

FREQUENCY CHANGER FOR SHORT WAVES

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Fig. 1

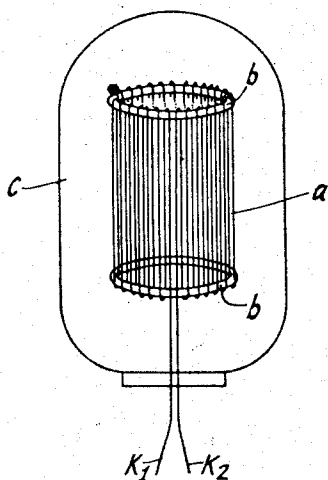


Fig. 2

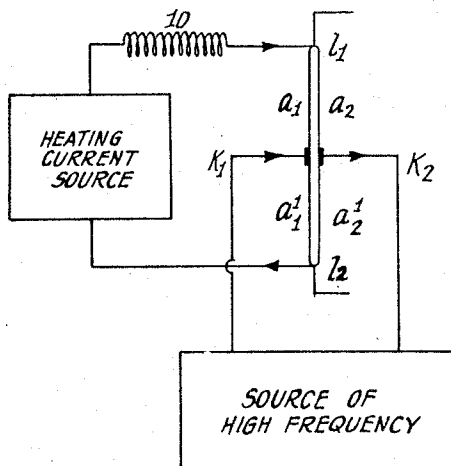


Fig. 3

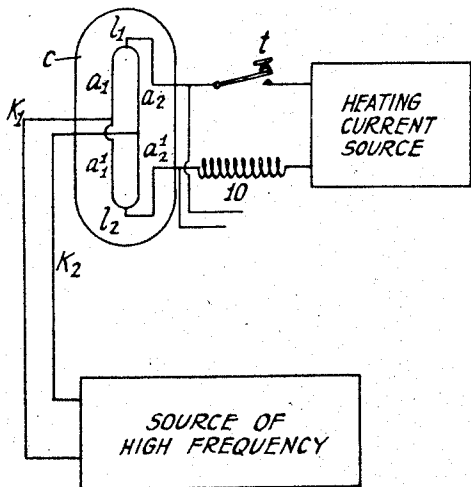


Fig. 4

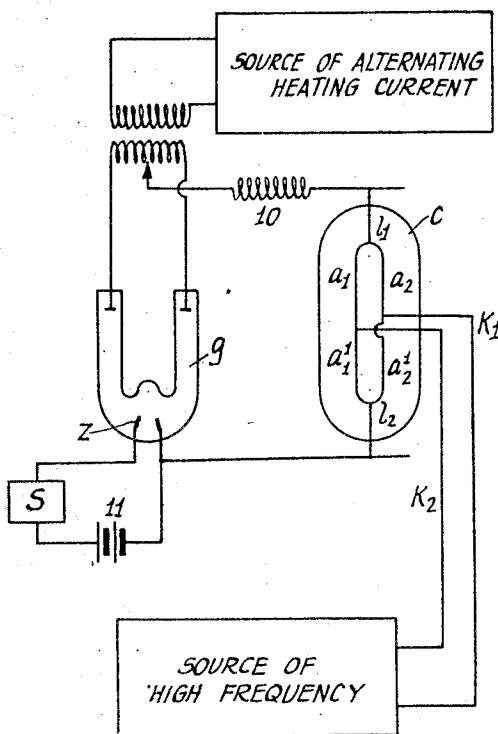
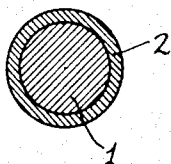


Fig. 5



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## UNITED STATES PATENT OFFICE.

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## FREQUENCY CHANGER FOR SHORT WAVES.

Application filed October 20, 1925, Serial No. 63,619, and in Germany September 12, 1924.

My invention relates to inductance devices, and, more particularly, to an inductance device which comprises an outer conductor having a core of conducting material and a layer of magnetic material.

An object of the invention is to provide ways and means for using an inductance device of this kind for frequency changers, modulating devices such as used in radio work, etc.

Other objects will be apparent from the following specification and claims when considered with the accompanying drawing in which,

Fig. 1 represents one embodiment of my invention.

Fig. 2 represents another embodiment of my invention.

Figs. 3 and 4 represent further embodiments, and

Fig. 5 is a cross-section, greatly enlarged, of the novel conductor used in the invention.

This application is an improvement over German application No. T-29,196, filed in Germany on August 16, 1924, and filed in the United States on August 14, 1925, under Serial No. 50,165.

In the parent application a frequency changer adapted to short wave work has been disclosed, which consists of a conductor provided with a thin layer of a ferro-magnetic or any magnetic material, the said ferro-magnetic material, if desired, being placed directly, without an intermediate insulation layer, upon the non-magnetic conductor.

Now, the present invention covers a further improvement upon the said frequency changer. It has been discovered that the frequency changer, as regards its power, is greatly dependent upon the temperature. Increase in heating generally increases the power and the efficiency. More particularly, it has been found that the most suitable temperature condition of the transformer or frequency changer depends both upon the supplied frequency as well as upon the useful and desired frequency in any given case.

Inasmuch as the device is very sensitive to temperature variations, the chief point and idea underlying the present invention

is to safeguard the frequency changer from accidental external temperature influences, and to act upon its state of heating in the desired manner; in other words, by providing means adapted to adjust and regulate the same.

According to the invention, it is furthermore feasible to eliminate possibly existing harmful effects of the heating relative to the chemical properties of the material. Finally, the possibility of adjusting the heating state ad libitum, on the one hand, and the sensitivity of the device to temperature variations, on the other hand, can be utilized for the object of controlling the power thereof, i. e., for telegraphy and telephony work.

The idea underlying the invention, consequently, resides, in the first place, in regulating the temperature condition of the frequency changer in the desired, well-defined manner.

Whenever the development of heat inside the device is such that the heating required for maximum power is automatically adjusted, provided that all external accidental influences liable to exercise a disturbing effect are precluded, all that is necessary to do is to eliminate any such influence. For this purpose, the conductor constituting the frequency changer should most suitably be arranged, similar to metal-filament lamps, inside a vacuum space, or, at any rate, within an atmosphere free from oxygen, the most preferable arrangement of the conductor being bifilar or zig-zag. The absence of oxygen or the provision of an atmosphere possessing properties neutral in chemical respect, insures chemical stability for the material from which the apparatus is made.

Referring first to Fig. 5, a conductor, as disclosed in the above-mentioned parent application, is shown. It consists of a core of a non-magnetic conducting material 1, such as copper and a layer of magnetic material 2, such as iron, which is very thin.

Referring now to Fig. 1, a frequency changer made up, for example, of a conductor having the cross-section shown in Fig. 5 is shown. The conductor *a* is arranged zig-zag or back and forth between two insulating refractory carrier rings *b*,

$b$  disposed within a vessel  $c$  which may be of glass, quartz, or the like. The vessel  $c$  may enclose a vacuum or a chemically neutral gas, the lead-ins  $K_1$ ,  $K_2$  being hermetically sealed within the walls of the vessel.

If the device fails to develop sufficient heat to produce by itself the desired high temperature, according to the present invention, the necessary heating is provided in any well known manner, electrically or by other means, for instance, by hot gases or heating ovens. Most suitable for this purpose are currents of low frequency or direct current. The heating currents can be conducted into special radiators or heating bodies, but most simply into the conductor of the frequency changer itself.

One form of construction for such a device is diagrammatically shown in Fig. 2 by way of example. The high frequency current flows through the bi-filar conductor by way of lead-ins  $K_1$ ,  $K_2$  through the branches  $a_1$ ,  $a_2$  as well as through the branches  $a_1^1$ ,  $a_2^1$  parallel to the former. Points  $l_1$ ,  $l_2$  equipotential with reference to the high frequency current serve as leads for the heating current.

It may be mentioned, by the way, that it is not absolutely necessary for the supply leads  $l_1$ ,  $l_2$  to be equipotential; for if the circuit of the heating current is, per se, of sufficient impedance to the high frequency currents, or else, if for the same purpose a protective inductance 10 is arranged in series with the heating current source, the supply points  $l_1$ ,  $l_2$  may be provided at any convenient point of the frequency changer.

If, in connection with the artificial heating of the frequency changer, external conditions happen to play an undesirable part, the device could also in such case be disposed inside a vessel as in Fig. 1, such an arrangement being illustrated in Fig. 3. The reference letters stand here for the same elements and parts as in the preceding illustrations.

The energy of the frequency changer can be controlled or modulated by varying or interrupting the heating current, this being accomplishable directly, for instance, by the aid of the key  $t$ , or else indirectly in any of the well known manners.

For instance, according to Fig. 4, the heating currents can be taken for the frequency changer  $c$  from a rectifier  $g$  supplied from an alternating current source, and the said heating currents can, in well known manner, be modulated by regulation of the ignition current between electrodes  $z$  by the aid of a suitable device  $s$  which may consist either of a key or a telephone, to adapt them to the uses of telegraphy or telephony work. A source of direct current 11 is placed in series with device  $s$  and electrodes  $z$ .

In the case of especially high frequencies it is a suitable scheme to maintain the iron of the frequency changer in incandescent, or nearly incandescent, state, especially in the neighborhood of the critical temperature of the iron.

It should be noted that the arrangement of the conductors  $a_1$ ,  $a_2$ ,  $a_1^1$  and  $a_2^1$  is that of a Wheatstone bridge.

Having described my invention, I am entitled to all modifications thereof that fall fairly within its spirit and scope as defined by the following claims:

1. In combination, an inductance device having a magnetic circuit and an electric circuit, both of said circuits being formed through a bi-filar conductor, a source of energy connected with said circuits, and means for controlling the output of said device by varying its temperature.

2. In combination, a bi-filar conductor having a core of conducting material and a layer there around of magnetic material, said core and said outer layer being of different materials, a source of energy connected with said conductor and means for controlling the output of said conductor by varying its temperature.

3. In combination, an inductance device comprising a plurality of conductors, each conductor having a core of non-magnetic conducting material and a layer of magnetic material, said conductors arranged to form branches of a Wheatstone bridge said conductors also being arranged bifilar fashion, a source of high frequency across diagonally opposite corners of said bridge, and a source of heating current across the other diagonally opposite corners for controlling the output of said changer by varying its temperature.

4. In combination, an inductance device comprising a plurality of conductors, one conductor having a core of non-magnetic conducting material and a layer of magnetic material surrounding said non-magnetic conducting material, said conductors arranged to form branches of a Wheatstone bridge, a source of high frequency across diagonally opposite corners of said bridge, a source of heating current across the other diagonally opposite corners for controlling the output of said changer by varying its temperature.

5. In combination, a frequency changer comprising a plurality of conductors, each conductor having a core of non-magnetic conducting material and an outer coating layer of magnetic material, said conductors arranged to form branches of a Wheatstone bridge, with pairs of adjacent conductors being arranged bifilar fashion, a source of high frequency across diagonally opposite corners of said bridge, between the pairs, a source of heating current across the other

diagonally opposite corners for controlling the output of said changer by varying its temperature.

6. In combination, a frequency changer comprising a plurality of inductances, each inductance having a non-magnetic electric circuit and a magnetic circuit circumferentially, surrounding said electric circuit, said inductances arranged to form branches of a Wheatstone bridge, a source of high frequency across diagonally opposite corners of said bridge, a source of heating current across the other diagonally opposite corners of said bridge for controlling the output of said frequency changer by varying its temperature.

7. In combination, a frequency changer comprising a plurality of conductors, a pair of said conductors each having a core of non-magnetic conducting material and a layer of magnetic material, all of said conductors arranged to form branches of a Wheatstone bridge, said pair of conductors also being arranged in bifilar fashion, a source of high frequency across diagonally opposite corners of said bridge, formed by the ends of said pair of conductors a source of heating current across the other diagonally opposite corners for controlling the output of said changer by varying its temperature.

8. In combination, an inductance device having a magnetic circuit and a non-magnetic electric circuit, both of said circuits being formed through a bi-filar conductor, and means for adjusting the temperature of said device to any desired degree.

9. In combination, a conductor having a core of non-magnetic conducting material and a layer there around of magnetic material and means for adjusting the temperature of said conductor to any desired degree.

10. In combination, a hermetically sealed container, an inductance device having a magnetic circuit and an electric circuit in said container, said circuits being formed through a bi-filar conductor, said conductor having a core of non-magnetic conducting material and an outer coating of magnetic material and means to adjust the temperature of said device to any desired degree.

11. In combination, a hermetically sealed container, a conductor having a core of non-magnetic conducting material and a layer of magnetic material on said conductor.

12. In combination, a hermetically sealed container, a conductor having a core of non-magnetic conducting material and a layer of magnetic material there around in said container, a source of heating current traversing said conductor.

13. In combination, a hermetically sealed container, an inductance device having a

magnetic circuit and an electric circuit in said container, said circuits being formed through a bi-filar conductor, a regulated heating current traversing said electric circuit.

14. In combination, a hermetically sealed container, a conductor having a core of non-magnetic conducting material and a layer of magnetic material there around in said container, an energy source connected with said conductor, a source of heating current traversing said conductor for controlling the output of said conductor by varying its temperature.

15. In combination, an inductance device having a magnetic circuit and an electric circuit, said circuits being formed through a conductor formed of two distinct materials, wrapped one over the other, said conductor being arranged bifilar, a vessel for hermetically sealing said conductor, a medium chemically inactive with said conductor contained in said vessel, and a heating source associated with said magnetic circuit for keeping the same in a state of incandescence.

16. In combination, a conductor having a core of non-magnetic conducting material and a layer of magnetic material thereon, and means for variably controlling the temperature of said conductor, said means including a source of heating current connected with said conductor, said source comprising a source of alternating current energy, a source of ignition current, and a rectifier connected to said sources.

17. In combination, a conductor wound bifilar fashion, a hermetically sealed vessel surrounding said conductor, a source of high frequency energy connected with said conductor, and a source of heating current connected with said conductor, said heating current being derived from a rectifier adapted to control the output of said conductor by variably controlling the temperature to which said conductor is heated.

18. In combination, a frequency changer comprising a plurality of conductors each comprising a core of non-magnetic conducting material and a layer of magnetic material, a hermetically sealed body enclosing said conductors, said conductors being arranged within said body to form branches of a Wheatstone bridge with pairs of adjacent conductors being arranged bifilar fashion, a source of high frequency across diagonally opposite corners of said bridge, a source of heating current across other diagonally opposite corners of said bridge, and means for controlling the output of said changer by varying its temperature.

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