May 29, 1945. R. J. WISE 2,376,888

FACSIMILE RECORDING SYSTEM AND APPARATUS

Filed Nov. 27, 1941 2 Sheets-Sheet 1

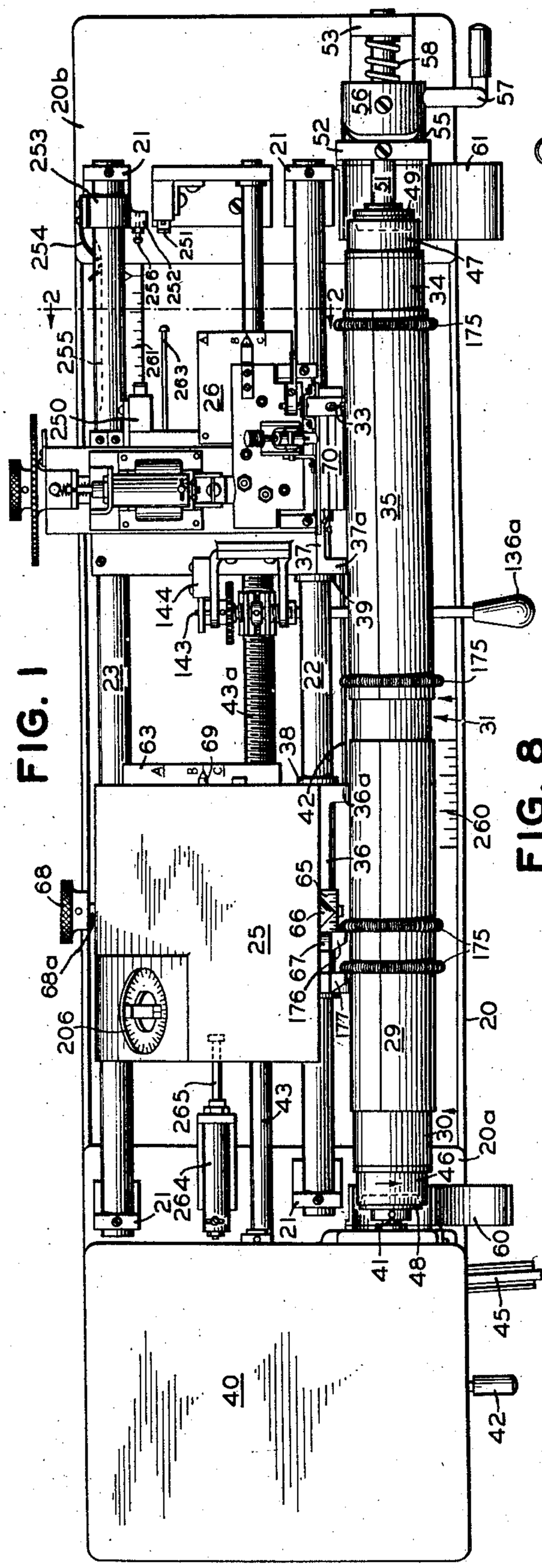

FIG. 1

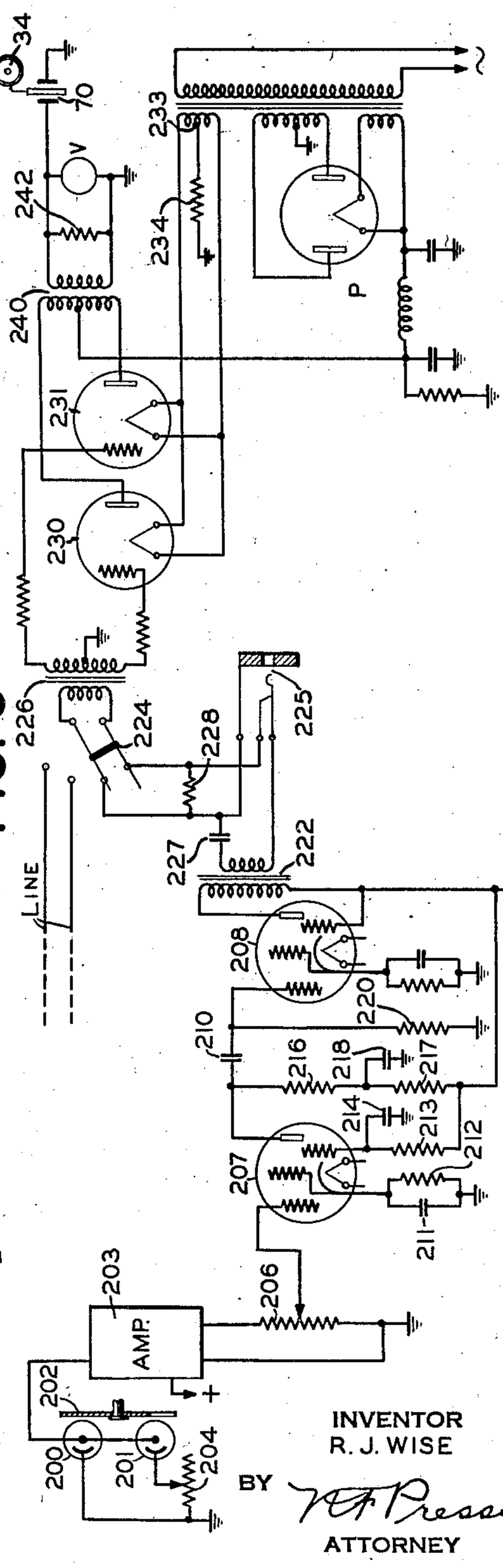

FIG. 8

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FACSIMILE RECORDING SYSTEM AND APPARATUS

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FIG. 2

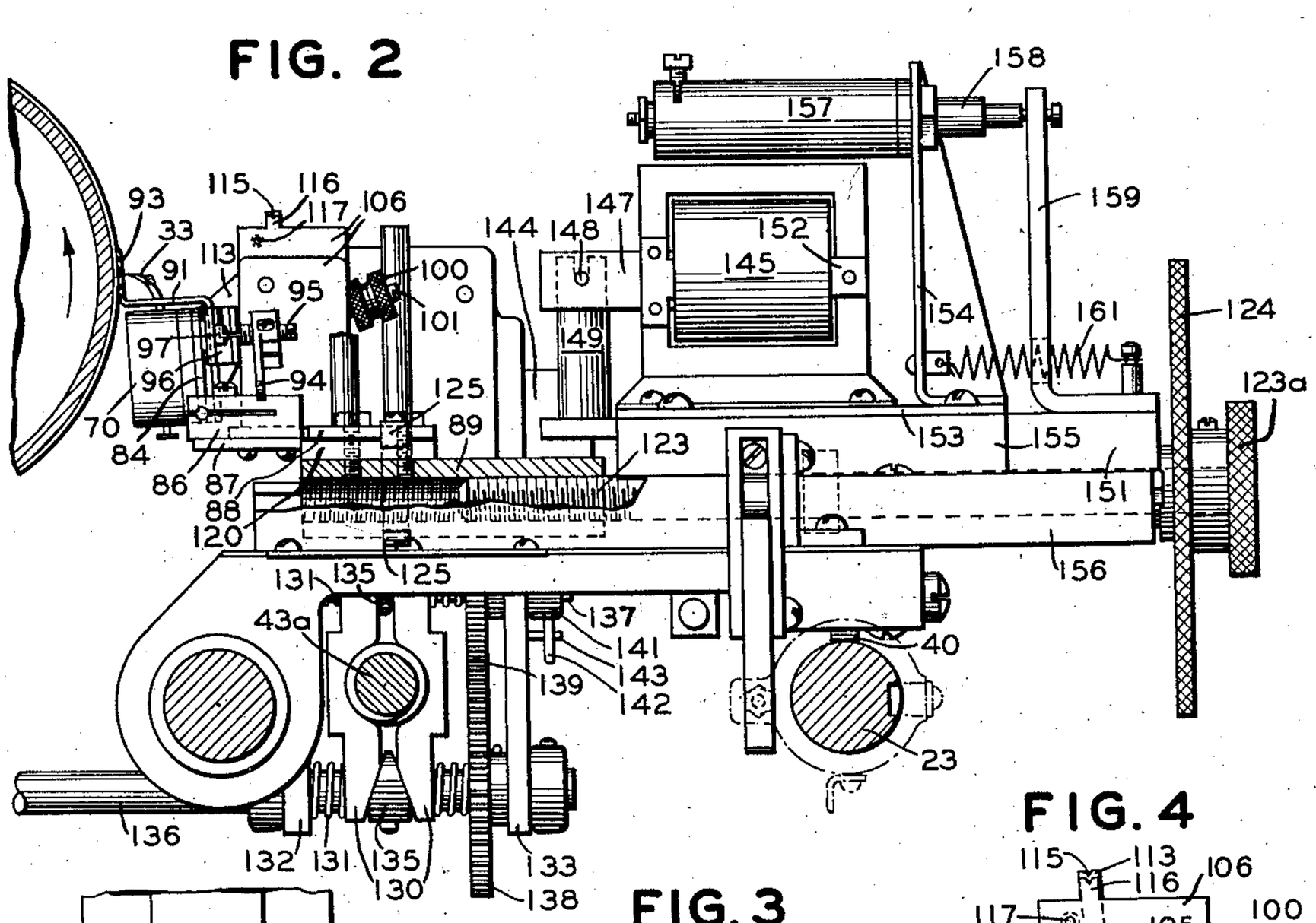

FIG. 3

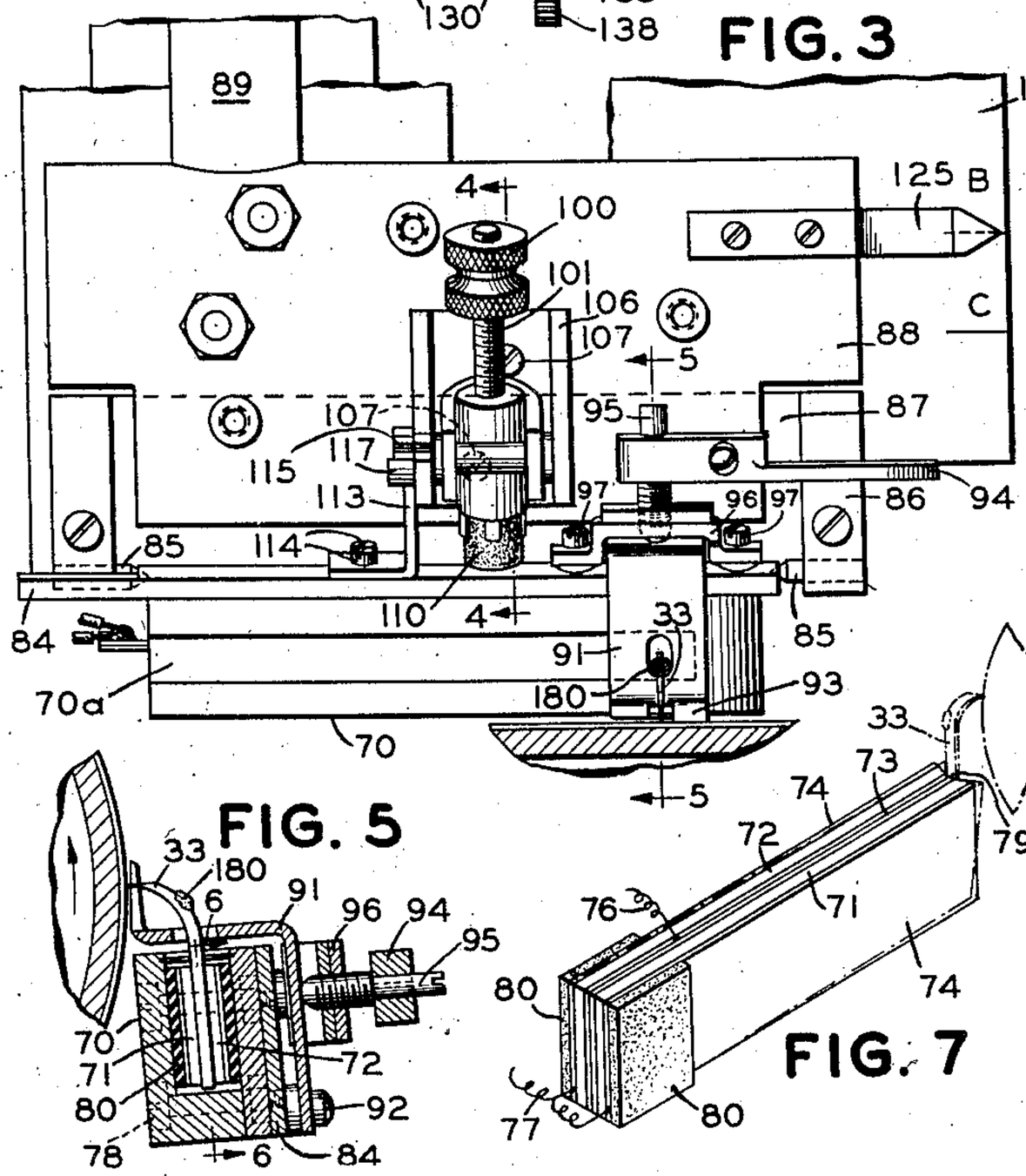

FIG. 4

FIG. 6

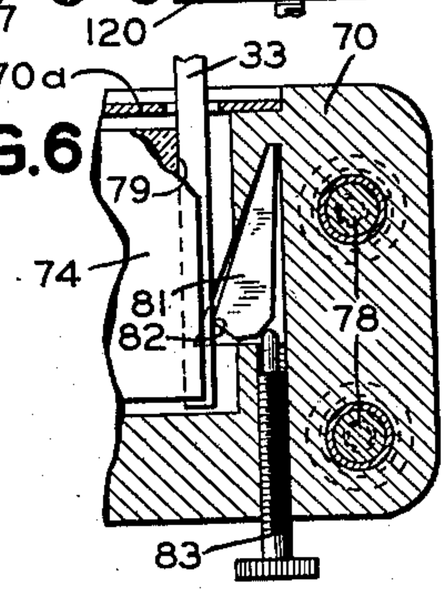

FIG. 5

FIG. 7

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FACSIMILE RECORDING SYSTEM AND APPARATUS

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Application November 27, 1941, Serial No. 420,610

14 Claims. (Cl. 234—1.5)

This invention relates to an improved system and apparatus for reproducing facsimile copies of pictures, drawings, writing and other subject matter, and is particularly adapted, although not limited thereto, to the production of a master copy of an original, from which numerous other copies may be made by the mimeograph, hectograph, and other printing processes.

In accordance with the present invention a picture, message, drawing or other subject matter is transmitted by facsimile signals generated in accordance with the subject matter appearing on an original sheet or blank, and is reproduced in facsimile upon a recording blank which may, if desired, comprise a stencil or other master blank from which a large number of copies may be made by various known printing or other duplicating processes. The recording blanks are carried by copyholders, such as rotatable cylinders or drums, that are scanned by the recording apparatus during the reproducing operation, and these copyholders may be interchangeable in the apparatus so that they can readily be placed into operative position in the recording apparatus and can readily be removed therefrom, either manually or automatically. The recording operation is effected by means of a suitably actuated recording stylus of the percussion type, i. e., one which intermittently contacts the recording sheet in accordance with the transmitted subject matter, thereby to change or affect the surface of the recording sheet to record thereon in facsimile the transmitted subject matter.

In recorders of the character heretofore employed for producing facsimile stencils and the like, the percussion recording stylus was actuated by an electromagnetic device which responded only to the direct current components of the signaling currents or to direct current impulses produced in accordance with the received signals. Such devices, however, are undesirably limited with respect to the recording speeds at which they may satisfactorily be operated. In commercial operation it was found that, with a recording drum having a circumference, for example, of the order of eight and one-half inches, the speed of rotation of such a drum necessarily was limited by the recording speed of the percussion unit, and could not well be increased in excess of approximately 90 R. P. M., which meant a linear scanning speed of approximately 765 inches per minute, whereas it is desirable to use speeds commensurable with those obtainable by electrosensitive recording blanks, for example, drum speeds of the order of 180 R. P. M., and thus obtain a linear scanning speed of approximately 1530 inches per minute. Moreover, with the prior devices it was necessary to maintain an undesirably high power value of the carrier current or other signaling currents employed for actuating the recording stylus, and the amplitude of the stylus swing and the frequency response characteristic of the unit were not uniform when producing stencils.

One of the objects of the present invention is the provision of facsimile percussion recording apparatus which operates satisfactorily at a rate such that the linear scanning speed at which the recording is effected may be greatly increased, and thus appreciably reduce the time required for producing a stencil or otherwise recording a given piece of subject matter. In the case of commercial telegraph circuits employed for transmitting facsimile messages from one city or point to another, it will be appreciated that any resultant saving in line time is of highest importance, and appreciably reduces the cost of such service. In accordance with the instant invention a percussion stylus is actuated by a piezo-electric device which is so constructed and operated that the linear scanning speed of the recording drum may be increased to speeds as high or higher than twice the linear scanning speed heretofore obtainable with prior percussion type devices, and thus substantially cut the necessary transmission time in half or less. Also, where a combined transmitter and recorder apparatus is employed in an office for producing stencils and the like, the time required for producing them may be approximately cut in half or less.

Another object of the invention is percussion recording apparatus of the character disclosed in which highly satisfactory recording is obtainable with much lower levels of the signal carrier current than heretofore and in which a signal modulated alternating current, which may be a frequency modulated carrier current, may be directly impressed upon the stylus-actuating device.

A further object is a recording unit in which the recording point of the percussion stylus may be made exceedingly small without penetrating the surface of a stencil sheet beyond a desired extent, and in which the stylus may be actuated at much higher frequencies against the surface of the stencil sheet or recording blank, whereby sharper and improved definition of the recorded subject matter may be obtained.

A further object is a percussion type facsimile recording apparatus which may be operated at greatly increased speeds of recording without any

tendency of the percussion stylus to drag upon or tear or otherwise adversely affect the stencil or other record being produced.

Still another object is a percussion recording unit which is simpler in construction and more easily adjusted with respect to the record blank upon which it operates, and in which greater stability of adjustment of the recording unit and greater uniformity in results are obtained.

A still further object is a recording unit in which less precision is required in the manufacture of the recording drums employed, and in which less attention need be paid to uniformity of thickness of the recording stencils or blanks and in which irregularities in the recording blank surfaces are less likely to deleteriously affect the record.

An additional object is to provide a percussion type facsimile recording unit which causes the darker areas of the recorded subject matter to be reproduced with greater clarity and detail.

The foregoing and other objects and advantages of the invention will appear from the following description of the illustrative embodiments of the invention, taken in connection with the accompanying drawings, in which:

Fig. 1 is a view of a combined transmitter and recording apparatus in which the recording apparatus is constructed in accordance with the present invention;

Fig. 2 is a view, in elevation, of the recording apparatus, taken along the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary top plan view of the recording unit employed, illustrating certain details of the stylus driving unit and the manner of mounting the same;

Fig. 4 is a detail in elevation taken along the line 4—4 of Fig. 3;

Fig. 5 is a detail taken along the line 5—5 of Fig. 3;

Fig. 6 is a detail taken along the line 6—6 of Fig. 5;

Fig. 7 is a perspective view of the piezo-electric stylus driving unit removed from its casing; and

Fig. 8 illustrates diagrammatically a circuit arrangement may be employed with the transmitter and recorder apparatus of Fig. 1.

Referring to the drawings, and particularly to Fig. 1 thereof, a base 20 forms the principal support for the apparatus and the driving and control mechanism therefor, which base is adapted to rest upon an apparatus table or cabinet or other convenient support, and a cabinet preferably being employed so that certain of the power unit and amplifier devices used may be embodied therein.

Secured to plates 20*a* and 20*b* on the base 20 are brackets 21 in which are mounted a front track or guide rail 22 and a rear track or guide rail 23 which slidably support the longitudinally movable transmitting scanning assembly 25 and the recording scanning assembly 26. Preferably, the transmitting scanning unit 25 comprises an optical pickup system for deriving facsimile signals from an original blank 29 which carries the subject matter to be reproduced or duplicated, the blank being secured upon a cylindrical drum portion 30 of a copyholder which is indicated in its entirety by the reference numeral 31. The copyholder 31 includes a cylindrical drum portion 34 adapted to support a recording blank or stencil blank 35 which is acted upon by the percussion stylus 33 of the recording unit 26.

In general, any suitable means for scanning the transmitting and recording blanks may be employed, for example, as disclosed in the d'Humy et al. Patent No. 2,301,024, issued November 3, 1942, or in the O'Brien and Estes Patent No. 2,260,862, issued Oct. 28, 1941. Also, any suitable type of transmitter may be employed for generating the facsimile signals supplied to the recording unit, such for example as illustrated in Patent No. 2,158,391, issued May 16, 1939, and Patent No. 2,176,442, issued October 17, 1939.

The transmitting scanning assembly 25 and the recording unit 26 are respectively mounted on traveling bases or carriage members 36 and 37, which latter members are each provided with guide blocks 38 and 39 slidably mounted on a front guide rail 22. The carriage members have rollers 40, one of which is shown in Fig. 2, that cooperate with the guide rail 23 to facilitate travel of the units 25 and 26 along the guide rails. The carriage member 37 of the recording unit is connected to the carriage member 36 of the transmitting unit, as by a carriage link 42 firmly secured to portions 36*a* and 37*a* of these units, so that any movement of the recording unit 26 longitudinally along the guide rods 22 and 23 will impart a similar movement to the transmitting unit 25, and vice versa. The various mechanical details for thus interconnecting the transmitting and recording units so as to cause them to operate in synchronism with respect to the line feeds thereof are disclosed in detail in my said copending application, and for the sake of brevity certain of these details are not illustrated in the drawings herein.

Power for operating the apparatus is supplied by a motor contained within a casing 40, the motor preferably being of the synchronous alternating current type, although if desired may be of the direct current type, it being understood that the speed of the motor for any given operation may be adjusted and maintained constant by any of the various suitable means known in the art for this purpose. The power is applied by the motor through the medium of reducing gear mechanism in known manner, which gear mechanism is also contained within the casing 40, the motor and gear mechanism causing rotation of the driven shaft 41 which rotates the transmitting and recording drums 30 and 34 in the direction indicated by the arrow on drum 30 during the scanning operations. The gear mechanism also drives a line feed shaft 43 which has a threaded portion 43*a* that directly drives the recording unit 26, and through the medium of the carriage link 42 also drives the transmitting unit 25 to cause line feed scanning movement of the units with respect to the transmitting and recording drums 30 and 34.

Preferably, and as disclosed in my aforesaid copending application, the apparatus is arranged to accommodate transmitting and recording drums of different diameters in order to accommodate transmitting and recording blanks of different sizes, and for this reason the gear mechanism within the casing 40 is adapted to be shifted, as by the gear shift lever 42, in order to provide different driving speeds to the drums and therefore change at will the peripheral speed of rotation of the drums 30 and 34. With the drum speed shift arrangement the linear scanning speed for the drums 30 and 34 may be changed if desired, or when drums of different diameters are used in place of the drums shown the number of revolutions per minute of the drums may be either reduced or increased to an extent such that the peripheral speed of rotation and hence

the linear scanning speed will remain approximately the same irrespective of the size of drums employed. Also, the driving ratio of the gears which cause rotation of the line feed shaft 43 may be changed, as by a shift lever 45, so that the speed of rotation of the feed screw and hence the number of scanning lines per inch may be varied. For example, when the shift lever 45 is in its right hand position, as shown in Fig. 1, the gear ratio may be such that the transmitting and recording units scan at the rate of 100 lines per inch, and if the lever 45 is shifted to the left the gear ratio may be such that the number of scanning lines may be increased to 120 lines per inch, the arrangement enabling the number of scanning lines per inch to be made such as to give the most desirable results depending upon the subject matter and the kind of service for which it is used.

If desired, and as described in detail in my aforesaid copending application, two line feed shaft members similar to the member 43, and which may be caused to operate at different speeds respectively, may be employed, one of which shafts produces the line feed scanning movement of the transmitter unit and the other of which produces the line feed scanning movement of the recorder unit, whereby when transmitting and recording drums of different diameters respectively are concurrently employed, the reproduced record may be enlarged or reduced with respect to the subject matter on the transmitting blank without causing distortion of the recorded subject matter. The foregoing various features of variable speed of the transmitting and recording cylinders and their respective line feed scanning means comprise subject matter claimed in my aforesaid copending application, and for the sake of simplicity such arrangements are not disclosed herein in detail.

The cylinder 31 has reduced ends 46 and 47 formed with internal tapered surfaces which receive complementary bearing members 48 and 49. The bearing member 48 is secured to and driven by the shaft 41 hereinbefore referred to, and serves to drive the cylinder 31. The member 49 is secured to a shaft 51 journaled in fixed upright bearing members 52 and 53 so as to be freely rotatable and also slidably movable longitudinally within the bearings to permit entry and withdrawal of the member 49 from the recessed portion of the end 47 of the cylinder 31, and thereby permit ready insertion and removal of the cylinder 31 and drums 30 and 34.

To facilitate the insertion and withdrawal of the member 49, preferably there is provided a tapered cam member 55 fixedly secured to the bearing support 52, and coacting with this cam member is a second tapered cam member 56 which is secured, as by a set screw, to the shaft 51. Secured to the cam member 56 is a handle 57, and when the handle is raised upwardly as viewed in Fig. 1, this causes rotation of the cam 56 relative to the fixed cam 55, the adjacent tapered camming surfaces of these members coacting to cause the member 56 to be shifted to the right as viewed in the figure and thereby cause longitudinal movement of the shaft 51 and withdrawal of the bearing member 49 from the recessed end 47 of the cylinder 31, after which the cylinder may be slid to the right a distance sufficient to release the opposite end 46 from its associated drive member 48. A compression spring 58 which loosely surrounds the outer end of the shaft 51, causes the member 56 to return to the working position when the handle is turned downwardly, the spring also causing the bearing member 49 to enter the end 47 of the cylinder thereby to insure that the cylinder is properly supported during rotation thereof and to maintain a proper driving connection between the members 46 and 48. Instead of employing a cylinder 31 having the transmitting and recording drums formed or mounted thereon, separate transmitting and recording drums may be employed and maintained in proper driving relation in the manner disclosed in my aforesaid copending application.

Fixed bracket members 60 and 61 are provided, each of the bracket members comprising two arcuate supports or saddles, the inner pair of these saddles preventing the cylinder 31 from dropping when it is released from the bearings 48 and 49 and the outer pair of saddles providing a convenient rest for the cylinder 31 to enable the blanks to be applied to and removed from the drums 30 and 34 at the beginning and termination of a reproducing operation.

As hereinbefore stated, any suitable transmitting unit may be employed. In general, in an optical pickup system such a transmitting unit employs a lens tube 66 containing lenses and an apertured plate aligned in position with respect to each other so that light from an exciter lamp is concentrated on a minute spot on the periphery of the drum 30 and consequently on elemental areas successively of the subject matter sheet 29 thereon during scanning. Another lens tube 67 contains lenses for directing the beam of light reflected from the elemental area of the record sheet 29 at the time being scanned onto an aperture and thence to a photocell, a light chopper in the form of a perforated disc being interposed between the photocell and the aperture in known manner, the number of perforations or notches in the disc and the speed of rotation thereof depending upon the desired rate of scanning, the frequency of the signal carrier current employed, and other factors. Preferably, and as disclosed in said Patents 2,158,391 and 2,176,442, the transmitter employs two light sensitive cells associated with the light chopper disc or discs in such manner that the signals produced by the transmitter need not be inverted before application to the recorder in order to provide a positive record from a positive original blank or a negative record from a negative original blank, although if desired one light sensitive cell may be employed and the signals inverted either in the transmitting or recording circuits by means of suitable signal inverters of a type well known in the communication art.

It is essential that the transmitting scanning apparatus and also the recording scanning apparatus be accurately positioned with respect to the spacing between the scanning elements of these units and the blanks containing the subject matter thus transmitted and recorded. For this purpose the transmitting unit 25 is mounted so as to be adjustable towards and from the drum 30, and its operative position may readily be adjusted as by rotation of the knob 68 and rod 68*a* to which the knob is secured, thereby to provide a proper adjustment or spacing between the transmitting scanning elements and the blank 29 on the drum irrespective of the size of the transmitting drum employed. A relatively fixed plate 63 is provided which bears indicia such as the letters A, B, C, which respectively correspond to three different sizes of transmitting drums that may be employed, the knob 68 being turned until a pointer

68 carried by the transmitting scanning unit is opposite the mark corresponding to the particular size of the drum to be used. A graduated drum or vernier 65 is provided for enabling a micrometer adjustment of the scanning elements of the optical pickup system relative to the scanning sheet. The foregoing adjusting members are disclosed in detail in my said copending application.

The recording stylus actuating device is enclosed in a casing 70, Figs. 1, 2, 3 and 5, the casing having mounted therein a composite piezo-electric element which may be built up from two similar crystalline plates 71 and 72, Figs. 5, 6 and 7, of homogeneous piezo-electric material assembled as shown in Fig. 7. These plates may be cut from a Rochelle salt crystal, in a manner well known in the piezo-electric crystal art, for example, with their extended plane surfaces substantially perpendicular to the electrical axis so that the directions of expansion and contraction of the plates when subjected to an electric field are at substantially 45° to the major longitudinal axis, or the plates may be cut so that one of them has a longitudinal dimension parallel to the major longitudinal axis of the crystal and the other with its longitudinal dimension parallel to the major transverse axis of the crystal, or the plates may be cut so as to have their longitudinal dimensions parallel to the major transverse axis or so that the plates have their longitudinal dimensions parallel to the major longitudinal axis.

When plates are cut from a crystal in the manner indicated above and subjected to an electrostatic field in the direction of the electric axis, the plates will expand on lines parallel to their faces at an angle of substantially 45° to the major longitudinal axis and will simultaneously contract along lines parallel to their faces and at substantially 90° to the lines of expansion. Thus, if the different plates are properly arranged with their longitudinal axes parallel and subjected to electrostatic fields in the same direction, the expansion of each plate will take place on lines parallel to the contraction of the other plate, and when the direction of the electrostatic fields is reversed, the plates will contract on the lines on which they formerly expanded, and vice versa.

The plates preferably are assembled as indicated in Fig. 7 and are provided with electrodes 73 and 74, the electrodes comprising tin foil applied to the sides of the plates and secured thereto in suitable manner, as by cementing. The two inner electrodes 73 are in electrical contact with each other and connected to the incoming signal circuit by means of a common conductor 76, and the outer electrodes 74 are connected together and to the other side of the signal circuit by means of a conductor 77, and in such an assembly the directions of expansion and contraction of one plate are respectively opposed to the directions of contraction and expansion of the other plate when the corresponding major crystalline axes of the two plates are parallel. When these plates are subjected to electrostatic fields by means of the signal currents applied to conductors 76 and 77 and the electrodes 73 and 74, the plate 71, for example, tends to expand along the same lines as the plate 72 tends to contract, and because of the mutual constraint of the plates the assembled element twists or oscillates about its central longitudinal axis and, if one end of the plate assembly, such as the left hand end as viewed in Fig. 7, is held in any suitable manner, the free end portions of the plates tend to have the twisting movement indicated by the dot-and-dash lines in the figure.

The plates 71 and 72 together with their electrodes 73 and 74 preferably are cemented together throughout their adjacent surfaces and along their edges by a suitable cement, the fixed end of the assembly also being secured to one end of the casing 70 by a suitable cement. As shown, resilient pads 80 of sponge rubber or other suitable material may be disposed between the fixed ends of the crystal plates and the casing 70, which pads protect the piezo-electric unit from mechanical shocks and jars and form a cushion therefor during the normal operation of the recording stylus. These pads of sponge rubber or the like also press the plates firmly together and counteract any tendency of the adhesive material to loosen under vibration. Machine screws 78, Figs. 5 and 6, clamp the sides of the casing together.

As shown in Figs. 6 and 7, the free end of the piezo-electric unit has a recessed portion 79 for receiving the percussion stylus 33, and the stylus has the outer end thereof formed or bent in such manner, as shown in Figs. 3, 5 and 7, that the twisting movement of the piezo-electric unit causes the point of the stylus to impact the stencil sheet in a direction substantially normal to the surface of the sheet, the length of the stylus also multiplying the movement imparted by the free end of the crystal unit so that such movement is increased to an extent sufficient to provide proper oscillatory movement of the stylus against the stencil or other recording blank. The stylus 33 is held in the recessed portion 79 of the unit by means of a wedge-shaped member 81 that has a wedge-shaped or knife-blade line bearing surface 82, Fig. 6, which contacts the stylus 33 in such manner that the stylus is firmly held against the crystal and yet does not interfere with the desired vibratory movement of the crystal and stylus in the proper direction to effect recording. A threaded adjustment screw 83 adjusts the position of the wedge 81 and also the degree of pressure exerted by the wedge-shaped bearing portion 82 against the stylus.

It is to be understood that the piezo-electric actuating unit may differ in character from that specifically described above, various other forms being well known in the piezo-electric art. For example, and by way of illustration only, the plates may be cut in such a way that when a difference of potential is applied to the armatures of the unit, the free portions of the plates are displaceable or oscillatable along a line substantially perpendicular to the plane of the plates, the stylus actuated thereby having the proper configuration so that it will impact on the surface of the record sheet in the proper direction to produce the desired record thereon.

The casing 70 is secured to a plate 84, the ends of the plate being pivotally mounted by pivot screws 85, Fig. 3, and thus the recording unit is hingedly mounted so as to enable the same to be freely movable in a direction transverse to the recording surface of sheet 35. The pivot screws 85 are mounted in bearings 86, which bearings are secured to a plate member 87, the latter member being secured to a support 88 of the scanning mechanism, as seen in Figs. 2 and 3. The supporting plate 88 is mounted on a plate 89 which is adjustable to adjust the position of the recording unit towards and from the recording drum in a manner hereinafter explained.

The unit 70 carries a stylus-positioning member or shoe 91, this shoe member being secured

to the plate 84 by means of screws 92, Figs. 3 and 5. The shoe member has an opening through which the stylus passes, the opening being sufficiently large to enable free movement of the stylus during recording operations. The shoe member 91 has an upstanding formed or bent portion 93 which bears against the recording surface of the stencil or other recording sheet at all times during the recording operation thereby to cause the recording unit accurately to follow the surface of the recording sheet and insure that the point of the stylus 33 will enter or impinge on the surface of the stencil sheet or recording blank only to a predetermined extent, and also assists in obviating any unwanted marking of the stylus or injury either to the recording blank or to the point of the stylus during recording.

The shoe member 91 is adjustable relative to the casing 70 by means of an arm 94 and a screw 95 which is threaded into a U-shaped frame member 96, the frame member 96 being secured as by screws 97 to the plate 84. The adjusting arm 94 is clamped as by means of a screw shown in Fig. 3 to the adjusting screw 95.

A knurled counterweight 100, Figs. 3 and 4, is adjustable longitudinally on a threaded rod 101 and urges the portion 93 of the shoe 91 into engagement with the recording blank in such manner that the degree of pressure exerted by the shoe on the blank may be controlled within very close limits. The rod 101 has one end thereof secured to and carried by a block 103, the block being held by a U-shaped member 104 which is pivotally mounted on a pin 105 that is secured to a bracket 106, the bracket 106 being secured to the plate 88 by screws 107. Member 103 of the threaded rod 101 carries a rubber cushion or damping member 110 which directly engages the plate 84 and causes resilient pressure to be exerted thereon for maintaining the shoe 91 against the surface of the recording blank.

The foregoing arrangement insures that the recording stylus will accurately follow, and be properly positioned to impinge on, the surface of the recording blank with the proper extent of movement and pressure at all times during recording, irrespective of irregularities in the thickness of the recording blank or stencil or irregularities in the surface thereof such as may be due to overlapping portions of the blank or to the character of the paper or other material of the blank or stencil or due to irregularities in the configuration or movement of the recording drum 34, and thus satisfactory recording is effected with greater permissible tolerances in the manufacture of both the recording blanks and the recording drum or other platen member employed, the arrangement being advantageous with an electromagnetically actuated stylus as well as one actuated by a piezo-electric element.

Mounted on plate 84 is a bracket 113 held by screws 114, the upper portion of the bracket 113 having thereon a line or groove 115. The member 106 has a similar line or groove 116, and the sliding plate member 89 is adjusted inwardly or outwardly by an adjusting screw-threaded shaft 123, Fig. 2, which is threaded into the member 89. The groove portions 115 and 116 are so positioned that, when the unit is in proper recording position, they coincide to give a ready and accurate indication of this fact. Interposed between the members 88 and 89 is a spacer plate 120 to give the desired height to the recording unit. The member 106 carries a stop pin 117, Figs. 3 and 4, which serves as a stop for the unit 70 to limit the forward permissible movement of the unit.

The rod being rotatable by the knurled knob 123a to adjust the recording unit to any of the desired positions, such as indicated by the indicia A, B and C that appear on a plate member 122 secured to the carriage of the recording unit, the indicia respectively corresponding to three different sizes of recording drums that may be employed. A graduated dial or vernier 124, Fig. 2, secured to the rod 123 enables very accurate adjustment of the recording stylus 33 relative to the recording blank or stencil. A pointer 125 carried by the member 88, Fig. 3, coacts with the plate 122 bearing the indicia to indicate when the recording unit is adjusted for the size of drum to be employed. The method of thus adjusting the recording unit is described in detail in my aforesaid copending application.

The line feed of the transmitting and recording units is effected by means of a split block assembly comprising identical opposed split halves 130, Fig. 2, which members are internally threaded to receive the feed screw thread 43a, the members being spring-pressed into engagement with the threads of the feed screw by means of four compression springs 131 which act between support members 132 and 133 and the upper and lower portions of the members 130. The members 132 and 133 comprise the legs of a U-shaped bracket which is secured to the recording unit carriage. Interposed between the inner tapered surfaces of the opposite ends of members 130 are two wedge-shaped members 135, the lower members 135 being secured to a split-nut release lever rock shaft 136, and the upper wedge-shaped member 135 being mounted on a rock shaft 137. Member 135 on shaft 137 is operatively connected to the shaft 136 by means of gears 138 and 139. When the handle 136a, Fig. 1, of the shaft 136 is rotated so as to turn the wedge-shaped members 135 from the positions in which they are shown in Fig. 2, rotation of these members forces the split-nuts apart a sufficient distance to effect their release from the threaded rod 43a and thus enable both the transmitting and receiving units to be moved longitudinally to any position such as their initial starting positions, after which the rod 136 is again turned in a direction such that the wedge-shaped members 135 assume the positions shown in Fig. 2 and again make effective the feed screw 43a.

In order that there may be no likelihood of injury to the recording blank or stencil by the stylus 33 or injury to the point of the stylus when a recording operation has been completed, and particularly when the transmitting and receiving units are to be moved to their initial starting positions, a collar 141 is secured to the rock shaft 137, the collar carrying a pin 142 which coacts with stop pins such as the pin 143 mounted on the bracket member 133. The pin 142 is adapted to control a stylus retracting switch 144 which controls the energizing circuit of a solenoid 145 which, when energized, causes retraction of its core, the core having secured thereto two side plates 147, and the inner movement of this core, due to energization of the solenoid 145, causing corresponding movement of a pin member 148 secured thereto. The pin 148 is positioned within a slot in a post member 149 secured to a slidable block 151, and through the member 89 and the rod 123 causes withdrawal of the stylus a predetermined distance from the

recording drum when the solenoid 145 is energized by closure of the switch 144, the limit of this retracted movement being determined by the core 147 striking a stop member 152 on the frame of the solenoid 145 when the stylus is in its proper retracted position.

The plate 153 comprised in the solenoid structure supports a bracket member 154, the plate 153 being secured to a block 155 mounted in guide members 156. Bracket 154 carries a dash-pot 157, the plunger 158 of the dash-pot being received within and actuatable by the upper end of a bracket member 159, the bracket 159 being secured to the block 151. A retractile spring 161 serves to urge the recording unit towards the drum 34, the movement of the recordng unit in this direction being limited by engagement of the inner end of the knurled knob 123*a* with the end of the member 156. The dash-pot 157 eases the impact of the stylus with the drum when the magnet 145 is deenergized, the dash-pot insuring that the stylus will gently contact the recording blank on the drum 34.

The original copy sheet 29 is wrapped around the transmitting drum 30, Fig. 1, preferably in such manner that the top of the copy is at the left hand end of the drum when facing the machine, the right hand edge of the copy overlapping the left hand edge by a slight margin. The copy may be held in position by any suitable means, such as an elastic band or garter 175, which preferably comprises a helical spring in the form of an annulus, such as disclosed in Patent No. 2,255,868. As shown in the figure, the leading garter member is advanced axially along the drum 30 from the left to right as scanning proceeds by a garter pushing plate member 176 secured to the supporting frame 36, and the trailing garter member is advanced by a second pusher plate 177 on the transmitting unit. The two elastic bands 175 are thus kept within a predetermined distance of each other and are kept immediately adjacent to the place where scanning is being effected, the bands rolling along on the copy sheet as the scanning proceeds and holding the copy sheet tightly against the drum and preventing distortion in the optical scanning system which otherwise might occur if the copy was not held tightly against the drum. Two similar garter members 175 are employed to hold the recording blank or stencil 35 on the recording drum 34, and usually these members may be placed adjacent to the ends of the blank 35, as indicated in Fig. 1.

Preferably, the resonant frequency of the stylus actuating unit, including the stylus, is made substantially to equal the carrier frequency employed. The desired resonant frequency of the unit may be predetermined either empirically or by calculation so that it is approximately the same or less than the carrier frequency and a small lump of solder 180, Fig. 5, may be applied to the stylus 33, after which the solder may easily be filed and reduced in mass until the resonant frequency of the unit including the stylus has the desired value. Due to its selective characteristic the unit will respond either to amplitude modulated signals or frequency modulated signals since it discriminates with respect to both frequency and amplitude modulation. If, for example, an alternating current is employed whose frequency is modulated in accordance with the black and white areas of the subject matter scanned on the facsimile transmitting blank, when a frequency representing a black or marked area is received, the stylus unit will vibrate at maximum amplitude and cause marking impacts to be applied to the recording blank, whereas when a signal frequency representing a light or unmarked area on the transmitting blank is received, which frequency is substantially different from the resonant frequency of the stylus unit, the amplitude of vibration of the stylus will be insufficient to cause marking impacts to be applied to the recording blank, and the record received will be delineated in black and white as determined by the different frequencies respectively of the incoming signals. If but one frequency is employed, the unit will respond to the amplitude modulation of such frequency, as determined by the marked and unmarked areas on the transmitting blank. To facilitate inspection of the actuating unit, the casing 70 has a slidable plate 70*a*, Fig. 3, which is received within grooves in the top of the casing, the plate being slidable to the left as viewed in the figure, after the stylus has been removed, to expose the crystal assembly within.

Referring to Fig. 8, there is shown a circuit arrangement suitable for interconnecting the transmitting and recording apparatus in accordance with the present invention, although other known electrical systems suitable for transmitting and recording in facsimile may be employed, depending upon the purpose for which the apparatus is to be used. At the transmitting end a scanning photoelectric cell 200 and a balancing photoelectric cell 201 preferably are employed in the manner set forth in the aforesaid Patents Nos. 2,158,391 and 2,176,442, and controlling the light applied to the cells is a light chopper 202 which is rotated at a constant predetermined speed by a motor in a manner well known in the art. In the embodiment shown the speed of the light chopper preferably is of the order of 3300 R. P. M. so that the apertured portions thereof will produce a carrier frequency of the order of 2500 cycles. When light is falling on both photocells, the signal amplitude is at a minimum due to the balanced arrangement of the cells, and no signal is transmitted at this time. When a black mark appears under the scanning ray, however, the two photocells become unbalanced relative to each other and at this time there is transmitted a carrier frequency of 2500 cycles which carrier is modulated by the appearance or non-appearance of a mark on the original copy. This modulating frequency depends upon the speed at which the white and black elemental areas pass by the scanning light. For example, with an elemental area of approximately eight circular mills where the scanning ray impinges on the subject matter appearing on the transmitting blank, and a drum of eight and one-half inches in circumference and a speed of 180 R. P. M., the carrier frequency will thus be modulated by a signal frequency of the order of 1400 cycles. In the circuit of the balancing photocell is an adjustable impedance or resistance 204 which enables the photocells to be accurately balanced with respect to each other so that each one puts out the same amplitude of signal. It will be understood that the phase relation between the two light beams for each of these photocells will be so adjusted as to most effectively balance when the scanning light is on the white background, as described in detail in the aforesaid patents.

The signal output from the photocells is connected to a pre-amplifier 203 of known type, and

the transfer of signals from this amplifier 203 to the succeeding amplifier stages is controlled by a gain control device 206. Connected to the gain control device 206 are two amplification stages comprising the pentode tubes 207 and 208. In both the pre-amplifier 203 and the two-stage amplifier 207, 208, the constants of the circuits, including the coupling condenser 210, are such that the amplifiers will not pass low disturbing frequencies caused by undesired pickup from interfering stray fields. The amplifiers preferably are so designed that they will pass frequencies principally in the band from 1000 to 7000 cycles, whereby the unit may be adapted to operate with carrier frequencies of from 1500 cycles to 5000 cycles. The amplifier tube 207 preferably is of the type known as the 6SJ7, although other equivalent types of amplifier tubes may be employed. The amplifier tube 208 preferably is of the type known as 6K6, although here again a tube of different type may be employed so long as it is suitable for the purpose. All stages of the amplifier including the pre-amplifier 203 are of Class A amplification, whereby each tube has a constant average plate current output regardless of the amplitude of signal applied to it.

Connected between the cathode and grid of the amplifier tube 207 is a self-biasing arrangement comprising a condenser 211, which may be of the order of 25 microfarads, and a resistor 212, which may be of the order of 3000 ohms. The screen grid of the tube is connected with a series resistor 213, this resistor being shunted by a by-pass condenser 214. Connected to the plate circuit of tube 207 is a coupling resistor 216 which is connected to ground through a condenser 218. A resistor 217 is connected in the plate circuit of tube 207 to give the desired plate voltage, the resistor also coacting with the condenser 218 to filter out variations in the plate supply current. The output of the amplifier 207 is applied to the input of amplifier 208, resistance 220 providing the proper grid leak resistance for the latter tube. The tube, as shown, may employ a self-biasing arrangement in the manner of tube 207.

The output from amplifier stage 208 is applied, through a transformer 222, to a switching system employing a double-throw switch 224, which, in the position shown, connects the amplifier stages 207 and 208 to a second transformer 226. The secondary of the transformer 222 is also connected to a test jack 225 which, when a plug is inserted therein, enables the decibel readings of the power level of the signals to be determined. Connected in circuit between the windings of transformers 222 and 226 are a tuning condenser 227 and an impedance 228, thereby to make the transformer circuit contribute to a more desirable frequency characteristic and widen the frequency band for the purpose of accommodating the higher modulating frequencies and thus obtain better detail in the record produced. The switch 224 is provided to enable the recording apparatus to be employed either with the transmitter shown at the left hand portion of Fig. 8, or to enable signals received from an incoming line to be applied to the recorder, the latter circuit being effective when the switch 224 is thrown upwardly to contact the terminals of the incoming line.

The output of transformer 226 is applied to two amplifier tubes 230 and 231 connected in a push-pull arrangement, and the output of these tubes supplies the driving energy for the recording unit 70. The output of the tubes 230 and 231 is applied, by means of a transformer 240, directly to the piezo-electric unit 70, which unit is responsive to the alternating modulated carrier current thus impressed thereon in accordance with the received signals. As shown, the tubes 230 and 231 in the last amplifier stage may be self-biased by means of a midpoint tap 233 to the transformer 240 which supplies the filament current, this midpoint tap being connected to ground through a suitable resistance 234. As indicated in the drawings, the power stage 230, 231 is supplied with a separate source P of filament and plate voltages to avoid feedback between the different amplifier stages which might occur if the same power pack were employed for all the amplifier tubes.

The resistance 242 is connected across the output of the transformer 240, the resistance having a value sufficient to stabilize the voltage applied across the terminals of the recording unit 70. A voltmeter V in the output circuit of the last amplifier enables the operator to set power levels and also facilitates balancing of the photocells of the transmitter. It will be understood that the load presented by the recording unit 70 to the amplifier output is practically that of the capacitive reactance, the unit being a voltage actuated device in which there is a straight line relation between voltage and stylus deflection.

Where the signals for operating the recorder are received from an incoming line, which may represent a circuit originating in another city or different locality from that of the recording unit, it will be understood that the incoming signals are suitably amplified prior to their application to the push-pull amplifier stage shown, and that these signals may be amplified either at the place of origin, at the receiving end, or intermediate these points.

In order to save operating time and cause the scanning operation by the transmitter to stop approximately as soon as the subject matter on the original blank has been scanned, irrespective of the length of the blank as measured longitudinally along the transmitting cylinder, a switch 250, Fig. 1, is provided, which switch may be mounted on the traveling carriage of the recording unit 70, the switch being connected, as by a flexible cord, in series with a carriage limit switch 251. Either of the switches when operated to open circuit position will cause the driving motor and hence the scanning units to stop. Coacting with the switch 250 is an actuating unit 252 therefor which, as shown in Fig. 1, may comprise a collar or sleeve member 253 that has a relatively close fit with the guide rod 23 on which it is mounted, the member 253 being slidable longitudinally along the guide rod and thus readily settable to different machine stopping positions corresponding to various positions of the transmitter at the time the subject matter on the transmitting blank has been completely scanned. As shown, the adjustable unit 253 has a spring member 254 carried thereby, which spring member resiliently engages in a spline 255 in the guide rod 23, thereby to prevent rotation of the unit about the guide rod and also to frictionally engage the guide rod so that the unit will remain in any adjusted position. The portion 252 of the unit 253 carries an adjustable switch-actuating pin 256 which is in the path of travel of the switch 250 and which operates to open the normally closed contacts of the switch 250 when the line feed movement of the transmitting carriage has caused the latter to completely scan the subject matter on the

transmitting blank, thereby automatically stopping the transmitting and recording operations.

The unit 253 is manually set by the operator prior to the scanning operation of any given subject matter, and to determine readily the setting to which the unit should be placed, there are provided corresponding calibrated scales 260 and 261, whereby the operator may place the subject matter sheet on the transmitting drum and visually discern the proper mark on the scales 260, and then set the unit 253 to the corresponding scale setting. In the event that the unit 253 is not initially set or is improperly set, a rod 263 secured to the recording carriage unit will engage the carriage limit switch 251 and automatically stop the driving motor and the transmitting and recording apparatus so that no injury can occur either to the scanning apparatus or to the recording sheet or stencil by reason of overtravel of the scanning units.

In order to prevent injury or shock to the transmitting and recording units when they are moved to their initial starting positions, there is provided a buffer in the form of a dashpot 264, Fig. 1, mounted on the frame structure 20a, the dashpot having a plunger 265 which is held in its extended position by a compression spring within the dashpot cylinder. When the transmitting and receiving carriages are returned to the left, a stop member on the transmitting carriage engages the end of the piston 265, and as this movement of the units toward the left is continued, the spring within the dashpot 264 is compressed so that it prevents undue shock to the units, the structure also providing a suitable means for limiting the extent of movement of the units toward the left and determining the desired initial starting position of the units.

Other control circuits for starting and stopping the recorder, particularly when it is connected to an incoming line instead of to the transmitter as shown in Fig. 8, may of course be employed, various kinds of which circuits suitable for the purpose are known in the facsimile recording art, for example, as shown in the aforesaid Patents 2,260,862 and 2,301,024.

While the invention has been described in connection with one illustrative form thereof, it will be evident to those skilled in the art that various other forms and modifications may be employed without departing from the spirit of the invention, and therefore the invention is not limited except as indicated by the scope of the appended claims.

What is claimed is:

1. Apparatus for producing in facsimile on a record sheet a copy of a picture, drawing or other subject matter, comprising a facsimile copying instrumentality responsive to an alternating current modulated in accordance with the elemental areas of the subject matter to be recorded, said copying instrumentality having a percussive recording stylus and a piezo-electric unit for actuating said stylus, means for causing said copying instrumentality to scan the record sheet, and means for applying said modulated alternating current to the piezo-electric unit to cause the recording stylus intermittently to oscillate and cause marking impacts to be applied to said sheet substantially at the frequency of the applied alternating current and produce thereon a facsimile record in accordance with the signals represented by said modulated alternating current.

2. Apparatus for producing in facsimile on a record sheet a copy of a picture, drawing or other subject matter, comprising a facsimile copying instrumentality responsive to a carrier current of a predetermined frequency which is modulated by a signal frequency in accordance with the elemental areas of the subject matter to be recorded, said copying instrumentality having a percussive recording stylus and a piezo-electric unit for actuating said stylus, means for causing said copying instrumentality to scan the record sheet, and means for applying said signal modulated carrier to the piezo-electric unit to cause the recording stylus intermittently to oscillate and cause marking impacts to be applied to said sheet substantially at the frequency of the applied carrier and produce thereon a facsimile record in accordance with the signals represented by said modulated carrier.

3. Apparatus for producing in facsimile on a record sheet a copy of a picture, drawing or other subject matter, comprising a facsimile copying unit responsive to an alternating current of a predetermined frequency which is modulated by a signal frequency in accordance with the elemental areas of the subject matter to be recorded, said copying unit comprising a percussive recording stylus and a piezo-electric element for actuating said stylus, means for causing said copying unit to scan the record sheet, means for applying said signal modulated alternating current to the piezo-electric element to cause the recording stylus intermittently to oscillate and cause marking impacts to be applied to said sheet substantially at the frequency of the applied alternating current and produce thereon a facsimile record in accordance with the signals represented by said modulated alternating current, the mass of said stylus and the frequency response characteristic of the piezo-electro element being such that the resonant frequency of said copying unit when in recording position substantially corresponds to the frequency of said first named alternating current.

4. Apparatus for recording in facsimile on a record sheet a copy of a picture, drawing or other subject matter, having a platen for holding blanks during recording operations, a recording device, means for causing said device to scan the blank on said platen, said recording device comprising a composite plate built up of a plurality of laminations each cut from a crystal of piezo-electric material, means for holding said plate so that a portion thereof may deform and vibrate when oscillating potentials are applied thereto, means for applying received alternating current facsimile signals to opposite sides of said plate to cause said portion of the plate to deform and vibrate in accordance with the oscillating voltage changes in said signals, a stylus operatively connected with said vibratile portion of the plate and actuatable by said deformation of the plate, said portion of the plate causing said stylus intermittently to oscillate and cause marking impacts to be applied to said record sheet substantially at the frequency of the applied alternating current to record thereon in facsimile the subject matter represented by said received signals.

5. Apparatus for recording in facsimile on a record sheet a copy of a picture, drawing or other subject matter, comprising a platen for holding blanks during recording operations, a recording device, means for causing said device to scan the blank on said platen, said recording device comprising a composite plate built up of a plurality of laminations each cut from a crystal of piezo-electric material, means for holding said plate so that a portion thereof may twist and vibrate when oscillating electrical potentials are applied there-

to, means for applying received alternating current facsimile signals to opposite sides of said plate to cause said portion of the plate to twist and vibrate in accordance with the oscillating voltage changes in said signals, a stylus operatively connected with said vibratile portion of the plate and actuatable by the twisting movement of the plate, said twisting movement causing said stylus intermittently to oscillate and cause marking impacts to be applied to said record sheet substantially at the frequency of said applied alternating current comprising the facsimile signals to record thereon in facsimile the subject matter represented by said received signals.

6. Apparatus for recording in facsimile on a record sheet a copy of a picture, drawing or other subject matter, comprising a platen for holding blanks during recording operations, a recording device, means for causing said device to scan the blank on said platen, said recording device comprising a composite plate built up of a plurality of laminations each cut from a crystal of piezo-electric material, means for holding said plate so that a portion thereof may twist and vibrate when oscillating electrical potentials are applied thereto, means for applying received alternating current facsimile signals to opposite sides of said plate to cause said portion of the plate to twist and vibrate in accordance with voltage changes in said signals, a stylus clamped to said vibratile portion of the plate and actuatable by the twisting movement of said plate, said stylus having a portion thereof formed to cause the free end of the stylus intermittently to oscillate and cause marking impacts to be applied to said record sheet substantially at the frequency of said applied alternating current comprising the facsimile signals in a direction substantially normal to the surface thereof to record thereon in facsimile the subject matter represented by said received signals.

7. Recording apparatus for facsimile telegraphy, comprising means for rotatably supporting a message cylinder for holding blanks during recording operations, driving means for rotating the cylinder, a recording device and means for causing said device to scan the blank on said cylinder, said recording device being mounted on a carriage, means for progressively moving said carriage longitudinally along said cylinder during rotation thereof to provide proper line feed of the recording device, said recording device comprising a percussive recording stylus and a piezo-electric unit responsive to voltage changes in incoming signals for actuating said stylus and causing it intermittently to oscillate and cause marking impacts to be applied to said record sheet in accordance with the signals received, and means for maintaining the pizeo-electric unit and recording stylus properly positioned with respect to the recording blanks notwithstanding irregularities in the surfaces of said recording blanks or the message cylinder, said last-named means comprising mounting means secured to said carriage and holding said piezo-electric unit so that the same is movable freely in a direction to follow the adjacent surface of said record blank as it rotates during recording operations.

8. Recording apparatus for facsimile telegraphy, comprising means for rotatably supporting a message cylinder for holding blanks during recording operations, driving means for rotating the cylinder, a recording device and means for causing said device to scan the blank on said cylinder, said recording device being mounted on a carriage, means for progressively moving said carriage longitudinally along said cylinder during rotation thereof to provide proper line feed of the recording device, said recording device comprising a percussive recording stylus and a piezo-electric unit responsive to voltage changes in incoming signals for actuating said stylus and causing it intermittently to oscillate and cause marking impacts to be applied to said record sheet in accordance with the signals received, and means for maintaining the piezo-electric unit and recording stylus properly positioned with respect to the recording blanks notwithstanding irregularities in the surfaces of said recording blanks or the message cylinder, said last-named means comprising mounting means secured to said carriage and holding said piezo-electric unit so that the same is movable freely in a direction to follow low the surface of said record blank as it rotates during recording operations, and a member operatively connected to said piezo-electric unit and controlled by the adjacent surface of the blank for controlling at all times during recording the operative position of said piezo-electric unit and the percussive stylus actuated thereby relative to the surface of the blank.

9. Recording apparatus for facsimile telegraphy, comprising means for rotatably supporting a message cylinder for holding blanks during recording operations, driving means for rotating the cylinder, a recording device and means for causing said device to scan the blank on said cylinder, said recording device being mounted on a carriage, means for progressively moving said carriage longitudinally along said cylinder during rotation thereof to provide proper line feed of the recording device, said recording device comprising a percussive recording stylus and a piezo-electric unit responsive to voltage changes in incoming signals for actuating said stylus and causing it intermittently to oscillate and cause marking impacts to be applied to said record sheet in accordance with the signals received, and means for maintaining the piezo-electric unit and recording stylus properly positioned with respect to the recording blanks notwithstanding irregularities in the surfaces of said recording blanks or the said message cylinder, said last-named means comprising means for hingedly mounting said piezo-electric unit on said carriage so that the unit is movable freely in a direction to follow the surface of said record blank as it rotates during recording operations, and a member rigidly secured to and carried by said piezo-electric unit and controlled by the adjacent surface of the blank for controlling at all times during recording the operative position of said piezo-electric unit and the percussive stylus actuated thereby relative to the surface of the blank.

10. A facsimile recorder for producing a record sheet of a picture, drawing or other subject matter, comprising a recording unit including a stylus and actuating means therefor responsive to signals representative of said subject matter for causing the stylus to apply marking impacts to said sheet and form a record in accordance with said signals, scanning mechanism for causing said recording unit to scan the record sheet, said recording unit carrying a stylus-positioning member and being mounted on said scanning mechanism so as to be freely movable in a direction transverse to the recording surface of the record sheet, and means urging said stylus-positioning member into operative engagement with

said recording surface of the record sheet for causing the stylus of the recording unit to be positioned accurately with respect to the record sheet at all times during recording and irrespective of irregularities in the recording surface of the sheet.

11. A facsimile recorder for producing a stencil sheet of a picture, drawing or other subject matter, comprising a recording unit including a percussion stylus and actuating means therefor responsive to signals representative of said subject matter for causing the stylus intermittently to engage said sheet and form a stencil in accordance with said signals, scanning mechanism for causing said recording unit to scan the stencil sheet, said recording unit carrying a stylus-positioning member and being mounted on said scanning mechanism so as to be freely movable in a direction transverse to the recording surface of the stencil sheet, and means urging said stylus-positioning member into engagement with said recording surface of the stencil sheet for causing the stylus of the recording unit to be positioned accurately with respect to the stencil sheet at all times during recording and irrespective of irregularities in the recording surface of the sheet.

12. A facsimile recorder for producing a record sheet of a picture, drawing or other subject matter, comprising a recording unit including a stylus and actuating means therefor responsive to signals representative of said subject matter for causing the stylus to engage said sheet and form a record in accordance with said signals, scanning mechanism for causing said recording unit to scan the record sheet, said recording unit carrying a stylus-positioning member and being mounted on said scanning mechanism so as to be freely movable in a direction transverse to the recording surface of the record sheet, means urging said stylus-positioning member into operative engagement with said recording surface of the record sheet for causing the stylus of the recording unit to be positioned accurately with respect to the record sheet at all times during recording and irrespective of irregularities in the recording surface of the sheet, and means for adjusting the position of said stylus-positioning member relative to the stylus to determine the operating position of the stylus.

13. A facsimile recorder for producing a record sheet of a picture, drawing or other subject matter, comprising a recording unit including a stylus and actuating means therefor responsive to signals representative of said subject matter for causing the stylus to engage said sheet and form a record in accordance with said signals, a casing enclosing said actuating means, scanning mechanism for causing said recording unit to scan the record sheet, said casing carrying a stylus-positioning shoe member and being pivotally mounted on said scanning mechanism so as to be freely rotatable in a direction transverse to the recording surface of the record sheet, and means urging said stylus-positioning shoe member into operative engagement with said recording surface of the record sheet for causing the stylus of the recording unit to be positioned accurately with respect to the record sheet at all times during recording and irrespective of irregularities in the recording surface of the sheet.

14. A facsimile recorder for producing a record sheet of a picture, drawing or other subject matter, comprising a recording unit including a stylus and a piezo-electric element responsive to signals representative of said subject matter for driving the stylus to cause it to engage said sheet and form a record in accordance with said signals, a casing enclosing said piezo-electric element, scanning mechanism for causing said recording unit to scan the record sheet, said casing carrying a stylus-positioning shoe member and being pivotally mounted on said scanning mechanism so as to be freely rotatable in a direction transverse to the recording surface of the record sheet, and adjustable means urging said stylus-positioning shoe member into operative engagement with said recording surface of the record sheet with a predetermined degree of pressure thereon for causing the stylus of the recording unit to be positioned accurately with respect to the record sheet at all times during recording and irrespective of irregularities in the recording surface of the sheet.

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