Jan. 29, 1946. F. P. MASON 2,393,921

RADIO TELEGRAPH RECEIVING ARRANGEMENT

Filed March 30, 1943

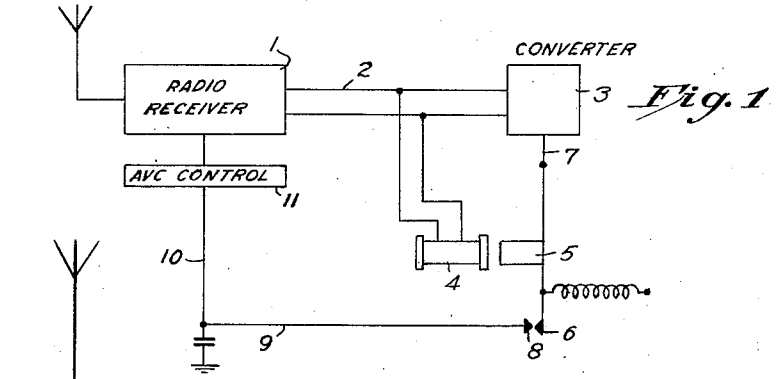

Fig. 1

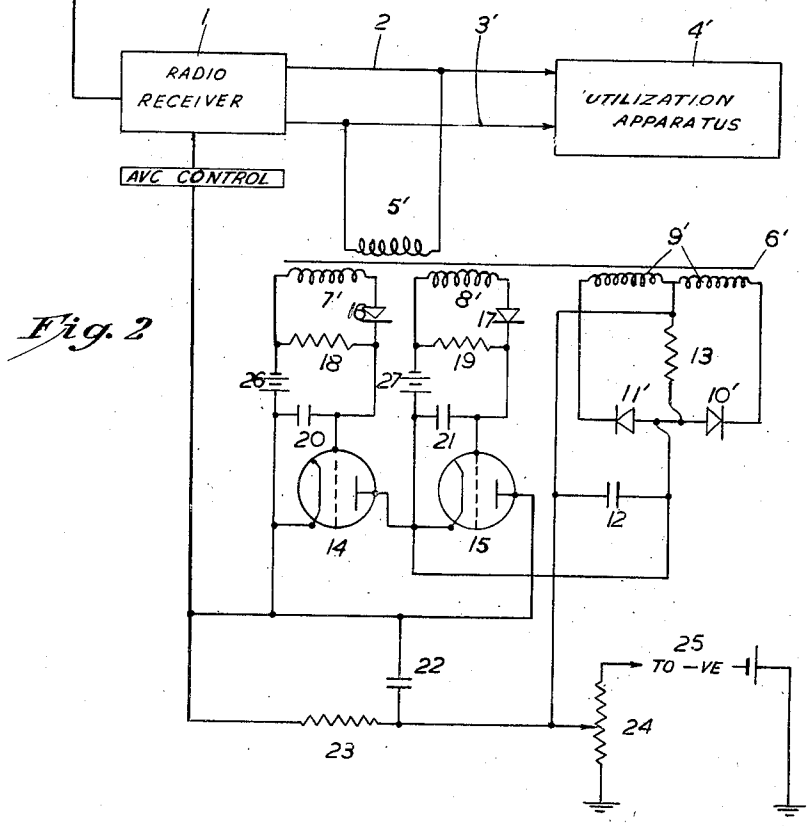

Fig. 2

Inventor
F. P. Mason
By George F. Hyde
Attorney

Patented Jan. 29, 1946 2,393,921

UNITED STATES PATENT OFFICE

2,393,921

RADIO TELEGRAPH RECEIVING ARRANGEMENT

Frederick Percival Mason, Croydon, England, assignor to Creed and Company Limited, Croydon, Surrey, England

Application March 30, 1943, Serial No. 481,105
In Great Britain May 8, 1942

5 Claims. (Cl. 178—88)

In any telegraph system it is desirable that the receiving apparatus should be provided with a substantially constant magnitude of signal, since it is common experience that apparatus of any kind may be adjusted to operate well at one value of input but will give unsatisfactory performance with either a greater or lesser input.

Telegraph receiving apparatus of the electromagnetic class will give satisfactory performance over a range of input of the order of 10:1, while recorders of the chemical paper type have rather less tolerance.

It is, therefore, evident that in wireless telegraphy, where the received signal may vary to an extent of 40 db, i. e. a ratio of 10,000:1, the signal will be of satisfactory strength for a small part of the transmitting period only.

This situation is generally recognised, and many solutions of the problem of maintaining constant the output of a radio receiver have been proposed. The majority of these solutions, however, are suitable only for modulated carrier transmissions, and fail to operate correctly under keyed-carrier conditions.

The object of this invention is to provide an automatic volume control especially suitable for keyed-carrier wireless telegraph. Throughout this specification A. V. C. denotes automatic volume control.

As in known systems, the general process is that of converting part of the amplified signal energy into grid bias for the amplifying valves. The novel feature of the method is the provision of positive, rapid adjustment of the control voltage during a marking period, and complete maintenance of the control voltage during a spacing interval.

Fig. 1 shows one embodiment of my invention using a mechanical relay.

Fig. 2 shows another embodiment of my invention using electronic relay devices.

The principle of operation may be understood by reference to Fig. 1, in which a radio receiver 1 has an output path 2 which devides to feed signals to a converter 3 and a utilisation device 4. Device 4 is shown, for simplicity, as an electromagnet provided with an armature 5, which it is assumed is utilised to effect recording of the message in any well known manner. The armature 5 also carries a contact 6, which is electrically connected to the output of converter 3 by conductor 7. A stationary contact 8 is connected to the ungrounded plate of a condenser 9; the same plate is connected by conductor 10 to the A. V. C. busbar 11 of the receiver 1. By A. V. C. busbar is meant the line carrying the negative automatic control bias to the portion or portions of the receiver upon which such bias operates, for example the grids of one or more tubes.

During the reception of no signals, device 3 and magnet 4 are unenergised, so that condenser 9 is uncharged and zero control voltage is applied to the receiver 1, which therefore operates at maximum sensitivity.

Upon the receipt of a signal, device 3 is energised and conductor 7 impresses a voltage on contact 6 proportional to the strength of the signal. Also, magnet 4 is energised, attracting its armature 5 to effect recording of the signal, at the same time closing contacts 6 and 8. Condenser 9 is immediately charged to the potential of conductor 7, and the gain of receiver 1 is immediately adjusted to suit the received signal strength. Operation during a marking condition is thus identical with that of a fast automatic volume control of normal type.

Reversion to the spacing condition causes conductor 7 to resume zero potential, but at the same time magnet 4 is de-energised, armature 5 deoperating and contacts 6 and 8 opening. Condenser 9 is thus disconnected at the moment of change, and its charge remains, during the spacing interval, at the value determined by the magnitude of the previous marking signal.

At each subsequent marking signal, the charge on condenser 9 is readjusted, at the beginning of the signal, to a value corresponding to the strength of the signal.

Thus, a fast-acting A. V. C. is provided which does not lose control during spacing periods. It will be seen that directly the signal has faded to below a strength sufficient to operate the electromagnet, no further adjustment of the control voltage is desirable, so that there is no attempt on the part of the receiver to increase its amplification to such an extent that noise operates the magnet 4. To this end, the receiver no-signal sensitivity would be adjusted so that noise does not operate magnet 4. It is also desirable that converter 3 is non-responsive to signals of noise magnitude, and for this purpose the converter may consist of a biased diode and load circuit of usual type. Alternatively, the lower plate of condenser 9, instead of being grounded, may be taken to an adjustable negative potential; this method would automatically ensure that the receiver no-signal sensitivity and the converter characteristic were correct.

The device may be applied at a radio receiving station in the following ways:

1. It may be incorporated in an amplifier designed to be connected to an existing radio receiver (such as, for example, the amplifiers used in the tape facsimile system or the Morse recorder).

2. It may be incorporated in the receiver itself.

3. It may be incorporated in an amplifier, as described in (1), with the addition of a control

connection taken to the A. V. C. busbar of the receiver.

Method 1 is convenient, and would operate on audio-frequency currents.

Method 2 would be used where a receiver is to be designed specifically to operate a telegraph receiving apparatus.

Method 3 is the most efficient method, but implies that a connection be brought out from the radio receiver.

It is to be understood that the method of carrying out the principle of the device is by way of illustration only, and in cases where the contacts 6 and 8 of Fig. 1 are undesirable or non-existant, then an arrangement as shown in Fig. 2 may be adopted. The operation is then completely independent of the nature of the receiving device 4.

The operation of the circuit of Fig. 2 is as follows:

The output of the radio receiver 1 is conveyed over conductors 2 and 3' to the utilisation device 4', the nature of which is immaterial. A transformer 6' is provided with a primary winding 5', two secondary windings 7' and 8', and a further center-tapped secondary winding 9'.

Winding 7' is provided with a load circuit comprising rectifier 16, resistor 18 and condenser 20, such that a unidirectional voltage is developed across resistor 18 when an alternating voltage appears in winding 7'.

The resistor 18 is connected in series with a battery 26, and the series circuit thus formed is connected between the grid and cathode of triode 14 in such a way that battery 26 normally biases tube 14 to cut off, but the voltage developed across resistor 18 overcomes this bias and renders the tube conductive.

Winding 8' co-operates with rectifier 17, condenser 21, resistor 19 and battery 27, to control triode 15 in a similar manner. Thus, when a tone output occurs on conductors 2 and 3', tubes 14 and 15 are rendered conductive.

Winding 9' is arranged to co-operate with rectifiers 10' and 11', condenser 12 and resistor 13, to produce a unidirectional voltage proportional to the amplitude of the signal on conductors 2 and 3'. The time constant of this circuit, and those of the circuits controlling tubes 14 and 15, are of the order of one-tenth of a dot interval.

One end of resistor 13 is grounded, and the other, the negative end, is connected to the anode of tube 14 and the cathode of tube 15. The cathode of tube 14 and the anode of tube 15 are connected together and to the ungrounded electrode of condenser 22. This electrode is also connected to the automatic volume control busbar 11 of the radio receiver 1. The other electrode of condenser 22 is grounded via the adjustable potential divider 24, over which a potential drop, negative with respect to ground, is produced by battery 25.

Since, during a marking interval, as has already been shown, a negative potential appears at the ungrounded end of resistor 13, and tubes 14 and 15 are rendered conductive, current flows from resistor 13 to condenser 22, or vice versa, according to whether the potential of the ungrounded electrode of condenser 22 is higher or lower than that of the ungrounded end of resistor 13. The power available from the network containing resistor 13 is arranged to be adequate for condenser 22 to adjust its charge in approximately one-tenth of a dot interval. Since the ungrounded electrode of condenser 22 is connected to the automatic volume control busbar 11 of the radio receiver 1, it is evident that, during a marking period, a fast-acting automatic volume control is exerted on the output signals supplied to device 4'.

During a spacing interval, since tubes 14 and 15 are rendered non-conductive, the charge on condenser 22 is not allowed to adjust itself to equalise the potential existing between itself and resistor 13. The potential of automatic volume control busbar 11 is thus substantially maintained at the value determined during the previous marking interval, and the gain of the receiver is maintained constant. If it were not for this feature, the gain would readjust itself to a high value such that the background noise is amplified sufficiently to constituting a marking signal.

In practice, it is desirable to provide a high resistance leakage path for condenser 22, such as resistor 23, in order that, in the event of a sudden drop in signal strength of considerable magnitude, the charge on condenser 22 can readjust itself in any desired period to increase the gain of the receiver. In such a case, if the decrease in signal strength occurred during a spacing interval, and was of such a magnitude that the tubes 14 and 15 failed to be energised, the condenser 22 has no opportunity to readjust its charge until the signals again reach their former strength. Since this period may be of any duration, the device 4' may not be actuated for long periods; the desirability of the leakage path 23 is thus demonstrated.

The leakage path 23 results in the receiver gain being increased to maximum after any desired period, so that during a long spacing interval the background noise might become effectively a marking signal. To overcome this difficulty, a control such as potential divider 24 may be provided, this being adjusted so that the background noise is just prevented from operating device 4'.

General advantages of A. V. C. are—

1. Much greater range of input signal magnitude allowable for satisfactory operation, as compared with a system not employing A. V. C.

2. Effective signal-to-noise ratio is greatly improved at high signal values, i. e., the signal to noise ratio which exists is always taken advantage of. If A. V. C. is not used, the signal-to-noise ratio is always equal to that obtaining during the reception of the weakest usable signal.

3. Manual volume control eliminated.

Advantages of the proposed system over existing systems

1. Greater range of input signal strength allowable.

2. More nearly constant signal output.

3. Signals do not become unworkable during a period during which signals are weakening, until the signals actually become too weak to be useful.

4. Noise does not become over-amplified during spacing signals, so that the effective signal-to-noise ratio is improved.

What is claimed is:

1. In a telegraph receiver having a gain control circuit, an automatic volume control device comprising, means to derive a potential proportional to the strength of received signals, a condenser connected in said gain control circuit of said receiver, means including two tubes for connecting said potential deriving means to said condenser, said tubes forming two connecting channels with the plate-cathode circuit of one tube connected

reversely to the plate-cathode circuit of the other tube, and a pair of separate circuits connected respectively to the grids of the two tubes to maintain the tubes conductive for the entire marking period of the signal and to make said tubes non-conductive during each spacing period of the signal, each of said separate circuits including a resistor shunted by a condenser and coupled to the output of said receiver through a rectifying device, whereby the potential on said condenser which controls the gain of said receiver is controlled by the strength of the incoming signal and is maintained constant during the spacing periods of the signal.

2. In a telegraph receiver which has an A. C. signal circuit and a gain control circuit and is adapted to receive signals composed of marking periods and spacing periods, an automatic volume control device comprising: potential-deriving means to derive a potential proportional to the strength of the received signals; a condenser connected in said gain control circuit; electronic means including two elements each having an anode-cathode current path and control electrode means to control the current flow therethrough, one of said elements being reversely connected with respect to the other element so that said elements form two conducting channels between said potential-deriving means and said condenser, said channels being conductive when said elements are rendered conductive and being non-conductive when said elements are rendered non-conductive; means for applying a bias to the control electrode means of said elements whereby said elements are rendered non-conductive during the spacing periods of the signal; and circuit means including rectifying means coupling the control electrode means of said elements to the signal circuit to apply a potential in opposition to said bias potential thereby to render said electronic valves conductive during each marking period.

3. In a telegraph receiver which has a gain control circuit and is adapted to receive signals composed of marking periods and spacing periods, an automatic volume control device comprising: potential-deriving means to derive a potential proportional to the strength of the received signals; electronic means including two elements each having an anode-cathode current path and control electrode means to control the current flow therethrough, one of said elements being reversely connected with respect to the other element so that said elements form two connecting channels between said potential-deriving means and said gain control circuit, said channels being conductive when said elements are rendered conductive and being non-conductive when said elements are rendered non-conductive; and control circuit means connected to the control electrode means of said elements for applying direct current potentials to said control electrode means during the marking periods, whereby during each marking period said elements are rendered conductive and the potential in said gain control circuit is proportional to the strength of the received signals and during each spacing period said elements are rendered non-conductive and the potential in said gain control circuit is maintained substantially constant.

4. In a telegraph receiver which has an A. C. signal circuit and a gain control circuit and is adapted to receive signals composed of marking periods and spacing periods, an automatic volume control device comprising: potential-deriving means to derive a potential proportional to the strength of the received signals; a condenser connected in said gain control circuit; electronic means including two elements each having an anode-cathode current path and control electrode means to control the current flow therethrough, one of said elements being reversely connected with respect to the other element so that said elements form two conducting channels between said potential-deriving means and said condenser, said channels being conductive when said elements are rendered conductive and being non-conductive when said elements are rendered non-conductive; and control circuit means connected to the control electrode means of said elements to render said elements conductive for each entire marking period and to render said elements non-conductive during each spacing period, said control circuit means including resistor means coupled through rectifying means to the signal circuit to impress direct current potentials on said control electrode means during the entire marking periods whereby said elements are rendered conductive.

5. In a telegraph receiver which has an A. C. signal circuit and a gain control circuit and is adapted to receive signals composed of marking periods and spacing periods, an automatic volume control device comprising: potential-deriving means to derive a potential proportional to the strength of the received signals; a condenser connected in said gain control circuit; electronic means including two elements each having an anode-cathode current path and control electrode means to control the current flow therethrough, one of said elements being reversely connected with respect to the other element so that said elements form two conducting channels between said potential-deriving means and said condenser, said channels being conductive when said elements are rendered conductive and being non-conductive when said elements are rendered non-conductive; and means forming a pair of separate circuits connected respectively to the control electrode means of said elements to impress a positive bias on the control electrode means during each marking period and to impress a negative bias on said control electrode means during each spacing period, each of said circuits comprising, a battery and a resistor connected in series across a condenser which is connected between the cathode and the control electrode means so that the battery tends to impress a negative bias on said control electrode means, and rectifier means connected to impress a potential across said resistor in opposition to the potential of said battery with said rectifier means deriving its current from the signal circuit, whereby said condenser is directly connected to said potential-deriving means during each marking period so that the condenser assumes the desired gain-control potential and whereby said condenser is disconnected from said potential-deriving means during each spacing period with the result that the gain-control potential is maintained substantially constant during normal spacing periods.

FREDERICK PERCIVAL MASON.