

Nov. 30, 1948.

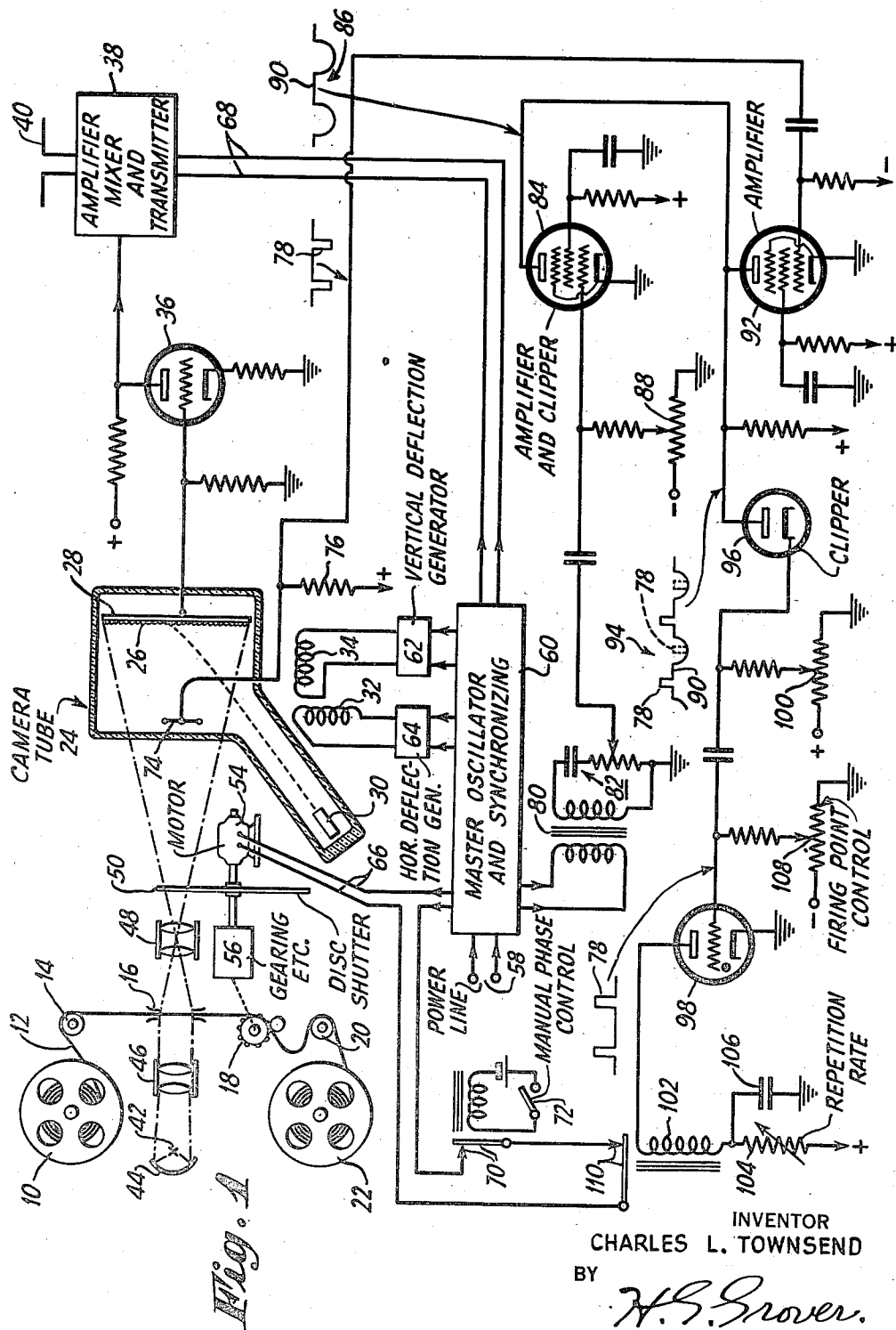
C. L. TOWNSEND

2,455,323

PHASING SYSTEM

Filed June 22, 1946

2 Sheets-Sheet 1



Nov. 30, 1948.

C. L. TOWNSEND

2,455,323

PHASING SYSTEM

Filed June 22, 1946

2 Sheets-Sheet 2

Fig. 2a

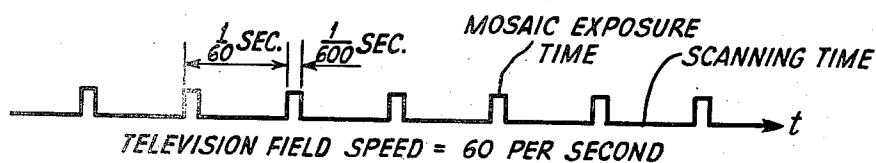


Fig. 2b

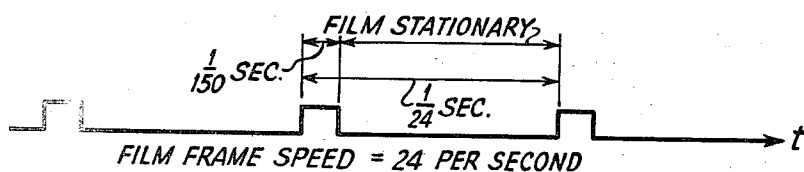


Fig. 3

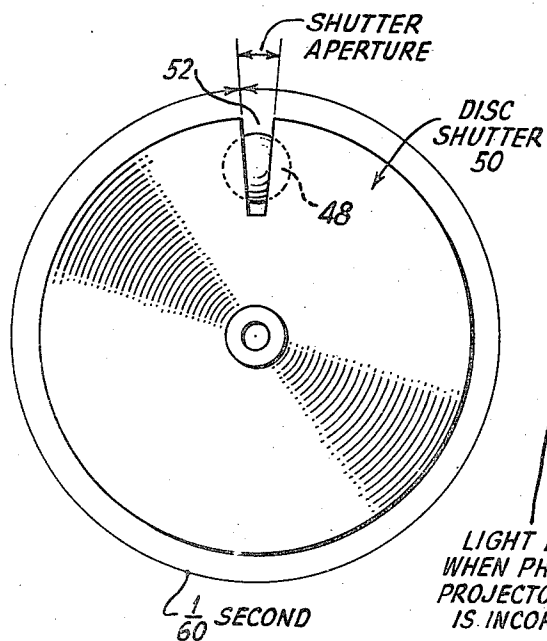
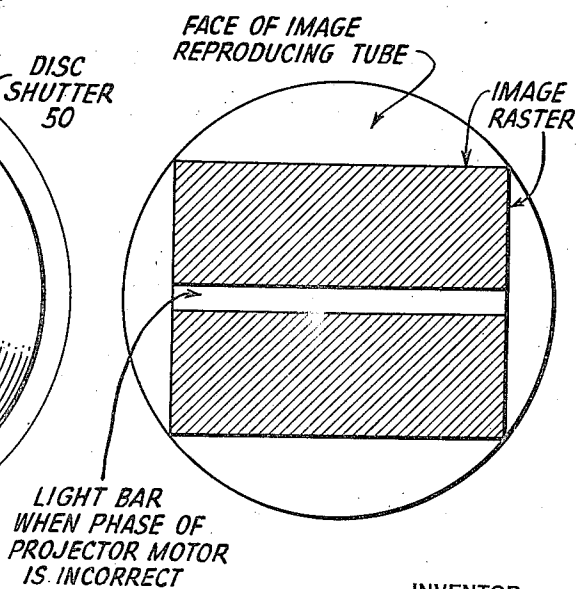


Fig. 4



INVENTOR
CHARLES L. TOWNSEND

BY

H. S. Rowe

ATTORNEY

UNITED STATES PATENT OFFICE

2,455,323

PHASING SYSTEM

Charles L. Townsend, Yonkers, N. Y., assignor to
Radio Corporation of America, a corporation of
Delaware

Application June 22, 1946, Serial No. 678,547

6 Claims. (Cl. 178—7.2)

1

The present invention relates to television systems of the type in which the subject matter to be transmitted is derived from motion picture film. More particularly, the invention relates to means for automatically correcting the phase of the motion picture projector motor in the event that this motor is out of phase with respect to what is desired for optimum conditions when the television transmitting system is placed in operation with a motion picture film serving as the image area from which the video signals are developed.

According to present television standards, the image field repetition frequency is at the rate of 60 fields forming 30 double interlaced frames per second. In film projection the film is ordinarily so advanced that it passes through the film gate in such a way as to be projected at a rate of 24 frames per second. The 30 frame projection rate is preferably maintained in television in order that the movement of the subject matter contained on the film appear in an optimum natural state to an observer of the reproduced image, while the 24 frame per second projection rate is customarily used in normal film projection and particularly so because of the sound signals to be removed from the sound track.

In film projection television systems employing a storage type camera tube of the "iconoscope" type, for instance, the mosaic, or light-responsive electrode of the camera tube upon which the optical image is projected, is scanned by a cathode ray beam in substantially complete darkness, that is, during the period between which successive light flashes of the film image are impressed on the mosaic. The general system is described, for instance by the United States Patent granted to R. D. Kell, Patent No. 2,166,214, on July 18, 1939, so that further detailed reference to the system is unnecessary herein. This scanning operation removes the electrostatic charge image which is built up on the mosaic as a result of the image light impressed thereon. The scanning of the mosaic by the electron beam produces the video signals. The next succeeding electrostatic charge image is built up by a very short "exposure" of the mosaic, or, in other words, a projection of a stationary film image on the mosaic during the time that the cathode ray beam is returned in a vertical direction (that is, the slower of the two directions of scanning) to its starting position for another scanning cycle.

In order that the image of a stationary film frame area be projected on the mosaic only during the vertical (or slow scanning direction) snap-

2

back or return trace period of the cathode ray scanning beam, it is necessary that the film frame areas be exposed to the camera tube mosaic at a rate which coincides with the slower scanning operation on the camera tube. It is further necessary that a suitable shutter be positioned along the optical axis of the film projector, and that the operation of this shutter be so synchronized with both the film movement and the camera tube beam deflection generators that the image of the film frame within the film gate is projected upon the camera tube mosaic during the beam snap-back or return in the slow portion of the scanning cycle where no video signal output is being developed.

The above requirements are customarily met by supplying alternating current to a synchronous film driving motor, the frequency of this alternating current having a predetermined relationship to the slower (vertical) scanning beam deflection in the camera tube as controlled by the beam deflection generator. The synchronous driving motor is mechanically connected both to the film moving device and to the shutter mechanism, so that the resulting operations of scanning, film movement, and mosaic exposure are properly coordinated.

As above brought out, and as shown by the Kell patent, supra, an image of a stationary film area or frame should normally be projected on the light-responsive mosaic electrode of the camera tube only during all or a portion of each vertical blanking interval. However, with the type of synchronous driving motor frequently employed, it is possible for this motor to lock into the power supply, when the system is first placed in operation, at either of two positions which are 180° (electrically) apart. In other words, it is possible for the synchronous driving motor to be 180° out-of-phase with the scanning beam deflection as controlled by the deflection generators which are customarily locked to the power supply frequency.

The result of such an out-of-phase condition is that the shutter opens to permit the projection of a light image of the film frame in the film gate upon the camera tube mosaic not during the vertical blanking period, as in the normal manner, but instead during approximately the mid-portion of the scanning period. This causes a horizontal bar of light to appear across the center of the reproduced image at monitoring or receiving points, as will be pointed out in more detail later.

It has heretofore been the practice to employ

a manually-controlled relay to bring the driving motor into correct phase. This relay is operated to open momentarily the current supply to the driving motor, and, during this period of momentary current interruption, the motor may slip through approximately a half revolution. When the current supply is again connected, the motor is usually co-ordinated in phase with the scanning operation, although occasionally several such interruptions of current may be required before correct phasing is obtained.

According to a feature of the present invention, correct phasing for a projector motor as used in television systems is obtained automatically. This is accomplished, in the preferred embodiment described, by utilizing the light projected on the mosaic of the camera tube each time that the shutter is opened to produce a series of control pulses. This control pulse series is superimposed in opposite phase on pulses produced during, and extending in each direction beyond the limits of the vertical blanking periods. If a control pulse and a blanking interval pulse occur simultaneously, the control pulse is cut off by the blanking interval pulse. However, if the phasing of the projector motor is incorrect so that the control pulse occurs during some portion of the scanning interval, then the control pulse is available to initiate the operation of a relay which interrupts momentarily the power supply to the projector motor in the same manner as the manually-controlled relay mentioned above.

One object of the present invention, therefore, is to provide an automatic motor and shutter phasing circuit for film projection television systems.

Another object of the invention is to provide a film projection television system in which a control variation is obtained for each projection of a film image on the light-responsive electrode of the camera tube, and means for comparing the phase of such control variation with that of pulses produced during the vertical blanking intervals, whereby a departure of said control variation from a predetermined phase relationship with the blanking interval pulses acts to bring about a re-establishment of the said predetermined phase relationship.

Other objects and advantages will be apparent from the following description of a preferred form of the invention and from the drawings, in which:

Fig. 1 is a partly schematic showing of a film projection television transmitting system in accordance with the present invention;

Fig. 2a represents graphically the ratio between the mosaic exposure time and the scanning time in the television system of Fig. 1;

Fig. 2b represents graphically one possible time ratio between stationary and moving periods of the motion picture film which is necessary in order that the purposes of the present invention may be accomplished;

Fig. 3 represents a plan view of the disc shutter employed in the system of Fig. 1; and

Fig. 4 illustrates the light bar which may appear in the reproduced image when the phasing of the projector motor of Fig. 1 is incorrect.

Referring first to Fig. 1, there is shown a supply reel 10 from which the film to be shown by television is withdrawn. The film 12 is passed over an idler roller 14 and through a film gate 16. The film 12 is drawn through the gate 16 in an intermittent manner, as determined by the intermittent rotation of the sprocket wheel 18. As any

known intermittent device may be used, as is also indicated by the mentioned Kell patent, the showing herein is completely diagrammatic and not specific. The film proceeds over an additional idler roller 20 and is wound up on the take-up reel 22.

Fig. 1 also shows a television camera tube 24 (illustratively shown as an iconoscope, although any other form of storage tube, such as the image iconoscope, the orthicon or image orthicon may also be used) including a light-responsive mosaic or electrode 26 with which is associated a signal plate 28. Within the camera tube 24 is an electron gun structure 30 for producing a beam of electrons, this beam of electrons being deflected in mutually perpendicular (usually horizontal and vertical) directions by means of the magnetic fields produced by the deflecting coils 32 and 34 respectively. These coils 32 and 34, by reason of their cyclically varying energization, cause the cathode ray beam to scan systematically the light-responsive mosaic electrode 26. The video signal output from the television camera tube 24 is derived from the signal plate 28 and is supplied to a pre-amplifier tube 35. The showing herein is purely conventional since this invention is not directed to the amplifier per se but for reference the amplifier shown by United States Bedford patent, No. 2,299,875, granted October 27, 1942 is among those which are suitable. The output from the amplifier tube 36 is then fed to additional line amplifiers, a mixer; a modulator, and thence to the transmitting device all shown schematically at 38. The transmitter 38, in accordance with known television practice, utilizes the video signals from tube 36 and synchronizing signals from a master oscillator (to be later described) to modulate a carrier wave in order that the signal energy may be transmitted by means of an antenna arrangement 40, or such signals may be supplied in any desired manner to any other form of communication channel, such as a coaxial cable.

When an optical image is projected upon the light-responsive electrode 26, electrostatic charges are produced thereon in accordance with the intensity of the optical image. As the cathode ray beam emitted from the electron gun 30 scans the light-responsive electrode 26, the charge image is removed, and a series of video signals accordingly developed. After the charge image has been entirely removed from the light-responsive electrode, another optical image is projected thereon for a short space of time, during which the cathode ray scanning beam is blanked or suppressed and returned in a vertical direction to its starting point for the next successive scanning cycle. During the scanning of the light-responsive electrode, no film image light is permitted to strike the electrode.

For projecting optical images from the motion picture film frames onto the mosaic 26, a source of light 42 is provided, with which is associated a reflector 44. The light from the source 42 is directed upon that portion of the film 12 which is present in the film gate 16 by means of a condensing lens 46. The light which is permitted to pass through the film is focused upon the light-responsive electrode or mosaic 26 by means of the projection or focusing lens system 48. A disc shutter 50 is positioned along the optical axis of the projector and is generally located between the focusing lens 48 and the camera tube 24. This shutter 50 is also shown in Fig. 3, and normally comprises an opaque disc

having an aperture or slot 52 on or near the periphery thereof.

Since the television field scanings of the image are at the rate of 60 per second, the speed of the shutter 50 is so chosen that the light images are projected on the light-responsive electrode 26 at the rate of 60 images per second, these images being actually projected on the light-responsive electrode 26 only during the time period between successive transmissions of the separate television fields, that is, between each successive field-scanning operation. In Fig. 2a is shown a representation of several television fields. These fields are indicated as a function of time, and, as represented in the drawing, each field cycle occupies $\frac{1}{60}$ of a second. Of this cycle, as explained above, not over 10 per cent, or $\frac{1}{600}$ of a second, is utilized for the vertical return of the cathode ray scanning beam. This return period coincides with the time that the light image from the film 12 is projected on the mosaic 26, or, in other words, the mosaic exposure time. Between each mosaic exposure time is a period of at least $\frac{1}{600}$ of a second, which is actually the useful field-scanning time of the mosaic 26. The general film advance method is also set forth by reference to United States patent of S. W. Seeley, No. 2,303,960, granted December 1, 1942.

Fig. 2b is related to Fig. 2a and shows the movement which may be imparted to the film 12 in order that 60 television fields may be transmitted from a film operating at 24 frames per second. One film frame cycle, as indicated in the drawing, occupies a time period of $\frac{1}{24}$ of a second, the film being moved during a portion of this cycle which corresponds approximately to $\frac{1}{150}$ of a second.

Since the exposure of the camera tube mosaic 26 must occur while the film 12 is stationary in the gate 16, a properly synchronized relationship must exist between the motion of the film 12 and the scanning operation of the camera tube 24. The means for obtaining this relationship includes a synchronous motor 54 on the shaft of which is mounted the disc shutter 50. Since this disc shutter 50, as shown in Fig. 3, is provided with a single aperture 52, the motor 54 is arranged to operate at a rate of 3,600 R. P. M. As shown in Fig. 3, the length of time consumed during one revolution of the disc 50 will then be $\frac{1}{60}$ of a second, and since the vertical return time of the cathode ray scanning beam occupies a period not in excess of $\frac{1}{60}$ of a complete field cycle, the aperture 52 has an arcuate dimension corresponding in time to an interval not greater than $\frac{1}{600}$ of a second.

In order that the film 12 may be moved in synchronism with the operation of the camera tube 24 and in synchronism with the rotation of the shutter disc 50, the film driving sprocket wheel 18 is mechanically connected to the motor 54 by means of a gear box 56. This gear box 56 contains gearing such that the sprocket wheel 18 will move the film 12 at a constant rate of 24 frames per second and also such that a regular intermittent motion will be imparted to the sprocket wheel 18.

Power for the projector apparatus and for the transmitting system is supplied from the power line terminals 58 to which is connected a master oscillator and synchronizing device 60. This master oscillator 60 supplies impulses at the rate of 60 per second which are fed to the 60 cycle vertical or field deflection generator 62, which operates through the deflecting coil 34

to cause the cathode ray scanning beam to be deflected vertically at the rate of 60 deflections per second. The waveform of the energy supplied to the deflection coils 34 is generally of sawtooth configuration or some modification thereof. The master oscillator 60 also supplies impulses at line frequency to the horizontal, or line, deflection generator 64, which operates to generate the proper waveform for energizing the horizontal deflection coil 32. The latter imparts the proper horizontal deflection to the cathode ray scanning beam in order to scan each line of the mosaic 26.

Energy is also supplied from the power line input portion of the master oscillator 60 by means of conductors 66 to the synchronous motor 54, the frequency of this energy thus being in fixed time relation with respect to the impulses which are supplied to the line and field deflection generators 64 and 62, respectively.

Since the television receiver must be accurately synchronized with the operation of the television transmitting system, synchronizing impulses are transmitted with the video signals. Accordingly, impulses from the master oscillator and synchronizing device 60 are supplied to the amplifier, mixer, and transmitter 38 by means of conductors 68. These synchronizing impulses are generally transmitted at the end of each line-scanning interval and at the end of each field-scanning interval, that is, during the horizontal and vertical retrace periods of the cathode ray scanning beam.

The motor 54, as above stated, receives energy from the power line input portion of the master oscillator 60 over the conductors 66. Since the master oscillator 60 supplies energy to the vertical deflection generator 62, it is evident that the motor 54 may have its operation synchronized with the field-scanning operation of the camera tube 24. When the disc shutter 50 is properly phased with the deflection of the cathode ray scanning beam, then the aperture 52 in the disc 50 is in alignment with the optical axis of the projector only during the time that the cathode ray scanning beam is being returned in a vertical direction to begin another field-scanning cycle. In other words, the film image is projected through the aperture 52 onto mosaic 26 only during the vertical blanking interval.

However, the synchronous motor 54 is so designed that it may lock into the power supplied by the master oscillator 60 at either of two positions which are 180° apart. In one of these positions, the aperture 52 in the disc shutter 50 is aligned with the optical axis of the projector during the vertical blanking interval. In the other of these positions, the aperture 52 is 180° away from alignment with such optical axis during vertical blanking. The result of this latter condition is that the aperture 52 reaches alignment with the optical axis of the projector not during vertical blanking, but instead approximately at the mid-point of the field scanning interval. This momentary exposure of the mosaic 26 during the scanning interval causes a light bar to appear across the center of the reproduced image, as shown in Fig. 4.

As previously stated, it has been customary to overcome a condition of this nature by utilizing a manually-operated phase-controlling device, which may constitute a relay in series with the motor 54. This manual phase control, as shown in Fig. 1, comprises a pair of normally-closed relay contacts 70 which are adapted to be opened

on the manual closing of a switch 72. Upon the closing of switch 72, the contacts 70 are disengaged to cut off the power supplied over conductors 66 to the motor 54, and the contacts 70 are caused to remain disengaged (either by the switch 72 being held open manually or by a time-delay device on the relay itself) until the motor 54 has slipped through approximately a half revolution to thereby attain a proper phase relationship with the deflection generator 62.

According to a feature of the present invention, this phasing operation of the motor 54 is carried out automatically by means which will now be described. The mosaic, or light-responsive electrode, 26 of camera tube 24 is of known construction and has on one of its surfaces a number of discrete photo-emissive particles. When light from the source 42 impinges on the mosaic 26, electrons are released therefrom, and each photo-emissive particle of the mosaic acquires a charge which depends upon the intensity of the illumination received by that particle. According to the present invention, the electrons which are released from the mosaic (when the latter is illuminated at the time the aperture 52 of disc 50 is in alignment with the optical axis of the projector) are in part collected by a metallic element 74 on the inner wall of the camera tube 24. This element 74, consisting of a silver evaporator used in the manufacture of the camera tube but otherwise previously unused, is connected to a source of positive potential (not shown) through a resistor 76. Hence, when the shutter 50 opens and exposes the mosaic 26 to light from source 42 for a short period of time, the released electrons are collected by the element 74 during the exposure period and flow through resistor 76 to develop across this resistor a series of pulses which may have a wave-form such as indicated by the reference numeral 78.

A transformer 80 has its primary winding connected to receive alternating current from the master oscillator 60, the frequency of this alternating current being equal to the frequency of the impulses supplied by the master oscillator 60 to the vertical deflection generator 62. The output of transformer 80 (which is of substantially sine wave configuration) is applied through a phase-shifting network 82 to the control electrode of an amplifier and clipper tube 84. The network 82 permits the introduction of any shift in the phase of the wave supplied by the oscillator 60 which may be required for proper operation of the system.

Tube 84 operates to clip the sine wave output of transformer 80 in the manner indicated by the reference numeral 86. The bias on tube 84, and hence the clipping level, may be controlled by varying a potentiometer 88, the latter being preferably adjusted to remove substantially one entire portion of each cycle of the sine wave output of transformer 80. Thus each cycle of the wave 86 includes a flat voltage base portion 90.

When the phasing of motor 54 is correct, the pulses 78 which are produced each time that the shutter disc 50 opens to emit light to the mosaic 26 will coincide in time with the negative excursions of the clipped wave 86. However, when the phasing of motor 54 is incorrect, to thereby result in the placing of a light bar across the center of the image raster as shown in Fig. 4, then the occurrence of the pulses 78 will coincide in time with the production of the flat voltage bases 90.

The pulses 78 developed across resistor 76 are

applied to the control grid of an amplifier tube 92 which operates to reverse the polarity of the negative pulses 78 so that they extend in a positive direction. The output of amplifier tube 84 (consisting of the clipped sine wave 86) is applied directly to the plate of the amplifier tube 92 or, in other words, the voltage variation represented by the wave 86 is mixed with the inverted pulses 78, as shown by the waveform 94. It will be understood that the solid-line portion of the waveform 94 represents an out-of-phase condition of the motor 54, or, in other words, shows the clipped sine wave output 86 of the amplifier tube 84 combined with the inverted pulses 78 (produced during the exposure time of mosaic 26) in such a manner that the pulses 78 in effect "sit up" on the flat voltage bases 90.

It will be appreciated that, when the motor 54 is operating in correct phase, the pulses 78 will be displaced a half-cycle in time from their position shown in solid lines in wave 94, or, in other words, the positive pulses 78 will occur simultaneously with the negative excursions of the wave 86 in the manner shown by the broken lines. The peak amplitude of the pulses 78 under the latter condition, therefore, will not extend appreciably if at all above the flat voltage base portions 90.

This composite wave 94, consisting of the combined waves 78 and 86, is applied to the anode of a diode clipper tube 96. The cathode of clipper tube 96 is connected to the control electrode of a gas-filled discharge tube 98. Tube 96 operates to clip off that portion of the composite wave 94 which lies below the flat voltage base 90. This clipping level may be adjusted by varying the positive potential on the cathode of tube 96 through adjustment of potentiometer 100.

It will now be appreciated that when the motor 54 is operating in correct phase so that the mosaic 26 is exposed during the vertical blanking interval, then the pulses 78 will occur during the negative excursions of the clipped sine wave 86, and will not extend appreciably if at all above the bases 90. Thus, an in-phase condition of the motor 54 has been represented in the waveform 94 by an illustration of the pulses 78 in dotted outline. However, when the phase of the motor 54 is incorrect, then the pulses 78, as above stated, will "sit up" on the voltage bases 90, as shown in solid lines, and will be applied as a positive voltage to the control electrode of the gas-filled triode 98 following the clipping action of tube 96.

The anode of the gas-filled tube 98 is connected to a source of positive potential through the relay winding 102 and an adjustable resistor 104. The upper end of resistor 104 (in the drawing) is connected to ground through a charging condenser 106. Tube 98 has its control electrode biased from a source of negative potential (not shown) through potentiometer 108. By varying the bias applied to the control electrode of tube 98, the firing point of the tube may be altered in any desired manner.

The two normally-closed contacts 110 associated with the relay winding 102 are connected in series with the two normally-closed contacts 70 of the manually-controlled relay between the motor 54 and the master oscillator 60, or, in other words, the motor 54, the contacts 70, and the contacts 110 are effectively in series relation.

Assuming that the tube 98 is non-conductive, condenser 106 will be charged from the source

of positive potential through resistor 104. This places a positive potential on the anode of tube 98. As long as no positive voltage pulse is received on the control electrode of tube 98, the latter will remain non-conductive due to its bias through potentiometer 108. However, when one of the pulses 78 is received on the control electrode of tube 98 due to the fact that the motor 54 is operating in incorrect phase, then tube 98 will become conductive, and current will flow through the tube and also through the relay winding 102. The relay contact 110 will then open to interrupt the power supply to the motor 54. As above brought out, this momentary interruption in the power supply to motor 54 will usually enable the motor 54 to slip sufficiently to obtain correct phasing.

The adjustment of resistor 104 determines the charging rate of condenser 106, or, in other words, the frequency at which the gas-filled triode 98 is rendered conductive when positive pulses continue to be supplied to its control electrode. In practice, it has been found that an operative interval of approximately one second is satisfactory.

While the manual phase control, including the relay contacts 70 and the manually-operated switch 72, has been illustrated in order to provide a basis for describing the operation of the present invention, it will be appreciated that the automatic phasing means set forth herein eliminates the necessity for using such a manually-controlled device, and in practice these components will normally be omitted.

While the pulses 78 have been shown as being obtained from the silver evaporator element 74 on the camera tube 24, it will be obvious that these pulses may be derived in a number of other ways such, for example, as by the diversion of a portion of the light passing through the aperture 52 onto a suitable photocell or other light-responsive medium.

Having thus described my invention, I claim:

1. In a television transmitter for the transmission of images, said transmitter including a motion picture film, a camera tube having a mosaic electrode, a motion picture projector including mechanism for intermittently moving said film into position whereby optical images of individual film frame areas are projected successively from said film upon said mosaic electrode thereby to develop on said mosaic electrode electrostatic charges, proportional to the intensities of light and shadow on the film frame projected, a synchronous motor for driving said intermittent mechanism, means in said camera tube for developing a cathode ray scanning beam to scan said mosaic electrode and means to cause the said beam to scan the mosaic thereby to produce video output signals, the combination of means responsive to the successive reception of projected optical images on said mosaic electrode for deriving a first voltage variation, means for deriving a second voltage variation having a fixed time relation with the deflection of said cathode ray scanning beam, means for combining said first and second voltage variations so that a control effect is produced when said variations have a predetermined phase relationship indicating a departure from phase identity between the synchronous motor and the deflection of said cathode ray scanning beam, and means to effect a time controlled interruption of the current supplied to said synchronous driving motor under the

control of the developed control effect thereby to bring about a change in phasing of said motor with respect to said beam deflection and establish phase identity therebetween.

2. Apparatus according to claim 1, in which said means responsive to the successive reception of projected optical images on said mosaic electrode for deriving a first voltage variation includes means for collecting the electrons released by said mosaic electrode due to the impingement thereon of said optical images.

3. Apparatus according to claim 1, in which said means to effect a time controlled interruption of the current supplied to said synchronous driving motor includes a normally-closed relay in series with a grid-controlled electron discharge device, said control effect being applied to the grid of said electron discharge device to render said device conductive and thereby control the opening of said normally-closed relay as a function thereof.

4. In a television transmitter for the transmission of images, said transmitter including moving picture film, a camera tube having a mosaic electrode, a motion picture projector including mechanism for intermittently moving said film into position whereby optical images of individual film frame areas are projected successively from said film upon said mosaic electrode thereby to develop on said mosaic electrode electrostatic charges representative of the intensities of light and shadow in the film frame projected, a synchronous motor for driving said intermittent mechanism, means in said camera tube for developing a cathode ray scanning beam to scan said mosaic electrode and means to cause the said beam to scan the mosaic in mutually perpendicular directions and thereby produce video output signals as a result of the neutralization by said scanning beam of said electrostatic charges, the combination of a normally-closed circuit breaker connected in series with said synchronous motor, means responsive to the successive reception of projected optical images by the mosaic electrode of said camera tube for deriving a series of voltage pulses, means for deriving a sine wave having a frequency equal to that at which said cathode ray scanning beam is deflected in one of its mutually perpendicular directions, means for clipping said sine wave at a substantially predetermined level so that each cycle of said wave will include a flat base portion, means for combining said series of voltage pulses with said clipped sine wave so that each pulse of said series will coincide in time with a corresponding flat base portion of said sine wave when said synchronous motor is out of phase with the deflection of said cathode ray scanning beam in the said one direction, means for removing the remaining portion of said clipped sine wave from said combined wave so as to leave only the said voltage pulses, and means for applying the voltage pulses thus remaining to control the opening of said normally-closed circuit breaker and thereby interrupt the current supply to said synchronous motor.

5. Apparatus according to claim 4, in which said means to control the opening of said normally-closed circuit breaker includes a gas-filled discharge tube and a condenser in series with said circuit breaker, a resistor, means for charging said condenser through said resistor from a source of potential, and means for varying the value of said resistor to control the rate of charg-

11

ing of said condenser and hence the anode potential of said gas-filled discharge tube.

6. In a television transmitter for the transmission of images, said transmitter including a moving picture film, a camera tube having a mosaic electrode, a motion picture projector including mechanism for intermittently moving said film into position whereby optical images are projected successively from said film upon said mosaic electrode to thereby set up on said mosaic electrode corresponding images in stored electrostatic charge, a synchronous motor for driving said intermittent mechanism, means for developing and deflecting a cathode ray scanning beam to scan said mosaic electrode and thereby produce video output signals as a result of the neutralization by said scanning beam of said electrostatic charge images, the combination of a normally-closed circuit breaker connected in series with said synchronous motor, means responsive to the successive reception of projected optical images by the mosaic electrode of said camera

12

tube for deriving a first voltage variation, means for deriving a second voltage variation having a frequency substantially equal to the field-scanning frequency at which said cathode ray scanning beam is deflected, means for comparing the phase of the two voltage variations, and means for applying the control effect produced as a result of a substantially predetermined phase relationship of the two said voltage variations to control the opening of the said normally-closed circuit breaker.

CHARLES L. TOWNSEND.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,165,778	Beers	July 11, 1939