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ELECTROMAGNETIC SWITCH

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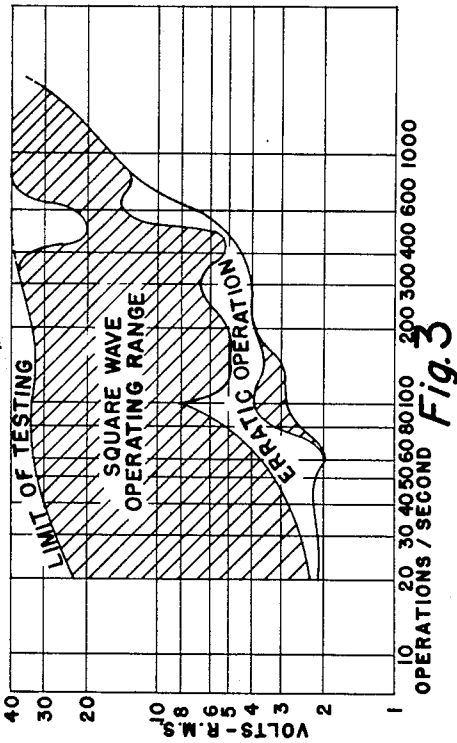


Fig. 1

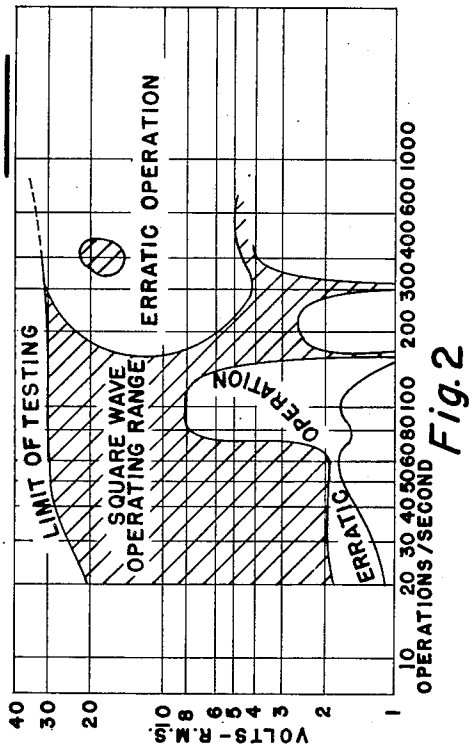


Fig. 2

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ELECTROMAGNETIC SWITCH

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This invention relates in general to switching devices and in particular to an improved construction of electromagnetic switches of the reed type. Such a switch is comprised of a pair of overlapped reeds made from magnetic material. The reeds are spaced slightly from each other in a gas-tight vessel and a coil is disposed around the outside of the vessel. When this coil is energized with current, the electromagnetic field produced by the current causes both reeds to move into contact with each other and thereby close an electrical circuit that is connected through the reeds.

The object of this invention is to provide a switch of the type described in the preceding paragraph that has a high degree of sensitivity and which is extremely dependable in operation.

Another object is to provide a switch of the class described which will operate on very low electromagnetic field strength.

Another object is to provide an electromagnetic switch which may be operated successfully at high speeds.

Another object is to provide an electromagnetic switch which is less susceptible to contact chatter or bouncing.

Still another object is to provide a switch of the above type which is more efficient in operation and less affected by vibration and acceleration for equivalent sensitivity.

Generally speaking, all of the foregoing objects are obtained by using magnetic leaves that have a relatively low natural or mechanical resonant frequency characteristic and by filling the vessel within which the leaves are contained with oil.

In switches of the type described, it may be generally stated that the sensitivity decreases approximately inversely with the natural frequency characteristic of the magnetic leaves. Thus very sensitive switches may be made by using magnetic leaves having a very low mechanical resonant frequency. However, if the vessel within which the leaves are contained, is evacuated or filled with an inert gas, it is obvious that because of the low resonant frequency characteristic of the leaves, the latter will move quite easily when subjected to even slight forces. Thus, when the switch is subjected even to slight jars or vibration, the leaves vibrate and will come together independently of the magnetic field produced by the coil and thus produce a spurious switching operation in the electrical circuit with which the switch is associated.

However, I have discovered that by filling the vessel with oil, many improved results are ob-

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tained. The oil exerts a damping effect upon the magnetic leaves and thus serves to inhibit any vibration thereof. Furthermore, oil provides better contact cooling since liquid is a much better heat conductor than gas or a vacuum. Because of this, the continuous current carrying capacity of the reeds may also be increased. Still another advantage to be derived from oil filling is that it permits a high speed operation with square wave contact action to a greater degree than is possible with switches having no oil in the vessel. Generally, consistent square wave operation of undamped switches is not practically obtainable above the natural frequency of the leaves. However, with oil filled switches, I have found that square wave contact operation is practical at frequencies well above the natural frequency of the leaves.

In order to illustrate my invention, there is shown in Fig. 1 a longitudinal view of a preferred embodiment in half section;

Fig. 2 is a graph showing results of laboratory tests made on the switch structure of Fig. 1, but without oil;

Fig. 3 is a graph of results obtained when the vessel was filled with oil, and which confirmed predictions with respect to the improved operation that could be expected when an oil filling was used.

Referring now to Fig. 1, the magnetic switch includes a pair of cylindrically shaped end plugs 10 and 11 of metal such as brass. Each of these is provided with a portion 12 of slightly reduced diameter upon which is fitted a sleeve 13 of metal. This latter must have a good metal-to-glass sealing characteristic, and I have found that an alloy sold under the trade-name of Kovar is quite satisfactory.

The plugs 10 and 11 are also provided with slots 14 into which are inserted and secured rectangular strips or reeds 15 and 16. Said reeds are one-eighth inch wide, three-fourths inch long and three one-thousandths inch thick, with a half-thousandth inch of silvering. These strips are made from magnetizable metal, and I have found that an alloy of approximately 50 per cent nickel and 50 per cent iron works very well. A tubular glass envelope 17 is provided to hermetically seal the reeds 15 and 16, the seal being made at the ends of the envelope 17 to the Kovar sleeves 13. Said glass envelope is filled with oil 24 for damping purposes.

Screws 18, at each end of the plugs 10 and 11 may serve as binding posts for the leads 19, 20

of an electrical circuit which is to be controlled by switch action.

A gas bubble 25 is provided within the glass envelope 17 to allow for expansion with temperature of the damping medium 24.

The components of the switch so far described are carried within the cored center of a spool 21 which is made of non-magnetic material such as phenol fibre. A coil of wire 22 is wound upon spool 21 and, in the illustrated embodiment, is adapted to be energized from a source of current applied to terminals 23 when a closing operation of the switch is desired.

Reference is now made to the graphs shown in Figs. 2 and 3, which show tests made upon the switch shown in Fig. 1 and of the particular dimensions and characteristics described hereinabove the leaves having a natural frequency of 150 cycles per second. In both graphs, data was plotted with frequency (operations per second) as the abscissa and R. M. S. A. C. voltage as ordinates on logarithmic cross-section paper. The graphs were obtained by slowly increasing the A. C. voltage through the 4000 ohm coil which supplied the electromagnetic field for the switch. When the A. C. voltage is increased, the point where the magnetic leaves 15 and 16 first make contact is shown by the bottom line on the graph. It is to be noted that when the switch leaves 15 and 16 first make contact, square wave operation is not generally obtained. As the voltage was increased, the point where square wave operation was obtained was also plotted. As the voltage was increased for a particular frequency, the point at which square wave contact operation ceased was also plotted. As a result of the tests, an area was found which represents the range of voltages and frequencies under which square wave contact operation obtained. This area is illustrated by the cross-hatched portions on each graph.

It will now be evident from a comparison between the graphs shown respectively in Figs. 2 and 3 that the cross-hatched area in the graph of Fig. 3 is much larger than that shown in Fig. 2. Since it will be remembered that the switch was filled with oil when data for plotting Fig. 3 was obtained but that the switch was air-filled when the data for Fig. 2 was secured, it will be evident that by using an oil filled switch, square wave contact operation obtains over much wider range of both frequency and voltage.

Also, as previously explained in an earlier part of this specification, the oil filled switch produces a highly desirable damping effect which reduces vibration of the leaves and hence inhibits spurious switch contact operations; it reduces arcing of the contacts, improves contact cooling; and, when combined with leaves having a low natural frequency, makes it possible to obtain switch operation at very low values of electromagnetic field strength and at high frequencies.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present

embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of royalties thereon or therefor.

What is claimed is:

1. A switch comprising a tubular glass envelope, a pair of metal plugs mounted in the ends of said envelope, each of said plugs having a slot therein on the inside thereof, a pair of rectangular reeds mounted in said slots respectively and constructed and arranged to overlap at the inside ends thereof to provide electrical contacts, said envelope having a non-conducting liquid therein surrounding said reeds, said envelope and plugs forming a substantially hermetically sealed chamber, a pair of means for attaching electrical connections to said pair of plugs respectively, a sleeve of non-magnetic material surrounding said envelope, and a coil wound upon said sleeve, the energization of said coil controlling the electrical circuit through said reeds.

2. A switch comprising a tubular glass envelope, a pair of metal plugs mounted in the ends of said envelope, each of said plugs having a slot therein on the inside thereof, a pair of rectangular leaves mounted in said slots and constructed and arranged to overlap at the inside ends thereof to provide electrical contacts, said leaves having a relatively low mechanical resonant frequency, said envelope having a non-conducting liquid therein surrounding said leaves, said envelope and plugs forming a substantially hermetically sealed chamber, a pair of means for attaching electrical connections to said pair of plugs respectively, a sleeve of non-magnetic material surrounding said envelope, and a coil wound upon said sleeve, said coil when energized magnetizing said leaves to cause them to flex toward each other and establish contact therebetween whereby square wave contacting operation well above the resonant frequency of the leaves is obtained.

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