

March 7, 1939.

J. V. L. HOGAN

2,149,292

FACSIMILE SYSTEM

Filed June 16, 1934

3 Sheets-Sheet 1

Fig. 1.

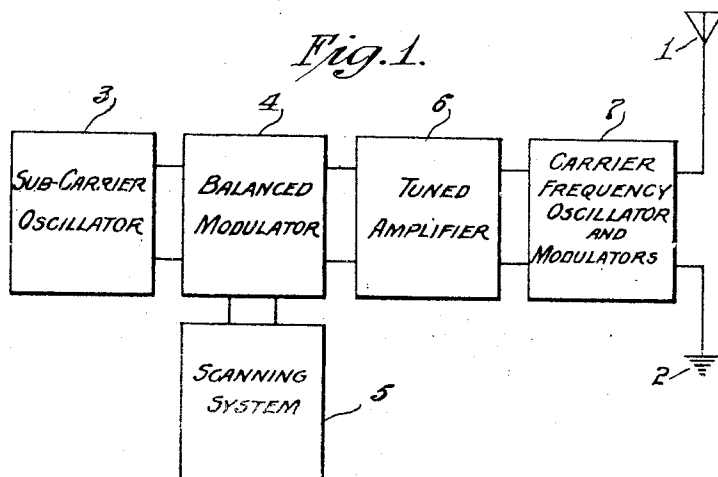


Fig. 2.

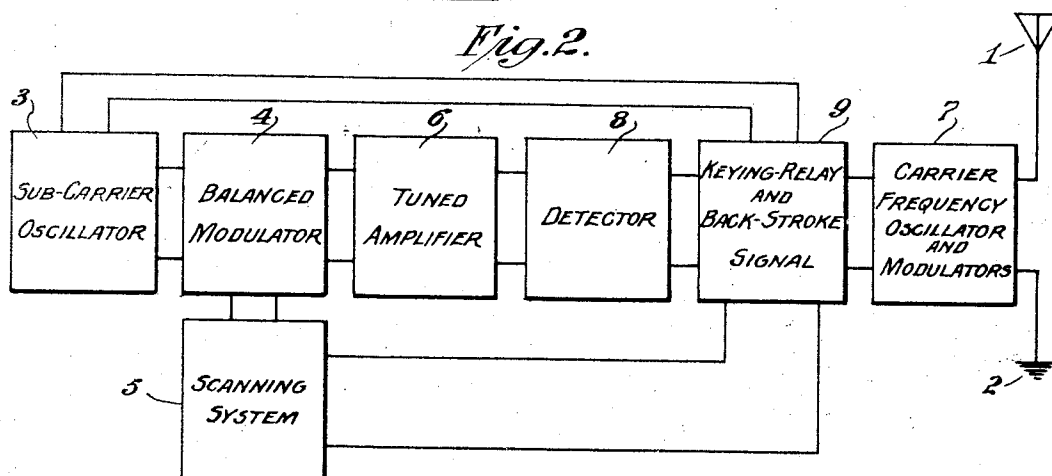
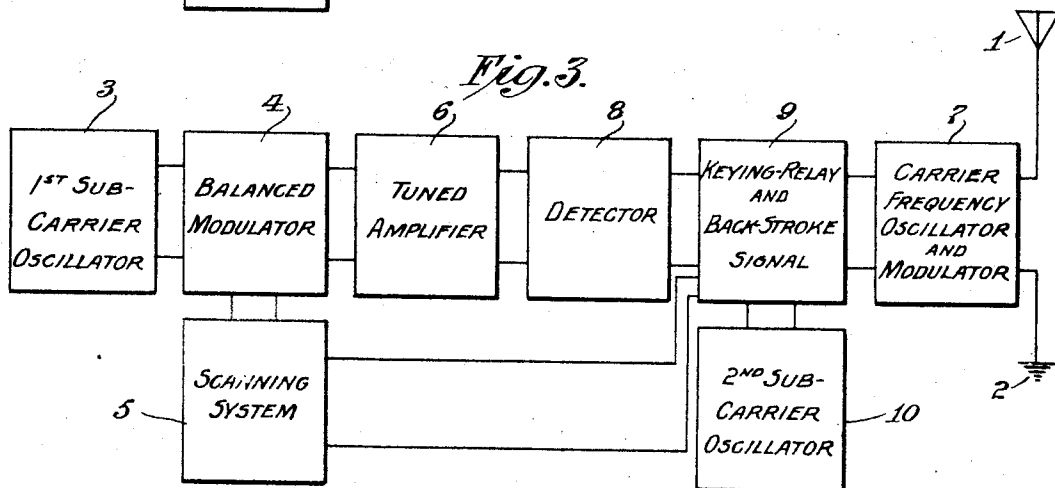
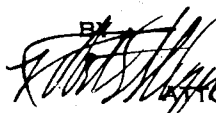


Fig. 3.



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3 Sheets-Sheet 2

Fig. 4.

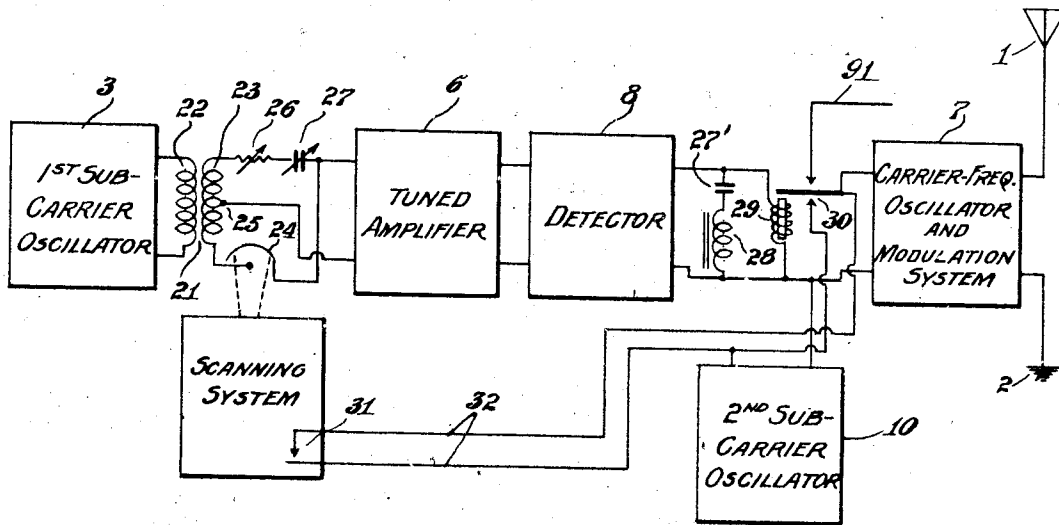
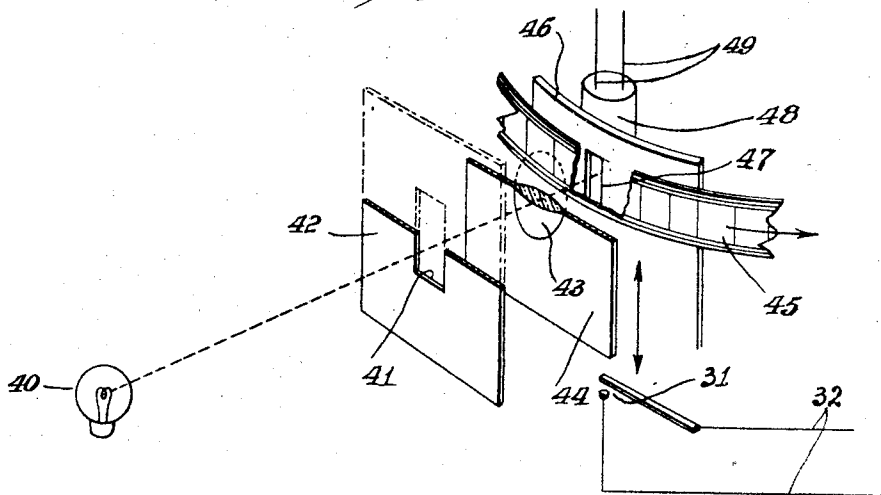
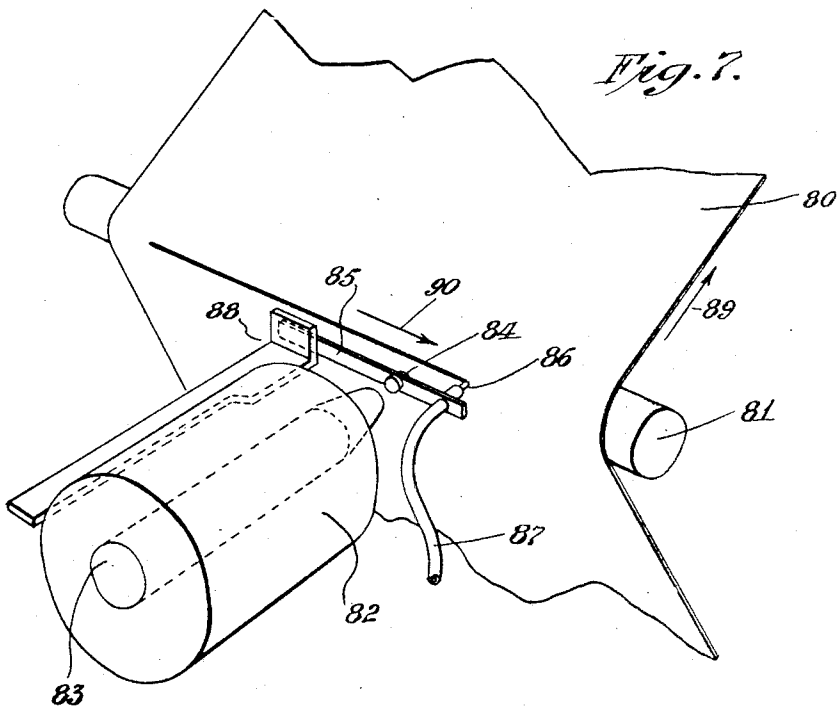
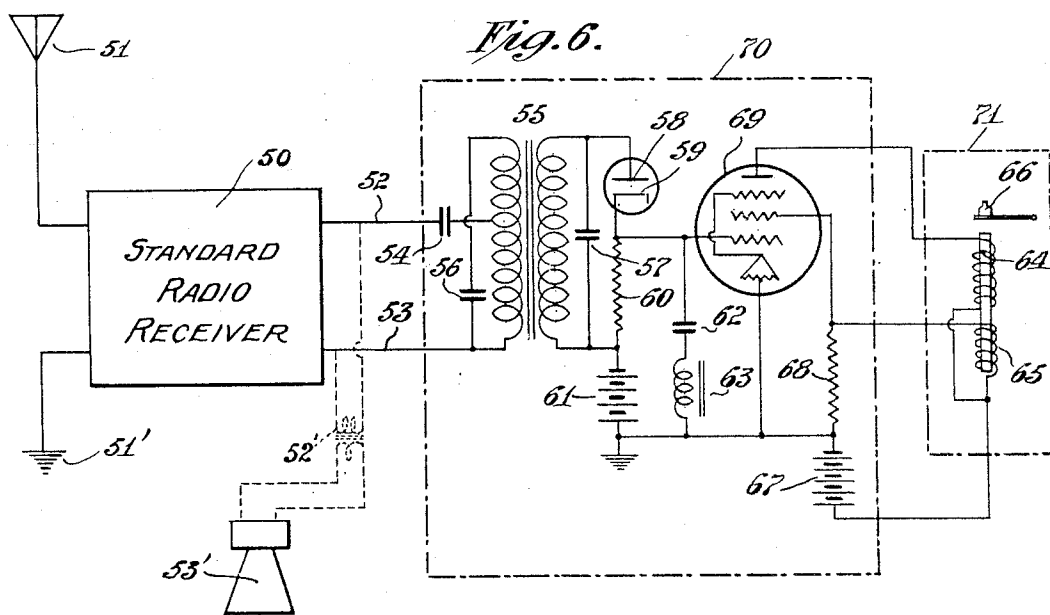


Fig. 5.



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UNITED STATES PATENT OFFICE

2,149,292

FACSIMILE SYSTEM

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Application June 16, 1934, Serial No. 730,856

5 Claims. (Cl. 178-6.7)

This invention relates to facsimile transmission systems and the like. By facsimile system is meant a system for the transmission to distant points of records, especially records printed, written, drawn or photographed upon the surface of some medium such as paper, film, or the like. Such systems utilize at the transmitter records, the various portions of which have different light reactive properties and reproduce at the receiver a so-called facsimile of the record which was acted upon at the transmitter. Such facsimile reproductions are not necessarily extremely precise or identical copies of the record at the transmitter, but may approximate, in exactitude, the matter to be transmitted merely to such degree as will serve to give a reproduction satisfactory for a particular purpose desired.

This invention deals more particularly with facsimile transmission systems where a graphic record is acted upon by electro-optical translation means, including a photoelectric cell and the electrical signals thus produced correspond in value to the light reactive properties of the various portions of the matter to be transmitted. At the receiver a translation of these electrical signals gives rise to an optical reproduction of the material acted upon at the transmitter. The transmission link between the transmitter and the receiver may be, for example, a physical line or a radiant energy channel.

One embodiment of this invention optically analyzes the image to be transmitted by a scanning process and causes the reproduction of such image upon a surface of paper or similar material at the receiver in the form of marks upon such surface.

This invention is especially suited for the reproduction of graphic records which may be satisfactorily reproduced by means of elements having only two distinct optical values. Such optical elements may be either black and white, or of any colors or shades having at least two light reactive values. It is preferred that the two light values be such as to give good optical contrast when one is superimposed on the other.

One object of this invention is to allow a permanent record, such as one produced by the employment of ink to be made upon ordinary paper not especially prepared or treated for the purpose, at a facsimile receiver. This is in contrast to many facsimile reproducing devices previously proposed or now in use, which produce records not as permanent as those of the ink type, or else require the employment of electrochemical, thermochemical, photochemical or other treated

paper with the consequent expense and/or delay in the reproduction due to necessary development, fixing, etc. of such electrochemical or photochemical surfaces and with the inconvenience inherent in the use of chemical agents.

Such photographic processes as those last referred to, which require subsequent chemical treatment, have the further disadvantage that any maladjustment or improper functioning of the receiving device, such as lack of synchronization with the transmitter, cannot be perceived by the operator of such a receiver until the entire transmission has ended and the photographic record has been developed. This invention avoids such difficulties by making a record which may be instantly visible to the operator and thus allows him to see and correct at once any maladjustment of the receiver, without losing an entire transmission due to any material delay in the appearance of the reproduced image. Furthermore this invention, by dispensing with the use of photographic paper or other electrochemical or thermochemical responsive surface allows a great gain in economy of material and simplicity of operation, even to the extent of removing such reproduction process from the status of an operation necessarily conducted by skilled technicians, to one which can be conducted by an ordinary layman capable of operating the usual household radio receiver.

Another object of this invention is to produce a facsimile reproduction which may be termed "continuous". Many types of previous facsimile systems have employed a surface whose area was limited; for example, a single sheet of paper of limited length wrapped once around a cylindrical roll.

While the use of such a limited surface may be satisfactory for the reproduction of a single picture, yet it demands virtually continuous attendance of an operator at the receiver in order to remove such single sheet when the reproduction has been made thereupon and in order to substitute a fresh surface therefor in order to receive the following reproduction. This invention allows the utilization of a so-called "continuous type" of record paper. A roll of paper having very great length in one dimension may be employed with this invention, thus reducing changes of the record necessarily made by the operator to a minimum number. This invention allows a similar continuous strip to be used at the transmitter.

Another object of this invention is to allow facsimile transmission and reproduction at high

rates of speed, such that, for example, events of current interest such as important news items or financial quotations may be made available with such rapidity and accuracy as to compare favorably with more complicated systems now used for such purposes, such as printing telegraphs and the like. This invention allows adequate detail to be maintained in such cases, even with high speed transmission.

A further object of this invention is to provide a facsimile reproducer which shall be able to function for long periods without the necessity for any attention on the part of an operator.

Such automatic operation will allow a facsimile reproducer giving a permanent record according to this invention to be employed over wire or radio channels during periods of the day when such channels are carrying the minimum amount of traffic and thus may be of great benefit in allowing such channels to be more efficiently employed than is at present possible with the uneven load distribution extending over the daily period of their utilization.

Still another object of this invention is to provide a facsimile receiver which shall be simple and cheap in construction and which can be employed in conjunction with household receiving apparatus such as a receiver for broadcast radio signals, notwithstanding that such radio receiver may have a normally poor response to low frequency signals such as those used in a facsimile transmission. A facsimile receiver of this type presents a wide field of utility in that it may be employed in household use as an appendage to types of radio receivers which are already to be found in widespread use in such locations or in other places where they must necessarily be capable of satisfactory operation by those who are laymen with respect to the electrical art.

Another object of this invention is to allow facsimile transmission by the employment of electrical signals which will not easily be confused with or interrupted by stray or static impulses or so-called "noise" effects originating in the terminal apparatus itself or elsewhere.

This invention may be used to produce such signals, particularly when only two light values are used for reproduction, as above described. Such a system allows substantially maximum efficiency at all times to be obtained with the use of a given carrier channel or frequency, in that all picture densities below a chosen value may give one hundred percent (100%) modulation and all other densities will give zero modulation, or vice versa.

This invention also is designed to allow a reverse reproduction of the object employed at the transmitter to be obtained at the receiver. Such a feature is of great practical utility in allowing the employment of photographic negatives without the necessity of making positive copies thereof, and yet allowing the reproduction to be obtained as a positive. It thus may employ either optical type of object, i. e., positive or negative, at the transmitter by an extremely simple change of adjustment thereat, while the receiver may easily be adjusted to reproduce such optical objects in correct or natural form. In this fashion this invention reduces the time necessary between the photographing of some scene or object to be transmitted and the actual transmission thereof. For example, news events may in this fashion be transmitted in a very short time after their actual occurrence.

Yet another object of this invention is to allow

material written by machine, for example, a typewriter, to be transmitted with the minimum delay between its printing and its actual transmission and reception.

Another object is to transmit facsimile signals in such fashion that a pen at the receiver may remain in contact with a recording surface when no signals are being received, giving a "pen-sealing" effect when the receiver is not in use and avoiding unwarranted evaporation or drying up of writing fluids used with the pen.

A further object of this invention is to provide a photoelectric translating system where alternating current is employed in connection with a photoelectric cell in such fashion that high percentage modulation may be obtained, notwithstanding the electrostatic capacity inherent in such cells.

Further objects of this invention are to provide means for illustrating radio lectures and the like by graphical illustrations simultaneously transmitted, to allow a permanent record of formulae, quotations, or the like to be obtained by a listener without the necessity for any effort on his part in transcribing the same.

Other objects of this invention are to allow the transmission of broadcasting of financial quotations, weather reports, and similar groups of figures or separate words which may be easily confused when received solely through the ear and to allow broadcasting stations to obtain a definitely measurable index of station coverage and program popularity.

This invention may be understood by reference to the drawings where

Fig. 1 is a block diagram representing the various cooperating units which may be employed with one form of transmitter embodying this invention.

Fig. 2 is a block diagram representing an alternative assembly of units which may be employed with another form of transmitter embodying this invention.

Fig. 3 shows a modified form of the structure of Fig. 2.

Fig. 4 shows a transmitter with certain portions in greater detail and showing details of certain circuits embodying novel features.

Fig. 5 shows schematically and without unnecessary detail, certain electromechanical and optical elements used to form a transmitting scanner which may be employed in conjunction with the electrical circuits indicated in Fig. 1.

Fig. 6 shows partly schematically certain elements which may be employed to form a complete receiver and certain of the circuits thereof.

Fig. 7 shows certain details of a receiver suitable for operation with the system of this invention.

Fig. 1 shows a block diagram of a facsimile transmitter according to this invention in which the component parts and their functions have been simplified. Referring to this figure, an oscillator 3 operating at a sub-carrier frequency such as 2400 cycles per second is shown. The output voltage of this oscillator is delivered to a balanced modulator 4 having a photo-electric cell as the modulating element. A mechanical or other type scanning system 5 may be employed to scan the subject to be transmitted and transmits light impulses of varying intensity, depending on the various optical densities of different portions of the object to be transmitted, to the photo-electric cell. The output of the balanced modulator, consisting of pulses of sub-carrier fre-

quency waves corresponding to light pulses received by the photo-electric cell, is fed to an amplifier 6 tuned to the sub-carrier frequency and capable of passing at least one side-band of the modulated sub-carrier frequency, preferably at least as great as the frequency of the scanning system light pulses. The output of the tuned amplifier is fed to a modulation system 7 where it modulates the carrier-frequency signal to be transmitted to the distant receiver.

The carrier modulated by the sub-carrier pulses may be radiated at any radio frequency, such as 1650 kilocycles from an antenna 1 in conjunction with a ground connection 2, or any other suitable radiating system may be used.

The radiated carrier wave of 1650 kilocycles, in this instance, is doubly modulated by (a) the 2400 cycle sub-carrier and (b) the scanning impulses of still lower frequency which modulate the 2400 cycle sub-carrier.

Fig. 2 shows a block diagram of a system which embodies some refinements over the system of Fig. 1 by the addition of a keying system and a system for generating a back stroke signal for the receiver recorder. The operation of the system of Fig. 2 is similar to that of Fig. 1 up to the output of the tuned amplifier 6, at which point the modulated sub-carrier pulses are rectified, as by detection means 8 such as a thermionic diode circuit included at this point, and the pulses of rectified current are fed to a keying relay 9. The keying relay thus operated is used to turn off and on an alternating voltage which may, as here shown, be derived from the sub-carrier oscillator. The back-stroke signal may also, as here shown, be derived from the sub-carrier oscillator. The back-stroke signal is turned on and the picture signal is turned off by a switch operated synchronously with the scanning system, during each return or non-operative stroke of the scanning process. One form of this switch and the purpose of the back-stroke signal will be later described in connection with Fig. 5. The keyed signal and back-stroke signal comprising, for example, a 2400 cycle tone, are used to modulate the carrier frequency. The modulated carrier frequency energy may then be radiated from the antenna as in the case of Fig. 1.

Fig. 3 shows a system similar to that of Fig. 2 with the modification that a second source of sub-carrier frequency energy such as generator 10 is used to supply the back-stroke signal and the keying relay output or picture signal. The second sub-carrier frequency may be the same as that of the first sub-carrier, or different therefrom; in either case the system has the advantage of stability over the system of Fig. 2 in which two varying and preferably independent loads are imposed on a single sub-carrier oscillator, with consequent possible coupling through the oscillator impedance. However, if the second sub-carrier frequency is different from the first, there may be another advantage in respect to tuned amplifier and modulator design, since any ratio of the two frequencies may be employed according to the results desired.

Referring now to Fig. 4, for the purpose of explaining in greater detail the system of Fig. 3, reference numeral 3 denotes the sub-carrier oscillator, or similar device for producing an electric current of definite frequency and intensity. Such oscillators are well known in the electrical art and since there may be used any suitable type, such as a type employing resonant circuits and/or piezoelectric crystals, it is not considered

necessary to illustrate the internal circuits of such oscillator in detail.

It is likewise possible to employ in place of the type oscillator just described, another type oscillator which is controlled or exteriorly governed by some other frequency, such as the frequency of a commercial power circuit which serves to supply energy to the entire transmitter. In many cases such secondarily controlled types of oscillators will be found advantageous.

Oscillator 3 acts to produce an alternating current of substantially constant frequency and intensity which serves as a carrier of the picture signal throughout the amplifying system employed at the transmitter. The frequency produced by this oscillator is preferably chosen higher than any frequency produced by the modulation of the photoelectric cell, in order that it may more satisfactorily function as a carrier of the signals produced by such modulation.

At 21 is indicated a transformer with primary winding 22 and secondary winding 23, serving to couple oscillator 3 to photoelectric cell 24. Secondary winding 23 is tapped at a point intermediate the extreme ends of the winding, as indicated by reference numeral 25. One end of the secondary winding is connected to one element of photoelectric cell 24 and the other end of winding 23 is connected to the other terminal of photoelectric terminal 24 through an adjustable resistance 26 and an adjustable condenser 27 connected in series with one another.

When condenser 27 and resistance 26 are adjusted so as properly to correspond with the resistance and capacity of photoelectric cell 24, an electromotive force will be impressed through these two elements upon photo-electric cell 24 in such phase relationship and to such degree as to balance or compensate for the sub-carrier voltage which passes through cell 24, when no light is falling upon the cell. This balanced modulator circuit constitutes a feature of great practical importance since it allows an alternating current to be employed in connection with a photoelectric cell, and still permits the useful output of the cell to be modulated through a wide range of values. If such a balancing or compensating circuit is not employed, the alternating carrier current from oscillator 20 will pass through cell 24, even when this cell is not illuminated, and in many cases, the current thus passing through the cell will be of a magnitude so much greater than that of the current due to the illumination of the cell, as practically to completely overshadow the latter.

In normal operation, the resistor 26 and condenser 27 are mutually varied until, with no light falling on the photoelectric cell, minimum sub-carrier voltage reaches the tuned amplifier. Now, with the above adjustment, if light is allowed to fall on the photoelectric cell, the balance is disturbed and an increased voltage representing an effective signal is passed to the tuned amplifier 6 and thence to the detector or rectifier 8, after amplification. Such signal usually is effective only when the potentials on the photoelectric cell are such that substantial electronic conduction therethrough occurs and this happens substantially every half-cycle of the sub-carrier oscillator. After passing through a transformer or similar device, it is evident that such signal again will become an alternating current.

The intensity of this sub-carrier signal is proportional to the amount of light acting upon the cell 24, within practical limits. Following the

rectifier 8, a resonant filter consisting of condenser 21' and inductance 23 may be connected as shown, and adjusted to resonate at the first sub-carrier frequency. This filter functions to eliminate the first sub-carrier and thus prevent its passage to the following circuits. Across the rectifier output is also the relay magnet coil 29. The relay coil 29 receives low frequency current pulses from the rectifier, since the sub-carrier voltage has been filtered out, and it is adjusted to operate on these low frequency pulses. These current pulses correspond in frequency and intensity to the pulses of light falling on the photo-electric cell 24. While the amplitudes of the pulses from the rectifier thus depend on the light values of the subject being scanned, the voltages supplied to the later circuits by the closing of relay contact 30 will have a constant maximum amplitude.

This transformation from varying amplitude pulses to constant amplitude pulses also aids in eliminating any noise which may have become associated with the initial type of pulses. The back-stroke signal switch 31 connected to the relay by wires 32 also supplies constant amplitude signals during the back or non-recording stroke of the scanner.

One means for operating switch 31 being shown later in Fig. 5, it suffices to say here that it may be operated from some part of a mechanical scanner stroke mechanism and may be synchronized with the return or non-operative stroke. Completing the operation of the system, the keyed pulses and back-stroke signals are used to modulate a carrier wave and the modulated wave radiated from antenna 1 and ground 2.

While a radio transmission system has been shown, the invention is not limited to radio transmission as, for example, the carrier frequency oscillator and modulator may be omitted and the keyed pulses and back-stroke signals may be fed directly to a wire line or recorded on a phonograph disc or motion picture film.

One suitable form of pick-up scanner is shown in Fig. 5. A concentrated light source 40 is used to shed light rays through a rectangular aperture 41 in mask 42. Behind this aperture a suitable objective lens 43, fixed in a screen 44, is caused to reciprocate in the plane of the mask, by the use of suitable mechanism not here shown. Film 45, whose plane is parallel to the direction of motion of lens 43, is moved continuously in a direction perpendicular to the motion of lens 43, and receives a small moving image of light source 40 through the agency of lens 43. Mask 46 with slot shaped aperture 47, placed behind the film, allows photo-cell 48 to receive the light which has passed through film 45. Scanning in one dimension is accomplished by the luminous spot from reciprocating lens 43 passing across the film in one dimension while the movement of the film gives scanning in the other direction.

Any suitable mechanism, as well known in the art, may be employed to secure the relative mechanical motions of the various elements, as above described.

Wires 49 convey the electrical output of cell 48 to the circuits of the balanced modulator, and back-stroke signal switch 31 may be operated by the motion of mask 43, which, through simple and well known mechanical means may be arranged to open this switch at one end of its stroke and close it again at the other end of its stroke. Thus as the image of source 40 passes transverse-

ly to the motion of the film, in one direction, scanning of the images on the film is effected, while on the return or non-scanning stroke, the switch 32 is automatically closed to prevent effective scanning.

It is understood that any other suitable mechanical or electrical scanner may be employed to produce facsimile signals, since this invention is not limited to the form of scanner disclosed in Fig. 5.

Fig. 6 shows a receiving system embodying a standard broadcast or other type radio receiver 50 connected to antenna 51 and ground 51', a coupling unit 70 and a recording pen 71. Leads 52 and 53 are brought out from the receiver, e. g. from the primary of the transformer 52' which supplies speaker 53', or from some other internal source of large "audio" signal energy.

The demodulation in the standard receiver and subsequent audio amplification will result in pulses of sub-carrier frequency voltage corresponding to the pulses of light falling on the photo-cell and to the back-stroke signal pulse. The pulses of sub-carrier voltage across wires 52 and 53 may be applied to at least a part of the primary of transformer 55 through condenser 54. Transformer 55 may be tuned in the primary by condenser 56, and in the secondary by condenser 57, to the modulated sub-carrier frequency or preferably to the center of one side-band thereof. The secondary voltage of transformer 55 may be applied to a rectifier consisting of a diode having an anode 58 and cathode 59. An impedance 60 and a biasing battery 61 may be connected in series with cathode 59. Rectified pulses now will appear across impedance 60, which pulses (after filtering out the sub-carrier voltage by means of condenser 62 and inductance 63) are applied to the control grid of output tube 69, together with biasing voltage from battery 61.

Output tube 69 is shown as a pentode type but may be any other output tube of sufficient power handling capacity and sensitivity. In the output circuit of tube 69 are pen operating coils 64 and 65 arranged to actuate magnetically pen element 66. A high voltage supply 67 (usually possessing appreciable internal impedance) is shown to operate tube 69. Coil 65 acts to create a polarizing field for pen 66 and may be energized as shown, by a current drawn through bleeder resistor 68, plus the screen-grid current of tube 69.

When a signal is impressed the plate current rises, and because of the effective impedance of the high voltage supply 67, the resistor current falls. However, the screen current simultaneously rises, and the circuits may be so proportioned that the sum of screen and resistor currents, i. e., the polarizing current in coil 65, remains substantially constant, or even rises, when signals are received. Coil 64 is connected in series with the anode circuit of tube 69 and receives the rectified and amplified output pulses previously described. Coil 64 thus energized, drives the pen 66.

Fig. 7 shows in more detail the construction of one form of the recorder pen. A strip of recording paper 80 is fed over a platen 81 preferably of cylindrical shape. The pen-driving mechanism consists of an electro-magnet 82 made up of coils 84 and 85 (Fig. 6) wound around a magnetic core 83, and a small iron armature 84 which is magnetically acted upon by the electro-magnet core 83 and is fastened to the pen reed 85. Pen point 86 with flexible ink feed tube 87, preferably

connected to an ink reservoir (not shown), may be attached to one end of reed 85 and the other end of reed 85 may be secured to mounting bracket 88, which in turn may be fastened to magnet 82 and hence move with it. The direction of paper feed is indicated by arrow 89 and the preferred direction of the pen on the active or marking stroke is indicated by arrow 90.

The pen pressing against the paper as shown produces a firm marking. With no signal being received, the pen is in contact with the paper and hence is marking upon it. When a pulse of current is fed to the coil system of electro-magnet 82, due to light falling on the photo-electric cell 24 and subsequent amplification, modulation, transmission, reception and rectification as described above, the pen is lifted from the paper, leaving a white space thereupon. Likewise on its return stroke, the pen is lifted from the paper by the action of the back-stroke signal previously described and no mark is made during this return passage. Each complete to and fro travel is accompanied by an appropriate motion of the recording paper in the direction indicated by the arrow 89. Any suitable mechanism, not here shown, may be used to secure this feeding motion of the recording paper.

In case of transmission from a negative picture subject, pulses may be generated at the transmitter corresponding to picture densities above a certain value (instead of below a certain value as in "positive" transmission), so that when received and recorded a positive reproduction is obtained. For such operation the balanced modulator described in connection with Fig. 4 above will ordinarily be adjusted to pass minimum sub-carrier current when the photoelectric cell is fully illuminated, the consequent unbalance being produced by reduction of photocell illumination as the darker portions of the transmitted image are scanned.

Another method of providing negative transmission is to fit relay 29 (Fig. 4) with a back-contact 91 and so to reverse the phase of the signal modulation by connecting it in place of the normal or front-contact 30. Either method effectively reverses the sense in which the system operates and provides "negative" transmission as here described.

While we have shown certain details of apparatus and circuits in the foregoing description, it is to be understood that we are in no wise limited to such particular forms as shown except in as far as defined in the following claims.

We claim:

1. An electro-optical transmission system including a light source illuminating an image to be transmitted, image scanning means operating according to a predetermined cycle, means for generating current of a sub-carrier frequency high compared to the frequency of said scanning cycle, photo-electric means for modulating a portion of said sub-carrier current in accordance with the light from said image, means for rectifying said modulated portion of said sub-carrier current and for obtaining modulation-frequency currents therefrom, means for controlling an additional portion of said sub-carrier current in accordance with said modulation-frequency currents during a portion of said scanning cycle and other means for controlling said additional portion of said sub-carrier current during the remaining portion of said scanning cycle, and means for transmitting said doubly controlled additional portion of said sub-carrier current.

2. An electro-optical cyclic transmission system including a light source illuminating an image to be transmitted, means for generating a substantially sinusoidal current of sub-carrier frequency, photo-electric means for modulating a portion of said sub-carrier current in response to the light from said image, means for rectifying said modulated sub-carrier current and for obtaining currents of modulation-frequency therefrom, means for keying a second portion of said sub-carrier current operated by said modulation-frequency currents during a portion of a transmission cycle and other means for controlling said second portion of said sub-carrier current during the remaining portion of said transmission cycle, and means for transmitting said keyed and controlled second portion of said sub-carrier current.

3. An electro-optical transmission system including a light source illuminating at least a portion of an image to be transmitted, means for generating a substantially sinusoidal sub-carrier, photo-electric means for amplitude modulating a portion of said sub-carrier in accordance with the light from said illuminated image, means for rectifying said modulated sub-carrier, means for obtaining modulation-frequency currents from said rectified sub-carrier, means for controlling the amplitude of a second portion of said sub-carrier operated by said modulation frequency currents, and means for transmitting said controlled portion of said sub-carrier.

4. A facsimile system including at the transmitter a first source of sub-carrier alternating current, photo electric means possessing inherent resistance and capacity for modulating the sub-carrier alternating current from said source, bridge circuit means for balancing out the resistance and capacity of said photo electric means under a given illumination of said photo electric means, a reciprocating scanning mechanism for exciting said photo electric means, switching means operated by said scanning mechanism so as to be open when said mechanism moves in one direction and closed when said mechanism moves in the other direction, a second source of sub-carrier alternating current, controlling means for the current from said second source and operated by said switching means, other controlling means for the current from said second source and operated by the modulated current from said photo electric means, and means for transmitting signals corresponding to the controlled current from said second source to a receiver, and including at the receiver means for receiving said signals, deriving therefrom corresponding controlled currents, and an intermittently recording element whose functioning is determined by said current, so that said recording element will be non-operative during the intervals when it is not actually recording signals corresponding to the modulated current from said photo electric means, in one direction.

5. A facsimile transmitting and receiving system comprising at the transmitter, means for scanning an image, compensated photoelectric means for generating currents corresponding to scanned light values of said image, means for generating signal impulses having a frequency greater than said currents corresponding to said light values, but having a frequency less than the frequency employed between the transmitter and the receiver, means for modulating said series of signal impulses according to said light

values, means for modulating said impulses independently of said light values, means for imposing said modulated impulses upon transmission carrier current of substantially higher frequency and, at the receiver, means for recording controlled by said signals modulated accord-

ing to said light values and non-recording means controlled by said independent modulations, substantially as described.

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5

CERTIFICATE OF CORRECTION.

Patent No. 2,149,292.

March 7, 1939.

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It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 5, second column, line 64, claim 4, strike out the comma and words ", in one direction"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 17th day of December, A. D. 1940.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.