Feb. 4, 1930. M. OSNOS 1,745,378

HIGH FREQUENCY CONTROL SYSTEM

Filed Oct. 21, 1925 2 Sheets-Sheet 1

Fig. 1

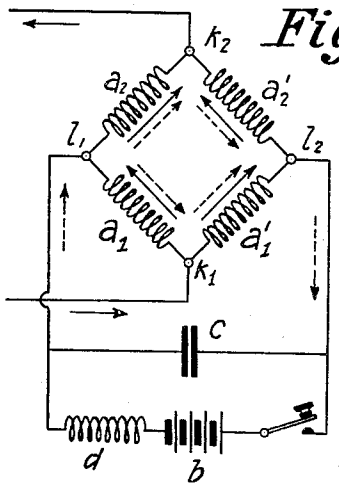


Fig. 2

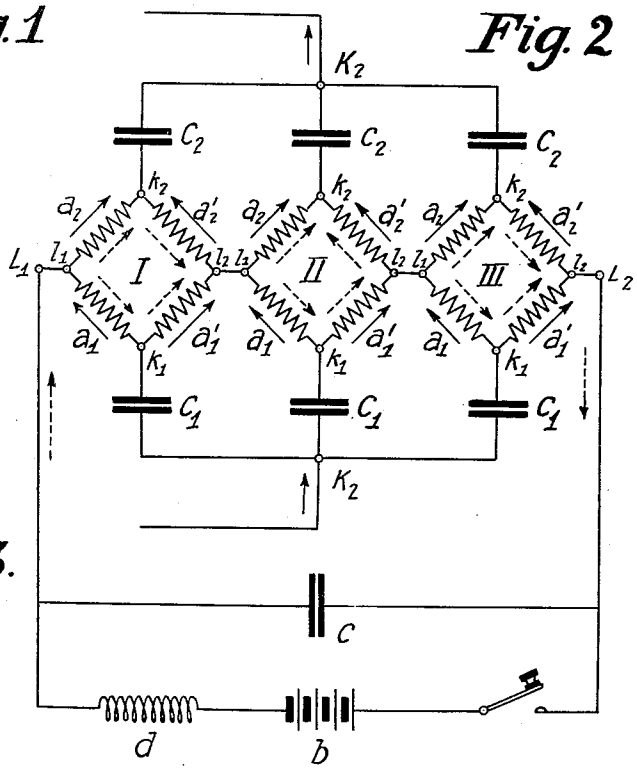


Fig. 3.

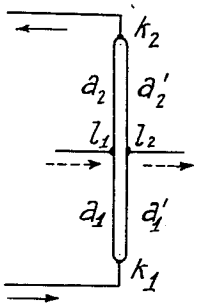
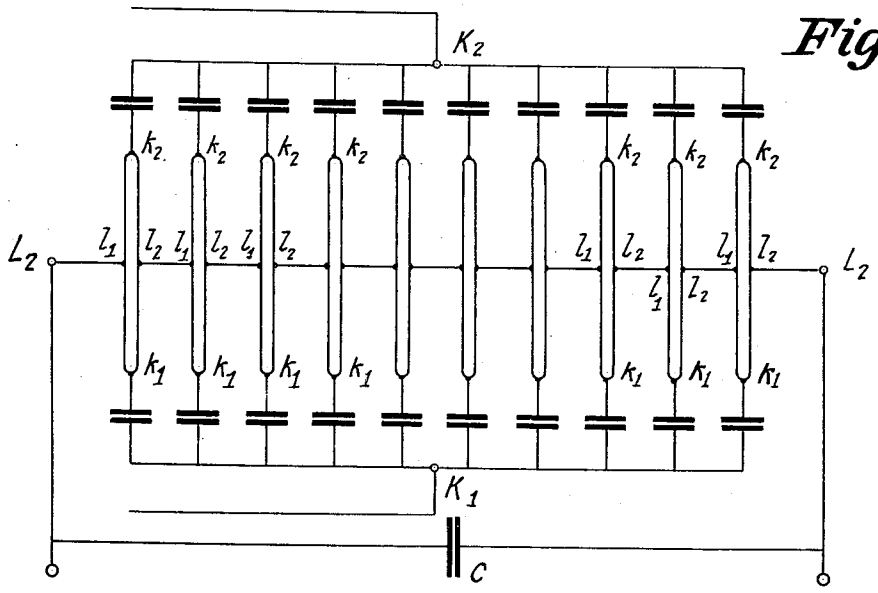


Fig. 4



INVENTOR
MENDEL OSNOS
BY Ira J. Adams
ATTORNEY

Feb. 4, 1930. M. OSNOS 1,745,378

HIGH FREQUENCY CONTROL SYSTEM

Filed Oct. 21, 1925 2 Sheets-Sheet 2

Fig. 5

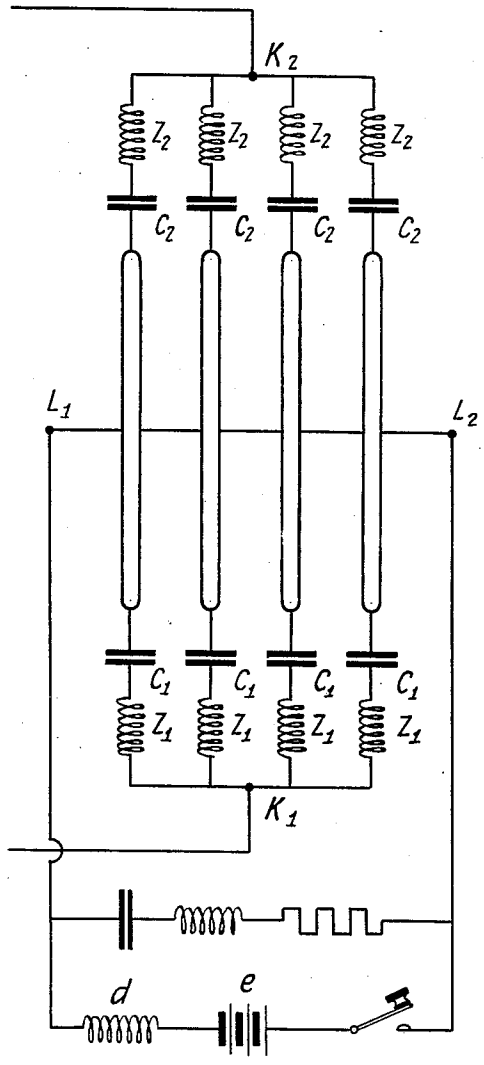


Fig. 6

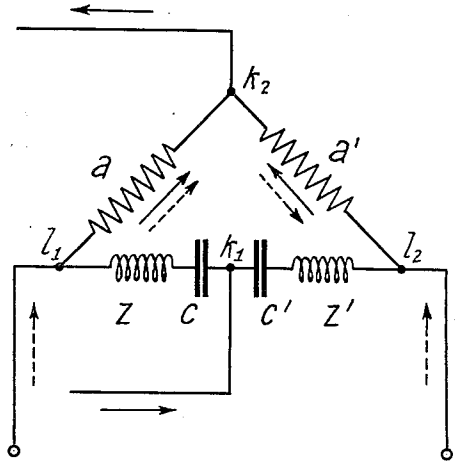
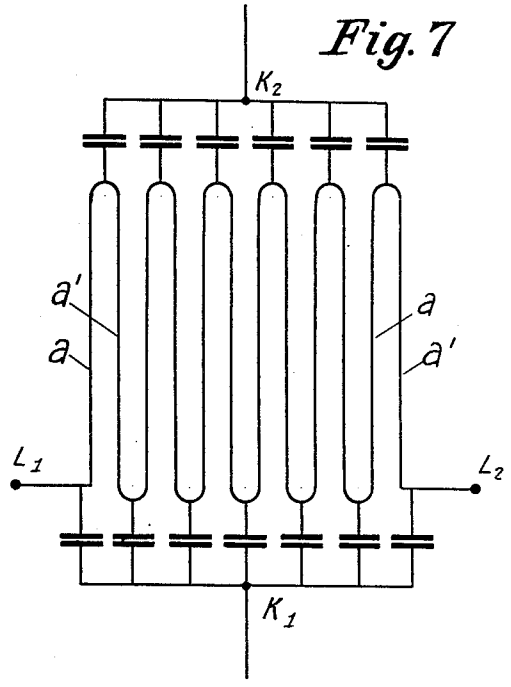


Fig. 7



INVENTOR
MENDEL OSNOS
BY
Ira J. Adams
ATTORNEY

Patented Feb. 4, 1930

1,745,378

UNITED STATES PATENT OFFICE

MENDEL OSNOS, OF BERLIN, GERMANY, ASSIGNOR TO GESELLSCHAFT FÜR DRAHTLOSE TELEGRAPHIE M. B. H., OF BERLIN, GERMANY, A CORPORATION OF GERMANY

HIGH-FREQUENCY-CONTROL SYSTEM

Application filed October 21, 1925, Serial No. 64,042, and in Germany November 1, 1924.

The suggestion has been made to build high frequency changers, modulators, and the like regulated and acted upon by control currents in such a way that both for the controlling as well as for the controlled currents, one and the same winding is used. In this manner, a separate controller winding is saved, while in addition the whole field is utilized free from leakage.

The arrangement according to the present invention offers special advantageous features if the modulator or the frequency changer consists of a high frequency conductor of the type disclosed by U. S. application Serial No. 63617, filed October 20, 1925. A conductor of the sort here under consideration consists of a wire, rod, tape or ribbon, etc. made of conductive material, preferably copper, coated with a thin film of ferromagnetic material, preferably iron, the said film or skin being brought upon said conductor either in the shape of a fine capillary wire wrapped thereon in one or more layers, or else in the form of a galvanic deposit, or the like, with, or preferably without, insulation.

Current conductors of the said sort make it feasible to generate very short waves; they operate under especially favorable conditions when in heated state, most conveniently in the neighborhood of the critical temperature of the iron. Fig. 3 shows an arrangement by way of example comprising such a conductor used in connection with, or as, a key or telephony modulator, or as a frequency changer.

Other and more specific advantages will be observed in connection with the following specification, claims and drawings in which:—

Fig. 1 shows a simple schematic arrangement,

Fig. 2, a modification,

Fig. 3, a unit of my device,

Fig. 4, a different modification using these units,

Fig. 5, a slightly different arrangement of the modification shown in Fig. 4,

Fig. 6, an adaptation of Fig. 5, and

Fig. 7 is still a different combination of units.

Fig. 1 shows, for instance, such a well-known arrangement comprising frequency changers or key modulators in what is known as the rhomb connection. In the showing of Fig. 1 a winding consisting of four parts, a^1, a^2, $a^{1'}$, $a^{2'}$, is passed in the direction k^1, k^2, by the high frequency currents, and in the direction l_1, l_2 by the auxiliary magnetizing currents, say, currents of low frequency, or, most conveniently direct current furnished from a battery b. The direction of the field of the high frequency currents at a definite instant are indicated in the figure by the solid arrows, while the directions of the field of the direct current are indicated by the broken arrows.

When using this device as a pure controlling modulator key or telephony modulator, modulation or control is effected by the break and make, or by the variation, of the current fed in the direction l_1, l_2. The harmonics of an even order, especially those of double frequency, set up at the terminals, l_1, l_2, are shorted by means of a condenser.

When the apparatus is used as a frequency changer, either the terminals k^1, k^2 for the odd multiple frequencies, or the terminals l_1, l_2 for the even harmonic frequencies could be used as the secondary terminals. In this latter case, the short-circuit condenser C is replaced by a consuming circuit for the secondary frequency, while battery b is safeguarded by a choker d. Modulation is produced in this case either by the aid of the frequency changer itself, or else by means of a separate modulation device at any suitable point of the arrangement. When modulation is produced by means of the frequency changer itself, conditions may be so chosen according to desires so that the detuning of the arrangement is accomplished either by making or breaking, or else by varying the controlling current. If the apparatus is exclusively used as a frequency changer, the controlling current flowing in axis l_1, l_2 merely serves the purpose of setting up at the terminal l_1, l_2 secondary even frequencies. In this case the exciting direct current in the sense of the invention is denoted as the controlling current in so far

as by its adjustment the desired secondary frequency of even order can be obtained.

Now, the arrangement as hereinbefore described involves a very serious disadvantage; since the controlling currents must substantially have the same order of magnitude as controlled currents, it follows that, in view of the number of turns being identical in the two current systems, the controlling current must have the same order of magnitude as the current to be controlled, hence, as a general rule, it must be comparatively large. But this requirement is often conducive to great difficulties: The keying apparatus becomes very heavy and allows only of faulty interruption or variation of the current, not to mention the fact that the direct current source of necessity must consist of a machine of abnormal type giving a large current at a small voltage. Especially telephoning is rendered very difficult on account of the requisite size of the speech current.

Now, the present application discloses means whereby this difficulty can be obviated, and the controlling current can be reduced to any desired fraction of the controlled current. The idea underlying the invention consists in that the windings are divided into any desired number of parts which are passed by the currents to be controlled in parallel, and in series by the controlling currents.

A few examples shall be described to illustrate and explain the basic idea of the invention.

In Fig. 2 each of the winding groups I, II, III is similar to the winding quadrangle Fig. 1. Also the denotations of the terminals of each group, of the battery, its protective coil, its parallel condenser, and the directions of the currents and the fields are the same as in Fig. 1. In the arrangement as shown, the same is used as a modulator.

The three groups of winding are arranged in parallel relationship with reference to high frequency currents flowing through the common terminals K^1, K^2 while they are in series with regard to the controlling currents flowing by way of terminals L^1 L^2. By-pass condenser C^2 blocks the way of the controlling currents and prevents them from flowing through the connecting terminals K^1, forcing them to pass through the upper sides of the winding quadrangles. Condensers C^2 C^1 play the identical part with reference to the lower halves of the said quadrangles. The condensers C^1 and C^2 furthermore serve as shorts for equalizing the higher harmonics, especially even multiples. For example, the harmonics of an even order set up in winding $a^{2'}$ of quadrangle I and in winding a^2 of quadrangle II are neutralized by way of the corresponding terminals k^2, condensers C^2, and the junction of terminal K^2. The situation is similar with regard to other winding parts with the exception of those united with the end terminals L^1, L^2, in the case of which equalization is brought about by condenser C. The latter, by the way, is not always required.

If the arrangement shown in Fig. 2 is to be used also as a frequency changer, it will be clear that condensers C^1 as well as condensers C^2 must be preserved in order to shut off the controlling currents from flowing by way of K^1 or K^2; but they no longer serve as an equalizing means for the secondary frequency which is now used as the working frequency.

For this purpose, each condenser C^1 or C^2 can have a convenient tuning inductance Z^1 and Z^2, respectively, connected in series with it, each of such tuning combinations $C^1 Z^1$ and $C^2 Z^2$ being wholly or partly tuned to the primary frequency, while it offers a practically complete block for the secondary frequency. The secondary working frequency can then be taken off at the end terminals L^1 L^2, if the condenser C is replaced by a suitably tuned consuming circuit. If the terminals K^1 K^2 are finally to be used also as secondary terminals for the odd harmonics, it is advisable to build the blocking paths or by-passes two-wave-fashion, that is to say, as systems tuned both to the primary and the secondary frequency.

The terminals k^1, k^2, or l_1, l_2, in this case play the same part as in the arrangements previously described. Also in this case, the controlling currents, such as direct current, keying or modulation current, or speech currents, are fed at the terminals l_1 l_2, and from the same terminals, in case of use as a frequency changer, the higher harmonic frequencies of an even order can be taken off similarly as in Fig. 1. When used as a modulator, the terminals k^1, k^2, carry the high frequency currents to be controlled or modulated, and when used as a frequency changer they may carry, apart from the currents of primary frequency, also the currents of secondary frequency, particularly odd harmonics, but, if desired, also even harmonics and quasi-harmonics. In the figure, the conductor is shown approximately bifilar with reference to the currents flowing in the axis l_1, l_2, but it could also roughly be bifilar with regard to the currents of the axis k^1 k^2, or most preferably with reference to both these axes, this latter plan being realized by that, e. g., the conductor structure shown in Fig. 3 is bent straight about the axis l_1 l_2 so that the terminals k^1 and k^2 approach one another. Another plan would be not to bend the conductor or to bend it not only in the middle, bifilar-fashion, but bending it zigzag-fashion at several places.

An approximately bifilar arrangement for the controlling key and speech currents is particularly highly favorable for telephony work seeing that in this case, owing to the in-

ductionless path for the speech currents, the overtones pass with more readiness, with the result that a better timbre is obtained.

Fig. 4 illustrates the application of the basic idea of the invention to a key choker according to Fig. 3. Also in this case the different elements of the kind depicted in Fig. 3 by means of their terminals k^1 and k^2 are united in parallel relative to the controlled currents, and by means of their terminals l_1 l_2 in series for the controlling currents. With a number of elements as indicated in the drawing, the controlling current, as will be noted, is diminished to one-tenth. As to the rest, this connection will be readily understood on account of its analogy with Fig. 2.

If the arrangement as before described shall be used as a direct current-excited frequency changer for the generation of even harmonics across terminals L^1 L^2, a convenient plan would be, as shown in Fig. 5, to provide an inductance Z^1 and Z^2, respectively in series with each condenser C^1 and C^2, respectively, which constitutes a block for the multiple frequency, while jointly with its condenser being totally or partly tuned to the fundamental wave, the parallel condenser C being then replaced by a suitably tuned consuming circuit.

In the arrangements hereinbefore cited by way of example, the basic element of the series-parallel connection was a winding quadrangle of the kind shown in Fig. 1, or a conductor quadrangle of the sort illustrated in Fig. 4. Inside the scope of the present invention will fall also arrangements comprising basic elements of other nature or property, as long as these elements contain parts or portions which are jointly passed by the controlled and the controlling currents. An example of an element so constituted is shown in Fig. 6. In this case only parts a and a' are the elements influenced by the iron, for instance, the windings placed upon the iron body or core, or the high frequency conductor wth an iron skin. The two other sides of the quadrangle are replaced by the condensers C and C′ which, under certain circumstances, may have tuned air-core chokers Z and Z′ connected in series therewith. Terminals k^1 and k^2, and l_1, l_2 have here the same significance as in the quadrangle elements.

Fig. 7 shows a combination of such elements (copper conductor coated with iron) according to the invention; also in this case the controlling current is fed at the terminals L^1 L^2, and the controlled current at terminals K^1 K^2. When the apparatus is used as a key or telephone modulator, it is of utmost importance that the same should be bifilar, as shown, not only for the controlling currents, but also for the controlled currents.

The invention is applicable also to machines in which the direct current and the alternating current flow in one and the same windings.

Having thus described my invention, what I claim is:—

1. An arrangement adapted for the control of high frequency currents by controlling direct currents affecting the degree of saturation of a saturable impedance comprising a high frequency controlled circuit and a low frequency controlling circuit, a saturable impedance forming a conductor common to each of said circuits for carrying the currents of both said circuits and arranged to provide parallel paths for said high frequency currents, said conductor being arranged in a plurality of parallel paths with respect to said controlling circuit, and means associated with each of said parallel high frequency current paths for blocking said controlling currents from the portion of said high frequency circuit which is external to the portion common to both said high frequency currents and said controlling currents.

2. An arrangement for controlling high frequency currents comprising a high frequency current path and a controlling current path, a saturable impedance traversed by both of said paths and having its saturation controlled by controlling currents, said saturable impedance being arranged bifilar with respect to said controlling currents and arranged to provide a plurality of parallel paths for said high frequency currents, and means for blocking said controlling currents from said high frequency circuit.

3. An arrangement for controlling high frequency currents comprising a high frequency current circuit and a low frequency controlling current circuit, a plurality of saturable impedances arranged in a plurality of structures of bridge formation for passing both said high frequency currents and said controlling currents and controlling the high frequency currents by the variations in the saturation of said impedance produced by said controlling currents, said bridge structures being series connected with respect to said controlling currents and parallel connected with respect to said high frequency currents whereby the amplitude of the controlling current with respect to the high frequency current is reduced, and means associated with each of said parallel high frequency paths for blocking the said controlling currents from said high frequency circuit.

4. An arrangement for controlling high frequency currents comprising a controlled high frequency current circuit and a controlling circuit of low frequency currents, a non-magnetic conductor having an outer magnetic material coating, said conductor being adapted for the joint passage of both said currents and divided into a plurality of sections whereby said conductor provides a plurality of parallel paths for said high fre-

quency current and a series path for said controlling current, and the high frequency currents are controlled by variations in the saturation produced in said magnetic material by said controlling currents.

5. An arrangement for controlling high frequency currents comprising a high frequency circuit and a low frequency controlling circuit therefor, a saturable impedance common to each of said circuits, said impedance being arranged to provide parallel paths for said high frequency circuit and a series path for said controlling currents, said impedance also being arranged bifilar with respect to said controlling currents, means for blocking said controlling currents from the portion of said high frequency circuit which is external to said common conductor, and means for controlling said high frequency currents by variations in the degree of saturation produced in said saturable impedance by said controlling currents.

6. An arrangement for controlling high frequency currents comprising a high frequency controlled current circuit and controlling current circuit therefor, a conductor providing a common path for both said high frequency currents and said controlling currents and providing parallel paths for said controlled high frequency current and series paths for said controlling currents, a magnetic portion associated with said conductor, means provided by said controlling currents for controlling the said high frequency currents by varying the degree of saturation of said magnetic portion of said conductor, means comprising capacitance and inductance series connected for blocking the controlling currents from said high frequency circuit which is external to said common path.

7. An arrangement for controlling high frequency currents comprising a high frequency controlled circuit and a low frequency controlling circuit, a plurality of conductors each having a saturable portion adapted to constitute a common path for both of said currents and adapted to control said high frequency currents by variations in the degree of saturation of said saturable portions of said conductors produced by said controlling currents, said conductor being arranged in a plurality of parallel paths with respect to high frequency currents and in a plurality of series paths with respect to said controlling currents, and means associated with each of said parallel paths for high frequency for blocking said controlling currents from the portion of high frequency circuit which is external to said common path.

MENDEL OSNOS.