

Jan. 14, 1930.

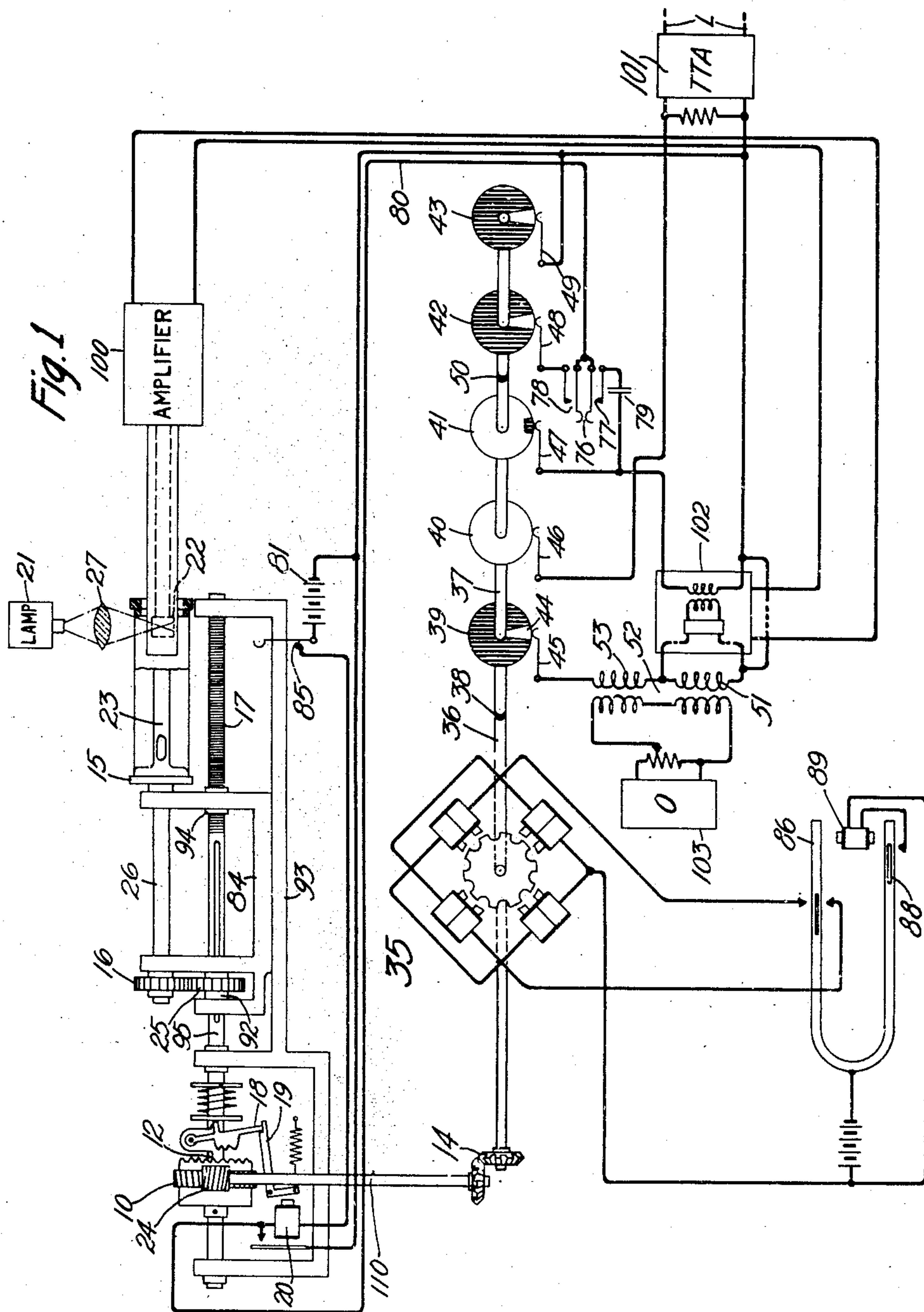
L. G. ABRAHAM

1,743,180

PICTURE TRANSMITTING SYSTEM

Filed Aug. 18, 1926

2 Sheets-Sheet 1



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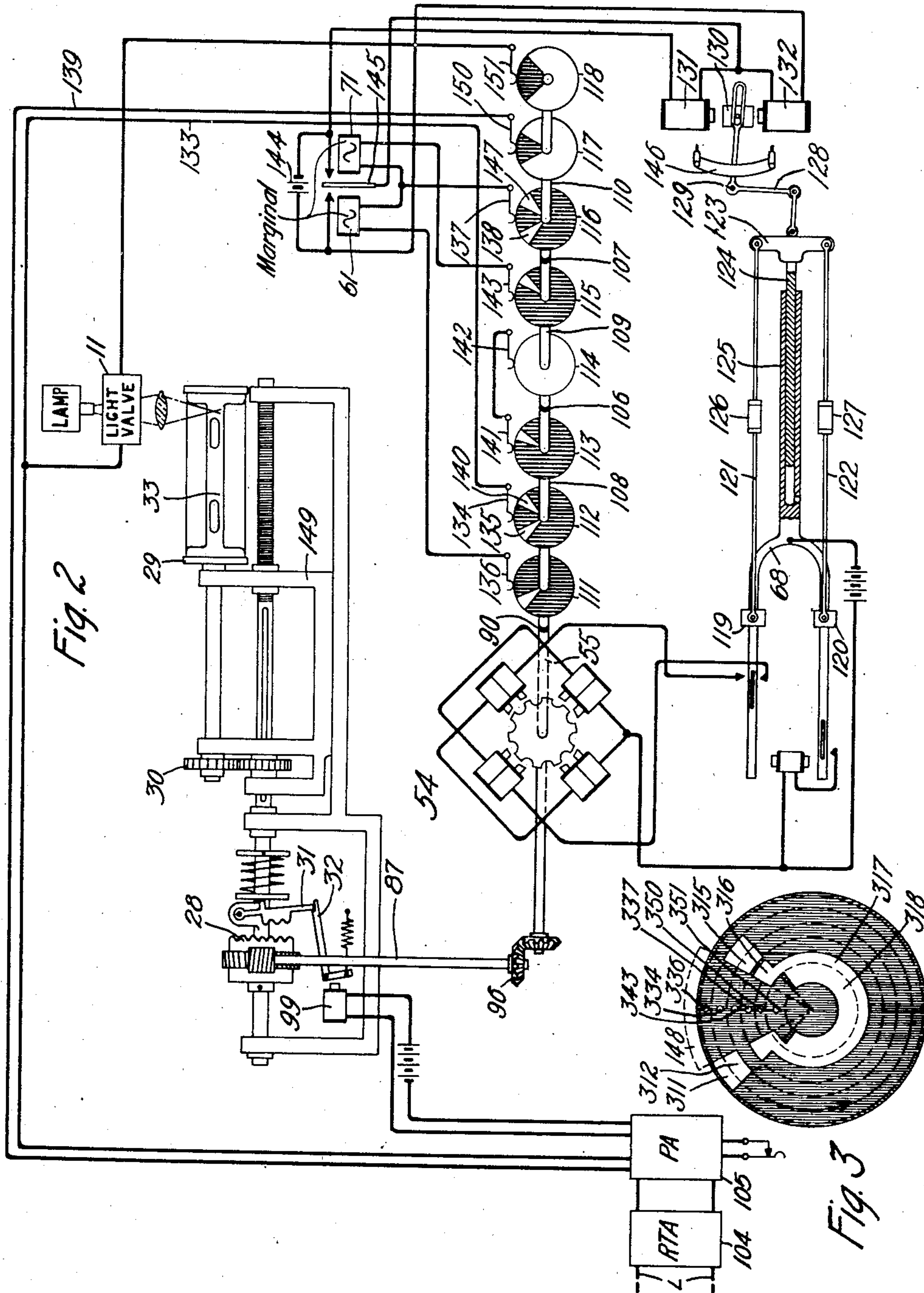
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2 Sheets-Sheet 2



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PICTURE-TRANSMITTING SYSTEM

Application filed August 18, 1926. Serial No. 130,062.

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

It is an object of the present invention to improve the synchronizing of two movable members in a signaling system.

In order that the signals sent from the transmitting station may be recorded in the proper manner at the receiving station, it is the practice in systems of the foregoing character to provide moving elements at the transmitting and receiving stations which move in synchronism. A rotating drum provides a convenient form upon which to hold the transmitting or recording element in picture transmission systems during the progressive scanning of the entire area of the picture. Both the transparent picture to be transmitted and the recording film may be 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 drum. This portion of the revolution is termed the "underlap period". It has been suggested heretofore that this underlap period be employed for transmitting impulses of carrier current of increased strength by means of which the driving motor may be synchronized.

In accordance with the present invention an arrangement is provided wherein synchronizing current transmitted during the underlap period is employed to control the natural period of a resonance means at the receiving station as by varying the position of weights on the tines of a tuning fork. In particular the invention contemplates an arrangement of commutators to variably operate magnets to adjust the position of these tuning weights in the direction to bring the fork into synchronism with that at the sending station.

In the embodiment of the invention disclosed, an impulse of carrier current of in-

creased intensity is transmitted during the underlap period by the sending station, although the impulse need only be of a character to distinguish the underlap period from the picture transmission period. At the receiving station the tuning weights on the controlling fork are connected by rods to a lever arm which is controlled by a pair of magnets. These magnets move the lever arm in opposite directions and thus move the tuning weights towards or away from the tip of the fork. A commutating arrangement driven under the control of the fork provides circuits which are closed to the incoming signaling leads for a short time before and after the underlap period of the receiving drum. Each of these circuits contains a relay and if the receiving apparatus slows down or speeds up enough to close one of these circuits, at the same time that the impulse of increased intensity is received, the corresponding relay is operated and in turn operates the magnet which moves the weights in the desired direction.

The operation of the invention will be more clearly understood from a consideration of the drawings in which Figure 1 shows a sending station for a picture transmission system, Fig. 2 shows a receiving station, and Fig. 3 shows a modification of the commutating arrangement forming a part of the invention.

While it has been chosen to illustrate the invention as applied to a system for transmitting pictures, it is understood that the invention is applicable to any signaling system wherein synchronism is desired and the driving means is controlled by a tuning fork. For a description of a complete system of the type disclosed, reference may be made to Patent No. 1,606,227, granted to J. W. Horton et al., Nov. 9, 1926.

Referring to Fig. 1, there is shown a driving motor 35, which may be of any type adapted to operate at a relatively constant speed. This motor is preferably a phonic wheel or other tuning fork controlled motor, and may be started in operation manually.

When magnet 20 receives a starting impulse, the spring actuated clutch member 18 is released. The clutch member thereupon co-

operates 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 100 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 100 is connected to the modulator 102, whereby the amplitude of the carrier waves generated by oscillator 103 are modulated, and are then impressed on the line L after passing through the transmitting terminal amplifier 101.

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 limiting the maximum amplitude of the modulated waves. 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.

For a complete disclosure of the operation of modulator 102, reference is made to the above identified patent to J. W. Horton, et al.

At the receiving station shown in Fig. 2, the modulated carrier waves are received over line L and are amplified by receiving

terminal amplifier 104 and picture amplifier 105, 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 54, which is preferably similar to motor 35, 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 included between the ends of the picture corresponds to the portion 23 of drum 15.

In order to avoid distortion in the received wave, it is necessary that drums 15 and 29 rotate in synchronism. At the sending station, motor 35 is controlled by the fork 86, while at the receiving station, fork 68 controls the operation of motor 54. 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 35 and 54, in the well known manner.

Motor 35 at the sending station also controls a shaft comprising sections 36, 37, etc., which are insulated from each other by means of the insulating segments 38 and 50. Rigidly and conductively 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 a greatly increased amplitude.

During the major portion of the revolution of drum 15, and assuming that no picture signals are being transmitted, 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 102, 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 while no picture is being transmitted, but when pictures are being transmitted, the current is modulated in accordance with the picture characteristics.

The tuning fork 68 which drives motor 54 is provided with adjustable tuning weights 119 and 120. These weights are connected by rods 121 and 122 to yoke 123. The location of weights 119 and 120 on the fork may be adjusted roughly by the position of rod 124, which slides in socket 125 in the fork itself. More accurate adjustment of the weights may be made by means of turn buckles 126 and 127. The frequency of vibration of the fork may, by these means, be brought very closely to that of fork 86. To bring the synchronism of the two forks under the control of fork 86, the crank arm 128 is moved under control of impulses from the sending station.

Crank arm 128 is pivoted on pin 129 and has one arm connected with yoke 123. The opposite arm is slidably mounted on armature 130, which is acted upon by magnets 131 and 132. The movement of armature 130 toward magnet 131 draws the weights 119 and 120 nearer the base of the fork whereas the action of magnet 132 forces them away from the base. These movements are, of course, quite small and serve to adjust the frequency of the fork between the desired limits. A dash pot 146 is provided for holding arm 128 in any position. Magnets 131 and 132 are connected in series to battery 144 so that they normally exert equal and opposite forces on

armature 130 when it is in the central position. Alternating current relays 61 and 71 control shunts about magnets 131 and 132 and are operated by the impulses of increased carrier current from the sending station when their circuits are closed by commutating discs 111 to 118. When either of the magnets is shunted, the other magnet exerts sufficient force to move the armature 130 toward the unshunted magnet.

According to one embodiment of the invention the commutating discs 111 to 118 are driven directly by motor 54. The shaft carrying these discs is divided into sections by insulating segments 90, 106 and 107. Section 108 carries discs 111 to 113; section 109 carries discs 114 and 115; section 110 carries discs 116 to 118. As the discs rotate, a circuit is closed just before the underlap period from conductor 133, brush 134, conducting segment 135 of disc 112, shaft section 108, conducting segment of disc 111, brush 136 through the winding of relay 61, brush 137, conducting segment 138 of disc 116, shaft 110, disc 117 to conductor 139. A similar circuit is closed just after the underlap period which extends from conductor 133, segment 140 of disc 112, shaft section 108, disc 113, brush 141, brush 142, disc 114, shaft section 109, disc 115, brush 143, winding of alternating current relay 71 to brush 137, conducting segment 147 of disc 116, shaft 110, disc 117, and thence to conductor 139. During the underlap period brushes 136 and 143 engage insulating segments of the commutating discs upon which they ride preventing the closure of the circuits of relays 61 and 71. Discs 117 and 118 serve to connect light valve 11 to the amplifier 105 for recording the picture current.

From the above description it will be apparent that as long as motors 54 and 35 remain in synchronism, the increased carrier current sent out during the underlap period will be ineffective at the receiving station. If now the tuning fork 68 slows down enough to close the circuit of relay 61 during the underlap period at the sending station, the impulse of carrier current of increased intensity will pass through relay 61 and that relay will operate. When relay 61 is operated, a shunt is closed through armature 145 around the winding of magnet 132. The pull on armature 130 is thus unbalanced and the armature is drawn toward magnet 131. This movement of armature 130 is transmitted by crank arm 128 to yoke 123, drawing weights 119 and 120 away from the tip of the fork 68 and increasing the speed of its vibration. Arm 129 is acted upon by a mechanical device 146 which holds the arm in place except when acted upon by one of the magnets 131 or 132 alone.

If the speed of the fork 68 should be increased out of synchronism, the circuit above traced will be closed while picture current is

being received, but this current will not operate relay 61 since relay 61 is marginal, as is relay 71. The circuit above traced for relay 71 will be closed during the underlap period at the sending station and relay 71 will be operated by the increased current received. The operation of relay 71 shunts magnet 131 permitting magnet 132 to draw armature 130 toward itself and force the weights nearer to the tip of the fork, thus slowing the speed of the fork.

The circuit of the light valve is held open for a period extending from a definite time before the underlap period to a definite time after the underlap period. The light valve therefore does not receive the increased carrier current.

When it is desired to transmit pictures, tuning forks 86 and 68 are initially set in motion, and motor 35 at the sending station and motor 54 at the receiving station started in operation. Shafts 36 and 55 are thus rotated, and unmodulated carrier current generated by oscillator O, is impressed on the line L by means of the winding 51 of transformer 52. After an interval, due to the action of relays 61 and 71 as above explained, motors 35 and 54 are synchronized. Shafts 110 and 87 are also driven but are ineffective since the clutch members 18 and 21 have been manually locked open at this time.

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 contact of key 85, winding of clutch magnet 20, conductor 80, contact 78 of key 76, brush 48 and commutator 42, commutator 43 and brush 49, to the negative pole of battery 81. Magnet 20 immediately locks under control of key 85. As soon after key 76 is operated as the underlap period occurs, 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, brush 49 and conducting segment of commutator 43 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. 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, contact 77 of key 76, conductor 80, locking contact of magnet 20, to the lower terminal of the modulator output coil. The reduction of current in the line as above described serves to set the receiving apparatus in readiness for the modulated carrier by operating magnet 99, as is fully described in the patent to Horton et al., referred to here-

inbefore. When magnet 20 energizes, it immediately locks under control of 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 contact thereof and release the clutch magnet 20. Should key 76 be maintained operated 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 102. 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, if the drum is in the underlap position, 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 Horton et al., 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.

In a modified embodiment of the invention, the commutating arrangement is mounted at one end of the drum 29. Fig. 3 shows a possible arrangement of the segments and brushes, the shaded portion representing insulation, and the clear portions, conducting material. The brushes 336, 334, etc., are represented diagrammatically by the dots shown in the center of the underlap region 148 and may be mounted in any suitable manner on carriage 149. Annular sections of the face of the drum of Fig. 3 (indicated by dotted lines) correspond to the separate discs of Fig. 2. The rings and brushes have been given the same numbers as in Fig. 2 with the initial digit 3 instead of 1. A comparison of Figs. 2 and 3 with this numbering in mind will render the operation of Fig. 3 self-explanatory.

What is claimed is:

1. In a synchronizing system, two rotat-

able members to be maintained in synchronism and located at different stations respectively, a transmission channel connecting said stations, means under the control of the rotatable member at one of said stations only, for impressing synchronizing current impulses on said transmission line, a tuning fork for controlling the speed of the second member, weights for varying the speed of said tuning fork, and means operated by the synchronizing impulses received over said transmission channel when said members are out of synchronism to move said weights to return said second member to synchronism with said first member.

2. In a synchronizing system, two motors to be synchronized, and located at different stations respectively, a transmission channel connecting said stations, means under the control of one of said motors only for sending synchronizing current impulses during a predetermined portion of each revolution of said motor, a tuning fork for controlling the speed of the second motor, weights for determining the speed of said tuning fork, means associated with said second motor for blocking said impulses when said motors are in synchronism and means for rendering said impulses effective when said motors are out of synchronism to move said tuning weights to return said second motor to synchronism with said first motor.

3. In a synchronizing system, two motors to be synchronized and located at different stations respectively, a transmission channel connecting said stations, means under the control of one of said motors for impressing synchronizing current impulses on said transmission line during a predetermined portion of each revolution of said motor, a tuning fork for controlling the speed of a second motor, weights for controlling the speed of said tuning fork, means for varying the position of said weights on said tuning fork, a commutator associated with said second motor effective when said motors are in synchronism to block said impulses and effective when said motors are out of synchronism to operate said weight positioning means to return said second motor to synchronism with said first motor.

4. In a system for synchronizing motors, means under the control of one motor for sending synchronizing impulses of characteristic amplitude during a predetermined portion of each revolution of said motor, a tuning fork for controlling the speed of a second motor, weights for regulating the speed of said tuning fork, a pair of relays responsive only to impulses of said characteristic amplitude to control said weight positioning means, a commutator associated with said second motor effective when said motors are in synchronism to block said impulses and effective when said motors are out of synchronism

to operate the proper one of said relays to return said second motor to synchronism with said first motor.

5. In a picture transmission system, a transmission line, a sending station, a receiving station, 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, means for recording said picture current at said receiving station, a pair of relays at the receiving station, and means for operating one of said relays in response to said increased current when said scanning means and said recording means are out of synchronism to return said recording means to synchronism with said scanning means.

6. In a picture transmission system, a transmission line, a sending station, a receiving station, means at said sending station for scanning a picture in successive linear elements, means for sending a 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, means for recording said picture current at said receiving station, a commutator at said receiving station, means for simultaneously driving said recording means and said commutator, a pair of marginal relays at the receiving station, means controlled by said commutator when said scanning means and said recording means are out of synchronism to direct said increased current to one of said marginal relays, and means under the control of said relays for returning said recording means to synchronism with said scanning means.

7. In a picture transmission system, a transmission line, a sending station, a receiving station, means at said sending station for scanning a picture in successive linear elements, means for sending a 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, means for recording said picture current at said receiving station, a commutator carried by said recording means, a pair of marginal relays at the receiving station, means controlled by said commutator when said scanning means and said recording means are out of synchronism to direct said increased current to one of said marginal relays, and means under the control of said relays for returning said recording means to synchronism with said scanning means.

8. In a picture transmission system, a transmission line, a sending station, a receiving station, means at said sending station for scanning a picture in successive linear elements, means for sending a current corresponding to said linear elements, means ef-

fective at the end of the scanning of each linear element for increasing the amplitude of said current, means for recording said picture current at said receiving station, a commutator carried by said recording means, a
5 tuning fork for controlling the speed of said recording means, weights for controlling the speed of said tuning fork, means for varying the position of said weights on said tuning
10 fork, a pair of marginal relays at said receiving station, means controlled by said commutator when said recording means and said scanning means are out of synchronism to direct said increased current to one of
15 said marginal relays to operate said weight positioning means to restore said recording means to synchronism with said scanning means.

9. In a synchronizing system, a plurality
20 of stations, speed control means comprising variable resonance means at one of said stations, means at said one station for varying the natural period of said resonance means over a range of values between fixed limits,
25 and means at another of said stations for controlling said last mentioned means when there is a departure from synchronism.

10. A synchronizing system comprising motive means at each station for the elements
30 to be synchronized, constant speed means comprising variable resonance means associated with the motive means at one of said stations, means at said one station for varying the natural period of said resonance
35 means over a range of values between fixed limits, and means at another of said stations for controlling said last mentioned means when there is a departure from synchronism.

11. In a synchronizing system, a plural-
40 ity of dynamo electric machines to be maintained in synchronism and located at different stations, respectively, means comprising a variable resonance means associated with a dynamo electric machine at one of said sta-
45 tions for maintaining said machine at a substantially constant speed, and means at another station for causing a change in the constants of said variable resonance means, when there is a departure from synchronism, to in-
50 crease or decrease the speed at which the dynamo electric machine is maintained constant.

In testimony whereof, I have signed my name to this specification this 17th day of
55 August, 1926.

LEONARD G. ABRAHAM.