

Sept. 18, 1934.

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1,973,726

FACSIMILE TRANSMISSION

Original Filed Feb. 7, 1929 2 Sheets-Sheet 1

Fig. 1

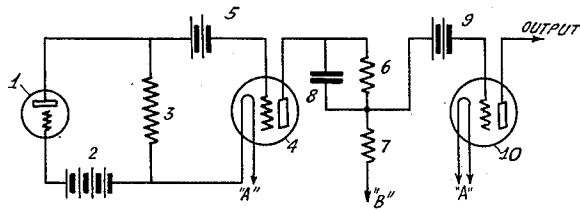


Fig. 2

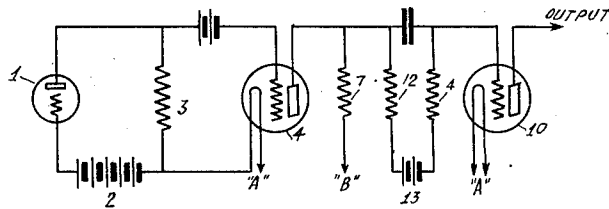


Fig. 3

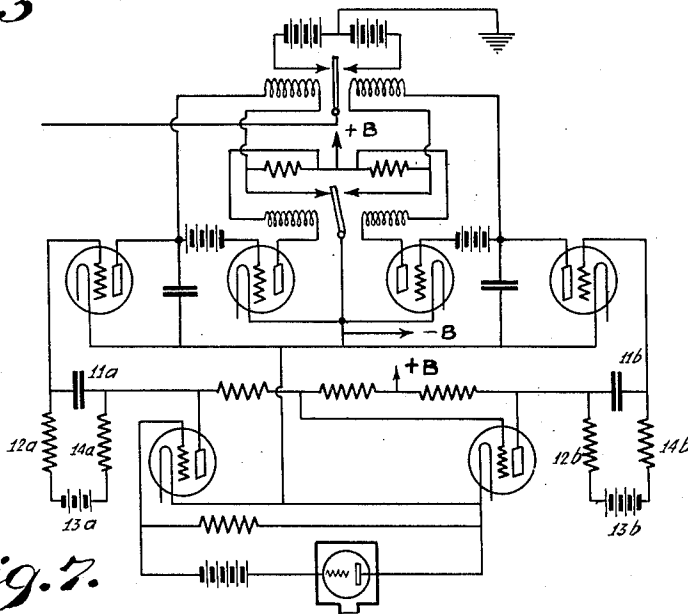
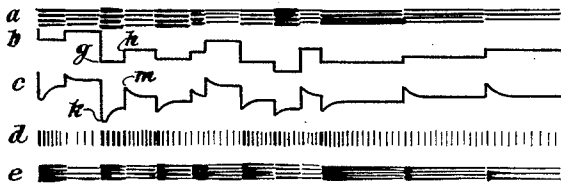


Fig. 7.



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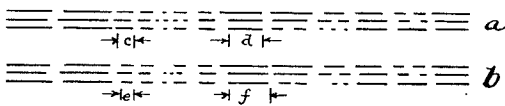
*Fig. 4*



*Fig. 5*



*Fig. 6*



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# UNITED STATES PATENT OFFICE

1,973,726

## FACSIMILE TRANSMISSION

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to Radio Corporation of America, a corpora-  
tion of Delaware

Application February 7, 1929, Serial No. 338,074  
Renewed September 12, 1931

13 Claims. (Cl. 41-17)

The present invention forms a divisional part of my copending application, Serial No. 101,612, filed April 13, 1926, and relates to picture transmission systems, and particularly to amplification systems for use in connection therewith.

An object of my invention is to provide an amplifier system in conjunction with a picture transmitting system adapted to cause the production of sharper detail in the picture as received over the signaling channel.

Another object of my invention is to provide an amplifier system in cooperation with a photoelectric cell and an illumination effect integrating system, whereby the effect of the integrating system is modified in response to sudden changes in illumination of the photo cell.

Another object of my invention is to provide an amplifier means adapted to produce a different amount of amplification of rapid electrical changes than it produces with slow electrical changes.

In the development of my photo modulator systems, disclosed in my applications, Serial Nos. 695,175, filed Feb. 26, 1924 and 726,235, filed July 16, 1924, I have produced systems for analyzing the lights and shades of a picture into integrated current pulses which occur at a frequency and extend for a duration which are determined by the unit light intensity of the picture.

The system as disclosed in the above mentioned copending applications contains a photoelectric cell, amplifiers associated therewith and integrating, amplifying, and relaying means, combined with synchronized scanning means, and reproducing means.

It has been found in the operation of the system as disclosed in the above mentioned application, that the total light from the picture being transmitted is effectively and very accurately integrated, but that no sudden responses are obtainable from the system in response to sudden changes in the light intensity from the print as the scanning means pass over its surface. In consequence there occurs a certain amount of loss of sharpness of outline and of detail.

My invention provides means whereby a sudden change in light from the picture causes an immediate response, with much less integration than the amount which occurs in the production of a uniform tint. This immediate response causes the production of much sharper lines in the reproduced picture, and much better detail. My invention provides this feature by means of modifications in the amplifying system which cause it to produce a much greater amplification

of a rapid current change than is produced for a slow current change. By this means a sudden change in the light intensity from the print produces a very large output of amplified current, and therefore, causes actuation of the recording means almost independently of the integrating feature of the system. By this means much sharper outlines are obtained in the reproduced print, and therefore, much greater detail.

Other objects and structural details of my invention will be apparent from the following description when read in connection with the accompanying drawings, wherein:

Figure 1 shows a form of embodiment of my invention in combination with a photo cell;

Figure 2 shows a preferred form of embodiment;

Figure 3 shows my device incorporated in the picture transmission system of the previously mentioned applications;

Figure 4 shows a print produced by the apparatus of my invention showing the extent to which the effect can be carried;

Figure 5 is a specimen of a normal print as produced by my system;

Fig. 6 illustrates a series of consecutive lines of a picture built up in accordance with my invention wherein portion *a* illustrates three successive lines of a picture without overvaluation of the tone values, and portion *b* illustrates the same picture with overvaluation of the tone values; and

Fig. 7 illustrates the manner of producing the various markings, more particularly outlining the assumed shade of the picture strip by portion *a*; the ordinary photoelectric response by portion *b*; the accentuation and the time control amplifier response by portion *c*; the markings as made into picture dots and dashes by portion *d*; and the net effect of reception by portion *e*.

Referring to the figures a photoelectric cell 1 is provided, having a current supply source 2 and an output resistance 3. A vacuum tube amplifier 4 is provided and connected thereto through a "C" battery 5. Filament heating means (not shown) are provided. In the anode circuit of the triode amplifier 4 are connected two output resistances 6 and 7. The resistance 6 is shunted by a condenser 8 and the resistance 7 is connected to suitable anode current supply sources. The output from the vacuum tube amplifier 4 is taken from the resistance 7 and conveyed through a "C" battery 9 to an additional amplifier 10, the output from which in the anode circuit thereof may be utilized in any desired manner.

In the operation of this embodiment of my

invention the resistances 3 and 7 serve as the coupling resistances of the usual resistance coupled amplifiers and function in the usual way, causing the transfer of amplified currents corresponding to the currents flowing in the photoelectric cell 1. However, the full amplifying power of the triode 4 is not utilized under static conditions because of the fact that a portion of the voltage drop in its output circuit occurs in the resistance 6. If the light impinging upon the cell 1 is changing relatively slowly, a portion only of the changing potential drop in the output circuit of the triode 4 is utilized. If, however, the light upon the cell 1 changes suddenly a sudden change occurs in the current through the triode 4 and its connected circuits. The sudden change is transmitted as a pulse through the condenser 8 and in consequence resistance 6 is, in effect, bypassed, with the result that the full amplifier voltage drop occurs momentarily in the resistance 7, giving a much increased pulse of amplified current from the triode 10. This may be proportionately utilized. By this means rapidly changing currents are much more highly amplified than slowly changing currents.

Referring to Figure 2, showing a preferred embodiment of my invention, a photoelectric cell 1 is provided as before and connected to a battery 2 and output resistance 3. An amplifying triode 4 has its input circuit connected across resistance 3 and a similar triode amplifier 10 has its input circuit fed from the output energy of tube 4. These are, however, differently connected. An output resistance 7 is provided as before, and a bypass condenser 11 is connected between the anode circuit of the triode 4 and the grid circuit of the triode 10. Shunting the condenser 11, is provided, in series, a resistance 12, a "C" battery 13 and a second resistance 14.

In the operation of this embodiment of my invention a slow change in light upon the cell 1 produces a slow change in current in the amplifier 4 which change is conveyed slowly through the resistances 12 and 14 and the C battery 13 to the grid of the triode 10, a substantial loss in energy occurring therein. In consequence a relatively smaller output of energy from the triode 10 occurs. A sudden changing of light upon the cell 1, however, causes a sudden change in current in the triode 4, the effect of which is conveyed directly and without loss through the condenser 11 to the grid of the triode 10, and full amplification thereof is thus obtained.

Referring to Figure 3 the preferred form of my invention is shown as embodied in Figure 1 of the previously mentioned application Serial No. 726,235.

The complete operation of the system disclosed therein with the preferred form of my present invention embodied therewith, will be readily understood by an examination of that application and the following outline.

As disclosed in that application the changes in light upon the photo cell 1 of Figure 3 effect the amplifiers 6 and 7 shown therein. The slow current changes are supplied to the amplifying triodes 14 and 15 which in turn cause the charging of the condensers 16 and 17 at a proportionate rate and cause the appropriate throw of the relays 22 and 29 in the fashion there disclosed. The devices of my present invention as embodied in the condensers 11a and 11b and the resistances 12a, 14a, 12b and 14b.

The result of the operation of my present invention when embodied in light photo transmis-

sion system is shown in Figures 4 and 5. In these examples Figure 4 shows the extent to which the process can be carried in the production of heavy tone values outlining the major details. It may be made to produce an effect which is almost one of "hallation". It thus accentuates the major outlines predominantly.

When carried to a less extent it produces an effect shown in Figure 5 which is that of a very great increase in detail and much improved sharpness of outline of the details.

It is to be noted that Figures 4 and 5 have been reproduced in the drawings by photomechanical processes since it has been found impossible to produce pictures of this character by manual means.

By this means I am enabled to obtain prompt response of the relays 22 and 29 of my photo modulator system to sudden changes in light intensity on the photo cell 1 and integrated response to slow changes of light intensity.

By Fig. 6, I have shown by portion a of the diagram a series of marking dots and dashes to represent consecutive lines of markings wherein there has been no overvaluation or accentuation of the tone values. On this figure in particular, two successive dashes have been identified as to their length of marking by the designations "c" and "d", and it should be noted in this connection that the dash identified as to duration by the legend "c" is of shorter duration than the mark immediately to the left thereof, whereas the marking identified as "d" is of longer duration than the marking immediately to the left thereof. By portion b of Fig. 6, I have shown the same set of marking lines representing successive lines of a picture, although showing the corresponding light values of line a as overvalued, emphasized, or accentuated. By making specific reference to the marking identified as "c" and corresponding to the mark identified as "c" in portion a of the figure, it is noted that where a short mark follows a long mark, so as to represent a lighter value than the preceding mark by the method herein set forth for emphasizing or overvaluing the tone changes from point to point, the marking is of a shorter duration, so that the outline of the image is more particularly set forth. Similarly, by noting the mark identified by the legend "f", which corresponds to "d" of portion a of the figure, this mark, since it is of darker value than the mark immediately preceding it and to the left thereof, is of a longer duration, and this represents a darker tone value. By the markings of Fig. 6, no effort has been made to represent an actual picture but merely to show by way of example how several successive lines of the picture are to be produced.

Making further reference to Fig. 6, it should be noted in comparing portion b with portion a that there is a dot in the first line of portion a, and since there is an overvaluation of light changes in portion b of the figure, this marking is entirely missing on the first line of portion b, and, similarly, in the middle line of portion a of the figure, there are four dots, and since the first of these is overvalued on portion b of the figure, only three dots appear, and, similarly, the same situation holds true for the third line of the picture.

Now making further reference to Fig. 7, the tone values on the picture element strip have been diagrammatically represented by portion a of the figure, wherein the portion furthest to the left represents dark gray, the next segment white, 150

the next segment black, the following light gray, and then dark gray, etc. These different intensities of tone value on the picture element strip then produce responses from the photo cell 1 of any of the figures in the form of current outputs of a strength such as designated by way of example by the line *b*. With the arrangement as shown by Fig. 3 in particular, as adapted to a system of the general type shown and described in my copending application Serial No. 338,072, above referred to, the change in tone value as represented by the letter "g" on the line *b* is accentuated to a point designated as "k" on line *c*, and, similarly, the change in tone value represented by the point "h" on line *b* is accentuated as shown by "m" on line *c* in the time control amplifier response. These markings as made into picture dots and dashes have been represented as to their intensity by the line *b* of Fig. 7, and the net effect of reception is shown in line *e*, where the sudden changes produce accentuated dark marks or extremely light marks, corresponding to the schedule of assumed tone values shown by line *a*.

While I have shown but one embodiment of my invention in the foregoing drawings and descriptions, it is capable of various modifications therefrom without departing from the spirit thereof, and it is desired therefore that only such limitations shall be imposed thereon as are required by the prior art or indicated by the appended claims.

I claim as my invention:

1. A picture consisting of a background having disposed thereon a mass of markings of light value different from said background, said markings being varied in concentration to produce with said background an effect of different values of light intensity, and modified to emphasize the outline of an image.

2. A picture comprising a background of arbitrary light value having disposed thereon a field of markings arranged in substantially parallel lines, the spacing between lines being fixed, the spacing between markings of the same line being varied to produce effects of varying light value and the positioning of said markings being modified to outline sharply an image.

3. A picture comprising a background of arbitrary light value having disposed thereon a field of marks arranged in substantially parallel lines with the spacing between lines fixed, said marks being varied in concentration in a manner to clearly portray varying effects of light and shadow and the position of said marks being so adjusted and modified with abrupt changes in light intensities that outlines of an image are accentuated and sharply defined.

4. A picture consisting of a background having disposed thereon a mass of dots representing intensities of light and shadow lying on one side of an arbitrary light value and a series of dashes representing light intensities lying on the other side of said arbitrary light value and having the markings representing the changes in the intensities of light and shadow in each case overvalued and emphasized at the points of change so as to sharply outline the image.

5. A picture formed of a series of markings

automatically recorded on a surface in varying degrees of density to indicate varying degrees of light and shadow in which the markings are overvalued at all points of change in light intensity so as to emphasize said changes and sharply outline and accentuate the image.

6. A picture comprising a background having thereon a mass of light value representations different from that of the background, said light value representations being varied in concentration to produce with the said background an effect of different values of light intensity and said light values being modified at points of representations of outlines of an image so as to place emphasis upon the outline.

7. A picture comprising a background having thereon a mass of light value representations of intensities different from that of the background and arranged in a series of substantially parallel lines of substantially fixed separation, said light value representations of each line being varied to produce the effects of varying intensities of light and shadow and the position of said light value representations being modified from the normal to accentuate the outline of an image.

8. A picture formed of a series of light value representations automatically recorded upon a surface in varying degrees of concentration to indicate varying degrees of light and shadow in which the light value representations are overvalued at all points of sudden change in light intensity so as to emphasize each sudden change and to outline sharply and accentuate the image outlines.

9. A picture comprising a series of light value representations which are over-valued at points of sudden change from black to white or vice versa so as to outline sharply a recorded image.

10. A picture record comprising a series of light value representations which are formed of dots and dashes so arranged as to accentuate and emphasize picture outlines.

11. A picture record having a background of arbitrary light value and a field of marks thereon arranged as dots and dashes in substantially parallel lines and modified along picture outlines to emphasize the outlines.

12. A picture record comprising a background and a plurality of dot and dash markings placed thereupon along a series of substantially parallel lines, said markings being so divided between dots and dashes that the dots in varying concentration represent picture portions of high light values and the dashes in varying concentration represent picture portions of low light values, and being further so arranged that for areas of changes between high and low light values an abrupt change between the character of the marking representations occurs.

13. A picture comprising a background having thereupon a series of light value representations in the form of dot and dash markings of varying degrees of concentration to indicate varying shade values and having the degree of concentration overvalued at points of sudden change from one to another shade value so as to increase the sharpness of the picture outline.

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