Sept. 3, 1940. A. LEIFER 2,213,550

PERIODIC DIRECT CURRENT INTERRUPTER

Filed Nov. 18, 1938

Fig. 1.

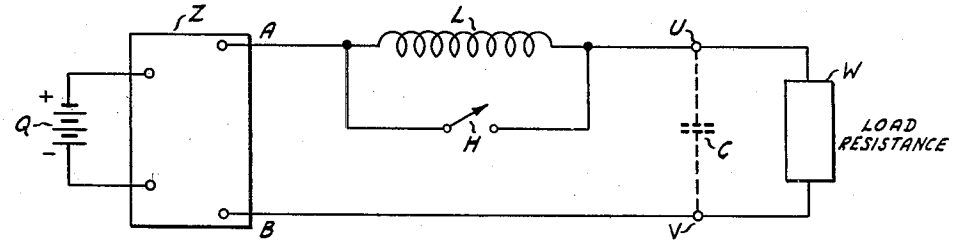


Fig. 2.

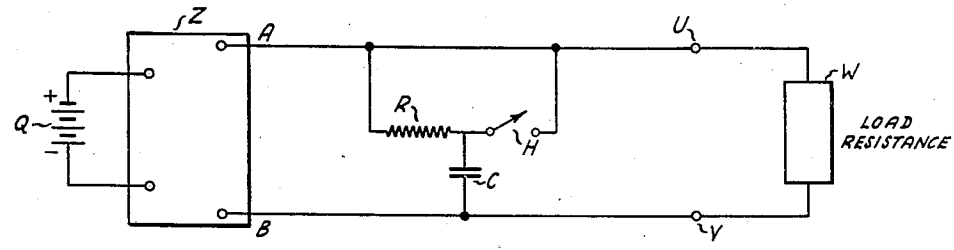
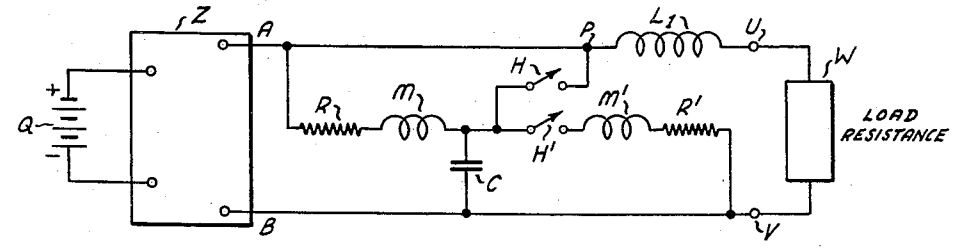


Fig. 3.



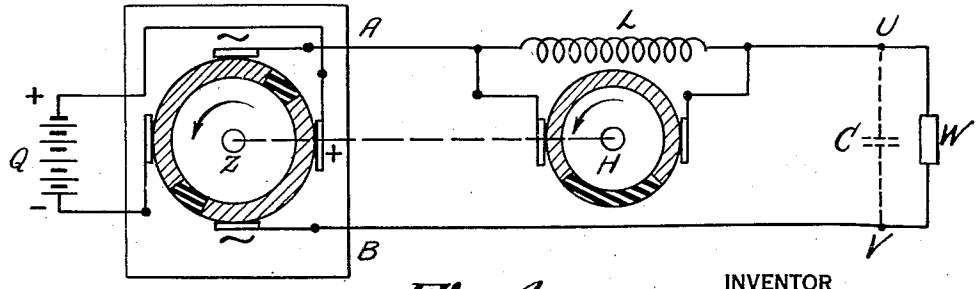


Fig. 4.

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Patented Sept. 3, 1940

2,213,550

UNITED STATES PATENT OFFICE

2,213,550

PERIODIC DIRECT CURRENT INTERRUPTER

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Application November 18, 1938, Serial No. 241,159
In Germany October 18, 1937

3 Claims. (Cl. 175—364)

In periodically operating D. C. switches or interrupters (choppers), especially in mechanical inverse rectifiers, sparking occurs the instant the contacts are opened and closed. This leads to damaging of the contacts, for where higher potentials and loads are dealt with the sparks may become a permanent arc. When the load is predominantly inductive in nature the opening spark is most severe since the interrupted current occasions a high potential at the circuit opening point. When the load is predominantly capacitive, the circuit closing spark, on the contrary, will be the heaviest since a large charge current flows the instant contact is established.

At least one of the sparks, according to the invention, may be substantially lessened by providing an accessory switch which is operated in synchronism, though in the presence of such a phase shift that when the main switch is closed the accessory switch is opened, and closed when the main switch is opened. The said accessory or auxiliary switch is connected either in parallel to the inductance contained in the lead to the consumer or load or else in series with a condenser charged to the D. C. potential to be switched across a high resistance in parallel relation to the consumer or load.

The operation of the arrangement of the invention shall now be explained in more detail by reference to the figures of the appended drawing which show exemplified embodiments thereof. Referring to Figs. 1 and 4, Q denotes a source of D. C. voltage supply which, by the action of the mechanical inverse rectifier or chopper Z, is changed over in period alteration double-pole fashion. Across the output terminals A and B of the choppers appears the voltage of the source Q in periodically changing or reversing sense. Across the terminals U and V is the load resistance W of which, in the present instance, the assumption is made that it possesses a predominantly capacitive-ohmic nature. The capacitive component of the load resistance is indicated symbolically by the capacity shown by dash lines.

While the terminal V is directly united with the terminal B, there is connected between the terminal U and the terminal A an inductance L the dimensions of which are suitably so chosen that it will form with the aggregate load (including wattless component) a nearly aperiodic circuit. In parallel relation to the inductance is an auxiliary switch H. The latter is so inter-locked with the switch contacts of the chopper that it is opened and closed in the same periodic alternation as the chopper contacts. Between the switch actions of the chopper contacts and those of the accessory switch H, however, is such a phase shift that each time the chopper contact is opened, in other words, upon a decrease of the potential across the terminals A and B, the accessory switch H is closed so that the coil L is short-circuited. Since at this instant the load has thus a capacitive nature, the capacity prevents unduly rapid collapse of the potential across the terminals A and B with the result that the circuit opening spark is diminished. However, the switch H should be operatively controlled in such a way that when the chopper contacts come together, in other words, upon application of the potential across the terminals A and B, the auxiliary switch is opened and that the coil L is in series with the load. The coil L prevents the flow of a strong circuit-closing current which charges the condenser C. The current has then risen to a comparatively large value only when the contacts of the chopper already have come to bear firmly on each other. In this manner the rush of current set up upon closing the circuit is essentially lessened.

The short-circuiting of the choke coil L is suitably effected at an instant, during the more or less aperiodic building up action, after application of the voltage across the terminals A and B, the potential across the terminals U and V is roughly equal to the potential across A and B so that the voltage at the coil itself has become very low.

In case the load resistance contains a markedly inductive component, it is feasible in the present instance to augment its capacitive component to an adequate degree by paralleling an additional capacity.

Another exemplified embodiment of the invention is shown in Fig. 2. What is first assumed in this scheme is that the load resistance W possesses a predominantly inductive-ohmic character. In parallel relation to the terminals U and V is the accessory switch H in series with a sufficiently large capacity C. In parallel relation to the switch is connected moreover a high ohmic resistance R. This resistance is so proportioned that during the contacting of the chopper Z, that is to say, during the time when a definite potential is applied across the terminals A and B, the condenser is charged across the resistance to nearly terminal voltage. The accessory switch H is so operated that briefly prior to the instant of disconnection of the chopper it is closed. The connection takes place in the absence of any appreciable circuit-closing spark at the auxiliary

switch for the reason that the same already has been charged practically to the potential across A and B. At the instant of opening of the chopper the condenser C is connected in parallel relation to the consumer or load and thereby precludes the chance of a rapid drop of the terminal potential and thus also of the production of a strong circuit-opening spark. Or, expressed in other terms, the current flowing through the load resistance W, which, owing to the inductive component, has a tendency to decrease as slowly as possible from its value, is taken by the condenser C in the form of a discharge current.

Shortly after the opening of the chopper contact, also the auxiliary switch H is opened so that upon reversal of the polarity of the potential across the terminals A and B no strong discharge current is able to flow to the condenser and a strong closing spark able to arise. The change in charge of the condenser C takes place in a gradual way by way of the resistance R.

If in the case of a chopper with double-pole switching the change (reversal) in charge of the condenser C fails to happen fast enough, it will be found expedient to enlarge the switch Fig. 2 in a way as shown in Fig. 3. This circuit organization comprises a further auxiliary switch H' which also operates in synchronism with the chopper contacts, though in the presence of such a phase shift that, upon disconnection of the condenser from the transmission line it allows the condenser to become discharged rapidly across the comparatively low resistance R'. Next the switch H' is opened again so that the charging of the condenser in inverse sense may proceed across the higher resistance R.

In series with the resistances R and R' are inductance coils M and M' which are so dimensioned that the circuits R, M, C, as well as R', M', and C are nearly aperiodic, so that charge and discharge of the condenser C takes place as rapidly and uniformly as feasible.

Between the junction point P of the line with the auxiliary switch H and the terminal U in the transmission lines is included a choke-coil L1 which will reduce the closing current also in the presence of a predominantly capacitive load.

In the case of markedly changing loads it is possible to change the condenser C and optionally also R and R' as well as the choke-coil L1 to different sizes. It is possible to combine the circuit organization Fig. 1 with the one shown in Fig. 2 or that in Fig. 3. The choke-coil connected in series in each case effects a reduction of the closing spark, while the parallel connected capacity insures a reduction of the opening spark.

The mechanical inverse rectifier or chopper may be a vibratory inverse rectifier comprising one or more inter-locked vibratory springs, or else a rotary change-over switch which is preferably used where larger loads are concerned. In such a rotary interrupter it is a particularly easy task to operate the auxiliary switch in synchronism, though in the presence of a phase angle in that the contact elements of the main and the accessory switches are mounted upon one and the same switch shaft or the sliding stationary cooperating contacts upon the circumference displaced in relation to one another.

I claim:

1. In a device for changing direct current into alternating current including a periodic interrupter means, a pair of input terminals for connection of said device to a source of direct current, an output circuit for said device including a pair of output terminals for connection to an alternating current utilizing load which is of a predominantly capacitive ohmic nature, impedance means, and means for periodically connecting and disconnecting said impedance means into said output circuit in synchronism with the operation of the interrupter device, said impedance means comprising an inductance of such a value that when connected in said output circuit it forms with said load an aperiodic circuit.

2. In combination with a periodic make and break device which is provided with a pair of input terminals for a connection of said device to a source of current and with an output circuit including a reactive load, an impedance, means acting in synchronism with the operation of the make and break device for periodically connecting said impedance in said output circuit, said impedance being so dimensioned that when connected in the output circuit it forms with the reactive load an aperiodic circuit.

3. An arrangement as described in the next preceding claim characterized by that the first named means renders the impedance device ineffective on break of the make and break device and effective on make of the make and break device.

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