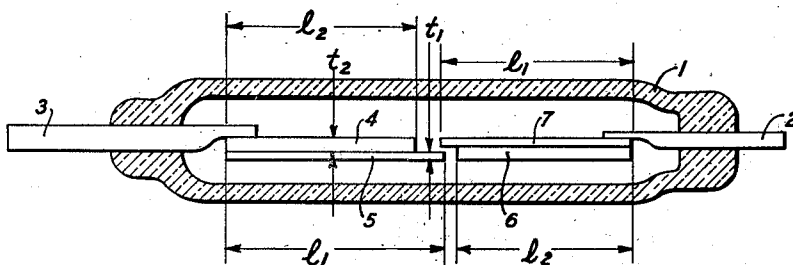


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CIRCUIT MAKER AND BREAKER
Filed Sept. 21, 1945

2,450,499

FIG. 1.



$$\frac{f_2}{f_1} = \frac{t_2 l_1^2}{t_1 l_2^2} = z$$

FIG. 2

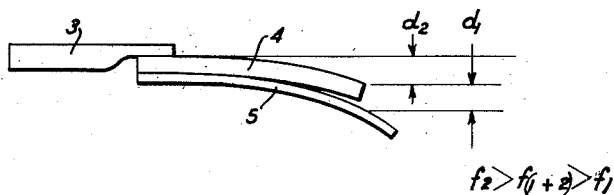
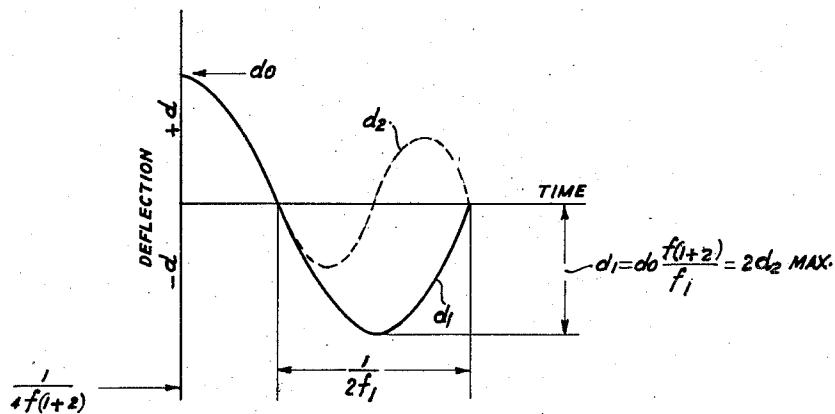


FIG. 3



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CIRCUIT MAKER AND BREAKER

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2 Claims. (Cl. 200—90)

1

This invention relates to circuit makers and breakers and particularly to glass enclosed magnetic reed contact devices.

It is an object of this invention to provide means for the dissipation of mechanical release transients in reed type switches. The glass enclosed reed type switch is particularly well suited to work in circuits where it must respond rapidly and accurately to periodic impulses but it has been discovered that where the periodicity of the driving circuit approaches the natural periodicity of the reeds variations often result in the response of the switch which depend on the phase relations between the operating impulses and the free vibration of the reeds upon release.

In accordance with this invention each reed of the switch is made in the form of a compound structure comprising two reeds having natural frequencies in the ratio of two to one whereby upon release and as these reeds begin to vibrate, each at its natural frequencies there will occur impacts between the free ends thereof which will result in the very rapid dissipation of such mechanical transients.

A feature of the invention is therefore a contact device in which the mechanically moving part consists of a pair of reeds tuned to such different frequencies that their free vibration will create mechanical interference with the free vibration each with the other.

The drawings consist of one sheet having three figures, as follows:

Fig. 1 is a cross-sectional view of a contact device constructed in accordance with the present invention;

Fig. 2 is an exaggerated view of one of the compound contact reeds at the extreme of its movement immediately upon release from its operated position; and

Fig. 3 is a graph used to explain the relative movement of the two elements of a compound reed and to indicate thereby the manner in which the desired result is achieved.

The contact device consists generally of a glass body portion 1 into the two ends of which a solid electrode 2 and a tubular electrode 3 are sealed. The tubular electrode 3 serves, during the construction of the device as a means for evacuating the space within the body 1 and filling it with any desired type of gas at any desired pressure. To each electrode there is affixed as by welding a compound reed such as that shown in Fig. 2 consisting of a short thick element A and a long thin element 5. Similar elements 6 and 7 are affixed to the electrode 2 and these various ele-

2

ments are arranged within the body 1 so that the ends of the long thin elements 5 and 7 overlap but are normally separated by a gap so that there is no electrical connection between them. When the contact device is inserted within a coil and such coil is electrically included in a circuit with a source of current the magnetic effect produced will cause the overlapping ends of elements 5 and 7 to move into mechanical and electrical contact with each other. When the electrical circuit through the said energizing coil is broken or the magnetic influence to which the reeds are otherwise subjected is removed the stress on the reeds is likewise removed and the reeds are left free to move away from each other. In prior art devices the simple reeds at such time go into free vibration with the result that there is danger of establishing contact between the two reeds as their free ends swing toward each other at the end of each cycle of free vibration. Moreover if the dissipation of energy is comparatively slow the next operation of the reeds may be adversely affected if it occurs before this free vibration has died out.

Through the use of the compound reeds of the present invention this danger is averted since the natural period of vibration of the two elements differs and therefore the short thick element 4 having the higher frequency acts as a buffer and prevents the full swing of the long thin element towards its operated position.

When contact is broken in the simple reed type of glass enclosed switch, the reeds undergo a damped oscillation with a fairly long time constant. In one well-known device of this nature, for instance, the oscillation frequency is about 850 cycles per second and the time constant is about 50 milliseconds. In cases where the switch must be operated at intervals which are not large compared to this time constant, variation often results which depends upon phase relations between the operating impulses and this transient oscillation.

By providing impact of some kind to produce disorder in the motion, the effect of these transients can be reduced. One arrangement which has been found to be particularly effective is to employ compound reeds, the two elements of which have natural frequencies in the ratio of 2 to 1. As shown in Figs. 1 and 2 the lower frequency reed is the longer of the two and is used as the contacting member. The higher frequency reed is on the contact side of the longer reed and just touches it in the rest position.

When a switch with double reeds of this kind

3

is released, the motion of the reed elements is as indicated in Fig. 2. The two reeds swing together through the plane of zero stress at a velocity determined by the natural frequency $f_{(1+2)}$, of the combination. Here they separate, coming together again in this plane after a half cycle oscillation of one and a full cycle oscillation of the other.

The velocities of the two reeds on impact are substantially equal and opposite. A maximum dissipation effect from the impact would be expected if the two reeds were effectively equal in mass, leaving no momentum unbalance. The conditions for momentum unbalance are somewhat difficult to analyze rigorously. Following are two approximations which appear to be consistent with experimental observations.

Method 1

Assume that each of the reeds 4 and 5 can be represented by a mass concentrated at the tip and a spring concentrated at the point of support. Assume equal and opposite angular velocity. Momentum balance would then obtain when the two moments of inertia were equal

$$b_2 t_2 l_2^3 = b_1 t_1 l_1^3 \quad (1)$$

where b , t and l are the width thickness and length respectively, of the reeds 4 and 5.

For the desired natural frequency relation,

$$\frac{t_2}{t_1} = 2 \frac{t_1}{l_1^2} \quad (2)$$

If $b_1 = b_2$, we obtain from (1) and (2)

$$\frac{l_1}{l_2} = 2^{\frac{1}{5}} = 1.148$$

$$\frac{t_2}{t_1} = 2^{\frac{3}{5}} = 1.518$$

Method 2

The two reeds have equal and opposite velocity just before impact at the point corresponding to

4

the tip of the shorter reed. Their effective masses with respect to this point should also be equal and their corresponding stiffness should be in the ratio of 2^3 to 1. That is

$$b_2 t_2^3 = 4 b_1 t_1^3 \quad (3)$$

If $b_1 = b_2$

$$\frac{l_1}{l_2} = 2^{\frac{1}{6}} = 1.122$$

$$\frac{t_2}{t_1} = 4^{\frac{1}{3}} = 1.590$$

Fig. 3 is a graphical representation of the ideal action. The full line graph after the plane of rest has been reached represents the movement in time of the long thin reed 5 and the broken line represents the movement in time of the short thick reed 4. They should meet in the plane of rest in order to achieve the desired maximum effect.

What is claimed is:

1. A sealed reed contact device having a compound reed constructed of two reeds commonly secured at one end and having natural periods of vibration in the ratio of two to one.

2. A sealed reed contact device having compound reeds sealed into opposite ends of a tube like plastic envelope, each said reed comprising a pair of flat springs commonly secured at one end and having natural periods of vibration in the ratio of two to one.

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