Sept. 16, 1941. G. H. RIDINGS ET AL 2,255,869

SYSTEM AND APPARATUS FOR FACSIMILE TELEGRAPHY

Filed March 28, 1939 3 Sheets-Sheet 1

FIG. 1

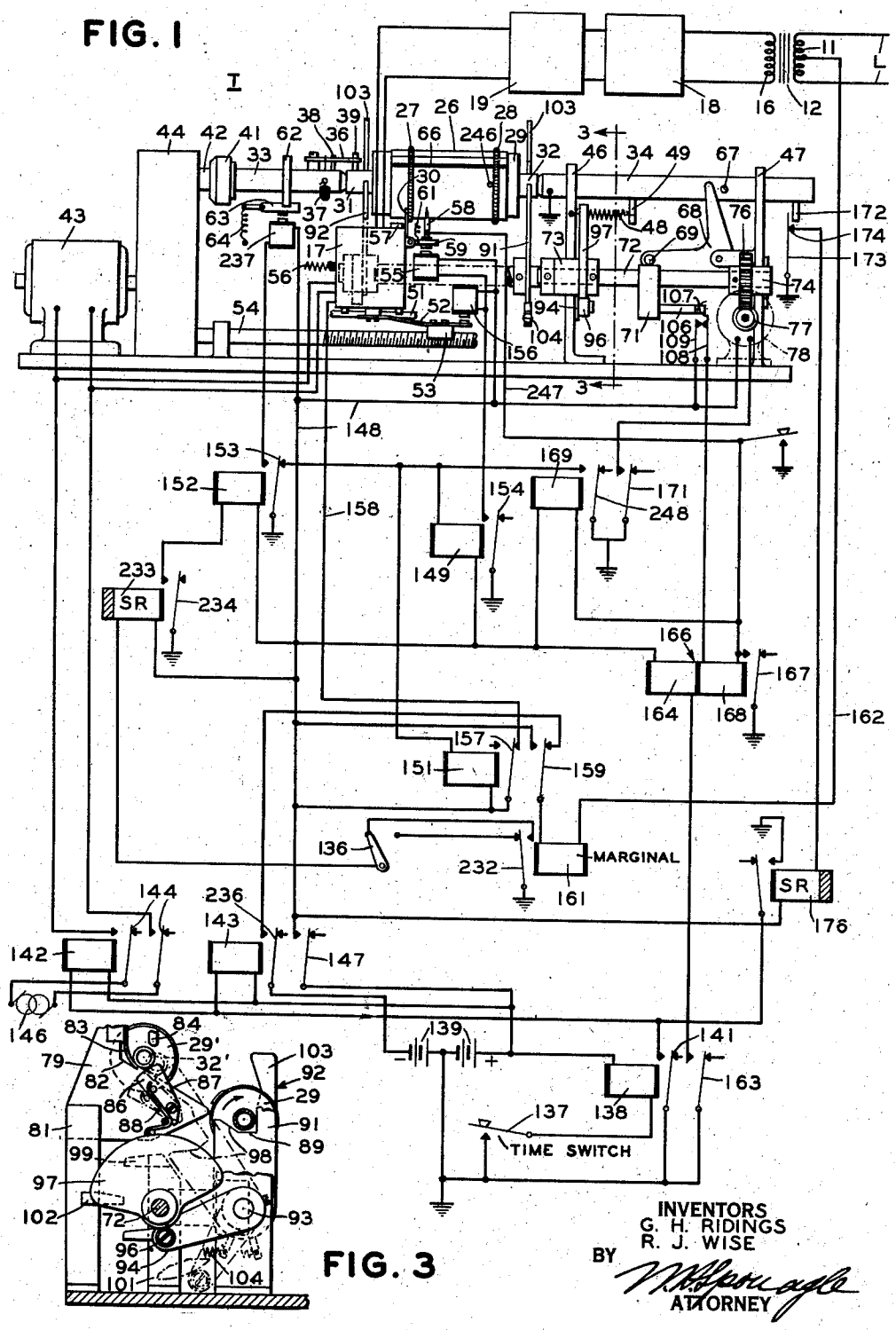

FIG. 3

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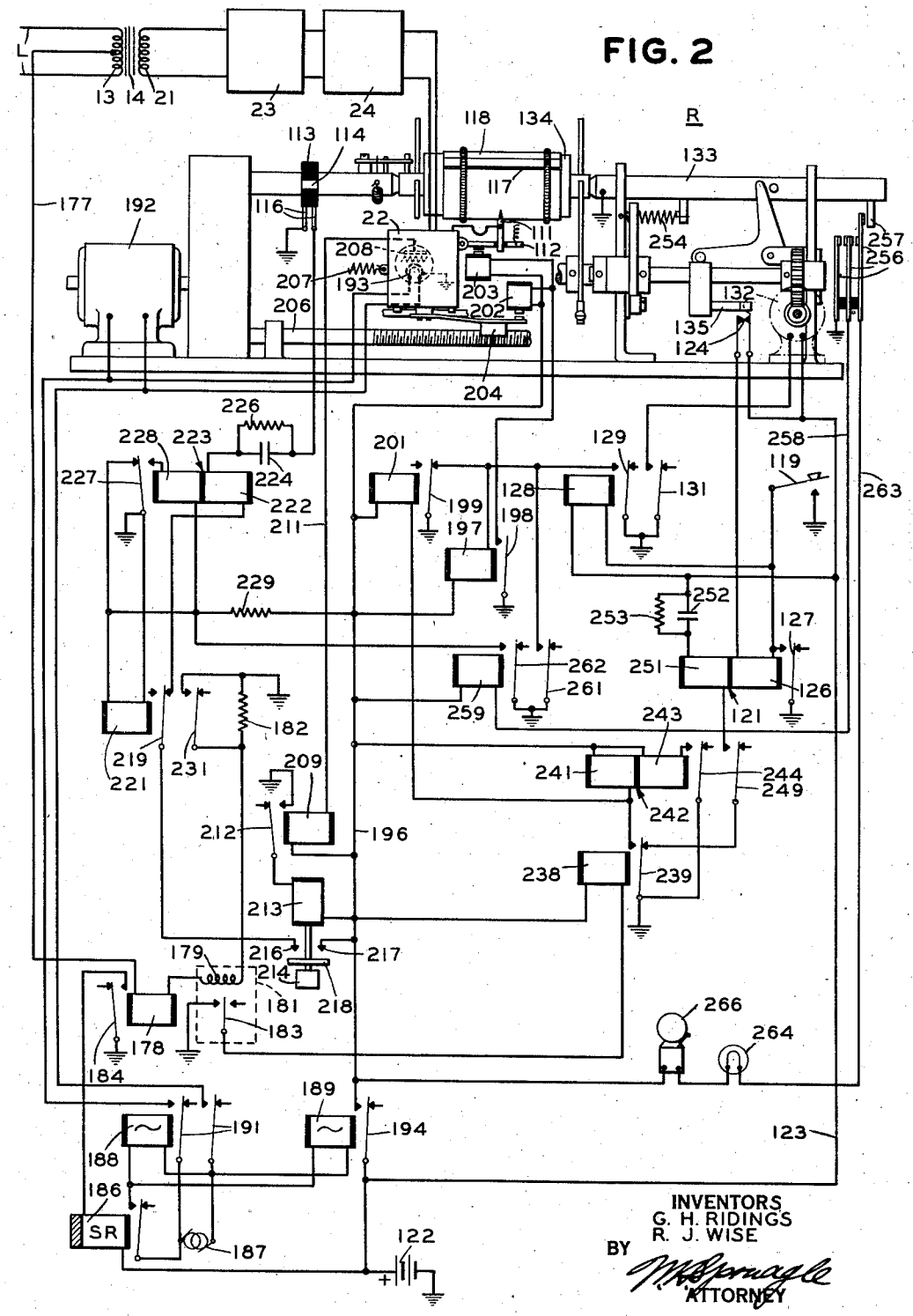
SYSTEM AND APPARATUS FOR FACSIMILE TELEGRAPHY

Filed March 28, 1939 3 Sheets-Sheet 2

FIG. 2



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Filed March 28, 1939 3 Sheets-Sheet 3

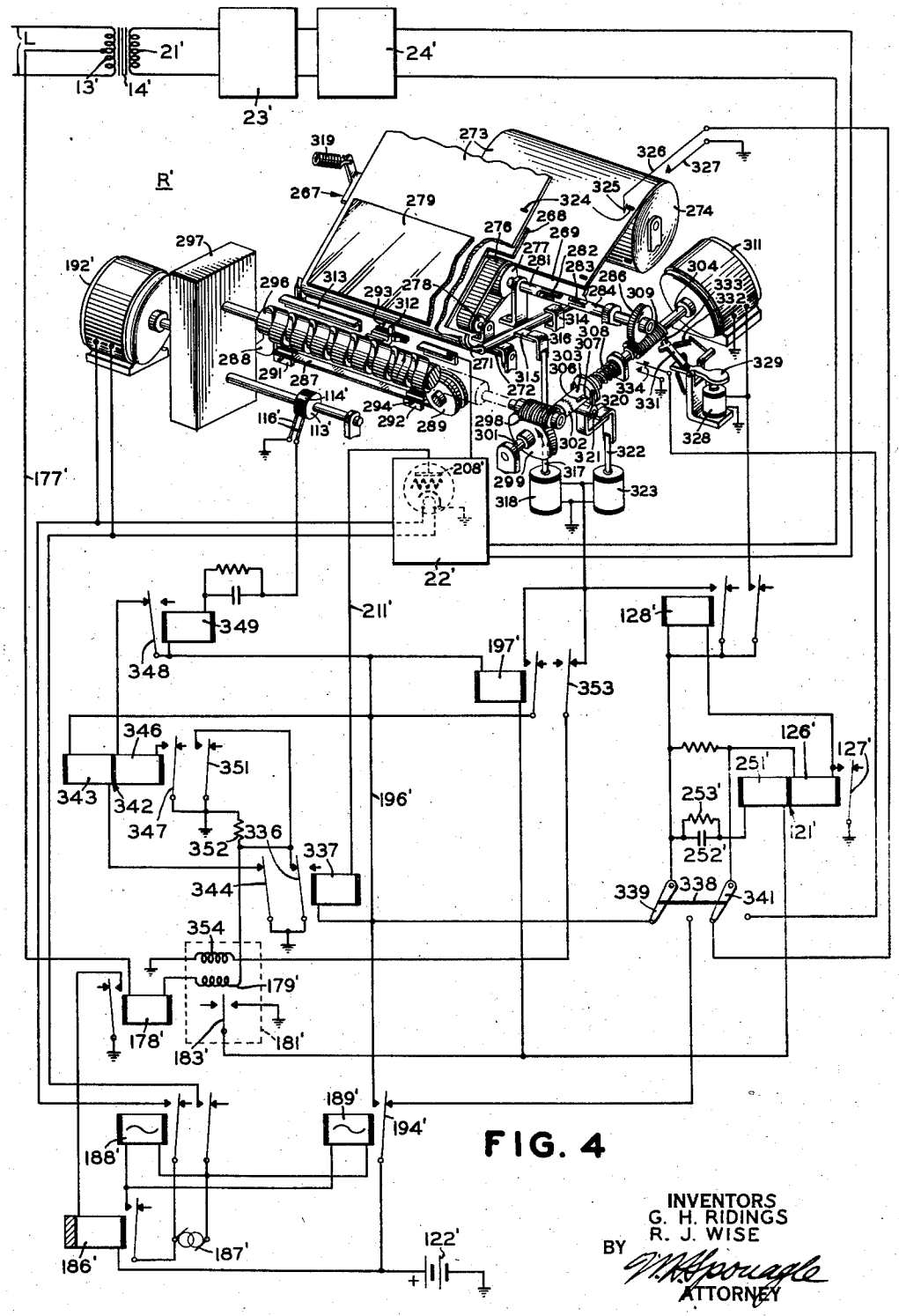

FIG. 4

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2,255,869

SYSTEM AND APPARATUS FOR FACSIMILE TELEGRAPHY

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Application March 28, 1939, Serial No. 264,512

23 Claims. (Cl. 178—5)

This invention relates to telegraph apparatus and has particular reference to novel automatic facsimile telegraph systems.

In a co-pending application of R. J. Wise, et al., Ser. No. 110,760, filed November 13, 1936, and entitled "System and apparatus for facsimile telegraph" there is disclosed and claimed means for the automatic control of facsimile telegraph apparatus. In one of the illustrative embodiments disclosed in said application the control signaling is effected after a scanning operation by automatically disconnecting from the transmission medium the picture-modulated carrier current and substituting therefor an unmodulated alternating current or tone signal. However, the invention disclosed in said application does not relate specifically to provisions for controlling the power supply of facsimile apparatus.

It is one of the major objects of the instant invention to provide an organization of instrumentalities whereby the transmitting and recording apparatus employed in a facsimile telegraph system is conditioned for operation only during such times as there is subject matter to be transmitted. It is obvious that, with such a mode of operation, numerous economies may be effected such as reducing the power consumed to operate the apparatus and minimizing depreciation of the equipment.

Another object of the invention resides in the provision of means whereby the apparatus of a plurality of facsimile telegraph circuits may be automatically conditioned for operation by a single operation performed at one of the terminals.

A further object of the invention is to provide means to control, from one station of a facsimile telegraph system, the power supply for the apparatus at one or more remote stations.

Another object of the invention is to effect the automatic control of a facsimile machine of the type which is capable of continuously scanning a sheet or web.

Another object of the invention is to automatically control the operation of facsimile apparatus whereby discrete recordings of subject matter are effected on a continuous web of recording material.

A further object of the invention is to automatically control the operation of facsimile apparatus whereby a continuous recording of discretely transmitted subject matter is effected.

Still another object of the present invention is to provide instrumentalities whereby the signaling employed for controlling the apparatus of a facsimile telegraph system is effected by direct currents sent over the transmission medium employed by the picture-modulated carrier.

A still further object of the invention is to provide various guard features whereby operation of the transmitting equipment of a facsimile telegraph system is prevented unless the recording apparatus is in condition to receive.

Another object of the invention is to provide means for automatically discontinuing the operation of the transmitting and recording apparatus of a facsimile telegraph system during the intervals between a series of subject matter transmissions.

The attainment of the foregoing objects and others more detailed will be understood from the following description of illustrative embodiments of the invention taken in conjunction with the accompanying drawings, of which:

Fig. 1 is a diagrammatic representation of salient mechanical features of the transmitting apparatus and their relation to the associated control circuits;

Fig. 2 is a similar illustration of the receiving and recording apparatus of a facsimile telegraph system;

Fig. 3 is a fragmentary sectional view of some of the mechanical features of both the transmitting and receiving apparatus, taken on the line 3—3 of Fig. 1; and

Fig. 4 is a schematic representation of a modification of the invention as utilized in conjunction with one form of a diagrammatically illustrated continuous recorder.

It will be understood that the showing of the mechanical details of the terminal apparatus is merely diagrammatic. Only enough of such detail is shown to illustrate the invention. It will be obvious that the present invention may be used with numerous other types of facsimile apparatus with equal facility.

In its broad aspect the invention contemplates the full automatic operation of a facsimile telegraph system by means of direct current control signals sent over a control signalling channel distinct from the facsimile carrier channel but which, if desired, may, although it need not necessarily, utilize the same transmission medium that is employed for the transmission of the facsimile carrier currents. Responsive to an operation occurring at one station of a facsimile telegraph system, the apparatus at this station is supplied with operating power and certain control relay equipment is operated to transmit a characteristic direct current signal

over the transmission medium. The reception of said characteristic signal is employed at a remote station to operate relay control apparatus, whereby the remote equipment is supplied with power. Means are also included in the remote station control apparatus which are responsive to the operative conditioning of said apparatus, and which are employed to transmit over the transmission medium a second characteristic direct current signal. The reception of said second signal at the first named station is utilized to phase the facsimile apparatus thereof with the facsimile apparatus of the remote station and simultaneously to send a third characteristic direct current signal by way of the transmission medium to the remote station. Reception of said third characteristic signal at the remote station causes the facsimile apparatus thereof to be placed into operation so that the image of a picture or other subject matter transmitted from one station will be reproduced at the other station.

The means provided at the transmitting and the receiving station or stations for supplying a succession of copyholders to the respective apparatus are disclosed and claimed in the above mentioned application of Wise, et al. The control circuits at the interconnected stations which form the novel subject matter of the instant application function in a manner to change the copyholders at their respective stations in response to a direct current signal initiated by a characteristic of the subject matter being sent from the transmitting station. Upon completion of the transmission of a series of such subject matter, means responsive thereto, located at the transmitting station, are employed to apply a characteristic electrical condition to the transmission medium to render the apparatus at both the transmitting and receiving stations inoperative by disconnecting the respective power supplies therefrom.

Where the receiving apparatus comprises a recorder employing a continuous recording medium, the control circuits and associated apparatus function in a manner to eject that portion of the medium bearing recorded subject matter and to feed a fresh portion into a recording position. Also, when a recorder of this type is utilized to make a continuous record of discretely transmitted subject matter, the control equipment is employed to effect continuity of the recording and, at the completion of the transmission of one or more pieces of subject matter, to eject a predetermined length of the medium from the recorder subsequent to the inoperative conditioning of the recording apparatus.

Referring to Figs. 1 and 2 of the drawings, there is shown transmitting apparatus designated generally by the character T and recording apparatus designated generally by the character R which apparatus is shown in detail in the above mentioned application of Wise, et al. The transmitter and recorder are connected with one another by means of a line L terminating at the transmitting station in winding 11 of transformer 12 and at the receiving station in winding 13 of the transformer 14. The winding 16 of transformer 12 is connected to any form of a facsimile carrier generator found in the prior art and housed in the carriage 17 through an amplifier 18 and an attenuator 19. A corresponding connection is made between the winding 21 of transformer 14 and any known type of demodulator housed in the carriage 22 through an amplifier 23 and attenuator 24.

In the apparatus shown in the drawings to illustrate the invention, the subject matter 26 to be transmitted is secured by means of a plurality of elastic retaining bands or spring garters 27 and 28 to a copyholder 29 in the form of a drum or cylinder. The toroidal member 27 is rolled lengthwise of the blank by a projection 30 mounted on the carriage 17. The copyholder 29 is provided with arbors 31 and 32 at the ends thereof which are supported for rotation by means of spindles 33 and 34 provided with conical ends for engaging aligned indentations in the ends of the arbors 31 and 32. The spindle 33 is used for rotating the drum by means of a driving connection comprising a pivoted arm 36 attached to the spindle 33 and urged by means of a spring 37 secured to the spindle and the arm 36 against a stop pin 38 extending radially from the spindle. The movable end of arm 36 engages an extension 39 formed on the arbor 31. A friction clutch 41 serves to connect the spindle 33 with a constantly rotating shaft 42 so that rotation of the spindle 33 may at times be arrested. A synchronous alternating current motor 43 is used to drive the shaft 42 at any desired speed through suitable reduction gearing 44.

The rod 34 which serves to support the arbor 32 for rotation is carried by brackets 46 and 47 and is adapted for reciprocating movement therein. A retractile spring 48 is attached to a pin 49 secured on the rod 34 and also to any suitable stationary member such as the bracket 46 and serves to urge the rod 34 toward the left as viewed in the drawings.

The carriage 17 is mounted for slidable movement on a pair of parallel rails 51, only one of which is shown. Rigidly attached to the carriage 17 is one end of a resilient member 52 which carries adjacent its free end an internally threaded member 53 commonly known as a half-nut. The member 52 is tensioned so as to normally effect engagement of the threads of the half-nut 53 with cooperating threads of a feed screw 54. The feed screw 54 is rotated at a suitable speed by means of the driving motor 43 acting through the reduction gearing 44. Upon the engagement of the half-nut 53 with the feed screw 54, a movement of the carriage 17 toward the right is effected. A retractile spring 56 is attached to the carriage 17 and to a convenient stationary member so that when the half-nut 53 is disengaged from the feed screw 54, the carriage 17 is returned to an extreme position toward the left as viewed in the drawings. A chamber 57, containing a system of lenses by which optical scanning of the subject matter 26 is effected, is mounted on the carriage 17. However, scanning may be secured by a stylus or other device without departing from the invention, since it is not limited to the use of any particular scanning means. Also mounted on the carriage is a stylus 58 carried by and insulated from a pivoted member 59 which is normally urged, by means of a spring 61 in an upward direction to effect the engagement of the stylus 58 with the picture or other subject matter 26 mounted on the drum 29. The function of the stylus 58 will be described later in connection with the description of the control circuits.

The driving shaft 33 is provided with a disc 62 having a peripheral notch formed therein. A pivoted latch 63 is mounted so as to secure co-

operation between it and the peripheral notch of the disc 62. The latch 63 is urged by a spring 64 toward a position in which it may engage the notched disc and thereby prevent rotation of the driving shaft 33. The angular position of the notch in the disc 62 relative to the lap 66 formed in the subject matter 26, as it is secured upon the copyholder 29, is such that, when the latch 63 is engaged with the notch, the lap is held in a definite position relative to the scanning device 57. In placing a sheet 26 on the copyholder 29, the lap 66 is always identically positioned relative to the pin 39, by any suitable means, such as aligning it with a mark on the copyholder. The significance of this feature will be better understood from the description of the operation of the system given hereinafter.

In order to release one copyholder and engage another for rotation, it is necessary that at least one of the rotational centers formed on the spindles 33 and 34 be withdrawn and, in this case, the spindle 34 is so arranged. Accordingly, the rod 34 is provided with a radially extending pin 67 which is engageable by the vertical arm of a bell crank 68 pivoted on the bracket 47. The horizontal arm of the bell crank 68 carries a pin or cam follower 69 extending from one side thereof. The cooperating cam 71 is provided with a flat surface on its periphery and is secured to a shaft 72, journaled in bearing 73 and 74 attached respectively to the brackets 46 and 47. A pinion 76 driven by means of a worm 77 secured to the shaft of a motor 78 imparts rotation to the cam shaft 72. As the cam 71 is rotated so that the pin 69 is carried into engagement with the raised portion of the cam, the horizontal arm of the bell crank 68 is raised, thereby imparting a clockwise movement to the vertical arm of the bell crank which engages the pin 67 of the rod 34, moving the latter to the right against the action of the retractile spring 48. It will be seen that, when the rod 34 has been moved to its extreme right position, the copyholder 29 may be removed and another put in the place thereof. The function of copyholder changing will be described presently. As the cam 71 continues its cycle of movement the pin 69 ultimately becomes disengaged from the raised portion of the cam, thereby permitting the spring 48 to draw the rod 34 toward the left so that its conical center may engage the indentation in the end of the arbor 32 of a fresh copyholder.

The mechanism disclosed and claimed in the above mentioned Wise, et al application, and which is provided for storing a supply of copyholders in readiness to be fed, one at a time, into the scanning device and the mode of operation of said mechanism will be described by having reference to Figs. 1 and 3. A rack or magazine is used to store the cylinders and comprises two similar rail members 79 (one of which is shown in Fig. 3) mounted on a pair of supporting brackets 81 and spaced apart slightly more than the length of the cylinder 29. The rail members 79 are each provided with a sloping edge 82 upon which the arbors of the copyholders are supported as they roll toward the operating position. A pair of resilient upright members 83 secured to the rail members 79 cooperate with the downturned ends 84 of an auxiliary pair of spaced rails (not fully shown, but which may extend upwardly at any convenient angle in order to provide an additional storage means for other cylinders) to guide the stored cylinders toward the scanning device. The next cylinder 29' to be fed into the scanning device is held in readiness by having its arbors 31' (not shown) and 32' supported by one end 86 of a pair of detents 87 each pivoted adjacent its other end on one of the rail members 79. The detents 87 are normally held in this cylinder restraining position by means of a pair of resilient members 88 attached thereto and to the rail members 79.

Upon completion of a scanning operation, the rod 34 is withdrawn from its operative engagement with the arbor 32 as previously described. This operation permits the copyholder 29 to drop so that its arbors 31 and 32 are received in recesses 89 (one of which is shown in Fig. 3) in a cradle formed by a pair of spaced tiltable members 91 and 92.

The members 91 and 92 are rigidly secured to a rock shaft 93 which is suitably journaled in bearings mounted in any convenient fixed brackets. Also secured to the rock shaft 93 is an arm 94 carrying at its outer extremity a cam follower in the form of a roller 96. A cam 97 with which the roller 96 is adapted to cooperate is attached to the cam shaft 72. When the shaft 72 is rotated by means of the mechanism driven by motor 78, the engagement of the roller 96 with the raised portion of the cam 97 results in a counterclockwise movement of the arm 94, as viewed in Fig. 3, thereby imparting a rocking movement to the spaced members 91 and 92.

When the cradle members 91 and 92 are moved as described above into the positions shown dotted in Fig. 3, an edge 98 formed in each of these members is brought into alignment with the upper edge of a finger 99 mounted on a bracket 101. The copyholder 29 is thus permitted to roll over the finger 99 dropping to a finger 102 oppositely extending from bracket 81. A plurality of other fingers extending oppositely and alternately from brackets 81 and 101 may be provided to guide the copyholder 29 into any suitable discharge device. It will be understood that corresponding fingers are provided at the other end of the copyholder.

A pair of upwardly extending arms 103 formed respectively on the cradle members 91 and 92 engage and move the detents 87 out of the downward path of the arbors 31' and 32' when the former are moved to the left as viewed in Fig. 3. Thus, the upper ends 86 of the detents 87 are disengaged from the arbors 31' and 32' of the copyholder 29'. This copyholder is thus permitted to drop so that the arbors thereof rest on the upper edges of the arms 103. When, by continued rotation of the cam 97, the rocker shaft 93 is permitted to return the members 91 and 92 to their upright positions under the influence of a spring 104 attached to one of the members and to any convenient stationary member, the upper edges of the arms 103 are removed thereby allowing the arbors 31' and 32' of the copyholder 29' to roll into the recesses 89 in the cradle members. The new copyholder 29' is thus carried into a position such that, when the members 91 and 92 have been fully restored to their upright positions, the indentations formed in the ends of the arbors may be engaged by the conical centering points formed on the spindles 33 and 34. Prior to such engagement, the axis of the copyholder, as it rests in the recesses 89 formed in the cradle members 91 and 92, lies slightly below the center of rotation provided by the spindles 33 and 34. However, because of the configuration of the ends of these spindles, the subsequent movement of the rod 34 toward the left, as viewed in Fig. 1, is instrumental in elevating the copyholder so that

it may rotate freely, without the arbors thereof making contact with the cradle members 91 and 92.

The initiation of the drum-changing cycle just described is effected by applying power to the motor 78 subsequent to a scanning operation, or at any other desired time, by means which will be described hereinafter. A cam 106, which may be attached to any convenient member mounted on shaft 72, is shown diagrammatically in the instant disclosure attached to one face of the cam 71. As viewed in Fig. 1, the movement of this cam is toward the observer. Accordingly, it is provided adjacent its outer extremity with a beveled portion 107 which is adapted to engage a contact lever 108 just prior to the completion of the drum-changing cycle. The movement of lever 108 resulting from this engagement serves to open the contacts 108 and 109 which, as will be seen later, is instrumental in disconnecting the power supply from motor 78. However, the mechanism is so designed that, before the motor can be braked to a stop, the cam 106 becomes disengaged from the lever 108 thereby permitting the contacts 108 and 109 to reclose.

The mechanism comprising the receiving apparatus shown in Fig. 2 is substantially identical with that of the transmitting apparatus just described except for a few details which will be pointed out hereinafter. Otherwise the remaining parts of the receiving apparatus R will be understood to be the same as corresponding apparatus shown at the transmitter T. The scanning device used at the transmitting station and shown in Fig. 1 housed in the chamber 57 is not used with the recording apparatus. Recording is effected by a stylus 111 mounted on a member 112 which is pivoted on the carriage 22. It will be understood, however, that this showing of a recording means is merely diagrammatic and that other recording devices may be used for this purpose in connection with the present invention with equal facility. In the receiving apparatus, a circuit controlling device comprising a disc 113 of insulating material and having a short conducting segment 114 is used in place of the notched disc 62 of Fig. 1. The angular position of the conducting segment 114 is chosen so that its engagement with the cooperating brushes 116 occurs at a time when the lap 117 in the recording sheet 118 bears a definite angular relation to the position of the stylus 111.

Before proceeding with the description of the automatic functioning of the facsimile apparatus, it is to be noted that there is provided means, similar to those disclosed in the Wise, et al application to which reference has previously been made, for initiating a drum changing cycle at any station independently of any other station. As shown in the instant application, drum changing at the transmitting station T of Fig. 1 cannot be effected until the local power supply has been connected to the control apparatus. However, at the receiving station R of Fig. 2, the control apparatus used in drum changing is directly connected to the local power supply. Hence, drums may be changed at this station at any time. Except for the respective power connections to the transmitting and receiving apparatus, which, if desired, may be arranged in any other convenient manner, the apparatus for changing drums and the operation thereof at both stations is identical. Inasmuch as it is assumed, at this point, that the facsimile apparatus is idle, the above mentioned drum changing operation will be described in connection with Fig. 2, although it will be understood that the description may be applied to Fig. 1 whenever power is supplied to the apparatus involved either by a direct connection or by means of a connecting switch.

To initiate a drum changing cycle at the receiving apparatus R of Fig. 2, a push button 119 is momentarily depressed. This manipulation results in the operation of relay 121 through a circuit from the positive side of the direct potential 122, conductor 123, normally closed contact 124 and winding 126 of relay 121 to ground at push button 119. This relay, when once operated, is locked by means of its armature 127 applying a ground to replace that originally applied by push button 119. Movement of the armature 127 to its front contact also places a ground on one terminal of the winding of relay 128, the other terminal of which is connected to conductor 123. The energization of relay 128 causes its tongues 129 and 131 to be moved into engagement with their respective front contacts, thereby applying a ground to one terminal of the motor 132, the opposite terminal of which is connected to conductor 123. The application of power to the motor 132 indicates a cycle of operations described hereinbefore in connection with the mechanical features of the apparatus whereby the rod 133 is moved first to the right and, when one copyholder 134 has been removed and a fresh one placed in the recording apparatus, to the left to engage said fresh copyholder for rotation. Upon completion of this cycle of operations, the cam 135 operates, as previously described, to momentarily open contact 124. The opening of this contact interrupts the locking circuit of relay 121 through winding 126, thereby restoring the armature 127 to its back contact. The removal of the ground from front contact of relay 121 deenergizes relay 128 which deenergizes the motor 132 by the removal of the ground therefrom.

The following portion of the description is directed to the novel control apparatus forming the subject matter of the instant application. It will be understood that the invention is not limited to use with the specific form of facsimile apparatus shown herein to illustrate the invention, but is applicable to numerous other types of facsimile systems, operating either continuously or intermittently, wherein control of the apparatus is effected from one or more of a plurality of interconnected stations.

It will be assumed that, at this time, there is no copyholder in operative position in the transmitting apparatus T of Fig. 1 but that there is a storage of copyholders carrying subject matter to be reproduced at the recorder awaiting transmission. Also switch 136 is positioned on its left hand contact, as shown.

Also, it will be assumed that the receiving apparatus R of Fig. 2 is supplied with a copyholder bearing a fresh blank in operative recording position and with a copious supply of fresh copyholders in the storage device provided therefor. It will be seen from a subsequent portion of the description that the transmitting and receiving apparatus will always be left in the above described conditions at the finish of a series of subject matter transmissions providing that the receiving station attendant maintains a supply of fresh copyholders in the storage device.

To start the series of operations which will result in the automatic transmission and recording

3 of this stored subject matter a switch 137 at the transmitter T is closed. The switch is of the type which, when once operated, remains in such condition for a predetermined length of time, after it is restored to its unoperative position. Numerous forms of such switches may be found in the prior art, one of which utilizes a clock mechanism for controlling its operation and is preferred in practicing the instant invention. Closure of this switch energizes relay 138 by means of direct current potential supplied from the source 139 through obvious circuits.

Operation of this relay causes one of its armatures 141 to apply a ground to one terminal of the windings of each of the relays 142 and 143 thereby operating said relays. The armatures 144 of relay 142 connect an alternating current potential derived from a source 146 to the driving motor 43 and to certain of the apparatus located in the carriage 17, such as the heating elements of the vacuum tube amplifier and the driving motor for a light chopper. The armature 147 of relay 143 applies positive potential from the direct current source 139 to conductor 148. As soon as potential is applied to this conductor, relays 149 and 151 are operated, one terminal of each of their windings being connected to conductor 148 and the other terminals to the back contact of relay 152 which is engaged by armature 153 to complete the circuit to ground. The operation of the armature 154 to the front contact of relay 149 energizes the stylus retracting magnet 155 and the carriage return magnet 156. Thus the carriage 17 is restored, under the influence of the retractile spring 56 to the extreme left hand end of its travel, and the stylus 58 is withdrawn. The operation of relay 151 effects, by means of one of its armatures 157, the removal of positive potential from conductor 158 which supplies the plate circuits of the amplifier housed in the carriage 17. The armature 159 of relay 151 applies positive potential through its front or left hand associated contact, the winding of relay 161 and conductor 162 to the midpoint of the winding 11 of transformer 12. Thus both conductors comprising the line circuit L have an equal positive potential applied thereto for a purpose which will hereinafter be described in detail. Relay 161 is one which operates on a marginal basis and, as will be seen later, the current applied to it at this stage is insufficient to effect the operation thereof.

Armature 163 of relay 138 energizes the operating winding 164 of relay 166 effecting the movement of its armature 167 to its front contact. The engagement of armature 167 of relay 166 with its front contact applies a ground to its winding 168, the other terminal of which is connected by way of the normally closed contact 109 to conductor 148 thereby locking this relay. The engagement of armature 167 with its front contact also applies ground to the winding of relay 169 which operates to apply a ground through one of its armatures 171 and its associated front contact to one terminal of the motor 78, the other terminal of which is connected to conductor 148. The application of power to the motor 78 starts the drum changing cycle previously described in which the first copyholder 29 is placed in operative position in the transmitting apparatus. It will be noted that under these conditions the rod 34 is restrained by the arbor 32 from being moved far enough to the left to permit the engagement of pin 172, attached to the rod, with a switch lever 173. Thus the ground connected to said lever is conducted by means of the contact 174 to the winding of relay 176, the other terminal of which is connected to conductor 148. The operation of this relay places a ground on the windings of relays 142 and 143 to replace the one originally supplied by armature 141 of relay 138. Thus, when relay 138 is rendered inoperative by the opening of the time controlled switch 137, the power switching relays 142 and 143 remain operated. The timing means of switch 137 may thus be regulated to maintain the closure of the contacts of this switch for a period slightly greater than that required for the operation of relay 176.

When the copyholder 29 has been placed in the transmitting apparatus T with the pin 39 engaged with the driving member 36, the shaft 33 is prevented from causing rotation of the copyholder by reason of the fact that the latch 63 is held in engagement with the notch of the disc 62 by means of spring 64. As previously explained, the lap 66 formed in the subject matter 26 is thus held in a definite position relative to the scanning device housed in the chamber 57. Also, the stylus 58 is held withdrawn and the half nut 53 is held disengaged from the feed screw 54 by means of their respective electromagnets 155 and 156 which are energized through the operated contacts of relay 149 which is energized as long as the armature 153 of relay 152 is engaged with its back contact.

Referring now particularly to Fig. 2, the positive potential applied to the line conductors L following the operation of the switch 137, and the relay operation resulting therefrom is also applied to conductor 177 connected to the midpoint of the winding 13 of transformer 14 in which winding the line is terminated. Conductor 177 connects this positive potential through the winding of relay 178, winding 179 of a polarized relay 181, and resistor 182 to ground. The application of positive potential to the winding of relay 181 moves the armature 183 to its right hand contact. Relay 178 is energized to operate its armature 184 to its front contact thereby applying ground to one terminal of the winding of relay 186, the other terminal of which is connected to the positive terminal of the direct current source 122. The operation of relay 186 closes an obvious circuit from the alternating current source 187 to the windings of relays 188 and 189. The operation of the tongues 191 of relay 188 to their respective front contacts applies alternating current potential to the driving motor 192 and to certain of the apparatus housed in the carriage 22 such as the vacuum tube heating elements 193. The operation of armature 194 of relay 189 to its front contact connects positive potential to the conductor 196. As soon as positive potential is applied to conductor 196, relay 197 operates its armature 198 to its front contact. The operating winding of this relay derives its potential from conductor 196 and its ground from armature 199 of relay 201 through its back contact. The operation of relay 197 applies the ground connected to its tongue 198 to one terminal of the respective windings 202 and 203 of the carriage return and stylus retracting magnets, the other terminals of which are connected to conductor 196. The stylus 111 is thus withdrawn from operative engagement with the recording blank 118 and the half nut 204 is disengaged from the feed screw 206, permitting the movement of the carriage 22 to its extreme left hand position under the influence of the spring

207. It will be noted that as soon as the driving motor 192 is supplied with alternating current potential, it causes rotation of the feed screw 206 and the copyholder 134. The rotation of the driving motors 43 and 192 respectively of Fig. 1 and Fig. 2 is synchronous. This synchronism is attained by any suitable means, such as deriving the power therefor from the same power system where convenient.

The potential for the vacuum tube plates 208 of the amplifier housed in carriage 22 is supplied from conductor 196 through the winding of relay 209 and conductor 211. As soon as the amplifier is conditioned for operation, plate current is drawn through the circuit just described, thereby operating the tongue 212 of relay 209 to its front contact which applies a ground to one terminal of the winding of relay 213, the other terminal of which is connected to conductor 196. Relay 213 is provided with a time delay feature such as a dashpot 214, the purpose of which is to close the contacts 216 and 217 by means of a bridging member 218 a predetermined time after the energization of the operating winding. This time delay is introduced for the purpose of permitting the amplifiers employed at the transmitting station sufficient time to be operatively conditioned. Such a precaution is necessary because the amplifying apparatus used at the transmitting station differs from that used at the receiving station and requires a longer time for conditioning. After said predetermined time has elapsed the conductor 196 is connected through contacts 216 and 217 by means of the bridge 218, through the tongue 219 and back contact of relay 221 to one terminal of winding 222 of relay 223. The other terminal of winding 222 is connected by way of a condenser 224 shunted by a high resistance 226 to one of the brushes 116 associated with the disc 113. Upon the revolution of disc 113 following the closure of the contacts 216 and 217 of relay 213, in which the conducting segment 114 is next brought into contact with brushes 116, the ground connected to one of these brushes is connected to the condenser 224, thereby completing a circuit to charge the condenser. Sufficient charging current is drawn through the operating winding 222 of relay 223 in the short time that the circuit remains closed through the brushes 116 to operate the tongue 227 to its front contact, which is instrumental in locking the relay in this position by applying a ground to one terminal of winding 228, the other terminal of which is connected to conductor 196 through resistance 229. The resistance 226 is for the purpose of discharging the condenser 224 following the operation of relay 223. The removal of the ground connected to tongue 227 of relay 223 from its back contact permits the operation of relay 221, which, until relay 223 is operated, has a ground connected to both terminals of its winding. However, one of said terminals is connected to the positive potential of conductor 196 through resistance 229. Thus the operating circuit for relay 221 comprises a connection to positive potential through resistance 229, the winding of relay 221 and ground connected to the tongue 227 of relay 223. The operation of armature 219 of relay 221 to its front contact opens the operating circuit to winding 222 of relay 223 at a second point. The operation of armature 231 of relay 221 to its front contact shunts resistance 182 connected in the direct current signaling circuit provided between the transmitter T and the receiver R.

The shunting of resistor 182 from the direct current signaling circuit causes a considerable increase in the current flowing in said circuit. This increased current is conducted through the winding of marginal relay 161 in Fig. 1 thereby energizing it sufficiently to operate its armature 232 to its front contact. The ground connected to armature 232 is thus applied, by way of switch 136, to one terminal of the winding of relay 233, the other terminal of which is connected to positive potential at conductor 148. The operation of armature 234 of relay 233 to its front contact energizes relay 152 and thereby switches the ground connected to the tongue 153 of the latter relay from its back contact to its front contact. Removal of the ground from the back contact of relay 152 deenergizes relay 149 and consequently the stylus retracting magnet 155 and carriage return magnet 156. The stylus 58 is moved into operative relation to the copyholder 29 and the half nut 53 is permitted to engage the feed screw 54 thereby causing the carriage 17 to be moved toward the right as viewed in the drawing. The removal of the ground from the back contact of relay 152 also deenergizes relay 151 permitting its armatures 157 and 159 to be restored to their respective back contacts. Positive potential is thus applied to conductor 158 and thence to the plate circuit of the amplifier housed in carriage 17. Negative potential from direct current source 139 is connected by armature 236 and front contact of relay 143 and armature 159 and its associated back contact of relay 151 through the winding of relay 161 and conductor 162 to the line L. The application of ground to the front contact of relay 152 energizes the phasing magnet 237 which withdraws the latch 63 from the notch in the disc 62 allowing the shaft 33 to be driven from the shaft 42 through the friction clutch 41.

Thus, rotation of the copyholder 29 is initiated simultaneously with the initiating of the movement of the carriage 17 toward the right thereby securing a helical scanning of the subject matter 26 attached to the copyholder 29. Also both of these functions are performed simultaneously with the application of negative potential to line L. It will be understood that, because of the synchronous operation of the driving motors 43 of Fig. 1 and 192 of Fig. 2, once the transmitting and recording apparatus is properly phased, as described hereinbefore, said apparatus will normally continue to function in said condition indefinitely, thereby obviating phasing between successive transmissions of a series. However, means for inter message phasing are disclosed in the application of Wise, et al., hereinbefore referred to, and the adaptation of this facility to the instant invention is believed to be obvious. Hence, it is not contemplated that the omission of this feature constitutes a limitation to the present invention.

The negative potential applied to the line L affects the winding 179 of polarized relay 181 of Fig. 2 in a manner to move the armature 183 to its left hand contact. A ground is thereby applied to operate relay 238 which, in moving its tongue 239 to its associated front contact, applies a ground to winding 241 of relay 242 and to the winding of relay 201. Relay 242 is locked in its present operated position through the application of the ground connected to tongue 239 of relay 238 to winding 243 through tongue 244 and its associated front contact of relay 242. The operation of relay 201 removes the ground

from its back contact and the winding of relay 197, thereby releasing the tongue 198 of the latter relay. The release of tongue 198 deenergizes the electromagnets 202 and 203 permitting the stylus 111 to be carried into operative relation with the recording blank 118 and effecting the engagement of the half-nut 204 with the feed screw 206, which is instrumental in moving the carriage 22 toward the right as viewed in the drawing. Thus the carrier current generated at the transmitter T and modulated in accordance with the tone values of the picture or other subject matter being transmitted is applied through suitable amplifying and demodulating apparatus to the recording stylus 111 whereby the transmitted tone values are reproduced on the recording medium 118.

It is to be noted that the sequence of operations initiated by the engagement of brushes 116 with segment 114 of the receiving apparatus of Fig. 2 immediately following the operative conditioning of said apparatus includes the transmission of a characteristic direct current signal from the receiver R to the transmitter T, in response to which the transmitting mechanism is released for operation simultaneously with the transmission of another characteristic signal over the direct current signalling circuit from the transmitter T to the receiver R whereby the receiving apparatus is released for operation. Thus the tone values recorded by the receiving stylus 111 are applied to the recording medium 118 in substantially the same position on the medium as the position on the sheet 26 from which they were scanned at the transmitter T.

After the completion of the scanning operation at the transmitter T of Fig. 1, the stylus 58 effects engagement with a perforation 246 formed in the sheet of subject matter 26. The ground connected to the rod 34 is thus applied by way of conductor 247 to winding 168 of relay 166, the circuit for which is completed through normally closed contact 109 to conductor 148. It will be understood that the invention is not limited to the use of the stylus and the perforated sheet means of detecting the end of a scanning operation, but contemplates the employment of other equivalent means, which are disclosed and claimed in the application of Wise, et al hereinbefore referred to. The operation and subsequent locking of relay 166 starts the cycle of drum changing described in detail hereinbefore. One step in this cycle is the operation of relay 169, the armature 248 of which is employed to energize electromagnets 155 and 156 through relay 149 by which stylus withdrawal and carriage return is effected. It also serves to operate relay 151 which, by reason of the movement of its tongue 159 to its front contact, applies positive potential to the line L.

In Fig. 2, this positive line potential is utilized to move the tongue 183 of relay 181 to its right hand contact thereby removing the ground from relay 238 and allowing the ground connected to its armature 239 to be switched from the winding of relay 201, thereby releasing the armature 199 of this relay to control the withdrawal of stylus 111 and the return of carriage 22, to the back contact of relay 238, through armature 249 and its associated front contact of relay 242 to winding 251 of relay 121. The circuit for winding 251 is completed through a condenser 252 shunted by a high resistance 253 to conductor 123. The charging current for condenser 252 is thus caused to effect the operation and subsequent locking of relay 121. The value of the steady state current flowing through winding 251 and resistance 253 is so small that the winding is insufficiently energized to maintain relay 121 in an operated condition. The purpose of this arrangement is to enable the contact 124 to effect the release of armature 127 of relay 121 at the proper time, even though the above described steady state current is, at that time, still flowing. As previously described, the operation of relay 121 causes the operation of other relays and mechanism whereby the copy holder 134 is removed from the machine and a fresh one substituted therefor. It is to be noted that the drum changing operations at the transmitter and receiver are initiated substantially simultaneously. Under normal conditions the respective operations are also completed substantially simultaneously. But since, as will appear presently, the initiation of the following recording operation of the receiving apparatus is controlled by the completion of the drum changing operation at the transmitter, it is preferable that the corresponding receiver operation be completed first.

The completion of the drum changing function at the transmitter T of Fig. 1 momentarily opens contact 109 to release relay 166 and the relays controlled thereby. Among the latter is relay 151 which, when released, applies negative potential through its armature 159 to the line L.

At the receiver R of Fig. 2 the negative potential applied to line L is employed to effect the engagement of armature 183 of relay 181 with its left hand contact, thereby effecting the operation of armature 239 of relay 238 to its front contact, which, as previously described, controls the positioning of the stylus 111 in operative relation with the recording medium 118 and the initiation of the movement of carriage 22 toward the right. The successive transmission and recording of subject matter proceeds in the manner described until the supply of such subject matter is exhausted at the transmitter T.

At the completion of the transmission of the last piece of subject matter to be sent, the apparatus at the transmitter T functions in the manner described to change the copy-holder 29. At the same time a characteristic signal is sent over the direct current signalling channel to effect a similar operation at the recorder R. At the transmitter, the copyholder 29 is removed from the transmitting apparatus, but, there being no others held in the storage device awaiting transmission, the drum changing cycle is completed by the mechanism provided therefor without placing a new drum in the machine. When the rod 34 is permitted to be moved toward the left under the influence of spring 48, the movement is no longer limited by an arbor 32. Hence the rod 34 is moved farther to the left than it is during normal operation of the transmitting apparatus, and in traveling this added distance effects the engagement of pin 172 with tongue 173 to remove the ground from contact 174. Removal of this ground results in the release of relay 176 which, in turn, releases relays 142 and 143 thereby disconnecting the alternating current and the direct current power supplies from the transmitting equipment. Upon the disconnection of the power supplies, operation of driving motor 43 and the apparatus housed in the carriage 17 is discontinued and all relays are restored to their unoperated positions. Also the source of

potential utilized for the direct current signalling channel over the line L is disconnected from said line.

Referring to Fig. 2, it is seen that the removal of the potential from line L releases the armature 184 of relay 178 resulting in the release of the armatures of relays 188 and 189 through relay 186. Thus alternating current and the direct current power supplies of the receiving apparatus is also disconnected, thereby restoring all of the apparatus to its idle condition. The state or condition in which the receiving apparatus is left differs from that of the transmitting apparatus in that a fresh copyholder 134 containing a blank recording sheet 118 has been placed in the recording apparatus prior to the disconnection of the local power supplies.

Accordingly, whenever there is added subject matter to be transmitted by means of the apparatus herein disclosed, said subject matter is placed in the storage device at the transmitter T and switch 137 is closed which, as described hereinbefore, initiates a series of operations resulting in the full automatic control of both the transmitting and receiving devices.

It will be noted that certain of the control relays employed in the illustrative embodiment of the instant invention are of the slow-to-release type. At the transmitting station of Fig. 1, for example, relay 176 is a relay of this nature, the reason therefor being to prevent the opening of its contacts due to momentary interruptions in the operating circuit. It has been found that, in operating a system of this nature, such momentary interruptions may occur by reason of the jar to which contact 174 is subjected while the mechanical apparatus is performing some of its normal functions, such as the changing of copyholders. Relay 233 of Fig. 1 is of the slow-to-release type since its operating circuit is controlled by the armature 232 and front contact of relay 161. It will be recalled that the winding of this relay is subjected to periodic reversals of current which may cause the armature 232 to become disengaged from its front contact during such current reversals. At the receiving station of Fig. 2 the relay 186 is of the slow-to-release type because its operating circuit is controlled by the engagement of armature 184 of relay 178 with its front contact. This relay is also subjected to current reversals, which may cause a chattering of the contacts.

Included in the control apparatus for the receiving device of Fig. 2 are a number of safety features designed to guard against the possibility of the transmitting equipment operating at a time when the recording apparatus is not in a receptive condition. Among such times may be when there is no drum in the recorder, when the line circuit L is open, when the driving motor 192 fails to start, and when the amplifier housed in the carriage 22 fails to become heated.

With the drum changing mechanism in its normal idle position and with no drum positioned in the recording mechanism the rod 133 is permitted to travel, under the influence of spring 254, far enough to the left, as viewed in the drawings, to effect the mutual engagement of a plurality of contacts 256 by means of a pin 257 extending radially from rod 133. The ground connected to one of the contacts 256 is thus applied to conductor 258 to operate relay 259. One of the armatures 261 of this relay operates relay 197 to withdraw the stylus 111 and return the carriage 22 to its extreme left hand position. Another armature 262 of relay 259 applies a ground to one terminal of winding 228 of relay 223 and the winding of relay 221, the other terminals of which windings are also connected to the ground of armature 227 of relay 223. Hence these windings are effectively short-circuited, permitting the armatures of the relays to be released to their back contacts. The disengagement of armature 231 of relay 221 from its front contact reintroduces the resistance 182 into the direct current signalling circuit, thereby reducing the value of the current flowing in this circuit.

In Fig. 1, relay 161 releases its armature 232 since the reduced value of the current flowing through the winding thereof provides insufficient energization to maintain the armature engaged with its front contact. The release of the armature of relay 161 results in the release of the latch 63 which becomes engaged with the peripheral notch formed in the disk 62 arresting the rotation of shaft 33. The movement of the armature 153 of relay 152 to its back contact, in response to the release of relay 161, operates relay 149 to effect the withdrawal of stylus 58 and the return of the carriage 17 to its extreme left hand position. It also energizes the winding of relay 151, the armatures of which are actuated to their front contacts. The polarity of the potential supplied to the direct current signalling current is thus reversed from negative to positive by the movement of armature 159 from its back to its front contact. Thus, it is seen that operation of the transmitting equipment is effectively prevented until the receiving apparatus can be supplied with a copyholder to record the transmission.

At the receiving station R, the closure of contacts 256 also applies a ground to conductor 263, which operates an alarm comprising a lamp 264 to give a visual indication and a bell or buzzer 266 to give an audible indication that the receiving mechanism is not provided with a copyholder.

In the event that the line circuit L is open and the transmitting apparatus is placed in operation by the closure of switch 137 of Fig. 1, the driving shaft 33 is prevented from rotating by means of the latch 63 engaging the notch of disk 62 as previously described. However, the direct current control signal originating at the armature 159 and front contact of relay 151 cannot reach the receiving apparatus of Fig. 2 to initiate operation thereat by energizing relay 178. Hence, there can be no direct current signal of increased amplitude sent from the receiver R to the transmitter T thereby preventing the operation of the phasing magnet 273 of Fig. 1 until suitable steps are taken to place the receiving apparatus in communication with the transmitting apparatus.

If, for some reason, the synchronous driving motor 192 of Fig. 2 fails to operate in response to the operation of relay 188, the transmitting apparatus is maintained inoperative by the engagement of the latch 63 with disk 62 for the reason that the direct current signal of increased amplitude is not sent from the receiving apparatus. The failure to send said signal is caused by the failure of relays 223 and 221 of Fig. 2 to operate, the circuit controlling the operation of these relays being incomplete by the non-engagement of brushes 116 with conducting segment 114 of disk 113.

The transmitting apparatus is prevented from phasing if the amplifier housed in carriage 22 of

Fig. 2 fails to become operatively conditioned by the heating of the vacuum tube cathodes employed therein. In this case the apparatus employed to send the direct current signal of increased amplitude is rendered inoperative by the non-operation of relay 209, the winding of which is included in the plate circuits of the amplifier vacuum tubes. Obviously, with no plate current being consumed by the amplifier, the relay 209 will not operate.

When the operation of the system herein disclosed is interrupted at the end of a series of subject matter transmissions, the transmitting apparatus T is left without a drum supported in operative position between the spindles 33 and 34. However, the receiving apparatus R is left in its idle condition with a copyholder 134 supported in operative position therein. At the start of a new series of subject matter transmissions the switch 137 of Fig. 1 is operated to supply the apparatus with power and to place a fresh copyholder 29 in the machine. Also armature 159 of relay 151 is operated to its front contact to send a signal of a positive polarity over the line L to operate armature 183 of relay 181 of Fig. 2 to its right hand contact, thereby opening the operating circuit of relay 238. It will be recalled from the previous description that this operation was utilized to initiate a drum changing cycle at the receiver R by operating relay 121. The operating circuit for this relay included the armature 249 and front contact of relay 242. Since a fresh drum 134 is held in position in the recording mechanism it is desirable that its discharge be prevented at the time that the first of a series of copyholders is placed in the transmitter T. This is accomplished by maintaining the operating circuit of relay 121 open at the front contact associated with armature 249 of relay 241, since this relay is not operated until the receiver has been placed in operative condition, the direct current signalling current increased to operate the phasing magnet 237 of Fig. 1 and a signal of negative polarity sent from armature 159 of relay 151 and its associated back contact to operate armature 183 of relay 181, Fig. 2, to its left hand contact, thereby applying ground to operate relay 238, which in turn closes the operating circuit through winding 241 of relay 242. As previously explained, this relay locks through winding 243 and armature 244 and remains in this condition for the duration of the series of subject matter transmissions and thus prepares the relay 121 for operation for all subsequent copyholder changes necessary for the remainder of the series.

Having reference now to Fig. 4 there is disclosed a modification of the invention used in conjunction with recording apparatus which may be operated in a manner to effect discrete recordings of the subject matter or, if desired, to effect a continuous recording of said subject matter. For the purpose of illustrating the operation of such apparatus, the mechanical details thereof are shown diagrammatically in a perspective view located at the upper part of this figure. A recorder of this nature is disclosed and claimed in a co-pending application of G. L. Erickson et al, Serial No. 263,632, filed March 23, 1939, and entitled Improvement in Facsimile apparatus.

In the following description the control apparatus which is similar to corresponding apparatus of Fig. 2 and which is employed for similar purposes is designated by similar reference characters with primes added thereto for distinction.

A paper guide 267 having angularly disposed faces 268 and 269 and an arcuate portion 271 is pivotally supported on a rod 272 located toward the front of the guide member. A continuous length of recording material 273 is supplied from a roll 274 and is disposed relative to the guide member 267 as illustrated. The paper is drawn from the roll by means of a friction drive comprising a belt 276 running over pulleys 277 and 278. The belt 276 is adapted to grip the paper 273 on the underside thereof as it passes over the face 268 and to force the outer surface of this portion of the paper against the inside of a smooth flat member 279 which may be of transparent material if desired. The driving pulley 277 for the paper feeding mechanism is rigidly mounted on a shaft 281 which is connected by means of a pair of universal couplings 282 and 283 to a shaft 284 to which is rigidly attached a pinion gear 286. The universal couplings 282 and 283 are provided with conventional slot and pin arrangements whereby the shafts 281 and 284 may, in effect, be moved lengthwise of each other. The purpose of such an arrangement will become apparent from a subsequent portion of the description.

An endless belt member 287 is supported by means of a pair of pulleys 288 and 289 and carries thereon a plurality of styli 291, 292 and 293 attached thereto by means of suitable supporting and guiding structures. The styli are spaced on the belt 287 in such a manner that when one of them becomes disengaged from the paper 273, the engagement of another with the paper is effected. Each stylus, in its operative engagement with the paper, is constrained to a horizontal movement by means of suitable guide members, not shown, cooperating with the supporting and guiding structure of the stylus. Each stylus is provided with a pin such as 294 of stylus 292 which is adapted for engagement with a helical groove formed on a feed screw 296. The feed screw 296 is rotated by means of the driving motor 192' acting through suitable reduction gearing 297.

The screw 296 is also employed to drive a worm gear 298 which is rigidly attached to one end thereof. Cooperating with the worm gear 298 is a pinion gear 299 which is fixed on a shaft 301. Also attached to this shaft is one portion 302 of a clutch. The other portion 303 of this clutch is mounted on a shaft 304 and is provided with a slot 306 cooperating with a pin 307 attached to the shaft 304 so that the clutch member 303 may be moved axially of the shaft. The clutch 302—303 is normally engaged, under the influence of a spring 308, to effect rotation of shaft 304 by means of motor 192'. Secured to the shaft 304 is a worm gear 309 which is arranged to impart rotation to the pinion gear 286 and thus perform the function of paperfeeding by means of the mechanism previously described. Shaft 304 also constitutes the armature shaft of a motor 311 which is normally deenergized during a recording operation.

Stylus 293 is provided with a contacting member 312 which is adapted for sliding engagement with a stationary rail member 313. The member 313 is connected electrically to the amplifying and demodulating apparatus housed in the container 22'. A disk 113' is driven at a suitable speed by the motor 192' acting through reduction gearing 297. The conducting segment 114' of this disk is arranged to effect contact with the cooperating brushes 116' at a time when one of the recording styli bears a definite relation to the recording medium 273. The purpose of this rela-

tion is, as in the previously described modification, to secure the proper phasing of the transmitting and recording apparatus.

In order to space the styli from the paper in the intervals between recordings, the paper guide 267 is arranged to be pivoted about the rod 272 between the two arms of a stop 314. The lower face 269 of the paper guide is provided with a projection 315. An angular actuating member 316 carried at the upper end of a rod 317 is arranged to engage the projection 315 to effect a downward movement thereof, thereby pivoting the paper guide 267 so that the portion of the paper being guided around the arcuate section 271 is moved out of operative relation with the stylus 293. The downward movement of the face 269 is limited by the lower arm of the member 314. The lower end of rod 317 constitutes an armature or plunger which is attracted by a solenoid 318 when energized. The paper guide 267 is normally urged, by means of a spring 319, against the upper arm of the stop member 314 so that the stylus 293 is operatively engaged with the recording paper 273. It will be noted that the movement of the paper guide is made possible by the extensibility of the couplings provided between end shafts 281 and 284. Also the universal couplings 282 and 283 provide a means of driving the paper feeding mechanism while the paper guide is depressed in its lower or retracted position.

During a recording operation, the paper 273 is fed through the recording apparatus at a relatively slow speed suitable for proper recording. In this instance the paper feeding mechanism derives its motion from the driving motor 192' which also serves to impart a horizontal motion to the plurality of styli. The rotative motion of the driving screw 296 is transferred to the paper feeding driving pulley 277 by means of the worm gear 298 and its associated pinion gear 299, the clutch 302—303, the worm gear 309 and its associated pinion gear 286 and the universal couplings 282 and 283.

The clutch member 303 is arranged to be moved axially of its supporting shaft 304, whereby this shaft is uncoupled from the shaft 301. A forked member 320 is pivoted at 321 and is adapted to engage a flanged portion of the clutch member 303. Engageable with the lower end of the forked member 320 is armature 322 of a solenoid 323. The energization of this solenoid causes the forked member 320 to move the clutch member 303 along the shaft 304 against the action of the compression spring 308. With the clutch thus disengaged paper feeding by means of motor 192' is discontinued, but if desired a predetermined length of paper may be fed through the recording apparatus at any desired speed by means of the motor 311. Preferably the speed at which the paper is fed under these conditions is much greater than the speed at which it is moved during a recording operation.

The paper 273 is provided, adjacent one edge thereof, or in any other convenient place, with a series of spaced openings 324. The spacing of these openings is such that when the apparatus is being operated as an intermittent recorder, the subject matter is recorded in a series of frames with the recordings invariably starting at corresponding points of the frames. Cooperating with the openings 324 is a finger 325 formed at the end of a light flexible contact member 326. The finger 325 is inclined as shown to eliminate any possibility of tearing the web. As the paper is being withdrawn from the roll 274 the free end 325 of the contact 326 is arranged to enter each opening whereby contact is made with a stationary contact member 327. Continued movement of the paper causes the end 325 of the contact member 326 to be ejected from the opening 324 and it is permitted to rest upon the surface of the paper until the following hole or opening is engaged. It will be understood that the contacts 326 and 327 merely serve to illustrate diagrammatically a means employed for the detection of the openings 324. It is contemplated that any one of a number of known means, including a light source and a light responsive element such as a photoelectric cell, may be utilized for this purpose without departing from the instant invention. The purpose of this arrangement is to arrest the fast paper feeding operation and will be described in detail hereinafter.

The paper feeding apparatus is also provided with a timing mechanism for the purpose of discontinuing the fast feeding of paper when the recorder is arranged for continuous recording and its specific function will become apparent from a subsequent portion of the description. The timing apparatus comprises a solenoid or electromagnet 328 and an associated armature 329, upon which is mounted a pivoted arm 331. The arm 331 is normally held in the position shown by means of a retractile spring 332. Adjacent the other extremity of the arm 331 is an upstanding pin 333. As shown in the drawings this pin is normally disengaged from but may be brought into engagement with the underside of the worm gear 309. The engagement is effected by energizing the electromagnet 328 whereby the armature 329 is attracted thereto, moving the pin 333 upwardly so that it becomes engaged with one of the convolutions of the worm gear 309. If the armature 329 is maintained in its operative position for a predetermined length of time, the arm 331 will be pivoted in a counterclockwise direction, as viewed from the top, until it effects the closure of contact 334. When the electromagnet 328 is deenergized, the pin 333 is disengaged from the worm gear 309 and the arm 331 is returned to the position illustrated by the restoration of the armature 329 to its normal position by means of a suitable retractile force acting thereon.

The recording apparatus illustrated in Fig. 4 may be employed with the transmitting apparatus of Fig. 1 so that the recording is effected on a continuous recording medium either in discrete units of subject matter or in a continuous recording of subject matter. The operation of the novel control apparatus forming the subject matter of this invention to effect the intermittent or discrete recording of subject matter by the receiver shown in Fig. 4 will be described first. In Fig. 1 it is necessary to operate the switch 136 to its right hand contact, after which the switch 137 may be operated to initiate the series of automatic operations previously described, whereby both the transmitting and the receiving apparatus are successively supplied with power, operatively conditioned, properly phased and thereafter operated in a full automatic manner.

Positive potential is applied to the line L from which it is transferred by means of conductor 177' of Fig. 4 to operate relay 178' and to energize winding 179' of relay 181' finally being conducted by the armature 336 and back contact of relay 337 to ground. The current which flows

from the armature 159 of relay 151 of Fig. 1 through the winding of relay 161 and the circuit just described is of relatively large magnitude, thereby operating the tongue 232 of relay 161 to its front contact. It will be seen that this operation prevents the operation of relays 233 and 152 of Fig. 1 and the apparatus controlled thereby.

In Fig. 4 the operation of relay 178' is instrumental in connecting alternating current and direct current power to the receiving apparatus in a manner similar to that described in conjunction with Fig. 2. The positive potential which is applied to the winding 179' of relay 181' causes the tongue 183' to be moved into engagement with its right hand contact thereby operating relay 197'. The operation of this relay energizes the solenoids 318 and 323, whereby the recording paper is withdrawn from operative engagement with the stylus and the clutch 302—303 is disengaged, thus preventing paper feeding by means of motor 192'. A double-pole double-throw switch 338 is placed on its left hand contacts when the recorder is being used for intermittent operation. The operation of armature 183' of relay 181' to its right hand contact also applies a ground to the operating winding 251' of relay 121'. As in the previously described arrangement relay 121' is operated by means of the charging current of condenser 252', drawn from conductor 196' through the blade 339 and left hand contact of switch 338, the subsequent steady-state current which is permitted to flow through this winding and resistance 253' being insufficient in itself to sustain operation of the relay. Once operated, the relay locks and operates relay 128'. The operation of this latter relay applies potential to the motor 311 which immediately starts to feed the paper 273 through the recording apparatus at a relatively high rate of speed. As soon as a fresh recording frame of the paper is properly positioned in the recorder, the finger 325 of contact 326 becomes engaged with one of the openings 324 to close the contact 326—327 and a ground is applied, by way of the left hand contact and switch blade 341, to one terminal of the locking winding 126' of relay 121'. Since a ground connection is also made to the other terminal of this winding, by means of the armature 127' and its front contact, this winding is effectively short-circuited thereby releasing the relay, which through its controlled circuits interrupts the feeding of the paper. It is contemplated that, if desired, means such as those shown in and described in conjunction with Fig. 2, may be employed to prevent the initial paper feeding where the recorder is left from a previous operation with a fresh frame of the recording medium in operative position.

As soon as conductor 196' becomes energized relay 342 is also operated by means of a circuit including winding 343, armature 344 and back contact of relay 337. A locking circuit is provided for relay 342 through its winding 346, armature 347 and front contact, and which also includes armature 348 and back contact of relay 349. The latter relay is operated periodically by the engagement of brushes 116' with segment 114' of the phasing disk 113'. Thus the locking circuit for relay 342 is periodically opened, but the opening of this circuit is ineffectual as long as the operating circuit through the winding 343 is continuous.

As in the previously described modification, when the amplifier housed in the container 22' becomes operatively conditioned, current is drawn through conductor 211' and the winding of relay 337. The operation of this relay removes the ground connected to its armature 336 from the control signaling circuit, but this circuit is still directly grounded by means of armature 351 of relay 342 which is engaged with its front contact. Operation of relay 337 opens the operating circuit through winding 343 of relay 342. Hence, when next the brushes 116' become engaged with the segment 114' to operate relay 349, the locking circuit for relay 342 is also opened causing the release of the armatures 347 and 351. Under these conditions a resistance 352 is introduced into the control signaling circuit, thereby reducing the amplitude of the current flowing therein.

This decreased current produces insufficient energization of relay 161 of Fig. 1 to sustain its operation. Thus the armature 232 engages its back contact to operate successively relays 233 and 152 and the apparatus controlled thereby causing the transmitting apparatus to be phased and the scanning operation initiated in a manner similar to that previously described. Simultaneously, the polarity of the potential applied to the control signaling circuit is changed from positive to negative effecting the release of relay 197' of Fig. 4 to initiate the recording operation of the receiver R.

At the end of a scanning operation the polarity of the control signaling circuit potential is reserved from negative to positive in accordance with the foregoing description of Figs. 1 and 2. The positive potential now applied to the signaling circuit effects the engagement of armature 183' of relay 181' with its right hand contact, thereby operating relays 197', 121' and 128'. The operation of these relays produces respectively the withdrawal of the paper from operative engagement with the styli, the discontinuance of paper feeding by means of motor 192' and the initiation of a more rapid paper feeding by means of motor 311 which continues until a fresh frame of recording material is operatively positioned in the recording apparatus.

Subsequent operation of the facsimile transmitting and receiving apparatus is substantially similar to that of the previously described modification. At the end of a series of subject matter transmissions a fresh blank of recording material is fed into the recorder just previous to the disconnection of the local power supply from the apparatus.

The recording apparatus disclosed in Fig. 4 is also susceptible of continuous operation, whether the transmitter be one of a continuous type or one of an intermittent type as shown in Fig. 1. The operation of the recording apparatus with a transmitter of the continuous type requires, in addition to the maintenance of synchronism between the driving motors for the respective transmitting and receiving apparatus, the automatic control of the functions described hereinbefore with the exception of the intermittent fast paper feeding and including also the function of paper feeding subsequent to a recording operation described hereinafter. In the instant invention there is also provided means for operating a continuous recorder with an intermittent transmitter.

For this type of operation the double-pole switch 338 of Fig. 4 is placed in its right hand position as viewed in this figure. It will now be seen that as soon as relay 189' operates its armature 194' to its front contact to supply the record-

ing apparatus and some of the control apparatus with power, relays 121' and 128' are disconnected from the power supply since the lever 339 connects these relays with the back contact of relay 189'. Accordingly, when the tongue 183' of relay 181' is moved to its right hand contact in response to a characteristic signal sent from the transmitter whenever a drum changing operation thereat is being initiated, relay 197' of Fig. 4 is operated to perform the functions of paper retraction and the interruption of paper feeding by means of motor 192'. Since, at this time, motor 311 is not energized because of the inoperative condition of relay 128', no blank paper is fed through the recording mechanism during the transmitter drum changing operation. Hence, when relay 197' becomes deenergized in response to a control signal originating at the transmitter at the beginning of a new scanning operation, the subject matter is recorded on the web medium 273 immediately below the last portion of the subject matter transmitted by the previous scanning operation.

Thus, the recorder is provided with means for arresting its operation during the period required for a drum changing operation of the transmitter. However, at the end of a series of such subject matter transmissions when the control signaling circuit is deenergized causing the local power supply to be disconnected from the previously operated recording aparatus, the armature 183' of relay 181' is left in engagement with its right hand contact. As soon as armature 194' of relay 189' becomes engaged with its back contact, the operating circuit through winding 251' of relay 121' is completed to the ground connected to the armature 183' of relay 181'. The operation of relay 121' and its subsequent locking to the ground connected to its armature 127' operates relay 128' to energize electromagnets 318 and 323 and motor 311, thereby causing the paper 273 to be fed through the recording apparatus. The operation of relay 128' also energizes, through an armature 353 and back contact of relay 197', winding 354 of polar relay 181' to disengage armature 183' from the ground connected to its right hand control, thereby interrupting the circuit through the operating winding 251' of relay 121'. Also at this time electromagnet 328 is energized to move the pin 333 into engagement with the worm gear 309. When the lever 331 has been carried to the other end of the worm gear 309 to close the contact 334, thereby short-circuiting winding 126' of relay 121' through the lever 341 and its right hand contact of switch 338, relay 121' is released, thus stopping the motor 311 and restoring the paper guide 267 and the clutch 302—303 to their normal positions. The timing of this paper feeding operation may be adjusted so that any predetermined amount of blank paper may be ejected from the recording apparatus in order that it may be detached therefrom. Thus it is seen that subsequent to the final paper ejection the recording apparatus and its associated control equipment is completely deenergized and is held in readiness to resume operation at any time in response to a characteristic control signal originating at the transmitter.

Having hereinbefore set forth the nature of the invention and the modes of operation of illustrative embodiments thereof, the novel features of the invention are defined with particularity in the appended claims.

What is claimed is:

1. In a facsimile telegraph system, a transmission medium, subject matter to be transmitted, transmitting and receiving apparatus operatively related to the terminals of said medium and utilized respectively to generate and record modulated alternating current signals representative of said subject matter, means for applying a plurality of different direct current voltage conditions to said medium, means for simultaneously impressing said alternating current signals and one of said direct current conditions upon said medium, means controlled by a characteristic of said subject matter for removing one of said direct current conditions from said medium and applying a second one of said conditions thereto, and means responsive to said second condition to perform control functions of said receiving apparatus.

2. In a facsimile telegraph system, a transmission medium, transmitting and receiving stations including apparatus for reproducing subject matter by means of modulated alternating current signals sent over said medium, a simplex signaling circuit for performing control functions at said transmitting and receiving stations, means controlled by said transmitting station apparatus for applying one polarity of potential to said simplex circuit, means controlled by said receiving station apparatus for changing the amplitude of the simplex signaling current, and means responsive to said amplitude change for applying to said simplex circuit a potential having a polarity opposite to said first named potential.

3. In a facsimile telegraph system, a transmission medium, transmitting and receiving apparatus connected to the terminals of said medium for the reproduction of subject matter by means of modulated alternating current signals sent over said medium, a simplex signaling circuit for controlling the operation of said transmitting and receiving apparatus, comprising a series connection of a polarity changing device and a marginal relay associated with one end of said signaling circuit, and a current strength changing device and a polarized relay associated with the other end of said circuit, said current strength changing device being operative to control said marginal relay and said polarized relay being under the control of said polarity changing device.

4. In a facsimile telegraph system, a transmission medium, facsimile transmitting and receiving apparatus connected to opposite ends of said transmission medium, control apparatus associated respectively with said transmitting and receiving aparatus, means for transmitting modulated alternating current facsimile signals over said medium, a communication channel interconnecting said control apparatus, means for transmitting direct current signals over said channel, a device connected to said channel for determining the polarity of said direct current signals, and means responsive to the transmitting and/or receiving control apparatus to govern the operation of said device.

5. In a facsimile telegraph system, a transmission medium, transmitting and receiving stations including apparatus for reproducing subject matter by means of modulated alternating current signals sent over said medium, a simplex signaling circuit for performing control functions at said transmitting and receiving stations, means responsive to the apparatus of either station to control the polarity of the simplex signals, and means responsive only to the apparatus at one of said stations to control the amplitude of said simplex signals.

6. In a facsimile telegraph system, a communication channel, transmitting and receiving apparatus associated with opposite ends of said channel for reproducing a picture or other subject matter by means of carrier current signals sent over said channel and modulated in accordance with tone values of said picture or other subject matter, an auxiliary signaling circuit for controlling the operative conditioning of said transmitting and receiving apparatus, and means responsive to an inoperative condition of said receiving apparatus for disabling the transmitting apparatus.

7. In a facsimile telegraph system, transmitting and receiving stations including facsimile apparatus for reproducing subject matter by means of modulated alternating current signals, a continuous web of recording material included in said receiving apparatus, means for feeding said web during a recording operation, means responsive to a characteristic of said subject matter to temporarily arrest the feeding of said web, and means responsive to another characteristic of said subject matter to control the feeding of said web after the completion of a recording operation.

8. In a facsimile telegraph system, a communication channel, transmitting and receiving stations associated with said channel, subject matter to be transmitted, means to operatively connect said transmitting apparatus with said channel, means for transmitting groups of facsimile signals representative of said subject matter at spaced intervals during said operative connection, means for effecting a continual recording of subject matter from said time spaced groups of facsimile signals, and means controlled by said transmitting means to temporarily disable said receiving apparatus during the intervals of time occurring between the transmissions of said groups of facsimile signals.

9. In a facsimile telegraph system, a communication channel, a plurality of stations including respectively transmitting and receiving apparatus associated with said channel, subject matter to be transmitted, means at said stations to supply local power to said apparatus, means associated with said transmitting apparatus to render operative said power supply means only during operating periods, a continuous web of recording material included in said receiving apparatus, means to effect a continuous recording of said subject matter on said web, and means to eject a predetermined length of said web after the termination of one of said operating periods.

10. In a telegraph system, a signaling circuit, a pole changing device for transmitting polarized signals over said circuit, means connected with said circuit to change the amplitude of said signals, and means responsive to the changing amplitude of said signals to control said pole changing device.

11. In a facsimile machine, a continuous web, an instrumentality associable with successive elemental areas of said web, a movable structure to support a portion of said web, and a mechanism to effect alternately the operative and inoperative positioning of said web portion relative to said instrumentality.

12. The invention as defined in claim 11 further characterized by means for feeding successive portions of said web through said machine irrespective of the positioning of said movable structure.

13. In a facsimile system, a communication channel, facsimile transmitting and receiving apparatus associated with said channel, a continuous web of recording material included in said receiving apparatus, means for controlling the operative or inoperative condition of said apparatus, means for feeding said web during an operative condition of said receiving apparatus, and means responsive to an inoperative condition of said receiving apparatus to eject a predetermined length of said web from said receiving apparatus.

14. In a facsimile telegraph system, a transmission medium, transmitting and receiving apparatus utilizing said medium for the reproduction of subject matter by means of modulated alternating current signals, an auxiliary signaling circuit for controlling said transmitting and receiving apparatus, a continuous web of recording material included in said receiving apparatus, means responsive to a signal sent over said auxiliary circuit and representative of a first condition of said transmitting apparatus to effect a relatively slow feeding of said web, means responsive to another signal sent over said auxiliary circuit and representative of a second condition of said transmitting apparatus to temporarily arrest the slow feeding of said web, and means responsive to a communication sent over said auxiliary circuit and representative of a third condition of said transmitting apparatus to effect a relatively rapid feeding of said web.

15. In a facsimile apparatus, an amplifier, a source of plate current for said amplifier, a relay in circuit with said current source, a signaling circuit including a serially connected resistance, contacts arranged to short-circuit said resistance to produce a rise of current in said signaling circuit for signaling purposes, and means including said relay to control said contacts in accordance with the operativeness or inoperativeness of said amplifier.

16. In a facsimile apparatus, an amplifier, a source of plate current for said amplifier, a relay in circuit with said current source, a signaling circuit, means for modifying the value of current in said signaling circuit for signaling purposes, and means including said relay to control said current modifying means in accordance with the operativeness or inoperativeness of said amplifier.

17. In a facsimile telegraph system, a communication channel, a transmitter and a receiver operably associated with the respective terminals of said channel, subject matter to be transmitted over said system, means for applying a plurality of different direct current potentials to said channel, means for superimposing on one of said potentials carrier currents modulated in accordance with said subject matter, means controlled in accordance with a characteristic of said subject matter being transmitted to interrupt said carrier current potential and to apply a second one of said potentials, and means responsive to said second potential to control said receiver.

18. In a facsimile telegraph system, a transmission medium, facsimile transmitting and receiving apparatus associated with said medium, a signaling channel for controlling said transmitting and receiving apparatus, an amplifier included in said receiving apparatus, and means responsive to a failure of said amplifier for disabling said transmitting apparatus.

19. In a facsimile telegraph system, a communication channel, transmitting and receiving apparatus associated with the terminals of said channel for the reproduction of subject matter by means of modulated carrier currents sent over

said channel, a driving motor included in both the transmitting and receiving apparatus, means for operating said motors synchronously, means for transmitting auxiliary signals to control said transmitting and receiving apparatus, and means including said auxiliary signal transmitting means responsive to the failure of the receiving apparatus driving motor for disabling the transmitting apparatus.

20. In a facsimile telegraph system, a communication channel, transmitting and receiving apparatus utilizing said channel for the transmission of carrier current signals modulated in accordance with subject matter to be transmitted, means for supplying copyholders to said transmitting and receiving apparatus, means for signaling over said channel to effect a changing of said copyholders, and means responsive to a condition wherein the receiving apparatus is not supplied with a copyholder for disabling the transmitting apparatus.

21. In a facsimile telegraph system, a transmission medium, facsimile transmitting and receiving apparatus connected for communication to the terminals of said medium, means for signaling over said medium to control said transmitting and receiving apparatus, and means responsive to a discontinuity of the transmission medium for disabling the transmitting apparatus.

22. In a facsimile telegraph system, a communication channel, facsimile transmitting and receiving apparatus connected respectively to opposite ends of said channel and including respectively scanning and recording means, means associated respectively with said transmitting and receiving apparatus for initiating movement of said scanning and recording means, control signal transmitters associated respectively with said transmitting and receiving apparatus, and means including either of said control signal transmitters for controlling both of said movement initiating means.

23. In a facsimile telegraph system, a transmission medium, transmitting and receiving apparatus connected to opposite ends of said medium, scanning means included in said transmitting apparatus, recording means included in said receiving apparatus, means associated respectively with said transmitting and receiving apparatus for initiating movement of said scanning means and said recording means, and means responsive to an inoperative condition of either the transmitting or the receiving apparatus for disabling both of said movement initiating means.

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