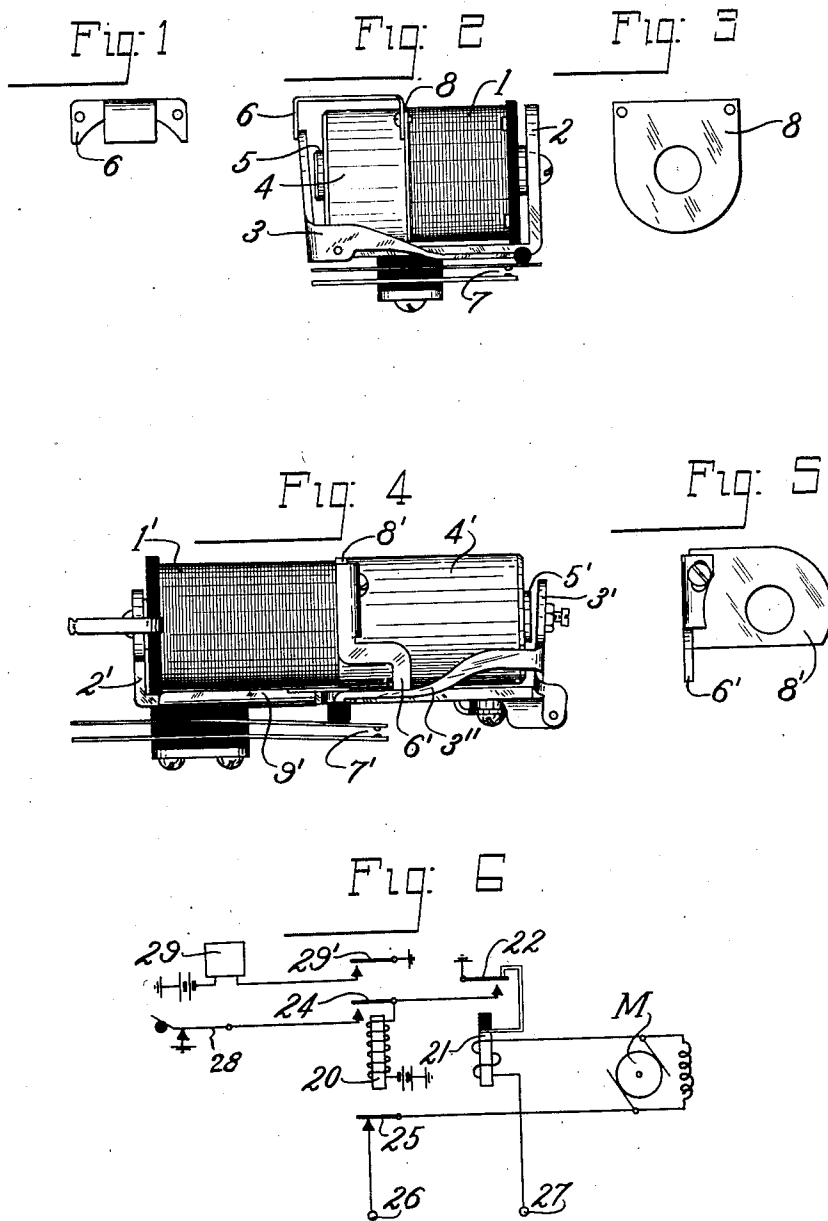


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ELECTROMAGNETIC RELAY

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ELECTROMAGNETIC RELAY.

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This invention relates in general to elec-
tromagnetic relays, and has for its principal
object the provision of a new and improved
relay which attracts its armature when the
circuit through its coil is broken.

Electromagnetic relays of the orthodox
type attract their armatures when the circuit
through their coils is completed, and allow
the armature to retract when the circuit is
broken. It frequently happens that circuits
can be greatly simplified by providing a relay
which works in the opposite direction, that
is, a relay which remains inert when a cur-
rent of normal value is passing through its
coil and which attracts its armature momen-
tarily when that current is broken.

A further object of this invention is the
provision of a relay which will remain inert
when a normal current is flowing through its
coil, but which will attract its armature to
its core should that current become excessive-
ly large, or should it become interrupted.

Further objects of my invention not spe-
cifically mentioned here will be apparent
from the detailed specification and claims
which follow.

The drawing comprising Figs. 1 to 6, inclu-
sive, show sufficient detail to enable a clear
understanding of my invention.

Figs. 1, 2, and 3 show one way of carrying
out the invention, Fig. 2 being the complete
assembly of a relay and Figs. 1 and 3 being
details. Figs. 4 and 5 represent a modifica-
tion, the first illustrating a complete relay,
and Fig. 5 showing a detail part. Fig. 6
shows a circuit wherein the relay shown in
Fig. 2 or that shown in Fig. 4, is utilized.
The structure and operation of the invention
will now be described more in detail.

Referring now particularly to Fig. 2, the
relay shown comprises the coil 1 wound
around the core 5, which is mounted on the
heel piece 2. This relay will be recognized
as the ordinary slow acting relay with a
copper slug 4 on the armature end of the core.
Such a relay, when the coil is energized will
attract the armature 3 to the core 5 and oper-
ate the spring 7 in the well known manner.
To convert this relay into a relay built in
accordance with the object of my invention,
I have added the magnetic washer 8 between
the copper slug 4 and the winding 1, and
attach to this washer the magnetic back stop

member 6 against which the armature 3 rests
when the relay is in its normal position. 55

In Figs. 4 and 5, I have shown the details
of a modification of my invention as shown
in Fig. 2, the modification being in the nature
of an improved magnetic back stop against
which the armature rests when the relay is in 60
its normal position. This relay consists of
the core 5, mounted on the heel piece 2'
around which core is the copper collar 4'
and the winding 1'. The armature 3' is also
mounted on the heel piece 2' and arranged to 65
operate the spring assembly 7' through the
medium of the armature lever 3''. In the
orthodox relay of this type, the armature
lever 3'' normally rests against the non-
magnetic back stop 9', which is assembled 70
on the heel piece 2' as a part of the spring
assembly 7'. In converting such a relay in
accordance with the objects of this invention,
I have replaced this nonmagnetic back stop
9' by a magnetic back stop of identical shape. 75
I have also added the magnetic washer 8'
between the copper collar 4' and the wind-
ing 1' of the relay and attached to this washer
the magnetic back stop 6', which rests against
the armature lever 3'', when the relay is in 80
its normal position. It will be readily seen
that by equipping this armature back stop
lever with a slot through which the mount-
ing screw extends, I have made it adjustable,
thereby facilitating an easy assembly of the 85
relay structure.

Figure 6 shows a circuit in which the relay
of my invention can be used, this circuit be-
ing shown by way of example. A direct
current motor M is connected to one side of 90
a source of power 26, through the springs 25,
and to the other side of the source of power
27 through the winding of relay 21. The re-
lay 21 which may be of the type shown in
Figs. 2 or 4 is so adjusted that when the nor- 95
mal current consumed by the motor M flows
to it, it will not attract this armature. Should
this current be interrupted or should the mo-
tor become overloaded and draw an excessive
current, the relay 21 will energize and open 100
the circuit of the motor thereby protecting it
from injury.

Having thus described my invention in
general, I will now proceed with a detailed
description of its operation. When the re- 105
lay shown in Fig. 2 is connected in a circuit

such as that shown in Fig. 6, and the key 28 opened, the relay 20 restores and at spring 25 closes a circuit from the terminal 26 through the springs 25, the armature of the motor, the winding of the relay 21 to the terminal 27. Current will start to flow in this circuit, and after an interval will build itself up to its normal strength. In the relay 21, during the interval that the current is building up in the coil 1, there is induced in the copper collar 4, a current which, according to Lenz's law, flows in such a direction that the magnetism which this induced current produces is in opposition to the magnetism set up by the current in the coil 1. That is, if the current in the coil 1 is in such a direction that the magnetic washer 8 becomes a north pole, the current induced in the copper collar 4 will be in such a direction that the face of the collar adjacent to the washer 8 will also be a north pole. These two north poles are opposing each other and preventing the free flow of flux through the core 5 and into the armature by way of the air-gap. However, the flux set up by the coil 1 flows through the magnetic washer 8 thence through the magnetic back stop 6 to the armature 3 into the heel piece 2 and thence back into the coil 1 through the core 5. The presence of this opposing magnetic motive force set up by the copper collar 4 prevents any appreciable amount of flux set up by the coil 1 from flowing through the core 5 and normal air-gap into the armature 3. When the current in the coil 1 has risen to its maximum value and is no longer building up, the currents induced in the copper collar 4 die away and consequently there is no opposing magnetomotive force in the copper collar. However, the majority of the flux produced by the coil 1 flows through the above named magnetic path for the reason that that path consists solely of iron and virtually short circuits the air-gap. The little flux that does enter the armature by way of the air-gap is insufficient to attract the armature to the core since the armature is held to the back stop by the flux now flowing through that junction. It will be seen that as long as the current in the coil 1 is of such value that the magnetic back stop member 6 is not over saturated, only a small amount of magnetism will flow through the air-gap from the core into the armature and consequently the armature will not be attracted. If the motor becomes overloaded and draws an excessively large amount of current, the coil 1 will set up a magnetomotive force sufficient to over saturate the magnetic back stop 6 with the result that more flux will flow through the air-gap into the armature. When this flux becomes sufficiently strong, the armature 3 breaks away from the magnetic back stop 6 and is attracted to the core 5 operating the springs 7 in the obvious manner. The relay

now being operated can be made to operate whatever protecting devices are necessary to prevent the overloaded motor from burning up.

If the current supply to a motor such as shown in Fig. 6, were to be interrupted, it might be necessary to notify an attendant of the fact so that he could take the necessary steps to bring the motor back into service. The relay of my invention may be used for this purpose in much the same manner as the no voltage release of the well known starting boxes. When the circuit to the coil 1 is interrupted, the current starts to die away at a rate dependent upon the inductive characteristics of the relay. This dying away of the current causes a corresponding decrease in the flux, and as a result of this decrease in flux a current is induced in the copper collar 4. The direction of the current in this copper collar is opposite to what it was when the current was building up in the relay, and as a consequence the magnetism set up by the induced current assists rather than opposes the flux set up by the coil. As was explained before the current through the coil is in such a direction as to make the magnetic washer 8 a north pole, and consequently the current induced in the copper collar makes the side of the collar adjacent to this washer a south pole, and the side near the end of the core 5, a north pole. The two magnetizing forces on the core 5 are now poled in the same direction with the result that more flux flows over the magnetic circuit from the core 5 through the air-gap into the armature 3 thence through the heel piece 2 back into the core. The decay of the flux set up by the coil lessens the attraction between the armature and back stop, thereby lessening the amount of flux that must flow through the air-gap to attract the armature to the core. Moreover the flux set up by the slug has two parallel paths of travel, both of which include the air-gap. The first path is from the slug end of the core 5 across the air-gap, through the armature and heel piece into the core, as traced above. The second path is from the slug end of the core 5 through the air-gap into the armature 3, through the back stop 6 into the slug end of the core. The direction of flow of the slug flux through this path is opposed to the direction of the coil flux, and neutralizes it. At the instant the flow of flux through this back stop path becomes zero, the attraction between the armature and back stop becomes zero and as all the flux flowing bridges the air-gap, the armature is attracted to the core. As soon as the current has completely died away in the winding 1 of the relay, the currents induced in the copper collar die away and the relay releases its armature, which returns to normal, unless the circuits are arranged so that the relay locks itself in energized position. If the arma-

ture 3 is against the core 5 when the coil 1 is energized, the flux set up by the coil will retain the armature in its operated position.

Referring now specifically to Fig. 4, which is a modification of Fig. 2, the magnetic back stop check is arranged to be in contact with the armature lever 3'' rather than the armature proper 3'. By this arrangement an advantage of leverage is obtained. When the current is building up in the coil 1' and the induced currents in the copper collar 4' are opposing this building up of flux, the flux flows over a circuit including the core 5', the magnetic washer 8', the back stop 6', the armature lever 3'', the armature back stop 9', the heel piece 2' and thence back into the core. Since there is a leverage of approximately two to one ratio in this arrangement, a comparatively small flux flowing between the back stop 6' and the armature lever 3'' will retain the armature in its normal position, as the attraction on the armature 3' by the core 5' must be at least twice as great in order to operate the armature. With an arrangement such as is shown in Fig. 4, it is difficult to wind the coil 1' so that the armature 3' can be attracted while the current is flowing through the coil, but it is very easy to attract the armature when the current is broken in the coil. Thus it will be seen that this modification is particularly adapted to circuits wherein it is desirable to have the relay energize only when the current through its coil is broken.

In Fig. 6, I show a circuit employing the relay of my invention. Relay 21 may be of either the types shown in Fig. 2 or in Fig. 4 and is used in series with the motor M to guard that motor against overload or no voltage release. The motor is a shunt wound motor adapted to run on a source of direct current which is brought into the terminals 26 and 27, the circuit leading through the break contacts 25, through the motor armature and field in parallel, through the winding of relay 21 to the opposite terminal. When the relay 21 is energized from either an overload current or break in the circuit, it closes a circuit traceable from ground to spring 22 and it makes contact to the winding of relay 20 to battery, energizing the relay 20, which upon energizing locks itself over a circuit from ground through key 28, through springs 24, through the winding of the relay to battery. Relay 20 upon energizing opens the motor circuit at springs 25 and at spring 29' closes the obvious circuit to the signal 29 to notify the attendant that the motor has been cut out of service.

While I have chosen to show my invention in connection with a particular type of relay, I have done so merely by way of example, as there are many modifications which can be made by one skilled in the art without departing from the scope of my invention.

What is claimed is:

1. An electromagnetic relay having an armature, a core and a coil, an auxiliary magnetic element for preventing the attraction of said armature to said core when said coil is energized below or up to a given value and for permitting attraction of said armature to said core when said coil is deenergizing.
2. An electromagnetic relay having an armature, a core and a coil, a magnetic shunt for preventing the attraction of said armature to said coil until said coil is energized by a current of definite strength and means for attracting said armature to said core when said current is disconnected and said coil is deenergizing regardless of the strength of current used for energizing said coil.
3. An electromagnetic relay comprising a core and an armature, an air-gap between said core and armature, a main and an auxiliary magnetizing means on said core, a completely closed magnetic shunt for said air gap attached to said core, the flux created by said main means flowing in two parallel paths in the same direction to prevent the attraction of said armature, one path including said shunt and excluding said air gap and the other path including said air gap, said auxiliary magnetizing means being responsive to the deenergizing of said main magnetizing means for creating a flux through said shunt in opposition to said first flux, said armature being attracted when said opposing fluxes in said shunt path are equal.
4. An electromagnetic relay comprising a core and an armature mounted on a heel piece, an air-gap between said core and armature, two magnetizing means located on said core, a path for the flux created by one of said means, comprising two parallel branches, one branch including and the other branch excluding said air-gap, a path for the flux created by said other means also comprising two parallel branches both of which include said air-gap, the branch of said first path which excludes said air-gap being a completely closed magnetic circuit serving to prevent the attraction of said armature to said core while said first magnetic means is energized by a current of constant value.
5. In an electromagnetic relay, a core and an armature mounted on a heel piece, a member of magnetizable material attached to said core serving as a back stop for the armature in its normal position, a main magnetizing means mounted on the heel end of said core, an auxiliary magnetizing means on the armature end of said core, an air-gap between said armature and core, means for energizing said main magnetizing means for creating a main flux, a primary completely closed magnetic circuit for said main flux comprising said back stop, armature, heel piece, and part of said core, a secondary magnetic circuit for said main flux comprising the entire core, air-

gap, armature and heel piece, means for energizing said auxiliary magnetizing means, a primary magnetic circuit for the flux created by said auxiliary means comprising part of said core, said back stop, armature and air-gap, a secondary magnetic circuit for said latter flux including the entire core, heel piece, armature and air-gap, said primary completely closed magnetic circuit of said main flux constituting a means for preventing the attraction of said armature to said core while said main magnetizing means is energized.

6. In an electromagnetic relay, a core and an armature attached to a heel piece, a member of magnetizable material attached to said core, and serving as a back stop for the armature in its normal position, an air-gap between said armature and core, a main magnetizing means located on the heel end of said core, means for energizing said magnetizing means, two parallel paths for the flux created thereby, one of said paths being a completely closed magnetic circuit excluding said air-gap and the other path including said air-gap, an auxiliary magnetizing means on the armature end of said core, said auxiliary means being inductively energized during the decay of the flux created by said main means, and two parallel paths for the flux created by said auxiliary means both including said air-gap, said first flux being effective to prevent the attraction of said armature, and said latter flux being effective to attract said armature to said core.

7. In an electromagnetic relay, a core and an armature attached to a heel piece, a member of magnetizable material attached to said core and serving as a back stop for the armature in its normal position, an air-gap between said armature and core, a main magnetizing means located on the heel end of said core for creating a primary flux in a magnetic circuit comprising two parallel branches, one of said branches being magnetically closed and the other branch including said air-gap as a reluctance, an auxiliary magnetizing means on the armature end of said core responsive to the decaying of said primary flux for creating another flux comprising two parallel branches both including said air-gap as a reluctance, said primary magnetically closed flux branch constituting a means for preventing the attraction of said armature by said main magnetizing means, and said auxiliary magnetizing means constituting a means for attracting said armature.

8. In an electromagnetic relay, a core and an armature attached to a heel piece, a coil and a copper slug on said core, a member of magnetizable material attached to said core between said coil and slug and serving as an armature back stop, said armature normally resting against said back stop, an air-gap between said armature and core, a main magnetic circuit including said core, air-gap,

armature and heel piece, an auxiliary completely closed magnetic circuit including part of said core, said back stop, armature and heel piece, said core when energized creating a flux traversing said auxiliary completely closed magnetic circuit to prevent the attraction of said armature to said core, and during deenergization inductively creating a current in said copper slug which produces a flux traversing said main magnetic circuit to attract said armature to said core.

9. An electromagnetic relay having a magnet and a normally open armature associated therewith, a primary magnetic circuit for the flux created through energization of said magnet by current connected thereto, a completely closed magnetic shunt circuit for causing said flux to pass through said shunt, the parts being so proportioned that said armature remains in its normal position on sustained current below or up to a value determined by the saturation point of said shunt, but closes at the disconnection of current at any value due to the flux in said shunt being reversed by inductive influence.

10. An electromagnetic relay comprising a magnetic circuit having an air-gap as a reluctance, contact springs, an armature held in a normal position by said springs wherein said reluctance is maximum and movable to a position wherein said reluctance is minimum, a winding for creating flux in said magnetic circuit, a completely closed magnetic shunt circuit around said reluctance and including said armature for forcing said flux to pass through said shunt instead of through said reluctance to prevent said armature from being attracted while said coil is connected to sustained current below or up to a given value determined by the saturation point of said shunt.

11. An electromagnetic relay comprising a magnetic circuit having an air-gap as a reluctance, contact springs, an armature held in a normal position by said springs wherein said reluctance is maximum and movable to a position wherein said reluctance is minimum, a winding for creating flux in said magnetic circuit, a completely closed magnetic shunt circuit around said reluctance and including said armature for forcing said flux to pass through said shunt instead of through said reluctance to prevent said armature from being attracted while said coil is connected to sustained current below or up to a given value determined by the saturation point of said shunt, and electroconductive means inductively responsive to a disconnection of current from said coil for creating a flux to move said armature regardless of the current value at which said disconnection occurs, said armature in turn operating said contact springs.

12. An electromagnet having a movable, normally open armature and a coil for creat-

ing flux in a primary magnetic circuit, a completely closed magnetic path for shunting said primary circuit to prevent the attraction of said armature while said coil is connected to sustained current, and electroconductive means inductively responsive to an interruption of current in said coil for creating flux to attract said armature. 15

13. An electromagnet having an armature and a coil for creating flux in a primary magnetic circuit, an auxiliary magnetic circuit for preventing the attraction of said armature in said primary circuit when said coil is connected to sustained current, and means responsive to an interruption of current in said coil for creating flux to attract said armature.

In witness whereof, I hereunto subscribe my name this 23d day of July, A. D., 1925.

JOHN ERICKSON.