

Aug. 2, 1960

J. D. ALLEN, JR

2,947,808

SIGNAL TRANSLATING APPARATUS

Filed June 21, 1955

2 Sheets-Sheet 1

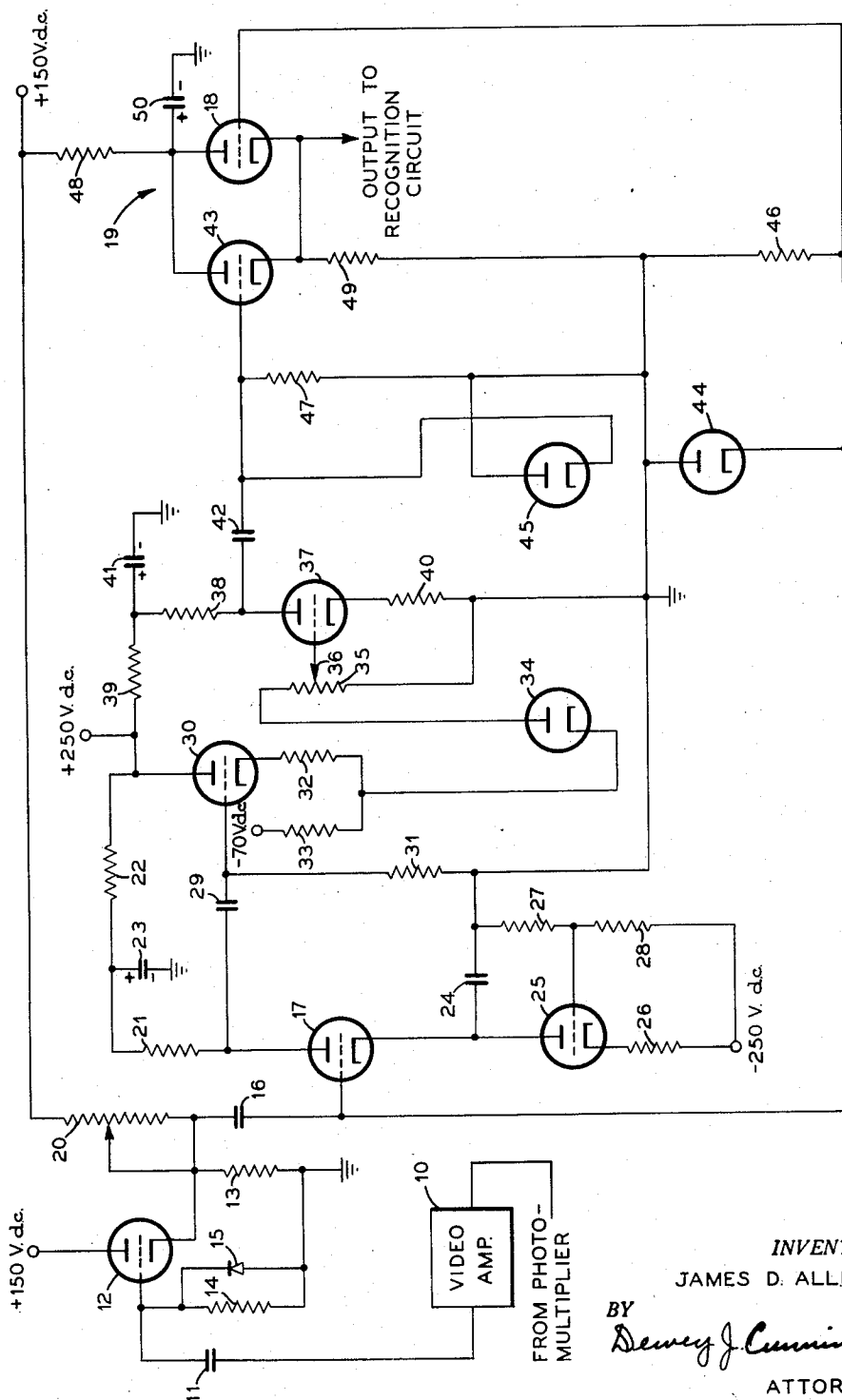


FIG. 1

INVENTOR.
JAMES D. ALLEN, JR.

BY
Dewey J. Cunningham
ATTORNEY

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2 Sheets-Sheet 2

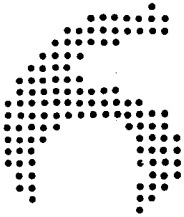


FIG. 7



FIG. 6



FIG. 8

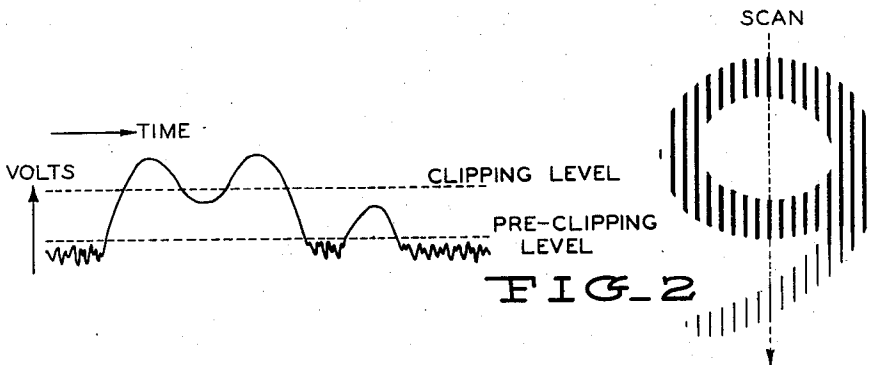


FIG. 2

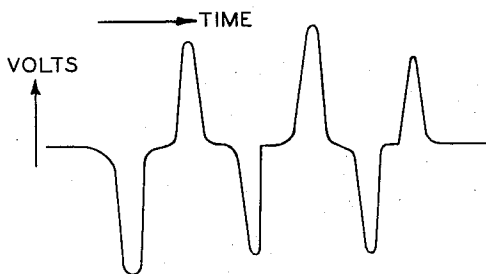


FIG. 3



FIG. 4

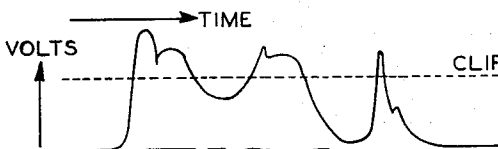


FIG. 5

INVENTOR.

JAMES D. ALLEN, JR.

BY

Dewey J. Cunningham

ATTORNEY

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2,947,808

SIGNAL TRANSLATING APPARATUS

James D. Allen, Jr., Endicott, N.Y., assignor to International Business Machines Corporation, New York, N.Y., a corporation of New York

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5 Claims. (Cl. 178-6.6)

The present invention relates to signal translating apparatus and particularly to a circuit for improving the signals received from a light sensitive device used in conjunction with apparatus for scanning graphic data.

An object of the invention is to provide an improved signal translating apparatus.

Another object of this invention is to furnish a circuit for improving the signals received from light sensitive devices.

Still another object of the present invention is to provide an improved circuit for increasing the data flow obtainable from apparatus which scans graphic data which may be degraded.

A further object of the invention is to provide a circuit which is adapted to receive video signals from a photomultiplier which is viewing the scanning of characters which may be degraded in certain aspects, said circuit providing reliable information relative to the degraded portions of said characters.

Other objects of the invention will be pointed out in the following description and claims and illustrated in the accompanying drawings, which disclose, by way of examples, the principle of the invention and the best mode, which has been contemplated, of applying that principle.

In the drawings:

Fig. 1 is a schematic diagram of the circuit forming the present invention;

Fig. 2 shows a character which is degraded or weak in certain aspects and the video signal obtained in a single scan through the character as indicated;

Fig. 3 shows the output waveform of the differentiating circuit for the video signal shown in Fig. 2;

Fig. 4 shows the derivative waveform supplied as one input to the mixer circuit for the video signal shown in Fig. 2;

Fig. 5 shows the output waveform from the mixer circuit for the video signal illustrated in Fig. 2;

Fig. 6 shows a typical degraded character having a weakened or light horizontal component;

Fig. 7 shows a dot pattern obtained by scanning the character shown in Fig. 6, clipping the signals to a predetermined level and periodically sampling the video signals; and

Fig. 8 shows a dot pattern similar to Fig. 7 but one which was produced by improving the video signals with the present invention.

The reading or sensing of graphic data, such as characters which are to be identified, is normally carried out by successively scanning the character so that successive portions thereof may be viewed by a light sensitive device such as a photomultiplier. One such scanning device may be found in application Serial No. 478,430 for Data Handling System, said application having been filed on

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December 29, 1954, by Mortimer D. Rogers. The photomultiplier supplies output signals which have an instantaneous amplitude which is a function of the amount of light viewed thereby at that instant. These signals are amplified and passed to a recognition circuit which is capable of interpreting the signals and providing an output signal indicative of the identity of the character scanned. In the present state of the art, reading apparatus of this type can perform reliably if the characters scanned are of good quality. That is, if the character has a very dark and full outline and is positioned on a white background, it is quite easy for the photomultiplier to supply suitable signals for the recognition circuit. In practice, however, these ideal conditions seldom exist.

Where characters are printed by means of a type bar striking a ribbon which is slightly spaced from a record medium, the quality of characters produced on the medium varies as a function of a number of factors. These factors include the quality of the paper and the ribbon, the degree of impact and the size of the character to be produced. Carbon copies of the record medium suffer even more, the quality of carbon paper used and the number of carbon copies produced being new factors to be considered. It is not unusual for significant portions of a character to be absent under normal visual conditions. However, it is desirable to recognize the character, if it is capable of identification by an average person, without requiring an extremely complex logical interpreting circuit in the recognition unit. In other words, it is possible to design recognition circuits for quality characters and even characters which are degraded slightly, but it would be indeed complex and uneconomical to design a recognition unit for any type of degraded character.

The present invention has been designed to obtain more information from the photomultiplier signals. This is accomplished by improving the amplitude of weak signals. Briefly, the present invention pre-clips the video signals to eliminate noise signals and spurious background signals. This means that before the video signals will be allowed to enter the signal improvement circuit, they must be above a predetermined amplitude. The video signal is then fed to a differentiating circuit which provides an output which is the inverted derivative of the input. The derivative output is rectified to eliminate the positive portions thereof, said rectified signals being then inverted and clamped to a reference potential. The video signal is also clamped to said reference potential and fed to a mixer circuit along with the said rectified derivative signal. The mixer circuit acts as a logical "or" circuit in that the output follows whichever of the inputs is highest in amplitude at any one time. The result is a mixed signal which has the derivative signal superimposed on the video signal. Since the derivative signal is comprised of relatively sharply peaked potentials, the mixed signal now is capable of having a portion thereof go above some predetermined clipping level which may be applied to the mixed signal. This affords an output signal for weak or degraded data which otherwise would not have been considered.

Referring now to Fig. 1 of the drawings, the output received from the photomultiplier is fed to a video amplifier 10. This amplifier is of conventional design and is arranged to have a suitable frequency response for the signals received. It will be understood that the signals may be fed through an automatic contrast control circuit before being fed to the present signal improvement circuit so that the amplitude of the video signals for portions of a character of given density will

be the same regardless of background. Such a contrast control circuit is illustrated in the application previously referred to. The output signals from the amplifier are coupled through a capacitor 11 to the control grid of a triode 12, the plate of said triode being connected to a positive D.C. potential, herein illustrated as +150 v. D.C. The cathode of triode 12 is connected through a resistor 13 to ground potential. The grid of triode 12 is connected to ground through a resistor 14. A diode 15 is arranged in parallel with resistor 14 and serves to clamp the video signal appearing on the grid to ground potential.

The output from triode 12 is taken from the cathode thereof and is fed through a capacitor 16 to the control grid of a triode 17 and to the control grid of a triode 18, the latter triode being one-half of the mixer circuit 19. This mixer circuit will be described in greater detail at a later point in the description.

Potentiometer 20 has one end connected to the cathode of triode 12 and the other end connected to a positive source of D.C. potential, herein illustrated as +150 v. D.C. It will be seen that potentiometer 20 and resistor 13 form a voltage divider between the said +150 v. D.C. source and ground potential. This arrangement allows a pre-clipping of the video signal. That is, triode 12 will not conduct until the input to the grid thereof rises above a predetermined level. This serves to eliminate noise and spurious background signals from the video signals which are to be subsequently improved.

The plate of triode 17 is connected through resistors 21 and 22 to a suitable source of positive D.C. potential, herein illustrated as +250 v. D.C., the mid-point of said resistors being connected to ground through a de-coupling capacitor 23. The cathode of triode 17 is connected to ground through a capacitor 24 and to the plate of a triode 25 which acts as a constant current device. The cathode of triode 25 is connected through a resistor 26 to a suitable negative D.C. potential, herein illustrated as -250 v. D.C. A substantially constant potential is maintained on the control grid of triode 25 by means of a voltage divider comprising resistors 27 and 28 which are connected between ground and -250 v. D.C., said control grid being connected to a point between the last-named resistors. The operation of the circuit including triodes 17 and 25 is such that the cathode of triode 17 will follow the input to the grid thereof in potential while the plate current through triode 17 follows the derivative of the grid potential, hence causing the plate of triode 17 to vary in potential as a function of the derivative of the grid potential. This action is afforded through the use of triode 25 as a constant current device. By way of explanation, it will be seen that triode 25 acts as a cathode follower, there being a constant voltage on the grid and cathode thereof. This holds the current through the triode substantially constant. With the plate of triode 25 connected to the cathode side of capacitor 24, the cathode of triode 17 can follow the negative excursions of the grid. Otherwise, capacitor 24 would stay charged when the grid of triode 17 goes in a negative direction.

The derivative signal appearing at the plate of triode 17 is coupled by means of a capacitor 29 to the control grid of triode 30, said grid being connected to ground through a suitable resistor 31. The plate of triode 30 is connected directly to said +250 v. D.C. source of potential and the cathode thereof is connected through resistors 32 and 33 to a suitable potential, herein illustrated as -70 v. D.C. The midpoint between the resistors 32 and 33 is connected to the cathode of a vacuum diode 34, the plate of said diode being connected through a resistance element 35 to ground. It will be seen that diode 34 is oriented such that only the negative portions of the differentiated signal will get through to the plate of the diode. A slider 36 is arranged on resistance element 35 such that a variable amount of the signal appear-

ing on the plate of diode 34 can be picked off. That is, the adjustment of this slider acts as a signal amplitude control. The potential on the slider 36 is connected to the control grid of a triode 37, the plate of said triode being connected through resistances 38 and 39 to said +250 v. D.C. source of potential and the cathode of said triode being connected through a resistor 40 to ground potential. The de-coupling capacitor 41 couples a point between resistors 38 and 39 to ground. Triode 37 serves to invert and amplify the signal received from slider 36, the output from the plate thereof being coupled through a capacitor 42 to the control grid of triode 43, the latter triode being the other half of mixer 19.

The video signal applied directly to the grid of triode 17, which was picked off and supplied to triode 18, as well as the differentiated signal supplied to the grid of triode 43, are clamped to ground potential by means of suitably oriented vacuum diodes 44 and 45, respectively. Appropriate D.C. return paths to ground for the control grids of triodes 18 and 43 are furnished by resistors 46 and 47, respectively. It will be noted that the plates and cathodes of triodes 18 and 43 are connected together, the plates being connected through resistor 48 to +150 v. D.C. and the cathodes being connected through resistor 49 to ground potential. The usual de-coupling capacitor 50 is inserted between said plate and ground potential.

The operation of the mixer circuit is such that the triode whose grid receives the higher potential has control. For example, if the grid of triode 43 begins increasing in potential beyond that on the grid of triode 18, the cathode of triode 43 rises to follow its grid, thus increasing the potential on the cathode of triode 18. This causes triode 18 to lose control. Therefore, the output potential from the cathodes follows the grid having the higher potential applied thereto.

The operation of the circuit will now be explained in conjunction with the waveforms shown in Figs. 2 through 5. Fig. 2 shows the numeral "9" with the lower or tail portion thereof weakened or degraded. It will be understood that a plurality of successive vertical scans would normally be made through the character. The waveform shown in Fig. 2 is only for one scan through the numeral as indicated. This signal appears at the grid of triode 12 in Fig. 1. It will be noted that the signal is referenced to ground potential due to the clamping action of diode 15. The output potential at the cathode of triode 12 follows the grid potential, except that the grid must rise above a predetermined level before the triode will conduct. This pre-clipping of the video signal is accomplished by connecting the cathode of triode 12 to the mid-point of a voltage divider formed by potentiometer 20 and resistor 13. This pre-clipping level is illustrated in the waveform shown in Fig. 2. The function of pre-clipping is to eliminate noise signals appearing near the ground level of the video signal. The setting of the pre-clipping level is made adjustable through potentiometer 20.

Because of the limited resolution of the scanning device, the dip in the signal between the first and second peaks, corresponding to the white area in the loop of the scanned "9," between the dark areas of the top and bottom of the loop, does not drop as far toward the pre-clipping level as the dip preceding the signal representing the weak tail of the "9."

As previously described, triode 17 has its cathode coupled to ground through capacitor 24. The arrangement is such that the cathode follows the grid potential but the potential at the plate is the inverted derivative signal shown in Fig. 3. So that the cathode can follow the negative excursions of the grid as well as the positive excursions, a triode 25 is connected to the cathode of triode 17 and serves as a constant current device. When the grid of triode 17 begins to go in a negative direction,

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triode 25 discharges capacitor 24 to allow the cathode to go in a negative direction.

Since the present invention has as its object the improvement of the video signals, it is desirable to add the derivative signal to the video signal which is obtained from the positive going video signals. To accomplish this, the derivative signal is fed through a triode 30, which is connected as a cathode follower, to a vacuum diode 34 which eliminates the positive portions of the inverted derivative signal. Triode 30 supplies a low source impedance for proper operation of said diode. The rectified derivative signal is now inverted by triode 37 and capacitively coupled to the mixer circuit 19, the waveform of this signal being shown in Fig. 4. Vacuum diode 45 serves to clamp the rectified derivative input to ground potential.

The video signal appearing at the grid of triode 17 is also clamped to ground potential by means of a vacuum diode 44 and supplied as the other input to mixer 19.

As previously described, the output potential from the mixer follows the higher one of the input potentials. The waveform shown in Fig. 5 illustrates the type of output signal produced.

Referring to Fig. 2, it will be seen that if a normal clipping level should be applied to the video signal, the signal obtained in scanning the tail of the numeral "9" would be lost. If the clipping level is lowered to pick up the weak signal, the dip in the video signal produced in going through the enclosed area of the numeral "9" is lost. That is, the clipped output signal would appear as though that portion of the character was solid. Therefore, with the clipping level shown, the video signal would be difficult to distinguish from that produced in scanning a "0," for example, unless the logic section of the recognition circuit was increased. However, with the inclusion of the derivative signal, that portion previously lost now shows up above the clipping level and provides usable information. While the numeral "9" has been illustrated, it will be obvious that the signals obtained in scanning other characters having degraded portions may likewise be improved. The present circuit is particularly helpful where the characters have degraded horizontal components. It should be pointed out that if only horizontal components of characters are to be dealt with, e.g., code marks, it is not necessary to rectify the derivative signals, since the presently eliminated portions of the derivative signals would serve to provide greater distinction to the lighter areas between said horizontal components.

By way of illustrating how the present invention improves the video signals, Fig. 6 shows an enlarged view of an actual numeral "6." Note that the lower horizontal component thereof is very faint. Fig. 7 shows a pattern of dots obtained by successively scanning the numeral shown in Fig. 6 with a plurality of vertical scans, the video signals obtained being clipped and sampled at the dot frequency. The sampling may be accomplished in a manner similar to that illustrated in the previously referenced application. That is, the clipped video signal is sampled periodically to determine the presence or absence of a video signal above the clipping level. Each dot indicates that the video signal was above the clipping level when it was scanning that point in the character. It will be seen that the lower horizontal component is missing completely.

Fig. 8 shows a dot pattern obtained in scanning the numeral "6," shown in Fig. 6, using the present invention to improve the video signals obtained. It is apparent that the lower horizontal component is now in the signals to be supplied to the recognition circuit.

From the above detailed description of the structure and operation of the present invention it will be seen that I have provided an improved signal translating apparatus. With this apparatus it is possible to materially increase

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the amount of reliable information obtained from graphic data scanning apparatus. Preliminary tests which have been conducted both with and without the present invention show that the present invention cuts down the erroneous identification of characters by at least a factor of six. It has also been found that the present invention affords pin-pointing of possible errors in characters so that the logic of the recognition can be improved in these areas to further reduce the error rate.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to a preferred embodiment, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art, without departing from the spirit of the invention. It is the intention, therefore, to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. Apparatus for improving the video signals obtained in scanning graphic data comprising a differentiating circuit arranged to receive said video signals for supplying derivative signals, means coupled to said differentiating circuit for eliminating predetermined portions of said derivative signals, and mixer means for receiving said video signals and the remaining derivative signals for supplying output signals which follow the instantaneously higher in amplitude of the signals fed to said mixer circuit.
2. An apparatus for improving video signals produced by scanning means which successively scans graphic characters, said signals varying in amplitude as said scanning means passes into said characters from the background upon which said characters are located, means for differentiating said video signals and producing derivative signals at times when said video signals are varying as a result of said scanning means passing from said background into a character, and a mixing circuit connected to receive said derivative signals and said video signals to produce output signals which follow the instantaneously higher input.
3. An apparatus for improving video signals produced by scanning means which successively scans graphic characters, said signals varying in amplitude as said scanning means passes into said characters from the background upon which said characters are located, means for differentiating said video signals and producing derivative signals at times when said video signals are varying as a result of said scanning means passing from said background into a character, means for controlling the amplitude ratio of said derivative signals to said video signals, and a mixing circuit connected to receive said derivative signals and said video signals to produce output signals which follow the instantaneously higher input.
4. In apparatus for improving video signals produced by scanning means which successively scans graphic characters, means for differentiating said video signals comprising an electron discharge device including an anode, a cathode and at least one control electrode, said cathode being coupled by means of a capacitor to a reference potential and said anode being connected through resistor means to a potential higher than said reference potential, the output potential from said anode being the inverted derivative of the video signals supplied to said control electrode, means for rectifying and inverting said derivative signals, and mixer means arranged to receive said rectified and inverted derivative signals and said video signals for producing output signals whose amplitude follows the instantaneously higher one of the inputs to said mixer circuit.
5. Apparatus for improving signals obtained in scanning data on a record medium comprising means for differentiating said signals to produce derivative signals,

a mixer circuit arranged to receive two input signals and to supply an output signal, means for clamping said derivative signals to a predetermined reference level and feeding them as one input to said mixer circuit, and means for clamping said video signals to a pre- 5 determined reference level and feeding them as the output to said mixer circuit, the output signals from said mixer circuit being such that the derivative signals are superimposed on said video signals.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,947,808

August 2, 1960

James D. Allen, Jr.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 14, for "therof" read -- thereof --; line 26, for "conduit" read -- conduct --; column 7, lines 6 and 7, for "output" read -- other input --.

Signed and sealed this 11th day of April 1961.

(SEAL)

Attest:

ERNEST W. SWIDER

Attesting Officer

ARTHUR W. CROCKER
Acting Commissioner of Patents