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2,428,011

RECEIVER FOR TIME OR DURATION MODULATED ELECTRICAL PULSES

Filed April 21, 1943

2 Sheets-Sheet 1

FIG. 1.

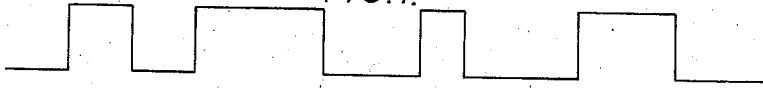


FIG. 2.

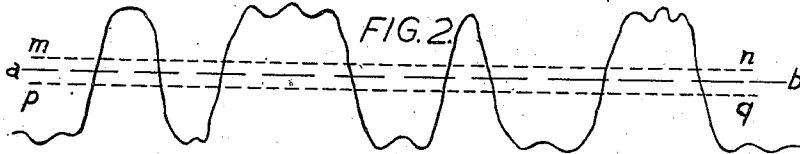


FIG. 3.

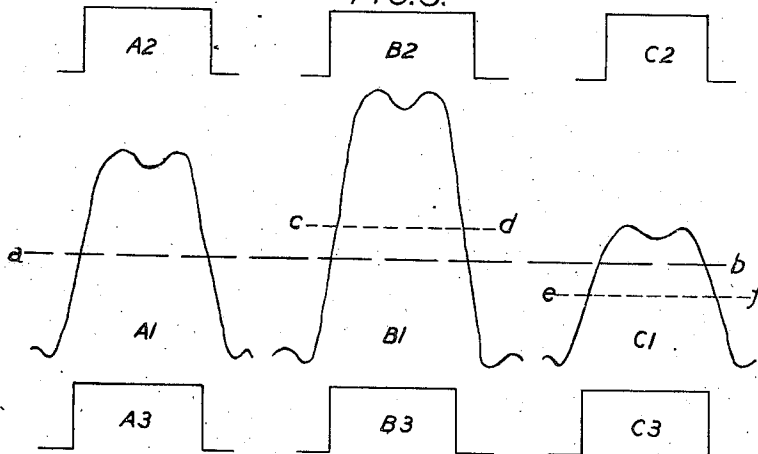
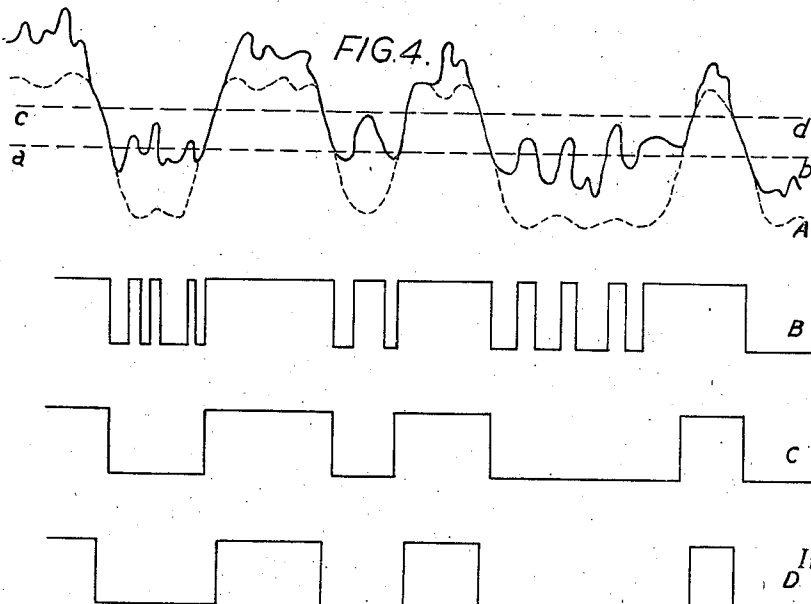


FIG. 4.



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2 Sheets-Sheet 2

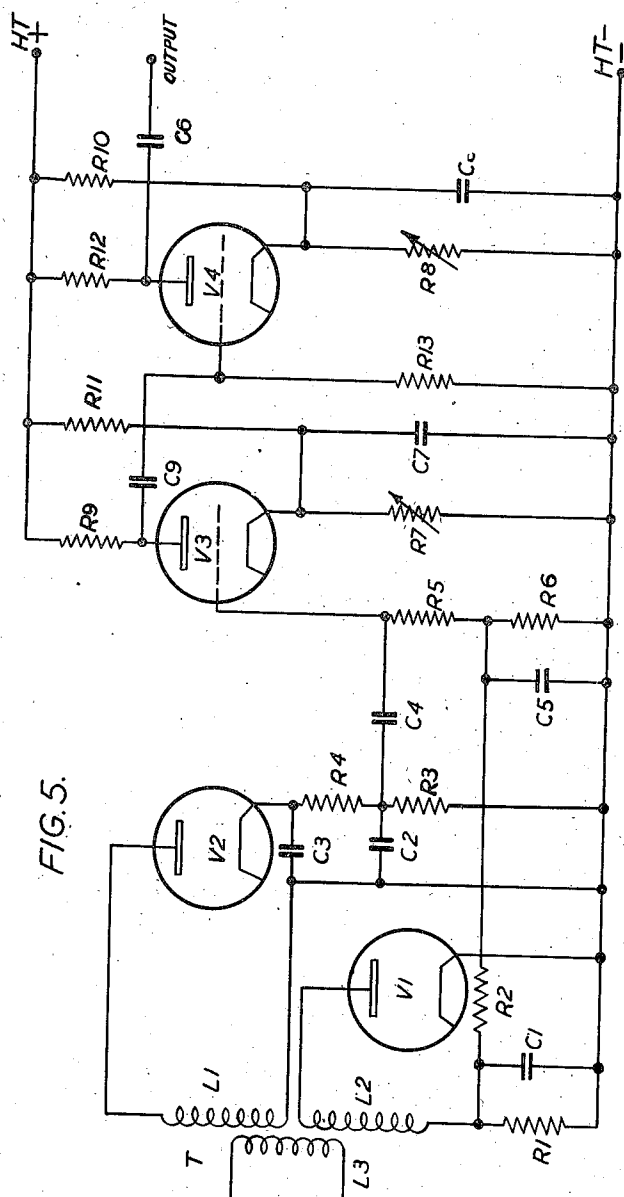


FIG. 5.

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RECEIVER FOR TIME OR DURATION
MODULATED ELECTRICAL PULSES

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9 Claims. (Cl. 250—20)

1

The present invention relates primarily to time modulated electrical pulse transmission systems and is principally concerned with the correction of distortion due to fading, interference and like causes. It is however also applicable more generally to transmission systems which involve amplitude limiting, such as, for example, frequency modulation systems, and the like.

The pulses employed in pulse transmission systems should ideally have vertical sides and square tops, but although substantially perfect pulses may be generated at the outset, they are liable to be distorted while passing through the various processes of transmission and reception, and this is particularly likely when the band width occupied by the channel has to be restricted. The distortion introduced in this manner is also made worse by fading, and by interference which may be picked up anywhere in the system. The present invention is concerned principally with means for reducing the effects of the distortion which has been caused in the ways just described.

According to the invention there is provided a receiving arrangement for an electrical pulse transmission system comprising means for limiting the amplitude of the received pulses between two amplitude levels differing by a predetermined amplitude, and means for varying the said levels in accordance with the power of the incoming signals.

According to another aspect, the invention consists in a receiving arrangement for an electrical pulse transmission system subject to interference, comprising limiting means for selecting a portion of the amplitude of the received pulses, and means for fixing the mean level at which the portion is selected in accordance with the level of the interference.

The invention will be more clearly understood from the following detailed description and by reference to the accompanying drawings in which

Figs. 1 to 4 are explanatory diagrams of time modulated pulses; and

Fig. 5 is a schematic circuit diagram of an embodiment of the invention.

In order to make the principles of the invention clear, an explanation of the effects of distorted pulses will first be given, together with a general description of the manner in which these effects may be minimised according to the invention.

Referring to Fig. 1, there is shown a series of ideal time modulated pulses, which it will be seen have substantially vertical sides and square tops. When these pulses are passed through a system

2

of limited frequency band-width, the pulses may be distorted as indicated in Fig. 2, the sides becoming inclined and the tops and bottoms rounded or "wavy." The effect on the sides of the pulses is substantially to increase the width at the base of each pulse and to decrease the width of the top, or in other words the sides of the ideal pulse appear to pivot about the middle points, thus producing the sloping pulses. A line *a, b* drawn half way up will be divided into sections having practically the same lengths as the original time modulated pulses of Fig. 1. The distorted pulses shown in Fig. 2 are obtained at the receiving end, and it has been found that substantially undistorted time modulated pulses may be obtained by cutting from the pulses a narrow slice *mn, pq* centred along the line *a, b* by means of a double limiting device; and by subsequent amplification, the slopes of the sides of the pulses so obtained may be so steepened that they become substantially vertical.

When demodulating the pulses according to the prevailing practice, it is usual to cut out a narrow slice at a fixed level which is independent of the received amplitude, and possibly also means may be provided whereby the cutting level can be changed from time to time to adapt the receiving arrangements to various conditions. This however does not take into account two sources of distortion, namely fading and noise, the effects of which will now be described.

In Fig. 3, *A*₁ shows one of the Fig. 2 pulses as received, taken to represent any time modulated pulse, the line *a, b* representing the centre line of the slice which the receiver is adjusted to cut out, and which, as already explained, it has been found should be half way up. This centre line will for convenience be called the "cutting level." If the signals are subject to fading, this pulse may be received sometimes with greater amplitude (as at *B*₁) or with smaller amplitude (as at *C*₁). The effect of the fading will be chiefly to change the vertical scale of the pulses as drawn, without affecting the horizontal scale. If therefore, the actual cutting level in the receiver is fixed, the relative level will be too low for the *B*₁ pulse and too high for the *C*₁ pulse, so that the corresponding derived square time modulated pulses will be respectively too long and too short. These derived pulses are shown at *A*₂, *B*₂ and *C*₂ in Fig. 3 for the three received pulses, respectively.

If, however, the cutting level be made variable so that it is always substantially half way up the pulse irrespective of the amplitude, all the derived pulses will have the same length, so that the distortion produced by the fading will have been

3

removed. The corresponding cutting levels for the B₁ and C₁ pulses are shown by the lines c, d and e, f respectively, and the resulting derived pulses are shown at A₃, B₃ and C₃; from which it is clear that they are all the same length.

In the arrangement of the invention, therefore, the cutting level is made variable under the control of the received power so that when the signal amplitude varies, the cutting level is automatically varied accordingly so that undistorted derived pulses are obtained irrespective of the fading. The details of this arrangement will be explained later on.

When excessive interference is being received with the pulses (assuming there is no fading), considerable distortion may be produced. This may be understood from Fig. 4, in which A shows the manner in which the interference may affect the received wave-form. The full line shows the wave form actually received, the dotted lines indicating the wave-form without the interference. If the cutting level be fixed at the half-way level a, b it will be clear that instead of getting the desired undistorted pulses as shown at C, a number of extra short pulses, and other effects, will be obtained as shown at B. If the cutting level be raised to c, d (Fig. 4, A) the peaks due to the interference will be avoided, and pulses as shown at D will be obtained. Since, however, the cutting level has been raised, these pulses will be to some extent distorted since their lengths are now incorrect. An improvement will have been obtained because generally the distortion produced by the interference will be considerably worse than that produced by changing the level.

It will be evident that the addition of interference will be equivalent to increasing the received power, so that if the receiver has been designed according to the invention to deal with fading in the manner explained, it will also raise the cutting level when excessive noise is present. It will also be clear that the raising of the cutting level can be made just sufficient to avoid the interference, so that the distortion which is unavoidably associated with the raising of the level will be always a minimum.

It will be evident also, that the arrangement of the invention will operate as described to obtain the best possible result when both interference and fading are simultaneously present, since the correction for both of these operates through the medium of the received power.

The details of an embodiment of the invention are shown in the form of a schematic circuit in Fig. 5. Radio frequency waves modulated with the time modulated pulses are applied to the primary winding L₁ of a transformer T. These waves are applied from the secondary winding L₂ to a diode valve V₂ where they are rectified, the time modulated pulses being obtained as voltage variations across the load resistance R₃. The radio frequency components are removed by means of the smoothing circuit consisting of the condensers C₂ and C₃ and the resistance R₄.

The pulses in the load R₃ are applied through a condenser C₄ to the grid of the first limiter valve V₃. The plate of this valve is connected through a resistance R₆ to the positive terminal of the high tension supply, and this valve is biased beyond the cut-off by connecting the cathode to the junction of resistances R₇ and R₁₁ connected across this supply. C₇ is the usual by-pass condenser for the cathode, and R₅ is the grid resistance.

The plate of V₃ is connected to the grid of

4

the second limiter valve V₄ through the condenser C₉, the plate of V₄ being connected to the high tension supply through the resistance R₁₂. This valve is also biased by connecting the cathode to the resistances R₈ and R₁₀ connected across the supply, C₈ being the by-pass condenser. The output is taken from the plate of V₄ through a condenser C₆.

A variable bias for the valve V₃ is developed across the resistance R₆ connected in series with the control grid. This bias is obtained from the incoming signals which are applied to the rectifier V₁ from the secondary winding L₂ of the transformer T. R₁ is the load resistance for V₁, and C₁, C₅, R₂ is a smoothing circuit having a time constant greater than the period of one cycle of the lowest signal frequency present. Accordingly a continuous negative bias is produced across R₆ which varies with the general level of the received signal, and is applied to the grid of V₃ in addition to the bias obtained from the cathode resistance R₇.

The pulses (Fig. 2) which are obtained across the resistance R₅ are applied in a positive sense to the control grid of V₃, and assuming first of all that the incoming signal level is steady, the resistance R₇ will be adjusted until the cut-off bias of the valve is overcome when the amplitude has reached the level p, q. The valve then becomes conducting and the plate voltage falls. This will cause the valve V₄ (which is normally conducting) to be cut off at the level m, n, which is determined by the setting of resistance R₈, which will be adjusted until a slice of the desired thickness is obtained, centered on either side of the line a, b.

If the incoming signals are subject to fading, so that their amplitude becomes reduced, for example, the variable bias voltage across R₆ will be correspondingly reduced, so that the first cut p, q produced by the valve V₃ takes place at the desired lower level. Similarly when the signal amplitude increases, the cut occurs at a higher level. The width of the slice, being determined by the resistance R₈, will be the same whatever the cutting level.

Since the effect of interference on the valve V₁ will be substantially the same as an increase in signal level, it will be evident that the cutting level will be raised in the presence of interference, as desired.

Figure 5 shows only one example of an arrangement for carrying out the invention, and other suitable circuits will easily be devised by those skilled in the art.

What is claimed is:

1. A receiving arrangement for an electrical pulse transmission system comprising means for limiting the effective portions of the received pulses to those between two amplitude levels differing by a predetermined amplitude, and means for automatically varying the mean level of the selected portion of said pulses in accordance with the power of the incoming signals.

2. A receiving arrangement for an electrical pulse transmission system subject to interference, comprising limiting means for selecting a portion of the received pulses between predetermined amplitude limits, and means for automatically fixing the mean level at which the portion is selected in accordance with the level of the interference.

3. An arrangement according to claim 1 comprising a rectifier for deriving from the incoming signals a continuous potential depending upon

5

the signal power, said limiting means including an amplitude limiting valve having a control grid, and means for applying the continuous potential to the control grid of said amplitude limiting valve.

4. A receiving arrangement for a constant amplitude electrical pulse transmission system comprising a first amplitude limiter valve adjusted to cut off below a predetermined pulse amplitude level, a second amplitude limiter valve coupled in tandem with said first valve and adjusted to cut off above a predetermined pulse amplitude level higher than the cut off level of said first valve, an input circuit, means for rectifying pulse modulated carrier waves received in said input circuit and for applying the rectified pulses to said first limiter valve, means for deriving from said input circuit a variable direct current voltage, means for applying said direct current voltage as a variable control grid bias to said first limiter valve, and means to maintain a normal bias for said limiter valve such that the valve will only operate above the level of noise and interference signals.

5. A receiving arrangement for a constant amplitude electrical pulse transmission system comprising a first amplitude limiter valve including a control grid and adjusted to cut off below a predetermined pulse amplitude level, a second amplitude limiter valve coupled in tandem with said first valve and adjusted to cut off above a predetermined pulse amplitude level higher than the cut off level of said first valve, an input circuit, a first diode detector coupled to said input circuit and having a first load resistor, means for applying the voltage developed across said load resistor in a positive sense to the control grid of said first limiter valve, a second diode detector coupled to said input circuit and having a second load resistor, a time constant circuit, and means for applying the voltage developed

6

across said second load resistor over said time constant circuit and in a negative sense to the control grid of said first limiter valve.

6. A receiving arrangement according to claim 5 in which said first and second limiter valves are each provided with an adjustable cathode lead biasing resistance.

7. A receiving arrangement for an electrical pulse transmission system comprising means responsive to changes in voltage between predetermined amplitude levels on the leading and trailing edges, respectively, of received pulses, and means automatically to vary the position of said levels with the amplitude of received pulses.

8. A receiving arrangement according to claim 7, in which the position of said levels is maintained at substantially half the amplitude of the received pulses.

9. A receiving arrangement according to claim 7, in which the position of said levels is maintained above the level of the interference.

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