

Nov. 18, 1941.

W. G. H. FINCH

2,263,332

HIGH SPEED PORTABLE FACSIMILE SYSTEM

Filed Sept. 24, 1937

4 Sheets-Sheet 1

Fig. 1

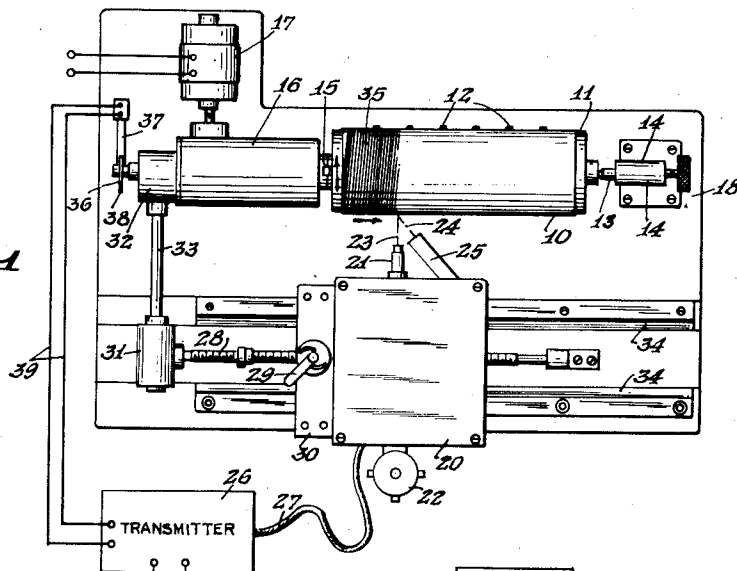
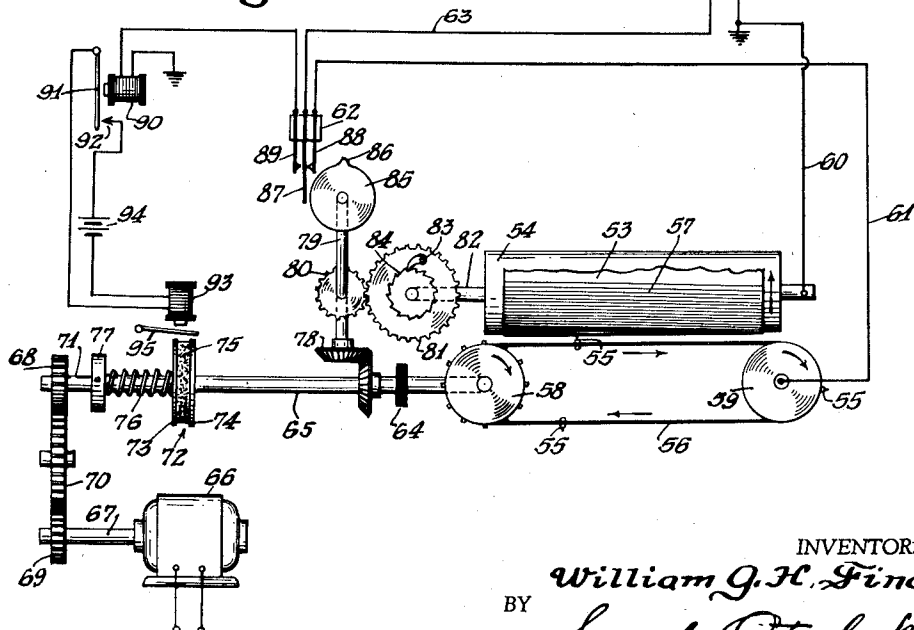


Fig. 2



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4 Sheets-Sheet 2

Fig: 3

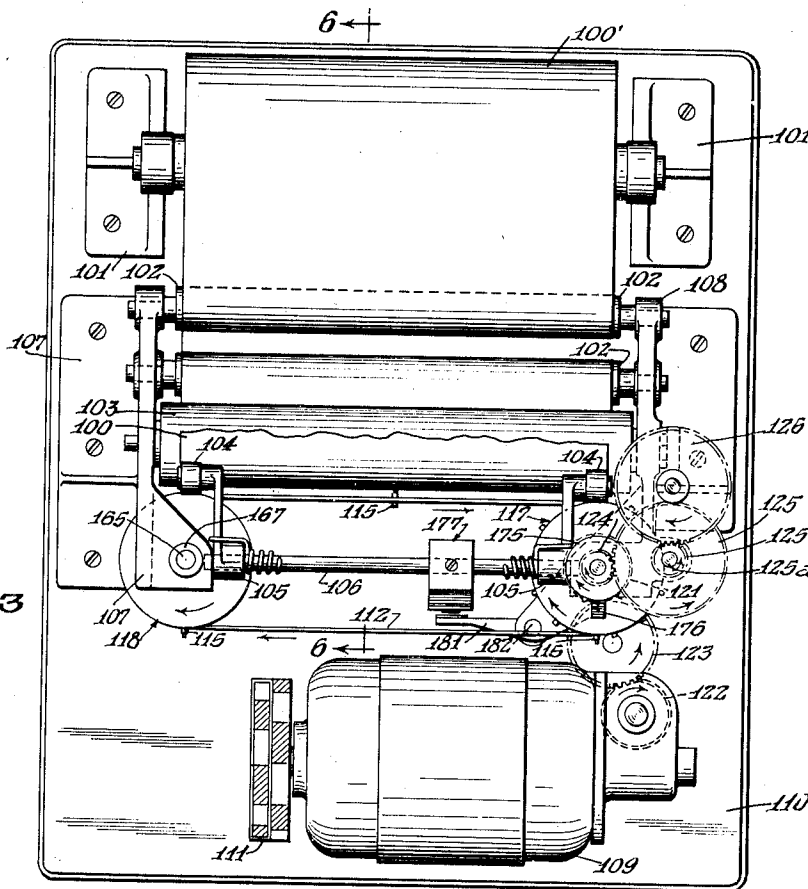
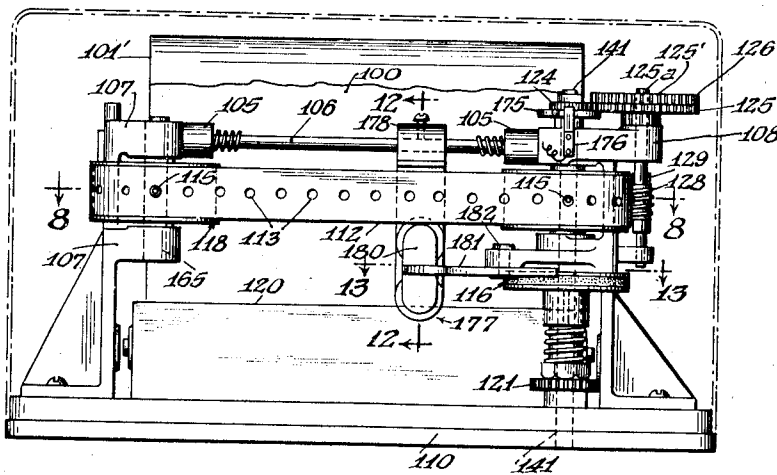


Fig: 4



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4 Sheets-Sheet 3

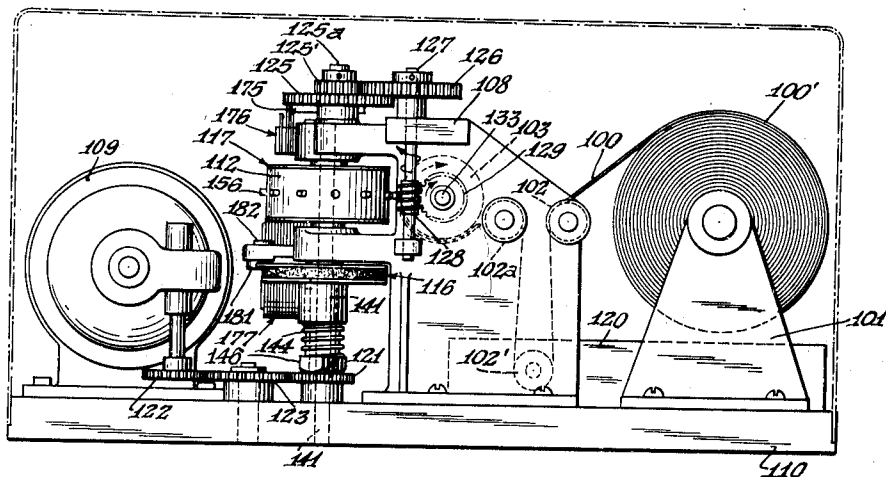


Fig. 5

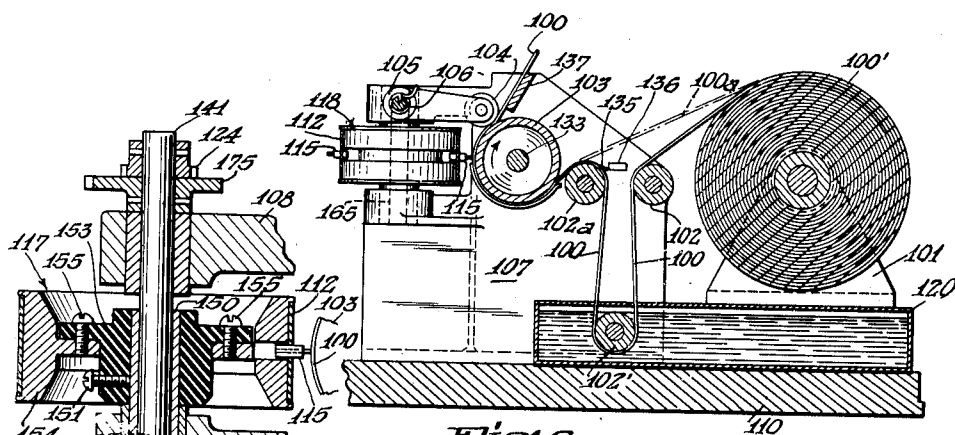


Fig. 6

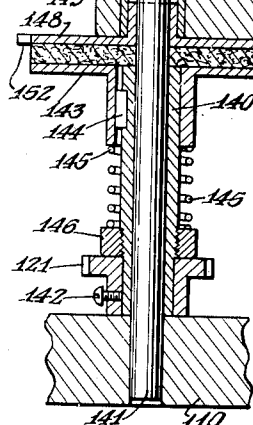


Fig. 7

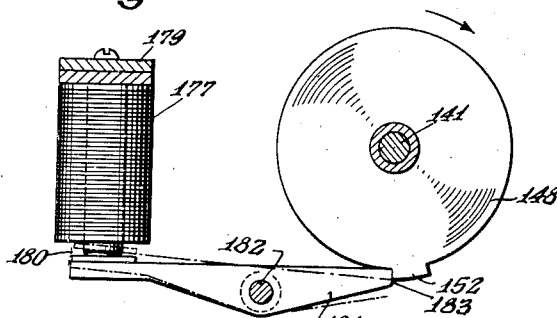


Fig. 13

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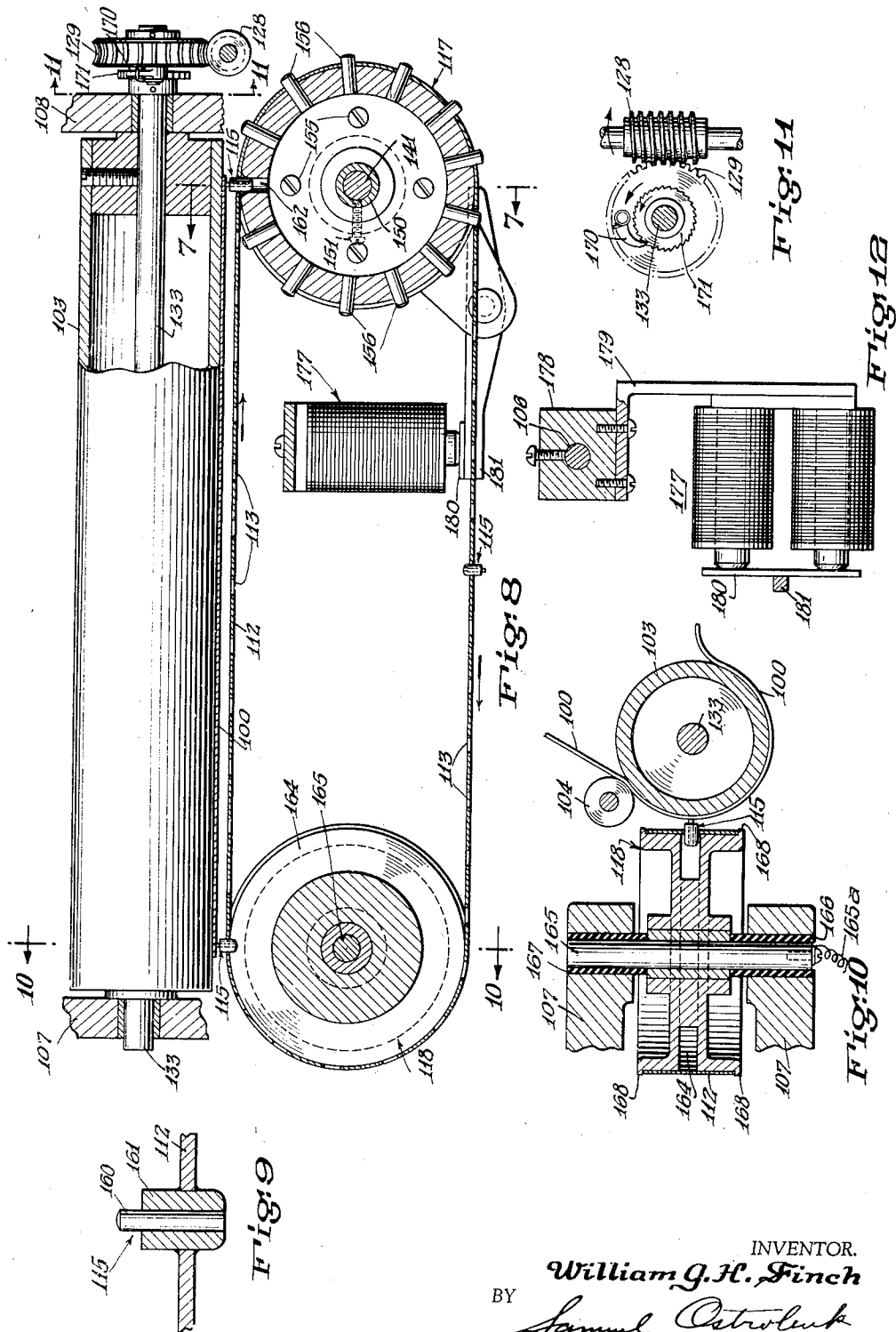
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HIGH SPEED PORTABLE FACSIMILE SYSTEM

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,263,332

HIGH SPEED PORTABLE FACSIMILE
SYSTEM

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Application September 24, 1937, Serial No. 165,448

2 Claims. (Cl. 178—6.6)

This invention relates to facsimile systems and more particularly relates to novel methods of and apparatus for transmitting and recording picture records at a high rate of operation.

Facsimile transmitters of the prior art operate with a rotatable drum upon which the picture to be transmitted is mounted, or employ a flat record sheet continuously feeding past the transmitter scanner. The facsimile recorders have hitherto corresponded to the transmitter scanners in that a rotatable drum recorder was used for a corresponding rotatable drum transmitter, and a continuous sheet or flat bed recorder was used for a similar type transmitter.

In the transmission of facsimile records, it is most practical to use the rotatable drum type of transmitter since the records to be transmitted usually come in relatively small lengths and are difficult to mount as a continuous sheet required for continuous sheet transmitters. On the other hand, it is more practical, particularly for layman operation of facsimile records, to receive the successive facsimile reproductions on a continuous sheet recorder. The obvious advantage of a continuous sheet recorder resides in the minimum amount of readjustment and manual operations required to obtain the successive recordings. Where the facsimile recording is performed in the home or aboard an aircraft or moving vehicle, it is most desirable to have a large roll of recording paper continuously fed past the receiving scanner to translate the signals as successive picture records on the sheet which is fed through the mechanism.

In accordance with my present invention I provide a novel facsimile system whereby a continuous sheet recorder is employed to translate signals originating from a revolving drum transmitter. Thus, successive news bulletins, news pictures, weather maps and the like may be mounted upon the drum of the transmitter and received in succession upon the continuous sheet recorder as though the successive transmitted records were being transmitted from a continuous sheet transmitter. The preferred transmitter I employ is of the removable drum type to enable the operator to mount the successive pictures for transmission upon a spare drum during the interval of transmission of the pictures.

An important feature of my present invention is to provide a novel high speed facsimile recorder employing a plurality of stylii successively operating upon the record sheet to minimize the "dead period" heretofore necessary in continuous sheet recorders. In a preferred form

of my invention I mount three stylii upon a continuously rotated belt or carrier, spaced on the belt by a distance equal to the width of the record sheet. The stylii are individually and successively moved into contact with the record sheet to form line by line scanning transversely across the sheet to compose the reproduction. The stylii are electrically interconnected to the rectified facsimile signals to electrolytically or electrostatically break down the record sheet along the scanning region.

The record sheet at the receiver is continuously advanced past the recording region during the recording intervals. This continuous movement of the record sheet is advantageous to form a slanted line of recording along the sheet to correspond to the helical trace along the picture being transmitted from the rotatable drum. This feature will be hereinafter described in more detail and simplifies the feeding mechanism for the recording paper. The prior continuous sheet recorders employed step by step line feeds which were advanced during the synchronizing interval.

The facsimile recorder of my present invention is equally applicable to wet or dry type electrolytic or electrostatic recording. A small tank is provided for containing the liquid employed with the wet type process. For dry type recording operation the record sheet is by-passed across the tank and fed directly to the scanner.

It is accordingly an object of my present invention to provide a novel method of and apparatus for transmitting and receiving pictures and the like.

Another object of my present invention is to provide a novel facsimile system employing a drum type transmitter and a continuous sheet recorder therefor.

Still another object of my present invention is to provide a novel continuous sheet facsimile recorder unit.

A further object of my present invention is to provide a novel inexpensive multiple stylii facsimile recorder capable of very high rate of operation.

Still a further object of my present invention is to provide a novel continuous sheet recorder wherein the recording paper is continuously advanced during the scanning periods.

Still a further object of my present invention is to provide a novel inexpensive rugged high speed continuous sheet facsimile recorder suitable for aircraft, home and mobile operation

with a minimum of skill required for operation thereof.

Another object of my present invention is to provide a novel method of and means for line by line synchronizing of multiple stylus facsimile recorders.

These and further objects of my invention become apparent in the following description of a preferred embodiment illustrated in the drawings, in which:

Figure 1 is a plan view of a preferred drum type facsimile transmitter.

Figure 2 is a diagrammatic representation of a preferred form for the multiple stylus continuous sheet facsimile recorder of my present invention.

Figure 3 is a plan view of a preferred construction for the facsimile recorder of my present invention.

Figure 4 is an end elevational view of the recorder of Figure 3, with the drive motor removed.

Figure 5 is a side elevational view of the recorder of Figure 3.

Figure 6 is a vertical cross sectional view taken along 6—6 of Figure 3.

Figure 7 is a vertical cross sectional view taken through the synchronizing drive mechanism along 7—7 of Figure 8.

Figure 8 is a horizontal cross sectional view taken along 8—8 of Figure 4.

Figure 9 is an enlarged detailed view of the stylus.

Figure 10 is a cross sectional view taken along 10—10 of Figure 8.

Figure 11 is an end view corresponding to 11—11 of Figure 8 through the platen drive mechanism.

Figure 12 is a cross sectional view taken along 12—12 of Figure 4 through the synchronizing magnet.

Figure 13 is a horizontal view taken along 13—13 of Figure 4 illustrating the synchronizing details.

In carrying out my invention, I prefer to employ a rotatable drum facsimile transmitter. However, it is to be understood that the continuous sheet recorder to be described is equally useful with a continuous sheet transmitter system.

The transmitter shown in Figure 1 corresponds to that described in my Patent No. 2,047,863, which issued on July 14, 1936, and is entitled "Telecommunications systems." The picture 10 to be transmitted is mounted upon a rotatable drum 11 by means of a series of film clamps 12. The rotatable drum is removably mountable between the spindle 13 set in tail stock 14 and the drive plate 15 operated through reduction gearing located in housing 16 by means of synchronous motor 17 operated at a predetermined speed. The system is secured upon a heavy cast iron base 18 to minimize vibrations.

The electrooptical scanning of the record or picture 10 is accomplished by the apparatus housed in the transversely movable carriage 20. The telescope 21 focuses a beam of light generated by a lamp source contained in a ventilated housing 22 at the rear of the carriage 20. When 100 lines per inch of scanning is required, the diameter of the scanning light beam 23 is made one hundredth of an inch. The beam 24 reflected from the record sheet 10 is focused by lens system 25 upon a photo-electric cell contained in the carriage 20 for producing an electrical cur-

rent varying in accordance with the elemental shading of the picture being scanned as is well known in the art. The electrical pulses are amplified by means of an amplifier preferably contained in a movable housing 20 and conducted to the transmitter 26 by a flexible cable 27.

The preferred rate of movement for the electro-optical scanner 20 is one inch per minute in direction parallel to the axis of the picture drum 11. Carriage 20 is motivated by a lead screw 28 coaxing with a worm-lock located beneath the carriage 20 and engageable and disengageable with the screw 28 by means of the cam lever 29 mounted upon extension plate 30 of the housing 20. The lead screw 28 is rotated at the necessary speed by means of a mechanical connection to the gearing system at 16 through the intermediate gearing 31 and 32 and the drive shaft 33. The scanner carriage 20 is accurately guided in its transverse movement by grooved tracks 34—34.

As will now be evident, the scanning of the record sheet 10 is performed along a continuous and contiguous helical path, as schematically indicated by the lines 35. The arrows adjacent the scanning region 35 indicate the direction of movement of the sheet 10 and the scanner beam 23.

I prefer to employ a synchronizing signal generated once per revolution of the drum 11 to maintain synchronous operation of the recorder scanner as will be described. The cyclic synchronizing impulse may be generated by a cam 36 connected mechanically to the drum 11 and rotating therewith, together with a cam switch 37 coaxing with the cam 36. Cam 36 contains a nib or projection 38 which actuates the cam switch 37 once per revolution of the cam 36. Cam switch 37 is electrically connected by leads 39 to the transmitter 26 to generate the synchronizing signal in a preferred manner. My Patent No. 2,047,863 discloses one manner of initiating the synchronizing impulse or signal during the underlap or "dead" portion of the picture corresponding to the region of clamping by clamps 12.

The generated picture and synchronizing signals may be caused to modulate a radio carrier wave or be directly transmitted by the wire line 40, or its equivalent, to the facsimile receiver indicated at 41, Figure 2. The receiver is adjusted to amplify the facsimile signals and impress them upon a push-pull transformer 42, the secondary of which connects to the control grids of a push-pull amplifier stage 43—43 through a variable grid resistor 44 for controlling the resultant amplitude of the facsimile signals at the recorder. I prefer to use screen grid amplifiers for the push-pull stages 43. The cathode resistor 43 is connected between the cathodes of the stages 43 and ground for suitably biasing the tubes in the conventional manner. Resistor 45 is shunted by a bypass condenser 46. The output of the push-pull stage 43—43 is connected through a push-pull coupling transformer 47 to a dual rectifier stage 48. The anodes 49 and 50 of stage 48 are connected to the outer terminals of the secondary of the transformer 47. The cathode 51 of the rectifier 48 serves as one terminal of the rectified signal output and corresponds to the positive terminal of the facsimile signals. The mid-point 52 of the output transformer secondary corresponds to the negative terminal of the facsimile signals. The illustrated electrical recording circuit is disclosed in detail in my copending application Serial No. 156,625,

filed July 31, 1937, and entitled "Facsimile recorder." It is to be understood that different circuitual arrangements for the transmitter and receiver are feasible with the recording to be described.

A schematic representation of the multiple stylus continuous sheet recording system forming an important feature of my present invention is shown in Figure 2. The sensitized record sheet 53 is motivated by means of a metallic platen 54. A plurality of stylus 55 are mounted on a common conveyor belt 56 and are moved along a predetermined region with respect to the platen 54 to trace successive lines of scanning 57 upon the record sheet 53, in a manner to be fully described hereinafter. A preferred conveyor 56 comprises a steel belt having sprocket holes and driven by the sprocket wheel 58. A coacting pulley 59 guides the belt 56 in its predetermined path.

The electrical signals are impressed between the stylus 55 and the sensitive record sheet 53. I prefer to place the record sheet 53 at the high or positive potential side of the signals and illustrate the metallic platen 54 as connected to the cathode 51 through connection lead 60. The negative side of the signals is connected to the stylus 55 through the metallic belt 56, the metallic idler pulley 59, connection lead 61, synchronizing cam switch 62, and connection lead 63. The stylus 55 and associated metallic conveyor 56 are electrically insulated from the remainder of the recording unit, as schematically indicated by the insulation block connection 64 inserted in the drive rod 65 for the sprocket wheel 58. The metallic platen 54 is connected to the framework of the recorder which is preferably at ground potential.

The preferred electrical disposition of the facsimile signal output connections, making the sensitive record sheet 53 positive and the stylus 55 negative, performs the useful function of preventing smudging of the recording due to small particles being removed during the electrical scanning action as fully described in my copending application Serial No. 156,625, referred to hereinabove.

The motivation of the facsimile recorder is preferably through an electrical motor 66 which is operated at a constant speed at or closely adjacent the predetermined synchronous speed corresponding to the speed of the transmitter motor 17. A preferred motor is a constant speed direct current motor having an electrical or mechanical governor control to maintain constant speed thereof. The shaft 67 of the motor 66 is geared to a pinion 68 through intermediate gearing 69 and 70. The stylus drive shaft 65 is mechanically connectable with the shaft 71 by means of a friction clutch 72. Clutch 72 comprises two discs 73 and 74 interconnected by a friction member such as felt pad 75. The clutch plate 73 is slidably secured to the shaft 71 and is mechanically biased against the friction plate 75 by the spring 76, one end of which is fastened to the shaft 71 by nut 77 and the end of which is secured to the friction plate 73. A continuous drive connection is accordingly established between the motor 66 and the sprocket drive wheel 58 for the stylus conveyor belt 56.

The record sheet 53 is moved transversely to the stylus 55 continuously at a predetermined rate. A gear connection to the stylus drive shaft 65 and geared at the proper ratio serves to drive the platen 54 during the movement of the stylus 55. Figure 2 has illustrated a bevelled gear connec-

tion 78 between shafts 79 and 65. A pinion or worm 80 is secured to the shaft 79 and coacts with a larger gear 81 which is mounted on shaft 82 connected to the platen 54. Gear ratios are designed to move sheet 53 at the predetermined rate corresponding to the transverse movement of the electrooptical scanner 20 at the transmitter, for example one inch per minute in a practical embodiment. The corresponding movement of the stylus 55 across the record sheet 53 is preferably equal to the rate of scanning of the record sheet 10 along scanner lines 35.

The width of the record sheet 53 is substantially equal to the circumferential length of the transmitter record sheet 10 in order that the successive scanning lines 57 at the receiver will correspond in length and position to the scanning lines 35 at the transmitter. The distance between the stylus 55 is exactly equal to the circumference of the transmitter drum 11. When three stylus are used on the common conveyor belt 56, the total length of the belt is equal to three times that of the circumference of the transmitter drum 11. The rate of rotation of the sprocket drive shaft 65 is designed to produce a linear rate of stylus belt 56 equal to the circumferential speed of the transmitter drum 11, as will now be evident to those skilled in the art.

Since the record sheet 53 is being advanced simultaneously with the transverse movement of the stylus 55, the successive scanning lines 57 traced upon the sheet 53 will be slightly inclined, as indicated in Figure 2. This inclination corresponds to the similar helical angle or inclination of the scanning lines 35 at the transmitter. The received picture will accordingly have the identical relative scanning as the transmitter to produce an accurate facsimile thereof. A continuous feeding of the record sheet 53, as in the manner described, avoids the prior art step by step feeding operation and provides a smoother feeding of the record sheet.

In order to permit the operator to withdraw the recording on the record sheet 53, and not interfere with subsequent recordings, I provide a pawl 83 and ratchet 84 arrangement. Ratchet 84 is secured to the platen shaft 82; and pawl 83, to gear 81. The pawl and ratchet 83-84 is a positive driving connection between gear 81 and shaft 82. However, should the paper 53 be withdrawn manually at a faster rate than the feed rate of the sheet 53, the pawl and ratchet will permit the slipping of the platen 54 so that the record sheet 53 may be readily moved and the successive scanning will continue as heretofore after withdrawing of an intermediate length of sheeting.

Synchronous operation of the stylus 55 is obtained by line by line synchronizing mechanism responsive to the cyclic synchronizing impulse transmitted. A synchronizing cam 85 is secured to the shaft 79 and is designed to rotate three times per revolution of the stylus belt 56, corresponding to the one revolution per scanning line of the recorder. A nib 86 projects from cam 85 and cooperates with the synchronizing cam switch 62. The lever arm 87 of switch 62 bears upon the contact 88 for maintaining the recording circuit between the stylus 55 and record sheet 53 normally closed during the scanning cycle. However, during the synchronizing period of the cycle, corresponding to the underlap period of the transmitter drum 11, and occurring between the ending of one scanning line and the begin-

ning of the next successive scanning line, the cam nib 86 moves against the lever arm 87 of switch 62 to open its contact with arm 88 connecting it to the third arm 89 of the switch. At this interval, which may be as much as 15% of the scanning line period, the rectified output of the detector tube 48 is connected to the synchronizing relay 90. During this interval, the synchronizing interval, the rectified synchronizing impulse being transmitted, energizes the relay 90 to close the armature 91 against the contact 92 to locally energize the synchronizing magnet 93 through the battery 94.

The driven friction plate 74 contains a projection or nib (not shown since it is positioned in the rear of the plate 74 as viewed in the diagram) which abuts one end of the armature 95 resting against the periphery of the plate 74. I prefer to rotate the shaft 65 and 71 at a rate of about one per cent faster than the normal synchronous rate for the system to insure the arrival of the projection on the plate 74 against the armature 95 at an instant before the reception of the synchronizing impulse. When the synchronizing impulse is received and synchronizing magnet 93 energized, the armature 95 is attracted to the magnet 93 away from the stop plate 74, permitting the continued rotation of the driven friction plate 74 through the friction clutch 72. The movement of the stylus 55 is accordingly started at the proper instant in the beginning of each scanning line operation in exact phase with the corresponding starting position at the transmitter drum, as will now be evident to those skilled in the art.

It is to be understood that line by line synchronism is maintained with the continuous sheet recorder having the multiple styli as represented. Prior synchronizing systems having multiple styli effected synchronism once per revolution of the styli and the facsimile results were not satisfactory, since the successive displacements of the scanning lines were more material and more erratic than is possible with the line by line synchronism attained by my present invention. It is to be further understood that my present invention may be practiced with more or less than the preferred three styli arrangement illustrated.

A high rate of mechanical scanning is afforded by the mechanism of my invention. It is feasible to operate the system with 200 and more scanning lines per minute without affecting the mechanical accuracy of scanning and the like. The only limitations to the high rate of scanning reside in the width of the electric band to be transmitted, which corresponds to the number of elemental picture impulses transmitted per second, and therefore corresponds to the total linear length of scanning effected during each second, as well as the type of carrier for the facsimile signals between the transmitter and receiver, as will be understood by those skilled in the art. The simplicity of the recorder of my present invention makes it eminently useful for home or mobile facsimile use. Picture details of 100 lines per inch are adequate in such applications. Half tone black-white or shaded picture scanning are satisfactorily reproduced by this system.

Figures 3 to 13 represent details of a preferred physical embodiment of a facsimile recorder carrying out the principles of my invention hereinabove described. Figure 3 is a plan view of the recorder with the cover removed illustrating the

roll of recording paper 100' rotatably supported in brackets 101-101. The recording paper 100 is passed over guide rollers 102 and around platen 103. Presser rollers 104 are arranged to press against the sheet 100 near the region of scanning. Rollers 104 extend from brackets 105, mounted upon a rod 106 supported between frame standards 107 and 108. Electrical motor 109 is supported upon the cast iron base 110 of the recorder unit and is arranged to drive the styli and recording sheet in a definite manner. Motor 109 is preferably a constant speed direct current motor having an electrical and mechanical speed governor control housed within to drive the apparatus at synchronous speed. The synchronous speed of the motor is determined by means of the checkered disc 111 in conjunction with a slot tuning fork by stroboscopic action in a manner well known in the synchronizing art.

Figure 4 is an end elevational view of the recorder shown in Figure 3 with the motor 109 removed to show the front elevation of the stylus conveyor 112. I prefer to use a steel belt for 112 containing sprocket holes 113 along its mid-section as illustrated. In the preferred instrument, three styli 115 are shown equidistantly mounted upon the conveyor belt 112. The separation between the styli 115 is equal to the length of one scanning line and corresponds to the circumferential length of the transmitter drum or length of the scanning operation at the transmitter. The stylus conveyor 112 is arranged to be driven by suitable gearing connection from the motor 109 through the intermediate friction clutch member 116 and the drive sprocket wheel 117. An idler or guide pulley 118 is arranged opposite the sprocket drive wheel 117 to maintain the belt 112 taut and in positive alignment and coaction with the record sheet 100.

Figure 5 is a side elevational view of the recorder shown in Figures 3 and 4 showing further details of the mechanical drive arrangements and disposition of the recording paper 100. The roll of recording paper 100' is rotatably mounted on brackets 101. The paper 100 is passed about the idler or guide rollers 102. One of the rollers 102' is immersed in the tank 120 which contains a suitable liquid necessary for the electrolytic action of the stylus on the sheet 100 as will be hereinafter described in more detail.

Motor 109 is geared to the pinion 121 through the intermediate gear 122 and 123 as shown in Figure 5. Pinion 121 operates the sprocket wheel 117 through the intermediately arranged friction clutch 116 in a manner to be described in detail in connection with Figure 7.

As seen in Figures 3, 4 and 7, a pinion 124 is mounted upon the top of the vertical driven shaft 141 for further driving the record sheet 100 as will be shown. The sprocket drive wheel 117 is secured to the vertical shaft 141 and rotates therewith. In Figure 5, the pinion 124 is hidden behind the gear 125 meshing therewith as seen in Figures 3 and 4. Gear 125 is mounted upon an independent shaft 125a set in the frame. Pinion 125' is secured to the same shaft 125a with gear 125 and meshes with a further gear 126. Gear 126 is directly connected to the worm 128 through the shaft 127 which drives the worm gear 129 which, in turn, rotates the platen 103 for driving the record sheet through the unit in a positive manner. A plurality of gears 124, 125,

125' and 126, in conjunction with the worm and worm gear arrangement 128—129, serves to reduce the speed of rotation of the platen 103 with respect to the rotation of the sprocket drive 117, so that the platen will advance the record sheet by a distance equal to the width of one scanning line during the execution of the excursion of one stylus 115 across the record sheet 100. In the illustrated embodiment, one rotation of the vertical shaft 141 rotates the sprocket wheel 117 once and moves one of the stylii 115 across the sheet 100 to execute one scanning line. The movement of the record sheet 100 is .01 inch during the execution of one scanning line to give a scanning differential of 100 lines per inch.

Figure 6 is a vertical cross-sectional view taken along 6—6 of Figure 3 transversely through the recording unit. The progress of the record sheet 100 from the roll 109 is clearly shown in this view. Sheet 100 is immersed through the liquid in tank 120 when a damp or wet recording process is employed. A wiper plate 135 supported in a strip 136 presses the wet sheet 100, as illustrated, to squeeze out the excess liquid therefrom. When a dry process is employed, it is unnecessary to pass the sheet through tank 120 and the sheet is directly passed about guide roller 102a along the dotted position 100a. A guide plate 137 supports the record 100 after it emerges from the platen 103.

For a suitable dry process recording, I employ a carbon content paper having a mercury oxide coating which produces a black picture upon an orange background, or a silver nitrate solution on a white paper to produce a black on white result. For the wet process, I employ ordinary white paper which is passed through a solution of iodide of starch contained in the tank 120 resulting in a sepia or brown finished result. A further dry process employs paper containing barium iodide passed through water contained in tank 120 to dampen the paper for electrolytic recording thereon resulting in a black-white picture.

Figure 7 is a vertical cross-sectional view taken along 7—7 of Figure 8 through the synchronous driving mechanism. The lower gear or pinion 121 is secured to the bushing 140 concentric about and rotatable with respect to the central shaft 141 of the drive. The gear 121 is directly and continuously driven by the electric motor 129 through intermediate gearing 122 and 123 clearly illustrated in Figures 3 and 5. Set screw 142 secures the hub of gear 121 to the lower end of the bushing 140. The upper end of the bushing 140 is arranged to drive the lower plate 143 of the friction clutch 116. The hub of drive plate 143 is slidably secured to the bushing 140 by a feather key 144. Spring 145 is set between a nut 146 and the bottom of the hub of friction plate 143 to mechanically bias the friction plate 143 against the friction pad 147 of the clutch 116. Friction pad 147 is preferably felt, although materials such as rubber or fiber may be employed.

The upper drive plate 148 of clutch 116 is pinned to the central driven shaft 141 by pin 149. The shaft 141 is vertically supported in bushings mounted in the bracket 108. The hub 150 of the driven friction plate 148 is fastened to the sprocket driver 117 by set screw 151. The stylii conveyor belt 112 is carried by the wheel 117 in a manner to be further described in detail in connection with Figure 8. Driven friction plate 148 contains a projection or nib 152 for coaction with the synchronizing magnet to

maintain the driven belt 112 in phase synchronous position as will be further described hereinafter.

In carrying out my invention, the stylii 115 are maintained at an independent voltage with respect to the record sheet 100 for electrostatic or electrolytic recording. Accordingly, the stylii 115 and associated conveyor belt 112 are insulatingly mounted with respect to the framework of the system. As shown in Figure 7, a preferred mounting for the belt 112 is to construct the sprocket wheel 117 and the two sections 153, the inner section; and 154, the outer section. The inner section and outer section 153 and 154 comprising sprocket wheel 117 are screwed together by screw members 155. The inner sprocket member 153 is made of insulation material. The outer sprocket member 154 is preferably made of aluminum or an alloy to have adequate wearing characteristics in use.

Figure 8 is a horizontal cross-sectional view taken along 8—8 of Figure 4 through conveyor 112 and associated driving mechanism. Belt 112, a flexible steel belt having perforations 113 at regular intervals for positive drive coaction with the sprocket wheel 117, is arranged about the drive sprocket wheel 117 and the driven sprocket wheel 118. The stylii 115 are symmetrically arranged equidistant about the belt 112. I prefer to employ three stylii 115, as shown, although fewer or more may equally well be employed with my invention. In this construction and in the illustrated embodiment, I construct the diameter of the sprocket wheels 117 and 118 so that their circumference is equal to one third the length of the belt 112. I arrange the sprocket pins 156 in driver sprocket 117 to engage with the sprocket holes 113 in a positive manner.

Figure 9 is an enlarged detailed view of the stylus 115 mounted upon the conveyor belt 112. Stylus 115 consists of a pin 160 set into a bushing 161 which is welded or soldered to the belt 112 at the position corresponding to one of the sprocket holes 113. The stylii 115 are arranged to project into a particular opening 162 in the drive sprocket 117, the sprocket hole 162 corresponding to a position of the sprocket pins 156.

The idler pulley 118 carries the belt 112. Figure 10 is a cross-sectional view taken along 10—10 of Figure 8 through the idler pulley 118. Pulley 118 contains a recess or cavity 164 of the pulley for admitting the bushing of the stylii 115 projecting beyond the belt 112. Pulley 118 is insulatingly mounted with respect to the frame and bracket mounting 107 of the machine. One method is to have a metallic or aluminum bushing rotatably mounted upon a rod 165 set in the bracket 107 in insulation bushings 166 and 167.

Pulley 118 contains projecting flanges 168 for accurately centering the belt 112. Electric contact is made to the stylii 115 through the belt 112 by its frictional contact with the metal pulley 118 and the rotational friction contact of the hub of pulley 118 with the supporting shaft 165. An electrical lead 165a is connected to the drive 165 for electrical connection with the facsimile signals. Lead 165a corresponds to the connection lead 61 of Figure 2 and is the negative potential lead for the signals. As described in connection with Figure 2, the positive potential lead for the signals is connected to the framework of the facsimile recorder, which preferably is a grounded potential and is conductively connected to the metallic platen 103 coating with the record sheet

100 during recording. Referring to Figure 8, the styli 115 are shown to coact with the record sheet 100 carried by the platen 103. Platen 103 is preferably constructed of brass for conductively connecting the paper 100 to the framework through brackets 107 and 108. Platen 103 is secured to a central shaft 133 set in brackets 107 and 108. Shaft 133 of platen 103 is driven by a worm and worm gear arrangement 128—129, as shown in Figures 5, 8 and 11.

Worm 128 is connected with a positive driving connection to the styli belt drive as hereinabove described in connection with Figures 2 and 5. Figure 11 is a side view corresponding to 11—11 in Figure 8 to illustrate the preferred drive connection for the platen 103. A pawl 170 is secured to worm gear 129. A ratchet 171 is pinned to the shaft 133 of platen 103. Pawl and ratchet arrangement 170—171 drives the platen in a positive manner through the worm and worm gear arrangement 128—129, and yet permits the independent rotation of platen which occurs when the record sheet 100 is manually withdrawn from the recorder.

The synchronizing details for maintaining the system in line by line synchronism is thoroughly described in connection with the schematic Figure 2 hereinabove. The synchronizing cam 175, corresponding to the cam 85 in Figure 2, is mounted upon shaft 141, as shown in Figures 4, 5 and 7. Cam 175 actuates cam switch 176 mounted upon bracket 108. The synchronizing magnet 177 is supported from rod 106, as shown in Figures 3 and 4. Figure 12 is an enlarged detailed view through 12—12 of Figure 4 of the synchronizing magnet 177 and its mounting on shaft 106 by means of a block 178 secured to shaft 106 and a bracket 179 extending from block 178. Synchronizing magnet 177 is arranged to attract armature 180 secured to lever 181 in response to a received synchronizing signal impulse, as will be understood by those skilled in the art.

The lever 181 is pivoted at 182 on bracket 108 as seen in Figure 4. Lever 181 is arranged to ride on the periphery of upper friction plate 148 of the friction clutch 116 as viewed in Figure 2. Figure 13 is a view taken along 13—13 of Figure 4 to demonstrate the coaction of the synchronizing lever 181 with the friction plate 148. The solid position of the lever 181 pivoted at 182 contacts the periphery of plate 148. A projection 152 of plate 148 abuts the tip 183 of lever 181 while it is in the solid position. This occurs when the driven friction plate 148 reaches the predetermined position shown before the synchronizing signal is impressed upon magnet 177. At the instant the signal reaches magnet 177, armature 180 is attracted thereto and lever 181 is moved to the dotted position shown in Figure 13, lifting the tip 183 beyond the position of the projection 152 to permit the driven friction clutch member 148 to execute one revolution. The synchronizing signal occurs for a small portion of the rotation cycle and lever 181 falls to the position shown in solid to again effect synchronizing control on the driven member 148.

Accurate phase synchronism at the start of each line is accordingly afforded by the multiple styli recorder and novel synchronizing arrangement. The friction clutch member 148 is secured to shaft 141, as illustrated at Figure 7, which drives the sprocket driver 117 and the platen 103 as hereinabove described. The gear ratios from shaft 141 controlled by friction plate member 148 are arranged so that one revolution

of the shaft 141 corresponds to the movement of one of the styli 115 across the record sheet. The circumference of the sprocket wheels 117 and 118 is equal to the distance between the styli 115 which distance corresponds to the circumference of the drum at the transmitter. The synchronizing signal occurs at the end of each scanning line to accurately position the styli 115 at the beginning of each scanning line maintain accurate phasing and synchronous recording by the successive styli on the record sheet 100.

In the illustrated embodiment, for example as shown in Figure 2, a positive drive connection is shown between the mechanism for motivating the styli 55 across the record sheet 53 and the mechanism for feeding the record sheet 53 including the platen 54 and the associated gearing 80 to 84. This positive driving connection is designed so that the ratio of gearing is such as to maintain a predetermined movement for the styli 55 and the record sheet 53, in the preferred embodiment corresponding to the related movements at the transmitter in the rotation of the drum 11 and the movement of the scanner carriage 20 transverse to the drum. In order to scan the record sheet along the lines 57 with an angle equivalent to the helical angle of the scanning lines 25 at the transmitter, the ratio of the transverse movement of the styli 55 and the continuous advance of the record sheet 53 axially should equal the ratio of the peripheral velocity of the drum 11 while rotating, and the transverse motion of the scanner carriage 20, as will now be evident to those skilled in the art. It is not necessary that the length of the record sheet 57 be identical with that of the periphery or the circumference of the drum; a proper contraction or enlargement in the reproduction being entirely permissible, as will be realized by those versed in the facsimile art. The synchronizing mechanism including the magnet 93 and the clutch 72 operate, in response to a transmitted cyclic synchronizing signal, to maintain the recording apparatus in phase synchronism with the transmitter drum 11. The styli 55 are arranged in a predetermined manner in relation with the positive feeding of the sheet 53 to start at one end of the sheet at the beginning of each scanning cycle, corresponding to the underlap portion of the record 10 as clamped on the transmitter drum 11.

Although the illustrated embodiment shows a plurality of styli 55 moved in a linear path along a recording sheet 53 maintained in a linear scanning region, it will now be obvious that a different arrangement for the styli or corresponding recording units is feasible and may be used with the principles of my invention. Thus the arrangement of a plurality of recording units symmetrically about a rotatable axis may be made to cooperate with a recording sheet 53 held in an arcuate scanning path to successively cooperate with the rotated multiple styli. The styli in this modification would trace the scanning lines 57 successively during each rotation of the common carrier for the styli. The synchronizing arrangement for the multiple styli rotated about a common axis will be similar to that illustrated in connection with the styli carried by a continuous belt 56 in that the cyclic synchronizing impulse transmitted once per revolution of the drum 11 would be employed to actuate the motivating mechanism for the styli after each trace of one recording unit across the recording sheet.

It will thus be evident that the important contribution of my present invention resides in the recognition and solution of the problem for maintaining a multiple recorder system in synchronism for reproducing a facsimile, namely the step by step synchronism for each of the plurality of recorder units or stylii between the execution of the recording for each unit or stylus upon the record sheet.

Furthermore, it will be evident that my present invention is not limited to a recording system where the record sheet is continuously advanced during the recording period. The step by step synchronizing of the recorder units or stylii may be accomplished without maintaining the positive drive connection 80 to 84 between the stylus motivating mechanism and the sheet feeding mechanism as shown in Figure 2. It is obvious that a step by step advancing means may be employed for the record sheet 53 which sheet could be advanced between the successive scanning line recordings, namely during the synchronizing interval for the multiple recording units. The individual recording units may have electro-mechanically actuated stylii for impinging upon the record sheet such as shown and described in my Reissue Patent No. 19,575. Such units when arranged in a multiple unit, for example three, to embody the high speed recording principles of my present invention, would essentially consist in the placing of three stylii one hundred twenty mechanical degrees apart and in a single plane adapted to be rotated in a single direction by the driving motor. It is to be understood that the synchronizing arrangement would accordingly be effective for each third of a revolution of the stylii carrier shaft, corresponding to the similar phase synchronizing action for each third of a revolution of the continuous belt carrier 56 for the stylii 55 in Figure 2. At any rate, the principles of my present invention may be embodied in various modifications for facsimile transmission and reception without departing from the broader spirit and scope of the invention, and accordingly I do not intend to be limited except as set forth in the following claims.

I claim:

1. A facsimile system including a transmitter having means for generating signals in accordance with the elemental shading of a record comprising a rotatable drum for carrying and rotating said record therewith and mechanism for scanning the record on said drum transversely of

the rotation of the drum whereby said record is scanned in a continuous helical path, means for generating a synchronizing signal cyclically in accordance with the rotation of said drum once per rotation of said drum and means for transmitting said generated signals; and a receiver having means for translating said signals including a continuous sheet recorder comprising means for continuously feeding a recording sheet at a predetermined rate past a predetermined scanning region during the recording periods, a plurality of stylii for successively individually recording a line of scanning on said sheet at said scanning region and means for successively motivating said stylii along said record sheet at a rate substantially equal to the peripheral velocity of said drum, a positive driving connection between said feeding means and said motivating means for maintaining the ratio between the axial and transverse scanning movements for said sheet corresponding to the related movements for the record on said drum and means responsive to said synchronizing signals for controlling said feeding means in phase synchronism with said scanning mechanism and for operating said motivating means into phase synchronism with the rotation of said drum.

2. A facsimile system including a transmitter having means for generating signals in accordance with the elemental shading of a record comprising a rotatable drum for carrying and rotating said record therewith and mechanism for scanning the record on said drum transversely of the rotation of the drum whereby said record is scanned in a continuous helical path, means for generating synchronizing signals once per rotation of said drum and means for transmitting said generated signals; and a receiver having means for translating said signals including a continuous sheet recorder comprising means for feeding a recording sheet past a predetermined scanning region during the recording periods, a plurality of recording units for successively individually recording a line of scanning on said sheet at said scanning region and means for successively motivating said recording units along said record sheet at a predetermined scanning rate and means responsive to said synchronizing signals for operating said motivating means into phase synchronism with the rotation of said drum after the operation of each of said plurality of recording units on said sheet.

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