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CONSUMING APPARATUS ADAPTED TO BE SUPPLIED BY DIRECT CURRENT

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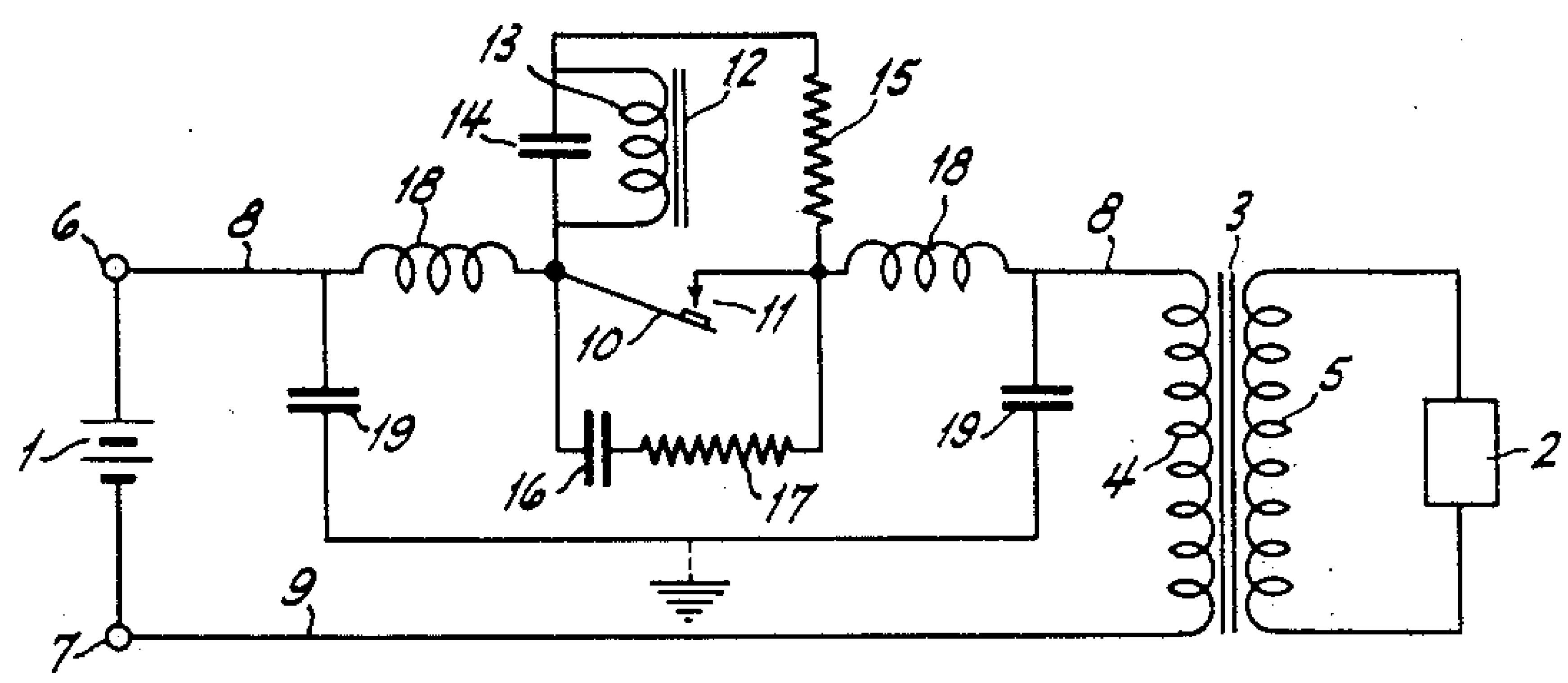

Fig. 1

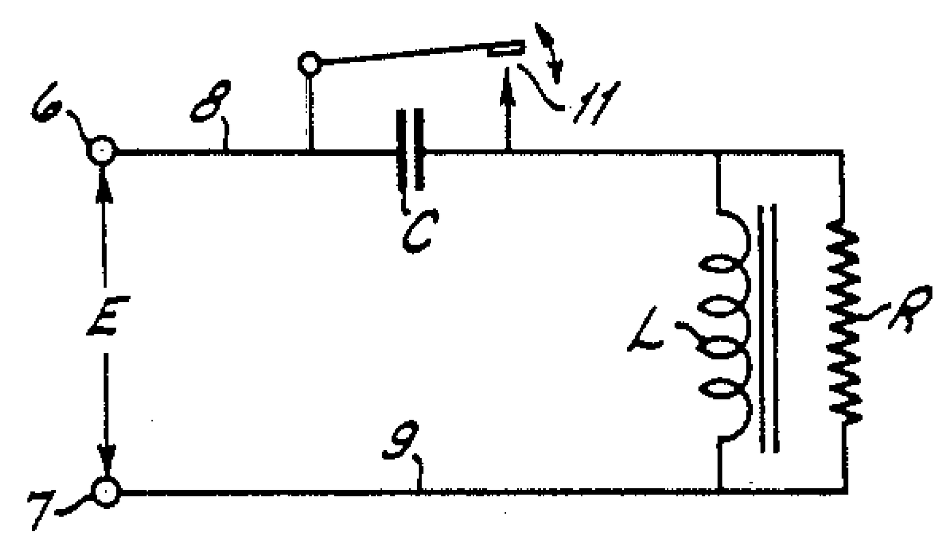

Fig. 2

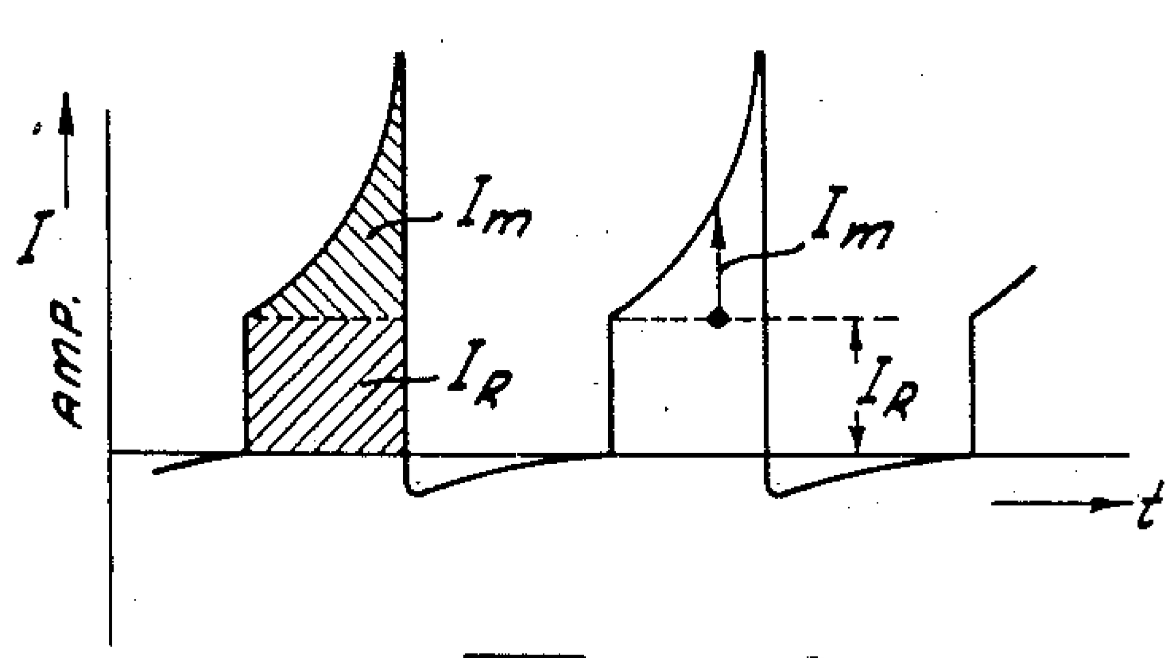

Fig. 3

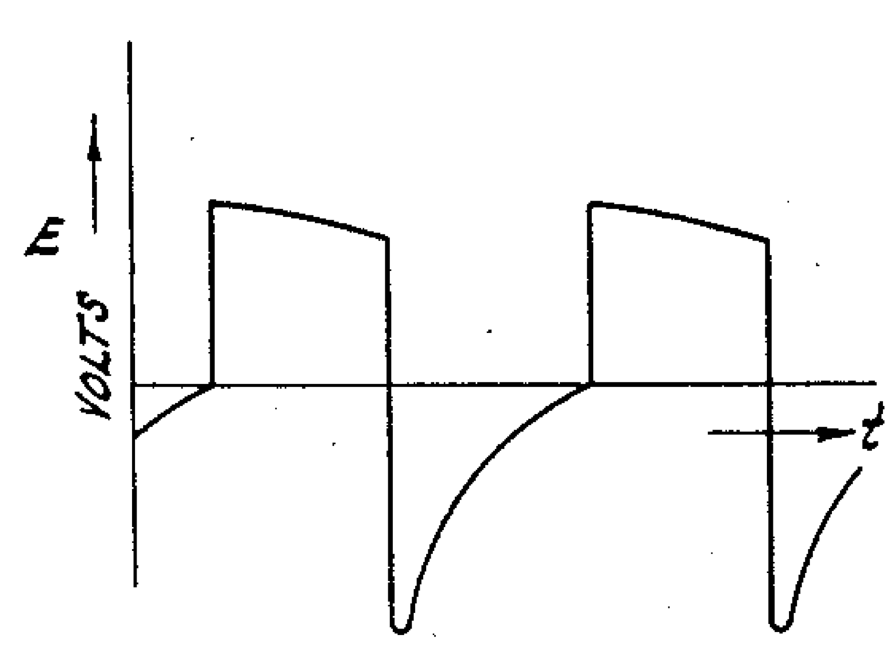

Fig. 5

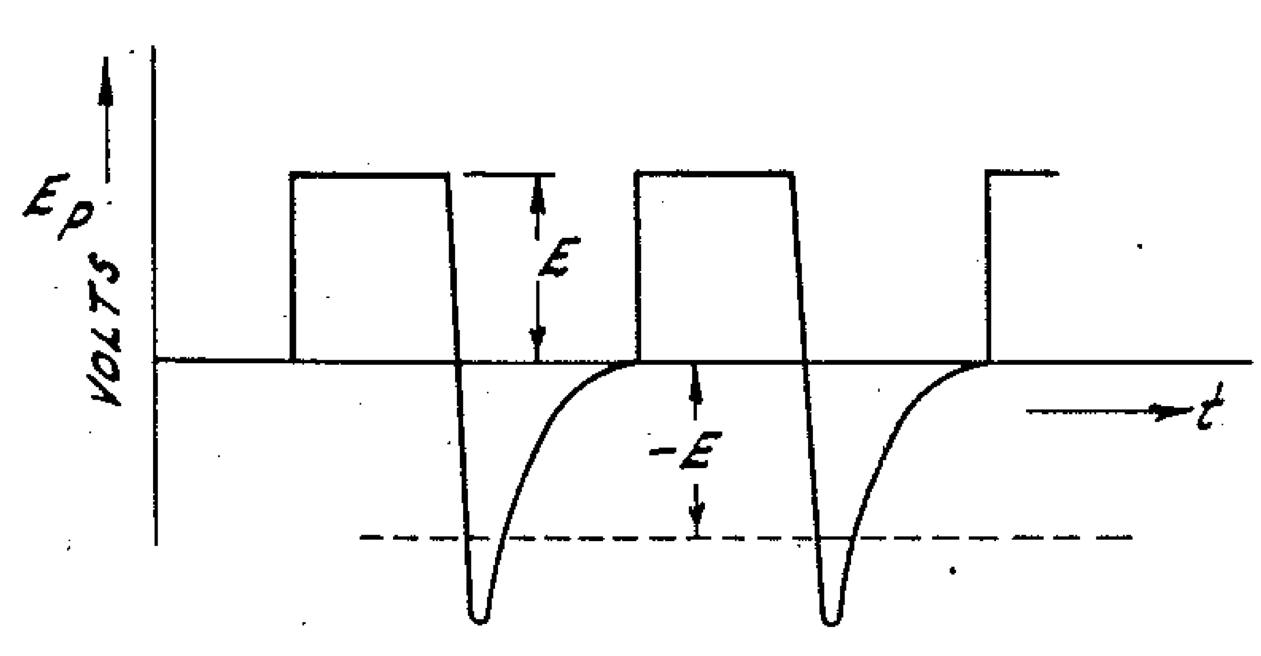

Fig. 4

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CONSUMING APPARATUS ADAPTED TO BE SUPPLIED BY DIRECT CURRENT

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5 Claims. (Cl. 175—365)

The invention relates to a consuming apparatus, more particularly a radio receiving apparatus, which is constructed for being supplied by alternating current and which is adapted to be supplied from direct current mains by the use of a vibrating member which periodically interrupts the direct current circuit which is connected to the primary winding of a supply transformer.

For supplying a radio receiving apparatus constructed for being supplied by alternating current supply from direct current mains use is frequently made of a vibrating member or vibrator converter by means of which a periodically interrupted direct current is supplied to the primary winding of the supply transformer which winding is included in a direct current circuit. The primary winding of the supply transformer is provided, for example, with a central tap which is connected to one of the terminals of a source of direct current whose other terminal is connected to a contact spring which is maintained in vibration by an electromagnet and by means of which the last mentioned terminal is alternately connected to the two ends of the primary winding with the result that the two halves of the primary winding are alternately traversed by a direct current, which currents magnetize the transformer in opposite senses. An arrangement of this type is described in United States Patent 2,137,375.

A drawback of this arrangement is that always only one of the halves of the primary winding is in function at a time and that the primary winding must have a central tap.

The above mentioned drawbacks are removed by utilizing a vibrator converter having two sets of interrupter contacts, by which the current traversing the whole of the primary winding is periodically commuted. Although in this case an extra use of copper for the primary winding and a central tap are avoided it is necessary, if the converter is utilized for the supply of a radio apparatus, to provide in each of the four connecting conductors which connect the interrupter contacts to the two connecting terminals of the mains and to the ends of the transformer winding respectively a filter to eliminate high frequency interference whereas the first mentioned known device requires three filters for the elimination of high frequency interference. Furthermore, the large number of interrupter contacts which, in view of a long life of the vibrator, are made of a particular and specially treated metal is inconvenient and expensive.

Moreover, if the above mentioned known devices are utilized for adapting a consuming apparatus constructed for being supplied by alternating current to be supplied from direct current mains, the two current supply conductors of the apparatus must be interrupted before the vibrator converter can be switched into circuit.

The drawbacks arising with these known devices are avoided by the present invention.

According to the invention, only one of the conductors which connect the ends of the primary winding of the supply transformer to one of the connecting terminals of the mains respectively comprises a contact which is periodically interrupted by the vibrating member, said contact being bridged by the series connection of a condenser and a resistance.

The current flowing through the primary winding when the interrupter contact is closed (said current being hereinafter referred to for simplicity as "positive half-wave") generates a magnetic field which produces, when the interrupter contact is opened, in the primary and secondary windings a current of opposite polarity (for simplicity referred to hereinafter as "negative half-wave") with the result that the above mentioned condenser is charged. According to one particularly advantageous embodiment of the present invention, in order to ensure that the negative half wave thus produced furnishes an appreciable proportion of the total output energy, the transformer is so dimensioned that during operation it is periodically highly saturated. In order to avoid, in particular when the interrupter contact is closed, too sudden a discharge of the condenser, a resistance should be connected in series with this condenser.

The value of the condenser and the degree of the saturation which periodically occurs in the transformer should preferably be so chosen that the maximum amplitude of the alternating voltage set up across the primary winding when the interrupter conductor is open is approximately equal to the feed voltage of the direct current mains and preferably higher than the said voltage.

The invention and the particular advantages which can be obtained in the application thereof will be set out in detail with reference to the drawing wherein Fig. 1 illustrates diagrammatically a preferred embodiment of the invention; Fig. 2 is a simplified diagram used to describe the invention; and Figs. 3, 4 and 5 are curve sheets used to illustrate the operation of the device.

Fig. 1 represents the circuit arrangement of a vibrator converter which is connected to a direct current supply 1 and which feeds a consuming apparatus 2 which is connected to the secondary winding 5 of a transformer 3. The ends of the primary transformer winding 4 are connected to terminals 6 and 7 of the supply by means of conductors 8 and 9 respectively. Only the conductor 8 includes a contact 11 which is periodically interrupted by a vibrating member 10 which is maintained in vibration by an electromagnet 12 which bridges the contact 11.

In order to reduce the current required for the excitation of the electromagnet to a minimum, a condenser 14 is connected in parallel with a field coil 13, said condenser being so dimensioned that the oscillatory circuit formed by the coil 13 and the condenser 14 has a natural frequency which corresponds to the natural frequency of the vibrating member 10. The ends of the coil 13 are connected directly to one of the portions of the contact 11 and, through the intermediary of a resistance 15 to the other contact portion respectively. The resistance 15 has for its purpose to reduce the voltage set up across the coil 13.

In order to avoid high frequency interference due to the opening and closing of the interrupter contact in the mains, the transformer and the consuming apparatus connected thereto, the contact portions which form the contact that is periodically to be closed are connected, via a filter by which high frequency interference is eliminated and which consists each of a coil 18 and a condenser 19, to one of the ends of the primary transformer winding 4 and to the connecting terminal 6 of the mains respectively.

It has been found that those electrodes of the condensers 19 which are not connected to the conductor 8 need not be separately earthed, so that the vibrator, which is associated with the interference eliminating filters to form a unit, has in general only two connecting terminals and thus switching the vibrator into circuit, in order to adapt a consuming apparatus, which comprises a supply transformer and is constructed for being supplied by alternating current, to direct current supply, can be effected in an extremely simple manner.

A condenser 16 and a series resistance 17 are connected in parallel with the interrupter contact 11.

The operation of the converter will be explained more fully with reference to the substitution diagram according to Fig. 2 and to the oscillographically plotted diagrams according to Figs. 3, 4 and 5.

Between the terminals 6 and 7 at which the arrangement is connected to the mains there exists the direct current voltage E. Into the conductor 8 are connected a condenser C and an interrupter contact 11 connected in parallel therewith.

The transformer 3 and the consuming apparatus 2 connected thereto are replaced by a self-inductance L and an ohmic resistance R connected in parallel therewith. The filters in the conductor 8 which serve to eliminate high-frequency interference are omitted because they are of no importance for the low frequency phenomena to be considered.

If the interrupter contact 11 is closed the condenser C is short-circuited and the coil L and the resistance R are located directly in parallel with the direct current supply. The current which then flows in the circuit (positive half wave) consists of two components viz. the current in the resistance R (I_R) and the magnetizing current of the coil L (I_m). In the time diagram of Fig. 3 these components are clearly visible. When the interrupter contact is closed I_R has practically at once its maximum intensity whereas, due to the gradually increasing saturation, the magnetizing current I_m is at first very small and then increases according to a curve of exponential character. This great increase of the magnetizing current causes accumulation of magnetic energy in the coil L during the period in which the interrupter contact is closed. When the contact 11 is opened this magnetic energy in the coil L causes a current having a polarity opposite to that of the current produced with the closed interrupter contact. By a proper choice of the cross-section of the core arranged in the magnetic field of the coil and of the value of the condenser C which operates exclusively when the interrupter contact is open, the accumulated magnetic energy causes across the coil L (or across the primary or secondary winding of the supply transformer) a negative half wave of the alternating voltage whose amplitude is larger than the feed voltage E. Accordingly the condenser is charged by the liberated magnetic energy up to voltage E_c which is higher than 2E. If the condenser is taken of too high a value the liberated magnetic energy is insufficient to bring about a sufficiently high charge whereas, if the condenser is taken of too small a value, the voltage on the condenser and the voltage between the contact portions become too high with the result that, when the contact is opened, an intense arc is produced. It has been found experimentally that the value of the condenser is not very critical. When the interrupter contact 11 is opened the charging of the condenser owing to the liberated magnetic energy produces in the direct current circuit a current which is opposite to the polarity of the feed voltage, as may be clearly seen from Fig. 3 (negative half-wave).

Fig. 4 shows a time diagram of the alternating voltage set up across the coil L or across the primary winding. Upon closing the interrupter contact the voltage E_p is substantially equal to E and during the remainder of the closing time it remains constant.

When the interrupter contact is opened the voltage decreases very rapidly and becomes negative ($E_p>E$) and then the negative voltage decreases according to a curve having an exponential course. As will be clear upon consideration of Fig. 2 the voltage on the condenser amounts to about E volts when the interrupter contact is being closed, so that in order to counteract the production of an arc between the portions of the interrupter contact when the latter is closed a resistance has to be connected in series with the condenser.

For the sake of completeness Fig. 5 shows the alternating voltage set up across the secondary winding 5. This alternating voltage has substantially the same shape as the voltage existing across the primary winding but the losses occurring with the strong saturation are manifested in this voltage, in particular in the positive half-wave.

Owing to its extremely simple system of connections, to the small number of elements and connecting conductors as well as to the simple means which ensure sufficient elimination of interference, the above-described vibrator-converter is particularly suitable for use in radio-apparatus, in which in general a very cheap converter is required.

In order to be able to form an idea of the values of the principal elements of the arrangement they are indicated below such as they are preferably utilized when the converter is utilized in a radio-receiver having a connecting value of about 25 watts. The self-inductance L of the unsaturated transformer, measured on the primary side, amounted into 6 henries in the case of a feed voltage E=220 volts and the load impedance R was 2000 ohms. As previously noted, the value of the condenser has been found to be not very critical. Satisfactory results are obtained with condensers between 0.2 μf. and 0.5 μf. The resistance 17 may be of comparatively small value, for example 50 ohms. The transformer has a core made of ordinary core sheet and is so dimensioned that the maximum magnetic induction amounts to about 14,500 gauss, which maximum value corresponds to a point of the horizontal portion of the magnetization curve of the core iron. With the above mentioned dimensioning the effective value of the alternating voltage set up on the primary side of the transformer was found to differ only very slightly from the direct current feed voltage. Sufficient elimination of interference is obtained by utilizing high frequency filters shown in Fig. 1 which comprise condensers 19 of 0.1 μf. and inductances 18 of about 1.5 henries. The interference eliminating filters, the vibrating member and the parts connected in parallel therewith, are preferably assembled in a metal casing which may be very small owing to the small size and the slight number of the elements, so that it can be easily mounted in the receiving apparatus and takes up little room.

We claim:

1. In a device for changing direct current potentials into alternating current potentials, a transformer provided with a pair of input terminals and a pair of output terminals, a pair of source terminals between which is adapted to be connected a source of direct current potential, a direct connection between one of said source terminals and one of said transformer input terminals, a connection including a vibrating make and break switch between the other of said source terminals and the other of said transformer input terminals, means for periodically making and breaking said switch during operation of the device, said last named means comprising a magnetic coil connected across said switch and a condenser shunted across said magnetic coil, said condenser and magnetic coil forming an oscillatory circuit having a natural frequency which corresponds substantially to the natural frequency of said vibrating switch, a condenser and a resistance in series connected across said make and break switch whereby the last named source terminal and the last named transformer input terminal are connected through said condenser and resistance, said condenser being of such a value that on break of said switch the voltage across the output terminals of the transformer rises to the order of magnitude of the supply voltage but of opposite polarity thereto.

2. A device as disclosed in claim 1 characterized by that the transformer is arranged so that in the operation of said device the transformer is periodically highly saturated.

3. In a device for changing direct current into alternating current, a pair of terminals adapted to be connected to a source of direct current, a transformer having a primary winding and a secondary winding, a direct connection between one of said terminals and one end of said primary winding, a connection including a continuously vibrating circuit interrupter between the other of said terminals and the other end of said primary winding, radio frequency by-pass means connected between said last named terminal and ground and the last named end of the transformer primary and ground, a driving coil for operating said circuit interrupter, an impedance, said driving coil and impedance being connected in series across said circuit interrupter, a condenser and a resistance in series connected across the interrupter and arranged so that on break of said switch the voltage across the primary of the transformer rises to a value of the order of magnitude of the supply voltage but of opposite polarity thereto, and a utilizing circuit connected across the transformer secondary.

4. In a device of the kind described, a transformer provided with a pair of input terminals and a pair of output terminals, a pair of source terminals adapted to be connected to a source of direct current, means for connecting one of said source terminals to one of said transformer input terminals, a continuously vibrating circuit interrupter including a pair of cooperating contacts, means for connecting one of said contacts to the other of said source terminals, means for connecting the other contact to the other of said transformer input terminals, a driving coil for said circuit interrupter connected between said two cooperating contacts, a condenser shunted across said driving coil, said condenser and driving coil forming an oscillatory circuit which has a natural frequency corresponding substantially to the natural frequency of the vibrating circuit interrupter.

5. In apparatus for changing direct current into alternating current, a transformer provided with a primary winding and a secondary winding, a load connected across said secondary winding, a source of direct current, a make and break switch including a vibrating element and means comprising an electromagnetic coil connected across said switch for driving said vibrating element to thereby periodically and alternately make and break the switch, a condenser connected across said coil, said coil and condenser being proportioned relative to one another so that they form a tuned circuit which is resonant substantially at the natural frequency of said vibrating element, a circuit including the primary of said transformer and said switch in series connected across said source, said switch acting in the operation of said apparatus to periodically connect the primary across said source whereby current from the source is periodically fed through said primary winding in one direction, said transformer being arranged so that said current causes it to become periodically highly saturated thereby accumulating a certain amount of magnetic energy which is released on break of the switch, a condenser connected across said switch, said condenser being proportioned with relation to the transformer so that on break of said switch the direction of the flow of current in said primary winding is reversed.

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