Jan. 26, 1937. W. G. H. FINCH 2,069,061

SYNCHRONIZING SYSTEM

Original Filed Feb. 26, 1936 2 Sheets-Sheet 1

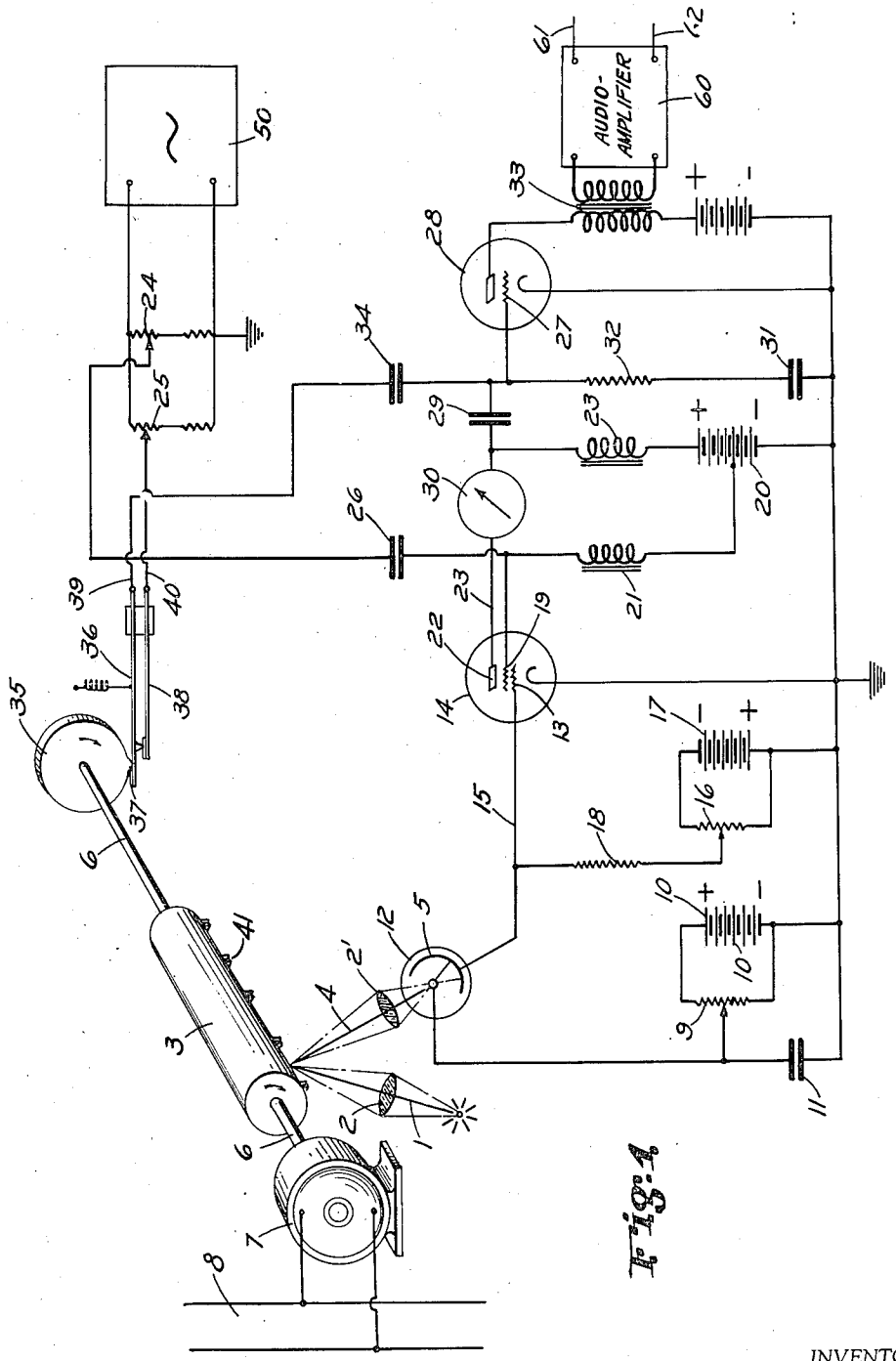


Fig. 1.

INVENTOR.
William G. H. Finch

BY

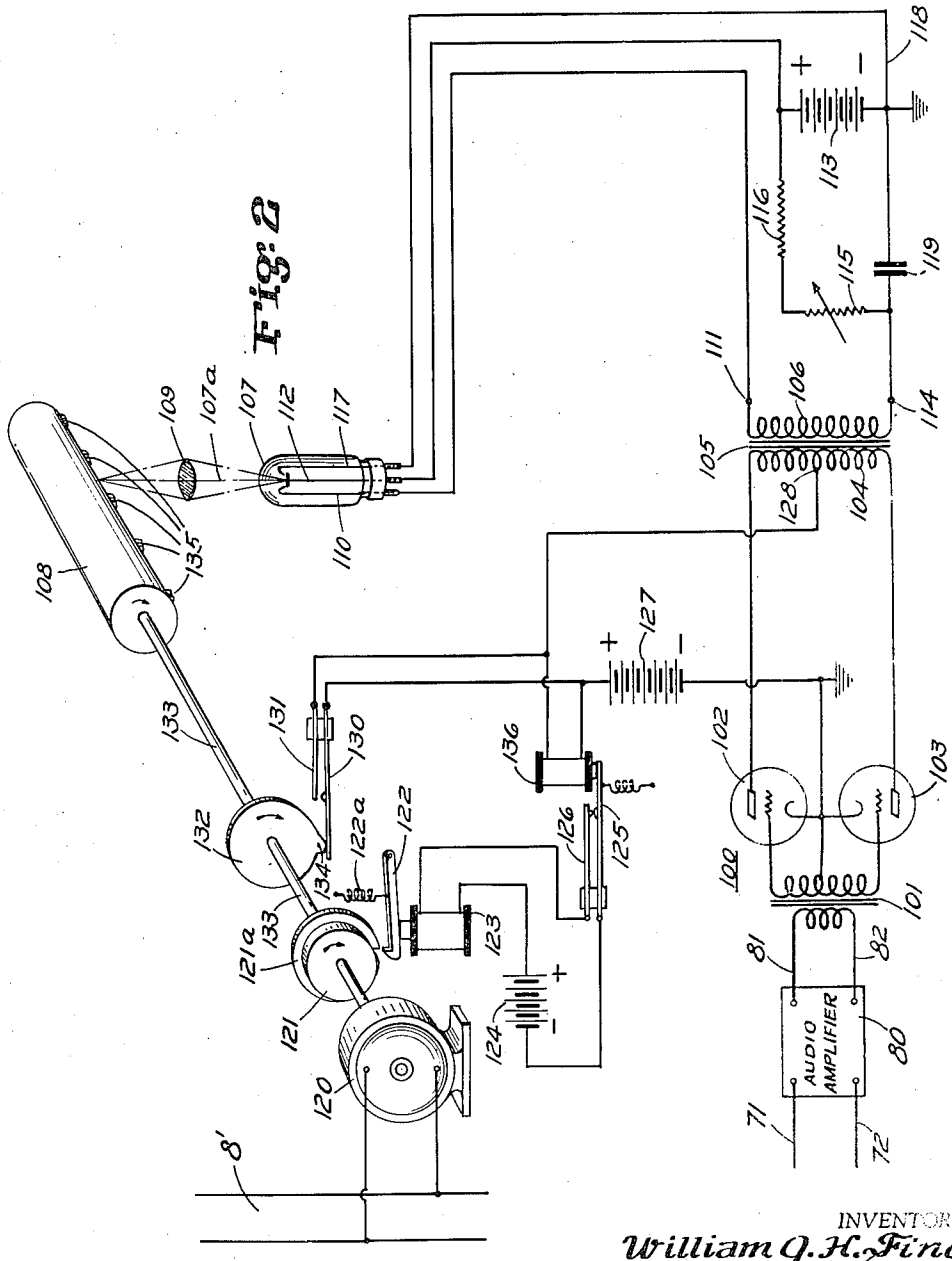
Samuel Astrolenk
ATTORNEY

Jan. 26, 1937. W. G. H. FINCH 2,069,061

SYNCHRONIZING SYSTEM

Original Filed Feb. 26, 1936 2 Sheets-Sheet 2

Fig. 2



INVENTOR.
William G. H. Finch
BY
Samuel Ostrolenk
ATTORNEY.

Patented Jan. 26, 1937

2,069,061

UNITED STATES PATENT OFFICE

2,069,061

SYNCHRONIZING SYSTEM

William G. H. Finch, New York, N. Y.

Original application February 26, 1936, Serial No. 65,869. Patent No. 2,047,863, dated July 14, 1936. Divided and this application April 15, 1936, Serial No. 74,419

6 Claims. (Cl. 178—69.5)

This invention relates to synchronizing systems and circuits therefor for maintaining electromechanical systems in phase synchronization particularly applicable to telepicture systems and is a division of application Ser. No. 65,869, filed February 26, 1936, now Patent No. 2,047,863, granted July 14, 1936.

In accordance with my present invention the synchronizing signal is transmitted during a predetermined portion of the rotation cycle, for example, during the "underlap" period of a picture drum transmitter. The synchronizing signal is intermittently impressed upon an intermediate stage of the picture signal amplifier during the "no picture" intervals. The receiver is maintained in at least approximate synchronization by a well known synchronous motor or synchronous drive means, and the synchronizing signal is operative during the receiver drum underlap period to maintain the drum in phase synchronism with the transmitter drum in a manner to be described in detail.

It is accordingly an object of my present invention to provide novel apparatus for and means of synchronizing electromechanical apparatus at remote points.

It is another object of my invention to provide novel circuits for efficient synchronous control of a telepicture system.

It is a further object of my invention to provide novel apparatus and circuits for maintaining a telepicture receiver in phase synchronism with a corresponding transmitter.

These and further objects of my invention will become apparent from the following description taken in connection with the drawings, in which:

Figure 1 is a schematic representation of a preferred telepicture transmitter, and

Figure 2 is a corresponding diagrammatic representation of a telepicture receiver employing my novel phase synchronizing system.

Referring to Figure 1, a source of light generates a beam 1 focused to a point by a lens system 2 upon the picture to be transmitted which is mounted on the cylindrical drum 3. If the picture is scanned one hundred lines per inch, the diameter of the light spot focused upon the picture should be .01 inch. The refracted beam 4 from the picture is focused upon the photoelectric cell 5 by lens system 2'. The intensity of the refracted beam 4 is proportional to the shading of the picture elements which are successively moved past the light beam 1. The picture drum 3 is rotated by shaft 6 driven by synchronous motor 7. Motor 7 is preferably connected to a commercial electrical supply system 8, for example, a 60 cycle, 110 volt system. Reduction gearing, not shown, reduces the motor 7 speed to, for example, 100 revolutions per minute at shaft 6.

The anode potential for the photoelectric cell 5 is supplied by the potentiometer 9 connected across a suitable direct current voltage source 10. Condenser 11 by-passes the potentiometer 9 section to ground. The cathode 12 of the photoelectric cell 5 is connected to the control grid 13 of a screen grid modulator tube 14 by means of connection lead 15. The control grid 13 is adjustably biased by means of potentiometer 16 connected across a suitable grid biasing source 17. The grid bias for control grid 13 is supplied from the potentiometer 16 through the grid input resistance 18.

Screen grid 19 is connected to a suitable potential point on the direct current source 20 through an impedance choke 21. The anode 22 is connected to the potential source 20 through an impedance choke 23. A tone generator 50, schematically indicated, produces an alternating current potential across two potentiometers 24 and 25. The tone generator 50 may be an audio frequency vacuum tube oscillator, or an alternating current generator driven by an electric motor or preferably geared to motor 7. The alternating current signal from tone generator 50 is coupled to the screen grid 19 through a coupling condenser 26. The impedance choke 21 prevents the tone signal from being by-passed to ground through the potential source 20.

The varying light beam 4 produces corresponding electrical variations at the control grid 13 of vacuum tube 14 as is well known in the art. Introducing a tone or carrier signal from generator 50 to the screen grid 19 corresponds to the well known screen grid modulation method. The signal produced in the output circuit of the vacuum tube 14 across the impedance choke 23 is coupled to the control grid 27 of amplifier stage 28 by means of the coupling condenser 29. A milliammeter 30 inserted in series with the anode 22 circuit in lead 23 serves as a visual indication of the operating condition of the telepicture transmitter.

When no light impinges upon the photo-cell 5, the control grid 13 has a potential corresponding to the adjusted bias by potentiometer 16 and the tone or carrier signal output of the vacuum tube 14 will be at a minimum. The indication of the milliammeter 30 will accordingly also be at a minimum. When a bright spot is

scanned on the picture being transmitted, the potential of control grid 13 will correspondingly increase. The anode 22 current will therefore also increase. The indication of milliammeter 30 will correspondingly increase. The alternating current or carrier current output proportionately increases as is well known to those skilled in the art. Meter 30 accordingly indicates the functioning of the telepicture transmitter.

The control grid 27 of amplifier tube 28 is impressed with an alternating current signal of frequency equal to the generated tone 50 and amplitude modulated in accordance with the varying intensity of the light beam 4 impinging on the photo cell 5. The grid bias for control grid 27 is supplied by the bias battery 31 connected to the grid 27 through grid resistor 32. The primary of audio transformer 33 is connected in the output circuit of amplifier stage 28. The secondary of transformer 33 is connected to the input of audio amplifier 60, for further amplification of the telepicture signals for transmission to a remote station. The output 61—62 of audio amplifier 60 may be connected to a land transmission line, or to a radio transmitter for modulating a radio frequency carrier wave for radiation to a remote receiver as is well known in the art.

Synchronization of the transmitter and receiver picture drums is accomplished by means of a synchronizing signal transmitted during each revolution of the transmitter drum 3 for controlling the synchronizing mechanism at the receiver to be hereinafter described. I prefer to transmit the tone or audio carrier signal of intensity greater than the maximum picture signal intensity for the cyclic synchronizing signals. In Figure 1 I schematically illustrate a preferred method for producing the synchronizing signals. The potentiometer 25 is adjusted for a suitable tone voltage to be intermittently impressed upon the control grid 27 through coupling condenser 34.

The synchronizing signals are transmitted during a small predetermined portion of the time required for each revolution of the drum 3. A cam 35 attached to the drum shaft 6 actuates the contact blade 36 of a cam switch. Projection 37 of the cam 35 closes the cam switch circuit blades 36—38 which are connected in series with the leads 39 and 40 from the potentiometer 25 to the coupling condenser 34. The angular position of cam projection 37 corresponds to the "dead" or underlap portion of the picture drum 3 where the "dead" edges of the picture being transmitted are fastened by clamping members 41.

A carrier voltage preferably of increased intensity as compared to the maximum telepicture signals is accordingly transmitted cyclically during the transmission of a picture for synchronizing the receiving drum or drums for the picture. The cam switch 136—138 connects the second amplification stage 128 to a synchronizing signal of sufficient magnitude so that the signal strength of the synchronizing signal output of stage 128 is equal to or preferably greater than the magnitude of a "white" or normally maximum picture signal at the output. Adjustment of potentiometer 125 is accordingly made. It is to be understood that the cam switch 136—138 is operated during the underlap or "no picture" portion of the telepicture cycle corresponding to about 10 or 15 degrees of the drum.

In adjusting the transmitter, potentiometer 9 is suitably set for operating the photoelectric cell 5. The potentiometer 16 is adjusted so that the bias for the control grid 13 permits a small tone signal to be transmitted during the black elements of the picture. The frequency of the carrier may, for example, be 2,000 cycles. In one embodiment, milliammeter 30 indicated .1 of a milliampere as the average direct current in the anode 22 circuit corresponding to black. A white picture element corresponds to the maximum value of transmitted carrier picture signal. The corresponding reading of the milliammeter 30 was 0.8 milliampere indicating an increased anode current.

Adjustments of the potentiometers 16 and 24 are made with black and white light signals impressed upon the photoelectric cell 5, giving corresponding meter 30 indications, in this example, of .1 to .8 milliampere. Intermediate shading between black and white corresponds to transmitted tone or carrier signals of intermediate intensity, and the meter 30 will have corresponding intermediate indications. The adjustments are made so that the maximum transmitted signal corresponding to white picture elements should not exceed a predetermined value. In half tone reproduction it is not desirable to have the maximum received signal, corresponding to white, too large, since the shading effect of the received picture will not be fully reproduced. It is preferable to have the maximum picture signal correspond to a light gray on the film at the receiver to insure all the variations between the maximum white signal and minimum black signal being reproduced.

A relatively small carrier output corresponding to black picture elements is preferably produced, to have the picture signals override any background or line noise or interference signals, although a zero carrier output may be used for "black". Although in my preferred telepicture system, the shading of a picture yields varying picture signal intensities, it is to be understood that black and white facsimile reproductions may be transmitted by such apparatus, the signals being represented by corresponding minimum and maximum carrier signal strengths.

It is to be understood that my preferred synchronizing system is applicable to other telepicture systems and circuits. For example, in a system dispensing with a tone or audio carrier corresponding to generator 50, a suitable impulse may be cyclically impressed upon an intermediate amplifier stage, preferably of signal wave shape which a "white" picture signal has. For example, if no "chopper" or audio-carrier for the picture signals is employed a suitable direct current biasing voltage cyclically applied to an intermediate stage of the signal amplifier would be used.

The cyclic or synchronizing signals are transmitted during the underlap period or "no picture" period of each cycle so as not to interfere with the picture record or signals. In Figure 2, I illustrate a schematic representation of a preferred telepicture receiving system controlled by the synchronizing signals for maintaining phase synchronism of the receiver record sheet with the transmitted picture. In this modification the tone carrier is not rectified but is directly reproduced on the record sheet to obtain a "broken" or half-tone picture representation. As will be evident to those skilled in the art, rectification of the tone or audio carrier wave will produce picture signals corresponding in wave form to those at the photoelectric cell 5. However my synchronizing system and circuits therefor are

equally applicable to different telepicture or facsimile systems and Figure 2 will particularly set forth my invention at the receiver station.

Referring to Figure 2, the input 71—72 of audio amplifier 10 is either connected by wire lines to the output 61—62 of the transmitter or to a suitable radio receiver (not shown) if a radio transmitter is used. If rectification of the picture audio carrier is desired the detector or demodulator is included within the amplifier unit 80.

The output of amplifier 80 is connected by leads 81—82 to the input stage of a push-pull class B amplifier 100, through the interstage transformer 101. The push-pull stage 100 comprises two amplifier tubes 102 and 103 connected in a well known manner. The output of the push-pull stage 100 is connected to the primary 104 of the output transformer 105. The output of the secondary 106 of transformer 105 is connected to a photolamp 107 containing a gas such as neon, for producing a light beam 107*a* output in accordance with the telepicture signals received. The light output 107*a* from lamp 107 is suitably focused upon the receiving drum 108 by a lens system 109.

I prefer to use a neon crater photo-lamp 107 having a control electrode 110 which is connected to one terminal 111 of the transformer secondary 106 and an auxiliary or striking electrode 117. The plate 112 of lamp 107 is connected to the positive terminal of a suitable direct current source 113, the negative terminal of which is connected to ground. The other terminal 114 of the transformer secondary 106 is connected to the plate 112 through a variable resistance 115 and fixed resistance 116. The auxiliary or striking electrode 117 is connected to ground by lead 118. As is well known in the art, the auxiliary electrode 117 maintains a striking or discharge condition at the photo-lamp plate 112, so that it will always be in readiness to respond to telepicture signals introduced between the plate 112 and the control grid 110. A by-pass condenser 119 is connected between the output terminal 114 and ground.

The receiver drum 108 is driven by a synchronous motor 120 connected to supply lines 8'. The lines 8' are preferably from the same alternating current supply as those of the transmitter 8 although such condition is not essential. The synchronous motor 120 drives drum 108 through the schematically indicated overrunning or positive clutch 121. The details of the drive mechanism of my present invention are optional except that they are intermittently controllable by the synchronizing signals to maintain drum 108 in phase synchronism. In my Reissue Patent No. 19,575 I disclose a synchronously operated mechanism for connecting and disconnecting a mechanical positive driving connection between the motor and the drum dependent upon signal actuation of a pawl engaging a ratchet wheel. The limits of the phasing positions are within the width of one tooth of the ratchet wheel.

In the parent application referred to and in my copending application Serial No. 72,991, filed April 6, 1936, is disclosed a preferred positive driving connection and disconnection means using an overrunning clutch corresponding to clutch 121 having a stop plate corresponding to stop plate 121*a* for operating the clutch. Although I prefer to illustrate my present invention with a positive drive connection and disconnection device it is to be understood that is merely by way of example and not limitation.

Drum 108 is preferably driven at a slightly faster speed than the corresponding transmitter drum 3, for example, in a ratio of 101:100. The clutch 121 is under control of armature 122 which is actuated by the synchronizing magnet 123, to maintain the drum 108 in phase synchronism with the transmitter drum 3 as will be hereinafter set forth. A direct current potential source 124 supplies the magnet 123 through the relay contacts 125—126.

The anode potential source 127 for the push-pull amplifier stage 100 is supplied to the center tap 128 of the primary 104 through the synchronizing cam switch 130—131. A cam 132 is connected to the shaft 133 at the driven side of the overrunning clutch 121. The projection 134 of the cam 132 is the same angular position of shaft 133 as the film clamping members 135 of the drum 108 corresponding to the underlap or "dead" portion of the drum. The cam switch 130—131 is normally maintained closed during the major portion of the rotation of cam 132, and the anode current from source 127 normally directly flows to the push-pull amplifier stage 100 during the reception of the telepicture signals.

The cam switch 130—131 is opened by the projection 134 of the cam 132 during the synchronizing or underlap period of the receiver. The underlap period of the drum 108 corresponds to the position of the film clamps 135 which clamp the "dead" edges of the record sheet. The projection 134 of cam 132 is angularly positioned to correspond to the position of the clamps 135. The anode current from source 127 is accordingly directed to the amplifier 100 through the synchronizing relay 136, which relay 136 is otherwise short circuited by switch 130—131. The synchronizing signal, as hereinabove described, occurs during the underlap period of the picture transmitter, and is preferably of greater magnitude than the telepicture signals. Synchronizing relay 136 is preferably a marginal relay responding only to the increased magnitude signals so as to avoid the possibility of interference of the synchronizing action by any of the telepicture signals. The push-pull amplifier 100 rectifies the alternating current synchronizing impulse in the anode lead, and the actuation of the relay 136 is by rectified or unidirectional current as will be understood by those skilled in the art.

Although I prefer to use synchronizing signals of increased intensity, and a marginal synchronizing relay, I have also successfully employed synchronizing signals of intensity equal to the "white" picture element signals operating an ordinary relay. It is also to be understood that the synchronizing magnet 123 may be directly energized by the synchronizing signals, displacing the relay 136. However, in large receivers it is preferable to employ a relay since local energization of the magnet permits the design of a more powerful clutch control mechanism.

The receiver drum 108 is prepared for the synchronizing signal during the receiver drum 108 underlap by cam 132. The synchronizing signal will accordingly flow through and energize the synchronizing relay 136 which then closes the relay contacts 125—126, locally energizing the synchronizing magnet 123. The synchronizing magnet 123, when energized, will attract the clutch trip armature 122 away from stop plate 121*a* to permit the overrunning clutch 121 to

normally continue to drive the receiver drum 108; i. e., should the drum 108 be in synchronism and in proper phase, the release of armature 122 away from the plate 121a would permit continued rotation without angular alteration. However, in the illustrated embodiment of my invention, the receiver drum is rotated slightly faster than the transmitter drum and the overrunning clutch 121 is accordingly momentarily tripped due to action of the armature 122 normally mechanically biased by spring 122a to tripping position. The synchronizing relay 136 actuates the synchronizing magnet 123 to cyclically attract the armature 122 away from the clutch stop plate 121a to maintain the scanning lines of the received picture in phase with respect to each other and the transmitter.

My novel synchronizing system accordingly cyclically transmits a synchronizing signal by introducing it to an intermediate amplifier stage at the transmitter during the "underlap" picture period which signal controls the receiver phase synchronizing relay and apparatus. My receiver relay system is operated in the class B push-pull amplifier anode supply connection lead so that audio-carrier frequencies are self-rectified. Although I illustrate a synchronizing relay 136 for operating a locally energized synchronizing magnet 123 it will be evident that the synchronizing magnet may be directly energized. The receiver cam switch 130—131 short circuits relay 136 during the picture translation period to avoid connection of any energy consuming device other than those normally connected in the telepicture receiver circuit and accordingly minimize frequency distortion. Upon reception of the synchronizing signal the drum 108 is adjusted to phase synchronism in its rotation cycle.

I claim:

1. In a telepicture system, a source of carrier current; means for transmitting said carrier with amplitude varying in accordance with the shading of a picture to be transmitted; means for cyclically transmitting said carrier with a predetermined amplitude; means for receiving and amplifying the transmitted signals comprising a first and second amplifier tube connected in opposed relationship including a common anode potential lead said amplifier tubes being suitably biased to produce a change in the amplitude of the anode current of said lead in response to said cyclically transmitted signals; a receiver scanning mechanism comprising a rotatable member; means for synchronizing the rotation of said member comprising a synchronizing magnet connected in series with said common anode potential lead; means for normally short circuiting said magnet during the intervals of picture recording; and means for cyclically rendering said magnet responsive to said anode current for maintaining said member in synchronous rotation.

2. In a telepicture system, a source of carrier current; means for transmitting said carrier with amplitude varying in accordance with the shading of a picture to be transmitted in predetermined intervals corresponding to successive lines of said picture; means for cyclically transmitting said carrier with a predetermined amplitude greater than the maximum picture signal amplitude; means for receiving and amplifying the transmitted signals comprising a first and second amplifier tube connected in opposed relationship including a common anode potential lead said amplifier tubes being suitably biased to produce a change in the amplitude of the anode current of said lead in response to said cyclically transmitted signals; a receiver scanning mechanism comprising a rotatable member; means for synchronizing the rotation of said member comprising a synchronizing magnet connected in series with said common anode potential lead; means for normally short circuiting said magnet during the intervals of picture recording; and means for cyclically rendering said magnet responsive to said anode current for maintaining said member in synchronous rotation.

3. In a telepicture system, a source of carrier current; means for transmitting said carrier with amplitude varying in accordance with the shading of a picture to be transmitted in predetermined intervals corresponding to successive lines of said picture; means for transmitting said carrier with a predetermined amplitude between the picture signal intervals; means for receiving and amplifying the transmitted signals including a first and second amplifier tube having a common anode potential lead said amplifying means being adjusted to produce a self-rectifying action of the signals in said lead; a scanning mechanism comprising a rotatable member; means for synchronizing the rotation of said member comprising a synchronizing magnet connected in said common anode potential lead; means cooperable with said rotatable member for normally short circuiting said magnet during the intervals of picture recording comprising a cam switch connected across said magnet, and for cyclically rendering said magnet responsive to said anode current for maintaining said member in synchronous rotation.

4. In a telepicture system, a source of carrier current; means for transmitting said carrier with amplitude varying in accordance with the shading of a picture to be transmitted in predetermined intervals corresponding to successive lines of said picture; means for transmitting said carrier with a predetermined amplitude greater than the maximum picture signal amplitude between the picture signal intervals; means for receiving and amplifying the transmitted signals comprising a first and second amplifier tube connected in class B push-pull relationship including a common anode potential lead; a scanning mechanism comprising a rotatable member; means for synchronizing the rotation of said member comprising a direct current synchronizing magnet connected in series with said common anode potential lead; means for normally short circuiting said magnet during the intervals of picture recording; and means for cyclically rendering said magnet responsive to said predetermined amplitude signals for maintaining said member in synchronous rotation.

5. In a telepicture system, a source of carrier current; means for transmitting said carrier with amplitude varying in accordance with the shading of a picture to be transmitted in predetermined intervals corresponding to successive lines of said picture; means for transmitting said carrier with a predetermined amplitude greater than the maximum picture signal amplitude between the picture signal intervals; means for receiving and amplifying the transmitted signals comprising a first and second amplifier tube including a common anode potential lead said amplifying means being adjusted to produce a self-rectifying action of the signals in said lead; a scanning mechanism comprising a rotatable

drum; means for synchronizing the rotation of said member comprising a direct current synchronizing magnet connected in series with said common anode potential lead; means for normally short circuiting said magnet during the intervals of picture recording comprising a cam switch connected across said magnet; and means for cyclically rendering said magnet responsive to said anode current for maintaining said drum in synchronous rotation comprising a cam connected to said drum for opening said cam switch between successive lines of picture recording.

6. In a telepicture system, a source of carrier current; means for transmitting said carrier with amplitude varying in accordance with the shading of a picture to be transmitted in predetermined intervals corresponding to successive lines of said picture; means for cyclically transmitting said carrier with a predetermined amplitude; means for receiving and amplifying the transmitted signals comprising a first and second amplifier tube connected in class B push-pull relationship including a common anode potential lead; a scanning mechanism comprising a rotatable member; means for synchronizing the rotation of said member comprising a synchronizing relay connected in series with said common anode potential lead; means for normally short circuiting said relay during the intervals of picture recording comprising a cam switch connected across said relay; and means for cyclically rendering said relay responsive to said predetermined amplitude signals for maintaining said member in synchronous rotation to actuate said magnet comprising a cam connected to said member for opening said cam switch between successive lines of picture recording.

WILLIAM G. H. FINCH.