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ALTERNATING CURRENT TRANSMISSION SYSTEM SUCH AS TELEPHONE SYSTEMS INCORPORATING ECHO SUPPRESSORS

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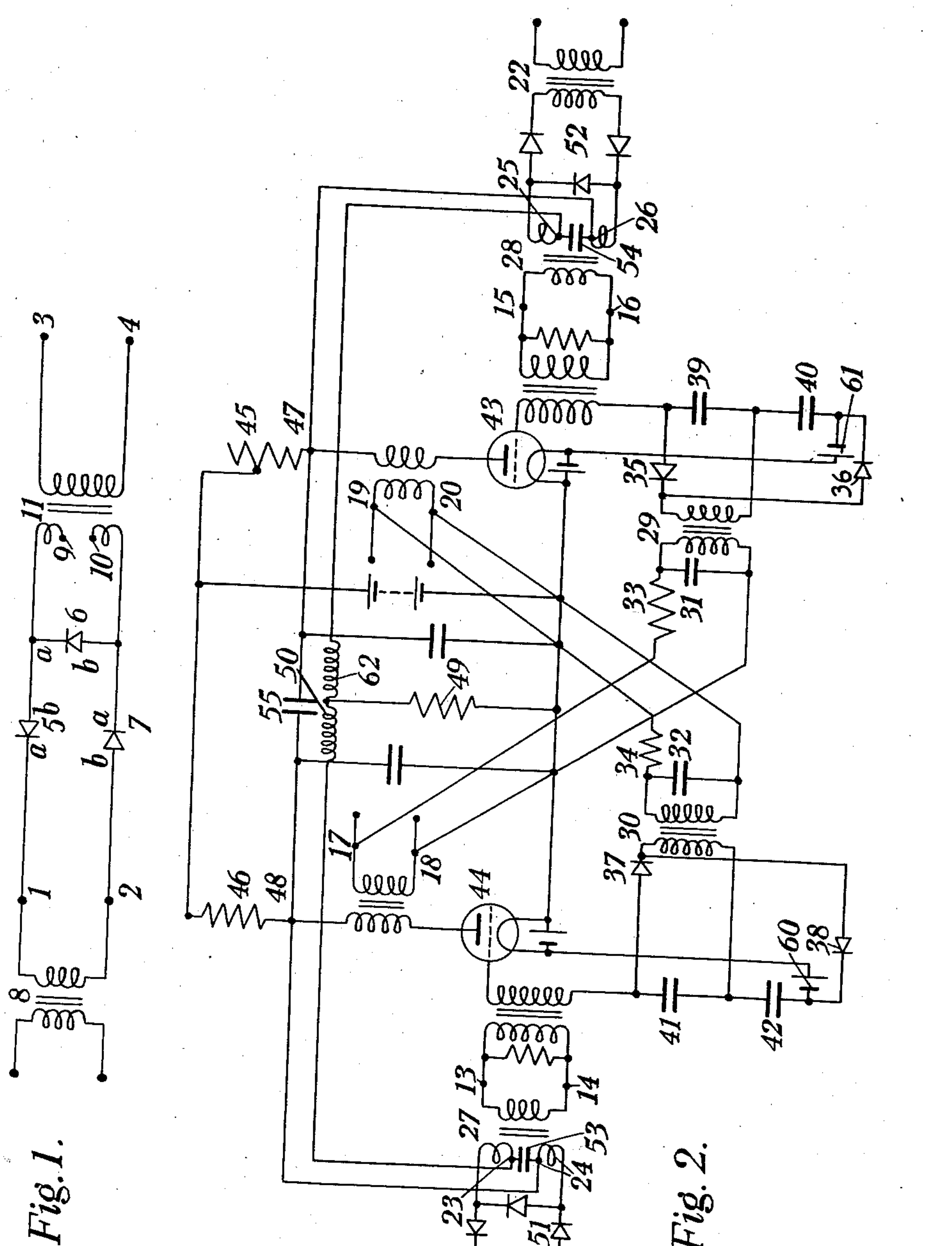

Fig. 1.

Fig. 2.

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ALTERNATING CURRENT TRANSMISSION SYSTEM SUCH AS TELEPHONE SYSTEMS INCORPORATING ECHO SUPPRESSORS

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5 Claims. (Cl. 179—170)

This invention relates to electric signalling systems having two-way complementary alternating current transmission circuits. The two circuits may be, for example, the "go" and "return" circuits of a telephone transmission system. Such systems are often arranged so that the attenuation of one circuit is increased, when transmission occurs in the other circuit, to prevent the transmission of echo signals in the one circuit; the present invention is directed towards effecting this increase of attenuation in a simple but effective manner.

In an electric signalling system having two-way complementary alternating current transmission circuits, according to the present invention, a variable attenuation network is incorporated in each of the circuits and is adapted to have its attenuation varied by D. C. control current so that during the transmission of signals in either of the circuits the attenuation of the network in the other circuit is such as substantially to prevent transmission therein and the circuit from which the control current is derived is so arranged that a change in the control current of one of the networks to increase or tend to increase the attenuation thereof is accompanied by a change in the control current of the other network to decrease or tend to decrease the attenuation thereof, whereby the attenuation of both networks cannot be changed simultaneously in the same direction. Preferably one or more dry plate rectifiers are arranged in series and/or shunt arms of each network and the D. C. control current is passed through the rectifiers in such a direction that a change of the control current in one direction increases the attenuation of the network whilst a change in the other direction decreases the attenuation of the network: alternatively the network may comprise one or more relays adapted to vary the attenuation under the control of the D. C. current.

The D. C. control current may be passed through the two networks in series so that a change in the control current tends to increase the attenuation of one of the networks and to decrease the attenuation of the other.

The D. C. control current may conveniently be derived from a pair of opposite corners of a D. C. bridge network which is adapted to be unbalanced in one direction by the transmission of signals in one of the transmission circuits and to be unbalanced in the opposite direction by the transmission of signals in the other transmission circuit. Preferably the bridge is so adjusted that in the normal condition when no signals are being transmitted the said pair of opposite corners are at substantially the same potential and the control circuits of the two attenuation networks are connected in series between the said corners and the junction of the said control circuits is connected through an impedance to one of the other corners of the bridge so that normally biasing current flows through the control circuits to maintain the attenuations of the networks at a small value.

Thermionic valves may be arranged in adjacent arms of the bridge so that the unbalancing of the bridge may be effected by varying the D. C. grid bias voltage of one or other of the valves and thereby varying the D. C. impedance of the valve. Preferably the valves also serve to amplify signal currents in the transmission circuits.

A condenser shunted by an impedance may be connected in the grid circuit of each valve and the condensers may be respectively associated through rectifiers with the transmission circuits so that signal currents are rectified and applied to the condensers and thereby vary the grid bias voltage of the valve.

The invention will now be described by way of example, with reference to the accompanying drawing, of which Figure 1 shows one form of variable attenuation network and Figure 2 shows the application of networks of this form to a telephonic amplifier to form an echo suppressor.

The variable attenuation network shown in Figure 1 is inserted between the line transformer 8, connected to points 1 and 2, and a transformer 11 which is connected to the input terminals of the associated thermionic repeater at points 3 and 4. Connected in the arms of the network are variable impedance elements, 5, 6, 7, which consist of rectifiers (such, for example, as copper oxide rectifiers) and which have a low impedance to the alternating current signals, when a steady current flows through them in the direction *a* to *b*. The steady D. C. control current is applied to the network between the points 9, 10, at the centre of one of the windings of the transformer 11. When the steady current flows from point 10, through rectifiers 7 and 5, to point 9, the network has a low attenuation to the signal currents, since the impedances to the signal currents of the series rectifiers 5 and 7 will be small and that of the shunt rectifier 6 will be large. When the direction of the steady current is reversed the attenuation of the network is large, as the impedances of the rectifiers 5 and 7 to the signal currents will be large and that of rectifier 6 will be small. The transformer 11 may be made the input transformer of the thermionic repeater and the associated input impedance is then connected across points 1 and 2.

Figure 2 shows one form of echo suppressor in which attenuation networks of the form described above are associated with thermionic repeaters in conjunction with auxiliary equipment, which is used to obtain the variation in the steady control current needed to control the attenuation of the networks. The two thermionic repeaters in the "go" and "return" paths of the signal circuit have their input terminals at points 13, 14 and 15, 16 and their output terminals at points 17, 18 and 19, 20, respectively. Single stage repeaters are shown, although multi-stage amplifiers can be used. The variable attenuation networks are inserted in the repeater circuits between the line transformers 21, 22 and the input terminals 13, 14 and 15, 16. The steady currents that control the attenuation of the networks, and which are fed into the networks at the points 23, 24 and 25, 26, in the centre of one of the windings of transformers 27, 28, respectively, are obtained and controlled in the following manner:—

The outputs from the repeaters at points 17, 18 and 19, 20 are applied respectively through resistances 33, 34, to the low windings of step-up transformers 29, 30, tuned by capacities 31, 32, to have maximum impedances at a frequency of about 1,000 cycles/sec. The voltages across the step-up windings of the transformers 29, 30, are rectified by means of rectifiers 35, 36 and 37, 38, and the rectified voltages are applied across condensers 39, 40 and 41, 42, connected in series with the grid circuits of the final stage amplifier valves 43, 44. The capacities of these condensers are selected so that their time constants, taken in conjunction with the backward resistances of the appropriate associated rectifiers, are about 0.25 second. The resistances 33, 34, prevent too much of the repeater output power from being shunted from the main transmission circuit. The action of the rectifiers results in the production of harmonics of the signal frequencies. These harmonics, which are greatest when the tuned transformers 29, 30 have their maximum impedances at the signal frequency, are prevented from being led back into the main output transmission circuit by the low impedances of the tuned transformers 29, 30, at these harmonic frequencies. If desired a suitable band pass filter may be inserted to prevent the harmonics being led back into the main output circuit. Double wave rectification also reduces the resultant signal distortion. Furthermore, extraneous low frequency signals are prevented from being rectified by the selective action of the tuned transformers 29, 30. If calling is effected by the transmission of currents of definite frequencies which may be transmitted simultaneously in both circuits, suitable filters may be inserted to prevent currents of these frequencies being rectified and so increasing the attenuation of one of the networks. The rectified voltages obtained across condensers 39, 40 and 41, 42, are of such polarities that the resultant negative grid bias voltages of the valves 43, 44 are reduced. When the rectified voltages become equal to the normal negative grid bias voltages supplied by batteries 60, 61, grid cathode filament current flows and prevents any further increase in the rectified voltage. Thus no excessive discharge time of condensers 39, 40, 41 and 42 can occur due to unduly large voltages being impressed on them when large signal voltages are rectified. Also the rectified voltage is never great enough to overload the rectifiers 35, 36, 37 and 38, and cause them to break down.

The reduction in the negative grid cathode voltage of either of the amplifier valves 43, 44, caused by signal voltages transmitted through the complementary amplifier, causes increased anode cathode current to flow. Resistances 45, 46, are connected in series with the anode supply voltage of the valves 43, 44. These resistances may be in part the resistances of anode chokes and anode current alarm relays. Since the anode current is never reduced from the normal value by the action of the complementary circuit signal currents, but is always increased, anode current alarm relays can be used.

The steady voltage that is applied at points 23, 24, to the variable attenuation network associated with the valve 44, is derived from the point 48, in the anode circuit of the amplifier valve 44, and one end, point 50, of a resistance 49, the other end of which is connected to the negative terminal of the anode-cathode supply battery. Similarly the steady voltage that is applied at points 25, 26, to the variable attenuation network associated with the valve 43 is derived from the point 47 in the anode circuit of the valve 43 and the point 50, at the end of resistance 49. The resistance 49 is very large compared with the resistances 45, 46, which are less than the normal anode cathode impedances of the valves 43, 44. Thus the current flowing through the resistance 49 is practically constant and is but slightly affected by any current changes that take place in the resistances 45, 46, due to changes in the grid-cathode potentials of the associated valves 43, 44.

When no signal currents are passing through either of the amplifiers the resistance 45 is adjusted until the points 47, 48 are approximately equipotential points. Approximately equal biasing control currents then flow through the attenuating networks 51, 52 to the point 50, each current being equal to one half of the current through the resistance 49. The network control currents are of such magnitude that the attenuation of the networks is a minimum. A reduction of control current to zero and then negative in either of the networks will then cause an increase in the network attenuation, whilst an increase in the network current will tend to decrease its attenuation. Condensers 53, 54, connected across points 23, 24, and 25, 26, by-pass the signal currents flowing in the networks and a smoothing condenser 55 may be connected between the points 47, 48. A choke 50 is inserted in the control circuits to decouple. A differential galvanometer may be temporarily connected across this choke to check the equality of the control currents in the quiescent state.

When a signal voltage is applied to, say, the "go" repeater via the line transformer 21, the output signal voltage at points 17, 18, causes an increase in the anode current of the valve 43 of the complementary "Return" repeater, as has already been described. The potential of the point 47 falls and the steady current in the network 52 decreases. This causes a corresponding increase in the current through the network 51, since the sum of the currents in the two networks 52 and 51 remains approximately constant. If the potential of point 47 falls below that of point 50, the steady current in the network 52 will be reversed, and the attenuation will be still further increased. Thus practically no signal will be transmitted through the network 52 even if it is applied to it via transformer 22.

When the signal applied to the "go" repeater ceases, the rectified voltage across condensers 39, 40, discharges through the backward impedance of the rectifiers 35, 36, causing the anode current through resistance 45 to decrease to the normal value. If desired separate discharge resistances may be provided across the condensers 39 and 41. The currents through the networks 52, 53, become equal and the attenuation of each network is a minimum. Since the sum of the network currents is approximately constant under all conditions it is not possible to increase the attenuation of both networks simultaneously, due, for example, to the simultaneous application of signal currents to the two line transformers 21, 22. If, under these conditions, it is desired, for example, that the network 52 shall have its attenuation increased, then the normal steady current that flows through it in the quiescent state is made slightly less than that flowing through the network 53, by suitably adjusting the value of the resistance 45.

I claim:—

1. In an electric signalling system having two-way complementary alternating current transmission circuits, the combination of two attenuation networks arranged respectively in the two transmission circuits, each of said networks consisting of at least one dry plate rectifier arranged in an arm of the network, a source of D. C. current, a control circuit connecting the source to each of said rectifiers, and a signal operated device arranged between said control circuit and the transmission circuits to control the D. C. current through said rectifiers, said device being arranged when operated by signals in either transmission circuit to cause a change in the D. C. current through said rectifiers tending to decrease the attenuation of the network associated with that transmission circuit and to increase the attenuation of the other network.

2. In an electric signalling system having two-way complementary alternating current transmission circuits, the combination of two attenuation networks arranged respectively in the two transmission circuits, each of said networks being provided with a D. C. circuit the current flow in which controls the attenuation of the network, a D. C. bridge network, said D. C. circuits being connected in a diagonal of said bridge network so that unbalancing of said bridge network causes a change of current in said D. C. circuits and therefore tends to cause a change of attenuation of said attenuation networks, the attenuation of one network tending to increase and that of the other tending to decrease, and a signal operated device arranged between said bridge network and the transmission circuits to unbalance the bridge network, said device being arranged when operated by signals in either transmission circuit to unbalance the bridge network in the direction tending to decrease the attenuation of the attenuation network in the transmission circuit in which the signals occur.

3. A combination as claimed in claim 2, wherein at least one arm of said bridge network comprises the anode-cathode impedance of a thermionic valve and said signal operated device is arranged between the grid circuit of said valve and at least one of the transmission circuits to change the grid bias voltage when signals occur in that transmission circuit.

4. In an electric signalling system having two-way complementary alternating current transmission circuits, the combination of two attenuation networks arranged respectively in the two transmission circuits, each of said networks consisting of at least one dry plate rectifier arranged in an arm of the network, a pair of thermionic valves arranged in the respective transmission circuits on the output side of the respective networks, a pair of impedances arranged respectively in the anode circuits of the valves, the two impedances and the anode-cathode impedances of the valves comprising the four arms of a D. C. bridge network, a source of D. C. current comprising one diagonal of said bridge network, said dry plate rectifiers connected in series comprising the second diagonal of the bridge network and being connected so that a change of D. C. current in said second diagonal tends to change the A. C. impedances of the dry plate rectifiers to increase the attenuation of one of the attenuation networks and to decrease the attenuation of the other attenuation network, a biasing impedance connected between an intermediate point of the second diagonal and a terminal of said source of D. C. current, a pair of condensers arranged respectively in the grid circuits of the two valves, control circuits connecting the output of each of said valves with the grid circuit of the other valve, and a pair of signal rectifiers respectively connected in the control circuits, each of said signal rectifiers being arranged to apply the rectified signal output of one valve across the condenser in the grid circuit of the other valve in such a direction as to unbalance said bridge network and cause current to flow in the second diagonal in the direction tending to increase the attenuation of the network associated with said other valve.

5. In an electric signalling system having two way complementary alternating current transmission circuits, the combination of two attenuation networks arranged respectively in the two transmission circuits, each of said networks being provided with a D. C. circuit the current flow in which controls the attenuation of the network, a source of D. C. current, a pair of thermionic valves connected across said source, the current in the said D. C. circuits being derived from the difference of the currents flowing in the anode circuits of the said valves, and a pair of condensers arranged respectively in the grid circuits of said two valves, said condensers being associated with the respective transmission circuits so as to be charged by signals therein in such a direction as to change the current in said control circuits in the direction tending to decrease the attenuation of the network in the transmission circuit carrying signals and to increase the attenuation of the other network.

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