Dec. 29, 1936. R. E. MATHES 2,066,047

RECEIVING SYSTEM

Filed Aug. 6, 1932 4 Sheets-Sheet 1

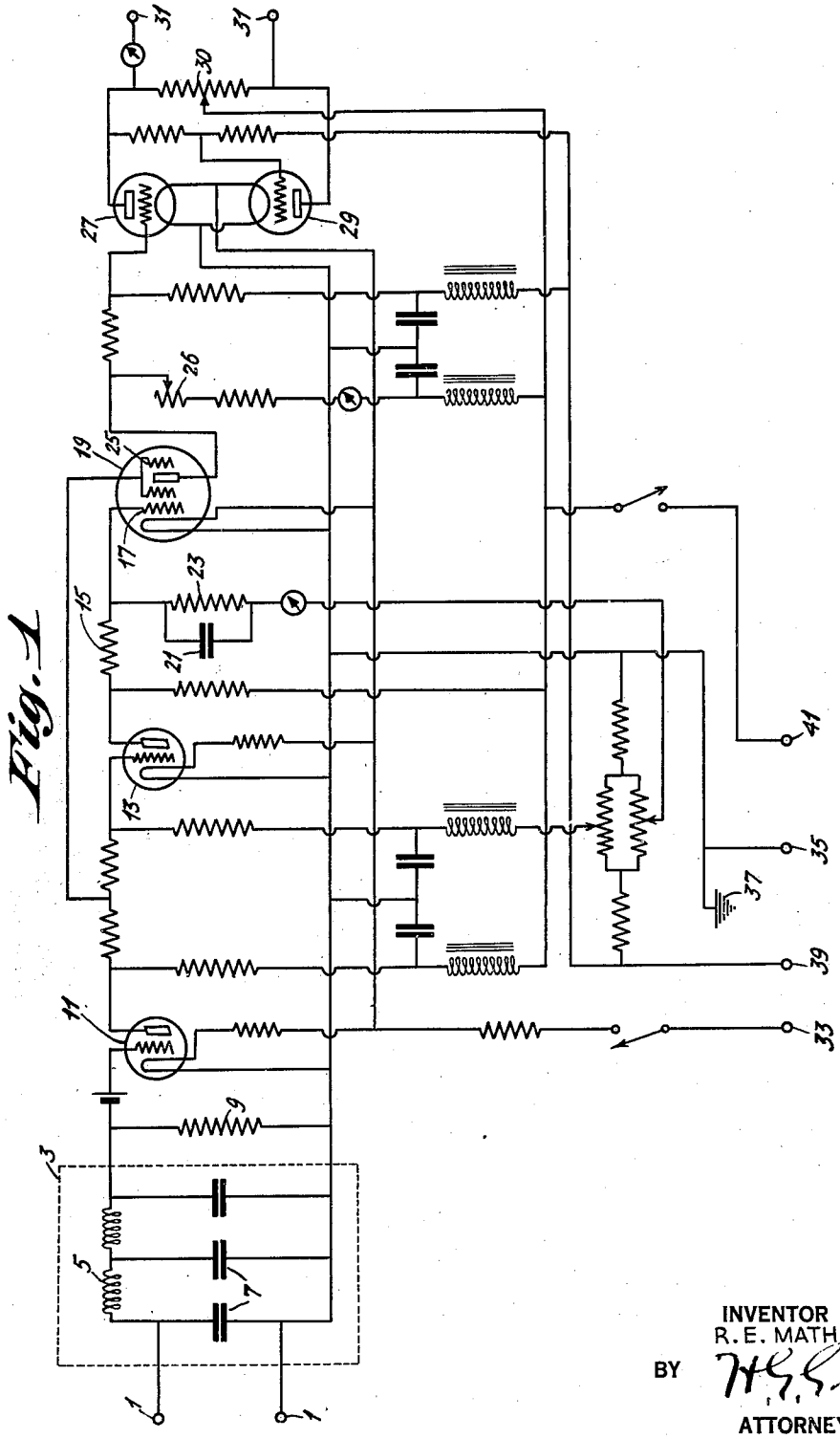


Fig. 1

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Fig. 2a

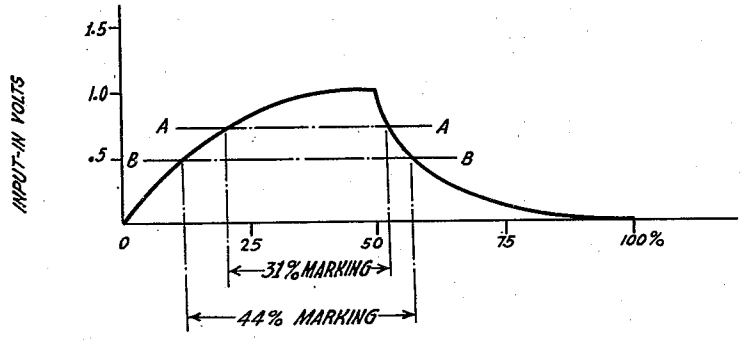
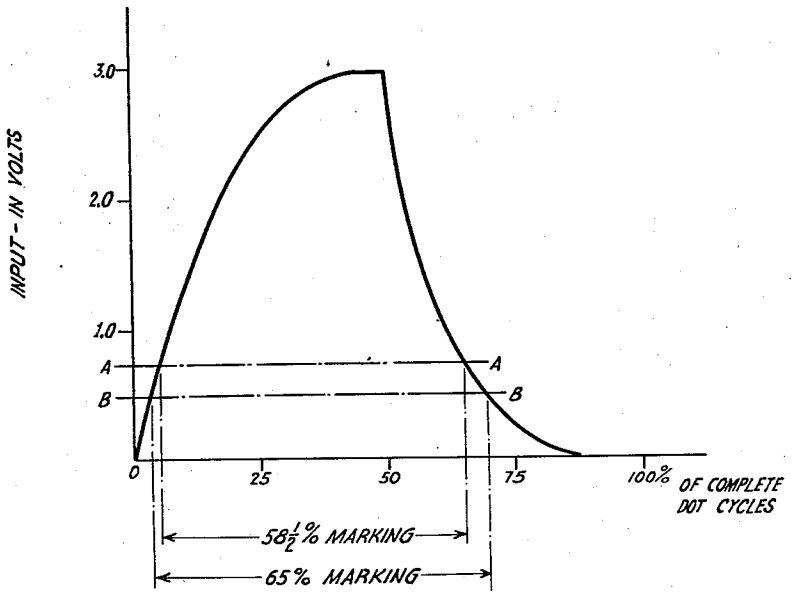


Fig. 2b



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Fig. 3a

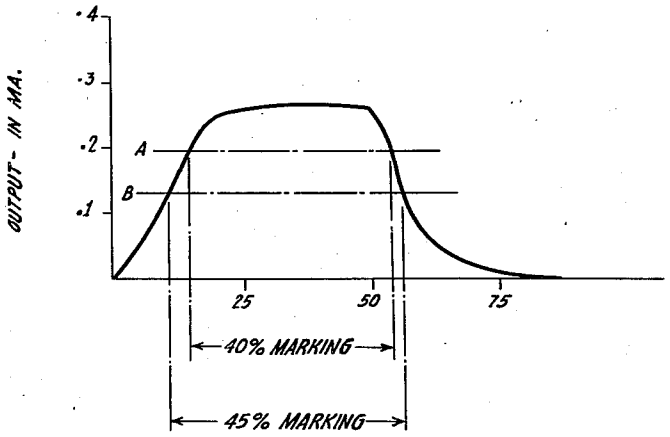
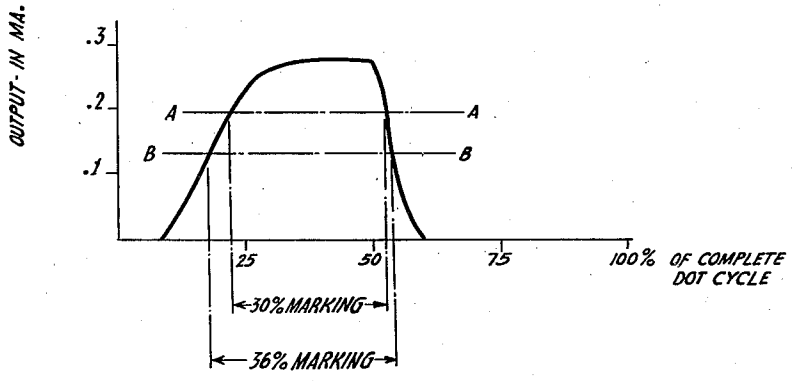


Fig. 3b



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RECEIVING SYSTEM

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Fig. 4a

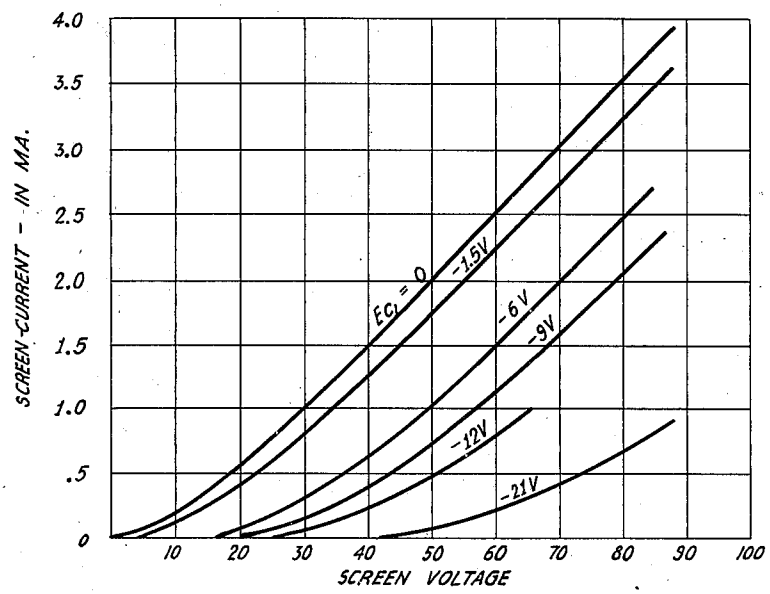
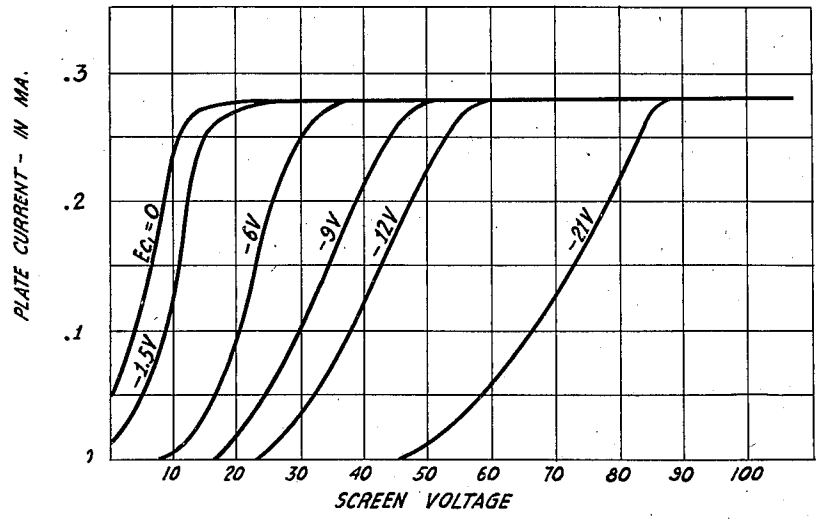


Fig. 4b



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Patented Dec. 29, 1936 2,066,047

UNITED STATES PATENT OFFICE

2,066,047

RECEIVING SYSTEM

Richard E. Mathes, Westfield, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application August 6, 1932, Serial No. 627,689

8 Claims. (Cl. 178—88)

The present invention relates to receiving systems for use in connection with radio or wire line transmission.

The invention is particularly applicable to systems for receiving telegraph signals or image signals for use in reproducing picture records.

According to the prior art so far as I am aware, the objection has frequently arisen in connection with reproducing transmitted telegraph signals formed as dots and dashes that in the space intervening between successive dots or dashes there was a so-called trailing of the signal which tended in reproducing the signals to fill the space between successive dots so that any two successive dots in a message, for example, might appear on the record tape as a dash due to the filling in of the spacing period, and thus the message was not readily discernible.

The same objections occur, of course, in connection with the reproduction of pictures by marking with a pen or recording on a light sensitive record by means of a glow tube, or the equivalent, actuated by the received signals, so that portions of the picture record which should be represented as light gray, for example, may assume a different effective intensity of representation and appear substantially black.

In the prior art with variable amplitude of signals when a limiting device is used to reduce the signals to a uniform amplitude value the input wave formation loses substantially its true formation due to the cut-off action of the limitor device. This does not, therefore, permit accurate recording and due to the cut-off action makes the length of the resultant marking dependent upon the initial slope of the input wave as controlling because the time between the start of each signal and the time the cut-off point is reached depends upon the rate at which the voltage builds up.

The present invention in its broadest aspects includes an arrangement whereby the amplitude of the received signals which may vary due to transmission conditions for radio work, or to varying line characteristics for line transmission work, may be limited to a predetermined amplitude value by a device which will herein be called a "bias limitor". This device has a function which is similar to the so-called automatic volume control systems used in the art at present in connection with broadcast receivers for radio work, so as to maintain substantially a constant level in the amplitude of the reproduced signal.

The device to be herein disclosed also incorporates as a part thereof a system by which the received signals are integrated so that it is possible to determine accurately the average amplitude of the received signals over a period which is long relative to an individual dot or dash but is short relative to the intensity changes usually experienced.

For fast and accurate operation of automatic printers for telegraph work or reproducing equipment for picture work, it is necessary that the proportion of marking to spacing current be maintained relatively constant in its effect upon the reproducing equipment, and it is for this reason that it is desirable to produce a system to limit the amplitude of the telegraph or picture signals to a predetermined value, while at the same time not affecting the ratio of the marking to spacing periods unduly.

Therefore, as a primary object of this invention I have sought to provide ways and means by which it is possible to reproduce more accurately transmitted code or marking signals.

As a further object of the invention I have sought to provide ways and means by which the effect of amplitude variations of controlling signals representing markings for telegraph work, or shade values for picture transmission and reception work, may be nullified.

As a further object of the invention I have sought to provide a system which will portray accurately the desired signal indications.

Still a further object of the invention is to provide a simplified arrangement for receiving code or other signals which will represent accurately the intended intelligence transmission and, at the same time, provide a system which is relatively simple in its construction and arrangement, as well as a system which can be constructed compactly, and which will utilize existing apparatus re-designed to produce the desired results.

Other and further objects and advantages of the invention will become apparent to those skilled in the art to which the invention relates by reading the following specification and claims in connection with the accompanying drawings, wherein:

Fig. 1 illustrates a preferred form of circuit arrangement serving to produce the desired results above enumerated;

Fig. 2*a* indicates an assumed form of input wave shape to the automatic bias limiter system of Fig. 1;

Fig. 2*b* illustrates the same general form of the input wave shown by Fig. 2*a* with the wave having

an amplitude substantially three times that of the wave of Fig. 2a;

Fig. 3a indicates the practical effect of the circuit shown by Fig. 1 to produce a marked decrease in the variation of spacing to marking indications with variations in the input voltage;

Fig. 3b is the same general wave shape as shown by Fig. 3a but applied to the input wave formation shown by Fig. 2b;

Fig. 4a indicates the curves for screen current plotted against screen voltage with the biasing limiter tube shown and described by Fig. 1; and,

Fig. 4b is a series of curves plotted to represent the plate current plotted against the screen voltage for the automatic bias limiting tube of Fig. 1.

To refer now specifically to the various figures of the drawings, reference may first be made to Figs. 2a and 2b where in Fig. 2a there is represented an input wave shape to energize the circuit including a bias limiter. The input wave is of such formation that the wave formation itself controls to a considerable extent and would, with apparatus normally used to reproduce the input signals, produce in the output circuit the effect of differing input wave shapes. By this figure, the line A—A represents one setting of a limiting device of the type known to the art as a "cutoff limiter" wherein the cut-off is such that it occurs at about 75% of the input voltage which results in approximately 31% marking period for each impulse, and line B—B represents the cut-off at approximately 50% of the input voltage, so that the marking impulses are of a duration approximately 44% of the actuating signal duration. The same general wave shape is illustrated by Fig. 2b except that the wave formation is of approximately three times the amplitude of the wave shown by Fig. 2a, so that the marking period with the bias limiter set at the level indicated as A—A is approximately 58½% of the complete dot cycle and with the bias limiter set to a value corresponding to the voltage indicated by the line B—B will be approximately 65% of the complete dot cycle.

From these figures, it is quite apparent that the plate current of the limiting tube will be for the cut-off points A—A or B—B along the line O—A—A—100 or O—B—B—100.

Any recording device which may be operated by the limiter would show a comparative portion of marking to spacing corresponding substantially to that shown by Figs. 2a and 2b, and in such a case the marking percentage variation, when using ink recorders, relay operated devices, automatic printers, or glow tubes, or similar apparatus, would have a serious effect upon the produced record. In cases where the recorder apparatus is used with the 31% marking period above shown, the dot duration period would be of insufficient duration to give a clearly readable record, whereas in the case of the 58% marking there would be a considerable tendency to close up the spaces between the dots and dashes, which would similarly minimize the readability of the signal or affect the observable shade intensity of the produced record. The effect on relays or printers would be of the same general character.

For these reasons, it is particularly desirable that for fast and accurate operation of automatic printers or facsimile reproducing equipment that the proportion of marking to spacing current be maintained relatively constant, and it is to overcome these difficulties that the arrangement shown by Fig. 1 has been developed.

To refer now particularly to the preferred circuit arrangement which is shown by Fig. 1, input voltages which are transmitted to the reproducing equipment from a receiver line or as a rectified radio signal may be impressed across the terminals 1—1, and after passing through a suitable filtering apparatus 3, which includes series inductance elements 5 and shunt capacities 7, may be impressed across a resistor element 9, or the equivalent, upon an amplifying tube 11. A part of the output from the amplifier 11 in the form of a pulsating direct current signal is then supplied to a second amplifying tube 13, which is herein termed an "integrating, reversing tube." After suitable amplification the signal is then impressed through a resistor 15 upon the control electrode 17 of the automatic bias limiter tube 19. Connected in parallel with the input circuit of the automatic bias limiter tube 19 is what I have termed an "integrating" circuit. This circuit includes parallelly connected capacity and resistance elements 21 and 23 respectively, which is for the purpose of integrating or smoothing out the variations caused by the keying as impressed by way of the input signals supplied to the terminals 1—1, so as to leave only the longer period variations which are caused by actual fluctuations in the mean amplitude of the input signals.

In opposite phase to the signals supplied through the integrating reversal tube 13 to the control grid 17 of the tube 19, the same signals appearing in the output circuit of the amplifying tube 11 are directed to the screen grid 25 of the tube 19, so that the voltages appearing upon the screen electrode 25 are 180 degrees out-of-phase with respect to the voltages appearing upon the control electrode 17 of this tube, which is due to the fact that the voltages on the control electrode 17 have been passed through the amplifier or integrating reversal tube 13, whereas the voltages upon the screen electrode have not been so amplified. According to this arrangement, therefore, it is seen that the integrating variations of the input voltage in proper phase are directed to the inner or control grid of the screen grid tube 19 so that this controlled grid acts merely as a secondary grid to provide an automatic bias for the remaining elements of the tube, and the screen grid, which is connected with the plate circuit of the first amplifying tube 11, controls the plate current flow from this automatic bias limiter tube as modified in accordance with the bias on the inner or control grid 17 which results from the action of the integrating circuit including the capacity and resistance elements 21 and 23.

Connected with the output of the tube 19 are a pair of push-pull connected amplifying tubes 27 and 29 respectively which serve merely as relay tubes used to amplify the output from the screen grid tube and to produce a push-pull action. The output from these push-pull connected tubes 27 and 29 appears across the output terminals 31.

Also connected with the output circuit of the push-pull amplifying tubes 27 and 29 is a potentiometer 30 which provides a manual control or adjustment by which the operator may adjust the output for different marking and spacing conditions so that in one case more power will be transferred to the load circuit than in another case. This will have the effect, when the circuit is used to operate a relay or other suitable electrical or mechanical device, of tending to offset the heaviness or lightness of the received signals which may have been produced by poor adjustment of the transmitting relay, by multi-

path radio signals, by distortion in landlines or other similar causes.

The filter system 3, which is in the nature of a low-pass filter, serves merely to smooth the action of the system and is not at all essential to the operation. As shown herein, all tubes are supplied with heating current from a common source connected at the terminals 33 and 35 and grounded at the point 37. Similarly, suitable biasing potentials for the grids may be supplied from a terminal 39 and plate voltages may be supplied from a terminal 41. In each case, appropriate bias resistors, not specifically identified by numerals, are arranged to control the screen and plate voltages in any desired manner.

The operation of the system it is believed will be quite apparent from the foregoing description, but for purpose of further explanation reference may be had to Figs. 4*a* and 4*b* of the drawings which illustrate the D. C. characteristics of the usual screen grid tubes when resistors are included in both the plate and screen grid leads. It is to be noted in connection with these figures that the screen voltage plate current characteristics have decreasing slopes with increasing negative bias on the control grid. It is seen, furthermore, that these characteristics reach a certain maximum value at which they flatten off completely. Thus, if a signal of any given wave shape is applied to the screen grid and the amplitude held below the limiting curvature, the plate current will approximate the same wave shape, providing the proper direct current voltage is supplied to the control grid. If the input amplitude is then increased considerably, the plate current output will remain substantially the same as before, provided the control grid direct current voltage is properly modified. If such modification of the control grid voltage can be accomplished simultaneously with variation of amplitude of the input wave shape, then the device, it will be seen, can function satisfactorily as a limiter which produces substantially constant output of the original wave shape regardless of the amplitude of the input voltage, as was described in connection with the description of the system shown by Fig. 1.

If now in the circuit shown by Fig. 1 the input amplitude increases beyond the limit provided for automatic adjustment of the control grid direct current bias, then, due to the saturation limiting indicated by the curves shown by Figs. 4*a* and 4*b*, the circuit of Fig. 1 will commence to act as a "saturation-limiter" and will cause the marking to spacing ratio to increase in a manner similar to the action of a cut-off limiter. This action, however, is superimposed upon the bias limiting action previously explained, with the net result of very greatly enlarging the range of input amplitude necessary to produce a given range of variation in the marking to spacing ratio. It should be noted in connection with this description, however, that the normal operating range of the device is intended to be confined below the point where this "saturation-limiting" takes effect.

By Figs. 3*a* and 3*b*, the practical effects of the circuit shown by Fig. 1 have been illustrated, and comparison with the wave formation shown by Figs. 2*a* and 2*b*, show a very marked decrease in the variation of marking to spacing ratio with a variation of input voltage.

In connection with the showing of Figs. 3*a* and 3*b*, it should be understood that the wave formations illustrated by Figs. 2*a* and 2*b* respectively may be considered merely as examples of the input wave shapes supplied to the automatic bias limiter circuit. It is particularly interesting to note that whereas increasing amplitude increases the marking to spacing ratio in a cut-off type of limiter it decreases that same ratio in the bias limiter herein disclosed. This offers a considerable advantage in practical operation as increasing amplitude of the incoming wave is often accompanied by a true lengthening of the signal wave shape, and in the automatic bias limiter herein disclosed the two effects will tend to practically offset each other, and this, it will be seen, results in a more uniform length of character appearing in the output circuit which is connected to the terminals 31. This output circuit, which has not been specifically shown, will include, as above stated, either an automatic telegraph printer, ink recorder, glow tube, or relay operated devices.

While the invention has herein been disclosed in only one of its preferred forms, it is nevertheless to be understood that from a practical viewpoint, many and various modifications may be made and still retain the broad scope of the basic principles taught by this disclosure. I, therefore, believe myself to be entitled to make and use any and all modifications of the arrangement herein disclosed, provided, of course, such modifications fall fairly within the spirit and scope of the invention, as defined by the hereinafter appended claims.

Having now described my invention, what I claim and desire to secure by Letters Patent of the United States, is as follows:

1. A signalling system including an input circuit, an output circuit and a multi-electrode thermionic device coupling the input and output circuits, means for supplying signals appearing in the input circuit directly upon one of the plurality of cold electrodes of the thermionic tube, polarity reversing means connected in parallel with said first named means, integrating means connected to said polarity reversing means, and means connecting a second one of the plurality of cold electrodes to the integrating means and the polarity reversing means, whereby constant amplitude output energy from the thermionic device irrespective of the intensity fluctuation in the input signals is maintained.

2. In a limiting device, a multi-electrode limiting thermionic tube, means for supplying signals to one of the electrodes of said tube, polarity reversing means parallelly connected with said first named means, integrating means connected to said polarity reversing means, and means for connecting the integrating means to a second one of the electrodes of said tube, whereby substantially constant amplitude output energy irrespective of fluctuation in average amplitude of the supplied signals is maintained.

3. In a system for obtaining constant level output energy, a signal source, a load circuit, and a multi-electrode thermionic tube for supplying signals to the load circuit, means for applying signals to one control electrode of the multi-electrode tube, polarity reversing means parallelly connected to said first named means, integrating means connected to the polarity reversing means, and means for connecting the integrating means to a second control electrode of the multi-electrode tube.

4. An energy transfer system comprising a thermionic tube having a plurality of cold electrodes, means to supply input signals of fluctu-

ating amplitude to one of said cold electrodes, polarity reversing means parallelly connected to said first named means, energy integrating means connected to said polarity reversing means, and means for connecting said integrating circuit to a second of said cold electrodes, whereby signals of substantially constant amplitude are produced irrespective of fluctuations in the average amplitude of the supplied signals.

5. In a signalling system for maintaining constant amplitude output energy and establishing a predetermined ratio between marking and spacing for telegraph communication, an input circuit having impressed thereon signals of fluctuating intensity varying between zero and a variable amplitude, a thermionic device having the control electrode thereof connected with the input circuit so as to have the input signals impressed thereupon, an integrating circuit connected across the input circuit to integrate the supplied signals so as to vary automatically the bias level of the thermionic device, means to supply to a second control electrode of the thermionic device the integrated input signals in substantially phase opposition to the signals supplied to the first control electrode to produce from the thermionic device substantially constant amplitude output energy, and a load circuit for utilizing the output energy from the thermionic device.

6. In a signalling system for maintaining constant amplitude output energy and establishing a predetermined ratio between marking and spacing for telegraph communication, an input circuit having impressed thereon signals of fluctuating intensity varying between zero and a variable amplitude, a thermionic device having the control electrode thereof connected with the input circuit so as to supply the input signals thereto, and integrating circuit including a parallel connected resistor and capacity element connected across the input circuit to integrate the supplied signals so as to vary automatically the bias level of the thermionic device, means to supply to a second control electrode of the thermionic device the integrated input signals in substantially phase opposition to the signals supplied to the first control electrode to produce from the thermionic device substantially constant amplitude output energy, and a load circuit for utilizing the output energy from the thermionic device.

7. In a signalling system for maintaining constant amplitude output energy for telegraphic communication, an input circuit having impressed thereon signals of fluctuating intensity varying between zero and a variable amplitude, a thermionic device having the control electrode thereof connected with the input circuit so as to supply the input signals thereto, an integrating circuit connected across the input circuit to integrate the supplied signals so as to vary automatically the bias level of the thermionic device, means to supply to a second control electrode of the thermionic device the integrated input signals in substantially phase opposition to the signals supplied to the first control electrode to produce from the thermionic device substantially constant amplitude output energy, a push-pull amplifying stage connected with the output of the said thermionic device, a load circuit connected with the output of the push-pull amplifier, and a potentiometer connected across the load circuit to unbalance to a predetermined degree the push-pull stage to compensate for discrepancies between the length of markings and spacing of certain of the impressed signals.

8. In a signalling system, an input circuit, an output circuit, an amplifier connecting said input circuit with said output circuit, said amplifier having at least two cold input electrodes, two parallelly connected signal controlled input circuits, means for directly impressing on one of the input electrodes one of the parallel inputs, and means for impressing an integrated version of the signal on the other input electrode from the other input circuit.

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