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FOUR POLE DEVICE WITH NONLINEAR RESISTORS

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Fig. 1

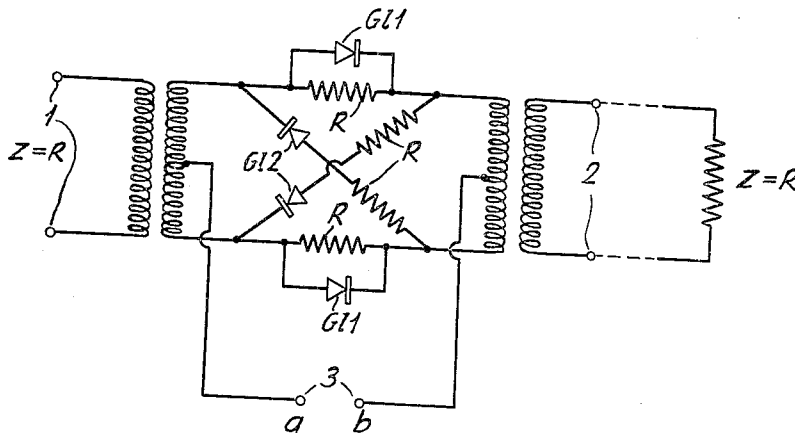
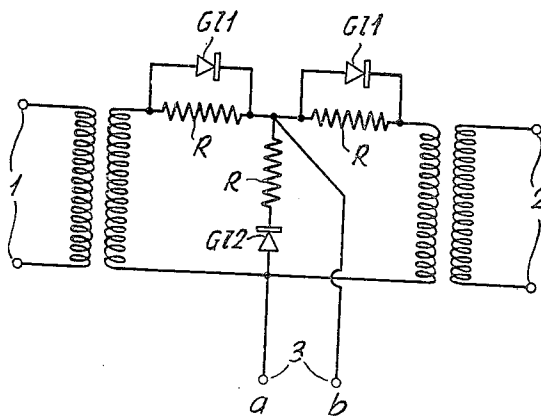


Fig. 2



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FOUR POLE DEVICE WITH NONLINEAR RESISTORS

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10 Claims. (Cl. 178-44)

The present invention relates generally to networks for controllably transmitting current from a source to a utilizing device and more particularly to four pole circuits containing nonlinear resistors, and whose damping is influenced by a control current or a control voltage of any type. Damping members of this type having controlled nonlinear resistors are generally known for the purpose of modulation, blocking and control. An advantage of the known damping members resides in the fact that the damping is determined at its upper as well as at its lower limit by the resistance of the controlled nonlinear members. Since the resistance of these members is not constant, and depends to a high degree on slight variations of the control current and load variations, constant and definite damping values could not be obtained with the hitherto known means.

In accordance with the present invention the controlled nonlinear resistors are combined with resistors not influenced by the control current such as for instance ordinary ohmic resistors in such a way that the damping of the four pole circuit is determined at one limit preferably the upper limit, substantially by the resistors of the circuit which are independent of the control. An especially suitable mode of construction is obtained by arranging the four pole device as a crossed member whose series members are formed by parallel arrangements of ohmic resistors and dry contact rectifiers, and whose parallel members are formed by connecting ohmic resistors and dry contact rectifiers in series. In this case the dry contact rectifiers act as controlled nonlinear resistors.

In place of the crossed member which has the action of a bridge circuit also T or H members may be utilized whose series branches and parallel branches are formed in the corresponding manner.

The two modes of construction noted above and incorporating the present invention are illustrated in the drawing wherein Fig. 1 is a circuit diagram illustrating a bridge type of controlling circuit, and Fig. 2 is a circuit diagram illustrating a T-type of network, both said figures incorporating the present invention.

In Figure 1 there is placed between the input terminals 1 and the output terminals 2, a bridge circuit formed of four identical resistors R having dry contact rectifiers added. The rectifiers are preferably so dimensioned that the resistance R is the geometric mean value obtained from the blocking resistances and passage resistances.

If a direct current source is connected to terminals 3 such that point *a* is positive and point *b* negative the circuit permits the passage of alternating current between terminals 1 and 2. The rectifiers *G1* represent low series resistances for the useful current, while the rectifiers *G2* represent high parallel resistances. At proper dimensioning, the input resistance *Z* is equal to *R*. If the current source at 3 has its poles reversed, the circuit has a blocking action. The rectifiers *G1* represent for the useful alternating current a very high resistance, and the rectifiers *G2* represent a very low resistance. The four effective resistances *R* representing a balanced bridge are essentially the active resistances. As in the considered blocking state of the arrangement the rectifiers *G1* have a very high resistance and the rectifiers *G2* a very low resistance. The resistances of said rectifiers may be neglected as compared to the resistances of the ohmic resistors *R*. The damping of the circuit, therefore, depends essentially on the resistance *R* only. The dependency on the nonconstant characteristics of the rectifiers is not essential and may easily be neglected. The apparent resistance is $Z=R$ also in the blocking range. The noise factor of the circuit is very low since all whole number harmonics are eliminated just as in any push-pull circuit. Owing to the symmetry of the circuit the terminals 1 and 2 are likewise in bridge arrangement with the control terminals 3, so that rapid variations of the control current do not induce E. F. F.'s in the useful circuits 1 and 2.

In Figure 2, the damping means between the input terminals 1 and the output terminals 2 consists of three ohmic resistors *R* of equal value and three dry contact rectifiers. The three resistors and the three rectifiers are arranged to form a T-member. In the series branches parallel arrangements of resistors and rectifiers are inserted, and in the parallel branches, a series arrangement of resistors and rectifiers is placed. The control voltage is applied at 3. If the control potential at the terminal *a* is positive, the damping of the member is high and determined essentially by the three ohmic resistors. When reversing the poles of the control potential, the ohmic series resistors are practically short circuited by the rectifiers *G1*. The parallel branch contains however the high blocking resistance of the rectifier *G2* in series to the resistor *R*.

When adding two further parallel connections each having an ohmic resistor and a rectifier the circuit can be completed to form a symmetrical H-member. The direction of passage of the ad-

ditional rectifiers would hereby have to be chosen such that it will be opposite to that of the rectifiers lying in the upper series branch.

The four pole circuits according to the invention are useful not only for the purposes of blocking, but can also be used generally for purposes of control. Therefore, they can be applied to the modulation, to the keying or to the control of the degree of amplification. For the last mentioned purpose they are especially suited owing to the steep increase of the damping curve.

If the damping of the four pole circuit is to be rendered dependent on frequency, it is possible within the scope of the invention to complete the aforescribed circuits by circuit elements which are dependent on frequency.

The most favorable working point of the nonlinear resistors can be set by means of bias potentials which may be different potentials for the individual nonlinear resistors.

I claim:

1. A damping circuit comprising a four-arm bridge device each of one pair of opposite arms thereof having a resistor in series with a rectifier device, each of the other pair of opposite arms comprising a resistor in parallel with a rectifier device, an input impedance device for the bridge connected between two diagonally opposite points thereof, an output impedance device connected between the other two diagonally opposite points of the bridge, and means for biasing said rectifier devices through a range of alternating current resistance values, each of said resistors being of the order of the geometric mean between the extreme of said range.

2. A network for controllably transmitting currents from a pair of input terminals to a pair of output terminals comprising ohmic resistors, nonlinear resistors and means for biasing said nonlinear resistors through a range of A. C. resistance values, said ohmic resistors being of the order of the geometric mean between the extremes of said range, said resistors being so arranged that at an extreme setting of said biasing means the transmission through said network is determined substantially solely by said ohmic resistors.

3. An electrical network including a pair of input terminals and a pair of output terminals, an input transformer provided with a primary winding and a secondary winding, said primary winding being connected across the input terminals, an output transformer provided with a primary winding and a secondary winding, said secondary winding being connected across said output terminals, means including an ohmic resistor shunted by a nonlinear resistor for connecting one end of the first named secondary winding to one end of the second named primary winding, means including an ohmic resistor shunted by a nonlinear resistor for connecting the other end of the first named secondary winding to the other end of the second named primary winding, a connection including a nonlinear resistor and an ohmic resistor in series between said first named end of the first named secondary winding and the second named end of the second named primary winding, means including a nonlinear resistor and an ohmic resistor in series for connecting the second named end of the first named secondary winding to the first named end of the second named primary winding, means connected between an intermediate point of the first named secondary winding and an intermediate point of the second named primary winding for

biasing said nonlinear resistors through a range of alternating current resistance values, said ohmic resistors being of the order of the geometric mean between the extremes of said range, said resistors being so arranged that at an extreme setting of said biasing means the transmission through said network is determined substantially solely by said ohmic resistors.

4. A network for controllably transmitting currents from a pair of input terminals to a pair of output terminals including the combination of ohmic resistor means and nonlinear resistor means with means for biasing said nonlinear resistor means through a range of alternating current resistance values, said ohmic resistor means being of the order of the geometric mean between the extremes of said range, said resistors being so arranged that at an extreme setting of said biasing means the transmission through the network is determined substantially solely by the ohmic resistor means.

5. A network for controllably transmitting currents from a pair of input terminals to a pair of output terminals comprising circuits connected between each of said input terminals and both of said output terminals, each of said circuits including an ohmic resistor and a nonlinear resistor, the nonlinear resistor in each instance comprising a dry contact rectifier, single means for biasing said nonlinear resistors through a range of alternating current resistance values, said ohmic resistors being of the order of the geometric mean between the extremes of said range, said resistors being so arranged that at approximately the upper extreme setting of said biasing means the transmission through the network is determined substantially solely by the ohmic resistors.

6. A network for controllably transmitting currents from a pair of input terminals to a pair of output terminals comprising an input transformer having a primary winding connected across said input terminals and a secondary winding, an output transformer having a secondary winding connected across the output terminals and a primary winding, a circuit comprising a pair of ohmic resistors in series between one end of the first named secondary winding and one end of the second named primary winding, a direct connection between the other end of the first named secondary winding and the other end of the second named primary winding, individual nonlinear resistors shunted across each of said ohmic resistors, means including an ohmic resistor and a nonlinear resistor in series connected between a point of the first named circuit which is common to said two first named resistors and said last named connection and means connected across said last named means for biasing said nonlinear resistors through a range of alternating current resistance values, said ohmic resistors being of the order of the geometric mean between the extremes of said range, said resistors being proportioned with respect to each other so that at an extreme setting of the biasing means the transmission through the network is determined substantially solely by the ohmic resistors.

7. A four-arm bridge circuit for controllably transmitting currents impressed between two diagonally opposite terminals of the bridge to a utilizing device connected between the other two diagonally opposite terminals thereof, each of a pair of opposite arms of the bridge including a nonlinear resistor and an ohmic resistor in series,

each of the other two opposite arms of the bridge including a nonlinear resistor in shunt with an ohmic resistor, all of said ohmic resistors being substantially of equal value, and means for biasing said nonlinear resistors through a range of alternating current resistance values to thereby control the transmission of currents through the bridge circuit.

8. A circuit as described in claim 7 by that the nonlinear resistors comprise dry contact rectifiers connected so as to be in series aiding in the closed circuit formed by the four arms of the bridge.

9. In a network for controllably transmitting currents from a pair of input terminals to a pair of output terminals, a four arm bridge circuit each arm of which includes at least an ohmic resistor and a nonlinear resistor, and means for biasing the nonlinear resistors in each of said arms through a range of alternating current re-

sistance values, the ohmic resistors in each of said arms being of substantially equal value.

10. In a network for controllably transmitting currents from a pair of input terminals to a pair of output terminals, a pair of substantially equal ohmic resistors in series connecting one of the input terminals to one of the output terminals, individual substantially similar nonlinear resistor means shunted across each of said ohmic resistors, a terminal common to the other of said input terminals and the other of said output terminals, a circuit including an ohmic resistor and a nonlinear resistor means in series, connected between a point common to said first two named ohmic resistors and the point common to the last named input terminal and output terminal, and means connected between said two common points for biasing all of said nonlinear resistors means.

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