April 6, 1937. J. W. HORTON ET AL 2,075,898

SYNCHRONIZING SYSTEM

Original Filed June 11, 1925 3 Sheets-Sheet 1

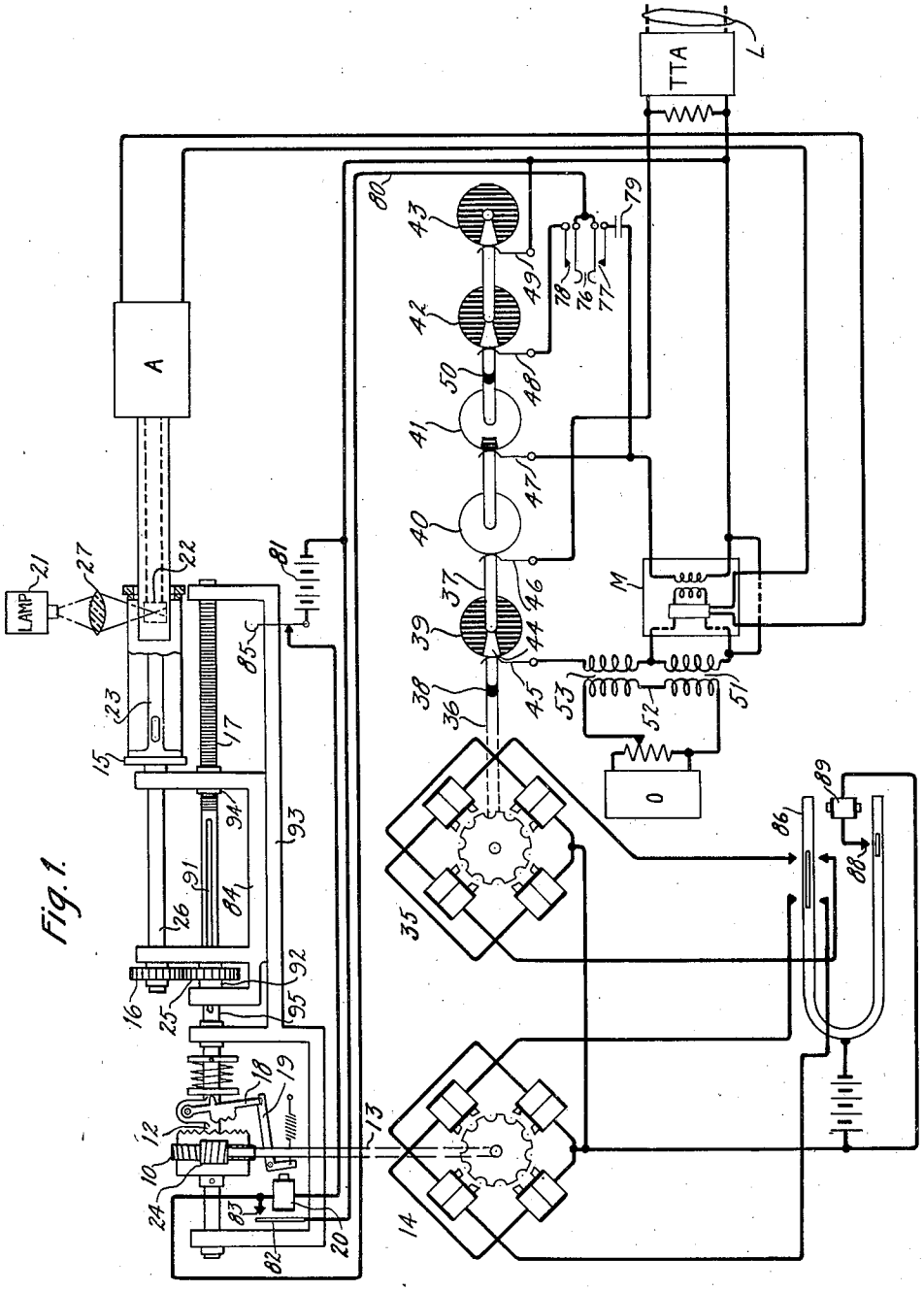

Fig. 1.

Inventors:
Joseph W. Horton
Donald M. Terry

by E. W. Adams Att'y.

April 6, 1937. J. W. HORTON ET AL 2,075,898

SYNCHRONIZING SYSTEM

Original Filed June 11, 1925 3 Sheets-Sheet 2

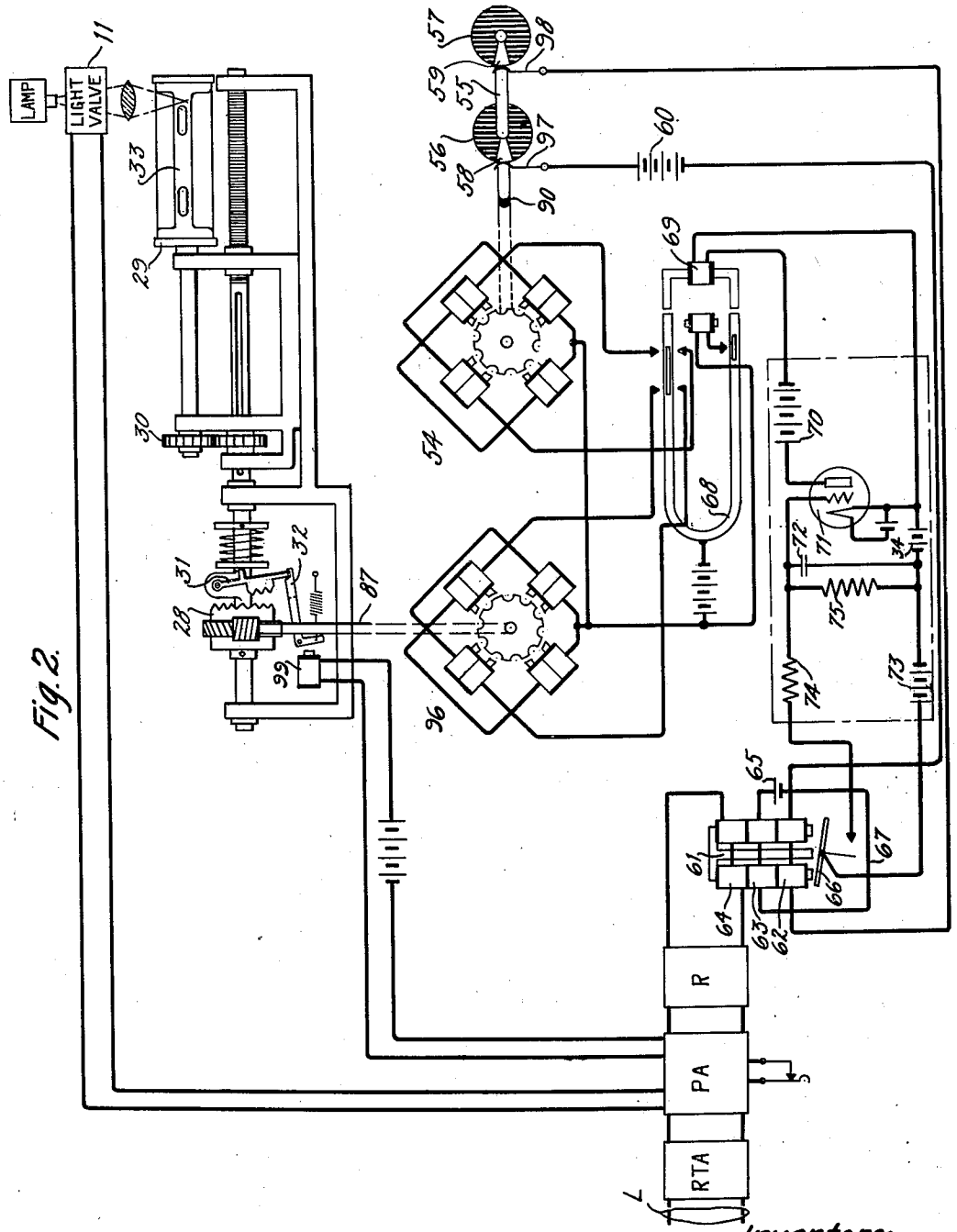

Fig. 2.

Inventors:
Joseph W. Horton
Donald M. Terry
by E. W. Adams Atty.

April 6, 1937. J. W. HORTON ET AL 2,075,898

SYNCHRONIZING SYSTEM

Original Filed June 11, 1925 3 Sheets-Sheet 3

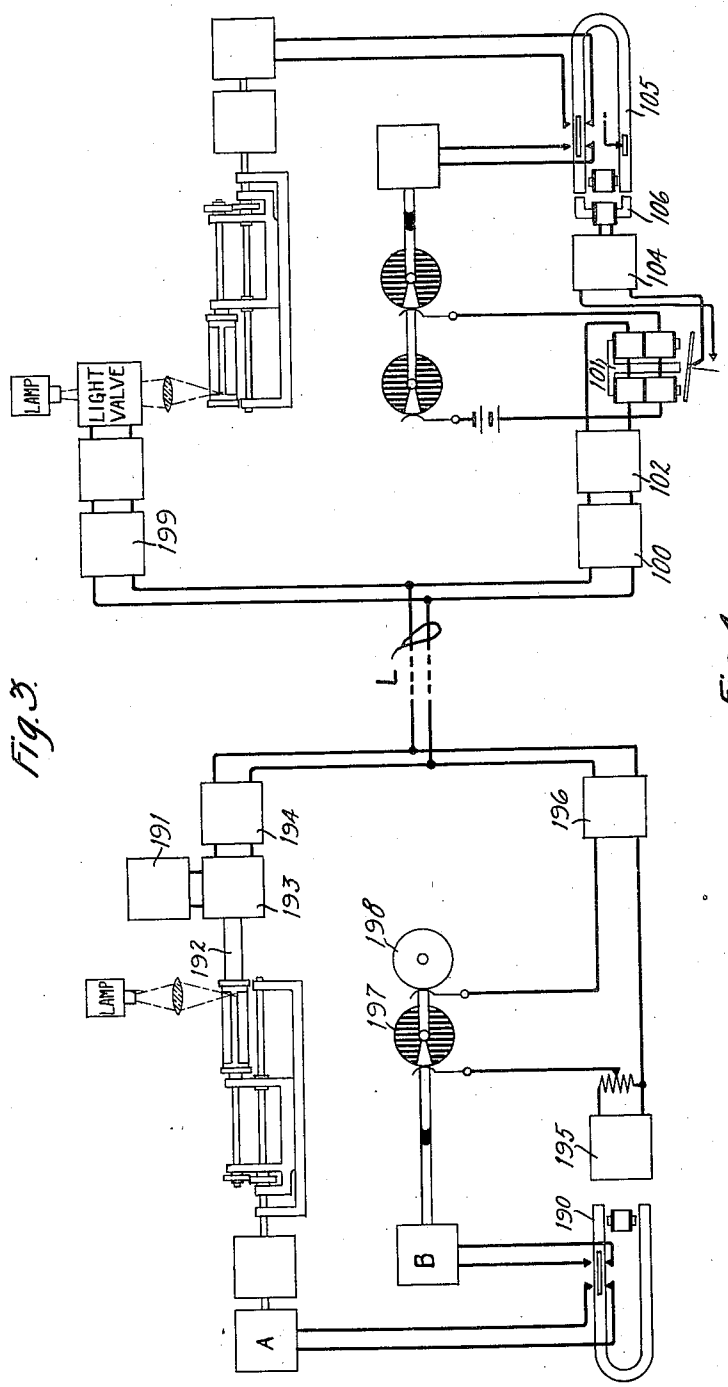

Fig. 3.

Fig. 4.

Inventors:
Joseph W. Horton
Donald M. Terry

by E. W. Adams. Att'y.

Patented Apr. 6, 1937

2,075,898

UNITED STATES PATENT OFFICE

2,075,898

SYNCHRONIZING SYSTEM

Joseph W. Horton, Cambridge, Mass., and Donald M. Terry, New York, N. Y., assignors to Western Electric Company, Incorporated, New York, N. Y., a corporation of New York

Application June 11, 1925, Serial No. 36,357
Renewed September 5, 1930

19 Claims. (Cl. 178—69.5)

This invention relates to control devices and more especially to the means for controlling the movement of synchronously operating members, such as employed in picture transmission systems and telegraph systems.

In order that the proper sequence and arrangement of signals sent from a transmitting station may be recorded at a receiving station, it has been the practice heretofore to provide a moving element at the receiving station which is adapted to move in synchronism with a corresponding element at the transmitting station. In systems of picture transmission, it has been found that a rotating cylinder or drum provides a desirable form upon which the transmitting or recording element may be mounted for the purpose of allowing a progressive scanning of the entire area of the picture. The transparent picture to be transmitted and the recording film are so positioned upon their respective drums that there is a portion of each drum which is not effective in the transmission of impulses corresponding to the picture characteristics. As the sending and receiving drums are rotated, these blank portions are presented to the light source once during each revolution of the respective drum. The portion of a revolution during which the blank portions of the drum are thus presented, is termed "the underlap period".

In the transmission of pictures it is essential, therefore, that the sending and receiving drums be continuously in phase and in synchronism, in order to avoid distortion in the reproduced picture. For this purpose a driving motor at the receiving station is maintained in constant synchronism with a driving motor at the sending station. In a preferred embodiment of the invention there is employed a "phonic wheel" or a tuning fork controlled motor for driving both the sending and receiving drums, each driving motor having associated therewith another motor for synchronizing purposes. The tuning fork associated with the driving and synchronizing motors at the receiving station has associated therewith a damping magnet which is adapted to be energized during the underlap period by means of correcting impulses. The energization of this damping magnet serves to control the synchronizing speed of the associated motors.

It is an object of this invention, therefore, to control the speed of driving members employed in signaling systems.

A feature of the invention relates to a signaling system wherein continuously operable driving elements at sending and receiving stations are controlled by means of carrier current of characteristic amplitude.

Another feature relates to a picture transmission system wherein special motors at the sending and receiving stations cooperate to maintain synchronous speed of the driving motors at each of said stations.

A still further feature relates to a speed controlling mechanism which is controlled jointly by apparatus at both ends of a transmission line to maintain synchronous speed of driving elements at each end thereof.

Other features and advantages not specifically enumerated will become apparent after a consideration of the following description and the appended claims.

Referring to the drawings, Fig. 1 shows circuits and apparatus at a sending station comprising driving and synchronizing motors controlled by a tuning fork; a source of light and a light sensitive cell; together with means for allowing the picture to be scanned. This figure also represents schematically by means of rectangles various modulating and amplifying equipment, as well as an outgoing transmission line.

Fig. 2 discloses substantially similar apparatus to that shown in Fig. 1 and is located at the incoming end of the transmission line.

Fig. 3 illustrates a modification of the invention as applied to a picture transmission system.

Fig. 4 is a curve showing the variations of the transmission line current at different periods of time.

While it has been chosen to illustrate the invention as applied to a system for transmitting pictures, it is understood that in its broad aspects the invention is not to be so limited. It will be apparent that the invention may be applied to any signaling system wherein rotatable elements at receiving and sending stations are required to operate in synchronism.

The invention as disclosed in the drawings is shown as applied to a system of picture transmission similar to that described in Patent No. 1,606,227, granted Nov. 9, 1926 to J. W. Horton, H. E. Ives and M. B. Long.

Referring to Fig. 1, there is shown a driving motor 14, which may be of any type adapted to operate at a relatively constant speed. This motor is preferably a phonic wheel or tuning fork controlled motor, and may be started in operation manually. A similar motor 35 is also provided for synchronizing purposes, as will appear hereinafter. When magnet 20 receives a starting impulse, the spring actuated clutch member 18 is

released. The clutch member thereupon cooperates with gears 10 and 24, whereby gears 16 and 25 are rotated. Mounted on the shaft 26, rotated by gear 16, is a drum 15, adapted to rotate with said shaft. The frame 84 in which the shaft 12 is rotatably mounted is adapted to move longitudinally along the base plate 93, when thread 17 rotates in threaded bearing 94. Gear 25 by means of the sleeve 92 is so mounted on shaft 95 as to move longitudinally and integrally with the frame 84. Thus when shaft 95 rotates, rotatory and longitudinal movements are imparted to gears 16 and 25. The gears 16 and 25 are so designed as to allow for the proper ratio between the rotational and longitudinal movements of drum 15.

The picture to be sent is mounted on drum 15, and as the drum rotates, light from the source 21 is projected by means of lens 27 on the drum and passing through the transparent portions of the picture affects the photoelectric, or other light sensitive, cell 22, which has its resistance varied in accordance with the characteristics of the picture. The cathode and anode of this cell are connected to the input circuit of amplifier A so that the variations in the resistance of the cell cause corresponding variations of current flow in the input and output circuits of the amplifier. The output circuit of amplifier A is connected to the modulator M, whereby the amplitude of the carrier waves generated by oscillator O are modulated, and are then impressed on the line L after passing through the transmitting terminal amplifier TTA. For a detailed description of the circuits and the method of operation of modulator M, reference may be had to the patent to Messrs. Horton, Ives, and Long, referred to hereinabove.

The picture is so mounted on drum 15 that between the ends of said picture there is an opaque portion 23 which intercepts the rays of light from the source 21 for a comparatively short period, called "the underlap period", during each revolution of drum 15. During this underlap period, therefore, the carrier waves are not modulated in accordance with the picture characteristics, but are changed in amplitude for synchronizing purposes, as will be described hereinafter.

From an inspection of Fig. 1, it will be noted that during the period of transmission of the picture characteristics that the lower right winding 51 of transformer 52 alone is effective to cause the carrier waves to be modulated, thus allowing a maximum amplitude to the modulated waves, represented by amplitude of portion A of the curve of Fig. 4. However, during the underlap period, both right windings 51 and 53 are effective, thereby increasing the amplitude of the carrier waves beyond their amplitude during the picture transmission period.

At the receiving station shown in Fig. 2, the modulated carrier waves are received over line L and are amplified by receiving terminal amplifier RTA and picture amplifier PA, after which the impulses affect the light valve 11, or they may be employed in any other manner for reproducing the picture. As shown, the driving motor 96, which is preferably similar to motor 14 is employed for rotating shaft 87, which is suitably geared to the crown wheel 28. A drum 29, similar to drum 15, is rotated by gear 30 when the spring actuated clutch member 31 is released by actuation of the start magnet 99. The portion 33 of the drum 29 included between the ends of the picture corresponds to the portion 23 of drum 15.

In order to avoid distortion in the received picture, it is necessary that drums 15 and 29 rotate in synchronism. For the purpose of maintaining accurate synchronism of the sending and receiving drums, there is provided at the sending station a motor 35 controlled by the fork 86, which also controls motor 14. By means of this arrangement motors 35 and 14 will operate in synchronism. A similar arrangement exists at the receiving station, fork 68 controlling the synchronous operation of motors 54 and 96. Each of the controlling tuning forks 86 and 68, once motion is imparted thereto, continues to vibrate at its natural period under control of a self-interrupting circuit. For example, contact 88 provides a self-interrupting circuit for the fork 86. This contact when closed completes a circuit from battery through the winding of the driving magnet 89. Magnet 89 is, therefore, energized and deenergized in correspondence with the natural frequency of the tines of fork 86. Each of the forks is also provided with sets of contacts for controlling the operation of the associated motors 14, 35 and 96, 54, in the well known manner. The tuning fork 68 located at the receiving station is also provided with a damping magnet 69 for varying the vibration period of this fork in a manner to be described hereinafter.

Motor 35 at the sending station controls a shaft comprising sections 36, 37, etc., which are insulated from each other by means of the insulating segments 38 and 50. Rigidly secured to this shaft are a number of disc-like commutators 39, 40, 41, 42 and 43. The shaded portion of each disc represents insulation and the unshaded portion represents conducting material. Arranged for cooperation with the commutators are brushes 45, 46, 47, 48 and 49. It will be noted, therefore, that a circuit is prepared by means of brush 46 and commutator 40 during the entire revolution of the shaft. Brushes 45, 48 and 49 are so positioned that they make contact with the conducting portions of their respective commutators only during that portion of a revolution which corresponds to the underlap period of drum 15. Similarly brush 47 is positioned so as to be insulated from the shaft section 37, only during the underlap period. The angular width of the conducting segments on commutators 39, 42 and 43, and of the insulating segment of commutator 41 may be such as to provide commutation during a complete underlap period or during only a portion of this period as may be necessary for synchronizing purposes.

The motor 35 is adapted to be continuously operated so that brush 45 closes a circuit through segment 44 and shaft section 37 once every revolution, namely, during the underlap period. During this period, therefore, a circuit may be traced from the upper conductor of line L, brush 46 and cooperating commutator shaft section 37, segment 44 and brush 45, right windings of transformer 52, thence through the lower conductor of line L. It will be noted that during the underlap period brush 47 rests on an insulating segment and consequently the carrier waves are unmodulated. Since both windings of transformer 52 are thus effective during the underlap period, the carrier current impressed on line L will have an amplitude represented by the portions B of the curve of Fig. 4.

During the major portion of the revolution of drum 15, and assuming that no picture signals

are being transmitted, then brush 45 rests on insulation and brush 47 rests on conducting material. Therefore, the upper winding 53 of the transformer 52 is rendered ineffective. The output circuit of the modulator is closed by means of a circuit completed from the upper conductor of line L, brush 46 and cooperating commutator 40, shaft section 37, brush 47 and commutator 41, through the output winding of modulator M, thence to the lower conductor of the line. The carrier current impressed on the line L, by means of winding 51, has a constant amplitude represented by the portions A of the line current curve. When pictures are being sent, however, the current A is modulated in accordance with the picture characteristics, as represented by section C of the line current curve.

The receiving station is provided with a synchronizing motor 54, corresponding to motor 35 at the sending station. Motor 54 controls a shaft having portions insulated from each other by means of the insulating segment 90. The portion 55 carries the commutator discs 56 and 57, having conducting segments 58 and 59, respectively, which are in electrical communication with the shaft section 55. Arranged for cooperation with the commutators 56 and 57 are brushes 97 and 98.

During the interval that brush 45 makes contact with segment 44, the increased carrier current impressed on line L by means of the right windings of transformer 52 passes through the rectifier R, and the upper windings of relay 61, causing said relay to attract its armature 66 to close its contacts. Shortly thereafter a circuit is closed from the negative pole of battery 60, through the lower windings of relay 61, brush 98 and segment 59, shaft section 55, segment 58 and brush 97, returning to the positive pole of battery 60. The energization of the lower windings of relay 61 is sufficient to overcome the attraction due to the energization of the upper winding and relay 61 releases its armatures to open the contacts. Thus, relay 61 remains operated for a brief interval during the underlap period included from the instant brush 45 makes contact with segment 44 till brushes 97 and 98 first make contact with segments 58 and 59, respectively. So long, therefore, as motors 35 and 54 are running synchronously the period during which the contacts of relay 61 are closed remains constant.

It is obvious, therefore, that should motor 54 for any reason decrease in speed, due to a decrease in the rate of vibration of fork 68, the period of closure of the contacts of relay 61 increases. Similarly, should motor 54 increase in speed, because of an increase of vibration of fork 68, this period is correspondingly shortened. During the time that relay 61 is operated, condenser 72 is charged by means of a circuit including battery 73, closed contacts of relay 61 and resistance 74. The condenser 72 thereupon continuously discharges through resistance 75, which is connected in parallel therewith, and the potential on the grid of tube 71 varies correspondingly. So long as the motors 35 and 54 are running synchronously, condenser 72 charges and discharges at a predetermined rate, depending upon the relative value of resistances 74 and 75 and the capacity of condenser 72. Thus, for each revolution of the sending and receiving drums, the grid of tube 71 is maintained at a constant average potential determined by the batteries 34, 73 and the relative values of condenser 72 and resistances 74 and 75, and an average current flows through the winding of magnet 69. It will be noted that increased energization of magnet 69 has a similar effect to a mechanical stiffening of the tines of the fork which thereupon vibrate at a faster rate, the converse being true when magnet 69 has a decreased current flowing therethrough.

Should fork 68 tend to vibrate at a slower rate than fork 86, motor 54 lags and the period of closure of the relay contacts increases as described above, and the mean potential on the grid of tube 71 increases, thus increasing the space current of said tube and the current through the winding of magnet 69, allowing the tines of fork 68 to vibrate faster. On the other hand, should motor 54 increase in speed, due to an increase in the vibration rate of fork 68, the mean potential on the grid decreases and a decreased current flows through the tube 71 and the winding of magnet 69 to correspondingly dampen the vibrations of fork 68.

When it is desired to transmit pictures, tuning forks 86 and 68 are initially set in motion, motor 35 at the sending station and motor 54 at the receiving station may be started in operation. Shafts 36 and 55 are thus rotated, and unmodulated carrier current generated by oscillator O, is impressed on the line by means of the winding 51 of transformer 52. After an interval due to the action of relay 61 and tube 71 as above explained motors 35 and 54 are synchronized, whereupon motors 14 and 96 may be started in operation.

Key 76 is next operated to close contacts 77 and 78. If this key is thrown during the occurrence of the underlap period of drum 15, a circuit is completed from positive pole of battery 81, through the contacts of key 85, winding of clutch magnet 20, conductor 80, contact 78 of key 76, brush 48 and conducting segment of commutator 42, conducting segment of commutator 43 and brush 49, to the negative pole of battery 81. Magnet 20 immediately locks under control of key 85. As soon as key 76 is operated during the underlap period, the output circuit of the modulator is shunted by means of a path traceable from the upper terminal of the modulator output coil, condenser 79, contacts 77 and 78 of key 76, brush 48 and conducting segment of commutator 42, conducting segment of commutator 43 and brush 49, to the lower terminal of the modulator output coil. Condenser 79 is of such capacity as to reduce the line current to substantially zero value, as indicated by the portions D of the line current curve. With magnet 20 locked should key 76 be held operated after the occurrence of the underlap period, the modulator output coil remains shunted over a path traceable from the upper terminal of said output coil, condenser 79, contacts 77 of key 76, conductor 80, locking contacts of magnet 20, to the lower terminals of the modulator output coil. The reduction of current in the line as above described serves to set up the receiving apparatus in readiness for the modulated carrier by operating magnet 99, as is fully described in the patent to Messrs. Horton, Ives and Long, referred to hereinbefore. When magnet 20 energizes, it immediately locks under control of the key 85. The pivoted arm 19 is attracted, releasing the clutch member 18, whereby the drum 15 is rotated. The above mentioned locking circuit for magnet 20 is maintained until the drum 15 has reached the limit of its longitudinal movement, whereupon a projection on the drum carriage engages a trip finger on key 85 to open the contacts thereof and release the clutch magnet 20. Should key 76 be maintained oper-

ated for more than a single revolution of the drum 15 then when brushes 48 and 49 next make contact with their cooperating conducting segments the condenser 79 short-circuits the output terminals of the modulator M. The synchronizing current is however applied to the line L by means of both windings of transformer 52 and brushes 45 and 46 as hereinbefore described.

Should the brushes 48 and 49 be in contact with their conducting segments that is, during the underlap position of the drum, when key 76 is first operated, then the modulator is short-circuited as above described and no modulated current flows in the line L until the underlap position is passed when brushes 46 and 47 complete a circuit through their respective commutators.

At the receiving station the interruption of the carrier current caused by the operation of the key 76 brings about the energization of magnet 99 as described in the patent to Messrs. Horton, Ives and Long referred to hereinbefore. Magnet 99 attracts the pivoted arm 32 whereby the clutch member 31 is released to cause the rotation of gear 30 and drum 29. When key 76 at the sending station is restored to normal the shunt circuit is removed from the output terminals of the modulator and carrier waves modulated in accordance with the picture characteristics are impressed on line L producing a line current of the general character represented by portion C of the curve of Fig. 4.

In the form of the invention illustrated in Fig. 3, a separate carrier wave of characteristic frequency is adapted to be impressed on the line, during the underlap period, for synchronizing purposes. In this case motors A and B for driving the picture transmitting drum and synchronizing commutators 197 and 198 respectively, at the sending station, are controlled by the tuning fork 190. Carrier current generated by the oscillator 191 is modulated and amplified by means of the modulator-amplifier 193 in accordance with the picture characteristics. After passing through the filter 194 the modulated current is impressed on line L. In a similar manner to that already described in connection with Fig. 1, at a predetermined interval during the revolution of the sending drum, preferably during the underlap period, as determined by the relative positions of brushes cooperating with commutators 197 and 198, carrier current of a special frequency generated by oscillator 195 is applied to line L.

At the receiving station represented in the right-hand portion of Fig. 3 the picture current and the synchronizing current are separated by filters 199 and 100, respectively. The carrier current generated by oscillator 195 will be passed by filter 100 and applied to the upper windings of relay 101 after passing through the rectifier 102. As a result of this arrangement since the special synchronizing current exists on the line only during the underlap period, relay 101 need not be a marginal relay. Relay 101 corresponds to relay 61 of Fig. 2. The action of relay 101 and the operation of the discharge device 104 is similar to that already described in connection with corresponding apparatus of Fig. 2. The synchronizing operation of tuning fork 105 is in this case controlled by magnet 106. The modulated carrier current generated by oscillator 191 is passed by filter 199 and functions in the reproduction of the picture in any desired manner.

The forms of the invention which have been described hereinbefore represent the tuning fork as a source of constant impulses for controlling the driving means but it is evident that any similar source providing for definitely recurring impulses could be employed. A source of alternating current can thus be substituted for the tuning forks as it is evident that the main requirement of the system is synchronization of the sending and receiving drums, since the speed of the system may vary within wide limits without affecting the picture reproduced.

What is claimed is:

1. A signaling system comprising a sending station, a receiving station, continuously movable means at said sending station adapted to operate in synchronism with corresponding continuously movable means at said receiving station, means controlled jointly by said sending and receiving stations for determining the synchronous operation of the continuously movable means, said last-mentioned means being responsive only to signaling current of characteristic amplitude.

2. In a carrier current transmission system, a sending station, a receiving station, means for generating a sustained alternating carrier current, means for modulating said carrier current by signalling currents, continuously rotatable elements at both of said stations, continuously vibrating means at said receiving station for controlling the rotatable elements thereat, a magnet for controlling the operation of said vibrating means, means effective at regularly recurrent intervals to increase the amplitude of said carrier current above the maximum signaling amplitude, and means responsive to said increased carrier current for varying the control of said magnet over said vibrating means to correspondingly vary the speed of the rotatable elements at the receiving station.

3. In a carrier current transmission system, a sending station, a receiving station, continuously operable driving motors and speed control means therefor at each of said stations, said speed control means being normally effective to maintain synchronous operation of said motors, means for modulating a carrier current in accordance with signals to be transmitted, means effective at regular intervals for increasing the amplitude of said carrier current and means at said receiving station responsive to said increased current and effective when said motors are running asynchronously to restore the synchronous operation of said motors.

4. In a signaling system, a sending station, a receiving station, continuously rotatable driving motors at each of said stations, a switch for each motor adapted to be closed for a certain period during each revolution thereof, a relay for maintaining synchronous operation of said motors, a circuit through said relay comprising a switch associated with one of said motors, another circuit through said relay comprising a switch associated with the other of said motors, the period of joint closure of both of said circuits being constant when said motors are running synchronously, and means effective when said motors are running asynchronously for correspondingly varying the period of closure of said circuits to cause said motors to run synchronously.

5. In a carrier current transmission system a sending station, a receiving station, a driving motor at each of said stations, a synchronizing motor at each of said stations, switches controlled by each of said synchronizing motors, speed control means associated each of said mators, a magnet for the speed control means at the receiving station to maintain the motors thereat in synchro-

nism, means for modulating a carrier current in accordance with signals to be transmitted, means controlled by the switch associated with the synchronizing motor at the sending station for increasing the amplitude of said current, and means controlled jointly by said increased carrier current and the switch associated with the synchronizing motor at the receiving station for varying the energization of said magnet when said motors are running asynchronously.

6. In a signaling system, a sending station, a receiving station, a continuously operable motor at each of said stations, a continuously operable synchronizing motor at each of said stations, speed control means at each station common to said motors thereat, an operating circuit for said control means adapted to be closed by one of said synchronizing motors, a releasing circuit for said control means closed by the other of said synchronizing motors, means effective when said motors are running synchronously for maintaining the effect of said operating and releasing circuits constant, and means effective when said motors are running asynchronously for varying the relation between the effect of the said operating and releasing circuits to restore the synchronous operation of said motors.

7. In a carrier current signaling system, a sending station, a receiving station, a continuously operable driving motor and a synchronizing motor at each of said stations, a relay common to said synchronizing motors adapted to be operated during a particular portion of each revolution of one of said synchronizing motors and adapted to be released for a particular portion of each revolution of the other of said synchronizing motors, means effective when said driving motors are running asynchronously for varying the periods of operation and release of said relay to restore the synchronous operation of said driving motors.

8. In a picture transmission system, a sending station, a receiving station, continuously operable driving means at each of said stations, means for sending carrier current modulated in accordance with the shade of successive points of successive linear elements of a picture, means effective between the successive linear elements for increasing the amplitude of said carrier current to control the synchronous movements of said continuously operable driving means.

9. In a picture transmission system, a transmission line, a plurality of stations, continuously movable means at said stations adapted to be operated in synchronism, means for scanning a picture in successive linear elements, means for sending current corresponding to said linear elements, means effective at the end of the scanning of each linear element for increasing the amplitude of said current, a marginal relay at one of said stations operated in response to said increased current for increasing or decreasing the speed of said movable means at said station.

10. A picture transmission system comprising a sending station, a receiving station, means for sending to said receiving station current varying in amplitude according to the characteristics of the picture, light controlling means at said receiving station responsive to said current for controlling the tone values of the picture to be produced, means for maintaining synchronism between continuously operable apparatus at said stations comprising means at the sending station for intermittently transmitting current impulses of a fixed amplitude different from the amplitudes corresponding to the picture characteristics, and means independent of said light controlling means at said receiving station responsive to said impulses for controlling the synchronous operation of the continuously operable apparatus at the sending and receiving stations.

11. An image producing system comprising a transmitting station and a receiving station, a source of carrier waves, means comprising a movable element for modulating waves from said source for giving them certain characteristics corresponding to the tone values of the elemental areas of a field of view an image of which is to be produced, switching means for periodically modulating the waves from said source to give them a characteristic different than said first mentioned characteristics, and means at said receiving station for producing an image of said field of view, said means comprising a continuously movable element, means for producing light having variations determined by the carrier waves having said first mentioned characteristics, and means independent of said light producing means responsive to the carrier waves of said second mentioned different characteristics for maintaining said movable elements in synchronism.

12. An electro-optical image producing system comprising means including a continuously movable element for scanning an object in a series of parallel lines to produce an image current having variations corresponding to the tone values of elemental areas of the object, means including a second continuously movable element for producing an image of said object under control of said image current, means for intermittently producing synchronizing current having a characteristic different from the characteristics of said image current at intervals during the period required for a single, complete scanning of the object, and means responsive only to said synchronizing current for maintaining said continuously movable elements in synchronism.

13. An electro-optical image producing system comprising means including a continuously movable element for scanning an object in series of parallel lines to produce an image current having variations corresponding to the tone values of elemental areas of an object, means including a second continuously movable element for producing an image of said object under control of said image current, means for intermittently producing synchronizing current at intervals separated by the line scanning period, and means responsive only to said synchronizing current for maintaining said continuously movable elements in synchronism.

14. An electro-optical image producing system comprising means for producing an alternating carrier current, means including a continuously movable element for scanning an object in a series of parallel lines to produce an image current for modulating current from said source of alternating carrier current, means including a second continuously movable element for producing an image of said object under control of said modulated carrier current, and means for intermittently producing alternating synchronizing current at intervals separated by the line scanning period for maintaining said continuously movable elements in synchronism.

15. Electro-optical image producing apparatus comprising a current path carrying a single current having time separated image portions corre-

sponding to the tone values of elemental areas of an object and synchronizing portions occurring only between successive image portions, means for producing light the intensity of which is controlled by current in said path for controlling the tone values of an image of said object, and continuously movable image synthesizing means the speed of which is controlled only by the synchronizing portions of said current independently of said light producing means.

16. Electro-optical image producing apparatus comprising a current path carrying a single modulated carrier current having time separated image portions corresponding to the tone values of elemental areas of an object and synchronizing portions having an amplitude greater than the amplitude of said image portions, occurring only between successive image portions, two circuits energized under control of current in said path, light controlling means in one of said circuits for controlling the tone values of an image of said object in accordance with the variations of said image portions of said modulated carrier current, continuously movable image synthesizing means, and means independent of said light controlling means for controlling the speed of said continuously movable image synthesizing means under control of the synchronizing portions of said modulated carrier current.

17. Image producing apparatus comprising a current path carrying a single current having time separated image portions corresponding to the tone values of elemental areas of an object and synchronizing portions having a different characteristic occurring only between successive image portions at intervals less than a complete scanning period, and means for setting up an image element by element comprising scanning means which scans with a continuous movement successive strips of the image in periods between which there are intervals when said movement is ineffective in the setting up of the image, means for producing the light variations of the image under control of the image portions of said current, and means under control of the synchronizing portions of said current for acting upon said scanning means to produce an acceleration or retardation of the scanning movement to correct for lack of synchronism with the transmitting apparatus.

18. Image producing apparatus comprising a current path carrying a single current comprising time separated image portions corresponding to the tone values of elemental areas of an object and synchronizing portions having a different characteristic occurring only between successive image portions at intervals less than a complete scanning period, and means for setting up an image element by element comprising scanning means which scans with a continuous movement repeatedly across the receiving field and beyond said field in an overlap region, means for producing the light variations of the image under control of the image portions of said current, and means under control of the synchronizing portions of said current operating while said overlapping region is being scanned for acting upon said scanning means to produce an acceleration or retardation of the scanning movement to correct for lack of synchronism with the transmitting apparatus.

19. Image producing apparatus comprising a current path carrying a single current comprising time separated image portions corresponding to the tone values of elemental areas of an object and synchronizing portions of greater amplitude occurring only between successive image portions at intervals less than a complete scanning period, and means for setting up an image element by element comprising scanning means which scans with a continuous movement successive strips of the image in periods between which there are intervals when said movement is ineffective in the setting up of the image, means for producing the light variations of the image under control of the image portions of said current, and means under control of the synchronizing portions of said current for acting upon said scanning means to produce an acceleration or retardation of the scanning movement to correct for lack of synchronism with the transmitting apparatus.

JOSEPH W. HORTON.
DONALD M. TERRY.