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2,372,344

SIGNAL TRANSMISSION SYSTEM

Filed Sept. 22, 1943

2 Sheets-Sheet 1

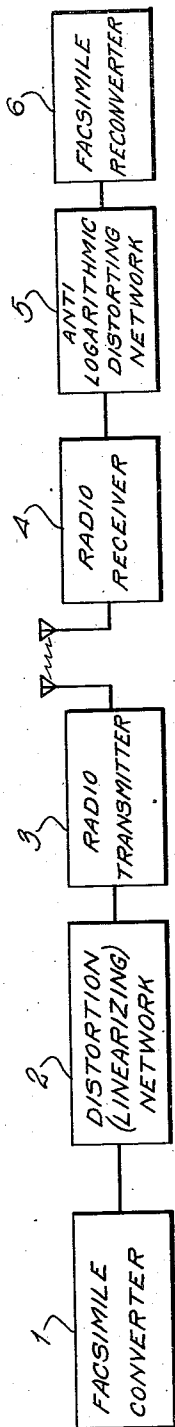
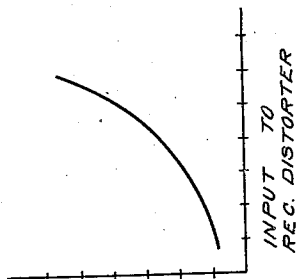
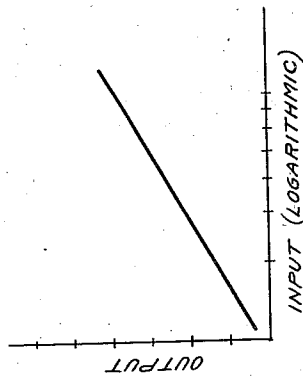
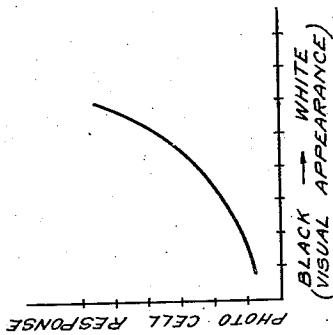


Fig. 1.



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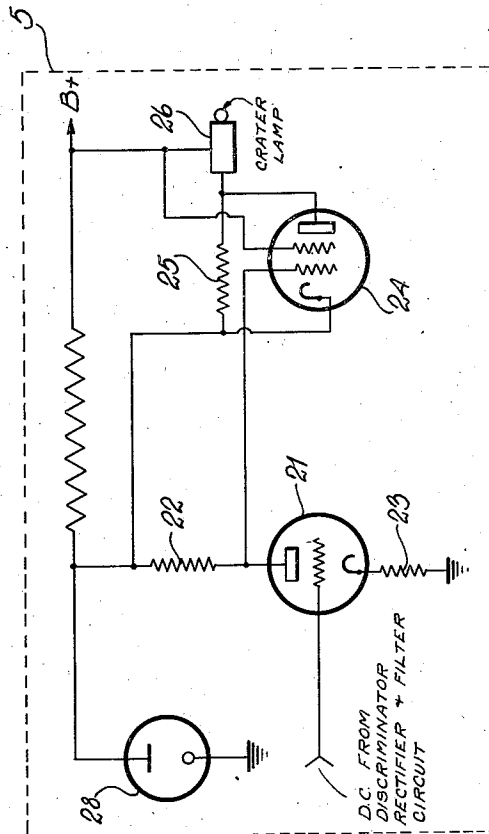
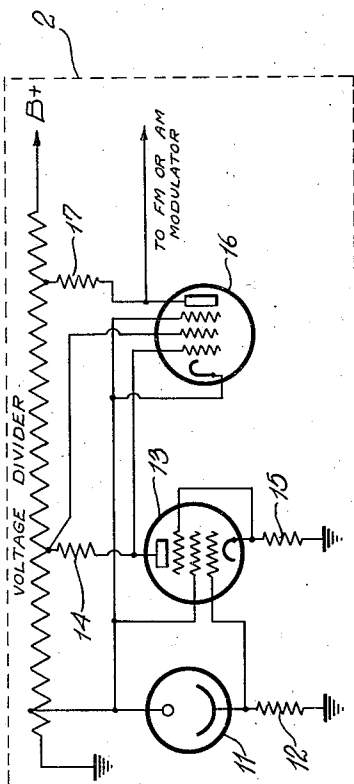
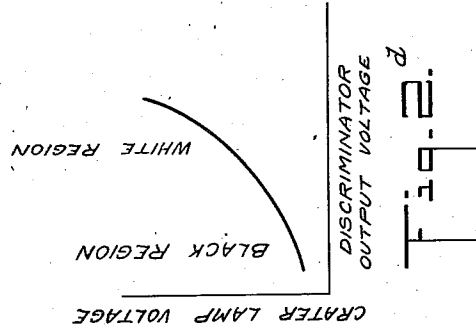
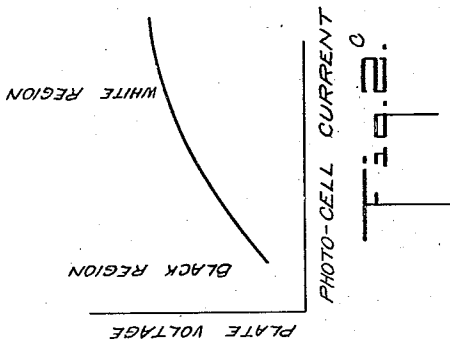
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SIGNAL TRANSMISSION SYSTEM

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2 Sheets-Sheet 2



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2,372,344

SIGNAL TRANSMISSION SYSTEM

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Application September 22, 1943, Serial No. 503,370

5 Claims. (Cl. 178—6)

This invention relates to facsimile transmission systems, and more especially to systems for transmission of facsimile or similar subject matter over radio channels or other channels subject to extraneous disturbances.

A principal object of the invention is to provide a method of signal transmission whereby the deleterious effects of static or other interjected noise, on the signal reproduction, are reduced to a minimum.

A feature of the invention relates to a method of electrically distorting the normal response of a facsimile converter so as to reduce the shade distortion in the reproduced subject matter, which shade distortion arises from interjected noise conditions such as static or the like.

Another feature relates to a distorting arrangement for converting the normal exponential response of a facsimile transmitting converter or similar exponential source of signal variation, into a linear response; and reconverting the linear variation at the receiver back to an exponential variation.

A further feature relates to the novel organization, arrangement and relative proportioning of parts which cooperate to produce an improved facsimile transmission system.

Other features and advantages not specifically enumerated will be apparent after a consideration of the following detailed descriptions and the appended claims.

While the invention will be described herein as embodied in a facsimile transmission system, it will be understood that the inventive concept is equally well applicable to other kinds of signal transmission where the response of the original signal generator at a transmitter follows a non-linear law. Accordingly in the drawings,

Fig. 1 is a schematic block diagram of a facsimile system embodying the inventive concept.

Fig. 1^a is a curve diagram showing the response curve of a facsimile converter at the transmitter.

Fig. 1^b is a curve diagram of the characteristics of the distorting amplifier or network at the transmitter.

Fig. 1^c is a curve diagram of the characteristics of the distorting network at the receiver for restoring the reproduced signal back to its original non-linear characteristic.

Fig. 2^a is a schematic of a typical distortion network at the transmitter.

Fig. 2^b is a schematic of a typical distortion network at the receiver.

In scanning an original subject-matter, if the absolute (i. e. independent of normal visual response) shade gradation is uniform or linear then the photoelectric response is likewise linear. Since however, the reproduction is to be a true visual reproduction of the original, what appears to the eye to be a visual uniformity or linearity

will be translated by the photoelectric cell into a logarithmic or exponential electric response.

It is well-known that in analyzing the shade variations along successive elemental strips of a facsimile subject-matter, there are many regions where, to the normal human vision, there is apparently a gradual and uniform change of shade density between white and black. This may be termed visual shade uniformity. It is also known that the photoelectric cell response in scanning such a visual uniform region, is not linear but is of a non-linear or exponential character. That is, for a visually uniform variation of shade density along a given elemental strip of the subject-matter, the electric response is exponential in character. This relation is illustrated graphically in Fig. 1^a where the abscissae represent variations of shade density from white to black; and the ordinates represent the electric response of the facsimile converter. Heretofore, it has been the standard practice to employ linear or distortionless amplifiers for amplifying the photoelectric signals from the facsimile converter. In fact the entire system both at the transmitter and at the receiver, has usually been designed with a linear transmission characteristic in mind.

I have found that in the transmission of telephotos via radio, the normal exponential relation between the original facsimile electric signal and the visually uniform shade densities gives rise to a number of disadvantages. One of them is that the interjection of extraneous noise such as static crashes, and the like, causes such noise to affect the facsimile reproduction of the darker shades to a disproportionately greater extent than the lighter shades. Consequently, noise crashes or similar disturbances are reproduced more noticeably in the darker regions of the reproduced picture than in the lighter regions thereof. In accordance with the present invention, these difficulties are overcome by distorting the original exponentially varying electric signal prior to transmission, into a linearly varying signal. For this purpose the original exponentially varying signal obtained from the scanning of a picture in the facsimile converter 1, is passed through a distortion amplifier or network 2 for converting the exponential response into a linear response. Thus as shown in Fig. 1^b, the exponential input represented by the logarithmically spaced abscissae, results in a linear output as represented by the equally spaced ordinates. This linear response is then used to control or modulate a radio transmitter 3 in any well-known manner. At the receiver 4 the radio signals, after suitable detection, reproduce the signals electrically with their linear characteristics. These linear signals are then passed through a redistorting amplifier or network 5 having an exponential relation between input and output as represented by Fig. 1^c.

This relation is therefore the counterpart of the original signal response illustrated by curve 1^a. This exponential response, after suitable amplification, in linear amplifiers of known construction, is applied to the facsimile reconverter 6 in the well-known manner. I have discovered that with this distorting method prior to transmission, the effects of noise crashes are much more even over the shade gamut of the reproduced picture. Inasmuch as the invention is concerned mainly with the method of distorting as described, only those parts of a facsimile system have been schematically illustrated as are necessary to understand the invention. It will be understood therefore that various changes and modifications can be made therein without departing from the spirit and scope of the invention. The invention is also applicable to any system of signal translation where an absolute uniform gradation of intensity of a signal source e. g., light intensity, sound intensity, etc., is not apparent to the human senses as a uniform excitation because of the logarithmic response of those senses, and wherein the signal translating device whether photoelectric cell or microphone etc., responds linearly to original absolute linear gradations of intensity.

Referring to Figs. 2^a and 2^b, there are shown in schematic form typical networks corresponding to 2 and 5 (Fig. 1). In Fig. 2^a, 11 is the photo cell scanning the subject matter, and 12 its associated resistor. The signal is fed to the control grid of tube 13, which is a high gain pentode. 14 is plate resistor of tube 13, and 15 is cathode bias resistor. The amplified signal on the plate of tube 13 is applied to the control grid of tube 16. Tube 16 in this case, is a remote cut-off pentode and the voltage developed across its plate resistor 17 is used to control the frequency modulator, which may be of the type disclosed in U. S. Patent No. 2,299,937. It will be noted that the cathode of tube 16 is returned to a point on the voltage divider so that the voltage drop across resistor 14 operates tube 16 in the proper region. When the photo cell is scanning black, the voltage on the plate of tube 13 is such as to cause tube 16 to operate in its high conducting region. Thus, the voltage on the plate of tube 16 is low. As the photo cell is then caused to scan through the grays to the white, the voltage on the grid of tube 13 increases, causing the voltage on its plate to drop, thereby in turn bringing the grid of tube 16 nearer cut-off. Because of the remote characteristic of tube 16, the approach to cut-off is not linear and by judicious choice of screen grid and plate voltages this characteristic can be made logarithmic as shown in Fig. 2^c. Therefore, the relation between photo cell current and tube 16, plate voltage is logarithmic.

In the receiving case in Fig. 2^b, the signal from the discriminator circuit is in the form of a D. C. potential which is proportional to the incoming frequency. This discriminator may be of the type disclosed in U. S. Patent No. 2,299,937. This signal is applied to the grid of tube 21, which is a triode acting as a D. C. amplifier. 22 is its plate resistor and 23 its cathode bias resistor. The signal from the plate of tube 21 is applied to the control grid of tube 24, which is a power pentode. The plate current of tube 24 is passed through crater lamp 26 for exposure of the negative. Resistor 25 presents holding current for

the crater lamp and determines the minimum value to which the crater lamp ever drops. When black is to be recorded tube 24 is operated at cut-off by proper adjustment of the voltage across resistor 22. Resistor 25 is adjusted so that the current through crater lamp 26 is correct for black. Then as the signal increases from black to the grays to white the control grid of tube 24 becomes less negative and tube 24 draws more and more plate current. This increase in plate current is not linear with respect to grid voltage and by proper choice of screen voltage and location on the characteristic curve, this relationship can be made logarithmic as shown in Fig. 2^d. Thus, the over-all characteristic of incoming frequency versus crater lamp current will be logarithmic and the distortion introduced in the transmitter will be corrected in the recorder. Preferably, the B- voltage is regulated by a suitable voltage regulator tube 28.

What is claimed is:

1. The method of reducing the shade distortion effects of extraneous disturbances in a facsimile transmission or the like, wherein the amplitude of the original signal response is non-linear, which comprises, distorting the amplitude of said response prior to transmission to render it linear, and redistorting the received signals to restore the original non-linear amplitude characteristic.

2. The method of telephoto transmission to reduce the effects of extraneous noise in the transmission channel which comprises, distorting the original exponential amplitude response of the transmitting facsimile converter to a substantially linear response, and at the receiver redistorting said linear response to restore the original exponential amplitude characteristic.

3. In a facsimile transmission system of the kind wherein the amplitude of the original signal response between shade gradations and electric signals is exponential, means to convert said exponential amplitude relation into a linear relation prior to transmission, a transmission channel subject to extraneous noise interjection, a receiver connected to said channel and having means to restore the received signals to their original exponential amplitude relation, and a facsimile reconverter to which said restored signals are applied.

4. In a system for transmitting facsimiles and the like, a facsimile converter, means to distort the amplitude output of said converter to one having a linear relation between uniform shade gradations and electric signals, means to transmit said signals over a radio channel or the like, means to receive and detect said signals, means to redistort said detected signals into signals having the original amplitude relation with respect to shade gradations, and a facsimile reconverter upon which said distorted signals are impressed.

5. A system according to claim 4 in which the first-mentioned distorting means includes a network whose electric signal input exponentially considered, results in a linear amplitude output; and the said redistorting means includes a network whose electric signal input, linearly considered, results in an exponential amplitude output.

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