Jan. 27, 1942. H. BARTELS 2,270,921

VIBRATOR

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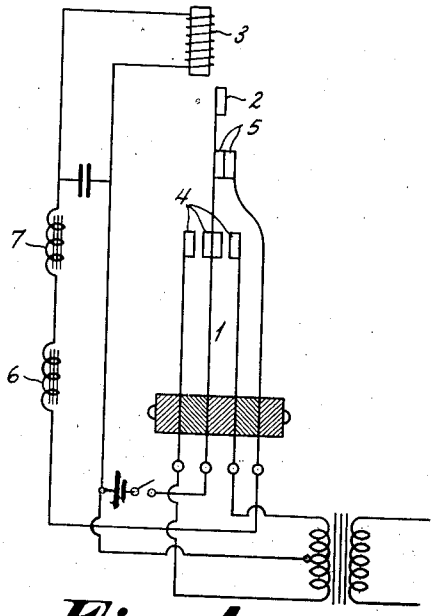


Fig. 1

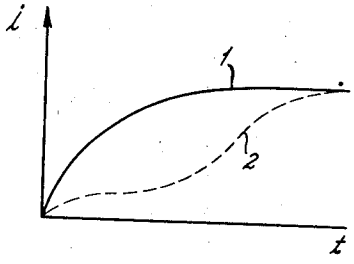


Fig. 2

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3 Claims. (Cl. 175—373)

Choppers serve the purpose of interrupting a direct current voltage and of feeding the ensuing alternating voltage superposed upon the direct current voltage to a transformer. These choppers essentially consist of a vibratory spring or blade which is fitted with contacts and is subject to electromagnetic excitation. The frequency of operation of these choppers is roughly equal to the natural mechanical frequency inherent in the vibratory spring.

The vibrations are maintained by way of an electromagnet the solenoid of which is energized by a current which, as a general rule, is opened and closed in synchronism with the chopper vibrations. Choppers may be excited in various ways, that is, either the working contacts which are included in the main or series circuit may be used directly therefor or else a distinct contact known as an exciter contact is used for the said object. In either case the circuit containing the exciting coil may be either interrupted or else the coil is short-circuited.

The object of this invention is to reduce the exciting power of choppers of the kind hereinbefore mentioned. More particularly, according to the invention accessory circuit elements are included in the circuit of the exciter coil which serve the purpose of occasioning a delay or lag in the rise of the exciting current.

The invention shall now be described in more detail by reference to the appended drawing wherein Figure 1 illustrates a chopper arrangement incorporating certain features of the present invention; and, Figure 2 is a graph used to describe the invention.

Referring to the drawing, Fig. 1 shows a fundamental diagram of a chopper. 1 denotes the oscillable or vibratory spring or blade the end 2 of which is caused to vibrate opposite the magnet 3 in the plane of the drawing. 4 denotes the working contacts, while 5 stands for the exciting contact. For the sake of greater simplicity the excitation of the oscillatory process or the vibrating shall be described by reference to a chopper fitted with an exciting contact.

As the current is switched in, the vibratory spring 1 will be attracted by the magnet 3; in other words, the spring will be deflected to the left-hand side in the plane of the drawing. Incidentally, the current is broken at contact 5, the spring flies back to a point beyond the neutral or median position on the right-hand side. Then the same process and cycle as before recurs: As a result of the current being made at contact 5, the magnet 3 is re-energized with the consequence that the spring 1 is pulled over again to the left-hand side.

It will be seen that a moment of attraction arises in the magnet 3 during the deflection of the spring away from the median position towards the right-hand side, as a result of the closure of contact 5. However, the attraction or pull during the motion of the spring out of the median position up to the maximum amplitude to the right acts in opposition to the vibration and is thus undesirable. In fact, it is only the second part of the attraction which arises during the time elapsing between the maximum deflection to the right-hand side and the median position as a result of the closing of contact 5 which has a useful effect in so far as it boosts and aids the oscillation of the spring. Hence, it is only the difference in the useful work of the magnet that is really active which lies between these two quarters of the period. In other words, the chopper will be able to operate only if the magnetic forces in these two times differ at least slightly from each other. As a general rule, this end is attained by making conditions so that during the first quarter period, as a result of the building up of the current, the magnetic force will not reach at once its crest value, and that during the second quarter period, as a result of the decay, the magnetic force is somewhat extended or prolonged.

By using the present invention a greater lag or delay in the building-up action is obtained, in other words, as great a reduction as possible of the current during the first quarter-period of the spring, figured from the instant when the exciting current has just been made.

One means which has proved eminently adapted consists of an iron-saturated choke-coil included in the circuit of the exciting contact. Fig. 1, for instance, shows such a choke-coil 6 with highly saturated iron. The building-up action of an unsaturated choke-coil is represented in Fig. 2 by the solid-line graph 1, while the same process of a highly saturated iron-cored choke-coil is indicated by graph 2, i denoting the current and t the time. It will be seen therefrom that the fact that the current is building up very slowly means an appreciable reduction in the working power of the magnet during the first quarter period of the spring vibration. The choke-coil 6 may be built into a mechanical construction unit with the exciting coil 3, for instance, in such a way that the exciting winding is made to act at the same time as the choke winding, and that an additional closed core con-

sisting of readily saturable material is brought into the winding.

In addition to these non-linear circuit elements a delay in the building-up period of the exciting current could be realized also by the aid of four-terminal networks, say, a coil 7 indicated in Fig. 1.

For the purpose of suppression of sparking, as known in the art a condenser may be cut between the poles of the exciting contact.

I claim:

1. In a circuit interrupter including a vibrator and a magnetic driving circuit for said vibrator, means in said exciter circuit for appreciably delaying the magnetic driving force applied to the vibrator to such an extent that it is mainly effective during travel of the vibrator in the direction of attraction of said magnetic force, said means comprising iron in a portion of the exciter circuit so arranged that the ratio of the flux linking said circuit to current flowing therein diminishes as the current approaches its maximum value whereby the effective instantaneous value of circuit inductance of the exciter circuit is relatively large for small currents and relatively small for large currents with the result that as compared to the rate of growth of current through a constant inductance of a value which is intermediate said large value and said small value of circuit inductance, the current increases more slowly at first and more rapidly thereafter.

2. In a circuit interrupter of the type provided with a vibrating element and an exciting coil for driving said vibrating element, a circuit including a make and break switching device and said exciting coil for periodically energizing the exciting coil, a choke coil in said energizing circuit in series with the exciting coil, said coil being arranged to become highly saturated, a predetermined time interval after each make of the switching device, said interval of time being sufficient to delay the magnetic driving force applied to the vibrator to such an extent that the driving force is mainly effective during travel of the vibrating element in the direction of attraction of the magnetic force.

3. The arrangement described in claim 2 wherein the exciting winding acts also as the choke winding and by that a closed core consisting of readily saturable material is mounted within said exciting winding.

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