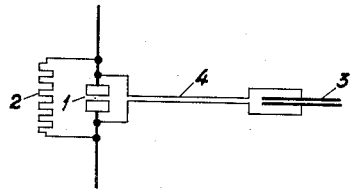
June 30, 1931. A. YTTERBERG 1,812,312

CIRCUIT BREAKING CONTACTS PROVIDED WITH CONDENSERS

Filed May 8, 1929

Fig. 1.



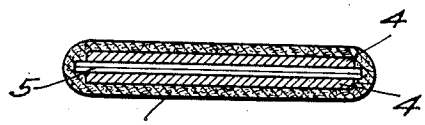


Fig. 2.

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UNITED STATES PATENT OFFICE

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CIRCUIT BREAKING CONTACTS PROVIDED WITH CONDENSERS

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For contacts intended to break a current under a voltage exceeding the arcing voltage of the contact material, generally about 20 volts, it is necessary if arcing shall be avoided, to connect a condenser in parallel to the contacts, said condenser being of sufficient capacity for absorbing the difference between the free energy of the circuit before and after the interruption. As soon as this difference is of any importance, it is also necessary to connect in series with the condenser an ohmic resistance of appropriate size for reducing the discharge current at the closing of the contacts to a tolerable value, and also for permitting a sufficient charging current to pass.

With such resistance materials which are reliable enough to be used in certain electrical apparatus, as voltage regulators for generators, and with contact-breaking capacities of several hundred watts as may be necessary in these, the resistance necessitates a certain length of the conductors between the contacts and the condenser. This has been found to cause difficulties to reduce the self-induction in the aforesaid conductors to a permissible value.

In the accompanying drawings, Fig. 1 shows diagrammatically a general arrangement of contacts and condenser according to the present invention, while Fig. 2 shows a cross-section of a suitable form of conductors connecting the contacts with the condenser.

Referring to Fig. 1, 1 represents a pair of contacts adapted to intermittently short-circuit a resistance 2, and 3 is a condenser connected in parallel to said contacts by conductors 4.

When the contacts 1 have pure metallic surfaces and are separated from each other with a sudden pull, both of which conditions it has been found necessary to fulfill in order to attain rupturing capacities of the aforesaid order of magnitude without arcing, the time during which the current shall drop from its original to its final value amounts to about 0.01 microsecond as a maximum. If the current is i and the self-inductance of the condenser circuit L, the voltage between the contacts is—

$$L\frac{di}{dt},$$

and if

$$\frac{di}{dt}$$

is constant, the said expression becomes equal to

$$L\frac{i_0 - i_1}{t}$$

where i_0 is the original and i_1 the final value of the current and t the aforesaid time. In voltage regulators, for which the invention is preferably intended, $i_0 - i_1$ is of the order of magnitude of about 2 amperes, and if the voltage shall not exceed 20 volts, the highest permissible value for L will be .1 microhenry.

A resistor of the ordinary rheostat type connected between the contacts and the condenser would give a total self-inductance of several microhenries. This type can therefore not be used for the present purpose. The first condition to be fulfilled if the self-inductance shall be reduced to a permissible value is that the resistance be incorporated in the proper conductors 4 leading to the condenser 3. If these conductors are made from usual round wire and are placed at the smallest distance allowed by the insulation, the total self-inductance may be reduced to about 1 microhenry for each meter of double wire. If the resistance can be made so small that the total length of double wire may be about .1 meter, and if the local conditions permit the placing of the condenser at such a small distance from the contacts, it is possible to use for the connection between contacts and condenser double resistance wire of the usual circular cross-section. The two aforesaid conditions are, however, seldom

fulfilled at a time in practice. Generally, the length of the double conductor must be about 1 meter, and it will then be necessary to take special steps for further reducing the self-induction. This can be done by making the two conductors 4 in the shape of thin bands the thickness of which amounts to about 1/20 of the width, and arranging them closely together with the thinnest possible layer of insulation. A cross-section of such bands is shown in Fig. 2 in which the bands 4, which may be of suitable resistance material, as a chrome-nickel alloy, are separated only by a thin strip 5 of presspahn or the like, and the whole surrounded by a suitable insulation 6 as impregnated cotton wire. In this manner, it is possible to reduce the self-inductance to about .1 microhenries per meter. In such cases, it is sometimes not necessary to make the whole of the conductors out of special resistance material, but a portion may be made out of a material of high conductivity, for instance copper.

I claim as my invention:—

1. In combination, a pair of contacts, a condenser in parallel thereto, and two conductors consisting of special resistance alloy and lying close together at the major portion of their length and connecting said contacts to said condenser.

2. In combination, a pair of contacts, a condenser in parallel thereto, and two band-shaped conductors of special resistance alloy lying flat together at the major portion of their length and connecting said contacts to said condenser.

3. In an electrical regulator, a pair of breaking contacts, a condenser, and two conductors connecting said contacts in parallel with said condenser and each comprising a special resistance alloy and arranged—throughout the major portion of its length—in close proximity to the other conductor.

4. In an electrical regulator, a pair of breaking contacts, a condenser, and two conductors connecting said contacts in parallel with said condenser and each conductor being made throughout at least a part of its length of special resistance alloy and having a maximum width and minimum thickness and arranged at the major portion of its length at a minimum distance from the other conductor.

5. In a voltage regulator, a pair of contacts, a condenser connected in parallel therewith, and connecting means consisting of a pair of conductors each having embodied therein a special resistance alloy and each having substantial width and minimum thickness and both lying flat together with a minimum space between them at the major portion of their length.

In testimony whereof I have signed my name to this specification.

ARLE YTTERBERG.