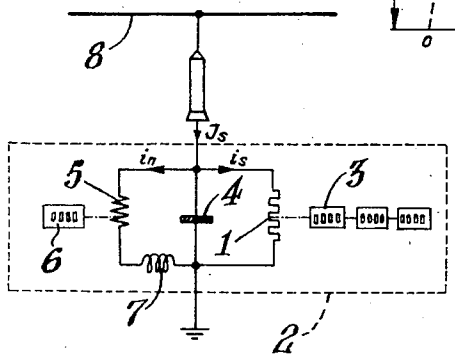
Nov. 7, 1950 P. FEHR 2,528,744

ELECTROMAGNETIC APPLIANCE

Filed Nov. 27, 1945 2 Sheets-Sheet 1

Fig. 1.



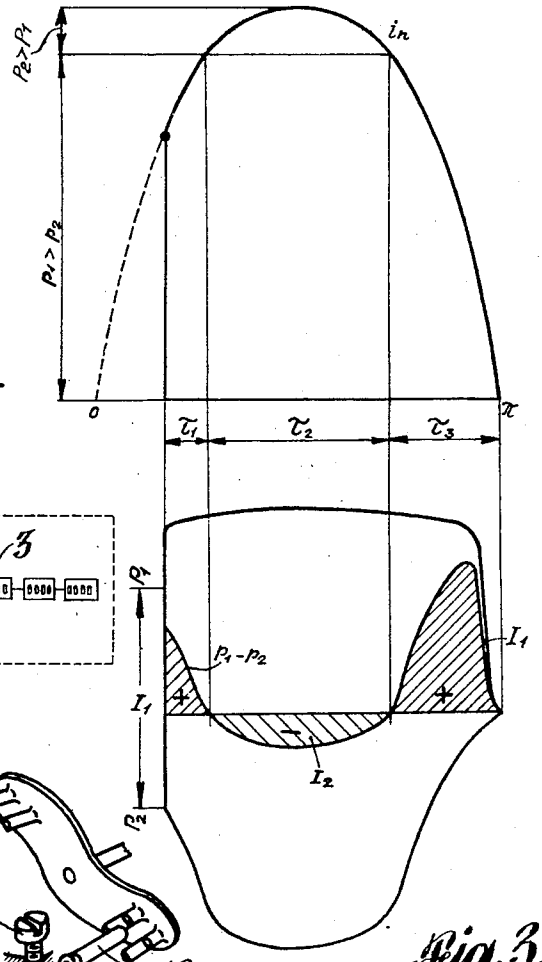


Fig. 3.

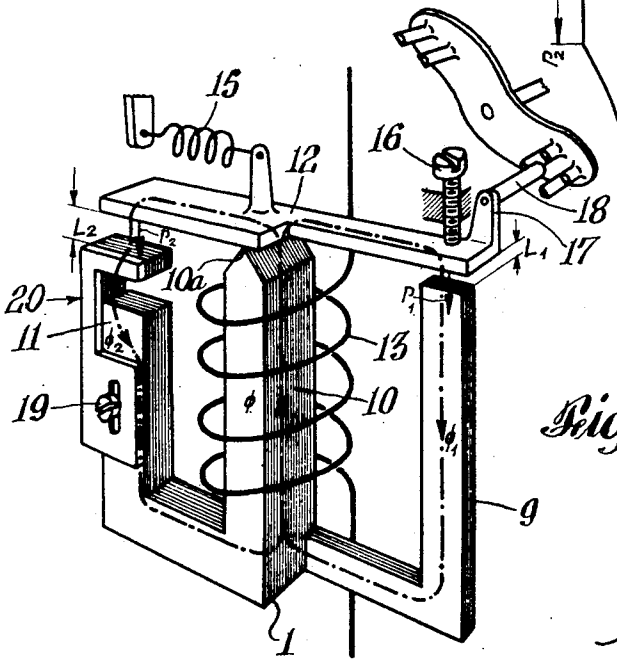


Fig. 4.

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Nov. 7, 1950 P. FEHR 2,528,744

ELECTROMAGNETIC APPLIANCE

Filed Nov. 27, 1945 2 Sheets-Sheet 2

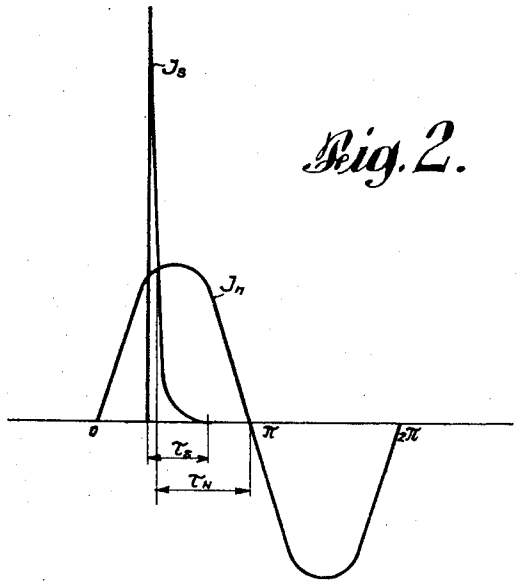


Fig. 2.

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Fig. 5.

Patented Nov. 7, 1950 2,528,744

UNITED STATES PATENT OFFICE

2,528,744

ELECTROMAGNETIC APPLIANCE

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Application November 27, 1945, Serial No. 631,097
In Switzerland November 30, 1944

1 Claim. (Cl. 177—311)

1

This invention relates to an electromagnetic appliance which in its essence is characterized by a magnetic structure having flux paths of different saturation so that current impulses of different duration and intensity can be recorded separately. The appliance may be used to ascertain separately, say, surges of current of short duration and high intensity and surges of longer duration and low intensity.

The appliance may preferably find utility in the so-called response counters, i. e. apparatus which serve the purpose of numerically indicating how often an overvoltage suppressor has been stressed due to excess voltages on overhead lines. In conjunction with such response counters, the appliance embodying the present invention may be used in combination with an integrating device any occurrence of a line current (termed "after-current" in the description) trailing an overvoltage discharge.

The accompanying drawing shows by way of example one preferred embodiment of the invention adapted for use in response counters.

Figure 1 shows a circuit diagram of a response counter system having the appliance associated therewith;

Figure 2 shows curves of an overvoltage surge J_s and of the line current J_n trailing, it being understood that no accurate scale is provided;

Figure 3 shows other curves;

Figure 4 shows the electromagnetic appliance; and

Figure 5 shows further curves.

In the example to be disclosed, appliance 1 embodying the invention forms part of response counter 2 (Figure 1) for overvoltages. Appliance 1 is mechanically coupled to counting train 3 which upon occurrence of an overvoltage records the trailing after-current. Counting train 3 is advanced each time by one unit by the electromagnetic appliance embodying the invention when said appliance is traversed by the after-current. The appliance or after-current relay thus integrates the number of after-currents incidental to overvoltages.

In response counter 2, relay 1 is connected in parallel with voltage-dependent resistance 4 traversed by an over-voltage current surge J_s. In parallel with resistance 4 is heating filament 5 cooperative with means including counting trains 6 to form a rush or surge-counting portion of the response counter. 7 denotes a suppressor and 8 the line wire circuit.

Proper counting of after-current requires after-current relay 1 not to respond to a current surge due to overvoltage but to respond to the line-current trailing an overvoltage surge. Consequently after-current relay 1 must be capable of differentiating the after-current J_n from the current surge J_s (Figure 2). During occurrence of an overvoltage surge, the current i_n in relay 1 runs as shown in the upper part of Figure 3. It attains a peak value of several hundred amperes (about 200 to 300 amperes) during a period of time generally less than 2 microseconds.

2

When the current surge J_s (Figures 2 and 3) dies away, then by reason of the line voltage, an after-current J_n flows through suppressor or deflector 7 to earth. The maximum value of the after-current is limited by suppressor 7 and may be, with new types, from 10 to 120 amperes. The impedance of the relay circuit is so chosen that practically the entire after-current J_n flows through after-current relay 1 to earth. Hence

$$J_n = i_n$$

The maximum duration of the after-current J_n amounts to half a cycle (Figure 2).

Figure 4 shows the electromagnetic appliance or relay 1 adapted to serve for counting after-currents.

Relay 1 comprises a three-limb laminated iron core, with the cross-section of limb 9 appreciably smaller than that of limbs 10 and 11. Control limb 10 has bearing edge 10a upon which is pivoted 12. Limb 10 also carries coil 13. The area of that part of the armature extending from pivot edge 10a to limb 11 is appreciably greater, about double, that of the remainder of the armature on the other side of bearing edge 10a. Armature spring 15 engages a finger on armature 12 and tends to urge an end of armature 12 against an adjustable abutment 16 for controlling the air gap L_1. At the end of its small section the armature 12 has rigidly fixed to it angle piece 17 carrying trip-pin 18 by which, upon attraction of the armature, the counter 3 (Figure 1) is released.

Air gap L_2 at the other end of the armature can be varied by set screw 19 controlling the position of movable pole piece 20.

The action of relay 1 is as follows:

Upon energization of coil 13 of the relay, the entire magnetic flux ϕ in limb 10 is divided into two fluxes ϕ_1 and ϕ_2 which traverse limbs 9 and 11, respectively. Air gap L_1 is adjusted to be small with respect to air gap L_2.

With increasing energization of coil 13 and by reason of the lower reluctance of flux path 9, the entire flux ϕ produced will practically go through

limb 9 till limb 9 becomes saturated. Upon attainment of saturation of limb 9 and with increasing energization of coil 13, flux ϕ_2 grows. Due to the large air gap L_2 and the large cross-section of limb 11 and the cooperating part of armature 12, saturation due to ϕ_2 will result at very high energization of coil 13 only.

Fluxes ϕ_1 and ϕ_2 generate attractive forces p_1 and p_2, respectively, which form opposed moments about bearing edge 10*a* of the armature. Attractive force p_1 increases to a peak value attained upon saturation in limb 9. Force p_2 may be a multiple of p_1.

By altering air gap L_2 it is possible to make force p_2 grow more slowly or quickly with respect to the attractive power p_1.

The peak of force p_1 is so chosen as to give the armature a running time which is somewhat smaller than the shortest duration of about 2 msec. of the after-current still to be counted.

For explaining the action of the relay let that half be first considered which is traversed by ϕ_1. Upon energization of coil 13 of the relay for a very short time (say, by an overvoltage surge) so that the current duration is considerably shorter than the running time of the armature, then, under action of force p_1, the right end of the armature receives an attractive impulse J_1 whose magnitude depends on the magnitude of force p_1 and time T, during which the same has acted. Consequently impulse J_1 is equal to the integral of force p_1 over time T.

Impulse J_1 is counteracted by tension spring 15 (Figure 4) so that for armature path L_1 impulse J_1 must attain a definite minimal value before counter 3 is actuated.

Now, a similar action takes place on the half traversed by flux ϕ_2 with the difference that corresponding impulse J_2 produced by force p_2 acts in opposition to impulse J_1. The tilting of armature 12 to the right or left or its rest on abutment 16 is caused by the impulse J_R resulting from J_1 and J_2. Therefore, the function of the relay is characterized by the general relationship:

$$J_R = J_1 - J_2 = \int_0^T p_1 dt - \int_0^T p_2 dt$$

The behavior of relay 1 at an overvoltage rush of current through coil 13 when the relay current i_n attains high values (of several hundred amperes) but of comparatively short duration (generally less than 2 msec.) may be indicated in Figure 5 the current i_n is represented, and from the bottom part of the figure it is evident

that the sum of the (positive) impulses J_1 is considerably smaller than the sum of the (negative) impulses J_2. In this case, the armature 12 of relay 1 is pressed against abutment 16 and no actuation of counting train 3 occurs.

With suitable selection of air gap L_2 and with after-currents say from 10 to 120 amperes, force p_1 is small compared with force p_2. But, since the time T during which force p_1 acts is comparatively great, amounting to about 3 or 4 msec., the sum of the impulse magnitudes J_1 exceeds the sum of those J_2 as expressed in Figure 3 in contradistinction to Figure 5 so that armature 12 becomes attracted to limb 9 and hence counting train 3 (Figure 1) is driven through one step.

What I claim is:

An electromagnetic device having a ferromagnetic E-shaped core, one of its outer limbs having a smaller cross section than the other, while an exciting coil is mounted on a central limb, an oscillating armature mounted on the central limb to be attracted to either of the outer limbs, spring means urging the armature towards the limb of larger cross section in which position the air gap between the limb of smaller cross section is considerably smaller than the air gap at the other outer limb, the air gap at said other limb being adjustable by means of a variably positionable pole piece, said armature having its ends of different cross section with the larger cross section at the end adjacent the limb of larger cross section, one end of the armature carrying a member to cooperate with and actuate a metering mechanism, whereby long impulses of lower intensity and short impulses of great intensity can be distinguished by the metering mechanism.

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