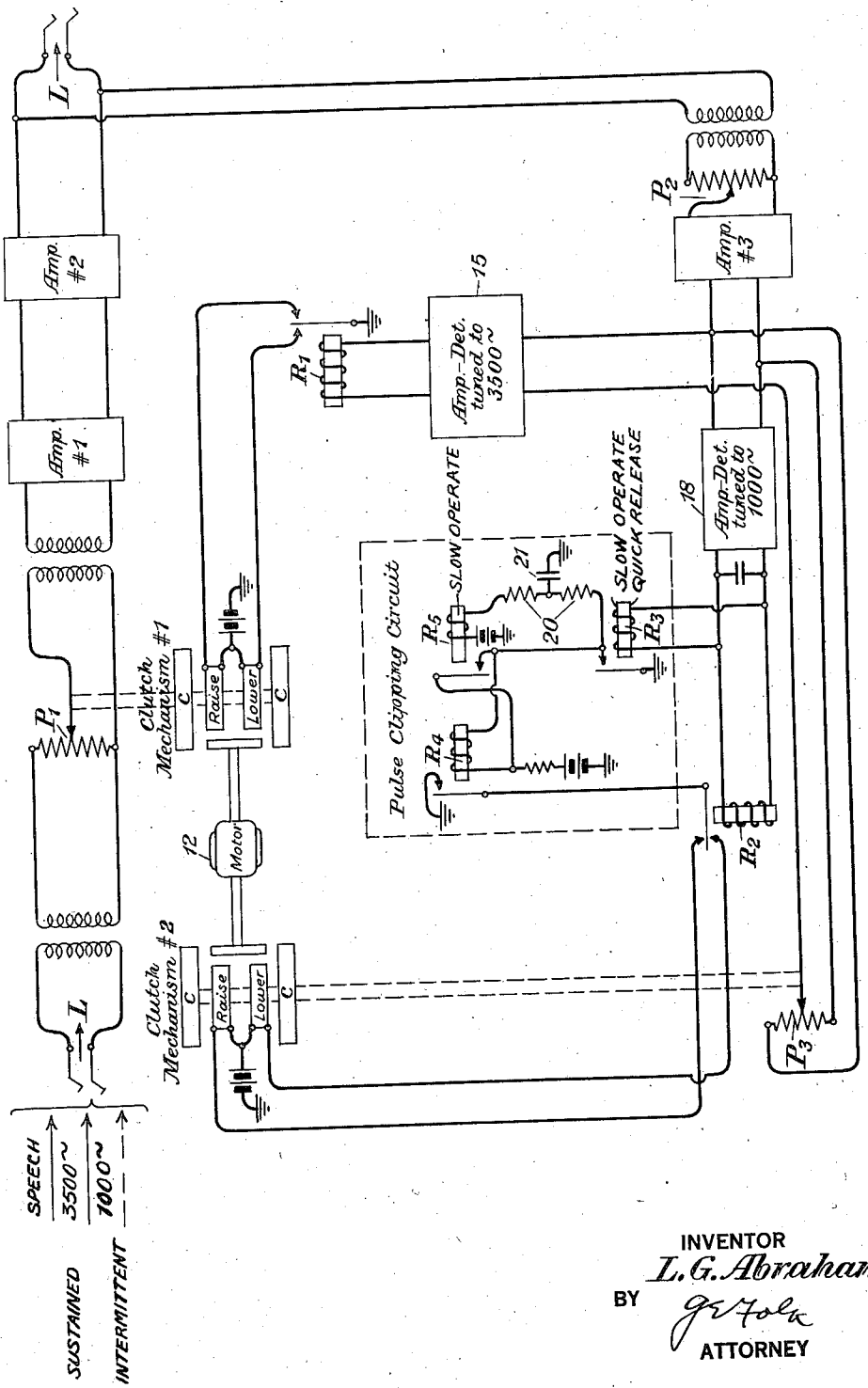
April 14, 1936. L. G. ABRAHAM 2,037,107

TRANSMISSION GAIN CONTROL

Filed Dec. 20, 1934



INVENTOR
L. G. Abraham
BY
ATTORNEY

Patented Apr. 14, 1936 2,037,107

UNITED STATES PATENT OFFICE

2,037,107

TRANSMISSION GAIN CONTROL

Leonard Gladstone Abraham, Madison, N. J., assignor to American Telephone and Telegraph Company, a corporation of New York

Application December 20, 1934, Serial No. 758,524

9 Claims. (Cl. 178—44)

This invention relates to devices for controlling the over-all transmission loss in a communication transmission line, and more particularly to lines in which a pilot current is transmitted over a transmission line and its intensity or its energy level on reception is used as a measure of the net loss in the line. This pilot signal is then used to bring about adjustments to keep the over-all net loss at a substantially constant desired value.

In certain cases where devices of this nature have been used, the pilot signal has been a sustained frequency outside but near the speech frequency band or other signal band to be transmitted. In other cases the pilot signal has been a tone within the message frequency band which is sent only intermittently and at moments not interfering with the message signal. In both cases the necessary equipment has been spoken of as a tonlar, an abbreviation of "tone operated net loss adjusting receiver."

The first of these has the advantage of being on continuously but has the disadvantage that its frequency is outside the signaling band to be transmitted. Since the variations of the line characteristics at that frequency are not the same as the changes in frequency characteristics within the signaling band, there is imperfect regulation. The advantage of the second type is that it makes adjustment for a typical frequency within the signaling band but it has the disadvantage that the circuit varies between adjustments and it may do so sufficiently to remove considerable of the advantage of the tonlar unless adjustments are made quite frequently.

The purpose of this invention is to combine the advantages of the two types of tonlars, that is, to obtain, continuously, substantially correct compensation for variations at some selected frequency within the signaling band. I accomplish this by sending continuously a frequency just outside the signal band which supervises the line for that frequency but the apparatus for which is itself adjusted or calibrated from time to time by an occasional signal of frequency in the transmitted signal band in such manner that the correction is really in terms of the latter. Thus the variations that occur frequently at both of these pilot frequencies are eliminated and the slow change in the transmission characteristic between these two frequencies is compensated for before it becomes appreciable.

The invention will be better understood by reference to the following specification and the accompanying drawing, in which the figure gives the essential circuit arrangement for a tonlar possessing the characteristics which I desire.

To make the description more definite and to give an example of the frequencies involved, it will be assumed that a speech signal is to be transmitted using the band of frequencies up to 3400 cycles. Then for the continuous control frequency we may take 3500 cycles, and for the intermittent frequency we may take 1000 cycles. It is to be understood, however, that these frequencies are given for illustrative purposes only and are not intended in any way to limit the scope of the invention.

Referring to the figure, there is shown an incoming transmission line L with repeating coils and amplifiers, there being two shown here. The gain of these amplifiers may be controlled at least in part, by a suitably located potentiometer P_1, here shown as on the input of the first amplifier, and the potentiometer is controlled by a clutch mechanism #1, operated by motor 12, to raise or lower the contact of the potentiometer P_1, thus controlling the net loss of the circuit in a manner hereinafter described. The 3500 cycle current and occasional 1000 cycle current which come over the transmission line are taken off at the output of amplifier #2 and impressed on the input of amplifier #3 through an adjustable potentiometer P_2. When 3500-cycle current alone is on the line it passes through an amplifier-detector 15, tuned to 3500 cycles, and then controls the relay R_1. If the current is too large, due to a decrease in transmission loss, the relay R_1 operates, causing the lower gain clutch of mechanism #1 to be actuated, thus changing the setting of P_1 and restoring the 3500-cycle current at the terminal of amplifier #2 to a value such that the tongue of relay R_1 is restored to its normal intermediate position. If, on the other hand, the 3500-cycle current is too weak, the relay R_1 closes on the back contact and the opposite effect is obtained, that is, the raise gain clutch of mechanism #1 is actuated, thus again changing the setting of P_1 to restore the 3500-cycle current at the output of amplifier #2 to its normal value. The sensitivity of the relay R_1 is controlled by a potentiometer P_3 across the output of amplifier #3, and by changing the setting of this potentiometer, one controls the amount of 3500-cycles at the output of amplifier #2 which is required to operate the clutch mechanism #1 in the one direction or the other. When the occasional 1000-cycle current is added, the circuit functions on the 3500-cycle current in the same manner except that the 1000-cycle current may bring about a change in the setting of the potentiometer P_3 for the purpose of adjusting or "calibrating" the 3500-cycle circuit to cause the relay R_1 to operate about that average value of the 3500-cycle current which is appropriate in view of the existing transmission loss at 1000 cycles.

More specifically, it will be seen that the 1000-cycle current is picked off by an amplifier-detector 18, tuned to 1000 cycles. It thus operates or releases the relay R_2, depending upon its

strength, and so causes the clutch mechanism #2 to adjust the potentiometer P_3, which in turn results in a corresponding adjustment in P_1 until the desired amount of 1000-cycle current is obtained at the output of amplifier #2.

After a sufficient time interval to insure that this adjustment has been made (and this will be in the order of half a second), a pulse-clipping circuit operates to remove the ground from the tongue of relay R_2 and prevents any further change in P_3. This pulse-clipping circuit operates as follows:

A relay R_3 is connected in the output of the amplifier-detector 18 in parallel to relay R_2. Controlled by the contact of relay R_3 are two other relays, R_4 and R_5, these being in parallel with each other and effective on the making of R_3. The relays R_4 and R_5 are both sensitive but R_5 is a slow-operate relay, rendered so by resistances 20 and grounded condenser 21. When current due to the 1000-cycle is present in the output of detector 18, R_3 operates and in turn brings about the operation of R_4 and R_5. The operation of R_4 applies ground to the tongue of R_2. A short time later R_5 operates to short-circuit R_4, which in turn releases and the ground is removed from the tongue of R_2. When the 1000-cycle current is removed (and it is on for a short time only), relays R_3 and then R_5 release, the tongue of R_2 is left ungrounded and the cycle is ready to be repeated. It is desirable, of course, that the relay R_3 shall not be responsive to any 1000-cycle oscillations coming from the speech message itself. This is accomplished, in practice, by arranging that the amplitude of the intermittent 1000-cycle control current shall be of a magnitude corresponding to testing conditions, that is, of a magnitude which should, in general, be large compared to any 1000 cycle not arising in connection with the speech message. In order further, however, to preclude operation of this relay R_3 by speech, it is desirable to make the relay R_3 a slow-operate and quick-release relay, in which case, it will not be operated except by the definite intermittent 1000-cycle control current.

It is apparent that many variations may be made in the combination of relays to bring about the desired results, all without departing from the spirit of this invention. This is particularly true of the pulse-clipping circuit, and the particular arrangement shown is for illustrative purposes only.

What is claimed is:

1. In a system for maintaining substantially constant transmission loss over a transmission line, comprising a source of sustained current of one frequency and a source of intermittent current of another frequency, each transmitted over the line as pilot currents, means responsive to the sustained current to adjust the gain in accordance with the net loss at that frequency, and means responsive to the intermittent current to adjust the sensitivity of the first-named means in accordance with the net loss at frequency of the intermittent current.

2. The method of adjusting tandem repeaters for gain in a line comprising those repeaters, which consists in sending a continuous current of one frequency and an intermittent current of another frequency over the line, using the first current to adjust the gain of the repeaters in accordance with line variations at that frequency, and using the second current to control the effectiveness of the first in accordance with line variations at that second frequency.

3. The method of adjusting tandem repeaters for gain in a telephone line comprising those repeaters, which consists in sending over the line a continuous current of a frequency outside the signal frequency band and an intermittent current of a different frequency within the signal band, using the first current to adjust the gain of the repeaters in accordance with line variations at that frequency, and using the second current to control the effectiveness of the first in accordance with line variations in the speech band.

4. The method of adjusting the transmission level in a line which consists in sending a continuous tone frequency current and an intermittent tone frequency current over the line, selectively separating these from the line where the adjustment is to be made, detecting these currents and applying the first current to introduce gain or loss in accordance with the intensity of the current of that frequency as detected, and applying the second current to calibrate and control the adjustments of the first in accordance with line variations at the second frequency.

5. In combination, a transmission line, repeaters therein, means for sending over said line a sustained tone frequency current, means for sending over said line a second intermittent tone frequency current, means for separating out and detecting these frequencies for transmission into derived circuits, and means in said derived circuits for adjusting the gain or loss of the line in accordance with line variations at the first frequency, and further means for controlling the adjustment by the first adjusting means in accordance with line variations at the second frequency.

6. A telephone line having a repeater station thereon, means controlled by a tone having a frequency outside the voice frequency range and transmitted continuously over the line for controlling the gain to hold the energy level beyond the repeater and at that frequency within desired limits, and additional means controlled by a tone having a frequency within the voice frequency range transmitted at intervals over the line for controlling the effectiveness of the first-named control means in accordance with line variations at the frequency of the intermittent tone.

7. The combination of claim 6 characterized by means for preventing operation of the second-named control means by currents transmitted during the intervals between the transmission of the intermittent frequency tone.

8. The combination of claim 6 characterized by means comprising a slow-acting relay for preventing operation of the second-named control means by voice currents during communication over the line.

9. The combination of claim 6 characterized by the fact that there is a slow-acting relay under control of detected intermittent frequency which relay prevents operation of the second-named control means by voice currents during communication over the line.

LEONARD GLADSTONE ABRAHAM.