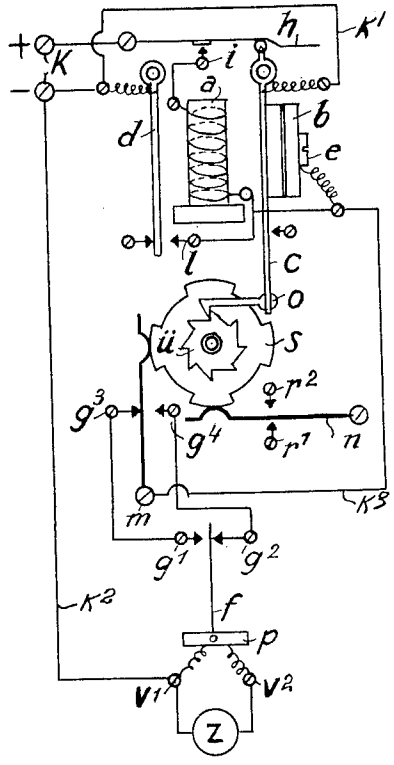
March 15, 1938. O. LÜHN 2,111,246

ELECTROMAGNETIC RELAY

Filed Sept. 27, 1935

Fig. 1.



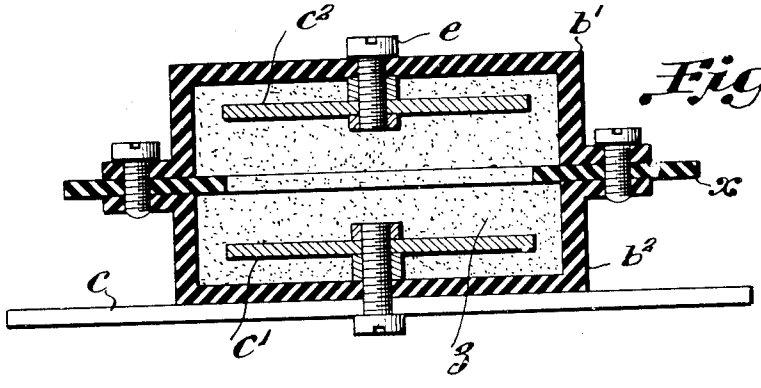




Fig. 2.

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## ELECTROMAGNETIC RELAY

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3 Claims. (Cl. 175—320)

Electric switches are known which are operated by direct current obtained, for instance, from a photo-electric cell on the illumination of the latter and passing through a contact instrument constructed as a galvanometer. However, known devices have the defect that, on account of the poor contact made by the needle forming the contact member, a reliable closing through the needle of the circuit of the not very sensitive relay cannot be achieved. This defect of devices of this kind arises from the sparking which occurs between the needle and the rigid contact with which it co-operates, which sparking is all the more noticeable when the contact of the needle is weak. This sparking prevents a reliable functioning of the device. The arrangement, in parallel with the contact, of a capacity adapted to obviate the sparking, helps matters to some extent, but it tends to cause the contacts to stick, so that again a reliable functioning of the apparatus will not be obtained.

The object of the present invention is to obviate these drawbacks and to obtain an apparatus in which a contact instrument constructed as a galvanometer with moving coil can be used with satisfactory results.

The invention consists in the provision of a variable resistance of special construction which is arranged in the circuit of an electro-magnet and an electric source and which normally prevents the magnet from being energized but which allows a partial energization thereof under the influence of weak pulsations of current, so as to close a main circuit for a complete operation of the switch, a contact maker, which may be operated through the medium of a photo-electric cell or the like, being provided for setting up the required pulsations of current, and means being provided for causing said contact maker and switch to co-operate for restoring the relay to operative position.

The relay is illustrated by way of example in the accompanying drawing Fig. 1 of which represents a diagram of the electric connections, and Fig. 2, a section of the variable resistance.

The relay comprises an electro-magnet *a*, armatures *d* and *c*, and a variable resistance or coherer *b* which is mounted on the armature *c* and which is composed of two U-shaped, pressed members $b^1$ and $b^2$ of insulating material. The resistance contains two vibratory electrodes $c^1$ and $c^2$ one of which is electrically connected to the armature *c* and the other to a binding post *e*. The U-shaped members are moreover charged with material, for instance tinsel $z^1$, adapted, as is usual in coherers, to become a good electric conductor, under the influence of weak pulsations of current and to lose the developed conductivity under the influence of the smallest shock, for instance, as produced in the present instance by the armature *c*. A good effect is obtained by arranging, between the two parts of the body of the resistance, a frame *x* of mica which slightly separates electrically the two portions of tinsel with which the U-shaped members are charged.

The variable resistance has two functions to perform, namely: to bring about a strong spark quenching at the contacts at the moment when current pulsations are produced by the contact of the needle *f* of a moving coil galvanometer with either of two contacts $g^1$ and $g^2$, and to cause a direct current to flow which releases the relay.

In order to break the circuit of the electromagnet immediately after the switching operation, a contact spring *h* is provided which is controlled by but insulated from the armature *c* and which co-operates with a rigid contact *i*, normally closed and which is connected to the positive pole of an electric source K, the contact *i* being connected to one end of the winding of the electro-magnet *a*. The other end of the winding is connected to the binding post *e*, through a wire $K^3$, to a contact spring *m*, and also to a contact *l* with which the armature *d* co-operates. The contact spring *m* is arranged to sweep a cam wheel *s* by means of which they are, according to the position of the wheel, brought into contact with contacts $g^3$ and $g^4$ which are electrically connected to the contacts $g^1$ and $g^2$ of the moving coil *p*. The needle *f* of the moving coil is connected through $V^1$ and a wire $K^2$ with the negative pole of the electric source which is also connected to the armature *d* and through a wire $K^1$ to the armature *c*.

The cam wheel *s* is connected to a ratchet wheel *u* and is rotated through one tooth space of the latter each time the armature *c* is restored to normal position after having been acted upon by the magnet *a*, the armature being provided with a pawl *o* which acts on the ratchet wheel. By the rotation of the cam wheel, the contacts *m* and *n* are alternately changed over so as to contact with one or the other of the contacts with which they co-operate. At each operation of the cam wheel, the contact spring *m* causes the connection between the needle *f* and the variable resistance, through one of the contacts $g^1$ and $g^2$, to be broken. A second contact spring *n* is provided which is controlled by the cam wheel

and which co-operates with contacts $r^1$ and $r^2$. The latter may be utilized for actuating signals indicating that the device has been properly operated.

If the needle *f* of the coil *p* should be moved by a current from a photo-electric cell *z* from the contact $g^2$ to the contact $g^1$, a hardly perceptible sparking will be set up by means of which weak pulsations of current are made to flow through the normally open shunt circuit traced through K—*i*—coil of *a*—$K^3$—*m*—$g^2$—$g^1$—*f*—$V^1$—$K^2$—K, and the conductivity of the resistance *b* will thus be increased so that direct current to the extent of 30–50% of the normal, will pass through the winding of the electro-magnet *a*.

The second, normally closed shunt circuit which is traced through K—*i*—coil of *a*—*e*—*b*—*c*—$K^1$—K, will thus be energized by the excitation of the coherer resistance *b* through the galvanometer. The relieving armature *d* of the magnet will then be operated and placed against the contact *l*, whereupon the full current will flow through the main circuit traced through K—*i*—coil of magnet *a*—*l*—*d*—K. This enables the magnet *a* to operate the armature *c* until the circuit is broken at *i* by the lifting of the spring *h*. Since in this operation the armature *c* strikes against the iron core of the electro-magnet *a*, the compensation effect of the variable resistance *b* sets in at the moment the circuit is broken, the value of the resistance is restored substantially to normal, and the armature *d* will therefore be restored to its initial position. The armature *c* also returns to its initial position and in so doing turns the cam wheel *s* so as to change the positions of the contact springs, i. e., the connection between, the resistance *b* and the contact against which the needle *f* bears, will be broken by the spring *m*, and the apparatus will be prepared for renewed operation.

I claim:

1. An electro-magnetic relay for operating switches and the like, comprising an electro-magnet, a switch operating armature for said magnet, a normally open main circuit for said magnet including a source of direct current capable of operating said armature, a normally closed shunt circuit for said magnet, a variable resistance in said shunt circuit operative to prevent normally a flow of current through the magnet and to allow such flow to a limited extent under the influence of electric pulsations, a normally open second shunt circuit connected to said resistance, a contact maker in said second shunt circuit capable of being operated by weak current for setting up pulsations in the resistance and causing a partial energisation of the magnet, means operated by the magnet under the influence of such partial energisation for closing the main circuit and operating the armature, a switch operating element connected to said armature, means for breaking the main circuit on the armature being operated, and means controlled by the switch operating element for restoring the relay to operative position.

2. A relay as claimed in claim 1 wherein the switch operating element comprises a rotary cam wheel and a pawl and ratchet mechanism for rotating said wheel, and wherein the means for restoring the relay to operative position comprises a spring contact arranged to be swept by said cam wheel.

3. A relay as claimed in claim 1 wherein the switch operating element comprises a rotary cam wheel and a pawl and ratchet mechanism for rotating said wheel, and wherein the means for restoring the operative position comprises a contact spring forming part of the second shunt circuit and arranged to be swept and oscillated by said cam wheel, and two pairs of contacts arranged in parallel in the second shunt circuit, one of said pairs of contacts being arranged in position to be alternately connected to said spring, the other pair of contacts being arranged in position to be alternately connected to the contact maker, the latter being operative to close the circuit by moving over from one contact to the other, and the spring being operative to open the circuit when, by the resulting movement of the switch operating element, its position is similarly reversed.

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