

Fig. 1

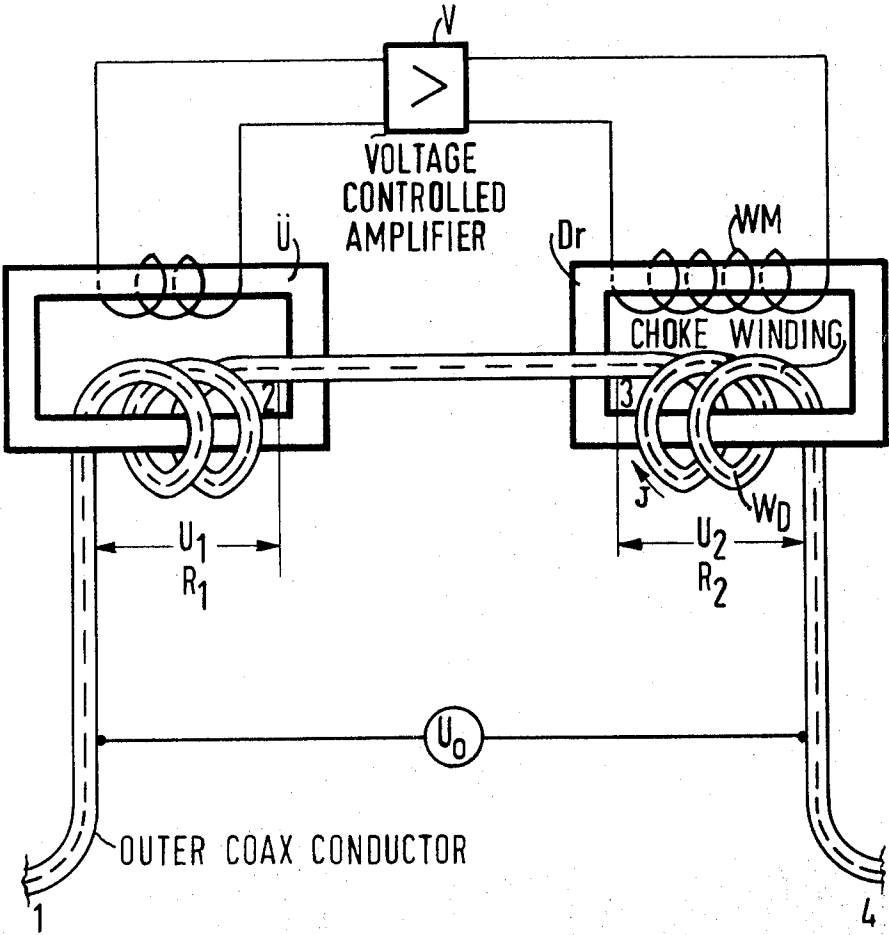
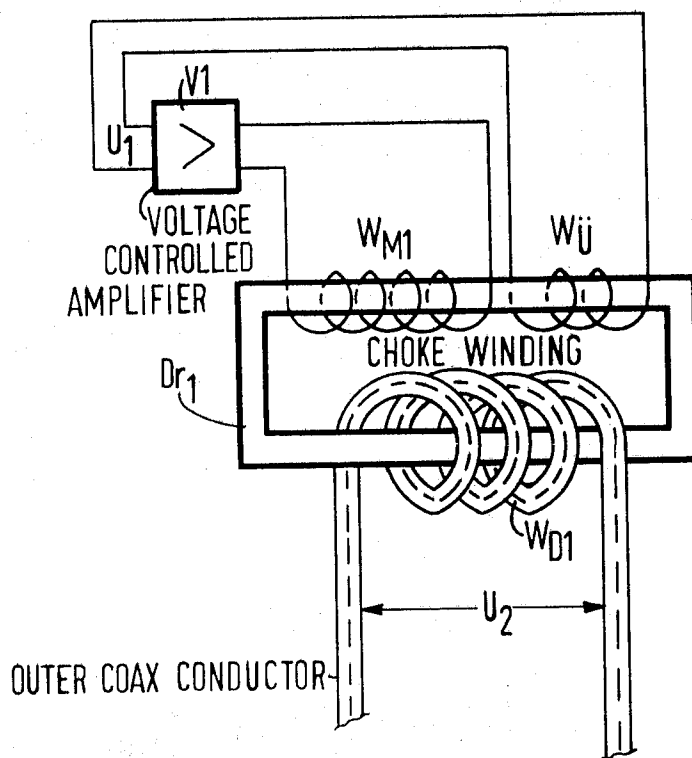


Fig. 2



METHOD AND APPARATUS FOR DECREASING SUPERIMPOSED OR INDUCED ALTERNATING CURRENTS IN DIRECT CURRENT AND HIGH FREQUENCY CIRCUITS

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of my earlier application, Ser. No. 114,532, filed Feb. 11, 1971, now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a method and apparatus for reducing induced alternating currents in high frequency circuits, and more particularly for reducing influencing voltage on coaxial lines through the use of coaxial chokes which are connected in circuit in the ground circuit and the outer conductor of the coaxial lines.

2. Description of the Prior Art

In order to suppress superimposed alternating voltages it is common practice to employ chokes in the filter circuits of current supply devices. It is also a well known practice in carrier frequency transmission intervals or stretches to reduce externally induced voltages on coaxial video lines caused by adjoining high voltage lines through the utilization of chokes. For this purpose, cables which have a metal sheath are wound several turns about a choke core. In order to be able to sufficiently reduce the interference voltages, the cable sheathing must present as low as possible an ohmic resistance and the choke must present as great as possible an inductance.

In both of the foregoing cases, the utilization of chokes is no longer an economical method to achieve the requisite high inductance values through large numbers of windings on lines, or cables which have excessively great cross sections, in that such apparatus takes up valuable space and the provision of such apparatus is not economically practical.

It is also known in the prior art to employ passive and actively driven step-down transformers in order to protect telecommunication cables from severe current interference. In the actively driven step-down transformer the induced voltage is supplied by way of an auxiliary wire of the telecommunication cable to the input of an amplifier. The output of the amplifier, controlled in this way, feeds into a primary winding of the step-down transformer which is not connected to the cable sheathing. This compensates for the wire voltages induced by a strong current installation. The energy generated by the amplifier serves essentially to cover the iron losses of the transformer.

SUMMARY OF THE INVENTION

The primary object of the present invention is to provide apparatus for effectively reducing through influencing external interference voltages induced in cables to improve the choking effect to a desired degree without there resulting awkward chokes due to a high number of choke windings and excessive size.

According to the present invention, the foregoing objective is realized through the use of means for increasing the effective inductance of a choke in a direct current supply circuit or in a high-frequency transmission

circuit through the utilization of an active two-terminal circuit to substantially suppress influencing currents on the outer conductor of a coaxial line.

Through the use of a circuit according to the present invention on message transmission intervals or stretches, there is provided a substantial advantage that is independent of phase relations of the current in the inner line circuit wire to cable shield and in the outer line circuit cable shield conductor to ground, since influencing currents, independently of the control of the active two-terminal circuit, are suppressed over an auxiliary wire in the outer conductor to ground circuit. Furthermore, the large number of secondary windings of a step-down transformer for a number of cable wires is eliminated.

According to an advantageous embodiment of the invention, the circuit for realizing induced or superimposed signal reduction can be constructed in such a way that the choke core is provided with an additional thin-wire magnetization winding having a high number of windings and that the magnetization winding is connected with the output of a voltage-controlled amplifier, preferably a multistage amplifier, which is controlled by a voltage derived from the alternating current flowing in the main winding of the choke. With this construction it is possible to supply to an amplifier input the control voltage over a control transformer whose primary winding is connected in series with the choke coil.

According to another circuit constructed in accordance with a second embodiment of the invention, the active circuit can be designed in the form of a feedback circuit in such a way that the choke core is provided with an additional feedback winding which is connected to an input of an amplifier, and with a thin-wire magnetization winding of a high number of turns which is connected with the output of the amplifier.

By use of the process of the present invention, the effective inductance can be increased in accordance with the chosen degree of amplification of the controlled amplifier. The main winding of the choke, therefore, needs only a relatively few turns.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages of the invention, its organization, construction and operation will be best understood from the following detailed description taken in conjunction with the accompanying drawing, in which:

FIG. 1 is a schematic circuit diagram of an embodiment of the invention which employs an amplifier which is fed by a control transformer to control a many turn magnetization winding of a choke; and

FIG. 2 illustrates a second embodiment of the invention which utilizes instead of a control transformer, a feedback winding on the same core as the magnetization winding of a choke for controlling through an amplifier the energization of the magnetization winding of the choke.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Since, as a rule, the outer conductor of a coaxial pair used in communication transmission stretches is grounded at the ends of the cable, between the two grounding points an interference voltage, which can be impressed voltage which is caused, for example, by

ground error currents from the alternating current main supply. Since the shielding action of the outer conductor is very little for low frequencies, and because the ground circuit inductance of the line is not great enough in relation to the ohmic resistance of the outer conductor (or of the cable sheathing), the impressed interfering voltage of low frequency is active in virtually full magnitude as an interference voltage in the main current circuit of the coaxial line. With the use of coaxial chokes it is not often easy to generate the required inductance. With an active auxiliary circuit such as is proposed according to the invention, relatively great inductance values can be realized with chokes of small dimensions.

In FIG. 1 there is illustrated in schematic form a choke Dr (a coaxial choke) for increasing the inductance of the ground circuit and having a choke winding W_D consisting of several turns of the coaxial line about a core. The choke is provided with an additional thin-wire magnetization winding W_M having a high number of turns. Connected in series with the choke winding W_D there is connected in circuit the primary winding of a control transformer U , so that both windings are traversed by an interference current arising in response to undesired influencing. The external voltage arising in the ground circuit, which voltage causes the current J through the choke winding W_D and the primary winding of the control transformer U is symbolically represented in the drawing by an active voltage source U_0 . The iron core of the choke Dr is magnetized by the magnetization winding W_M . The magnetization current is delivered by an amplifier V which is driven on its input side by way of the voltage induced in the secondary winding of the control transformer U , the output of the amplifier V being connected to the magnetization winding W_M . The control voltage is derived from the current J flowing in the choke winding W_D and in the primary winding of the control transformer U . On the choke winding W_D there arises a voltage U_2 which, in correspondence to the amplification of the amplifier V , is greater than the voltage U_1 on the terminals 1 and 2 of the primary winding of the transformer U . The sum of the interference voltage U_0 induced by influencing, of the control voltage U_1 and of the amplified voltage U_2 must be equal to zero. The reference character R_1 is provided to designate the input apparent resistance of the control transformer U between the terminals 1 and 2 and the reference character R_2 is provided to designate the apparent resistance of the choke winding W_D between the terminals 3 and 4. In this active circuit, the choke winding W_D represents a controlled voltage source E , which has an electromotive force induced by means of the magnetization winding W_M , which electromotive force is greater by the amplification degree of the amplifier V than the voltage drop U_1 which is provided by the current J on the input apparent resistance R_1 of the control transformer U . The degree of amplification of the amplifier V corresponds to the voltage amplification between the input of the transformer (terminals 1 and 2) and the choke winding W_D (terminals 3 and 4) in no-load operation. The current J which drives an outer voltage U_0 through the circuit may be seen through the expression

$$J = U_0 + EMF/R_1 + R_2 = U_0 + J \cdot R_1 \cdot V/R_1 + R_2 = U_0/R_1 + R_2 - R_1 \cdot V \\ = U_0/R_1 + R_2/R_1 + R_2 - R_1 \cdot V$$

For an amplification which is equal to zero there is provided the current J from the apparent resistances R_1 and R_2

$$J = U_0 / R_1 + R_2$$

The winding of the active circuit is given, when the amplification is greater than zero, by the following expression which designates the reduction factor r

$$r = R_1 + R_2/R_1 + R_2 - R_1 \cdot V$$

The real part of the quotient must not be negative, since self-excitation of the circuit would otherwise set in. For this reason, the magnetization W_M of the choke must be correctly poled and the phase rotation in the amplification path must remain under 90° for voltage amplifications greater than 1. For an effective reduction of the alternating current J the relation $R_1 \cdot V R_1 + R_2$ must hold. If the apparent resistances R_1 and R_2 are equal, the current J is then reduced by half of the value of the amplification.

If the active circuit is to possess frequency characteristics of an inductance, then the apparent impedances R_1 and R_2 of the transformer U and of the choke winding W_D must be inductive in nature and the voltage amplification of the amplifier V independent of frequency. A pair of wide-band amplification stages each having properties of voltage controlled current sources fulfill these requirements when they are connected over a coupling member which rotates or shifts the phase by 90° and reduces the voltage proportionally with frequency. Voltage-controlled current sources are realizable with transistor circuits. The coupling member can be provided by capacitive load resistance as a phase shifter.

The circuit according to FIG. 2 operates with a feedback amplifier and therefore does not require a control transformer. The choke winding W_{D1} traversed by interfering current is disposed in common with the magnetization winding W_{M1} and the feed-back winding W_U on the common iron core of the choke $Dr1$. The iron core is thereby magnetized by a magnetization winding W_{M1} through the provision of an amplifier V_1 which is controlled on its input side by the voltage on the feed-back winding W_U and whose output delivers the magnetization current to the magnetization winding W_{M1} . If the choke winding W_{D1} is placed on an outer voltage U_0 , i.e., if in consequence of an external influencing an interfering current flows through the choke winding, the choke winding W_{D1} , in correspondence to the example of execution according to FIG. 1, represents a controlled voltage source whose electromotive force has a value

$$EMF = U_0 V/U$$

Here, U_0 signifies the reduced outer voltage, V the voltage amplification U_2/U_1 of the circuit when U_2 is the voltage drop on the choke winding W_{D1} and U_1 is the feedback voltage, U the translation ratio of the feedback voltage and R the apparent input resistance of the choke winding. The current J in the choke winding W_{D1} becomes

$$J = U_0 + EMF/R = U_0 + (U_0 \cdot V/U)/R = U_0/R \cdot (1 + V/U)$$

The reduction factor r of the circuit for the current J is, therefore,

$$r = 1 + V/U$$

In order that the reduction factor r will be less than 1, the feedback winding must be poled in such a way that the quotient of amplification and feedback translation ratio can be negatively substituted, that is

$$r = 1 - V/U$$

if the reduction factor is negative, then self-excitation of the circuit will occur.

The present invention may be simply and easily employed in connection with high frequency lines, such as in high-frequency information transmission systems, and in filter circuits of power supplies in place of conventional chokes to minimize undesired interference waves.

Many changes and modifications may be made of the invention by one skilled in the art without departing from the spirit and scope of the invention, and it is to be understood that I intend to include within the patent warranted hereon all such changes and modifications as may reasonably and properly be included within the scope of my contribution to the art.

I claim:

1. A circuit for reducing induced interfering alternating voltages in a coaxial line, comprising: coaxial choke means including core means, a magnetization winding on said core means and a coaxial line wound about said core means; means including a secondary winding on said core means for deriving a control voltage from an interfering alternating current flowing in the outer conductor of said coaxial line; and a voltage controlled amplifier connected between said secondary winding and said magnetization winding for controlling the magnetization of said core means and suppression of the inter-

ference in accordance with the interfering alternating current.

2. A circuit according to claim 1, comprising a feedback circuit connected between said means for deriving a control voltage and said magnetization winding including said amplifier.

3. A circuit according to claim 2, wherein said means for deriving a control voltage comprises a feedback winding carried on said core means along with said coaxial line of said choke and said magnetization winding and connected to the input of said amplifier.

4. A method of reducing superimposed or induced interference voltages in a coaxial line, comprising the steps of: winding the coaxial line about a core of a coaxial choke and about a core of a control transformer to serve as a primary winding for each; increasing the effective inductance of the choke by deriving a control voltage with a secondary winding on the control transformer in accordance with the current traversing the outer conductor of the coaxial line and applying the control voltage to a magnetization winding on the choke core to suppress the interfering voltage.

5. A circuit for reducing induced interfering alternating voltages in a coaxial line comprising: a coaxial choke means including core means, a magnetization winding on said core means and a coaxial line wound about said core means including an outer conductor; means including a control transformer for deriving a control voltage from an interfering alternating current flowing in said outer conductor of said coaxial line including a primary winding constituted by the outer conductor of said coaxial line and a secondary winding; and a voltage controlled amplifier connected between said secondary winding and said magnetization winding for controlling the magnetization of said core means and suppression of the interference in accordance with the interfering alternating current flowing in said outer conductor.

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