

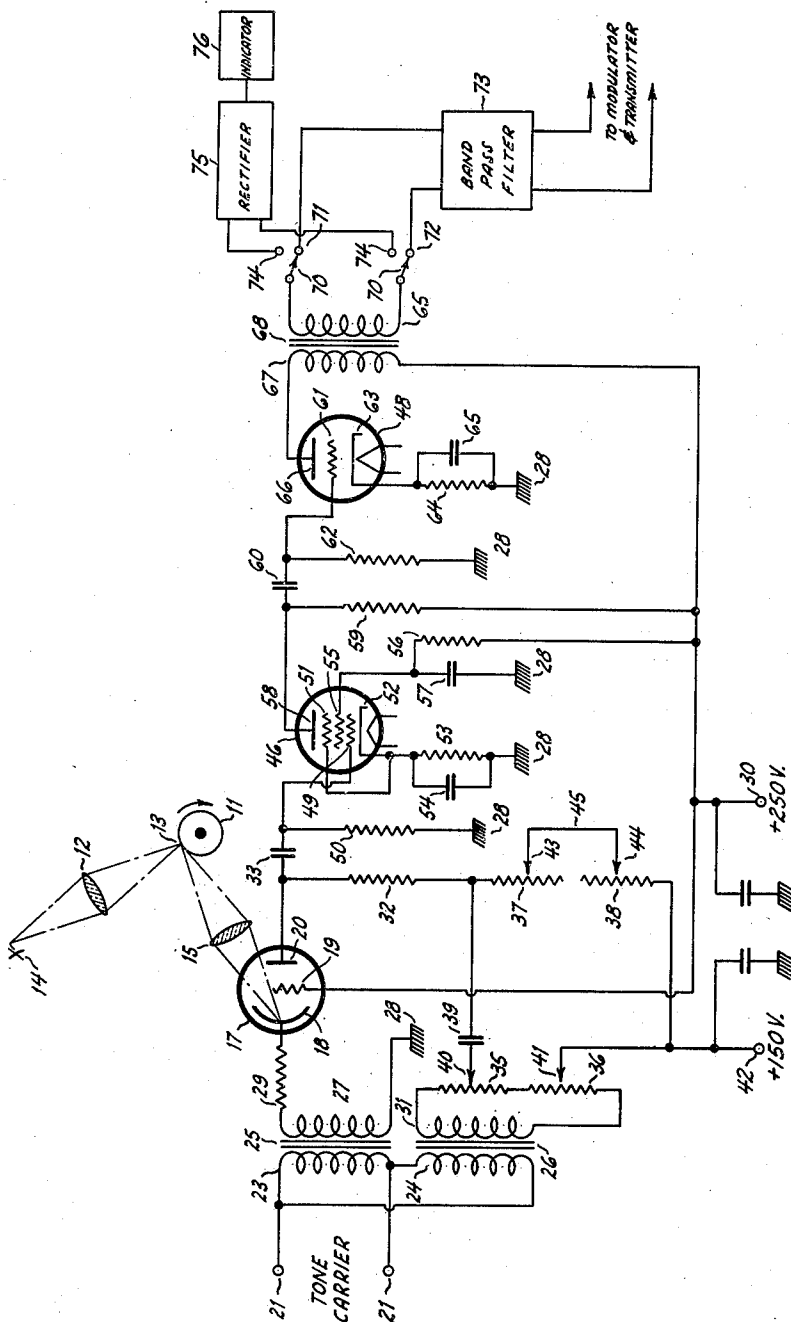
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ELECTRONIC CIRCUIT

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ELECTRONIC CIRCUIT

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This invention relates to a circuit which finds particular application in connection with facsimile transmission systems and which is also applicable to use in measuring systems or the like.

In its essential portions the present invention, as applied to a system for transmitting electrical signals which represent the varying light values of a subject as used in the transmission of pictures, it is frequently desirable, in order to avoid the use of the so-called direct current amplifier systems, to provide ways and means for providing a modulated alternating current output from the system. In this form of system the magnitude of the envelope of the modulated alternating current output is instantaneously proportional to the amount of light upon a related elemental area of the subject of which the electro-optical likeness is to be produced at receiver points.

In its essence the present invention embodies the use of a secondary emission type of photo-tube with a tone carrier frequency applied electrostatically in a cathode circuit of the tube to which tube a counter-electromotive force is also applied for balancing out a capacity current which may result in the absence of illumination. If such capacity currents should be high in value they would preclude the possibility of relatively greater change in light values from being able to cause any substantial depth of modulation. In combination with this arrangement, there has been provided a suitable amplifier and either a filter arrangement through which the resultant signals may be fed to a transmitter or a suitable rectifier from which the direct current output may be utilized for the purpose of obtaining monitor indications or for the purpose of obtaining direct readings in cases where it is desirable to measure varying light values as in photometric investigations.

In general, many facsimile scanner modulator systems, as now used in the art, have been found to be non-linear over their entire operating range and some systems of the type now known do not produce as great a contrast of ratio output for a change from white to black or vice versa in the scanning operation as is desirable to produce good quality pictures.

Accordingly, as one of the primary objects of this invention, this system has as its object that of overcoming these defects of the prior art.

Still other objects and advantages of the invention are to provide a circuit arrangement for use in facsimile transmission systems which is relatively simple in its arrangement and which

will, nevertheless, provide a relatively high output signal which will be substantially linear throughout the entire operational range.

Still other objects and advantages of the invention are to provide a circuit arrangement for use in facsimile systems which are efficient in operation, readily set-up, and which embodies a relatively few number of component parts.

Still other and further objects of the invention will become apparent from a description in connection with the accompanying drawing, wherein the single figure thereof illustrates in conventional manner one form of circuit for carrying out the aims and objects of the present invention.

In the system, as it is preferably constituted, there is provided a form of secondary emission photo-tube onto which the light of the image, as it is scanned, is projected. This photo-tube has a carrier or tone frequency voltage applied thereto and, at the same time, there is applied through the same tube a counterelectromotive force which precludes the possibility of any high capacity leakage current flowing in the anode circuit of the tube. The output energy from the secondary emission photo-tube which translates the variable intensities of light and shade on the picture subject into electric currents is then suitably amplified and passed through a suitable form of bandpass filter to modulate or to key a suitable form of transmitter. From the transmitter the resultant output signal can be directed to any desired form of receiver apparatus by either a radio or a wire-line connecting channel.

Various other objects and advantages of the present invention will become apparent to those skilled in the art from the following description particularly when considered with the drawing wherein the single figure shows one form of the present invention.

Referring now more particularly to the drawing for a further understanding of the invention, there is, as is known in the prior art, provided in connection with facsimile apparatus, a scanning drum 11 which is arranged to rotate, for example, as shown by the arrow. Supported upon the scanning drum 11 is a record or subject of which it is desired to produce at receiving points an electro-optical likeness. Onto the record carried upon the drum 11 there is projected by way of the optical system 12 a spot of light 13 from the source 14. Intermediate the optical system 12 and the surface of the drum 11 or at any point intermediate the drum and the light source 14, there may be provided, as is known in the art, any suitable

form of light diaphragm device for controlling the shape and size of the illuminated spot 13 upon the record surface supported upon the drum.

As the drum rotates in the direction shown by the arrow the drum moves along a helical path relative to the light source 14 or the light source moves slowly relative to the rotating drum so that the spot of light falling upon the record surfaces carried upon the drum traces a helical path over the record surface. The amount of light reflected from the record surface carried upon the drum 11 is proportional to the intensity of light and shadow of the record instantaneously illuminated. This reflected light is then directed by way of the optical system 15 so as to energize or activate a suitable light translating element. According to the present invention the light translating element is provided in the form of a secondary emission type photo-tube 17 in which is contained a photoelectric cathode element 18, a screen or collector electrode 19 and a dynode or anode 20. Such a tube may be a tube of the general type which is known in the art and has been sold to the trade under the designated indicia type "C-704."

In accordance with the amount of light from the record subject which falls upon the photosensitized cathode element 18 will depend the number of photoelectrons released from the light sensitive electrode element 18 thereof. As has already been explained in the art, it is usually desirable, in order to avoid the use of the so-called direct current amplifiers, which are more difficult to operate than the better known A. C. type, to modulate directly by the light translating element a suitable tone frequency which may be an alternating current usually of sine wave formation and of a frequency of the order of 3000 cycles to 5000 cycles or higher depending upon the recording speeds desired.

In accordance with the present invention the tone frequency which is developed by any suitable form tone frequency generator (not shown) is supplied at the terminal points 21 and serves to energize the primary windings 23 and 24 of the transformers 25, 26. The secondary winding 27 of the transformer 25 is connected at one end to a ground or earth connection point 28 and at the other end through a resistor 29 to the cathode element 18 of the secondary emission photo-tube 17. The screen or collector electrode 19 of the secondary emission photo-tube 17 is connected with a source of voltage (for example, of the order of 250 volts) at the terminal point 30 while the dynode or anode 20 of the secondary emission photo-tube 17 is connected to one end of a resistor 32 and also to one terminal of a condenser 33, later to be referred to.

It, of course, is apparent that with such an arrangement under conditions when the photocathode 18 of the secondary emissive photo-tube 17 is unilluminated, there may result some capacity current flowing through the tube. It is desirable for the reasons above stated to avoid such a current path and, therefore, there is supplied to the tube by way of the secondary winding 31 of the transformer 26 a counter-electromotive force derived from the same tone frequency or carrier which is supplied to the cathode element 18 of the secondary emission photo-tube 17. The circuit for supplying this counter-electromotive force comprises, in addition to the secondary winding 31 of the transformer 26, also a plurality of potentiometers 35 and 36 and rheostats 37, 38, as well as a condenser element 39. It will be seen that the secondary winding 31 of

the transformer 26 is series connected with the two potentiometers 35 and 36. Of these two potentiometers it is preferable to have one of relatively high resistance so that it may be used for making the coarse adjustments by varying the position of the slider element 40 while the other potentiometer 36 may be of relatively low resistance for making more accurate adjustments. The exact amount of resistance should be determined by varying the position of the slider 41. The slider element 40 of the potentiometer 35 is connected to one terminal of the condenser 39, the other terminal of which connects to the lower end of the output resistor 32 of the secondary emission photo-tube 17. The slider element 41 of the potentiometer 36 connects to the terminal point 42 to which positive voltage is applied and which voltage may be of the general order indicated by the drawing.

Also, as shown, the fixed terminal of the rheostat 37 is connected to the righthand terminal of the condenser 39 and also to the lower end of the resistor 32 while the fixed terminal of the rheostat 38 is connected also to the terminal connection point 42 to which the positive voltage is supplied.

The slider elements 43 and 44 of the rheostats 37 and 38, respectively, are connected together by way of the conductor 45. As was the case with the potentiometers 35, 36 the rheostat 37 is preferably one of high resistance so as to be used for coarse adjustment while the rheostat 38 of relatively low resistance is used for making relatively fine adjustments by varying the position of the slider element 44.

The amplifier for amplifying the output energy from the tube 17 preferably comprises a plurality of vacuum tube amplifiers 46 and 48 and their associated resistors, condensers and transformers. The righthand terminal of the input condenser 33 is connected to the control electrode 49 of the tube 46 and also to one end of the leak resistor 50. The other end of the leak resistor 50 connects to the ground connection point 28. The suppressor grid 51 and the cathode 52 of the tube 46 are connected together in known manner and connect to ground 28 through the usual shunt path which comprises a resistor 53 and a shunt condenser 54. The screen grid 55 is connected to the high potential terminal 30 by way of the resistor 56 which is shunted by a condenser 57 having its lower terminal connected to ground at 28.

Heater current for heating the cathode 52 is supplied in the usual manner and is not shown. The anode or plate electrode 58 of the tube 46 also connects to the high potential terminal 30 by way of the output resistor 59 and, at the same time, is connected to one terminal of a blocking condenser 60 which couples the output of the tube 46 into the input of the tube 48. The opposite end of the blocking condenser 60 connects to the control electrode 61 of the amplifier tube 48 and also to the upper end of the leak resistor 62 whose lower end is grounded at 28. The cathode element 63 of the tube 48 is connected as usual to ground 28 through the shunt path comprising the cathode resistor 64 and a bypass condenser 65. The anode or plate electrode 66 is connected through the primary winding 67 of the output transformer 68 to the terminal point 39 from which the high potential for supplying anode voltage is derived. The secondary winding 69 of the transformer is connected through a switching element 70 when the switch arms are in their lower position to terminal points 71, 72 into a bandpass fil-

ter 73 and from that point to the modulator and transmitter in order to key or to modulate the transmitter equipment for sending signals to points of reception.

The upper cut-off frequency of the bandpass filter is preferably adjusted below twice the value of the tone or carrier frequency supplied to the terminal points 21. The lower cut-off frequency of the filter 73 is not critical but should be far enough below the carrier frequency to give a pass band width wide enough not to increase the build-up time of the signals.

In cases where it is desired to provide direct recordings or to monitor the signal appearing in the output of the amplifier 48 the switch arms 70 may be moved to their upper contacts 74 to energize a rectifier element 75 from which direct current output may be obtained to provide in any suitable form of indicating device 76 which is made responsive to direct currents an indication of the relative intensity of the light falling upon the photosensitive cathode element 18 of the secondary emission photo-tube 17.

While the operation of the system, as above described in its constituent parts, is substantially evident as to the connections, it will be seen that substantial increase in the current flow in the conventional types of photo-tubes is possible by the increased current flow supplied by secondary emission in a tube of the type described.

When the light which has reflected from the record subject carried upon the drum 11 reaches the photo-cathode 18 of the secondary emission photo-tube, it causes emission of electrons from the surface 18 and these electrons flow to the dynode element 20 because of its high direct current potential relative to the cathode. The dynode element 20 which is of relatively large area is formed of a material which readily produces secondary emission and the secondary electrons released from the dynode element 20 are then collected by the screen or collector electrode 19 which is at a still higher positive potential than is the dynode element 20. Thus, due to the release of secondary electrons from the surface of the dynode element 20, the potential of the dynode element for increased light values causing release of a large number of photo-electrons from the surface 18 will become more positive.

In the circuit, as shown, the tone carrier is supplied as a potential on the photo-cathode 18 of the secondary emission photo-tube 17 by way of the transformer 25 and this causes a modulation of the stream of electrons caused by photo-emission from the element 18. Consequently, the output dynode current is a pulsating direct current whose magnitude is proportional to the value of the incident light. However, it can be seen, that the output may, under unbalanced conditions, also contain an A. C. component which is the electrostatic leakage current across the inter-electrode capacity of the cathode element 18 to the dynode element 20.

In all facsimile systems or other types of systems used to translate light into electric currents the total quantity of light available is usually relatively small and also in facsimile apparatus, as the speed of translation increases, higher carrier frequencies are required and hence the capacity leakage current becomes greater. It is because of this feature that it would be desirable to supply a voltage for bucking or balancing this capacity current effect from becoming effective in the input of the amplifier tube 46. The connections from the secondary winding 31 of the trans-

former 26 serve to provide this counter-electromotive force through the resistor capacity network which produces a voltage across the resistor combination 37, 38 which is of proper phase and may be adjusted to proper magnitude to counter-balance the electrostatically induced voltage upon the dynode 20. The two potentiometers 35 and 36 and the two rheostats 37 and 38 provide this adjustment which is essentially rather critical. After the adjustment is made it is practically fixed for any frequency supplied to the terminal points 21 and for any secondary emission type photo-tube 17. Under this condition the input energy supplied to the amplifier 46 consists only of the desired modulation voltage developed across the resistor 32 and some harmonic voltages of the carrier when the light from the record subject carried upon the record drum 11 modulates the photo-cathode 17. The amplifier should preferably be one of relatively high gain since the secondary emission photo-tube output is relatively weak because of the small amount of light available and because of the relatively high speeds with which the record subject carried upon the drum 11 is scanned.

Also, the bandpass filter 73 is desirable in order to remove the harmonics of the tone carrier from the output, since these harmonics, especially the second, are usually very large in magnitude in the amplifier output. These usually are present because of the discriminating effect of the counter-electromotive force circuit which does not completely balance them out.

From what has been above stated, it is, of course, to be understood that instead of providing two separate transformers 25 and 26 in the input there may be substituted a single three winding transformer in which the first winding would be connected to the tone carrier input as shown at the terminal points 21 and the second winding might then be arranged to supply the tone carrier to the secondary emission photo-tube cathode circuit, and the third winding could supply the tone carrier to the counter-electromotive force circuit. Likewise, it is obvious that the form of amplifier used and shown by the drawing is merely illustrated as being one which is suitable for use in connection with the system of the type described but obviously any conventionally high impedance input, high gain amplifier, can be used and replace that which has been illustrated.

Similarly, in connection with the counter-electromotive force circuit it is possible to supply the output voltage in series with the resistor 50, for example, or also in series with the resistor 62 instead of in series with the resistor 32 as described and, therefore, it is intended that the foregoing description shall be considered in an illustrative and not in a limiting sense.

Many and other modifications of this invention can be made without departing from the spirit and scope of the invention in its present form and, therefore, I believe myself able to make all such modifications as are obvious to those skilled in the art which fall fairly within the spirit and scope of this invention.

What I claim is:

1. A transmission system comprising a light converting device including a photoelectric element, a secondary electron emission output electrode and an intermediate accelerating and collecting electrode, a source of carrier frequency energy, a source of light energy, means for energizing the photoelectric element by said light energy, means for applying the carrier frequency

energy between the photoelectric element and a point of fixed potential, means for maintaining said output electrode and said intermediate electrode positive with respect to said point of fixed potential whereby the carrier frequency energy present at the output electrode is modulated by secondary electron emission in accordance with the intensity of the energizing light energy, a load circuit connected to receive the modulated output, a compensating network including the output electrode and the collecting electrode of said light converting device, means for supplying to the compensating network a predetermined amplitude of unmodulated carrier frequency energy, and means for controlling the phase and amplitude of the compensating energy supplied to the compensating network so as to neutralize the capacity current flowing between the photoelectric element and the secondary emission output electrode of the light converting device whereby the output of the device to the load circuit may be reduced to substantially zero when no light energy is projected on the photoelectric element.

2. A transmission system comprising a light converting device including a photo-electric element, a secondary electron emissive output electrode and an intermediate accelerating and collecting electrode, means for applying operating

potentials to said output and collecting electrodes with respect to a point of fixed potential, a source of carrier frequency energy, a source of light energy, means for energizing the photo-electric element by said light energy, means for applying the carrier frequency energy between the photo-electric element and said point of fixed potential whereby the carrier frequency energy present at the output electrode is modulated by the secondary electron emission from the output electrode as determined by the photo electrons released in accordance with the intensity of the energizing light, a load circuit connected to said output electrode to receive the modulated output, a compensating network including the output electrode and the collecting electrode of the light converting device, means for supplying to the compensating network a predetermined amplitude of modulated carrier frequency energy, and means for controlling the phase and amplitude of the compensating energy supplied to the compensating network so as to neutralize the capacity current flowing between the photo-electric element and the secondary emission output electrode of the light converting device whereby the output of the device to the load circuit may be reduced to substantially zero when no light energy is projected on the photo-electric element.

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