June 4, 1929. J. ERICKSON 1,716,357

ELECTROMAGNETIC RELAY

Original Filed June 17, 1921

Fig:4

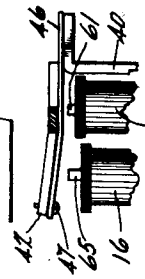


Fig:2

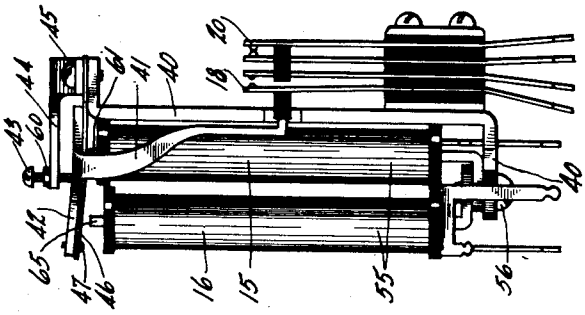


Fig:3

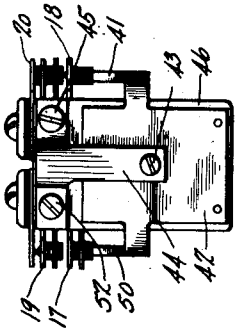


Fig:1

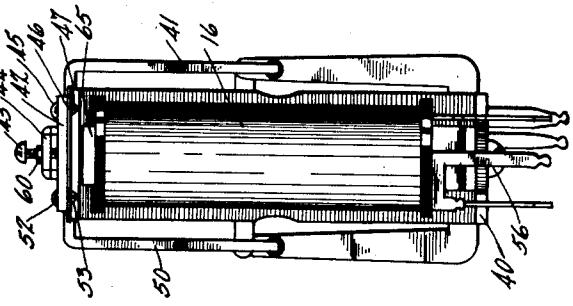
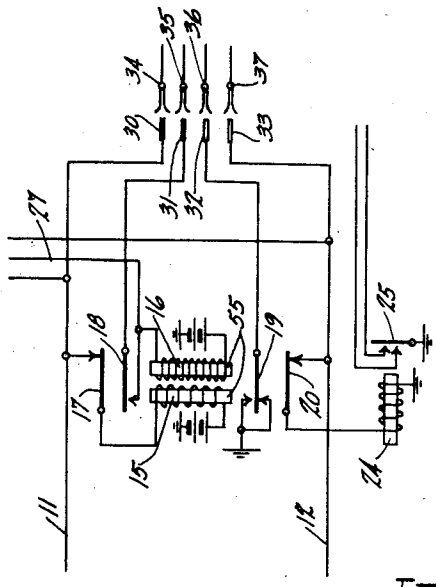


Fig:5



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UNITED STATES PATENT OFFICE.

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ELECTROMAGNETIC RELAY.

Application filed June 17, 1921, Serial No. 478,377. Renewed November 2, 1925.

The present invention relates in general to electromagnetic relays and has for its object the provision of a new and improved marginal or two-step relay.

Relays of this character have been constructed before and generally have two windings of different magnetizing strengths, or a single winding the magnetizing strength of which can be altered by the introduction of a resistance in series with it or by other appropriate means, the object in any case being to secure either partial or a complete operation of the relay as desired. While these prior arrangements accomplished the desired results it will be appreciated that the operation of a relay so constructed was not as positive as could be desired.

The marginal relay of the present invention was designed with a view to producing a relay whose operation is absolutely positive.

The improved relay in its preferred form is illustrated in the drawing which will now be referred to for a more detailed explanation of its construction and operation.

Referring now to the drawing, Figs. 1 and 2 show front and side views, respectively, of the improved relay. Fig. 3 shows a top view, and Fig. 4 a detail of the armature with the lever for moving the springs broken away.

Fig. 5 shows a line circuit of an individual subscriber's line in a finder switch system. The particular line circuit shown in Fig. 5 is similar to the one shown and described in the U. S. patent to Powell, No. 1,308,553, granted July 1, 1919, the only difference being that the improved marginal relay of the present invention is used in the individual line circuit therein disclosed instead of the old type of marginal relay.

The operation and construction of the improved marginal relay will now be described in detail with reference to Figs. 1, 2, 3, and 4. Like parts in the various figures have been given like reference characters in order to facilitate the explanation. The relay proper is made up of the two coils 15 and 16 mounted upon the cores 65 and 61, which are attached by means of a single screw 56 to the iron heel piece 40. The armature 42 is bent so as to form an obtuse angle, that is, the front part of the armature 42 when in normal position is further away from the core 65 than its back part is away from the core 61. This will be readily seen in Fig. 4. A flexible spring 46 is attached to the armature 42 by means of the screws 52 and 45. This spring is preferably made of non-magnetic material. The armature 42 is attached to the heel piece 40 by means of the screws 45 and 52, which secure the spring 46, to which the armature 42 is attached, in position on the heel piece 40, the latter being bent at right angles in order to form a suitable mounting place. The armature 42 is adapted, when operated, to move the springs 17–20, inclusive, through the medium of the levers 50 and 41. The springs 17 and 19 together with their working and resting contacts are fastened on one side of the heel piece 40 where they are adapted to be operated by the lever 50 in the usual manner. The springs 18 and 20 and their associated contacts are mounted on the opposite side of the heel piece 40 and are adapted to be operated by the lever 41. The armature 42 is limited in its movement and adjusted by means of a back stop screw 43 which is adapted to be locked in its proper position by means of a lock nut 60. The back stop screw 43 is screwed into the bracket 44, the latter being held in place on the heel piece 40 by means of the screws 52 and 45, which also hold the armature with its attached spring in position.

In order to describe the operation of the improved marginal relay it will be assumed that the coil 15 is energized. When this occurs magnetic flux will be set up in a circuit which includes the core 61 of the coil 15, the heel piece 40, and the armature 42. The armature 42 will be attracted against the core 61. A certain amount of flux will be set up in the core 65 of the coil 16; however, this flux will have no appreciable effect on the armature 42 as the core 65 is practically short circuited by the heel piece 40. Most of the flux will therefore flow through the heel piece and thus the armature 42 will only be attracted until it engages the core 61 of the coil 15. When the armature is in this position only certain of the springs are operated,

that is, the spring 19 breaks away from its resting contact but does not engage its working contact, while the spring 18 engages its working contact. The springs 17 and 20 are not operated at this time. When the winding 16 is energized, which may take place either when the coil 15 is energized or deenergized, as this does not affect the operation, except that if the coil 15 is energized the current flow through the coil 16 must be in the opposite direction to the current flow through the coil 15, armature 42 is fully attracted and changes its fulcrum from a point close to the heel piece 40 to the angle where the armature is bent. By this operation springs 17 and 20 are forced out of engagement with their resting contacts while the spring 19 is operated into engagement with its working contact. The magnetic flux is set up in a circuit which includes the core 65, the core 61 and the armature 42, a certain amount being shunted by heel piece 40.

From the above it will become apparent that if the coil 15 is energized alone only the springs 18 and 20 are operated, while if the coil 16 is energized all the springs will be operated. It will, of course, be understood that any desired adjustment can be made with the springs controlled by the armature 42 without departing in any way from the spirit of the present invention.

It will now be in order to explain why the spring 46 is made of non-magnetic material. It is sometimes desirable to energize the core 16 without deenergizing the coil 15. Under these conditions it is necessary for the armature 42 to shift its fulcrum as described. Now if the spring 46 were of magnetic material the armature 42 would tend to stick to the heel piece 40 as there would be practically no air gap between the armature 42 and the heel piece 40 and thus the armature would be prevented from changing its fulcrum. By making the spring 46 of non-magnetic material this difficulty is not encountered.

Having described the operation and construction of the improved relay in general its operation in the circuit shown in Fig. 5 will now be briefly described. For this purpose it will be assumed that the subscriber having the individual line equipment shown therein removes his receiver in order to initiate a call. When the receiver is removed at the calling substation the coil 15 and the relay 24 are energized in series over the calling line loop. The coil 15, upon energizing, operates the spring 18 into engagement with its working contact, and separates the spring 19 from its resting contact, this being due to the construction of the relay 55, as was described, it being of course understood that the wiring of the relay 55 is a circuit arrangement for the relay shown in Figs. 1–4, inclusive. When the spring 19 is forced out of engagement with its resting contact the ground potential on the test contact 32 is removed and the calling line terminals 30–32, inclusive, are rendered selectable by an idle finder switch. Relay 24, upon energizing, closes the starting circuit of the finder switches whereby the wipers of the first idle finder switch are rotated in search of the contacts associated with the calling line. It will be assumed that the wipers 34–37, inclusive, are the wipers of the finder switch which is operated. Immediately upon the test wiper 36 engaging the test contact 32 of the calling subscriber's line the finder switch will stop, there being no ground potential upon the test contact 32 due to the operation of the spring 19. By well known arrangements in the finder switch ground will now be extended by way of wiper 35, contact 31, armature 18 and its front contact, and through the winding of the coil 16. The coil 16 is energized over this circuit and, upon operating, attracts all the armatures. By this operation the circuit of the line relay 15 and the starting relay 24 is opened and a test potential is again placed upon the contact 32. The subsequent operations wherein a connection is finally established with the desired called line will take place in the same manner as is described in the before mentioned patent.

When the line having the line equipment shown in Fig. 5 is called, the connector, upon making connection with the line places a ground potential on the private normal conductor 27 and energizes the coil 16. The winding 16, upon energizing, attracts all the armatures 17–20, inclusive, thereby disconnecting the line of the calling substation from its normal battery and ground connections in its individual line equipment. The subsequent operations wherein the called subscriber is signalled, the conversation completed, and the connection released will take place in the usual manner.

It will be understood that the circuit arrangement shown herein is purely for illustrative purposes and that the use of the new marginal relay is not necessarily confined to a finder switch system but may be used wherever a relay having a marginal operation is required. It will be seen that a relay of this type operates in a very positive manner.

Having fully described and ascertained the features of the invention what is considered to be new and desired to have protected by Letters Patent will be pointed out in the appended claims.

What I claim is:

1. In an electromagnetic relay, a pair of coils wound upon different cores, an armature for said relay consisting of a piece of magnetic iron bent to form an obtuse angle, supporting means adapting said armature to move about two different fulcrums, one of said coils provided to operate said armature

to move on the first of said fulcrums, the coil energized being the one nearest to said first fulcrum, and the other of said coils provided to operate said armature about the other fulcrum.

2. In an electromagnetic relay, a pair of coils wound upon different cores, an armature for said relay consisting of a piece of magnetic iron bent to form an obtuse angle and adapted to move about two different fulcrums, a heel piece, said armature being attached to said heel piece by means including a flat flexible spring, the said heel piece and the nearest one of said cores constituting the said two fulcrums, one of said coils provided to operate said armature about one of said fulcrums, and the other of said coils provided to operate said armature about the other fulcrum.

3. In an electromagnetic relay having a pair of coils, a movable armature for said relay consisting of a piece of magnetic iron bent to form an obtuse angle, supporting means adapting said armature to move about two different fulcrums, one of said coils provided to operate said armature about one of said fulcrums, the other coil provided to operate said armature about the other fulcrum, contact springs controlled by said armature in each case, and a spring actuating member moving in the same direction during both movements of the armature.

4. In an electromagnetic relay having a pair of coils wound upon different cores, a magnetic circuit for said relay including an armature, said armature consisting of a piece of magnetic iron bent to form an obtuse angle, an air gap of one distance between said armature and one of said coils and an air gap of a greater distance between said armature and the other of said coils, the first of said coils provided to operate said armature to close the first mentioned air gap without closing said second air gap, the other of said coils provided to operate said armature to close the second of said air gaps, and a third gap closed while the second gap is open and open while the second gap is closed.

5. In an electromagnetic relay having a pair of coils wound upon different cores, an armature being bent to form an obtuse angle, a magnetic circuit including an air gap between one of said cores and said armature, and a second air gap larger than the first between the other core and said armature, both gaps being normally open, sets of contact springs adapted to be operated by said amature, one of said coils provided to attract said armature to close the first mentioned air gap and shorten said second air gap without closing the same, the operation of the armature in this case being effective to operate one of said sets of springs, and the other of said coils provided to attract said armature to close the second air gap at the same time operating all the springs of said armature.

6. In an electromagnetic relay, a pair of cores each containing a coil, a magnetic circuit with three separate air gaps, said air gaps being normally open, a movable armature included in said magnetic circuit responsive to an energization of one of said cores to reduce the opening of the first said gap and shorten the second said gap without changing the third gap, said armature also responsive to the energization of the other of said cores to shorten said second gap and further open said third gap without further changing said first gap.

7. In an electromagnet, an armature having a contact actuating element operable in two distinct stages in the same direction, a core for attracting said armature to operate the same in the first stage, the end of said core serving as a fulcrum for said armature in the second stage, and a second core for attracting said armature to operate the same in the second stage.

8. In an electromagnet, an armature having a contact actuating element operable in two distinct stages in the same direction, a core spaced away from said armature when the latter is in normal position, a second core normally closer to said armature than the said first core and energizable to attract said armature and operate the same in the first stage, thereby decreasing the distance between the armature and the first core, and supporting means for the armature such that upon the energization of said first core the armature will perform the second stage of its movement about the end of the second core as a fulcrum.

9. In an electromagnet, an armature subject to attraction by said magnet in two stages, a core, a support serving as a fulcrum for said armature in the first stage of its movement, and a second core between said first core and support serving as a stop for the armature at the end of the first stage of its movement and also serving as a fulcrum for the armature during the second stage.

10. In an electromagnetic relay, two magnet cores and a heel piece disposed in parallel planes and magnetically connected at one end, the second core lying between the first core and the heel piece, and an armature having two fulcrums, one on the free end of said heel piece and the other on the free end of said second core, said armature responsive to magnetization of said second core to move about the first fulcrum into engagement with the second fulcrum, and responsive to magnetization of said first core to move about said second fulcrum.

11. In a two step relay, an armature, a support for said armature, a magnet core for operating said armature a definite distance on said support as a fulcrum, contact springs

actuated by said armature, a second magnet core for causing said armature to resume its movement for an additional distance, means attaching said armature to the said support such that the armature is permitted to shift its fulcrum at the beginning of the second stage of its movement, and other contact springs actuated by said armature in the second stage of its movement.

12. In an electromagnetic relay, two cores and a heel piece disposed in parallel planes, an armature extending across the end of said cores and the end of said heel piece, a thin spring of nonmagnetic material disposed between said armature and the ends of said cores and heel piece, means for attaching one end of said spring to the heel piece, and means for attaching the other end of said spring to said armature.

13. In an electromagnet, a heel piece and a core disposed in paralleled planes, an armature extending across the end of said core and the end of said heel piece, means including said core for operating said armature in two distinct stages, said heel piece serving as a fulcrum for said armature in the first stage and said core serving as a fulcrum for said armature in the second stage.

14. In an electromagnet, a heel piece and a core disposed in paralleled planes, an armature extending across the end of said core and the end of said heel piece, means including said core for operating said armature in two distinct stages, said heel piece serving as a fulcrum for said armature in the first stage and said core serving as a fulcrum for said armature in the second stage, and a thin spring of non-magnetic material disposed between said armature and the ends of said core and of said heel piece serving as a support for said armature.

15. In an electromagnet, two cores and a heel piece disposed in parallel planes, an armature extending across the end of said cores and the end of said heel piece and being operable in two distinct stages, one of said cores provided for attracting said armature in the first stage and the other core provided for attracting said armature in the second stage, said heel piece serving as a fulcrum for said armature in the first stage, and one of said cores serving as a fulcrum for said armature in the second stage.

16. In an electromagnet, two cores and a heel piece disposed in parallel planes, an armature extending across the end of said cores and the end of said heel piece and being operable in two distinct stages, one of said cores provided for attracting said armature in the first stage and the other core provided for attracting said armature in the second stage, said heel piece serving as a fulcrum for said armature in the first stage, one of said cores serving as a fulcrum for said armature in the second stage, and a spring of non-magnetic material disposed between said armature and the ends of said cores and of said heel piece serving as a support for said armature.

17. In a relay provided with a pair of windings, a heel piece and a core disposed in parallel planes, an armature extending across the end of said core and the end of said heel piece and being operable in two distinct stages, one of said windings provided for attracting said armature in the first stage, and the other winding provided for attracting said armature in the second stage, said heel piece serving as a fulcrum for said armature in the first stage, and said core serving as a fulcrum for said armature in the second stage.

18. In a relay provided with a pair of windings, a heel piece and a core disposed in parallel planes, an armature extending across the end of said core and the end of said heel piece and being operable in two distinct stages, one of said windings provided for attracting said armature in the first stage, and the other winding provided for attracting said armature in the second stage, said heel piece serving as a fulcrum for said armature in the first stage, said core serving as a fulcrum for said armature in the second stage, and a flat spring disposed between said armature and the ends of said core and of said heel piece serving to support said armature.

19. In a relay provided with a pair of windings, a heel piece and a core disposed in parallel planes, an armature extending across the end of said core and the end of said heel piece and being operable in two distinct stages, one of said windings provided for attracting said armature in the first stage, and the other winding provided for attracting said armature in the second stage, said heel piece serving as a fulcrum for said armature in the first stage, said core serving as a fulcrum for said armature in the second stage, and a flat spring disposed between said armature and the ends of said core and of said heel piece serving to movably support said armature on said heel piece.

20. In a relay, a heel piece and a core provided with a first winding disposed in parallel planes, a second winding, an armature extending across the ends of said core and said heel piece and being operable in two distinct stages, said first winding provided for operating said armature in the first stage and said second winding provided for operating said armature in the second stage, said heel piece serving as a fulcrum for said armature in the first stage, and said core serving as a fulcrum for said armature in the second stage.

21. In a relay, a heel piece and a core provided with a first winding disposed in parallel planes, a second winding, an armature extending across the ends of said core and said heel piece and being operable in two distinct

stages, said first winding provided for operating said armature in the first stage and said second winding provided for operating said armature in the second stage, said heel piece serving as a fulcrum for said armature in the first stage, said core serving as a fulcrum for said armature in the second stage, and a member of flexible non-magnetic material disposed between said armature and the ends of said core and said heel piece serving to movably support said armature on said heel piece.

In witness whereof, I hereunto subscribe my name this 13th day of June, A. D. 1921.

JOHN ERICKSON.