April 30, 1929. W. H. PETERSÉN 1,711,285

INDUCTION TYPE RELAY

Filed March 8, 1927

Fig. 1.

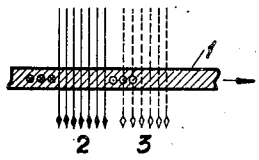


Fig. 2.

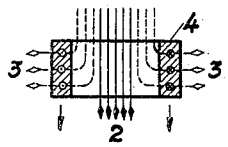


Fig. 3.

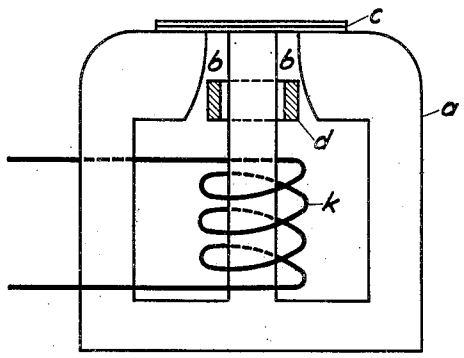
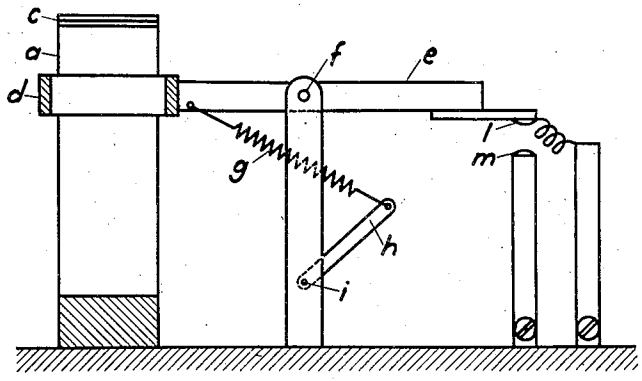


Fig. 4.



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UNITED STATES PATENT OFFICE.

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INDUCTION-TYPE RELAY.

Application filed March 8, 1927, Serial No. 173,689, and in Sweden October 14, 1926.

Relays the action of which is based on electromagnetic forces may be divided into three chief classes which are most usually designated as electro-magnetic, electro-dynamic, and induction type relays, depending on whether the force developed is a force between two magnet cores, between one magnet core and a coil having terminals, or between an iron core and a conductor closed on itself in which a current is produced by induction. Relays of the second type are comparatively complicated and are generally only used where the relay is intended to indicate the mutual relation between two different circuits representing, for instance, a current and a voltage. Each of the electromagnetic and the induction type relays possesses, as they have hitherto been constructed, its characteristic features which have limited to some extent its use. For instance, the electro-magnetic relays exert greater forces for the same quantity of power consumed, but the forces of the induction type relays vary according to more even and soft curves. The return to the initial position, should the actuating current decrease again, is generally more difficult to accomplish in the electro-magnetic relays, while the induction type relays have other inconveniences, for instance, they require generally more space.

The present invention relates to a relay of the induction type which combines to a great extent the valuable properties of earlier induction relays and earlier electromagnetic relays. For instance, it may easily be arranged to occupy very little space and to require very little power compared with the force exerted.

In the accompanying drawing, Figs. 1 and 2 show a pair of diagrams serving to illustrate the principal difference between the hitherto employed type of induction relay and the type forming the object of the present invention. Figs. 3 and 4 are two views perpendicular to each other, partially in section, of a form of the present invention.

The hitherto usual induction type relays have practically always as movable member a conducting disc, moving in an air gap in an alternating current electromagnet. A portion of the iron core of the said electromagnet, adjacent to the air gap, is surrounded by a short-circuited coil, causing its flux to be of another phase than the main flux. In Fig. 1, 1 represents the induction disc, while the full-drawn lines of force 2 represent the original flux, and the dotted lines of force 3 the flux displaced in phase by the short-circuited coil. Both of these fluxes traverse the disc practically at right angles and are thus parallel to each other. The first-named flux induces eddy currents in the disc, said currents flowing perpendicularly to the plane of the paper in the section shown and being represented, in the usual manner, by dots or crosses, depending on whether their direction is upward or downward at the intersection with the said plane. The one branch of the said currents, in the example shown the ascending one, produces with the phase-displaced flux 3 electromagnetic forces. (In reality the conditions will of course not be quite as simple as here described, as for instance also the phase-displaced flux will induce eddy currents, but as these are weaker than those just referred to, they may be neglected at an outline study.)

The circumstances, that the two active branches of the flux—the mainly inducing branch 2 and the mainly electro-dynamically active branch 3—are parallel to each other in traversing the disc, causes only one side of the eddy current loop to be electro-dynamically active, and moreover is the cause that new portions of the disc must successively get under the influence of the flux as the disc moves, if the force shall not be diminished. These two conditions, which both represent an incomplete utilization of the material, explain the low value of forces as compared with consumed power and necessary space in hitherto constructed induction relays.

Fig. 2, on the other hand, diagrammatically illustrates the principle of the present invention. The induction member here has the shape of a closed loop 4 which is traversed by the inducting portion 2 of the magnetic flux. The electro-dynamically active portion 3 of the said flux forms, in passing through the loop 4, a larger or smaller angle with the flux 2, preferably a substantially right angle therewith. The currents induced in the loop by the flux 2 will not be of eddy current character but substantially uniformly distributed over the entire cross-section of the loop. As they are intersected substantially at right angles by the electro-

dynamically active flux 3, the mechanical force, which is substantially parallel to the flux 2, will be the largest possible with respect to the copper quantity employed. In the same time, the said force is easily controllable practically at will by an alteration of the flux intensity from point to point where the loop is displaced.

In Fig. 2, the direction of current is shown opposite to Fig. 1, although the inducing flux has the same direction. In reality, there is some phase displacement in both cases, the active component of current being with reference to the electro-dynamically active flux oppositely directed in Fig. 2 against in Fig. 1.

For accomplishing the fluxes directed as shown in Fig. 2 with respect to the current loop, the arrangement of magnet core shown in Figs. 3 and 4 may for instance be employed. This core *a* is here three-legged with the inducing coil *k* placed on the middle leg. Between the latter and the two side legs are rather wide air gaps *b* in which the two active sides of the current loop *d* are moving. The inducing branch of the magnetic flux continues in the middle leg through the loop *d* and is transferred to the side legs over a comparatively narrow magnetic bridge *c*, formed for instance by a couple of plates laid over the three legs. It has been found advisable to arrange this branch of the flux to be closed entirely through iron with a portion restricted in this manner in parallel with the air gaps in which the electro-dynamically active flux branch proceeds. By an appropriate choice of the shape of the air gap and of the cross section (and magnetic properties) of the plates *c* practically any desired shape may be obtained for the curve expressing the relation between the position of the loop *d* in the air gap and the force acting thereupon.

The loop *d* may in practice preferably be supported by one end of a lever *e* swinging on a pivot *f* and carrying at its other end a contact *l* cooperating with a fixed contact *m*. The force exerted by the relay may be counteracted by a spring *g*, one end of which is fixed to the lever while the other is secured to an arm *h* adjustable around an axis *i*. These details may of course be varied in different ways within the scope of the invention.

I claim as my invention:

1. A relay for alternating currents having an electromagnet with a three-legged iron core having air gaps between the middle leg and the outer legs thereof, means for forcing a magnetic flux one way through the middle leg and back through the outer legs of said iron core, a movable closed conductor surrounding said middle leg, means constituting a restricted magnetic path shunting the air gaps between said middle and outer legs, and current-controlling means actuated by said conductor.

2. A relay for alternating currents comprising an electromagnet with an iron core having three legs formed with air gaps varying in width from one end to another, means constituting a restricted magnetic path shunting said air gaps, a movable closed conductor surrounding one of said legs, and current-controlling means actuated by said conductor.

3. A relay for alternating current comprising a laminated iron core having two air gaps traversed by magnetic fluxes in parallel, means for generating said fluxes, a short-circuited electric conductor traversed by a portion of said core and movable in said air gaps about an axis outside its own periphery, and current-controlling means actuated by said conductor.

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

WILHELM HENNING PETERSÉN.