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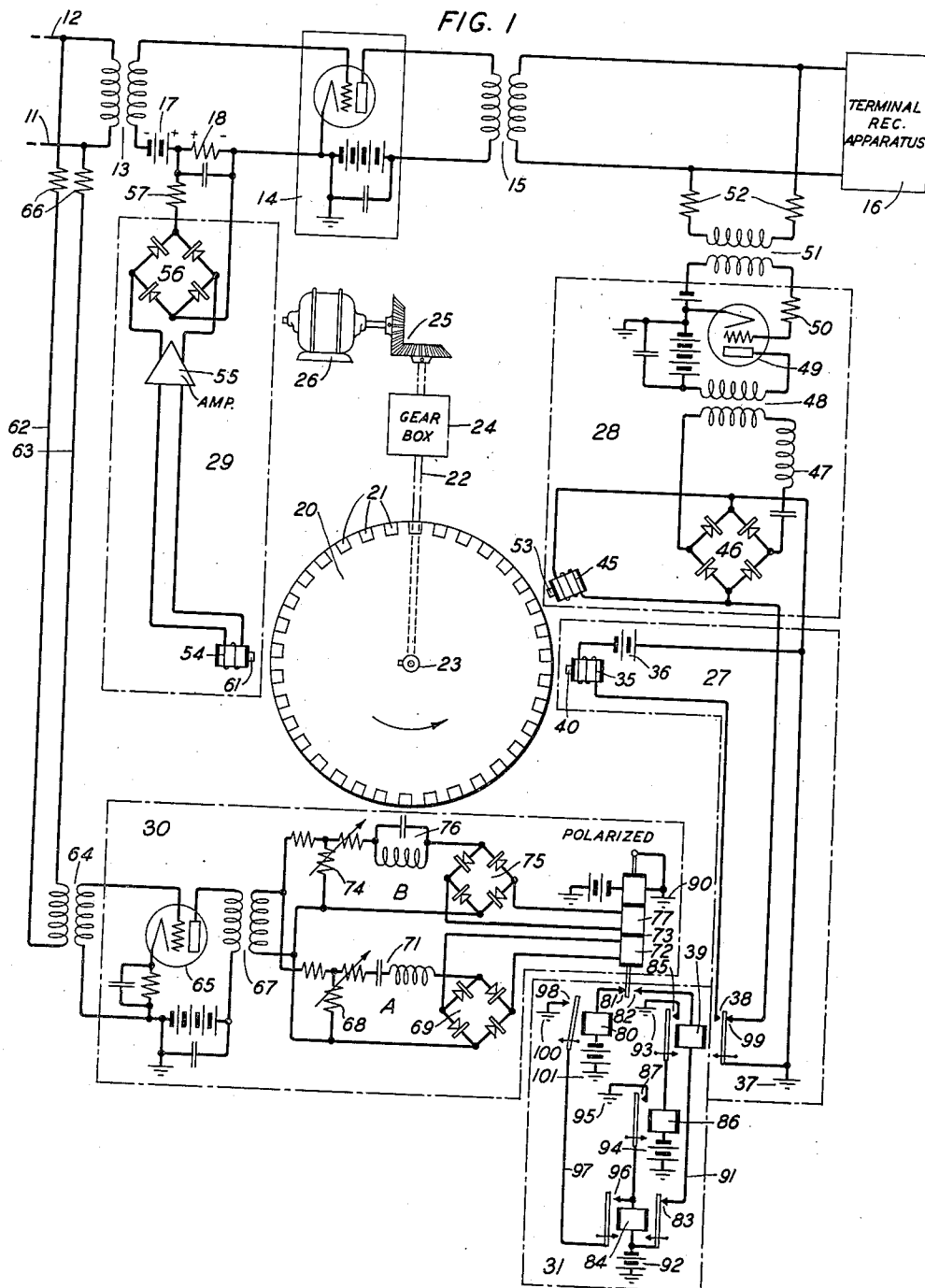
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TRANSMISSION LEVEL CONTROL

Filed Oct. 27, 1937

2 Sheets-Sheet 1



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FIG. 2

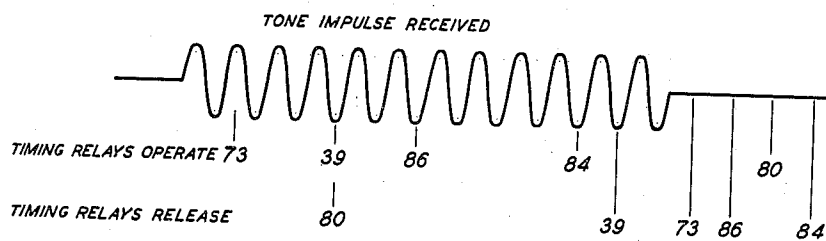
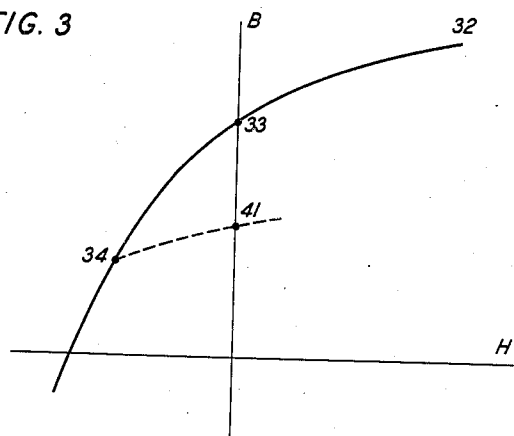


FIG. 3



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TRANSMISSION LEVEL CONTROL

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This invention relates to signaling systems having lossor apparatus located in a signal receiving station and more particularly to an arrangement for adjusting the loss in such apparatus under control of transmitted control current.

In long transmission lines it is necessary to include transmission control apparatus at one or more points to compensate for variations in transmission. One circuit used heretofore to provide suitable transmission control in such systems embodied a potentiometer whose adjustments are effected by a motor-clutch mechanism controlled by a transmitted control current. Another circuit for the same purpose included a thermionic amplifier having a biasing condenser charged to an amount depending on the amplitude of the received control current. The present invention contemplates a tone-adjusting circuit embodying discrete magnetizable elements whose magnetization is varied by a received tone current and thereafter utilized to vary the induction of a device that controls lossor apparatus.

An object of the invention is to provide a facile arrangement for expeditiously controlling transmission adjusting apparatus by means of a control current transmitted over the line.

In the embodiment of the invention herein disclosed it is assumed that the control current transmitted over the line is of a frequency within the frequency range of the signaling currents. A plurality of discrete magnetizable elements is initially provided with a maximum value of magnetization which is subsequently decreased by an amount that is proportional to the control current received over the line during an adjusting interval. The final value of magnetization is utilized to vary the induction of a device that produces biasing potential for controlling the gain of a grid bias-variable mu thermionic amplifier located in the receiving terminal. Inasmuch as the frequency of the control current is within the frequency range of the signaling currents, the invention also embodies provisions for restricting changes in the magnetization of the elements to only those intervals during which control current is being transmitted over the line.

The invention will be more readily understood from the following description taken together with the accompanying drawings in which:

Fig. 1 shows the invention conditioned for signaling transmission;

Fig. 2 illustrates the sequence of operation of timing relays in response to a control current received over the line; and

Fig. 3 is a typical magnetization curve of the magnetizable elements.

Fig. 1 shows a terminal receiving station in which a signaling transmission line, comprising conductors 11 and 12, is applied through a transformer 13, lossor apparatus 14 and transformer 15 to terminal receiving apparatus 16. For this illustration the lossor is a grid bias-variable mu thermionic amplifier having a biasing battery 17 and resistance 18 connected in its grid circuit. As current flows through the resistance 18 in a manner to be subsequently explained the voltage developed thereacross is in opposition to that of biasing battery 17 shown in Fig. 1. This varies the grid bias applied to the lossor, and consequently the gain thereof. Therefore, by controlling the amount of current flowing through the resistance 18 a signal supplied to the terminal receiving apparatus can be maintained at a predetermined level. It is understood that the lossor apparatus may be any one of several well-known types such, for example, as silver sulphide, or a grid bias-variable impedance thermionic amplifier, or direct or alternating current bias variators. For the purpose of this description, it is assumed that the circuit shown in Fig. 1 is in the condition that it would be in between lossor adjustments which are accomplished in a manner to be hereinafter explained. In other words, Fig. 1 shows the receiving end conditioned to receive signaling currents transmitted over the line.

A drum 20 containing a plurality of peripherally-disposed discrete magnetizable elements 21 is suitably attached to a shaft 22 journaled at 23 and driven through gear box 24 and bevel gears 25 by a synchronous motor 26 so as to rotate in the direction shown by the arrow. Associated with the magnetizable elements 21 is a polarizing circuit 27, a depolarizing circuit 28 and a pickup circuit 29. A starting circuit 30 and a timing circuit 31 control the effectiveness of the polarizing and depolarizing circuits whereby the amount of magnetism provided in the elements 21 is fixed for a given interval of time in a manner that will be subsequently explained.

The polarizing circuit comprises in series a polarizing coil 35, battery 36, and normally open inner right contact 38 of relay 39. Associated with the polarizing coil 35 is a pole-piece 40 which, after the inner right contact 38 of relay 39 is closed to connect battery 36 to the polarizing coil 35 as will be later explained, serves by the flux set up therein to provide in the elements 21 a maximum value of magnetization as the latter are passed therebefore. Between adjustments

the polarizing circuit is disabled due to the open inner right contact 38 of the relay 39 as shown in Fig. 1.

The depolarizing circuit comprises a depolarizing coil 45 connected across one diagonal of a copper-oxide bridge rectifier 46 having its opposite diagonal connected through a series tuned circuit 47 to the secondary winding of a transformer 48. The primary winding of the latter is connected to the output of a thermionic amplifier 49 whose input is connected to a transformer 51 applied across the transmission line. Suitable impedances 52, 52 interposed in the primary side of the transformer 51 serve to reduce shunting loss through amplifier 49. Associated with the depolarizing coil 45 is a pole-piece 53 which, due to the direction of the current flow in the coil 45, serves to set up flux in a direction opposite to that set up in the pole-piece 40 by the coil 35. The tuned circuit 47 passes amplified control current received from the amplifier 49. An impedance 50 is disposed in the grid circuit of the amplifier 49 to prevent the depolarizing effect of the pole-piece 53 from attaining a value that would tend to reverse the magnetism in the elements 21. The depolarizing circuit is disabled as shown in Fig. 1 by a ground 37 applied through the closed outer right contact 38 of the relay 39 to the diagonal of the rectifier 46 to which the depolarizing coil 45 is connected.

The pick-up circuit consists of a coil 54 connected to the input of a thermionic amplifier 55 having its output applied across one diagonal of a copper-oxide bridge rectifier 56 whose other diagonal is applied across a resistance 57 and a resistance 18, both of which are connected in series. As previously mentioned, the resistance 18 is also disposed in the input of the lossor. Associated with the coil 54 is a pole-piece 61 in which flux is set up to a value depending on the magnetization of the elements 21 as the latter are passed therebefore. This flux induces in the coil 54 current which is rectified and caused to flow through resistance 18 to develop thereacross the voltage that varies the gain of the lossor in the manner mentioned hereinbefore.

The starting circuit includes leads 62 and 63 connecting the signaling transmission line and the primary winding of transformer 64 whose secondary winding is applied to the input of a thermionic amplifier 65. The leads 62 and 63 embody impedances 66, 66 utilized to reduce shunting loss of the amplifier 65. The output of amplifier 65 is impressed on the primary winding of a transformer 67 whose secondary is applied to paths A and B. The path A embodies an adjustable impedance network 68 connected across one diagonal of a copper-oxide bridge rectifier 69, and also a series resonant network 71 in one branch thereof. The opposite diagonal of the rectifier 69 is applied to winding 72 of a polar relay 73. The path B includes an adjustable impedance network 74 connected across one diagonal of a copper-oxide bridge rectifier 75 together with a parallel resonant network 76 in one branch thereof. The opposite diagonal of the rectifier 75 is applied to the winding 77 of the polar relay. The series resonant network 71 in path A is designed to effect the operation of the polar relay in response to current of control frequency while the parallel resonant network 76 in path B is arranged to prevent the operation of the polar relay while currents of other frequencies are being transmitted over the line to-

gether with current of the control frequency. The adjustable impedance networks regulate the relative sensitivities of the paths A and B.

The timing circuit includes a slow-release relay 80 whose energizing circuit is controlled through left contact 81 of the polar relay, and a slow-operate fast-release relay 39 whose energizing circuit extends through right contact 82 of the polar relay and contact 83 of slow-operate relay 84. Extending through the left contact 85 of the relay 39 is the energization circuit of a slow-operate relay 86. As previously mentioned the disabling or effectiveness of the polarizing and depolarizing circuits is controlled through the inner right contact 38 and the outer right contact 99 of relay 39. An energization circuit for relay 84 is completed through the left contact 87 of relay 86. The functioning of the timing circuit will be more adequately explained hereinafter.

The operation of the circuit will now be described:

As previously mentioned, it is assumed that the circuit shown in Fig. 1 is in condition for signaling transmission and therefore the loss in the lossor has been previously adjusted to provide at the receiving terminal signaling current of a predetermined level. That is, a rectified current corresponding to the current induced in the pick-up coil 54 is flowing in the resistance 18 to cause a biasing voltage of a certain value to be impressed on the grid of the lossor so as to produce a predetermined output. The pulse of control current for automatically accomplishing a subsequent adjustment of the lossor is of a frequency lying substantially at the mid-point of the signaling range. As this pulse is received over the line from a sending station, not shown, a portion is diverted over leads 62 and 63 and through transformer 64, amplifier 65 and transformer 67 to be applied to paths A and B. Since the path A is resonant to the frequency of the control current the rectified current corresponding thereto is impressed on winding 72 to operate the polar relay which closes the right contact 82. The control current is blocked in anti-resonant path B.

Relay 39 operates in response to an energizing circuit which includes ground 90, armature and closed right contact 82 of the polar relay, winding of relay 39, lead 91, right contact 83 of relay 84, and battery 92. This closes the inner right contact 38 of relay 39 to render the polarizing circuit effective by applying battery 36 to the polarizing coil 35. At the same time the outer right contact 99 of relay 39 is opened to render effective the depolarizing circuit 28 by removing ground 37 from the one diagonal of the rectifier 46.

Another portion of the control current passes through the lossor to energize the depolarizing circuit. In passing before the polarizing coil 35, the elements 21 are magnetized to some value such as 32 in Fig. 3. After leaving the saturating coil 35, this magnetization falls to some value 33 (Fig. 3) which in all cases depends on the retentivity of the elements 21. As the elements 21 move along, the depolarizing current in the coil 45 causes the magnetization of the elements 21 to decrease to some value such as 34 in Fig. 3. This magnetization rises slightly to some value such as 41 in Fig. 3 as the elements 21 pass beyond the effect of the depolarizing coil 45. Thus, the decrease in magnetization from 33 to 41 varies in proportion to the level of the control

current received over the line at the receiving terminal. The magnetization in the elements 21 after passing from the depolarizing effect of the depolarizing circuit constitutes a history of the received control current. As the elements 21 containing the history pass before the pick-up coil 54 a voltage is induced therein. A rectified current corresponding to the induced voltage flows through the resistance 18 to produce there-
 10 across an opposition voltage which varies the bias applied to the grid of the lossor by battery 17 and thereby the gain of the lossor as hereinbefore mentioned.

Accordingly, as the received pulse of control current increases, the current flowing in the depolarizing circuit also increases to cause proportional decreases in the magnetization of the elements 21. Hence, the current induced in the pick-up circuit decreases in proportion to current increases in the depolarizing circuit. This occasions decreases in the opposition voltage developed across the resistance 18. As the opposition voltage decreases, the biasing voltage applied to the grid of the lossor increases, and therefore the gain of the lossor decreases. Similarly, as the received pulse of control current decreases, the current flowing in the depolarizing circuit decreases to cause proportional increase in the magnetization of the elements 21. Consequently,
 30 ly, the current induced in the pick-up circuit increases in proportion to the current decreases in the depolarizing circuit. This occasions increases in the opposition voltage developed across the resistance 18. As this voltage increases, the biasing voltage impressed on the grid of the lossor decreases, and hence the gain of the lossor increases.

It is therefore evident that the voltage induced in the pick-up coil 54 is a maximum when the magnetization of the elements 21 has the value 33 in Fig. 3 and no depolarizing control current is flowing in the coil 45. Further, as control current is received in the receiving station, this current flowing in rectified form in the depolarizing coil 45 demagnetizes the elements 21 to some value less than the value 33. So long as the polarizing and depolarizing circuits are effective, variations in the magnetization of the elements 21 occasioned by variations in the received control current changes the amount of current induced in the pick-coil 54 and thereby the gain of the lossor. Consequently, it is evident that the loss effected in the lossor is a function of the output of the lossor.

After a predetermined number of revolutions of the drum during an interval when the polarizing and depolarizing circuits are effective, the magnetization of each of the elements 21 reaches stability to cause a substantially constant voltage to be induced in the pick-up coil 54 whereby a substantially constant voltage is developed across the resistance 18. This fixes the bias applied to the lossor at a certain amount so that the gain thereof attains a predetermined and substantially constant level. The latter produces at the receiving end a signal having a predetermined level.

As relay 39 operated, its left contact 85 also closed to operate relay 86 through an energization circuit including ground 93, closed left contact 85 of relay 39, winding of relay 86 and battery 94. This closes left contact 87 of relay 86 whereby relay 84 is operated due to an energizing circuit comprising ground 95, closed left contact 87 of relay 86, winding of relay 84 and battery

92. Relay 84 is locked up through a locking circuit comprising battery 92, the winding and closed left contact 96 thereof, lead 97, closed left contact 98 of relay 80 and ground 100. Relay 80 was released when the polar relay operated to remove its armature from left contact 81 to right contact 82 to interrupt the energizing circuit of relay 80 extending from ground 90 through the armature and closed left contact 81 thereof, winding of relay 80 to battery 101. Therefore, relay 80 was released simultaneously with the operation of relay 39.

The operation of relay 84 opens its right contact 83 to interrupt the previously described energizing circuit of relay 39. The latter relay 15 quickly releases thereby opening its inner right contact 39 and closing its outer right contact 99 to respectively disable the polarizing and depolarizing circuits in the manner hereinbefore described. Under control of a suitable timing circuit located at the sending station, not shown, the control current is removed from the transmission line. For the time being, therefore, the fixed magnetization of the elements 21 holds the loss in the lossor at a predetermined value until the next subsequent adjustment. The line is now conditioned for signaling transmission such that signals of predetermined level are received at the receiving terminal apparatus.

Upon the termination of the pulse of control current, the polar relay releases to close left contact 81 and to open right contact 82. The release of relay 39 also opens left contact 85 to interrupt the energizing circuit of relay 86. The release of the polar relay completes the previously mentioned energization circuit of relay 80 whereupon the latter operates to open its left contact 98. This serves to interrupt the hereinbefore mentioned locking circuit for relay 84 which now releases to close its right contact 83 thereby conditioning the timing circuit for the next subsequent impulse of control current.

The relay arrangement constituting the timing circuit is so arranged that the effectiveness of the polarizing and depolarizing circuits is extended for an interval of sufficient duration to enable the magnetization provided in the elements 21 to attain a state of stability in accordance with the level of the received control current. Upon the attainment of such condition and during the period when the line is conditioned for signaling transmission as shown in Fig. 1, the polarizing and depolarizing circuits are disabled in the manner previously explained. Fig. 2 shows the sequence of operation of the timing relays during and immediately after the period when an impulse of control current is received at the receiving terminal.

Inasmuch as signaling currents include a current of the frequency of the control current, the path B of the starting circuit is arranged to pass all currents of frequencies other than the frequency of the control current while path A of the same circuit is arranged to pass current only of the frequency of the control current as described above. The sensitivity of these paths is so adjusted that during signaling transmission signaling current in path B applied to winding 77 of the polar relay prevents current of the frequency of the control current in path A from falsely operating the polar relay. Consequently, the operation of the polar relay is restricted to only those intervals when an impulse of control current for the purpose of adjusting the lossor

apparatus is being exclusively received at the receiving terminal.

It is understood that the pole-piece 40 associated with the polarizing coil 35 is located at a circumferential distance s from the pole-piece 53 associated with the depolarizing coil 45 so that $s=vt$, where v =velocity of the elements 21 and t =time of travel in the release direction of the armature of relay 39 associated with the polarizing and depolarizing circuits.

What is claimed is:

1. In a signaling transmission system having a transmission adjusting apparatus located at a receiving terminal and including a magnetizable element, the method of controlling the transmission adjusting apparatus which comprises magnetizing the element according to the level of a control current received at intervals over the system, utilizing the magnetization of the element to produce a voltage for actuating the transmission adjusting apparatus during intervals when control current is being received, and utilizing the magnetization of the element to produce a voltage for actuating the transmission adjusting apparatus during intervals when no control current is being received.

2. In a signaling transmission system having a transmission adjusting apparatus located at a receiving terminal and including a plurality of magnetizable elements, the method of controlling the transmission adjusting apparatus which comprises highly magnetizing the elements during intervals when a control current is being received over the system, reducing the magnetization of the elements according to the level of a control current received at intervals over the system, utilizing the magnetization of the elements to produce a voltage for actuating the transmission adjusting apparatus during intervals when control current is being received, and utilizing the magnetization of the elements to produce a voltage for retaining the transmission adjusting apparatus in a fixed position during intervals when no control current is being received over the system.

3. In a signaling transmission system, a signal line, a terminal receiving station, an adjustable loss apparatus in said station, and control means operated in response to a pulse of control current received at intervals over said line for adjusting said loss apparatus according to the energy level of the received pulse of control current, including a magnetizable element magnetized according to the energy level of the received pulse of control current and whose magnetization is utilized to produce a potential for actuating said loss apparatus during intervals when control current is being received and also during intervals when no control current is being received.

4. In a signaling transmission system, a signal line, a terminal receiving station, a thermionic amplifier in said station, means for automatically adjusting the gain of said amplifier according to the energy level of pulses of control current received at intervals over the line comprising a magnetizable element magnetized according to the energy level of the received pulses of control current and means responsive to the magnetization of the element to produce a voltage for controlling the bias on said amplifier during intervals when control current is being received and also during intervals when no control current is being received.

5. In a signaling transmission system, a signal line, a terminal receiving station, an adjustable

loss device in said station, and control means operated in response to a pulse of control current received at intervals over said line for automatically adjusting said loss device according to the energy level of the received pulse of control current comprising a plurality of magnetizable elements whose magnetization corresponds to the energy level of the received pulse of control current, means responsive to the magnetization of the elements for producing a voltage to actuate said loss device during intervals when control current is being received and also during intervals when no control current is being received, and means operated in response to the receipt of the pulse of control current for controlling the intervals during which the magnetization of the elements is effected.

6. In a signal transmission system, a signal line, a terminal receiving station, an adjustable loss device in the transmission line at said station, control means at said station for automatically adjusting said loss device according to the energy level of pulses of control current received at intervals over the line comprising a plurality of discrete magnetizable elements, means for providing in each of said elements a maximum magnetization, means for demagnetizing said elements according to the energy level of the received pulses of control current, means for utilizing the net magnetization of said elements to produce a voltage to operate said loss device, means for passing the elements to the magnetizing, demagnetizing and utilizing means in order, and means for rendering the magnetizing and demagnetizing means effective for a predetermined interval in response to the receipt of the pulses of control current.

7. In a signal transmission system, a signal line, a terminal receiving station, an adjustable loss device at said station, control means operated in response to pulses of control current received at intervals over the line for automatically adjusting said loss device according to the energy level of the received pulses of control current comprising a plurality of magnetizable elements, means for providing said elements with maximum magnetization, means for demagnetizing said elements according to the energy level of the received pulses of control current, means utilizing the net magnetization of said elements to produce a voltage for operating said loss device, means for passing said elements to the magnetizing, demagnetizing and utilizing means in order, means for rendering the magnetizing and demagnetizing means effective for an interval of such duration that the magnetization of said elements attains a state of stability, and means responsive to the received pulses of control current for operating the last-mentioned means and responsive to received signaling currents for rendering ineffective the last-mentioned means when current of the frequency of the pulse of controlled current is included in the frequency range of the signaling currents.

8. In a signal transmission system, a signal line, a terminal receiving station, an adjustable loss device in said station, and means operated by pulses of control current received at intervals over the line to automatically control said loss device according to the level of said pulses of control current comprising a plurality of magnetizable elements magnetized according to the level of said pulses of control current, means responsive to said received pulses of control current for adjusting the magnetization of the elements

such that all elements are magnetized substantially to the same amount, and means responsive to the magnetization of the elements for producing voltages that control said loss device during intervals when pulses of control current are received and during intervals when no pulses of control current are received.

9. In the signal transmission system according

to claim 8 in which the means for adjusting the magnetization of the elements includes a balancing circuit so arranged that magnetization adjustments are effected during intervals when control current is being exclusively received and is prevented during intervals when signaling current is being exclusively received.

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