June 10, 1930. J. F. FARRINGTON 1,762,969

HIGH FREQUENCY ATTENUATING NETWORK

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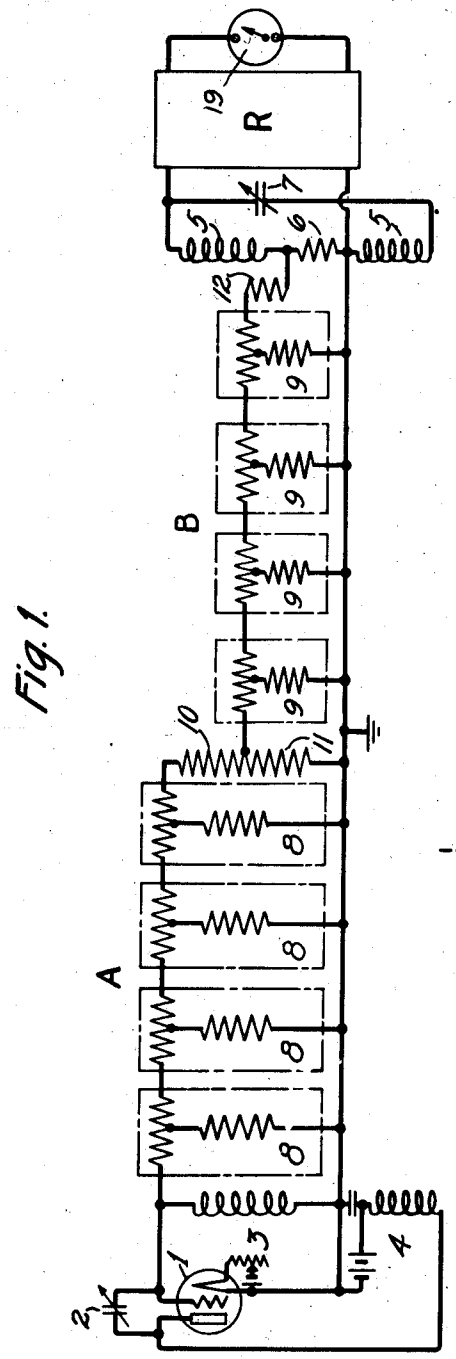


Fig. 1.

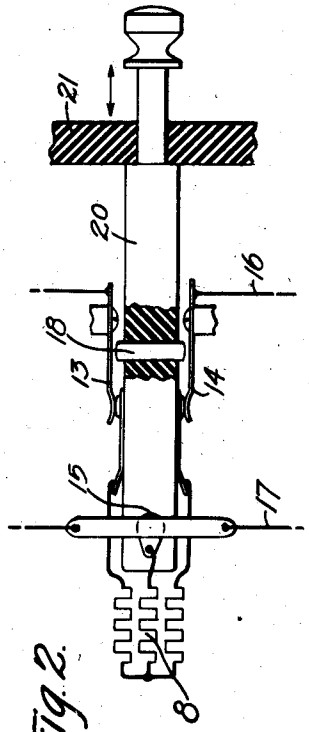


Fig. 2.

Inventor:
John F. Farrington
by E. W. Adams Atty.

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UNITED STATES PATENT OFFICE

JOHN F. FARRINGTON, OF FLUSHING, NEW YORK, ASSIGNOR, BY MESNE ASSIGNMENTS, TO WESTERN ELECTRIC COMPANY, INCORPORATED, A CORPORATION OF NEW YORK

HIGH-FREQUENCY ATTENUATING NETWORK

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This invention relates to non-reactive attenuation networks adapted to be used for current attenuation for measurements and other purposes at radio frequencies.

In field strength measuring sets and other radio signaling systems, it frequently is desirable to impress local oscillations upon a certain portion of a receiver circuit. In attempting to govern the amplitude of these locally applied oscillations it has been the practice to use a potentiometer connected between the source of oscillations and the point to which the oscillations are to be applied. A disadvantage of this system is that, as the adjustment of the potentiometer is changed, the impedance into which the oscillator works is altered, producing a variation in the frequency of the oscillations generated.

In order to overcome this difficulty, a network has been devised which comprises a plurality of attenuation units which may be inserted at will to produce different ratios of input current to output current without altering the input impedance of the network.

In constructing units of both high and low attenuation values for use at high frequencies adapted to work into the same terminating resistance to produce an attenuation network having a constant input impedance as the number of units is varied, difficulties arise due to the effects of undesired capacity and inductance in the elements of the attenuation units and in the connecting leads.

It is an object of this invention to increase the facility with which attenuations of high frequency waves may be made and to facilitate the use of apparatus for making and determining the magnitude of such attenuations.

Another object is to provide for varying the attenuation of a locally applied oscillation while maintaining constant the impedance of the load into which the oscillation generator operates.

A feature of the invention is an attenuation network for use in high frequency apparatus in which the effects of capacity and inductance are negligible.

A further feature of the invention is an attenuation box for use in high frequency apparatus in which units having different attenuation values are adapted to work into different terminating impedances.

These objects and features of the invention and others which will be apparent as the nature of the invention is disclosed are attained by employing an attenuation network composed of a plurality of units, each unit comprising a T-resistance network having negligible inductance and capacity. Certain network units hereinafter called the high attenuation units, such for example as those corresponding to attenuations of greater than 10 decibels are designed to work into a given terminating impedance, while other units, hereinafter designated as low attenuation units for example those corresponding to attenuations of less than 10 decibels are adapted to operate with a different terminating impedance. The low attenuation units are connected to the high attenuation units by means of an L network which, taken in connection with the impedance of the low attenuation units presents the proper termination for the high attenuation units.

The shunt impedance of the low attenuating units is of such large value that the capacity effect becomes troublesome at high frequencies unless the units are made of low impedance and the shunt impedance of the high attenuation units is of such small value that it is incapable of being constructed non-inductively when the connecting leads are considered unless the units are made of high impedance, hence it becomes desirable to construct the various units to operate between different terminating impedances.

Although the novel features which are believed to be characteristic of this invention will be pointed out with particularity in the claims appended hereto, the invention itself, its objects and advantages, the mode of its operation and the manner of its organization will be better understood by referring to the following description taken in connection with the accompanying drawing forming a part thereof in which Fig. 1 is a diagrammatic representation of a signalling system embodying this invention, and Fig. 2 is a

view partly in section of one form of attenuation unit to be used therewith.

Fig. 1 shows a source of oscillations 1, the frequency of which is determined by the tuned circuit composed of condenser 2 and inductances 3 and 4. Inductance 3 also serves as coupling means for transferring energy from the oscillator 1 to an attenuation network comprising sections A and B. Energy passed through this attenuation network, is impressed upon a translating circuit herein shown as a tuned loop aerial or antenna circuit including inductances 5 and tuning capacity 7, across the resistance 6 inserted between the inductances. Receiver R may be any suitable form of apparatus to be actuated by energy from the oscillation generator and may include a detector, such as a rectifier, and suitable indicating means 19.

Section A of the attenuation network comprises units of different attenuation values which for purposes of illustration may be considered as capable of producing current ratios equivalent to 10, 20, 30 and 40 decibels, each such network unit being composed of a T-resistance network 8 so designed that, when the proper terminating impedance is employed, the impedance looking into the section remains constant irrespective of the number of units connected in the circuit. Section B is composed of units of lower attenuation value such for example, as that of 1, 2, 3 and 4 decibels similarly constructed of T-resistance networks 9, but adapted to work into a terminating impedance different from that with which section A is designed to operate.

Section B is connected to section A through a transition network composed of series resistance 10 and shunt resistance 11 having such values that the sum of the impedance of resistance 10, and impedance of resistance 11 taken in connection with section B in parallel thereto, is equal to the required terminating impedance for section A whereas resistance 11 taken in connection with section A in parallel thereto, presents substantially the proper terminating impedance for section B. Section B is terminated at its other end in an impedance consisting substantially wholly of resistance 12 in series with resistance 6 which is connected in the loop circuit. Resistances 12 and 6 combined present the proper terminating impedance for section B.

In Fig. 2 is shown a method of constructing the various units 8 or 9 so that they may be plugged into the circuit at will and when removed the capacity of the units will be negligible. Resistance units 8, which should be wound so as to have a minimum of inductance and capacity, are mounted on an insulating plug 20 supported by and adapted to slide in panel 21. The inductance is reduced by making the wires short and winding them non-inductively in accordance with known methods and the capacities are reduced by making the resistances and the leads of as small area as possible. Contacts 13, 14 and 15 make connection between the three resistance units and the line 16, 17 when the plug is in the position shown. With the plug pushed down resistances 8 are disconnected from the line 16, 17 at contacts 13, 14 and 15 and line 16 is completed by conducting bar 18 which then connects contacts 13 and 14. As the resistance units are entirely disconnected in the latter position their capacity to the line and to ground will be negligible.

An attenuating network of the type described which has proven satisfactory at high frequencies has been constructed with the units of section A designed to operate between impedances of 200 ohms and the units of section B designed to operate between impedances of 20 ohms. In this case resistance 10 was approximately 190 ohms and resistance 11 was 20 ohms. Resistance 12 was taken at 19 ohms, leaving one ohm for the resistance 6 in the loop circuit.

When a potentiometer is used in place of the attenuation network herein described it is extremely difficult to maintain the frequency of the oscillations constant due to the impedance being altered each time the attenuation is varied. In the operation of this circuit the required number of units may be selected to give the desired degree of attenuation without effecting the impedance into which the oscillator works.

Although this invention has been shown and described by way of illustration only as applied to a specific system in a particular manner, it is not to be limited thereto but only in accordance with the scope of the invention as defined by the following claims.

What is claimed is:

1. In a system including a source of oscillations and a load circuit, means for varying the attenuation of said oscillations comprising an attenuation network composed of a plurality of attenuation units each having a fixed attenuation characteristic which is different from that of the others, comprising groups each having a constant characteristic impendace regardless of the number of units and adapted to operate between different terminating impedances, and means for inserting each unit in the network at will while maintaining a continuity of circuit between the remaining units, said network being connected between said source of oscillations and said load.

2. In a radio receiving circuit including a loop aerial and a source of high frequency oscillations, a resistance included in said loop, a tuned circuit adapted to establish the frequency of said oscillations, an attenuation box connecting said tuned circuit and said resistance, said attenuation box being composed of a plurality of T-resistance units of different

attenuation values, certain of said units, combined in one group, being adapted to operate with a lower terminating impedance than other of said units, combined in another group, the groups being connected through a resistance network including a series and a shunt resistance of such values that the input impedance of the attenuation box remains substantially constant irrespective of the number of units connected in the circuit.

3. A resistance unit for inserting a T-resistance network in a line comprising a plurality of resistances, an insulating contact supporting means, contacts carried thereby whereby said resistances are connected to said line in one position and whereby said resistances are disconnected from the line in another position, and other contacts also carried by said supporting means for closing said line when the unit is in the last mentioned position.

4. A system comprising a source of local oscillations, a load circuit, an attenuation network interconnecting said source and said load, comprising a plurality of units of different attenuation values comprising a plurality of groups, the attenuation values for the units in each group occupying a range different from that of the other groups and each such group being adapted to operate with a different terminating impedance than the other group, and a transition network for connecting each pair of adjacent groups of units.

5. In a system, a space discharge oscillator, a frequency establishing circuit, and a receiving circuit in combination with an attenuation box connected between said frequency establishing circuit and said receiving circuit, said attenuation box being composed of a plurality of T-resistance units having different attenuation values and comprising a plurality of groups adapted to operate with different terminating impedances, and a transition resistance network for connecting each pair of adjacent groups of different terminating impedance in such manner that the impedance of the attenuation box as a whole remains constant while the number of units is varied.

6. In a system of the character described, an attenuation network comprising a series of units of different attenuation values, said units comprising a plurality of groups, the attenuation values for the units in each group occupying a range different from that of each of the other groups and each such group being adapted to operate into a different terminating impedance from that of the other groups, each pair of adjacent groups being connected by a transition network comprising a series and a shunt resistance.

7. In a system of the character described, an attenuation network comprising a series of units of different attenuation values, said units comprising a plurality of groups, the attenuation values for the units in each group occupying a range different from that of the other groups and each such group being adapted to operate into a different terminating impedance from that of the other groups, each pair of adjacent groups being connected by a transition network comprising a series and a shunt resistance of such value that said series resistance and shunt resistance combined and taken with the subsequent series of groups, present the proper terminating impedance for one of each of said connected groups constituting a pair, and said shunt resistance taken with the subsequent series of groups looking in the opposite direction presents the proper terminating impedance for the other of each of said connected groups constituting a pair.

8. In a system of the character described, an attenuation network comprising a series of units each composed of a T-resistance network, said units having various attenuation values, said units comprising a plurality of groups adapted to operate into different terminating impedances, each pair of adjacent groups being connected by a transition network comprising a series and a shunt resistance of such values that their combined resistance, taken with the subsequent series of groups, presents the proper terminating impedance for one of each of said connected groups constituting a pair and the shunt resistance, taken with the subsequent series of groups looking in the opposite direction, presents the proper terminating impedance of the other of each of said connected groups constituting a pair.

9. A system comprising a source of local oscillations, an attenuation network connected thereto and a work circuit to which energy is transferred from said source through said attenuation network, said attenuation network comprising a series of units each composed of a T-resistance network, said units having various attenuation values, said units comprising a plurality of groups adapted to operate into different terminating impedances, each pair of adjacent groups being connected by a transition network comprising series and shunt resistances of such value that their combined resistance, taken with the subsequent series of groups, presents the proper terminating impedance for one of each of said connected groups constituting a pair, and the shunt resistance, taken with the subsequent series of groups looking in the opposite direction, presents the proper terminating impedance of the other of each of said connected groups constituting a pair.

In witness whereof, I hereunto subscribe my name this 3 day of April, A. D. 1925.

JOHN F. FARRINGTON.