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AUTOMATIC SELECTIVE FADING CONTROL CIRCUITS

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Fig. 1

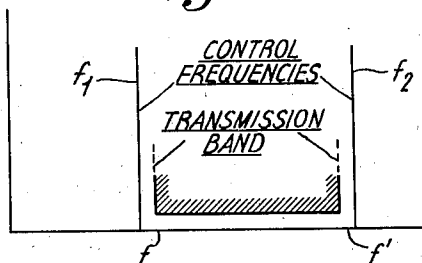


Fig. 2

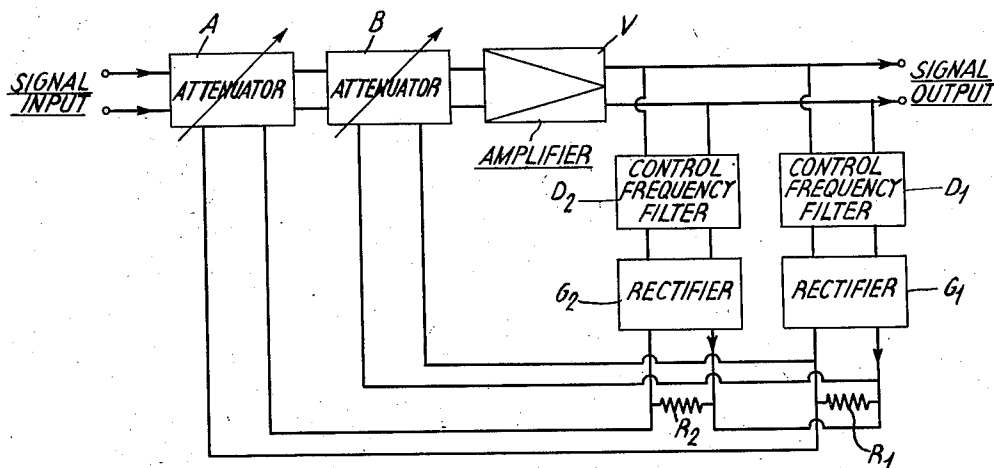
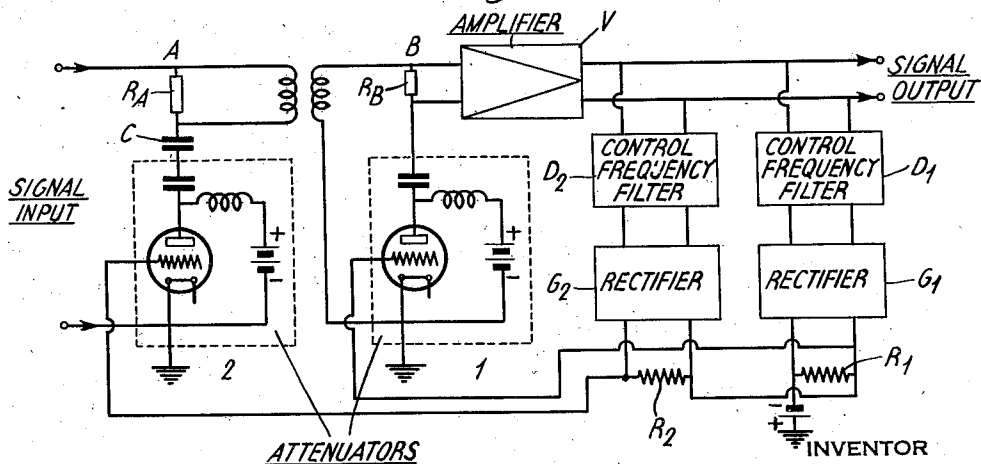


Fig. 3



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AUTOMATIC SELECTIVE FADING
CONTROL CIRCUITS

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5 Claims. (Cl. 178—44)

The present invention relates to automatic sig-
nal transmission control systems, and more par-
ticularly to circuits for compensating for the ef-
fects of selective fading.

5 For the purpose of insuring an automatic regu-
lation of transmission measure it is known to
transmit a distinct control, or pilot, frequency,
and to use the amplitude variations thereof at
the receiving end for the purpose of controlling
10 the regulator means. In transmission systems
predicated upon carrier frequency, it has also
been suggested in the prior art to use the car-
rier frequency itself for the causation of the
regulator action so that the transmission of a
15 special control, or piloting, frequency could be
dispensed with. However, in arrangements of
this kind, there is only one criterion for such
changes in attenuation as occur over the trans-
mission path, namely, the change in damping of
20 one frequency, while it is known in the art that
such changes in attenuation are not uniform for
all of the different frequencies comprised inside
the used frequency band or spectrum.

In radio transmission systems the dependence
25 on the frequency of the changes of damping are
particularly marked so that, in spite of the above-
described regulating methods, the quality of
transmission will be impaired by selective fading.
However, it is not only in radio transmission sys-
30 tems, but also in the case of transmission over
long lines, where the various frequencies expe-
rience non-uniform damping. In order that the
regulator means may, to a certain degree, be
adapted to these working conditions, recourse has
35 been had in the past to frequency-dependent
regulator means. In these, as will be seen, if the
regulation is insured by acting upon a receiving
amplifier, the gain is not brought about by par-
allel shifting of the amplifier curves, but the gain
40 is altered to different degrees for the different
frequencies.

These arrangements have the disadvantage
that a definite frequency dependence for the regu-
lator action is fixed from the outset so that a
45 definite shape of the amplifier characteristic per-
tains to a definite incoming amplitude of the con-
trol frequency. The changes in attenuation of
transmission systems, however, do not always oc-
cur with the same frequency dependence. On
50 the contrary, they are a function of atmospheric
influences; of the temperature; and, in the case
of wire transmission systems, of the particular
properties of the different lines connected to-
55 gether to form a communication path. Hence,

an adequate equalization, or compensation, of
the changes in the transmission measure is im-
possible if the frequency dependence of the regu-
lator action has been pre-fixed.

In another method known in the prior art, for
5 the purpose of compensating selective variations
of the transmission measure, the frequency
range, or spectrum, to be regulated is divided into
a number of partial bands which are separately
10 regulated. This may be accomplished, for in-
stance, by that a distinct control frequency is
allotted to each such partial band. If these lat-
ter are chosen sufficiently closely together, it is
feasible by the aid of this method to so make the
15 regulation of the transmission measure that the
frequency function of the attenuation changes
will be considered. However, it will be under-
stood that the expenditure for circuit elements
attendant upon this last-named method is ex-
20 traordinary. Both at the sending, as well as at
the receiving, end filters must be provided de-
signed to divide the frequency spectrum to be
transmitted into the partial bands. In addition,
as many control frequencies must be transmitted
25 as there are partial bands; and each of these con-
trol frequencies must be filtered out of each one
of these partial bands by additional filter means,
then amplified, rectified, and then used for the
regulation of amplifiers co-ordinated separately
30 to each one of the various partial bands.

Hence, amplifiers must also be provided for each
of the partial bands, or channels. It will thus be
seen that this method may be used only if, and
when, the particular nature of a given practical
35 case warrants, or makes, apparently acceptable
such considerable equipment in an economic re-
gard.

Now, the present invention discloses ways and
means whereby a compensation of selective
40 changes in the transmission measure which meas-
ures up to practical requirements is realizable
without having the spectrum of frequencies to be
transmitted divided into partial bands. Accord-
ing to the invention, the frequency function of
45 attenuation of a regulator device jointly traversed
by one or more of all signal frequencies of the fre-
quency band to be transmitted is controlled in
dependence upon at least two different control,
or piloting, frequencies. Because of the fact that
50 the regulation action is made a function of at
least two different frequencies it is feasible to take
into consideration in the regulating action at the
receiving end the actual frequency dependence of
the attenuation changes occasioned in the trans-
55

mission system. As to the rest the regulation according to the invention is preferably effected in the following fashion: Two control frequencies are sent out which are contained within the lower and the upper boundary zone in the band to be transmitted, or else directly below or above the same. At the receiving end the amplitude of one of these control frequencies is used for regulating the absolute amount of the amplification factor or gain of the receiving amplifier so that, under the influence of these control frequencies, a parallel shift of the amplifier curve is caused.

The frequency dependence of the regulating action is affected by the difference of the amplitudes of both control frequencies. Inasmuch as the two control frequencies are located at different places in the frequency band or spectrum to be transmitted they will be affected to dissimilar degrees upon the arising of selective attenuation changes with the result that the difference in their amplitudes represents a criterion insofar as it indicates in what frequency zone within the band to be transmitted there has occurred a more or less marked damping decrease or damping increase. Hence, according to whether the amplitude difference of the two control frequencies exceeds or falls below a definite mean value, the gain for the low or for the high pitches or frequencies may be influenced in the desired manner. The control of the gain in dependence upon the amplitude difference, as will be noted, results in a rotation of the characteristic rather than a parallel shift in the amplification characteristic.

For the control of the absolute magnitude of the gain, according to this invention, also the sum total of two or more control frequencies may be utilized. It is also possible to insure the frequency-dependent regulation of the gain in another manner than hereinbefore described. For instance, a piloting frequency included inside the lower region or below the frequency band to be transmitted may be utilized for influencing the transmission measure for the lower frequencies, and another control frequency located inside the upper boundary region or above the same may be employed for the control of the higher frequencies.

Fundamentally speaking, such a control or regulator action could be brought about by the use of a controllable attenuation network comprising complex resistances which would be connected ahead of (and in series with) the receiving apparatus or the receiver amplifier. Action upon the network by the lower control frequency would have to be brought about in such a way that essentially only the attenuation of the network for the lower frequencies is acted upon, whereas the higher one of the two control frequencies would have to influence the attenuation for the higher frequencies, without causing incidentally an alteration in the damping for the lower frequencies.

Hence, it is shown that the basic idea of the invention may be carried into practice in various ways. What remains essential in this connection is that for the control two or more frequencies are used, and that the control action is produced without a division of the frequency band to be transmitted becoming necessary by means of filters. Hence, the invention provides a solution to the problem of insuring a compensation in selective alterations of the transmission measure without going to the trouble and expense of providing means for the division of the spectrum into a plurality of channels furnished with distinct control

frequencies that has so far been necessary in the method hereinbefore described.

The underlying idea of the invention is useful both for wire as well as for radio transmission systems; and its advantages will be apparent both in multiple as well as in simple transmission systems.

So far as the regulation of the gain in the receiving amplifiers is concerned, there are especially suited voltage dividers which consist of linear resistances and controllable regulating resistances. For the latter it is preferable to use resistances whose resistivity changes under the action of a control quantity, say, a control or piloting voltage having such great inertia that they will be able to follow and respond to slow control impulses, while operating as or like linear resistances so far as the signal currents to be sent are concerned. What may be utilized for this purpose are the so-called hot conductors in the form of uranium dioxide filaments in vacuo.

In the case of long wire lines which comprise a plurality of amplifiers, the invention provides for regulation by stages or in sections in this manner that some of the amplifiers are regulated by the aid of a control frequency or the aggregate voltage of two or more frequencies by parallel shifting of the amplifier curve, and that frequency-dependent gain regulation in dependence upon two or all control frequencies is effected only at greater intervals.

The figures described in what follows serve to explain more fully the basic idea of the invention with a view to afford a better understanding of an exemplified embodiment.

In the drawing:—

Fig. 1 graphically shows the position of the control frequencies in the transmission band,

Fig. 2 schematically illustrates an embodiment of the invention,

Fig. 3 shows circuit details of the embodiment of Fig. 2.

Fig. 1 shows the position of the two control frequencies f_1 and f_2 in reference to the frequency band to be transmitted which extends from f to f' . The distance of the two control frequencies from the boundaries of the band to be transmitted is so chosen that these are readily separable or filterable by the aid of filter circuits known in the prior art.

In Fig. 2 an exemplified embodiment is shown schematically. In the rear of (above) the receiving amplifier V are branched off the two control frequencies by way of filters D_1 and D_2 , and these, after rectification in rectifiers G_1 and G_2 , are then used to act upon the regulator devices A and B connected below the amplifier. The regulating means B which serves for causing a parallel shift of the amplifier curves is only controlled by the fall of potential across the resistance R_1 . The gain adjusted by the regulator device B , as will be seen, is only dependent upon the incoming amplitude of the control frequency branched off by way of the filter D_1 .

The regulator device A which brings about a frequency-dependent control of the amplification factor or gain is fed with the difference of the voltages produced across the resistances R_1 and R_2 acting as a control voltage. The frequency-dependence of the regulating action, as will thus be noted, in the desired manner, is made a function of the difference in attenuation for both control frequencies.

Fig. 3 shows the two attenuator devices A and B in more detail. What is involved are voltage

dividers which consist of the linear input resistances R_A and R_B and the controllable nonlinear input resistances 2 and 1, respectively. The nonlinear resistances are electronic tubes whose grid 5 biasing voltages are controlled as a function of the output potentials of the rectifiers. Instead of electron tubes recourse could be had also to other controllable resistances, say, to the hot conductors above mentioned. The resistance R_B 10 is an ohmic resistance so that by the control of the non-linear resistance 1 only a parallel shift of the amplifier characteristic is produced.

The resistance arrangement R_A contains one, or more, frequency-dependent resistances which 15 conjointly with the capacity C and the non-linear resistance 2 result in the desired turn in the amplifier characteristic.

While I have indicated and described several systems for carrying my invention into effect, it 20 will be apparent to one skilled in the art that my invention is by no means limited to the particular organizations shown and described, but that many modifications may be made without departing from the scope of my invention, as set 25 forth in the appended claims.

What I claim is:

1. In combination with an amplifier of high frequency energy, the latter comprising a band of frequencies and at least two spaced control frequencies located adjacent the upper and lower 30 limits of the band, an energy input circuit for the amplifier, an output circuit for the amplifier, means coupled to the output circuit for deriving a direct current voltage from energy of one of 35 said control frequencies, a second means coupled to the output circuit for deriving a second direct current voltage from energy of the other con-

trol frequency, means in the input circuit, responsive to one of said voltages, for controlling the amplitude of said band frequencies in a substantially uniform manner, and a second means 5 in said input circuit, responsive to the differential of both voltages, for controlling the amplitude of said band frequencies in a non-uniform manner.

2. In a system as defined in claim 1, one of said control frequencies being disposed below the 10 lower limit of the frequency band, and the other control frequency being located above the upper limit of the band.

3. In a system as defined in claim 1, each of said output circuit means comprising a control 15 frequency filter followed by a rectifier.

4. In a system as defined in claim 1, each of the input circuit means comprising an electron discharge device having an electrode connected to its corresponding direct current voltage de- 20 riving means.

5. A method of regulating the signal transmission through an amplifier system which consists in impressing on said amplifier energy comprising a band of frequencies and a pair of spaced 25 control frequencies located adjacent the limiting frequencies of the band, amplifying the energy, deriving from energy of one of the control frequencies a direct current voltage, varying the amplitude of said band frequencies by equal in- 30 crements prior to amplification with said voltage, deriving from energy of the other control frequency a second direct current voltage, and varying the amplitude of said band frequencies prior to amplification with the differential of said two 35 voltages.

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