K. HÖHN.

ELECTROMAGNETIC TIME RETARDING RELAY.

APPLICATION FILED JUNE 16, 1915.

1,216,570. Patented Feb. 20, 1917.

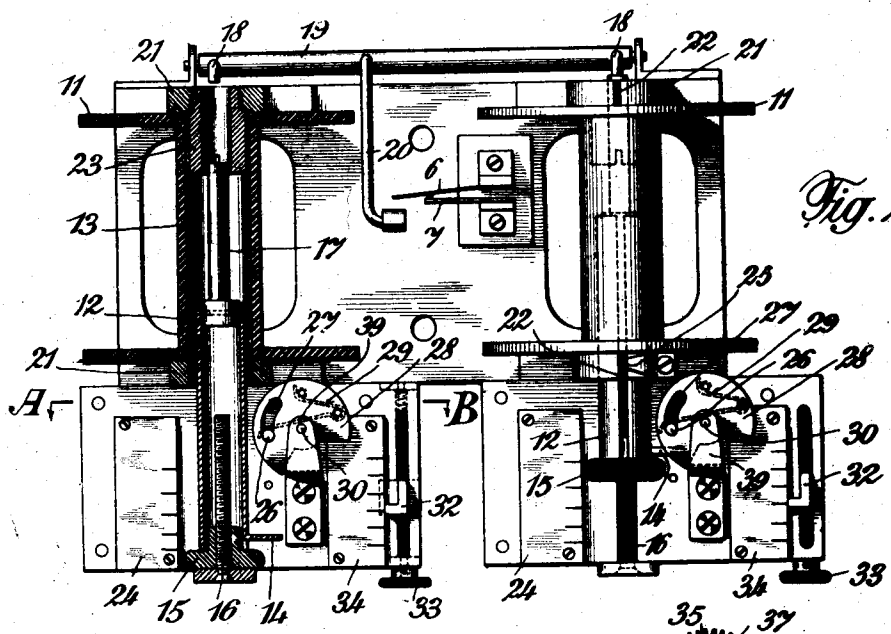


Fig. 2

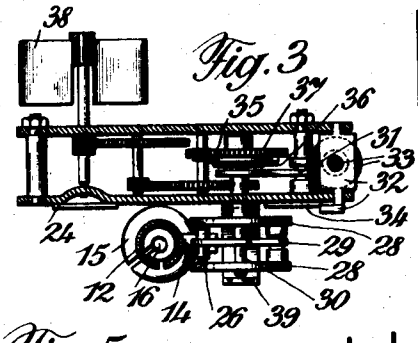


Fig. 3

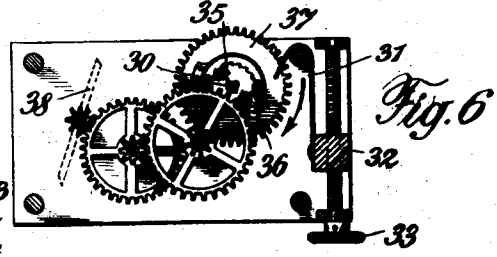


Fig. 6

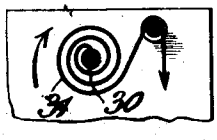


Fig. 5

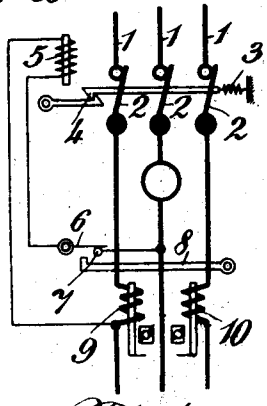


Fig. 1

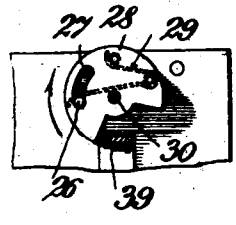


Fig. 4

Inventor:
Karl Höhn,
By Hemmendinger & Co
Atty

UNITED STATES PATENT OFFICE.

KARL HÖHN, OF ZURICH, SWITZERLAND.

ELECTROMAGNETIC TIME-RETARDING RELAY.

1,216,570. Specification of Letters Patent. Patented Feb. 20, 1917.

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To all whom it may concern:

Be it known that I, KARL HÖHN, a citizen of the Republic of Switzerland, residing at Zurich, Switzerland, have invented new and useful Improvements in Electromagnetic Time-Retarding Relays; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawing, and to letters or figures of reference marked thereon, which form a part of this specification.

This invention relates to improvements in electromagnetic time retarding relays having in contradistinction to the hitherto known relays of this kind the advantage of being so cheap and of such a compact design that they can be used for many new purposes and in many cases where such relays have been too expensive. The electromagnetic time retarding relays according to this invention are particularly adapted to be mounted in switch boxes.

The main feature of the invention consists in that the armature of an electromagnet, effecting the retarded actuation of a contact device, or a suitable latch device, describes, under the influence of the electric current exciting it, a great part of its stroke, unhindered and loose, so that it may produce at first a considerable strengthening of the magnetic flux that passes through the coil of the magnet and store up at the same time a considerable amount of kinetic energy. Upon the storing up of this energy the armature strikes against an elastic member of the retarding device projecting into the further path of movement of said armature. The elastic pressure of said member is so adjusted or regulated, that this pressure is usually not overcome by the kinetic energy of the armature. Owing to this, the retarding device is set into operation and prevents the armature from moving quickly into its end position. If, however, the kinetic energy stored up in the armature is exceptionally great, for instance owing to a short-circuit, said armature overcomes the elastic pressure of said member, so that the armature is able to carry out suddenly its whole stroke.

Immediately upon the setting into motion of the retarding device, the armature has also to tension a spring or lift a weight, chiefly for the purpose to prepare in connection with a ratchet mechanism or an uncoupling device said retarding device immediately for a new complete time-retarding period before the armature is moved on its returning movement back into its initial position of rest.

One mode of carrying the invention into effect is shown by way of example in the accompanying drawing. In Figure 1 it is assumed, that a bipolar electromagnetic time retarding relay according to this invention is used in combination with an automatic triple pole switch and a minimum voltage releasing device to protect the circuit of a low tension three-phase motor from damaging overloads by switching off said circuit from the network.

Fig. 2 shows a time retarding relay embodying my invention, the left side of this figure being partly a front view and partly a section while the right side is a front view;

Fig. 3 is a section on the line A—B of Fig. 2 and

Figs. 4, 5 and 6 show details.

A motor not shown in the figures is connected by means of a triple pole switch 2 to a low tension three-phase circuit 1. The switch 2 is acted upon by a spring 3, which is normally prevented by the latch 4 from exerting its action upon said switch. A minimum voltage coil 5 connected in a single phase manner to the switch causes the latch to disengage the core of said coil as soon as the voltage fails, whereupon the spring 3 opens the switch 2. In the circuit of the voltage coil 5 there is further arranged a contact spring 6. This spring may be brought out of engagement with the contact 7 connected to the network by means of a lever 8, the lifting of which may be effected by either one or the other of two electromagnetic time retarding relays 9 and 10 placed directly in the main circuit. The construction of these relays can be best seen in Fig. 2, in which the magnet windings are omitted for the sake of clearness. Each magnet winding is carried by a spool 11 within which there is provided a thin brass tube 13 having a longitudinal slot and acting as a guide for an armature or cone 12. The latter consists of a slotted tube of soft iron provided on its lower end with a lateral projection 14. The slot serves, in a well known manner and in the same manner as

laminations to prevent the eddy currents generated in metallic parts encircled by alternating currents from doing any damage. Such an armature is much cheaper than one consisting of a number of single stamped out sheet-irons isolated one from the other and it has the further advantage of permitting the use of a round coil instead of a more expensive rectangular one.

The armature 12 rests normally on a nut 15 capable of being adjusted in a vertical direction along a threaded bolt 16. This permits the stroke of the armature to be varied for the different releasing current strengths in accordance with the working requirements. The upper part of the armature 12 carries a pin 17, which upon a movement of the armature into the coil, lifts an arm 18 fixed to a shaft 19 and rotates the latter. To this shaft 19, which corresponds to the lever 8 shown in Fig. 1, there is rigidly connected a lever 20. Upon a rotation of the shaft 19 the insulated end of the lever 20 moves the spring 6 away from the contact 7 (see also Fig. 1). The coils of the two relays 9 and 10 are arranged one beside the other on a common yoke 21 which is slotted at 22.

In the upper part of the yoke of the magnet there is arranged a slotted magnet pole 23 of soft iron projecting into the coil 11. The pin 17 may be moved through this pole 23. At the side of the adjusting screw 15 there is arranged a scale 24 to facilitate the adjustment of the releasing current strength. On the left hand side of Fig. 2 the lower end of the armature 12 is on the level of the lowest division of the scale, while on the right hand side it is on the level of the uppermost scale division.

25 denotes a guide for the armature 12.

Within reach of the path of movement of the lateral projection 14, but above the division of the scale 24, there is arranged a pin 26 resting with its two ends in the slots 27 of two disks 28. This pin 26 is acted upon by a V-shaped spring 29 (Fig. 4) disposed between the two disks 28 operatively connected one to the other. The disks 28 are fixed to the shaft 30, to which is also fixed one end of a spiral spring 31 (Fig. 5), while the other end of the latter is rigidly connected to a block 32. This block 32 can be adjusted by means of a screw 33, so as to vary the duration of time after which a switching off is brought about by the relay and which duration can be ascertained from the data of a scale 34.

A ratchet wheel 35 (Fig. 6) is also rigidly connected to the shaft 30, which by means of a spring controlled pawl 36 is capable of imparting a rotary motion to a wheel 37. The latter forms the driving gear of an auxiliary-retarding mechanism, the last member of which is formed by a fly 38.

The working of the hereinbefore described relay is as follows:

If, owing to any accident occurring in one of the three phases or between two outer mains, a short circuit takes place, so that a dangerous high current flows through the windings of one of the two relay coils, the corresponding armature is pulled upward with such power, that the lateral projection 14 strikes against the pin 26 moving the latter against the action of the V-shaped spring 29, in the slots 27. The necessary energy to accomplish this has been stored up by the armature while it was moved through the stretch of the graduation 24 without encountering any hindrance. In the extreme position of the pin 26 the armature pin 17 effects a lifting of the lever 18, thus rotating the shaft 19 and raising the lever 20. The latter thereby interrupts the contact between 6 and 7, so that the coil 5 (Fig. 1) becomes dead. The core of the latter falls therefore downward and releases thereby the latch 4, whereupon the spring 3 opens the triple pole switch 2 and disconnects the motor and the auxiliary devices connected therewith from the circuit 1.

If, on the other hand, there arises an increase of current which becomes dangerous only after a certain length of time in which case a sudden switching off of the motor would be quite out of place, the armature 12 is also dragged into the coil 11, but it is moved much more slowly through the range of adjustment of the scale 24 than in the previous case. The movement of the armature 12 is stopped by the lateral projection 14 striking against the pin 26, its energy being in this case not sufficiently great to overcome the action of the V-shaped spring 29, so that it has to be assumed, that said pin is now rigidly connected to the two disks 28. If the overload is a permanent one, the armature is pulled farther into the coil. The pin 26 is now moved along the slots 27, by the projection 14, against the action of the spring 29, and when said pin reaches the upper ends of the slots a further movement of the pin will cause the two disks 28 and also the shaft 30 to rotate in the direction of the arrow in Fig. 4. During this movement of the disks and shaft there has to be overcome the action of the spring 31 and at the same time there is set in motion, by means of the ratchet wheel 35 the pawl 36 and the driving wheel 37 of the auxiliary retarding mechanism and its fly 38. According to the strength of the overload-current it takes a longer or shorter time before the pin 17 raises the lever 18 to such an extent, that the contact between 6 and 7 is interrupted. This duration of time can be increased during the working and without running any risk by tensioning the spring 31 (Fig. 6) by means of the

screw 33. The values for a certain current strength may be determined by the scale 34 (preferably 2–10 seconds for 100% overload with regard to the normal working current). The time adjustment could as well be effected by an adjustment of the disks 28 relatively to their extreme position. For other overloads the corresponding duration of time may be easily calculated since this duration increases with regard to the value read off of the scale 34 approximately in the same measure as the overload in question is smaller than the overload of 100% serving as a base. If desired, there may also be used a table to determine without further calculation the actual releasing times for the most common overloads, as for instance overloads of 20%, 30%, 40%, 50% and so on.

If the overload ceases before the armature 12 has reached its uppermost position, *i. e.* before about 95% of the retardation has expired, the armature falls immediately back into its position of rest. While this takes place the pin 26 is returned by the spring 29 to the lower ends of the slots 27 and the retarding mechanism is uncoupled, the ratchet wheel 35 passing beneath the pawl 36 and rotating in a direction opposite to that shown by the arrow in Fig. 6. Also the disks 28 together with the shaft 30 are moved back, owing to the action of the spring 31, into their position of rest, in which they are arrested by a stop 39. The screw 15 permits the strength of the releasing current to be adjusted in such a way, that the releasing is only brought about after the strength of the current is more than 1.2 to 3 times greater than the normal working current. By choosing the current transformers in a suitable manner the relay can be used for any current and for any voltage. Owing to the fact, that the armature is capable of carrying out a wholly clear stroke, which surpasses the upper adjustment limit for the releasing current, the time adjustment is not affected in any way by the armature adjustment. As will be seen in Fig. 2, the retarding mechanism as well as the contact device are arranged laterally and not in a line with the armature. This arrangement permits the height of the apparatus to be diminished. From the above description of the manner of operation of the device it may be seen, that on ordinary overload the armature actuates, before acting upon the lever 18, the retarding mechanism, while on great overload and when a short circuit takes place, said armature acts directly upon the lever 18 without influencing in any way the retarding and other mechanism.

The hereinbefore described bipolar time retarding relay is also adapted to be used as well for three-phase current and two-phase alternating current as also for single-phase current and continuous current. In the last two cases it is only necessary to provide a single pole arrangement. Notwithstanding the fact that I do not use any laminated sheet-iron the losses due to magnetization are very small owing to the small number of ampere-turns required for the actuation of the retarding mechanism. Particularly in the case where, as shown in Fig. 2, the adjustment of the releasing current is effected wholly independently of the time adjustment, the number of ampere-turns has to be only a little greater than in a similarly built ordinary maximum current relay. With regard to the latter and the safety fuses the maximum-current time retarding relay has, however, the great advantage, that it may be adjusted in a much more sensitive manner, so that it protects, without causing a wholly useless interruption of working when short, not dangerous current impulses are produced a current circuit much better from dangerous overloads. By choosing the size of the springs 29 and 31 in an appropriate manner and by using an anchor escapement or a similar member prolongating the releasing time instead of the ply it is possible to protect in a quite safe manner also motors working with an abnormal high starting current. Thus, it is not necessary to resort to the wrong expedient to connect at random and without using any protecting device a motor during its starting period to the network by simply using means overbridging the relays or the safety fuses respectively.

For such currents, which have only to be switched off when the system is overloaded, but not upon a failing of the voltage I use a closed-circuit releasing device instead of an open circuit-current releasing device. In this case the time retarding relay does not have to be fitted with an opening switch 6 (Figs. 1 and 2) but with a closing switch, which causes the excitation of the releasing coil acting upon the latch 4 of the switch 2. Instead of acting upon a contact device, the electromagnetic time retarding relay can also influence directly a suitable latch device.

The time retarding relay can also be provided with a voltage winding and it can further be actuated from a distance as an independent time retarding relay by means of a regulating device such as an amperemeter, voltmeter, an output measuring instrument, frequency-meter, pressure-meter, tachometer, a heat measuring instrument or the like in order to open or close an operative current circuit after a certain adjustable duration of time has expired. In case the regulating device cuts the time retarding relay out of the circuit before its releasing time has expired, the armature

drops immediately back into its position of rest without affecting in any way the operative current circuit, just in the same manner as it has been described with regard to the time retarding relay, which is dependent upon the maximum current. In this case the scale 24 used for adjusting the strength of the releasing current can be dispensed with and it is sufficient to provide only one electromagnet. The V-shaped spring 29 can also be dispensed with, if the pin 26 is rigidly connected to the disks 28.

The time retarding relay may also be subjected to other modifications than those shown in the drawing without departing from the scope of the invention.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. In an electromagnetic time retarding relay, the combination with a releasing device and actuating means therefor, of an electromagnet, an armature attracted initially with a free stroke by the latter, means arranged laterally of the armature and engaged by the latter at the end of its free stroke to retard the movement of the armature, said retarding means adapted to be set directly in motion by the kinetic energy acquired by the armature during its unhindered stroke, means whereby a sudden unretarded movement of the armature is permitted through its whole path of movement at an exceedingly high overload, means controlled by the armature for operating the means for actuating the releasing device, and means to prepare the retarding means for a new, complete time-retarding period before the armature is moved on its returning movement wholly back into its initial position of rest.

2. In an electromagnetic time retarding relay, the combination with a releasing device and actuating means therefor, of an electromagnet, an armature attracted initially with a free stroke by the latter, means arranged sidewise of the armature and engaged by the latter at the end of its free stroke to retard the movement of the armature, said retarding means adapted to be set directly in motion by the kinetic energy acquired by the armature during its unhindered stroke, means whereby a sudden unretarded movement of the armature is permitted through its whole path of movement at an exceedingly high overload, means for regulating the stroke of the armature, means controlled by the armature for operating the means for actuating the releasing device, means to prepare the retarding means for a new, complete time-retarding period before the armature is moved on its returning movement wholly back into its initial position of rest, and means operatively connected to the last mentioned means adapted to regulate the working speed of the retarding device.

3. In an electromagnetic time retarding relay, the combination with a releasing device and actuating means therefor, of an electromagnet, an armature movable in the latter and attracted initially with a free stroke, a lateral projection on the armature, a shaft, a ratchet wheel fixed on this shaft, a train of toothed wheels, one of the latter being loose on said shaft, a pawl on this loose wheel adapted to engage with said ratchet wheel, means usually operatively connected to said shaft and adapted to be acted upon by said projection of the armature for the purpose of setting said shaft in motion by the kinetic energy acquired by the armature during its unhindered stroke, so that the movement of the latter is retarded during its further path of movement; means actuated by the train of toothed wheels for limiting the speed of the wheels, means to return said shaft and said means usually operatively connected therewith, back into the initial position of rest before the armature is moved on its returning movement wholly back into its initial position of rest, and means operatively connected to these returning means adapted to regulate the working speed of said train of toothed wheels.

4. In an electromagnetic time retarding relay, the combination with a releasing device and actuating means therefor, of an electromagnet, an armature movable in the latter and attracted initially with a free stroke, a lateral projection on the armature, a shaft, a ratchet wheel fixed on the latter, a train of toothed wheels, one of the latter being loose on said shaft, a pawl on the loose wheel adapted to engage with said ratchet wheel, means usually operatively connected to said shaft and adapted to be acted upon by said projection of the armature for the purpose of setting said shaft in motion by the kinetic energy acquired by the armature during its unhindered stroke, so that the movement of the latter is retarded during its further path of movement, means actuated by the train of toothed wheels for limiting the speed of the wheels, means whereby a sudden unretarded movement of the armature is permitted through its whole path of movement at an exceedingly high overload, means controlled by the armature for operating the means for actuating the releasing device, means to return said shaft and said means usually operatively connected therewith back into the initial position of rest before the armature is moved on its returning movement wholly back into its initial position of rest, and means operatively connected to these returning means adapted to regulate the working speed of said train of toothed wheels.

5. In an electromagnetic time retarding relay, the combination with a releasing device and actuating means therefor, of an electromagnet, an armature movable in the latter and attracted initially with a free stroke, an adjustable support for the armature to vary the stroke thereof, a lateral projection on the armature, a shaft, a ratchet wheel fixed on the latter, a train of toothed wheels, one of the latter being loose on said shaft, a pawl on the loose wheel adapted to engage with said ratchet wheel, means usually connected to said shaft and adapted to be acted upon by said projection of the armature for the purpose of setting said shaft in motion by the kinetic energy acquired by the armture during its unhindered stroke, so that the movement of the latter is retarded during its further path of movement, means actuated by the train of toothed wheels for limiting the speed of these wheels, means whereby a sudden unretarded movement of the armature is permitted through its whole path of movement at an exceedingly high overload, a pin carried by the armature for operating the means for actuating the releasing device, means to return said shaft and said means usually operatively connected therewith back into the initial position of rest before the armature is moved on its returning movement wholly back into its initial position of rest, and means operatively connected to these returning means adapted to regulate the working speed of said train of toothed wheels.

6. In an electromagnetic time retarding relay, the combination with a releasing device and actuating means therefor, of an electromagnet, an armature movable in the latter and attracted initially with a free stroke, an adjustable support for the armature to vary the stroke thereof, a lateral projection on the armature, a shaft, a ratchet wheel fixed on the latter, a train of toothed wheels, one of the latter being loose on said shaft, a pawl on the loose wheel, adapted to engage with said ratchet wheel, means usually operatively connected to said shaft and adapted to be acted upon by said projection of the armature for the purpose of setting said shaft in motion by the kinetic energy acquired by the armature during its unhindered stroke, so that the movement of the latter is retarded during its further path of movement, means actuated by the train of toothed wheels for limiting the speed of these wheels, means whereby a sudden unretarded movement of the armature is permitted through its whole path of movement at an exceedingly high overload, a pin carried by the armature for operating the means for actuating the releasing device, and means to return said shaft and said means usually operatively connected therewith back into the initial position of rest before the armature is moved on its returning movement wholly back into the initial position of rest, said returning means comprising a spring connected at one end to said shaft, and an adjustable stop connected to the other end of said spring adapted to regulate the working speed of said train of toothed wheels by influencing the tension of said spring.

7. In an electromagnetic time retarding relay, the combination with a releasing device, of an electromagnet, an armature movable in the latter and attracted initially with a free stroke, an adjustable support for the armature to vary the stroke thereof, a lateral projection on the armature, a shaft, a ratchet wheel fixed on the latter, a train of toothed wheels, one of the latter being loose on said shaft, a pawl on the loose wheel adapted to engage with said ratchet wheel, means actuated by said train of toothed wheels for limiting the speed of these wheels, means usually operatively connected to said shaft and adapted to be acted upon by said projection of the armature for the purpose of setting said shaft in motion by the kinetic energy acquired by the armature during its unhindered stroke, so that the movement of the latter is retarded during its further path of movement, means whereby a sudden unretarded movement of the armature is permitted through its whole path of movement at an exceedingly high overload, a coiled spring connected at one end to said shaft and adapted to return the shaft and said means usually operatively connected therewith and acted upon by the projection of the armature back into the initial position of rest before the armature is moved on its returning movement wholly back into its initial position of rest, an adjustable nut connected to the other end of said coiled spring adapted to regulate the working speed of said train of toothed wheels by influencing the tension of the coiled spring, a pin carried by the armature, a rock-shaft adapted to be actuated by said pin, and an arm on the rock-shaft to actuate the releasing device.

In testimony that I claim the foregoing as my invention, I have signed my name in presence of two subscribing witnesses.

KARL HÖHN.

Witnesses:
WERNER GUBLER,
CARL HÜSLER.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."