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R. R. RIESZ

2,078,974

MODULATING SYSTEM

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FIG. 1

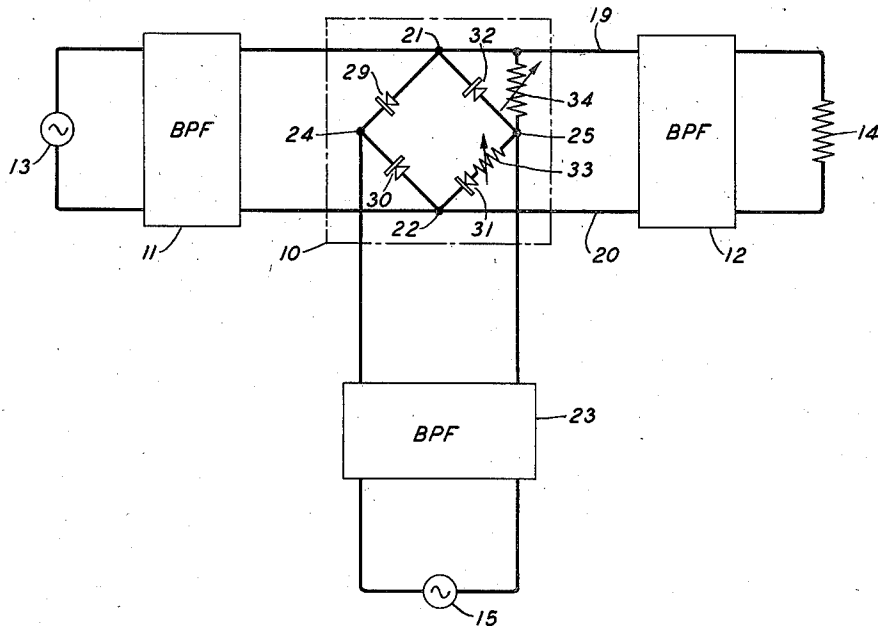


FIG. 1A

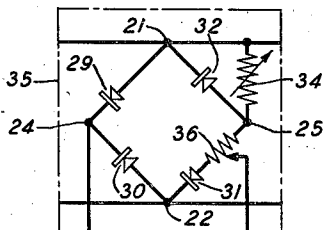


FIG. 1B

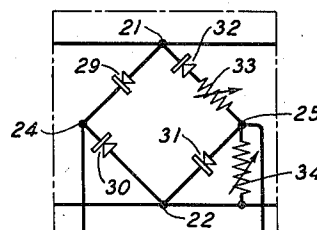


FIG. 1C

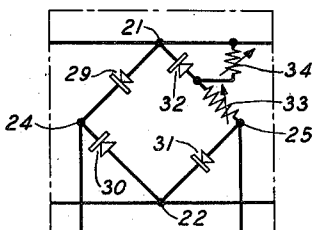
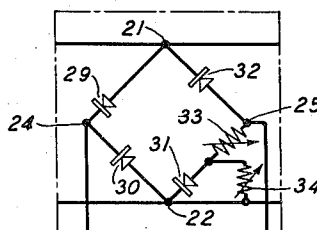


FIG. 1D



INVENTOR

R. R. RIESZ

BY

H. A. Burgess

ATTORNEY

UNITED STATES PATENT OFFICE

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MODULATING SYSTEM

Robert R. Riesz, Mount Vernon, N. Y., assignor to
Bell Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

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4 Claims. (Cl. 179-171)

This invention relates to modulating systems, and more particularly to modulating systems employing physically inert non-linear resistance elements as modulating apparatus.

An object of the invention is to obtain increased suppression of the carrier in the output circuit of a modulating system.

In a preferred embodiment, the invention comprises a plurality of physically inert non-linear resistance elements arranged in the form of a Wheatstone bridge in a modulating system to effect signal modulation of carrier waves. A relatively small resistance connected in series in one carrier conductive arm and a relatively large resistance connected in shunt with one carrier non-conductive arm serve to produce a high precision balance of the bridge in the conductive and non-conductive directions, respectively, thereby obtaining increased carrier wave suppression in the output circuit.

The invention will be more fully comprehended from the following description taken together with the accompanying drawing in which:

Fig. 1 illustrates a preferred embodiment of the invention; and

Fig. 1A shows one modification of the invention;

Figs. 1B, 1C and 1D illustrate other modifications of the invention.

Fig. 1 illustrates a modulating system embodying a Wheatstone bridge network 10 which is connected in shunt with filters 11 and 12. The filter 11 adapted to pass a band of modulating frequencies produced at a signaling source 13 is directly connected to the output filter 12. A load 14 is connected across the output filter 12 which is adapted to pass side-band frequencies lying adjacent to the carrier frequency produced by a generator 15. Leads 19 and 20 connecting filters 11 and 12 are also joined to points 21 and 22 of the bridge network 10 whose points 24 and 25 are connected to filter 23 associated with the carrier generator 15.

The Wheatstone bridge network 10 comprises physically inert non-linear resistance elements 29, 30, 31 and 32. These may be of any suitable non-linear type, such, for example, as copper-oxide rectifiers or other non-linear resistors of suitable type. The rectifiers are poled as indicated by the arrows in Fig. 1, such that non-linear resistance elements 29 and 30 are poled in a carrier non-conductive direction toward common terminal 24 while non-linear resistance elements 31 and 32 are poled in a carrier con-

ductive direction away from common terminal 25.

The operation of the Wheatstone bridge in a modulating system is well-known and consists in applying a signaling voltage across the points 21 and 22 and, at the same time, impressing a carrier voltage across the points 24 and 25. These voltages together with the non-linear resistance elements produce a modulation action whereby the carrier currents and signaling currents are combined in the well-known manner to effect a signal modulation of the carrier wave of the carrier suppressed type. This is most efficiently accomplished when the non-linear resistance elements comprising the bridge network 10 are balanced to a high degree of precision in both the conductive and non-conductive directions with respect to carrier.

In a preferred embodiment, the invention comprises a variable resistance 33 connected in series with the non-linear resistance element 31 of a conductive arm and a variable resistance 34 connected in shunt with the non-linear resistance element 32 of a non-conductive arm, the terms conductive and non-conductive being used with reference to the carrier wave.

By a use of these resistances an accurate balance of the bridge network 10 in the conductive and non-conductive directions may be obtained as follows.

With no signal current but with carrier current flowing in the conductive direction, resistance 31 is varied to produce the best bridge balance for the conductive direction. Also, with no signal current but with the carrier current flowing in the non-conductive direction, resistance 34 is varied to effect the most accurate bridge balance for the non-conductive direction. Accordingly, by alternate adjustments of the resistances 33 and 34, the bridge network 10 may be eventually balanced to a high degree of precision. Obviously, a precise balance is desirable so as to obtain maximum suppression of carrier waves in the output circuit.

It will be noted, however, that resistance 33 is effective in only one arm in the conductive direction and one arm in the non-conductive direction, and further, that shunt resistance 34 is effective in connection with but one arm of the non-conductive direction. Inasmuch as resistance 33 has a relatively low value of the order of 5 ohms, it will not appreciably affect the balance in the non-conductive direction. Likewise, since resistance 34 has a relatively large value of the order of 5500 ohms, it will not appreciably

influence the balance in the conductive direction.

It will be understood that the same result is also attained when the resistance 33 is connected in series with either resistance element 31 or 32 and the resistance 34 in shunt with either the resistance element 31 or 32. Bridge circuits embodying these modifications are shown in Figs. 1B, 1C and 1D.

The connection of the series resistance 33 and shunt resistance 34 in the above combinations depends on the conducting and non-conducting resistance values of the non-linear resistance elements. The respective resistance values may be indicated as follows: In balancing a Wheatstone bridge, it is essential that

$$\frac{R_{29}}{R_{30}} = \frac{R_{32}}{R_{31}}$$

Then in the conducting direction,

if $\frac{R_{29}}{R_{30}} < \frac{R_{32}}{R_{31}}$

resistance 33 is inserted in series with resistance element 31; and

if $\frac{R_{29}}{R_{30}} > \frac{R_{32}}{R_{31}}$

resistance 33 is placed in series with resistance element 32.

Similarly, in the non-conducting direction,

if $\frac{R_{29}}{R_{30}} < \frac{R_{32}}{R_{31}}$

resistance 34 is connected in shunt with resistance element 32; and

if $\frac{R_{29}}{R_{30}} > \frac{R_{32}}{R_{31}}$

resistance 34 is connected in shunt with resistance element 31.

Fig. 1A illustrates a modified Wheatstone bridge network 35 that may be substituted for the bridge network 10 of Fig. 1. In Fig. 1A, a potentiometer 36 is interposed between the non-linear resistance elements 31 and 32 poled in the conductive direction away from contact point 25. By this arrangement, the conductive arms containing resistances 31 and 32 may be varied simultaneously. Further, it is seen that the potentiometer 36 is effective in both non-conductive arms as well as both conductive arms. The potentiometer 36 has a relatively small resistance; therefore it will not appreciably affect the balance in the non-conductive direction. Likewise, the resistance 34 is rela-

tively large, hence it will not appreciably affect the balance in the conductive direction.

In Fig. 1A, the resistance 34 may be connected in shunt with either resistance element 31 or 32 depending on the non-conducting resistance values of the non-linear resistance elements as illustrated above relative to Fig. 1.

It will be understood, of course, that the bridge networks 10 and 35 may be balanced to a high degree of accuracy in a minimum of time when the four non-linear resistance elements are substantially identical.

What is claimed is:

1. A modulating system of the carrier suppressed type comprising a source of modulating waves connected in an input circuit of the system, an output circuit, a balanced Wheatstone bridge comprising a physically inert non-linear resistance element in each of its arms, the Wheatstone bridge being interposed between the input and output circuits, a source of carrier waves connected to the Wheatstone bridge for modulation therein by said modulating waves, and means for increasing the degree of suppression of the unmodulated carrier component by providing a more accurate bridge balance than is afforded by balancing said non-linear resistance elements against one another comprising a resistance connected in series with a non-linear element in one arm of the bridge and a resistance connected in shunt relation to the non-linear element in a different arm of the bridge, said series and shunt resistances being proportioned to provide the required degree of balance.

2. A modulating system according to claim 1 in which the series resistance has such a value as will unappreciably affect the bridge balance in the non-conductive direction while the shunt resistance has a value that will unappreciably affect the bridge balance in the conductive direction.

3. A modulating system according to claim 1 in which the resistance connected in series in an arm is in series with one of the non-linear resistance elements poled in a conductive direction away from a common terminal.

4. A modulating system according to claim 1 in which the resistance connected in series is a potentiometer interposed between the two non-linear resistance elements poled in the conductive direction away from a common terminal.

ROBERT R. RIESZ.