

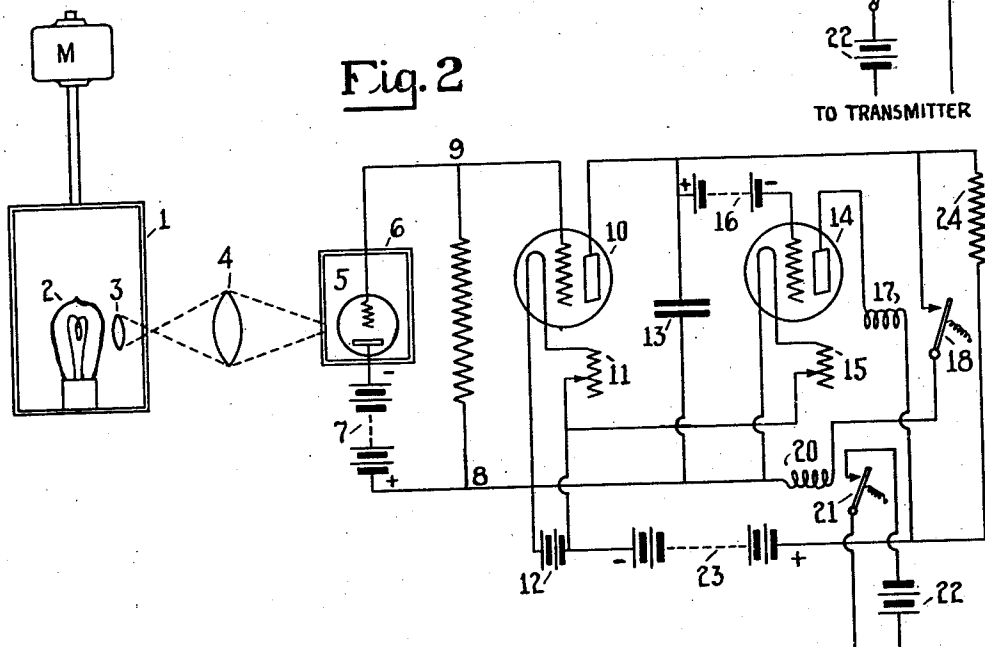
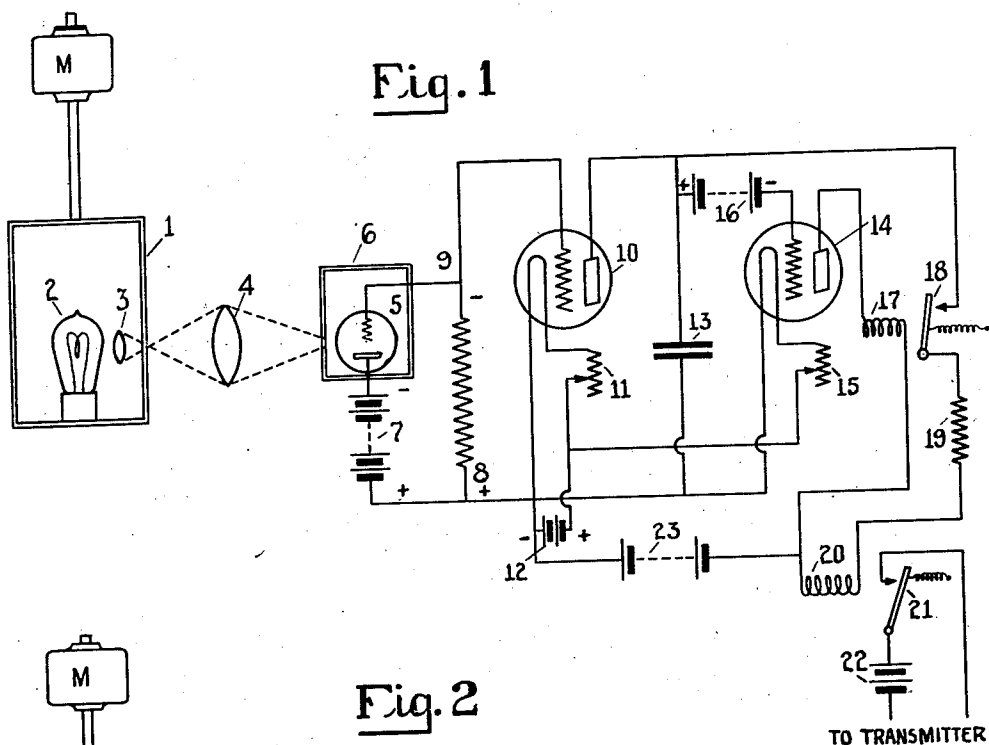
March 8, 1932.

R. H. RANGER

1,848,839

METHOD AND MEANS FOR REPRODUCING AND TRANSMITTING PICTURES

Original Filed Feb. 26, 1924 2 Sheets-Sheet 1



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By his Attorney *Geo. J. Adams*

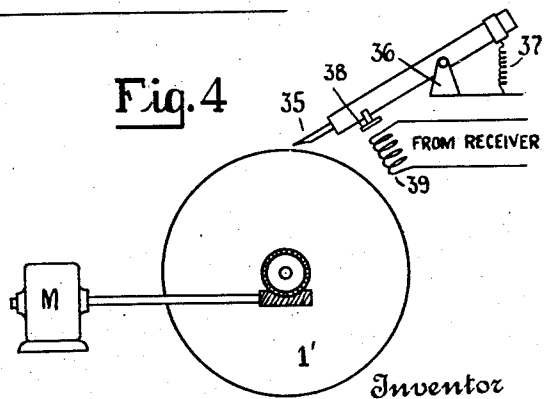
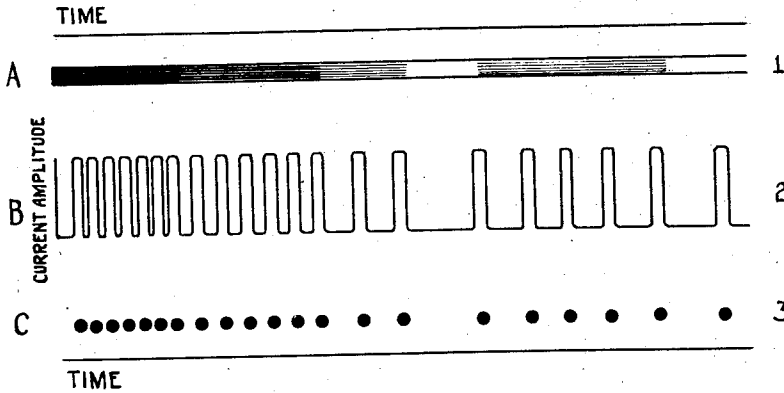
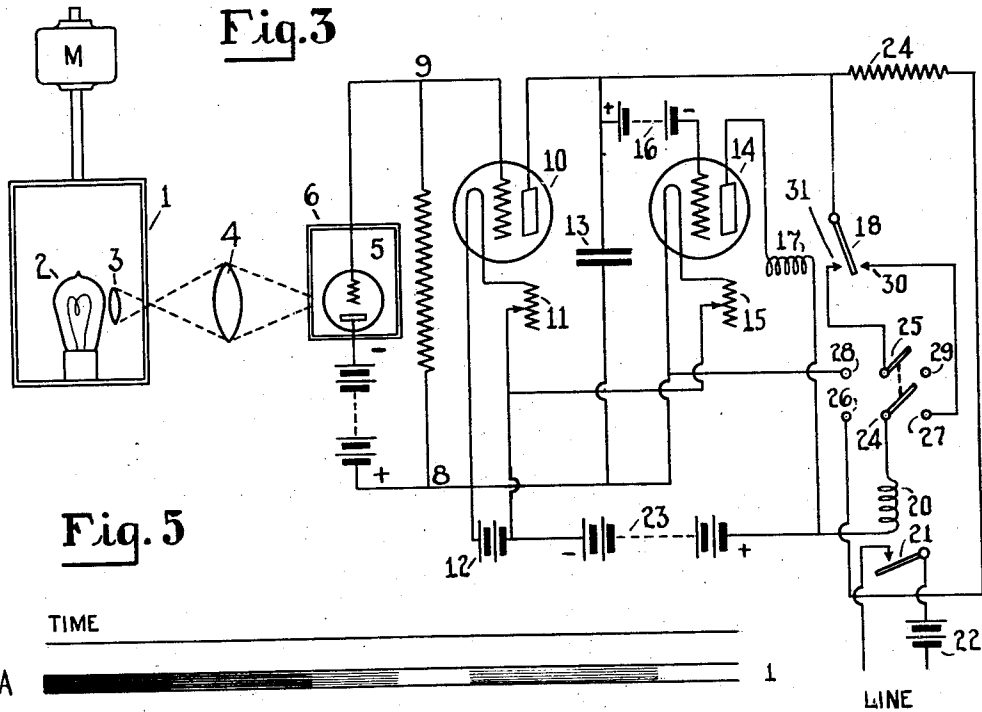
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METHOD AND MEANS FOR REPRODUCING AND TRANSMITTING PICTURES

Original Filed Feb. 26, 1924 2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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METHOD AND MEANS FOR REPRODUCING AND TRANSMITTING PICTURES

Application filed February 26, 1924, Serial No. 695,175. Renewed December 24, 1930.

This invention relates to a new and improved process of duplicating or reproducing pictures or the like and, although my invention may be used for the purpose of producing duplicates and reproductions of pictures or the like at the place where the originals are found, it is also particularly adapted to produce such duplicates at any distance from the place where said originals are found, utilizing for the purpose of control of the reproduction any existing telephone, telegraph or radio circuits.

My invention contemplates as a new article of manufacture a picture or pictorial representation in which the effects of various intensities of light are produced in a novel manner, and contemplates also a process by which such pictures may be produced. The pictures which I produce and the process by which I produce them render my invention particularly useful for transmitting pictures to a distant point by means of telephone, telegraph or radio circuits, particularly the latter.

While I have referred to the use of my invention for producing duplicates of pictures and the like, it should be understood that my invention is not limited thereto, but that I may produce duplicates of visual or graphic records of any sort, such for instance, as copies of motion picture films, manuscripts, letters or documents, finger prints and the like, and I therefore wish it understood that I have used the term "picture" throughout the specification and claims in the broad sense as defined above to include the various articles given by way of example and others, as will be understood by those skilled in the art.

It is an object of this invention to produce a picture or a visual record in which the effects of varying light intensity are produced in a novel manner.

It is another object of this invention to produce a practical and simple process for duplicating or reproducing pictures.

It is still another object of my invention to produce a process by which the reproduction of the picture may be made at any distance from the original.

It is still another object of my invention to produce a process for the reproduction of pictures which is particularly adapted for use in transmitting pictures to a distance by the use of telephone or telegraph lines or by the use of radio circuits.

Still other and ancillary objects of my invention will be apparent from the specification.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims; my invention itself, however, both as to its organization and method of operation will best be understood by reference to the following description taken in conjunction with the accompanying drawings, in which

Fig. 1 shows an arrangement of apparatus adapted to translate light intensity into electrical fluctuations of novel character.

Fig. 2 shows a modified form of apparatus adapted to translate light intensity into electrical fluctuations of novel character, but in the inverse sense from those produced by the apparatus of Fig. 1.

Fig. 3 shows an arrangement which is controllable at will to give either of the arrangements of Figs. 1 and 2.

Fig. 4 shows recording apparatus adapted to be operated by the apparatus shown in Figs. 1 to 3 inclusive.

Fig. 5 is a diagram showing the relation between light intensity falling upon the light sensitive cell, current in the transmission circuit controlled by relay 21 and the dots as produced by the recorder, and

Fig. 6 is a typical example of a picture produced by my process.

Broadly speaking, my invention contemplates translating the light intensities of the picture to be transmitted or reproduced progressively into a series of impulses of substantially uniform duration and intensity, but separated by variable spacing as shown more particularly by Fig. 5. In this figure, part A represents the intensity of light falling upon the photo cell, part B the current impulses produced by relay 21 and part C the recorded impulses. As will be seen, this figure shows how a positive may be produced

by the recorder from a positive at the transmitter, but as will be pointed out hereinafter, my invention is adapted equally well to produce a negative from a positive or vice versa.

While my invention is adapted for reproduction of pictures at a distance utilizing telephone and telegraph circuits, it is primarily and particularly adapted for transmission of pictures by radio, and especially useful in connection with the present high power stations since the entire transmitting and receiving apparatus may be utilized without change, as the picture to be transmitted is sent out in the form of a series of impulses of uniform intensity and duration. This permits the utilization of the full power of the transmitting apparatus on each impulse whereby delicate tonal variations in the picture may be transmitted at the full power of the station, thus minimizing the effect of static and other interference on the reception of the picture. Moreover, as the impulses are all of very short time duration, the power consumption at the transmitter will be a minimum.

In general, it may be stated that the underlying principles of my invention consist in utilizing a beam of light, the intensity of which is controlled by the picture to be reproduced, and which may be easily obtained by projecting light upon or through the picture to be reproduced, to control the resistance of a light sensitive element of a type well known in the art. The variations of resistance of the said element are then utilized to control the spacing between impulses or the like of an electrical current or wave in such a manner that the spacing period is an indication of the intensity of light of the picture.

My invention may take a number of forms. For instance, a direct current from a battery or other local source may be interrupted periodically say from 1 to 10 times per second whereby the spacing time between uniform impulses is varied in accordance with the light intensity of the picture to be transmitted or reproduced, or the magnitude of the current may be varied without total interruption, if desired. In a similar manner and particularly in using my invention to transmit pictures by radio, an alternating current of any desired frequency may be interrupted or varied, or again a high frequency oscillating current or so-called carrier current may be interrupted or varied in amplitude or may have superposed thereon currents of lower frequency, which superposed currents are interrupted as described. For instance, using a carrier current of 1,000 kilocycles, a frequency of 1,000 cycles may be superposed thereon in the form of dots, the number of such dots per second being a function of light intensity. The actual transmission may also occur on what have been des-

ignated as "spacing periods", the essential character of my invention being the translation of a picture into marking and spacing periods, one of which is constant and the other variable.

Referring specifically to Fig. 1, there is provided a transparent drum 1 arranged in a manner so that the picture to be reproduced may be supported thereon. A suitable source of light herein shown as a lamp 2 is arranged in a manner to supply light to said picture, which lamp in the present instance is shown as mounted within the drum 2, and a suitable lens 3 is provided for condensing the light upon a small section of the picture. Drum 1 is arranged for rotation and may be driven by any suitable means, such as a motor, diagrammatically shown and designated as M. A suitable cabinet 6 is provided having a small opening therein and having a light sensitive cell 5 of any suitable type well known in the art mounted within and adapted to have the light from source 2 fall thereupon.

The light from source 2 after passing through a section of the picture is again condensed by lens 4 and projected upon the light sensitive cell 5 within the cabinet 6. While I have indicated that the light 2 is arranged within the drum, it will be readily understood that this is by way of example only and that the light may be any suitable source and arranged in any desired manner, the only condition to be fulfilled being that light from a small section of the picture shall fall upon the light sensitive cell 5.

In reproducing the picture, it is, of course, necessary that light from all parts of the picture to be reproduced should fall upon the light sensitive cell and a convenient way of providing for this is to arrange drum 1 upon a support having suitable screw threads, whereby as the drum is rotated by motor M it is also caused to travel slowly in an axial direction. It will thus be seen that during rotation of the drum, light from each and every part of the picture will be progressively thrown upon the light sensitive cell 5.

Connected to one terminal of the cell 5, I provide a source of E. M. F. 7 having its negative terminal connected to one electrode of the cell, the other terminal of said source 7 being connected to point 8. The other terminal of cell 5 is connected to point 9 and between these points I connect a relatively high resistance. It will thus be seen that a uni-directional current will tend to flow from source 7 through points 8 and 9 and thence through cell 5 to the source, and that the value of this current will be the greater, the greater the intensity of light falling upon the cell. It is also evident that the potential drop between points 8 and 9 will thus be an indication of the light intensity of the particular section of the picture from which light is being projected upon the cell.

While my invention is not limited to the apparatus shown for utilizing such potential drop to create fluctuations, the spacing period of which is proportional to light intensity, a very satisfactory arrangement is that shown wherein a three-electrode thermionic relay 10 is connected in a manner to have its input electrodes subjected to the resistance drop produced across and between points 8 and 9. The cathode of tube 10 is connected to point 8 and the control electrode or grid to point 9. The cathode is energized to produce electron emission by a source of E. M. F. 12 and variable resistance 11 is provided for maintaining the cathode at the proper temperature to control the degree of electron emission. Connected in the anode-cathode circuit of said thermionic relay, I provide condenser 13 and I provide an additional thermionic relay 14 having its input circuit connected across condenser 13 as shown. A battery 16, known in the art as a "C" or "bias" battery, is provided for maintaining the potential of the grid of tube 14 at the proper value and in the present instance I have found that satisfactory results are produced when battery 16 has a potential of the order of 60 volts. The cathode of relay 14 is energized by any suitable source such, for instance, as source 12, which also energizes cathode of relay 10 and an additional variable resistance 15 is provided for controlling electron emission in relay 14.

Connected in the output circuit of tube 14, I provide winding 17 of relay 18 and connected to the opposite terminal of the winding 17 I provide a suitable means for maintaining the plate of tube 14 positive such, for instance, as a source of E. M. F. 23, the potential of which may be of the order of 110 volts. The negative terminal of said source is connected to the common filament circuit of the relays 10 and 14 in a manner to complete the plate-filament circuits thereof. In the plate circuit of relay 10, I provide winding 20 of relay 21 and a resistance 19, the function of which will be explained later. Also, in series with winding 20 and resistance 19, I provide a relay 18 normally maintained in closed position by suitable means, such as a spring as shown, but adapted to be opened under the action of coil 17 under conditions to be explained. The fixed contact of relay 18 is connected to the anode of tube 10 in a manner to maintain a potential difference equal to the E. M. F. of source 23 between the anode and cathode of said tube when relay 18 is closed. Relay 21 controlled by soil 20 is provided for closing a circuit through local battery 22, and this may be utilized for controlling the reproducer directly or for controlling the telephone, telegraph, or radio circuit for the purpose of repeating the operation of relay 21 at any distance therefrom.

Assuming for the moment that relay 18 is

open and condenser 13 discharged, it will be seen that a negligible space current will be flowing in the tube 10 due to the fact that no plate voltage is applied to this tube. Likewise, a negligible space current will be flowing through relay 14 for the reason that, although plate voltage is applied to this tube, the negative bias imparted to the grid by battery 16 is such as to prevent the flow of space current in a well known manner.

Now assume that relay 18 is closed due to spring action. Immediately plate voltage is applied to relay 10 and condenser 13 begins to charge and under normal conditions will continue to be charged until its potential is equal to that of source 23. It is also to be noted that immediately upon the closure of relay 18 this charging current flowing through winding 20 causes relay 21 to close. However, as condenser 13 begins to charge, the potential of grid of tube 14 will become more positive with respect to the filament thereof, and depending upon the value of batteries 16 and source 23, at some point during the charge of condenser 13, grid of tube 14 will reach such a potential that sufficient space current begins to flow in tube 14 and through winding 17 to cause relay 18 to be opened, thus cutting the plate voltage off from tube 10 whereupon relay 21 is opened by its spring. Space current continues to flow in tube 10, being now, however, supplied by the charge remaining upon condenser 13 and as condenser 13 discharges through tube 10, the potential of grid of tube 14 becomes negative, whereupon the space current flowing in tube 14 is reduced, relay 18 is closed by its spring, and the cycle is repeated.

It may be pointed out that under normal conditions, relay 18 swings to closed position followed practically instantly by relay 21, condenser 13 is thereupon charged almost immediately and relay 17 is energized, as above described, causing armature 18 to open, which, by cutting off the direct supply of plate current to tube 10, also causes relay 21 to open again. The cycle of operations will be continued indefinitely, relay 21 closing for a very short interval of time and then opening again, and the time interval between opening of relay 21 and the subsequent closure being dependent, among other things, on the rate at which condenser 13 discharges, the value of grid bias battery 16, and the potential upon the grid of tube 10. In general, it may be said that the lower the E. M. F. of battery 16 is below that of source 23, the longer such time interval, and it may be noted that by choosing battery 16 of sufficiently low value, it is possible to prevent fluctuations of relay 21. Under such conditions, for dark spots on the picture, relay 21 will close and remain closed as long as the picture is dark. As the picture becomes light, relay 21 will open and remain open

until a dark spot is again reached. Such an adjustment is of value for producing copies of manuscripts, letters, etc. wherein only two values are desired. In this connection, it may be noted that by proper adjustment of bias battery 16 between the low potential giving only two values and the potential of local source 23, any range of contrasting light values may be obtained in the picture finally produced. However, for a definite value of condenser 13 and battery 16, the time interval between the opening of relay 21 and its subsequent closing is strictly dependent upon the intensity of light falling upon the photo sensitive cell 5, since it will be seen that the greater the light intensity the greater the negative charge upon the grid of tube 10, and, consequently, the slower condenser 13 will be discharged by the plate of tube 10.

It may be stated that if condenser 13 is allowed to charge very rapidly, the closure and subsequent opening of relay 21 is practically instantaneous and, therefore, I have provided resistance 19 in the charging circuit of this condenser which allows relay 18, and therefore relay 21, to be closed for a length of time sufficient to operate further relays if desired.

The local circuit controlled by relay 21 and energized by battery 22 may be used to control, modify, modulate or influence in any desired way a radio or telegraph transmitter in a manner to change the characteristics of the transmitted effects in accordance with the closures of relay 21, but it should be particularly noted that in the transmission of pictures by radio, it is of advantage to use a conventional system wherein the full power of the station is radiated during the time that relay 21 is closed and no power is radiated at other times. Such a result may be accomplished by a number of ways forming no part of my invention as will be evident to those skilled in the art. For the purpose of merely duplicating pictures without transmitting the same, relay 21 may be used to control a recorder of the type shown in Fig. 4 connected directly in circuit therewith.

Referring to Fig. 2, I have shown an alternative arrangement adapted to give variations in the opposite sense from the apparatus shown in Fig. 1. For instance, whereas the apparatus shown in Fig. 1 is adapted to decrease the spacing intervals for lower intensities of light, the arrangement shown in Fig. 2 is adapted to increase the same, for decreasing intensity of light. The construction of this arrangement is in general similar to the arrangement shown in Fig. 1, except that the source of supply 23, instead of being cut off from the plate of tube 10 and condenser 13 by the operation of relay 18, is connected permanently thereto through a high resistance 24. Relay 18 is then connected as shown in a manner to short circuit condenser 13 when

closed. The operation is substantially as follows:

Condenser 13 is charged by source 23 through resistance 24 while relay 18 is open, and source 23 also supplies plate current for tube 10. Resistance 24 is chosen of such high magnitude that the value of plate current flowing in tube 10 has considerable effect on the time taken to charge condenser 13. For instance, for a high intensity of light falling on a photo electric cell 5, the drop through resistance 8 and 9 will be relatively large and the space current in tube 10 will be small because of the negative bias on the grid. Under the circumstances, condenser 13 charges quickly. The potential of the grid of tube 14 is thereby quickly carried over into the range where tube 14 draws plate current. The flow of plate current in tube 14 energizes winding 17 and closes armature 18. The closure of armature 18 short circuits condenser 13 allowing it to discharge, and the surge of current due to the discharge of condenser 13 energizes winding 20 thereby closing relay 21. At the same time, the discharge of condenser 13 causes the grid of tube 14 to become negative with respect to the filament in a manner to cut off the flow of plate current in the tube, whereupon the operation is repeated.

It will be seen that the flow of plate current in tube 10 has a considerable effect on the spacing intervals of relay 21 for the reason that when the grid of tube 10 is negative and plate current is cut off, condenser 13 may charge rapidly. When, however, plate current is flowing in tube 10, which corresponds to a condition of relatively little light on photo cell 5, part of the current which would otherwise charge condenser 13, is diverted to supply the plate current for the tube, and therefore the rate of charge of condenser 13 is slower.

Referring to Fig. 3, I have shown an arrangement by which it is possible to obtain in effect either the circuit shown in Figs. 1 or 2, depending on the position of switch arms 24 and 25 which are operated together to cooperate with operating contacts 26, 27 and 28, and dummy contact 29. It will be seen that when the switch 24, 25 is thrown to the right, the circuit will be that of Fig. 1; whereas, when thrown to the left will be that of Fig. 2.

Reception and reproduction of the picture may be accomplished, for instance, by apparatus such as that shown in Fig. 4, wherein a drum 1' is provided driven by a motor M through any suitable arrangement, such as worm and gear. A suitable pen or stylus is mounted in a manner to be brought into and out of contact with the surface of the drum 1'. This may be accomplished in a number of ways, for instance, as in the arrangement shown wherein the pen 35 is piv-

oted at a point intermediate its ends and mounted upon a support 36. As shown, a spring 37 normally tends to hold the point of the said pen out of contact with the surface of drum 1'. An armature 38 is attached to the pen and coil 39 is provided for attracting the said armature in such a manner that upon the energization of coil 39, the pen or stylus is brought into contact with the surface of drum 1'.

It is obvious that the speed of drums 1 and 1' must be controlled in such a manner that the angular speed of each is equal and it is also apparent that the longitudinal travel of drum 1' with respect to pen 35 or vice versa will be controlled in accordance with the travel of drum 1 with respect to light sensitive cell 5. A practical arrangement for preventing distortion of the picture due to differences in the travel of the two drums is obtained when they are made the same diameter, driven at the same speed and caused to travel longitudinally at the same speed.

My invention is not concerned with methods for obtaining the exact synchronism in speed between the drums 1 and 1', as means are known in the art for obtaining such synchronism. For instance, two similar motors may be used and each regulated by an automatic speed regulator to run at constant speeds. It is then necessary that coil 39 be subject to impulses when relay 21 is closed and only at that time. This condition may be obtained by operating coil 39 from a radio receiver when the impulses are transmitted by radio or any other suitable receiving arrangement when they are transmitted in any other way, and obviously the impulses may be amplified to any extent desired to obtain satisfactory operation.

In operation a sheet of paper will be secured to drum 1' and the stylus or pen 35 kept supplied with ink, the motor started and adjusted to the speed desired. It will then be apparent that the incoming impulses will cause the pen to move against the drum making dots thereon, as shown in part C of Fig. 5. Upon the completion of the transmission of the picture, the picture will be found to be reproduced upon the paper of the drum and will be similar in appearance to a stippled etching, as shown more particularly by Fig. 6.

Obviously other methods of recording may be used. For instance, satisfactory results may be obtained by the use of a photographic recorder such as shown in U. S. Patent No. 1,787,851, granted on Jan. 6, 1931, upon an application filed jointly by E. F. W. Alexander and myself, for an invention relating to picture transmission by wire or radio.

While I have shown and described my invention with the particularity required to enable those skilled in the art to practice and obtain the benefits of the same, it will be evi-

dent that modifications and changes may be made without departing from the spirit and scope of my invention.

Having described my invention, what I claim is:

1. The method of reproducing pictures and the like which comprises the step of progressively projecting light from different sections of the picture to be reproduced upon a light sensitive cell at a uniform rate and utilizing the current changes thereby produced in said light sensitive cell to thereby continuously vary the number of modifications of uniform duration and amplitude energy impulses per unit of time of an electric current.

2. A method of reproducing pictures and the like which comprises the step of progressively projecting light from different sections of the picture to be reproduced at a uniform rate of speed upon a light sensitive element and utilizing the changes in said light sensitive element thereby produced to produce intermittent changes each of equal duration and amplitude in an electric current in a manner to cause the number of said changes per unit of time to continuously vary according to intensity of light falling upon said element.

3. A method of reproducing pictures and the like which comprises progressively controlling the value of a resistance according to intensity of light in different sections of the picture to be reproduced, and utilizing the changes of resistance so produced to produce continuous changes of uniform duration and amplitude in an electric current in such a manner that the number of such changes per unit of time is controlled according to intensity of light in a small section of a picture to be reproduced.

4. A method of transmitting pictures and the like which comprises producing from the desired picture and transmitting a series of electrical impulses each of equal duration, and uniformly varying the number of said impulses per unit of time according to the intensity of light in a differential section of said picture.

5. A method of reproducing pictures and the like which comprises progressively and uniformly translating light intensities of different sections of the picture into a plurality of marking and spacing periods, all of one class of periods being of substantially uniform duration and the periods of the other class continuously varying in duration.

6. A method of reproducing pictures and the like which comprises progressively and continuously translating light intensities of different sections of the picture into a plurality of electrical marking impulses, said marking impulses being substantially uniform in duration, and the spacing periods separating said impulses varying in duration.

7. A method of reproducing pictures and the like which comprises progressively trans-

lating light intensities of different sections of said picture into a plurality of electrical marking impulses, said marking impulses being of substantially uniform intensity and duration, and the spacing periods separating said impulses continuously varying in duration in proportion to the light intensity of said picture.

8. A method of transmitting pictures and the like which comprises translating light intensities of progressive different sections of area of the picture into marking impulses of substantially uniform duration, and separated by spacing periods of continuously varying duration and transmitting said impulses.

9. A method of transmitting pictures and the like which comprises translating light intensities of progressive different sections of area of the picture into marking impulses of substantially uniform intensity and duration, and separated by spacing periods of continuously varying duration and transmitting such impulses.

10. A method of reproducing pictures and the like which comprises progressively projecting upon a light sensitive cell light from different sections of the picture and utilizing the variations in said cell thereby produced to control an electric current in a manner to produce marking impulses of substantially uniform duration, separated by spacing periods of continuously varying duration.

11. A method of reproducing pictures and the like which comprises progressively projecting upon a light sensitive cell light from different sections of the picture and utilizing the variations in said cell thereby produced to control an electric current in a manner to produce marking impulses of substantially uniform intensity and duration, separated by spacing periods of continuously varying duration.

12. A method of transmitting pictures and the like which comprises progressively projecting upon a light sensitive cell light from different sections of the picture and utilizing the variations thereby produced to control an electric current in a manner to produce marking impulses of substantially uniform duration, continuously varying the period of said marking impulses in accordance with the light and shade of said picture, and controlling a transmitter in accordance with such impulses.

13. A method of transmitting pictures and the like which comprises progressively projecting upon a light sensitive cell light from different sections of the picture and utilizing the variations thereby produced to control an electric current in a manner to produce marking impulses of substantially uniform intensity and duration and separated by spacing periods of continuously varying duration, and controlling a transmitter in accordance with such impulses.

14. The method of reproducing pictures and the like which comprises translating light intensities of successive portions of the picture to be reproduced into pulsating electric currents of equal duration, the number of such pulsations per unit of time being continuously variable and being controlled according to light intensities of successive portions of the picture to be reproduced, and suitably recording such pulsations.

15. A method of transmitting pictures and the like which consists in transmitting a series of marking impulses of substantially uniform intensity and duration, separated by spacing periods of continuously varying duration and suitably recording said impulses.

16. A method of transmitting pictures and the like which consists in transmitting a series of equal energy radiating impulses, separated by spacing periods of continuously varying duration and suitably recording the same.

17. A method of transmitting pictures and the like which comprises progressively translating light intensities of successive sections of the picture into electric impulses of uniform duration, continuously varying the spacing of said impulses in accordance with the light and shade of said picture, transmitting said impulses, and suitably recording the same.

18. A method of transmitting pictures and the like which comprises progressively translating light intensities of successive sections of the picture into electric impulses of uniform duration, continuously varying the spacing of said impulses in accordance with the light and shade of said picture, controlling a transmitter in accordance with such impulses, and suitably recording the impulses received.

19. A method of transmitting pictures and the like which comprises progressively translating light intensities of successive sections of the picture into electrical impulses of uniform duration and intensity, continuously varying the spacing of said impulses in accordance with the light and shade of said picture, transmitting such impulses, and suitably recording the same.

20. A method of transmitting pictures and the like which comprises progressively translating light intensities of successive sections of the picture into electrical impulses of uniform duration and intensity, continuously varying the spacing of said impulses in accordance with the light and shade of said picture, controlling a transmitter in accordance with such impulses, and suitably recording the impulses received.

21. In apparatus for reproducing pictures and the like, a light sensitive element, means for projecting upon said element light from progressive different sections of the picture

to be reproduced, a relay and means interposed between said relay and said light sensitive element for causing response of said relay for uniform periods of time, separated by varying periods of time.

22. In apparatus for reproducing pictures and the like, a light sensitive element, means for projecting upon said element light from progressive different sections of the picture to be reproduced, a relay and means for controlling said relay, said means being controlled by said light sensitive cell in a manner to continuously vary the period between termination of response and beginning of the subsequent response of said relay.

23. In apparatus for reproducing pictures and the like, means for storing a predetermined quantity of electricity, a variable resistance light-controlled path for permitting discharge of electricity stored in said storing means, and means operated in response to predetermined decrease of potential across said storing means to recharge the same.

24. In apparatus for reproducing pictures and the like, means for storing a predetermined quantity of electricity, a variable resistance light-controlled path for permitting discharge of electricity stored in said storing means, means operated in response to predetermined decrease of potential across said storing means to recharge the same and a relay controlled by flow of charging current.

25. In apparatus for reproducing pictures and the like, means for storing a predetermined quantity of electricity, a variable resistance light-controlled path comprising a thermionic element for permitting discharge of electricity stored in said storing means, and means operated in response to predetermined decrease of potential across said storing means to recharge the same.

26. In apparatus for reproducing pictures and the like, means for storing a predetermined quantity of electricity, a variable resistance light-controlled path for permitting discharge of electricity stored in said storing means, means for supplying current at a predetermined rate to said storing means, and means operated in response to predetermined maximum potential across said storing means for discharging the same.

27. In apparatus for reproducing pictures and the like, means for storing a predetermined quantity of electricity, a variable resistance light-controlled path for permitting discharge of electricity stored in said storing means, means for supplying current at a predetermined rate to said storing means, and means operated in response to predetermined maximum potential across said storing means for discharging the same and a relay controlled by flow of discharge current.

28. In apparatus for reproducing pictures and the like, means for storing a predetermined quantity of electricity, a variable resistance

light-controlled path comprising a thermionic element for permitting discharge of electricity stored in said storing means, means for supplying current at a predetermined rate to said storing means, and means operated in response to predetermined maximum potential across said storing means for discharging the same.

29. An apparatus for transmitting pictures and the like comprising, means for successively translating light intensities of successive portions of a picture into electric impulses of uniform duration, means for continuously varying the time interval between said impulses in accordance with the light and shade of the picture, means for transmitting said impulses, and means for recording the same.

30. An apparatus for transmitting pictures and the like comprising, means for successively translating light intensities of successive portions of a picture into electric impulses of uniform duration and intensity, means for continuously varying the time interval between said impulses in accordance with the light and shade of the picture, means for transmitting said impulses and means for recording the same.

31. An apparatus for transmitting pictures and the like comprising, means for transmitting a series of equal energy electric impulses, means for separating said impulses by spacing periods of continuously varying duration, said continuously varying spacing periods being controlled in accordance with the pigmentation of the transmitted picture and means for recording the same.

32. A method of transmitting pictures and the like which comprises transmitting a series of marking impulses of uniform intensity and duration, separating said marking impulses by spacing periods varied in duration in proportion to the intensities of light and shade in the picture to be transmitted, and recording the said spaced marking impulses.

33. An apparatus for transmitting pictures and the like comprising means for translating a picture surface into marking impulses of uniform intensity and duration, means for variably spacing said marking impulses by separations varied in proportion to the varying intensities of light and shade in the picture being transmitted, and means for suitably recording said variably spaced marking impulses.

34. An apparatus for transmitting pictures and the like comprising means for successively translating varying intensities of light and shade in the picture being transmitted into electrical impulses of uniform duration, means for continually varying the separation of said impulses in proportion to the intensities of light and shade in said picture being transmitted, and means for suit-

ably recording said transmitted impulses, whereby a picture is produced which substantially corresponds to the original transmitted picture.

5 35. In a picture transmitting system, means for producing from a picture a series of electrical impulses, of constant duration and amplitude, and means for varying the number of said impulses per unit period of
10 time in accordance with variations in the intensity of light and shadow on elemental areas of the picture record.

36. The method of producing signals corresponding to a picture record which comprises producing a plurality of signals each
15 of constant frequency and amplitude to represent shade areas of the picture subject, and varying the time period of separation between each of said series of signals to represent variations in the intensity of shadow
20 of the shade areas of the subject.

37. The method of transmitting intelligence corresponding to selected record subjects of which an image is to be reproduced
25 which comprises translating the record subject into a series of signal producing impulses of uniform intensity and duration, and variably spacing said signal producing impulses in proportion to the varying intensities of light and shadow on the record subject of which an image is to be reproduced.
30

38. The method of producing signals corresponding to a picture record which comprises producing a train of signals each of
25 constant frequency, amplitude and time duration to represent elemental shade areas of the picture subject, and separating each of the said signals by varying time to represent variations in the intensity of shadow
30 of the subject shade areas.

39. The method of transmitting intelligence corresponding to selected record subjects of which an image is to be reproduced which comprises translating the record subject
35 into a series of signal producing impulses of uniform intensity and duration, and producing a variable time spacing between each of said signal producing impulses, said time separation being varied in proportion to the varying intensities of light and shadow on successive elemental areas of the record subject of which an image is to be reproduced.

40. A system for transmitting signals corresponding to picture record subjects which comprises means for generating a carrier frequency, means for producing a series of impulse signals each of constant frequency, duration and amplitude for representing extreme tonal values of the record subject of which an image is to be reproduced, interrupting the series of impulse signals completely for time periods proportionate to the tonal density of the record subject, and keying
40 the carrier frequency on and off com-

pletely by the presence and absence of said record impulse signals.

41. A system for transmitting signals corresponding to picture record subjects which comprises means for generating a carrier frequency, means for producing a series of impulse signals each of constant duration and amplitude for representing extreme tonal values of the record subject of which an image is to be reproduced, interrupting the impulse signals completely at a rate proportionate to the tonal density of the record subject, and keying the carrier frequency on and off completely by said record impulse signals.
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42. In a receiving system for reproducing visible records of image subjects, the method which comprises receiving a series of image signals each of constant frequency and duration and each being separated by spacing periods varying in accordance with the variations in intensity of light and shadow on the subject of which an image is to be reproduced, and producing from the signals visible image representations each of equal intensity and duration and separated from each other by separations corresponding to the separations between each of the series of received signals.
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43. In a receiving system for reproducing visible records of image subjects, the method which comprises receiving a series of image signals each of constant duration and each separated from the other by spacing periods varying in time duration in accordance with the variations in intensity of light and shadow on successive elemental areas of the subject of which an image is to be reproduced, and producing from the signals visible image representations each of equal intensity and duration and separated from each other by separations corresponding to the separations between each of the series of received signals.
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44. In a system for receiving signals corresponding to picture records, means for receiving signals each of constant and equal duration and amplitude and separated from each other by a time separation proportionate to the variations in intensity of light and shadow on a record subject of which an image is to be reproduced, an image representing means actuated by said received signals for producing a series of visible indications each of like intensity and duration and separated from each other by a separation corresponding to the separation in the received signalling impulses so as to produce an image representation simulating in tonal values the image subject from which the received signals were produced.
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45. In a system for receiving signals corresponding to picture records, means for receiving a series of image signals each of constant and equal duration and amplitude and
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separated from each other by a time separation proportionate to the variations in intensity of light and shadow on successive elemental areas of a record subject of which an image is to be reproduced, an image reproducing means actuated by said received signals for producing a series of visible indications each of like intensity and duration and separated from each other by a separation corresponding to the separation in the received signalling impulses so as to produce an image representation simulating in tonal values the image subject from which the received signals were produced.

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