. If tube 44 is removed from the circuit, the bias is removed from tube 43 and the plate current, of course will rise sharply. This system is used also to operate the magnets 50 and 51 in the right hand section as well as magnets 90 and 91 to operate the throw-off arm 98, as hereafter explained, the tubes controlling these magnets being connected to the conductors 70a and 70b. Therefore it will be seen that as magnet 48 has a great amount of current flowing in it, and magnet 49 very little current in it, with the condition of no alternating current signal, armature 52 will be drawn into the magnet 48. An essential part of this invention is the manner of causing a large plate current swing of tube 43 and causing it to be at or near cut-off with no grid signal excitation.

The gear rack 56 attached to the armatures 52 and 53 will cause the gear 58 to move clockwise, forcing the pencil or stylus holding system downwardly. As a resonant signal is received, it will cause magnet winding 49 to receive more current, decreasing the current in the magnet 48 proportionately. This will cause the armature 53 to be attracted by magnet 49 causing a reverse rotation of the gear 58 and the stylus holding system to move upwardly.

It will be understood that the magnet windings 50 and 51 are connected to a circuit and operating apparatus similar to that shown in Fig. 2 by means of a conductor 70a at the point 47, the only difference being that the filter corresponding to the filter 76 has a different filter value. This action upon the gear 59 which is also attached to the pencil or stylus moving arms will give any desired movement to a pencil or stylus 62 carried thereby.

As an example the oscillator 21 of Fig. 1 may have a frequency of 400 cycles per second; the filter 76 of Fig. 2 will be arranged so that it will be resonant at 400 cycles per second; oscillator 22 may have a frequency of 2000 cycles per second, and the circuit and apparatus to which the magnets 50 and 51 are connected will have its filter resonant at 2000 cycles per second.

Similarly magnets 90 and 91 are arranged back of and at approximately ninety degrees from magnets 48, 49, 50 and 51, and an armature 92 is arranged to slide in a tube 93. To one end of the armature 92 a rod 98 is connected at right angles thereto and resting lightly against the central connected pencil or stylus supporting arms 60a and 60d at the under side thereof as indicated in Figs. 3 and 4. The throw off bar 98 presses against the lever arms 60a and 60d as shown in Figures 3 and 4, and these lever arms may be arranged so that they may move outward from the panel while still being rigidly attached to the spindles 106—107 for up and down motion. By this method the variations of signal strength from oscillator 23 of Fig. 1 may be used to control the pressure of the writing instrument on the writing surface of the receiver, thereby producing shading. The circuit energizing the magnets 90 and 91 may be identical with the energizing circuit shown in Fig. 2 and it is connected by a conductor 70c to the common point 47. This system however will be actuated by oscillator 23 of Fig. 1 having a frequency different than those of the other two sets of magnets, the filter for this system being resonant at the frequency of the oscillator 23. When the magnet 91 is energized by the system it will cause the rod 98 to press against the arms 60a and 60d respectively raising the pencil 62 from the paper when no writing is desired.

In the receiving unit as shown in Figs. 3 and 6, a panel 101 has a slot 102 through which paper 103 from a coil 104 mounted at the rear of the panel extends over the face of the panel and under rails 105 so that new paper may be pulled from the roll over the panel to be written on. The end arms 60a and 60d of the pencil or stylus supporting system are mounted upon spindles or shafts 106 and 107 projecting through the face of the panel and secured to gears 58 and 59 for operating their corresponding different magnet pairs as shown in Fig. 2.

Supported at the pivoting point 61 between the arms 60b and 60c as also shown in Figs. 10 and 11, is a pencil or stylus 108 which is adapted to bear upon the paper 103 at the face of the panel. Underlying the system of stylus supporting arms is the rod or throw-off bar 98 which extends rearwardly through openings 109 in the panel, is preferably of U-shape and the extremities are slidably mounted at the rear in brackets 110. Connecting the extremities of the bar 98 is a cross piece 111 attached centrally to an extension 112 of the armature 92 of magnets 91 and 90, the so-called throw-off magnets.

Below the bar 98 at the back of the panel are the pairs of magnets 48 and 49, 50 and 51, with their corresponding racks 56 and 57 engaged by the gears 58 and 59 mounted on the shafts 106 and 107. All of these parts are mounted at the rear of the panel upon its supporting base 113 by suitable standards and supports as shown in Figs. 6 and 7, but not specifically designated as they form no particular part of the invention.

In Fig. 8 is shown an arrangement of armatures 114 and 115 for windings, as 48 and 49, slidable in a tube 116, the armatures being connected by a rack, as 56, and in engagement with a gear 58. The armatures 92 for the magnets 90 and 91 which require no operating rack or gear may be connected as shown in Fig. 9, by a rod 117.

When a signal of definite frequency supplied by the transmitter at the sending station causes excitation of the grids of radio tubes 43 and 44, or corresponding tubes of the other circuits of the system described in connection with Fig. 2, the power of the magnet 48 decreases while the power of magnet 49 increases in proportion. When no power excites the grids of the tubes, magnet 48 will have full power, causing its armature to be drawn into the winding; with the tube grids excited, the power of the magnet 49 will increase and that of magnet 48 will decrease, drawing the armature 53 into its magnet winding 49. Thus it will be seen that as the transmitter sends signals of audio-frequency of different values and of varying intensity, the receiving unit will act in synchronism with signals causing the stylus holding lever arms of the receiving system to correspond with the position of the stylus arms of the sending station. The tube 43 does not operate as a rectifier solely, but rather as a power controller. The rise in anode current of tube 43 upon grid excitation of the tubes 43 and 44 is due in a great measure to the shift in grid bias of tube 43 caused by the decrease in anode current of tube 44. If tube 43 operated as a rectifier only, it would require a very high negative grid bias. Consequently the grid excitation voltage would have to be quite high. This would

lower the efficiency of the filter in discriminating between the voltages of the differing frequencies.

Ordinarily a tube operating as a rectifier works with a fixed grid bias. In the circuit employed in the present invention the grid bias is made variable.

By the use of the special circuit described, it is possible to obtain a very large change in anode current without excessive values of grid excitation voltages.

It is the change in anode current and not the value of the current that determines the movement of the writing instrument.

Tube **44** operates also by means of the variation of its grid bias upon grid excitation. This grid bias change is effected by grid current flowing upon grid excitation. The greater the grid excitation the greater will be the grid bias on tube **44** while with no grid excitation there will be practically no grid bias.

Tubes **43** and **44** and their companion tubes in the other circuits could best be designated as electronic relays. The action of these tubes operate so that the grids control the direct current of the anode circuit as to intensity, by the variation of grid bias. The rectification action of tube **43** plays but a small part in the anode current swing. The tube **43** acting as a rectifier alone, produces only about 25% of the anode current swing that it had when tube **44** acts in conjunction with it.

The operation of this system resembles that of a telautograph with the difference that this system may be operated by radio. A pen, pencil or stylus **121** placed at the pivot **33** of the pivoted arm system at the sending station is moved over a plane, paper, or other surface as represented by the outline **120** in Fig. 1 to write any desired message or to form any desired drawing or display, and the movement of the pencil causes a corresponding movement of the movable contact arms **35** and **36**, thereby varying the impedances **27** and **28** connected to the oscillators **21** and **22** respectively. Variation of these impedances causes a corresponding variation of alternating current frequencies from the oscillators **21**, **22** and also **23**, which as above explained, selectively operates the pairs of magnets at the receiving station or stations which reproduces the movement of the stylus supporting pivoted arm system at each receiving station, simultaneously repeating the message or reproducing the drawing or design which is broadcast from the sending station. Provision is even made for raising the pencil or stylus from the receiving drawing plane whenever the stylus at the sending station is also raised or removed from the drawing plane at the sending station.

The writing instrument controls the lever arms which in turn control the movable arms of the variable resistors **35** and **36**. It will be seen that a vertical movement of the writing instrument will not cause any change in ratio between these arms and therefore no change in ratio of the audio-frequency currents which these variable resistors control. Only a change of amplitude will result. The receiving units filtering system will discriminate between the signals of different audio-frequencies operating each set of magnets according to the amplitude of the signal to which its filter system is attuned. Therefore a vertical movement of the transmitter writing instrument will be duplicated by the writing instrument of the receiving unit. A horizontal movement of the writing instrument, however, will cause a change of ratio between the variable resistors, and hence a change in ratio of the audio-frequencies transmitted, that is, one audio-frequency will increase in amplitude and the other will decrease. This change of ratio of the two audio-frequency signals upon being received by the receiving unit will cause one set of magnets to be excited more than the other, that is, one increasing and the other decreasing. This will cause a horizontal movement of the receiving units writing instrument. Likewise any combination of vertical and horizontal movements such as a circle or an oval may be transmitted and received, depending upon the variation of ratio and change in amplitude of the two audio-frequencies.

Likewise each set of magnets operates by means of the special circuit described previously, to increase and decrease its field strength in proportion to the amplitude of the incoming signal. For example, the field strength of the magnet **49** will increase and that of magnet **48** will decrease upon application of a signal resonant to the filter to which the grids of the tubes controlling these magnets are connected.

By this method and apparatus signals, messages, and drawings of various kinds may be broadcast and received as freely as the radio sound programs. The receiving sets may be separate from or in connection with the sound producing systems and might also be an attachment for application to various radio sound systems. Although a specific radio operating circuit is shown for energizing the pairs of magnets it is obvious that various modifications and improvements may be made in the specific apparatus and in the radio control thereof without departing from the spirit and scope of the invention.

I claim:

1. In a radio autograph, a transmitting station comprising means for producing a plurality of definite audio-frequencies, said means having a constant impedance network with variable resistances therefor in connection with each audio-frequency means, a movable arm for varying each of said resistances, and a plurality of pivotally connected arms having a stylus located at one of the pivot points thereof and operative to vary the said resistances in accordance with the movement of the stylus in writing, drawing and the like.

2. In a structure in accordance with claim 1, the connected movable arms consisting of four arms pivotally connected together in series, the two end arms being connected to the variable resistances and the two inner arms having a common pivot at which the stylus is located.

3. A structure in accordance with claim 1 in which the resistance coils for each different audio-frequency means and for each network are arranged with their contacts in opposite arcs so that a contact arm movable between them is mounted on a fixed axis which is connected to the extremity of one of the said arms.

4. In a radio autograph apparatus embodying a receiving unit for converting audio-frequency into mechanical movement comprising a pair of magnets, each, receiving current varying in intensity in accordance with the audio-frequency impulses from a sending station, a stylus, means for actuating the stylus, the said means embodying connected armatures movable in the windings of the magnets and a rack and pinion mechanism actuated by the connected armatures for moving the stylus at the receiving station.

5. In a radio autograph apparatus, a plurality of audio-frequency oscillators at the sending station, a plurality of corresponding audio-frequency receivers at the receiving station, a stylus and plurality of connected arms for operating the stylus at the sending station, and means in connection with the arms for varying the intensities of the oscillators at the sending station in moving the stylus over a plane surface and also to vary one of the oscillators when the stylus is removed from the plane surface, electro-magnetic means at the receiving station controlled by the audio-frequency receivers, a stylus and a system of movable arms therefor actuated by the electro-responsive means for moving the stylus in accordance with the writing movement of the stylus at the sending station, and two of the said electro-responsive means including an armature operable by the said electro-responsive means, and a bar for engaging the stylus supporting arms at the receiving station to control its writing contact in accordance with the variations from the corresponding oscillator at the sending station.

6. In a radio autograph, a receiving station comprising a plurality of electro-responsive devices controlled by radio receiving sets attuned to definite audio-frequencies and varied by impulses of different intensities, said devices comprising magnet windings arranged in pairs and each pair comprising connected cores, a rack and pinion connected to two different pairs of cores with the pinions thereof fixed and their axes in alignment, a plurality of arms pivoted together and the end arms attached to the said pinions, a stylus attached at the pivot point between two adjacent inner arms, a contact bar attached to the connected core of other electro-responsive devices and movable thereby to raise and lower the said stylus supporting arms from and to writing position.

7. A radio autograph receiving apparatus in accordance with claim 6, comprising a panel located beneath the said arms and the lifting bar, a roll of writing material supported by the panel and extending over the panel and under the said arms, lifting bar and the stylus so that the stylus will bear upon the writing material when the stylus is not raised from the lifting bar.

8. In a radio autograph apparatus for receiving writings and drawings from a distant point by means of radio, means for converting a plurality of alternating current signals into various mechanical movements, said means comprising separate electronic relays each resonant with a particular frequency, electro-responsive devices having variable magnetic fields and connected to said electronic relays, armatures operating in the said varying magnetic fields of said electro-responsive devices, and a system of levers for mechanically attaching and operating a writing instrument by said armatures.

9. In a radio autograph apparatus, electronic relays having grids biased to decrease anode current with grid excitation, electronic relays having grids biased to increase anode current with grid excitation, each of said electronic relays having an input circuit resonant with a definite alternating current frequency, and means connecting the circuit from a common power supply and through a common bias arrangement, electro-responsive devices in the anode circuit of the electronic relays to be operated by the said anode currents, armatures operating in the magnetic fields, of the electro-responsive devices, and means connected to the armatures and actuated by the electro-responsive devices to produce movement of a writing instrument and others to remove a writing instrument from a writing surface.

10. In an apparatus of the character described, means for removing a stylus from a writing surface at a receiving station, said means embodying electronic relays having input circuits excited by a definite alternating current frequency, an output circuit including electro-responsive devices, and mechanical means attached to the armature of said electro-responsive devices arranged to move the stylus from said surface.

11. In an apparatus for receiving writing, drawings and the like, a plurality of electronic relays each embodying a grid element, each pair of electronic relays having an input circuit resonant to a definite alternating current frequency connected in a circuit through a bias arrangement common to both electronic relays, whereby grid excitation of the first pair of electronic relays operates to decrease anode current of the said first of the pair and causes an increase in anode current of the other of the pair by lessening of grid bias, caused by the decrease of anode current of the first of said electronic relays.

12. In a system for receiving writings, drawings and the like from a distant point, a plurality of alternating current receivers, each of said receivers embodying an amplifier, a filtering unit, two or more electronic relays, electro-responsive devices adapted to be attached to the anodes of the said electronic relays and to a source of current, armatures operating in the magnetic fields of the said electro-responsive devices, a writing implement, and a lever and link connection between the armatures of the electro-responsive devices and to one of which levers said implement is pivotally connected.

CLARENCE H. KEHM.