

April 7, 1942.

L. M. POTTS

2,278,485

PHOTOELECTRIC TRANSMITTER

Filed Dec. 22, 1938

3 Sheets-Sheet 1

FIG. 1

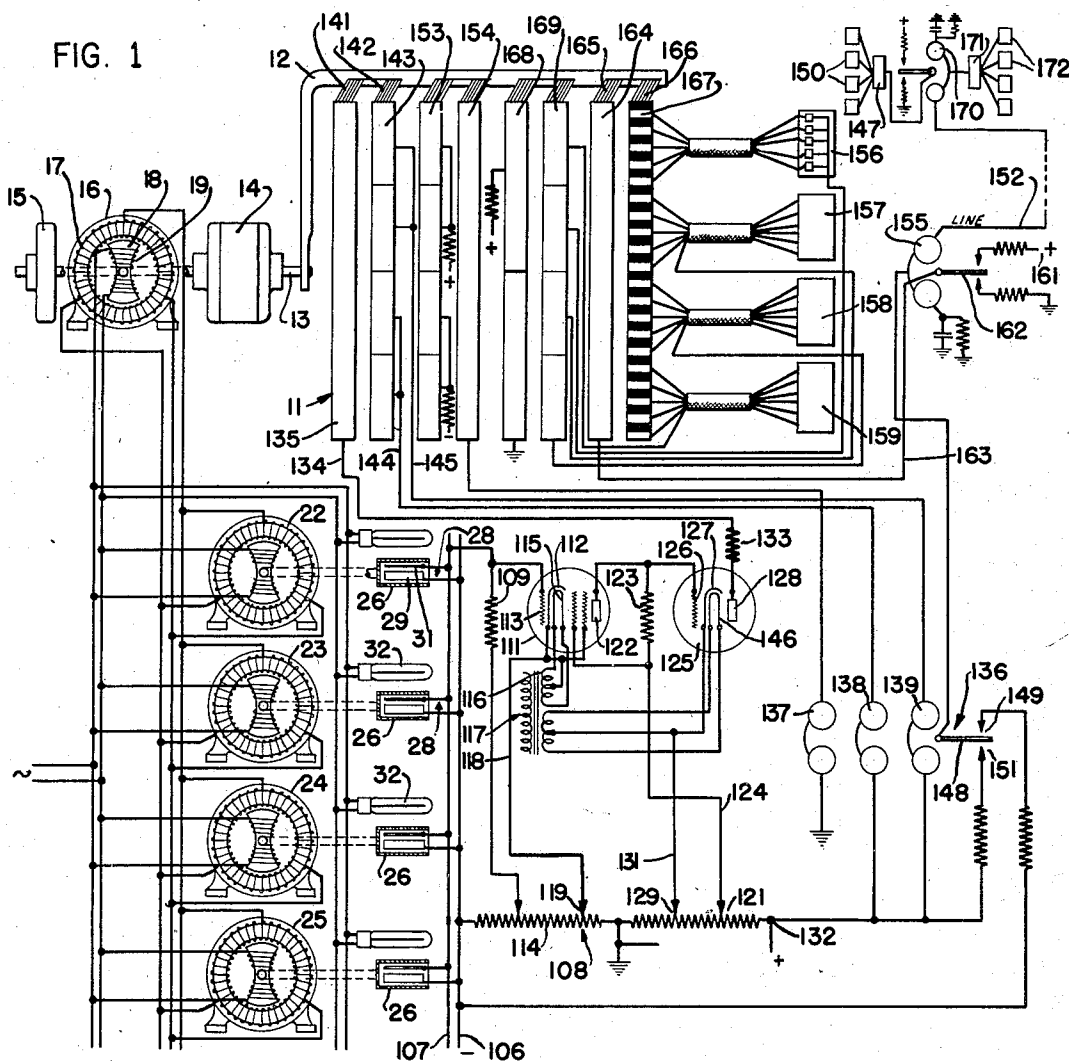


FIG. 4

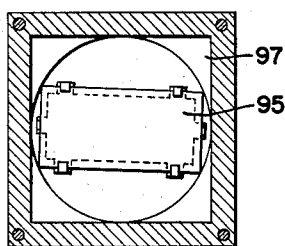


FIG. 5

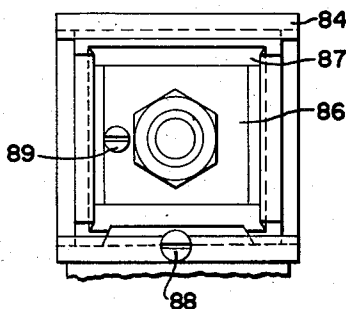
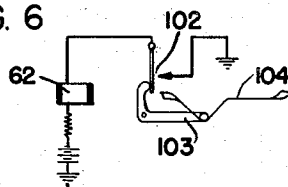


FIG. 6



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3 Sheets-Sheet 2

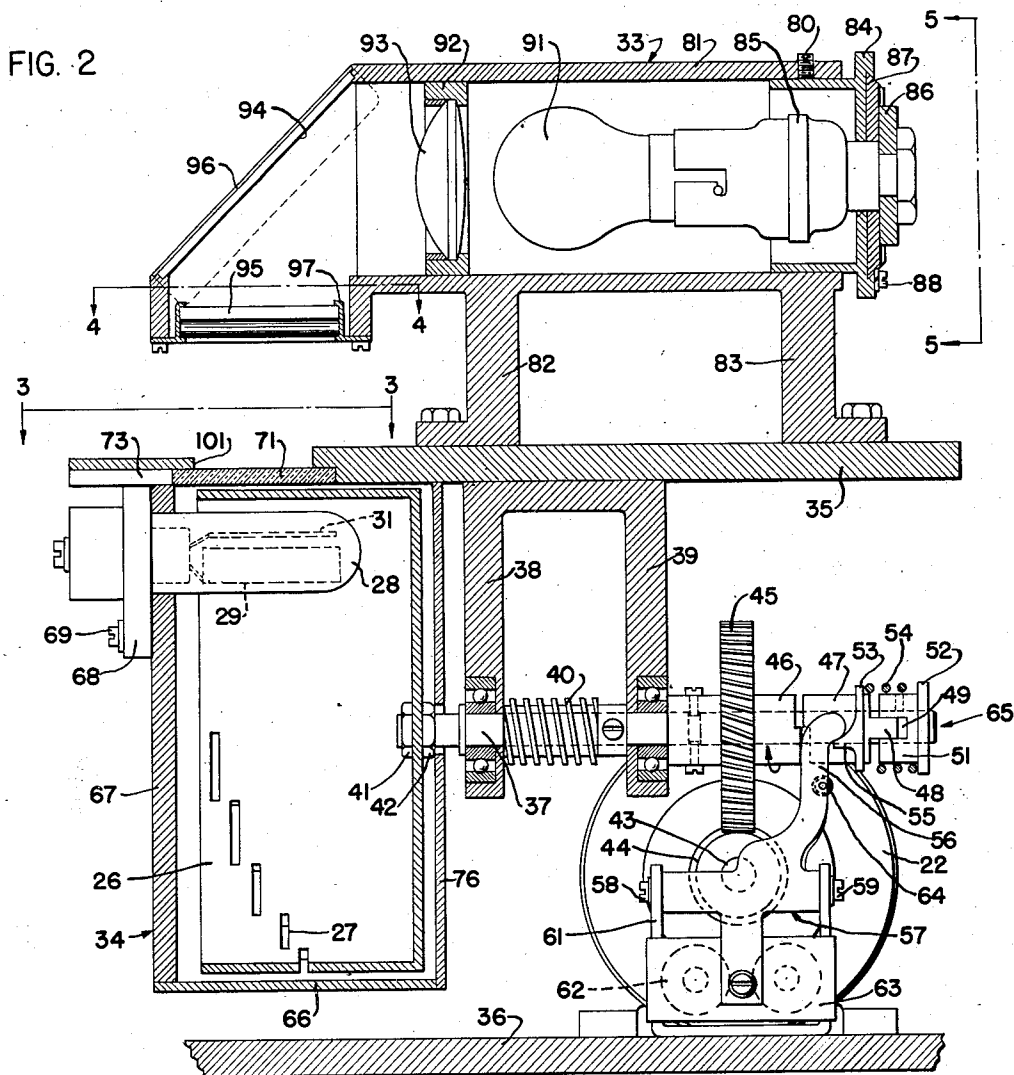


FIG. 7

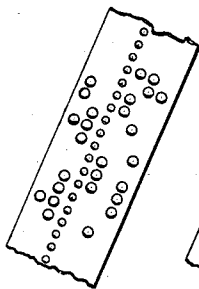


FIG. 8

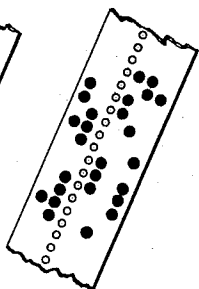
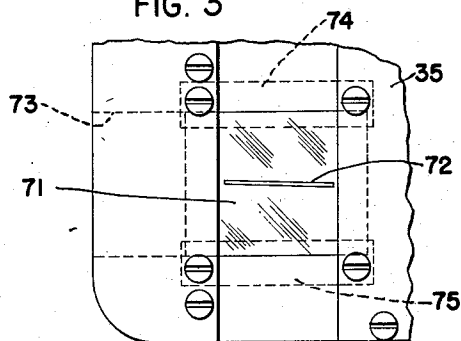


FIG. 3



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PHOTOELECTRIC TRANSMITTER

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3 Sheets-Sheet 3

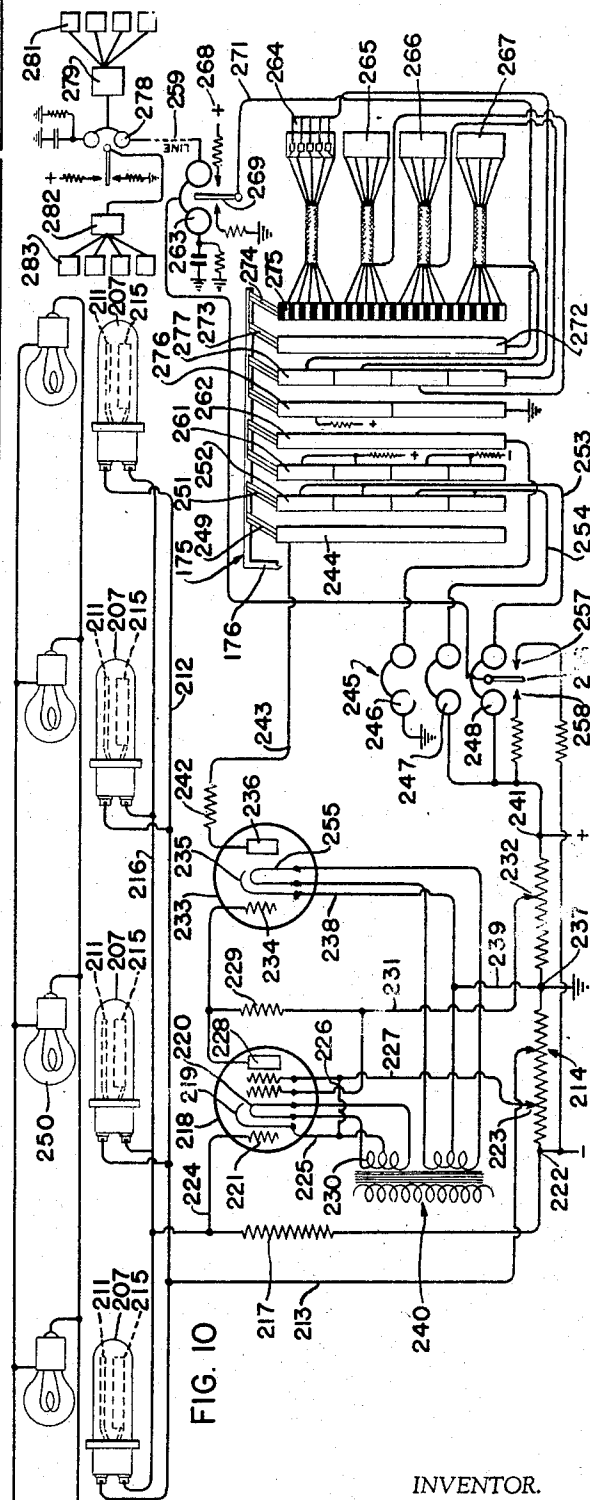
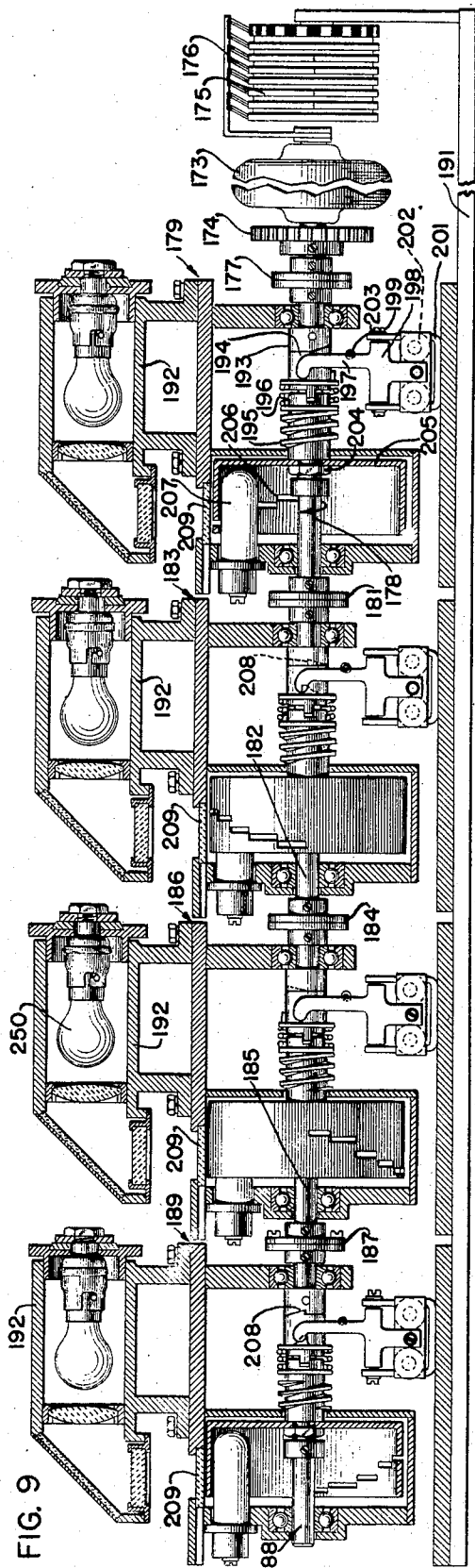


FIG. 10

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UNITED STATES PATENT OFFICE

2,278,485

PHOTOELECTRIC TRANSMITTER

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Application December 22, 1938, Serial No. 247,181

32 Claims. (Cl. 178—50)

The present invention pertains to telegraph transmitters and particularly to a transmitter in which the transmission of signaling impulses is controlled through a photoelectric system.

The primary object of the invention is to control photoelectrically the transmission of permutation code signals in a multiplex telegraph signaling system.

Another object is to provide in a multiplex signaling system, a plurality of photoelectric transmitters, each transmitter comprising a scanning device, and each scanning device acting as a transmitting distributor.

Another object of the invention is to provide a photoelectric signaling system having a plurality of scanning devices, and means within the system to maintain a predetermined phase relation between the scanning devices.

Another object is to provide in a multiplex signaling system, a plurality of photoelectric scanning devices, means to transmit character signals, and means to control successive signals by different ones of said scanning devices.

A further object of the invention is to provide in a multiplex signaling system, a plurality of photoelectric scanning devices driven by direct connection from a motor, and means for maintaining between said devices a definite phase relation.

Another object of the invention is to provide a photoelectric signaling system having a plurality of scanning devices, wherein each scanning device is provided with its independent motor drive, and means within the system to maintain a predetermined phase relation between the scanning devices.

The system according to one embodiment of the present invention comprises a plurality of groups of synchronous motors connected in series. To one motor in each group is associated a sunflower type of multiplex distributor and to each of the other motors of each group is associated a scanning device of the type disclosed in United States Patent 2,177,077, granted October 24, 1939, to L. M. Potts. The scanning drums of the transmitters in each group have their apertures arranged so that the five apertures on one drum occupy one-quarter of the circumference, and the drums of the different transmitters are so arranged that the apertures in the next transmitter begin where the apertures in the preceding transmitter end, so, if all the drums were considered as one there would be twenty apertures equally spaced around the circumference. According to another embodiment of the invention

a photoelectric multiplex system is provided wherein all of the photoelectric transmitters are driven by direct shaft connection from a single motor. With this arrangement the scanning devices and circuits therefor are similar to that of the first-mentioned embodiment.

A feature of the system according to the present invention consists in providing a single amplifying circuit for each group of scanners; that is, all of the photoelectric cells in each group are connected in parallel and to a single amplifying circuit which may be similar to the amplifier disclosed in said patent. In the plate circuit of the last tube in the amplifying circuit is a polarized relay having three windings, one of which is a biasing winding, the biasing action of which is governed by one pair of the rings on the distributor. Another pair of rings on the distributor controls the excitation of two operating windings of the polarized relay in such a manner that the normal impulses in some of the channels are made positive and in others negative, so that when all channels are idle, reversals will still be sent for synchronizing purposes, as is the usual practice. A fourth pair of rings of the distributor serve to connect the plate circuit of the last tube in the amplifying circuit to one or the other of the operating windings of the relay, and the relay serves to transmit to the line impulses controlled by the four transmitters.

A better understanding of the invention may be had from the following description, taken in conjunction with the accompanying drawings, wherein like reference characters designate similar parts throughout the several views, and in which,

Fig. 1 is a diagrammatic view of the circuits and apparatus for a transmitting distributing arrangement embodying the present invention;

Fig. 2 is a cross-sectional view of the scanning device employed with the present invention;

Fig. 3 is a view taken on line 3—3 of the Fig. 2;

Fig. 4 is a view taken on line 4—4 of Fig. 2;

Fig. 5 is a view taken on line 5—5 of Fig. 2;

Fig. 6 is a schematic view of the tape control circuit for the photoelectric transmitters;

Fig. 7 is a perspective representation of a portion of perforated tape;

Fig. 8 is a perspective representation of a portion of printed tape;

Fig. 9 is a cross-sectional view of a photoelectric transmitting arrangement in which a

plurality of transmitters are driven by direct shaft connection from the motor; and

Fig. 10 is a schematic diagram of the electrical circuit employed with the arrangement shown in Fig. 9 when printed tape is used.

Having reference to Fig. 1, which is a schematic representation of a specific embodiment of the present invention, the transmitting distributor is indicated generally by the reference character 11. The distributor arm 12 of the transmitting distributor 11 is secured to a shaft 13 of an impulse or other suitable synchronous motor 14, such as used for driving multiplex distributors, which motor is provided with a suitable damper 15. A control motor 16 of a type known as auto-synchronous is also associated with the motor 14. Motor 16 may have an ordinary field winding 17, of the type in which the field has a large number of spaced slots and the winding equally distributed around the circumference. The armature 18 of motor 16 has two poles with a single winding 19 whose terminals are brought to collector rings (not shown). Three equally spaced terminals are brought out from the field winding of the control motor 16. If any number of such motors 16 have the corresponding field terminals connected together and the brushes connected to the same source of alternating current, and any one of the armatures 18 is moved, all of the other armatures will follow exactly. The motor 16 is connected in this manner to four other similar motors 22, 23, 24, and 25, so that the motors 22 to 25 will be kept in exact phase relation to motor 16. Each of the motors 22 to 25 drives a photoelectric transmitter similar to that shown in the aforementioned patent.

To the shaft of each of the synchronous motors 22 to 25 is secured a scanning cylinder 26. The scanning drums or cylinders 26 have apertures arranged as shown in Fig. 9. It will be noted that (in a four channel multiplex system) the five apertures 27 on one drum occupy one-quarter of the periphery. It will also be observed that the drums or cylinders 26 on the different transmitters associated with the motors 22 to 25 are so arranged that the apertures in any one of the drums or cylinders begin where the apertures in the immediately preceding cylinder end, so that, if all the drums or cylinders are considered as one unit there would be twenty apertures 27 equally spaced around the periphery.

Positioned within the scanning cylinder or drum 26 (Fig. 2) is a photoelectric cell 28, which is indicated diagrammatically in Fig. 1 by a cathode 29 and an anode 31. The optical system is shown diagrammatically in Fig. 1 by the incandescent lamp 32.

Having reference to Fig. 2, there is shown a photoelectric transmitter similar to that shown in Figs. 6 and 7 of the aforementioned patent to which reference may be had for a more detailed description of the structure. The photoelectric transmitter illustrated in Fig. 2 comprises essentially an optical system or apparatus and a scanning mechanism indicated generally as 33 and 34, respectively. The base portion of the transmitter comprises a top plate 35, a bottom plate 36 and vertical post (not shown) separating said plates. From the lower surface of top plate 35 is suspended the scanning arrangement 34, which comprises a shaft 37 journaled in brackets 38 and 39 depending from and integral with top plate 35. Clamped between nuts 41 and 42, threaded on shaft 37 at the left extremity

thereof, is a scanning cylinder or drum 26. In this manner, cylinder 26 is adjustable longitudinally of shaft 37, as well as angularly thereof with respect to the stop position of the shaft, as will hereinafter appear. The scanning cylinder 26 is provided with a helically arranged series of slots 27 corresponding in number to the number of code hole positions in the tape. It will be observed that with the present structure no provision is made, as in the structure shown in said patent, for an additional slot corresponding to the stop signal, because in multiplex transmission start and stop signals are not required.

Fixedly carried on the shaft 37 and disposed between the brackets 38 and 39 is a worm 40 which controls, through suitable gearing, the proper movement of the perforated tape, as shown in Fig. 12 of said patent and therein fully described. For purposes of the present disclosure it need only be mentioned that the size of the gears interconnecting the worm 43 and the feed roller for the tape are so calculated as to produce the proper rate of movement of the tape which is caused to move continuously to cooperate with the rotating scanning cylinder 26 to effect sequentially the sensing of the code combinations perforated in the tape. Rotation is imparted to shaft 37 by its associated synchronous motor 22—25, which has secured to the armature shaft 43 (Fig. 2) a pinion 44 which meshes with a worm gear 45 loosely carried on shaft 37. Gear 45, with its integral hubs, is mounted on the shaft 37 in such a manner as to prevent the longitudinal movement of gear 45 on said shaft. The hub 46 is provided with a single clutch tooth, thus providing a positive clutch which has only one tooth so that the transmitting shaft 37 is always picked up in the same phase position. The gear ratio between the motor 22 and the shaft 37 is in the present embodiment 1 to 1, so that the shaft 37 rotates with the same speed as the motor 22 and will act as though it were an extension of the shaft 13 of the transmitting distributor 11. Slidably mounted on shaft 37 and cooperating with the hub 46 is a sleeve portion 47, which together with the hub portion 46 forms a positive clutch. Sleeve portion 47 is provided with a pair of diametrically arranged tongues 48 which fit into a corresponding pair of grooves 49 in a collar 51 fixed to the shaft 37. In this manner a slidable connection is provided between sleeve portion 47 and collar 51. Compressed between a flange 52 integral with the collar 51 and a flange 53 integral with sleeve portion 47 is a compression spring 54. Flange 53 is also provided with a cam portion 55 which cooperates with an arm 56 of an armature lever 57 pivotally mounted at 58 and 59 on a bracket 61 carrying a magnet 62.

Armature lever 57 is provided with armature 63 which cooperates with the cores of the electromagnet 62. A spring 64 normally draws arm 56 of armature lever 57 toward the collar 47. The extremity of arm 56 is conformed to cooperate with the cam portion 55, so that when the electromagnet 62 is de-energized, arm 56 will be drawn toward the sleeve 47 bringing the end of arm 56 into the path of the cam portion 55, whereupon, as the sleeve 47 rotates clockwise (viewing the shaft 37 in the direction of the arrow 65), the camming relation between cam portion 55 and the extremity of arm 56 will cause the sleeve 47 to be urged rightwardly against the action of spring 54, thereby disengaging the clutch members 46 and 47. Upon energization

of electromagnet 62 the armature 63 will be attracted, causing the armature lever 57 to be rotated so as to extend the spring 64, thereby disengaging the end of arm 56 from the cam portion 55, whereupon spring 54 will urge the sleeve 47 leftwardly into engagement with the portion 46 of the clutch which rotates with the gear 45, causing rotation of shaft 37 and consequently initiating rotation of the scanning drum 26. The scanning drum 26 is so located angularly that when the drum 26 is in its stop position (with the clutch disengaged) a blank portion of the drum periphery corresponding to some other channel of the multiplex will be presented toward the scanning position. It has been found that most favorable results are obtained when the slots or scanning aperture 27 are located (with the drum 26 in the stop position) as shown in Fig. 2, so that, when the clutch is re-engaged, the drum 26 will rotate a considerable distance, before the scanning apertures 27 come to the scanning position, and will have attained steady motion.

Surrounding the scanning cylinder 26 is a cover member 66, and fixed to one end of the cover member 66 is an end piece 67 provided with an aperture eccentrically located with respect to the scanning cylinder 26 to permit the insertion of the photoelectric cell 28 in as close proximity to the scanning position as possible. The photoelectric cell 28 is suitably mounted in a portion 68 of insulating material which is mounted by screws 69 to the portion 67. Disposed above the scanning cylinder 26 and arranged over that region thereof embracing the helically arranged slots 27 is a glass plate 71 which, according to the form of the invention herein shown, comprises an opaquely coated glass element in which the slit 72 (Fig. 3) is formed by cutting away a portion of the opaque coating. It may also be advantageous to coat both the upper and lower surfaces of the glass plate 71 and to put corresponding and registrable slits in both surfaces. Plate 71 fits slidably in a groove 73 in the lower side of top plate 35 and is held in place by a pair of supporting guides 74 and 75 (Fig. 3). Plate 71 thus is readily removable for cleaning, and due to the fact that it is snugly fitted into plate 35, it serves as a cover plate to close the chamber containing the photoelectric cell 28.

The cylindrical cover member 66 is closed at its inner end by a plate 76 secured to top plate 35, and it will be understood that the housing for the scanning drum is light tight, except for the light which passes through the slot 72 in the plate 71 as controlled by the perforated tape. Slit 72 is disposed obliquely and at such an angle as to compensate for the continuous movement of the tape; that is, due to the obliquely arranged slit it is possible to transmit a plurality of elementary signal impulses photoelectrically while the tape is in motion. The transmission of signals in any particular channel takes place during a quarter of a revolution of the scanning drum 26 (in a four-channel multiplex system) while the corresponding tape moves during the entire revolution of the scanning drum, so that the tape (in such a system) moves substantially four-twentieths of a letter space (assuming a 5-unit code) from the middle of the No. 1 code impulse to the middle of the No. 5 code impulse of the same channel. For this reason, a slope of four-twentieths of a letter space gives sufficiently accurate timing. The timing is, of course, somewhat changed by the unequal spacing of

the code perforations in the tape due to the feed perforations, but the difference is so slight as not to be objectionable. It is manifest that the slope of the slit 72 would be different for each different number of channels of the multiplex system.

The optical apparatus 33 comprises a housing 81 mounted by means of integral members 82 and 83 upon top plate 35, and a cap member 84 adapted to be telescoped into said housing. Cap member 84, after being adjusted telescopically, is locked by means of a lock screw 80. Adjustably carried in the cap member 84 is a lamp socket 85 secured to a plate 86, dovetailed for vertical movement into a second plate 87 which, in turn, is dovetailed for horizontal movement into cap 84. Plate 87, after being adjusted, is locked by a lock screw 88, and plate 86 is locked after adjustment by a lock screw 89 (Fig. 5). With this arrangement, incandescent lamp 91 inserted in the socket 85 is universally adjustable.

Presented in front of lamp 91 and carried in a frame 92 is a lens 93 which directs the light rays from lamp 91 onto an inclined mirror 94 disposed at a 45 degree angle so as to reflect the rays of light downwardly through a cylindrical lens 95 onto the photoelectric cell 28. Mirror 94 is suitably positioned in the housing 81 and held in place by a cover plate 96. Cylindrical lens 95 is carried in a frame 97 attached to the housing 81 and, as indicated in Figs. 2 and 4, is arranged so that its longitudinal axis is parallel to and in the same vertical plane as the slot 72.

The tape guiding mechanism associated with the embodiment of the invention disclosed herein is as shown in Figs. 6 and 11 of the aforementioned patent, and reference may be had to said patent for an understanding of the detailed structure of said mechanism. It is sufficient merely to state herein that the tape passes through the tape guideway or track 101.

With the transmitting apparatus shown in Fig. 2, the three essential elements for performing the scanning function; namely, the scanning cylinder, the perforated tape, and the scanning plate, are brought into closest possible proximity with each other, and collectively they are arranged close to the optical system or apparatus. In this transmitter, the relative speeds of rotation of the tape feed roller and the scanning cylinder 26 are such that although each cylinder 26 makes one complete revolution during the interval of time in which the tape moves the distance between two consecutive rows of perforations, the actual scanning takes place in one-quarter revolution. The arrangement, however, is such that each perforation is substantially central with the scanning position when that perforation is being scanned. With this arrangement, the time interval of each signal element is governed by the angular extent of the slots 27 in the scanning cylinder 26, and due to the close proximity of the cylinder 26 to the scanning plate 71 the light flashes upon photoelectric cell 28 will be sharp and distinct to cause a sharp turning-on and cutting-off of the photoelectric effect.

The transmitter shown in Fig. 2 is initiated into operation by closing the circuit of the auto-synchronous motors 18 and 22-25, thus causing the rotation of pinion 44 and gear 45. The scanning cylinder 26 and the tape feed roller are prevented from rotating due to the de-energization of electromagnet 62 and the consequent en-

gagement of armature lever 57 with the clutch member 47. Upon energization of magnet 62, by closing the contact 102 (Fig. 6) by the tape stop lever 103, the arm 56 of armature lever 57 becomes disengaged from the clutch member 47, and the scanning cylinder 26 and tape feed roller (not shown) are permitted to rotate. The tape 104 (Fig. 6) is placed in the tape track or guide-way 101 and the tape guide member (not shown) is caused to rest thereupon. Contact 102 may then be closed to that transmitter. As previously mentioned, a transmitting mechanism such as shown in Fig. 2, is associated with each of the autosynchronous motors 22, 23, 24, and 25, each one of the transmitting mechanisms shown in Fig. 2 serving to control the transmission of messages over a particular channel of a multiplex system. According to the present invention four such channels are provided, and the reason for arranging the scanning slots 27 in the manner shown in Fig. 9 is so that each tape will be scanned successively, and correspondingly, messages will be transmitted over the channels of transmission successively.

All of the photoelectric cells 28 are connected in parallel and are also connected to a single amplifying circuit indicated generally as 105 (Fig. 1) which is similar to that shown in Fig. 15 of the afore-mentioned patent. Specifically, in the amplifying system herein disclosed the plate current is reduced to zero in at least two places in a multi-stage amplifier, so that the "on" and "off" conditions are not affected by values of the control light above or below a certain value; that is, the amplifier used with the photoelectric transmitter disclosed herein has two stages. In the first stage, a certain amount of light cuts off the plate current, and any additional illumination has no effect in altering the final output of the amplifier, the current in the second stage being determined by the local adjustment of the circuit. When the light falls below a certain value, sufficient current flows in the plate circuit of the first electronic tube to reduce the current in the plate circuit of the second electronic tube to zero, and any further decrease of illumination has no effect upon the final output.

Having reference to Fig. 1, the photoelectric cells 28 are connected in parallel to conductors 106 and 107. As is known, the impingement of light upon the light sensitive cathode 29 causes the emission of electrons therefrom which flow toward the anode or positive electrode 31 of the photo-cell. The cathode 29 is supplied with operating voltages from a source 108, and ordinarily changes in the electron stream flowing within the cell, due to varying light intensities falling thereon, will cause varying potential differences to be set up across a resistance 109 which is connected in series with the photo-cell electrodes.

The resistance 109 is also connected in the grid circuit of a multi-electrode electronic tube 111 having a cathode 112 and a control grid 113. The resistance 109 and the cathode 112 may be so connected to the source 108 as to provide a normal grid biasing source 114. The cathode 112 is of the hot cathode type and is heated by a filament 115 connected to a source of current 116, for example, the secondary circuit of a transformer 117. As thus far described, the circuit comprising source of current 108, photocell 28 (of any one of the four transmitting units), and resistance 109 is the source or input circuit for the grid control circuit comprising grid 113, cathode

112, conductor 118, biasing source 114, and resistance 109. The plate circuit of electronic tube 111 includes the portion of potentiometer source 108 included between taps 119 and 121, conductor 118, cathode 112, plate 122, resistance 123, and conductor 124, and is the source or input circuit for the grid control circuit of a second electronic tube 125, comprising a grid 126, cathode 127 and a plate 128. The control circuit for grid 126 includes portion of source 108 included between taps 121 and 129, conductor 124, resistance 123, grid 126, cathode 127, and conductor 131. The plate circuit of tube 125 extends from portion of source 108 between points 129 and 132, conductor 131, cathode 127, plate 128, thence through resistance 133, over conductor 134 to ring 135 of the transmitting distributor 11. It will be observed from Fig. 1, that there is located in the plate circuit of the last tube 125, a polarized relay 136 having three windings 137, 138, and 139. Therefore, the last traced circuit continues from ring 135 over brushes 141 and 142 to segmented ring 143 of the distributor 11, and thence over conductors 144 or 145, as the case may be, through windings 138 or 139, respectively, of the polarized relay 136 and back to source 108. Cathode 127 is heated by a filament 146 which, like filament 115, may be connected to the secondary of transformer 117.

Perforations in the tape 104 (Fig. 7) are indicative of marking signals, and the presentment of a perforation into the scanning region 72 (Fig. 3) will permit the impingement of the light beam upon the cathode of the photocell 28, thereby stimulating the emission of electrons therefrom and thus permitting current to flow in said first-mentioned circuit, which is coupled by means of resistance 109 to the control circuit for grid 113. The grid 113 is influenced thereby so as to cut off the flow of electrons from cathode 112 to plate 122 and thus reduce the plate current of the tube 111 substantially to zero. Cutting off the plate circuit of tube 111, which is the source circuit of the grid control circuit of tube 125, renders the grid 126 more positive and increases the flow of current in the plate circuit of tube 125 sufficiently to actuate the polarized relay 136 to hold the armature 148 thereof against contacts 149 or 151 as the case may be, depending upon the channel over which the signal impulses are transmitted, to impress marking current on the line wire 152. Winding 137 of the polarized relay 136 is a polarized winding and, through rings 153 and 154 of the transmitting distributor 11, is connected to the positive terminal for two channels and to the negative terminal for the remaining two channels. By this arrangement the normal impulses in some of the channels are made positive and in others negative so that when all channels are idle, reversals will still be transmitted for synchronizing purposes, as is the usual practice. Rings 135 and 143 serve to connect the amplifiers to one or the other of the operating windings 138 and 139 (which are reversed), and the relay 136 in response thereto serves to transmit, to the line, impulses controlled by all four transmitters of the multiplex system. The duplexing line relay 155 serves to control the receiving printers 156, 157, 158, and 159 at the transmitting station in response to received signals. The impulses for operating the local printers 156—159 are derived from the source 161, and extend over armature 162 of the relay 155, then over the conductor 163 to the ring 164 of the dis-

tributor 11, then over brushes 165 and 166 to the segmented ring 167.

The printers 156 to 159 are connected to the segments of the ring 167. Rings 168 and 169 supply starting impulses to the printers 156 to 159 in the usual manner. The signals thus transmitted over line wire 152 may be utilized to control through a remote line relay 170 and receiving distributor 147, the operation of a group of telegraph printers or recorders 150, for example, of the type disclosed in United States Patent No. 1,665,594, issued to H. L. Krum. The remote station, indicated by the line relay 170, is also provided with a transmitting distributor 171 for two-way communication over a duplex line, local printers 150 being also provided thereat.

Modification

According to Figs. 9 and 10, a modified form of the invention hereinbefore disclosed and embodying the same fundamental principles has been provided. Fig. 9 shows a four-channel photoelectric multiplex system in which all of the transmitters are driven by direct shaft connection from the motor. The arrangement comprises an impulse or synchronous motor 173 as is commonly used in multiplex synchronous telegraph systems. There is also provided a damper 174 of a suitable type to damp out oscillations. Located at one end of the motor shaft are the commutator rings 175 over which pass the brushes 176 driven by the motor 173. The commutators 175 are substantially similar to those shown in the transmitting distributor 11, shown in Fig. 1. The other end of the motor shaft is coupled by means of a coupling 177 to the shaft 178 of a photoelectric transmitter, indicated generally as 179. The photoelectric transmitter 179 is similar to the transmitter shown in Fig. 2. The shaft 178 of the photoelectric transmitter 179 is coupled by means of a coupling 181 (similar to coupling 177) to a shaft 182 of a photoelectric transmitter, indicated generally as 183. The shaft 182 of the photoelectric transmitter 183 is coupled by means of the coupling 184 to a shaft 185 of a photoelectric transmitter, indicated generally as 186. Similarly, shaft 185 is connected by means of a coupling 187 to the shaft 188 of a photoelectric transmitter 189. The motor 173 and the photoelectric transmitters 179, 183, 186 and 189 are mounted as a unit upon a base plate 191. Each of the photoelectric transmitters 179, 183, 186 and 189 is provided with an optical apparatus 192, similar to the optical apparatus 33 shown in Fig. 2, the details of which will not be repeated. The paper holding arrangement, and the gears and parts for driving the tape are not shown in this figure, but are similar to that shown and described in the aforementioned Patent No. 2,177,077.

Carried on shaft 178 of the photoelectric transmitter 179 is a single toothed clutch comprising a portion 193 fixed to said shaft and a driven portion 194 slidable axially on said shaft. The driven portion 194 is splined to a pinion 195, and compressed between flanges integral with clutch portion 194 and pinion 195 is a compression spring 196. The flange on the clutch portion 194 is provided with a cam portion (more clearly shown in the photoelectric transmitter 189) which cooperates with an arm 197 of an armature lever 198 pivotally mounted at 199 on a bracket 201 carrying an electromagnet 202. A spring 203 normally draws arm 197 of armature

lever 198 toward the clutch portion 194. The extremity of arm 197 is conformed to cooperate with the cam portion on the flange of the clutch portion 194, so that when the electromagnet 202 is de-energized, arm 197 will be drawn toward the sleeve or clutch portion 194, bringing the end of arm 197 into the path of the cam portion, whereupon, as the sleeve portion 194 rotates in the direction noted by the arrow, the camming relation between cam portion and the extremity of arm 197 will cause the clutch portion 194 to be urged leftwardly (as viewed in Fig. 9) against the action of the spring 196, thereby disengaging the clutch members 193 and 194. Conversely, upon energization of electromagnet 202, the armature 198 will be attracted, causing the armature to be rotated so as to tension the spring 203, thereby disengaging the end of arm 197 from the cam portion, whereupon spring 196 will urge the sleeve of cam clutch portion 194 rightwardly into engagement with the driving portion 193. As previously mentioned, the pinion 195 serves to impart movement to the tape moving mechanism, as described in said Patent No. 2,177,077.

Clamped between the pinion 195 and a nut 204 is a scanning cylinder 205, which is provided with scanning apertures 206 comparable to apertures 27 shown in Fig. 2. A photoelectric cell 207 is positioned within the scanning cylinder 205, similarly to the manner shown in Fig. 2.

Photoelectric transmitters 179, 183, 186 and 189 are similarly constructed, and differ from each other by the relative positions of the teeth on the driving clutch portions 193 and 194. Since the arrangement in Fig. 9 is such as is provided for a four-channel multiplex, the teeth 208 of the grab clutches are spaced ninety degrees apart. Similarly, the series of groups of helically arranged scanning apertures 206 are likewise spaced ninety degrees apart; that is, the scanning apertures 206 in each of the scanning cylinders 205 are spaced one-fourth of a circumference or 90 degrees behind one another in the order of transmitters 179, 183, 186 and 189.

The arrangement of the four-channel multiplex system, shown in Fig. 9, is illustrated in its operating position, wherein the magnets 202 of each of the transmitters 179, 183, 186 and 189 are assumed to be energized, thereby permitting the clutch portions of the several single-tooth clutches to be in operative engagement. Furthermore, when all of the magnets 202 are de-energized, the scanning cylinders 205 will be stopped or arrested with the apertures 206 in the same position; namely, that shown in transmitting distributor 189. In this manner, with the clutches shown as described, the scanning cylinders 206 are stopped by the armature of the control magnet 202, so that the solid portion of the scanning cylinders are opposite the slits in the glass plates 209, so that no light will fall on the photoelectric cells 207, and phasing impulses will be transmitted in this quadrant of the photoelectric multiplex as will presently appear. Furthermore, when the scanning cylinders 206 are stopped in the position shown in the transmitter 189, the scanning drums 206 will rotate a substantial distance before the scanning apertures 206 arrive at the scanning position so that the scanning drums 205 will have attained steady motion.

In Fig. 10 is illustrated how the electrical circuit shown in Fig. 1 may be modified when translucent printed tape (such as illustrated in

Fig. 8) is employed as the control strip, thereby reversing the marking and spacing light conditions on the photoelectric cell, and is similar to the circuit illustrated in Fig. 1 except that the normal grid bias of the electronic tube is made more negative, and the photoelectric cell has been connected in such a manner as to bias the grid positively when light falls upon the photocell. In both of the circuits (Fig. 1 and Fig. 10) the same effect is obtained in the tube of the second stage of amplification, so that marking signals of the same kind or nature are transmitted over the line wire.

It will be remembered that with the circuit shown in Fig. 1 perforated tape as shown in Fig. 7 was employed to control the impingement of light on the photocell 28, and that a perforation in the tape was indicative of a marking impulse, so that the presence of light upon the photocell 28 was likewise indicative of a marking condition. With the circuit shown in Fig. 10, the contrary is true; that is, the printed spots or areas on the translucent tape shown in Fig. 8 are indicative of marking signals, and being impervious to light, prevent the falling of light upon the photocells 207, so that in this instance the absence of light upon the photocells is indicative of a marking condition. The circuit arrangement may be such that the plate circuit of the second tube in each case be controlled in the same manner so that the marking signals transmitted over the line wire are of the same characteristic. To achieve this result, the anodes 211 of the photocells 207 are connected in parallel to a conductor 212, which is connected by a conductor 213 to the source 214 (analogous to 100, Fig. 1). Cathodes 215 of photocells 207 are connected in parallel to a common conductor 216, and are supplied with operating voltages from the source 214 through a resistance 217. Like photocells 28 (Fig. 1), photocells 207 also function as a switch to control the "on" and "off" conditions of the control light. The resistance 217 is also connected to the grid circuit of a multi-electrode electronic tube 218, having a cathode 219 and a control grid 221. The resistance 217 and the cathode 219 are so connected to the source 214 as to provide a normal grid biasing source included between terminals 222 and 223, which, as compared with the normal grid biasing source 114 (Fig. 1) is more negative. Thus, the grid control circuit of tube 218 extends from source 214, through resistance 217, over conductor 224, through grid 221, cathode 219, and over conductors 225, 226 and 227 to source 214. The negativeness of the grid control circuit just traced is effective, when no light falls upon the photocell to cut off the plate current of tube 218, the plate circuit of which extends from source 214, over conductors 227, 226 and 225, cathode 219, plate 228, resistance 229, and conductor 231 to terminal 232 of potentiometer source 214. This plate circuit just traced is the source or input circuit for the grid control circuit of the second electronic tube 233, comprising a grid 234, cathode 235 and a plate 236. The control circuit for grid 234 includes portion of source 214 included between terminals or taps 232 and 237, conductor 231, resistance 229, grid 234, cathode 235, and conductors 238 and 239. The plate circuit of tube 233 extends from portion of source 214 included between taps 237 and 241, through conductors 239 and 238, cathode 235, plate 236, thence through resistance 242, and over conductor 243 to ring 244 of the trans-

mitting distributor 175. It will be observed from Fig. 10, that there is located in the plate circuit of the last tube 233, a polarized relay 245 having three windings 246, 247, and 248. Therefore, the last traced circuit continues from ring 244, over brushes 249 and 251 to segmented ring 252 of the distributor 145, thence over conductors 253 or 254, as the case may be (as will presently appear), through windings 247 or 248, respectively, of the polarized relay 245, and thence back to source 214. Cathode 235 is heated by a filament 255 which, like filament 220, may be connected to the secondary of transformer 240. The current for the exciter lamps 250 may also be derived from the secondary of transformer 240, or any other source of current.

Printed areas or spots on the translucent tape (for example, as indicated in Fig. 8) are indicative of marking signal impulses, and the presentment of a printed area into the scanning region will block or prevent the impingement of the light beam upon the cathode of the photocell 207. The effect of this condition upon the circuit shown in Fig. 10 is to render the grid 221 more negative, which reduces the plate current of tube 218, which in turn renders the grid 234 of tube 233 more positive to thus increase the plate current of the tube 233. It is, therefore, seen that the absence of light on photocell 207 has the same effect on tube 233 as the presence of light on photocell 28 (Fig. 1) had on tube 125. Increasing the flow of current in the plate circuit of tube 233 causes the polarized relay 245 to hold its armature 256 against contacts 257 or 258 as the case may be, depending upon the channel over which the signal impulses are transmitted, to impress marking current on the line wire 259. Winding 246 of the polarized relay 245 is a polarized winding and, through rings 261 and 262 of the transmitting distributor 175, is connected to the positive terminal for two channels and to the negative terminal for the remaining two channels. By this arrangement, the normal impulses in some of the channels are made positive and in others negative so that when all channels are idle, reversals will still be transmitted for synchronizing purposes, as is the usual practice. Rings 244 and 252 serve to connect the amplifiers to one or the other of the operating windings 247 or 248 (which are reversed), and the relay 245 in response thereto serves to transmit, to the line, impulses controlled by all four transmitters of the multiplex system. The duplexing line relay 263 serves to control the receiving printers 264, 265, 266 and 267. The impulses for operating the local printers 264—267 are derived from the source 268, and extend over armature 269 of the relay 263, then over the conductor 271 to the ring 272 of the distributor 175, then over brushes 273 and 274 to the segmented ring 275.

The printers 264 to 267 are connected to the segments of ring 275. Rings 276 and 277 supply starting impulses to the printers 264 to 267 in the usual manner. The signals thus transmitted over line wire 259 may be utilized to control, through a remote line relay 278 and receiving distributor 282, the operation of a group of telegraph printers or recorders 283, for example, of the type disclosed in United States Patent No. 1,665,594, issued to H. L. Krum, in the same manner as described in connection with Fig. 1. The remote station, indicated by the line relay 278, is also provided with a transmitting distributor 279 for

two-way communication over a duplex line, local printers 283 also being provided thereat.

Although the present invention is described in connection with a certain specific disclosure, it is contemplated that all forms which come within the range and scope of equivalency are intended to be embraced within the purview of the appended claims.

What is claimed is:

1. In a multiplex signaling system, a plurality of photoelectric transmitters, each transmitter comprising a cylindrical scanning device having a helically arranged series of slots, one corresponding to each element of a code, and means whereby each scanning device acts in succession as a transmitting distributor for the signals controlled by the transmitter of which it forms a part.

2. In a photoelectric signalling system, a plurality of scanning devices, an independent motor drive for each scanning device, and autosynchronous means to maintain a predetermined phase relation between the scanning devices.

3. In a signaling system, a plurality of photoelectric cells, a corresponding plurality of cylindrical scanning devices, each having a helically arranged series of apertures embraced in a predetermined angular portion thereof, one aperture corresponding to each element of a code to render said devices effective to transmit code signals, and means to control the transmission of code signals by said scanning devices sequentially.

4. In a multiplex telegraph system, a plurality of transmitting distributors, a separate motor to drive each distributor, and autosynchronous means to continuously maintain each transmitting distributor in the correct phase relation to each of the others.

5. In a multiplex signaling system, a plurality of photoelectric scanning devices, each comprising a cylindrical shutter member having a helically arranged series of slots, one corresponding to each element of a code, and means to simultaneously operate the scanning devices in such a phase position that they are effective in a predetermined sequence.

6. In a multiplex signaling system, a plurality of photoelectric transmitters, each transmitter comprising a scanning device, means whereby each scanning device acts as a transmitting distributor for the signals controlled by the transmitter of which it forms a part, means to arrest any scanning device and means to transmit all spacing signals corresponding to the stopped scanning device.

7. In a multiplex signaling system, a plurality of photoelectric transmitters, each transmitter comprising a scanning device, means whereby each scanning device acts as a transmitting distributor for the signals controlled by the transmitter of which it forms a part, means to arrest any scanning device, means to transmit all spacing signals corresponding to the stopped scanning device, and means to transmit synchronizing signals when all said distributors are stopped.

8. In a multiplex signaling system, a plurality of photoelectric cells, a corresponding plurality of scanning drums, each drum having a series of slots, one corresponding to each element of a code, means associated with each drum to activate under control of said drum each cell according to code signals representing different messages, an amplifier common to all the cells, and distributing means associated with said amplifier to transmit on a common circuit a plurality of

messages according to the activation of all said cells.

9. In a multiplex signaling system, a plurality of photoelectric cells, a plurality of corresponding receivers; and scanning means comprising a plurality of rotary shutter devices to associate each cell in succession in an operative relation to its corresponding receiver.

10. In a multiplex signaling system, a plurality of photosensitive members, an exciter lamp associated with each of said members, rotary shutter means to control the action of said exciter lamp on its corresponding member according to a message to be transmitted, a plurality of recorders, and means operative over a single circuit to control in succession each recorder by its corresponding photosensitive member.

11. In a transmitting device, a plurality of constantly rotating shafts, a distributing device adapted to be automatically coupled to and uncoupled from each shaft, and means to couple said distributing devices in predetermined relative positions.

12. In a multiplex telegraph system, a plurality of cylindrical transmitting distributors, each having a helically arranged series of slots arranged in quadrature, each slot corresponding to an element of a code, each distributor corresponding to a channel of communication, and means to simultaneously operate the distributors in such a phase position that they are effective in a predetermined sequence to transmit code signals under the control of said slots.

13. In a multiplex telegraph system, a master distributor, a separately motor driven secondary distributor for each channel, and means controlled by the master distributor to operate the secondary distributors in a predetermined phase relation.

14. In a multiplex photoelectric transmitter, a plurality of scanning drums, each drum carrying a series of slots, one corresponding to each element of a code, and means to rotate the drums so that the first slot in one drum shall become effective immediately after the last slot in the immediately preceding drum has become ineffective.

15. In a multiplex telegraph system, a plurality of transmitters, and means independent of the transmitters to determine the character of the marking and spacing impulses in each of the channels.

16. In a multiplex telegraph system, a plurality of photoelectric transmitters, one corresponding to each channel, an amplifier controlled by the transmitters, and means associated with the amplifier to make the character of the spacing and marking impulses of one channel different from the character of the marking and spacing impulses in another channel.

17. In a photoelectric transmitter, a plurality of photosensitive devices, each comprising a rotatable scanning cylinder and each corresponding to an independent message channel, and means autosynchronous to render said devices operable in such a phase position that they are effective in a predetermined sequence.

18. In a photoelectric transmitter for synchronous multiplex telegraph systems, a control form of partially light conducting material and having thereon groups of code impressions less light conducting than the unimpressed material, means comprising a continuously rotating shutter device to photoelectrically scan

each group in succession, said device having an opening corresponding to each impulse in a cycle of transmission, said impressions being divided into groups representing channels of the multiplex system with each group corresponding to a set of impulses representing a character signal, and means controlled by said means to control the signals transmitted over the multiplex system.

19. In a photoelectric telegraph transmitter, a plurality of control tapes, photoelectric means to generate signals under control of the tapes, and means to combine the signals for transmission in succession over a single telegraph line.

20. In a synchronous multiplex telegraph system, a plurality of rotary signal distributors, one for each channel of the multiplex, and means to simultaneously operate the distributors in such a phase position that one distributor after another becomes effective in a predetermined sequence.

21. In a synchronous multiplex telegraph system, a plurality of rotary signal distributors, one for each channel of the multiplex, means to simultaneously operate the distributors in such a phase position that one distributor after another becomes effective in a predetermined sequence, and independent signal control means associated with each distributor to control the character of the transmitted signals.

22. In a telegraph apparatus for the transmission of code signals, a relay, a transmitting switch forming a part of the relay, and means associated with the windings of the relay to invert the operation of the transmitting switch for some of the signals.

23. In a signaling apparatus, an electronic amplifier, a plurality of photoelectric cells, scanning means comprising a plurality of rotary shutter devices to operatively associate different photoelectric cells with the amplifier at different times, and a single-toothed clutch device associated with each scanning means in such a manner that the several teeth are operatively related in predetermined angular phase, whereby a predetermined phase relation is maintained between said shutter devices.

24. In a signaling system, an electronic amplifier, a plurality of photoelectric cells, scanning means comprising a plurality of rotary shutter devices to associate the photoelectric cells with the amplifier, a constantly rotating member, and means to start said shutter devices in a predetermined phase relation to the constantly rotating member.

25. In a photoelectric transmitter for synchronous multiplex telegraph systems, a control form having thereon groups of light controlling code impressions, means comprising a continuously rotating shutter device to photoelectrically scan each group in succession, said device having an opening corresponding to each impulse in a cycle of transmission, said impressions being divided into groups representing channels of the multiplex system with each group corresponding to a set of impulses and representing a character signal, and means controlled by said means to control the signals transmitted over the multiplex system.

26. In a synchronous multiplex telegraph system, a constantly rotating distributor adapted

to determine the character of the spacing signal in each channel of the multiplex, and a signal distributor adapted to change spacing to marking signals according to signals to be transmitted.

27. In a synchronous multiplex telegraph system, a constantly rotating distributor adapted to determine the character of the spacing signal in each channel of the multiplex, a signal distributor adapted to change spacing to marking signals according to signals to be transmitted, and means to stop the second mentioned distributor when no signals are to be transmitted.

28. In a telegraph system, a transmitting relay, biasing means to determine the direction of operation of the relay corresponding to a spacing signal, and means to reverse the biasing means for some of the signals to be transmitted.

29. In a multiplex synchronous telegraph system, a constantly rotating member, a distributor individual to a channel of the multiplex, means to arrest the distributor, and means to start the distributor in a predetermined phase relation to the constantly rotating member.

30. In a signaling system, a plurality of electronic devices each including a cathode, means to increase the electronic mobility of the cathode according to signals to be transmitted and different for each cathode, and means comprising a plurality of scanning drums wherein each drum is provided with a helically arranged series of slots, each slot corresponding to an element of a code, and means comprising a plurality of single-toothed clutch devices, wherein the several teeth are operatively related in predetermined angular phase to render said drums operable in such a phase position that they are effective in a predetermined sequence to combine the signals generated on a single circuit.

31. In a photoelectric transmitter for synchronous multiplex telegraph systems, a control form of light controlling material and having thereon groups of code impressions different in light control than the unimpressed material, means comprising a continuously rotating shutter device to photoelectrically scan each group in succession, said device having an opening corresponding to each impulse in a cycle of transmission, said impressions being divided into groups representing channels of the multiplex system with each group corresponding to a set of impulses representing a character signal, and means controlled by said means to control the signals transmitted over the multiplex system.

32. In a photoelectric transmitter for synchronous multiplex telegraph systems, a continuously rotating shutter device having an opening corresponding to each impulse in a cycle of transmission, said openings being divided into groups representing channels of the multiplex system with each group corresponding to a set of impulses representing a character signal, means to illuminate each opening as it passes a predetermined angular position, and means to control the illumination of each opening according to impulses to be transmitted over the multiplex system.

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