

Dec. 29, 1936.

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2,066,262

FACSIMILE RECEIVING SYSTEM

Original Filed Nov. 11, 1935 2 Sheets-Sheet 1

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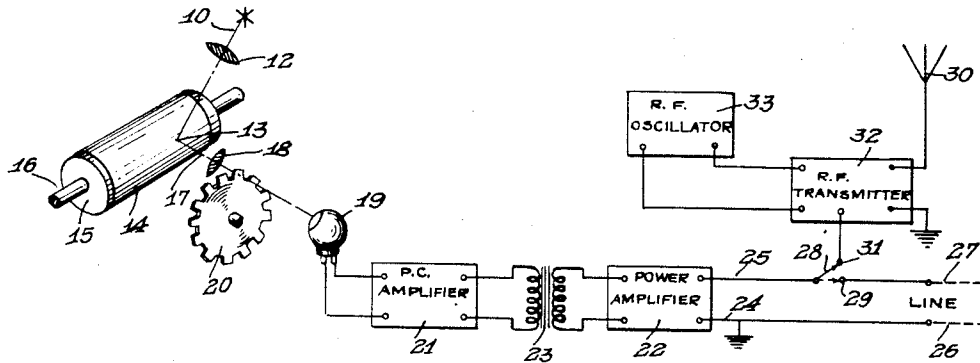


Fig. 1

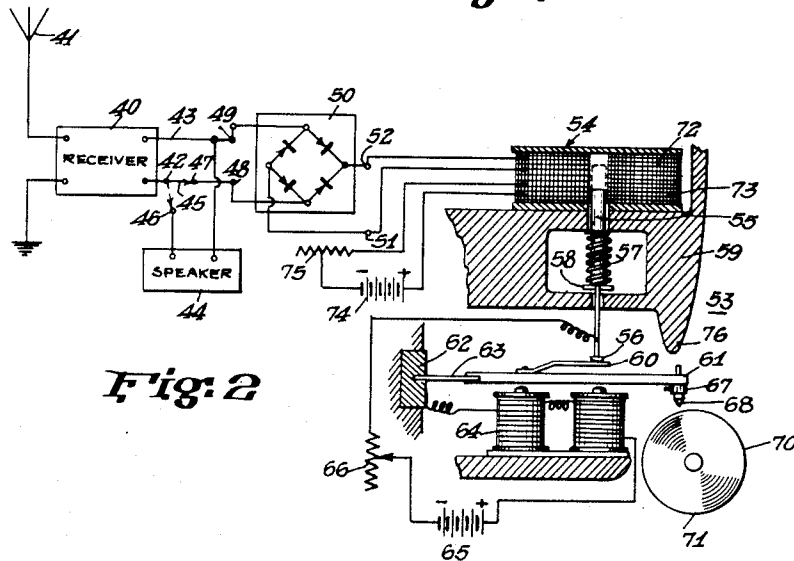


Fig. 2

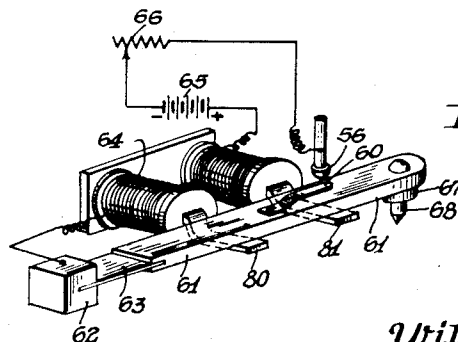


Fig: 3

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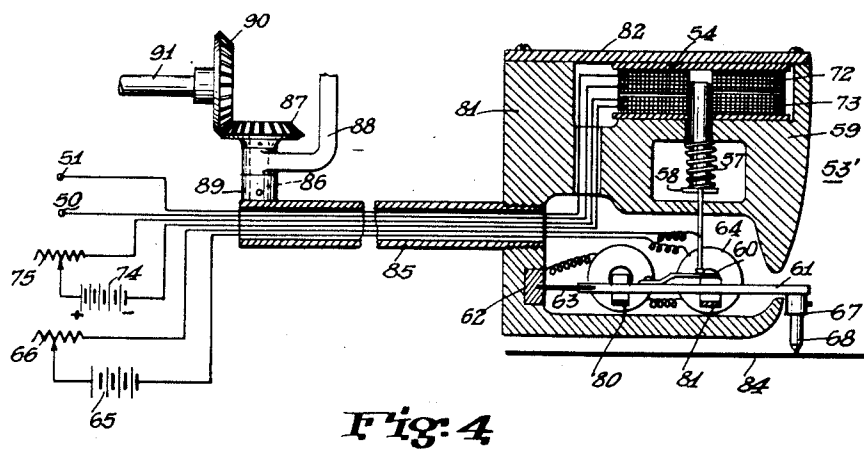
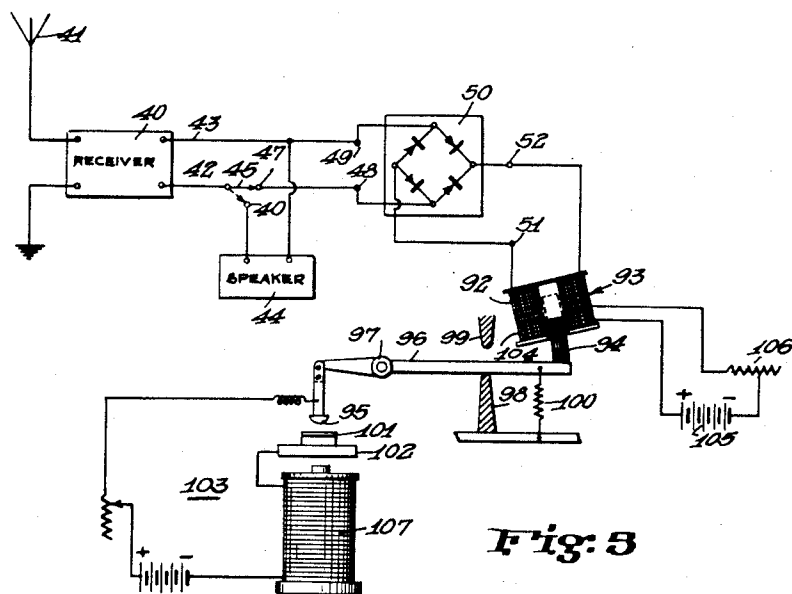
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FACSIMILE RECEIVING SYSTEM

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FACSIMILE RECEIVING SYSTEM

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Original application November 11, 1935, Serial No. 49,222, now Patent No. 2,060,778, dated November 10, 1936. Divided and this application May 2, 1936, Serial No. 77,474

11 Claims. (Cl. 178—5)

This invention relates to facsimile systems and more particularly relates to facsimile receivers utilizing local energization for picture recording controllable by the facsimile signals, and is a division of my co-pending application Serial No. 49,222, filed November 11, 1935, now Patent No. 2,060,778, granted Nov. 10, 1936.

Facsimile signals generally comprise amplitude modulated currents varying in accordance with the elemental shading of the picture being transmitted. The recording or translating picture systems heretofore have depended upon the energy of the amplified received signals to actuate the recording stylus. I contemplate local energization of the facsimile reproducer at a predetermined frequency and compose the picture by causing the received facsimile signals to reduce the normal local marking frequency in accordance with the amplitude of the signals.

The predetermined frequency of the local energization produces a plurality of adjacent discrete dot impulses corresponding to a dark picture segment. The amplitude varying facsimile signals correspondingly vary the local marking frequency, resulting in fewer discrete dots or markings per unit area corresponding to brighter picture segments. My present invention produces pictures having a half-tone effect. A further modification of my present invention resides in direct etching of a zinc plate by the facsimile recording stylus to yield a metallic picture record suitable for newspaper mat reproduction, dispensing with intermediate photographic steps.

It is accordingly an object of my present invention to provide novel facsimile reproducing means utilizing local energization for reproduction power controlled by the incoming signals for improved translation efficiency.

Another object of my invention is to provide novel facsimile reproduction means whereby half-tone reproductions are effected from otherwise normal picture transmissions.

A further object of my invention is to provide a novel facsimile reproducer for directly recording a half-tone picture on a sheet or directly etching a metallic plate.

These and other objects of my invention will become apparent in the following description taken in connection with the drawings, in which:

Figure 1 is a schematic illustration of a commonly used "chopper" amplitude modulated facsimile signal system.

Figure 2 is a preferred modification of an electromechanical facsimile reproducing system utilizing local signal energization.

Figure 3 schematically illustrates a modification of the reproducing unit of Figure 2.

Figure 4 is a sectional elevation of a preferred embodiment of an assembled reproducing unit illustrated in Figure 3.

Figure 5 is another modification of a facsimile reproducing system.

Referring to Figure 1, a beam of light 10 generated by light source 11 is focused by lens system 12 to a point 13 on a picture record 14 secured to the drum 15 rotated in a predetermined manner by shaft 16. The picture 14 is also moved axially so that the light point 13 will in turn continuously scan the picture. The refracted light beam 17 is focused by lens system 18 to photo-electric cell 19. A chopper wheel 20 is interposed between the light beam 17 and photo-cell 19 in order to break up otherwise slowly varying picture currents to produce a predetermined audio carrier frequency so that an ordinary instead of direct current photo-cell amplifier 21 connected to the output of photo-cell 19 may be employed.

The output of photo-cell amplifier 21 is coupled to a power amplifier 22 by coupling transformer 23. The output 24—25 of audio amplifier 22 represents the facsimile signals to be transmitted either over wire line 26—27 when switch 28 is closed on contact 29; or radiated by antenna 30 when switch 28 is closed on contact 31 connecting audio amplifier 22 to the radio frequency transmitter 32 modulating the carrier wave generated by the radio frequency oscillator 33 in a manner well known in the art.

When transmission of the facsimile signal is by radio frequency carrier wave, a corresponding radio receiver 40 is utilized in conjunction with receiver antenna 41. If the radio frequency oscillator 33 generates a carrier wave in the ordinary radio broadcast band, an ordinary broadcast receiver 40 may be used. The output 42—43 of receiver 40 is normally connected to a loud speaker unit 44 when the switch 45 is closed on contact 46. However, for facsimile reproduction according to my system, it is only necessary to turn the switch 45 on contact 47 to introduce the facsimile signals to the input 48—49 of rectifier unit 50.

The rectifier unit 50 is represented as a copper-oxide unit connected in a well known manner to convert the alternating current signals due to the chopper action of wheel 20, or other audio carrier means, to the original pulsating signals of the picture 14 at the output 51—52 thereof. Rectifier 50 although illustrated as a copper-oxide rectifier may be of the electronic type but

a copper-oxide unit is preferable for simplicity and ruggedness.

The output 51—52 of the rectifier unit 50 is connected to the electromechanical reproducing unit 53. The principle of the action of the reproducer 53 is described in the parent application above referred to where it is utilized to electromechanically translate amplitude modulated signals to corresponding frequency modulated signals before transmission at the transmitting station.

Reproducer unit 53 comprises a solenoid section 54 which controls the movement of a plunger 55 containing a contact point 56 at one end. Plunger 55 is mechanically biased downwardly by spring 57 pressing against a transverse pin 58 set in plunger 55. Plunger 55 is preferably of laminated, soft iron construction. The spring 57 and pin 58 are enclosed in a recess within insulation frame member 59.

Contact 56 coacts with contact spring 60 attached to the armature 61. Armature 61 is compliantly attached to metallic post 62 by a leaf spring 63. An electromagnet 64 is connected in the local series circuit comprising battery 65, rheostat 66, contact point 56, contact spring 60, armature 61, leaf spring 63 and metallic post 62. This local electromechanical circuit functions in a manner similar to a buzzer and operates at its predetermined highest frequency when no signal passes through the electromagnet 54 from rectifier 50.

Retainer 67 holding a stylus 68 is mounted at the end of armature 61. A record sheet 70 upon which the picture is to be reproduced is mounted upon drum 71 which is rotated in phase synchronism with the transmitter drum 15. The synchronizing circuits for maintaining drums 15 and 71 in synchronism are not illustrated since they form no part of the present invention.

Solenoid 54 comprises two coil sections 72 and 73. Coil 72 is connected to the output 51—52 of rectifier 50 and is actuated by amplitude modulated picture currents. A direct current from battery 74 is passed through coil 73 through rheostat 75 in order to locally adjust the predetermined frequency of vibration of armature 61 with no facsimile signal input. The frequency of vibration of armature 61 depends upon the position of contact 56, the mass of armature 61 and the compliance of leaf spring 63 as is known to those skilled in the art. This frequency of vibration may for example be made three thousand cycles.

A black picture signal corresponds to a minimum facsimile signal intensity and the upper frequency of vibration of armature 61. Record sheet 70 will be impressed by a succession of discrete dots or markings relatively closely spaced at the high frequency of vibration of armatures 61 so that a dark or black picture section will result thereon.

During a white picture signal, a facsimile current of maximum intensity will be impressed upon coil 72 attracting plunger 55 higher, to for example the dotted position shown in Figure 2, and against the action of biasing spring 57, correspondingly raising the position of contact point 56. The frequency of vibration of armature 61 will accordingly be reduced since a greater excursion must be effected by it for successive contacting of point 56 and contact spring 60. A projection 76 of frame 59 limits the upper excursion of armature 61. If plunger 55 is sufficiently attracted away from armature 61, the vibration of armature 61 will accordingly cease during the

interval of such attraction and no marking impulses will occur on record sheet 70. A "white" facsimile signal will accordingly correspond to an unaffected or white reproduction area. It is to be understood that a white facsimile signal may be made to correspond to a frequency of 200 cycles so as to maintain a continuous vibration of armature 61.

Intermediate shading of the picture transmitted will result in facsimile signals of intermediate intensity between the maximum and minimum signals. Intermediate intensity facsimile signals will attract plunger 55 into solenoid 54 in correspondingly varying degrees. The mean position of contact 56 mechanically connected to plunger 55 is accordingly determined by the relative intensity of the received facsimile signals. The frequency of vibration of armature 61 will be correspondingly varied from maximum, for example 3000 cycles to the minimum for example, 200 cycles and vibration at any intermediate frequency corresponding to the position of contact 56 which in turn corresponds to the relative intensity of the received signals. Since the record sheet 70 is continually moved past stylus 68 the markings of stylus 68 upon the sheet will be of a frequency equal to the vibration frequency of armature 61. A higher frequency will result in more closely spaced markings or dots to represent a darker picture area. A lower frequency of vibration will result in fewer dots being recorded per unit area corresponding to a brighter picture segment. The intermediate picture shadings will be determined by the corresponding varying frequency of the armature 61.

Stylus 68 may be a metallic engraving or etching tool for directly engraving a metallic plate such as zinc to produce a half-tone replica of a normal transmitted picture, dispensing with intermediate photographic steps. Such direct half-tone composition is particularly useful in a newspaper plant where half-tone pictures must be etched into a zinc plate for production of printing platens thereof. Although I have illustrated record sheets 70 as mounted on a drum, it will be evident to those skilled in the art that the recording surface may be arranged as a plane to facilitate direct engraving.

The major portion of the energization for effecting the facsimile markings is locally generated by the vibrator unit 53 in conjunction with the source of energy 65. The picture signals are used to determine the position of a plunger 55 to correspondingly determine the mean position of contact 56. A relatively high efficiency of translation is accomplished by the reproducer unit of my present invention. A simple, efficient, rugged and light facsimile recording unit herein disclosed together with the rugged rectifier unit 50 may be attached to the output of an ordinary radio receiver to record transmitted pictures. The important use for such a facsimile unit lies in aircraft work where space and weight and simplicity are important features.

The electromagnet 64 may very well be positioned at one side of the vibrating armature 61 instead of beneath it, to permit the armature to be mounted nearer to the sheet being marked. I have accordingly shown a modification of the electromechanical system of unit 53 in Figure 3 where the electromagnet 64 is placed at one side of the armature 61 and the poles 80 of the electromagnet are extended underneath the armature 61. The poles 80 may be bent as illustrated so 75

that the centers of the coils 126 are above the level of the poles 80.

Figure 4 is a sectional view through a preferred embodiment of the reproducing unit employing the principle schematically shown in Figure 3. A housing 81 encloses the reproducing unit 53' and is integrally built up with frame member 59. The frame member 59 has a recess enclosing the spring 57 and the transverse pin 58 similar to Figure 5. The solenoid 54 is mounted between the member 59 and the cover plate 82. The metal post 62 is set in the housing and supports the vibrating armature. The poles 80 of the electromagnet are shown set in the bottom of the structure. The coils 64 of the electromagnet are shown with their centers above the poles 80 so that a minimum distance is obtained between the bottom 83 of the reproducing unit 53' and the vibrating armature 61. The retainer 67 and stylus 68 project from the end of the armature 61. A sheet 84 is fed underneath the marking stylus 68 in any well known manner. The sheet 84 may be mounted on a drum or fed continuously from a roll at a predetermined rate in synchronism with the transmitter in a manner well known in the art.

A hollow shaft 85 is affixed to the reproducing unit as illustrated in Figure 4. The leads connecting to the solenoid 54, the contact point 56 and the electromagnet 64 are passed through the tubular shaft 85 to form connections to the corresponding part of the receiving circuit of Figure 2. The reproducing unit 53' is caused to traverse over the surface of the sheet 84 in synchronism with the scanning beam on the transmitted picture. The shaft 85 is fastened to a shaft 86 on which is mounted the bevelled gear 87. A bracket 88 and sleeve 89 rotatably support the gear 87. A coacting bevelled gear 90 transmits the rotative drive power from shaft 91 to rotate the reproducing system 53'. The recording unit 53' is caused to travel over record sheet 84 at a speed and phase relationship identical as compared to the transmitted picture in order to properly compose the facsimile reproduction from the signals.

A further embodiment in the application of my invention is illustrated in the receiver of Figure 5. The facsimile signals from the receiver 40 (similar to that of Figure 2) which are further rectified by the copper-oxide rectifier 50 are connected to the solenoid coil 92. The solenoid 93 of this embodiment is used to transmit the effect of its attraction on the plunger 94 to the contact point 95 by means of a lever 96 which is pivotally supported at 97. The movement or excursion of the contact point 95 is generally small for the vibrating electromechanical system. By suitable lever arrangement, the movement or excursion of the plunger 94 may be made several times that of the contact point 95.

The lever system 96 produces a mechanical advantage so that a positive control of the contact point 95 is had over the small excursions of the contact 95 by relatively greater excursions of the plunger 94. It may be advantageous to make the plunger slightly arcuate at the solenoid 93 as illustrated in Figure 5.

Suitable mechanical stops 98 and 99 are arranged on either side of the vibrating lever 102. A spring 100 is used to mechanically bias the contact point 95 away from the contact spring 101 vibrating armature 102 shown in an end view. Coil 104 of solenoid 93 is connected to a direct current source 105 through rheostat 106 to mag-

netically effect the normal position of plunger 94. The polarity of the biasing magnetic field from coil 104 may be to attract plunger 94 up into solenoid 93 so that contact point 95 will have its lowest position with respect to electromagnet 107.

The polarity of the rectified facsimile signals at 51-52 is applied to coil 92 of solenoid 93 to buck the magnetic field of coil 104 permitting spring 100 to bring plunger 94 to a lower position in proportion to the facsimile signal strength. A "white" facsimile signal will buck the steady magnetic field of coil 104 to permit spring 100 to draw lever 96 against stop 98 whereby contact point 95 is in its extreme position. Armature 102 will accordingly vibrate at its lowest frequency during a "white" picture signal.

The local electromechanical vibratory circuit 103 is similar to that of Figure 2. The relative masses and compliances of the components of this vibratory mechanical system are designed so that no mechanical resonances occur in the operating frequency range and the relative mechanical impedances of the co-acting mechanical parts are matched for optimum translation efficiency. The modification shown in Figure 5 utilizes the mechanical advantage of a lever system to obtain a larger amplitude of plunger movement as compared to the corresponding amplitude of movement of the frequency varying contact point. The specific design of the lever system schematically illustrated at 96 may be varied for particular requirements.

The polarity of the rectified facsimile signals occurring at points 51-52 is connected to the solenoid of the electromechanical translating units of my present invention in a predetermined manner in order to derive "positive" or "negative" reproductions of the transmitted picture. The above modifications were described to produce positive reproductions, but by merely reversing the polarity of the facsimile signal connections to the corresponding solenoid coil, a reversed or negative picture will be made. A simple reversing switch connected in the signal circuit preferably at terminals 51-52 may be used for alternatively making a positive or negative facsimile.

I claim:

1. A facsimile recording system responsive to amplitude modulated picture signals comprising an electromechanical unit including an armature, means for normally vibrating said armature at a predetermined frequency, a stylus connected to said armature, and means associated with said armature, responsive to said signals for mechanically changing the frequency of vibration of said stylus in accordance with variations in the amplitude of said signals to impress said stylus against a record sheet in accordance with said vibrations.

2. A facsimile recording system responsive to amplitude modulated picture signals comprising means for rectifying said signals into corresponding unidirectional currents; and an electromechanical unit comprising an armature, means for normally vibrating said armature at a predetermined frequency, a stylus connected to said armature, and means associated with said armature responsive to said currents for mechanically changing the frequency of vibration of said stylus in accordance with variations in the amplitude of said currents to impress said stylus against a record sheet in accordance with said vibrations.

3. A facsimile recording system responsive to amplitude modulated picture signals comprising

means for rectifying said signals into corresponding unidirectional currents, and an electromechanical unit comprising an armature, a stylus connected to said armature, and means associated with said armature, responsive to said currents for mechanically changing the frequency of vibration of said stylus in accordance with variations in the amplitude of said currents including a solenoid having a coil electrically connected to said currents and a variably positioned contact member controlled by said solenoid for regulating the frequency of vibration of said armature to impress said stylus against a record sheet in accordance with said vibrations.

4. A facsimile recording system responsive to amplitude modulated picture signals comprising an electromechanical recording unit comprising an armature, means for normally vibrating said armature at a predetermined frequency, a stylus connected to said armature, and means associated with said armature, responsive to said signals for mechanically changing the frequency of vibration of said stylus in accordance with variations in the amplitude of said signals including a solenoid having a coil electrically connected to said signals and a variably positioned contact member for regulating the frequency of vibration of said armature to impress said stylus against a record sheet in accordance with said vibrations.

5. A facsimile recording system responsive to amplitude modulated picture signals comprising means for rectifying said signals into corresponding unidirectional currents; and an electromechanical unit comprising an armature, means for normally vibrating said armature at a predetermined frequency, a stylus connected to said armature and means associated with said armature, responsive to said currents for mechanically changing the frequency of vibration of said stylus in accordance with variations in the amplitude of said currents including a solenoid having a coil electrically connected to said currents, a variably positioned contact member controlled by said solenoid for regulating the frequency of vibration of said armature to impress said stylus against a record sheet in accordance with said vibrations, a second coil on said solenoid, and a source of direct current connected to said second coil for controlling the normal vibration frequency of the armature.

6. A facsimile recording system responsive to amplitude modulated picture signals comprising means for rectifying said signals into corresponding unidirectional currents; and an electromechanical unit comprising an armature, a stylus connected to said armature, and means associated with said armature, responsive to said currents for mechanically changing the frequency of vibration of said stylus in accordance with variations in the amplitude of said currents including a solenoid having a coil electrically connected to said currents, a variably positioned contact member controlled by said solenoid for regulating the frequency of vibration of said armature, a second coil on said solenoid, a source of direct current connected to said second coil for controlling the normal vibration frequency

of the armature, and an electromagnet having pole means cooperative with said armature, said contact member and said armature being circuitally connected with said electromagnet, said pole means extending transversely of said armature.

7. A facsimile recording system responsive to amplitude modulated picture signals comprising an electromechanical recording unit comprising an armature, a stylus connected to said armature, and means associated with said armature, responsive to said signals for mechanically changing the frequency of vibration of said stylus in accordance with variations in the amplitude of said signals including a solenoid having a coil electrically connected to said signals, a variably positioned contact member for regulating the frequency of vibration of said armature, a second coil on said solenoid, a source of direct current connected to said second coil for controlling the normal vibration frequency of the armature, an electromagnet having pole means cooperative with said armature, said contact member and said armature being circuitally connected with said electromagnet, said pole means extending transversely of said armature, a plunger for said solenoid, and lever means connecting said plunger and said contact member.

8. A facsimile recording system responsive to amplitude modulated picture signals comprising an electromechanical recording unit comprising an armature, means for normally vibrating said armature at a predetermined frequency, a stylus connected to said armature, and means associated with said armature, responsive to said signals for mechanically changing the frequency of vibration of said stylus in accordance with variations in the amplitude of said signals including a solenoid having a coil electrically connected to said signals, a variably positioned contact member for regulating the frequency of vibration of said armature, a plunger for said solenoid, and lever means connecting said plunger and said contact member.

9. An electromechanical recording unit comprising an armature; means for normally vibrating said armature at a predetermined frequency, a stylus connected to said armature; and means associated with said armature, responsive to signals for mechanically changing the frequency of vibration of said stylus in accordance with variations in the amplitude of said signals.

10. The method of facsimile recording which comprises receiving transmitted amplitude modulated alternating current picture signals; rectifying the signals into corresponding unidirectional currents; and electromechanically translating the currents into marking impulses of frequency varying in accordance with the amplitude of the currents.

11. The method of facsimile recording which comprises receiving transmitted amplitude modulated picture signals; and electromechanically translating the picture signals into marking impulses of frequency varying in accordance with the amplitude of the picture signals.

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