March 8, 1960 D. J. NORTON 2,928,029

TRACTIVE ARMATURE RELAYS

Filed Oct. 7, 1957 3 Sheets-Sheet 1

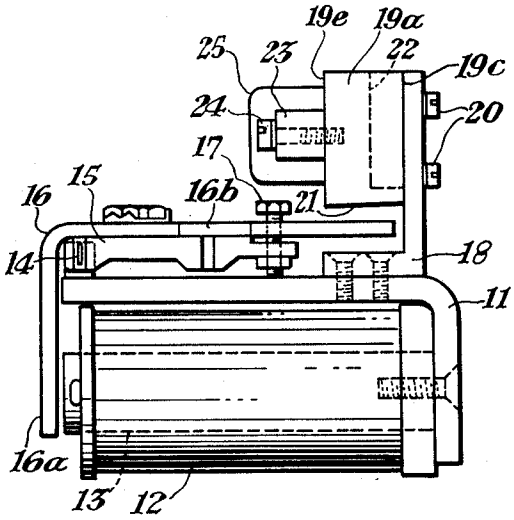


Fig. 1a.

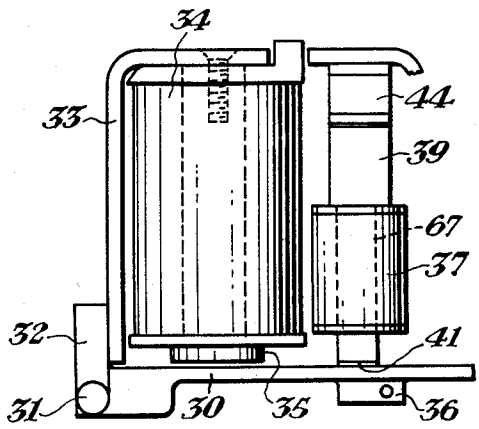


Fig. 2a.

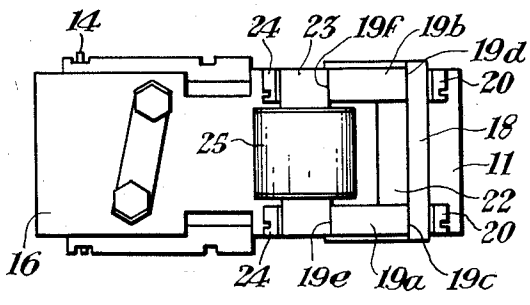


Fig. 1b.

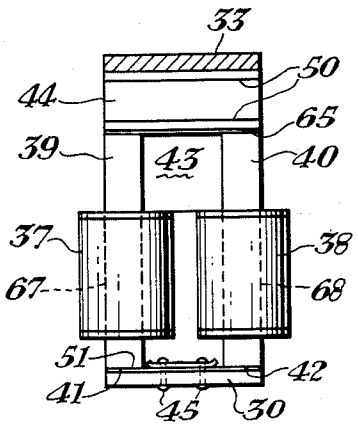


Fig. 2b.

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TRACTIVE ARMATURE RELAYS

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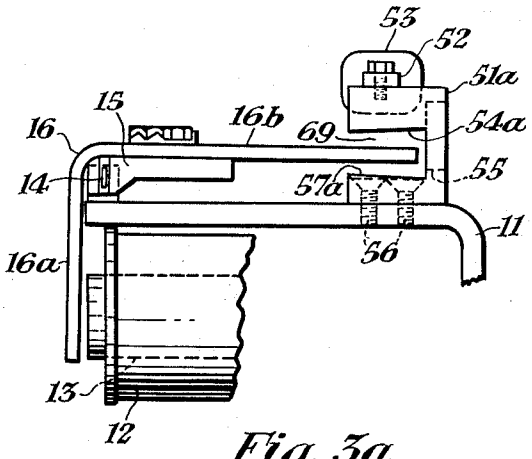


Fig. 3a.

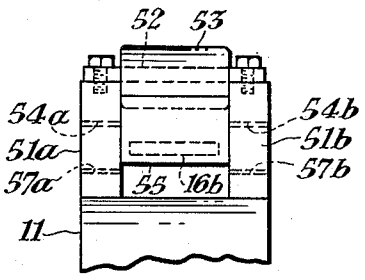


Fig. 3b.

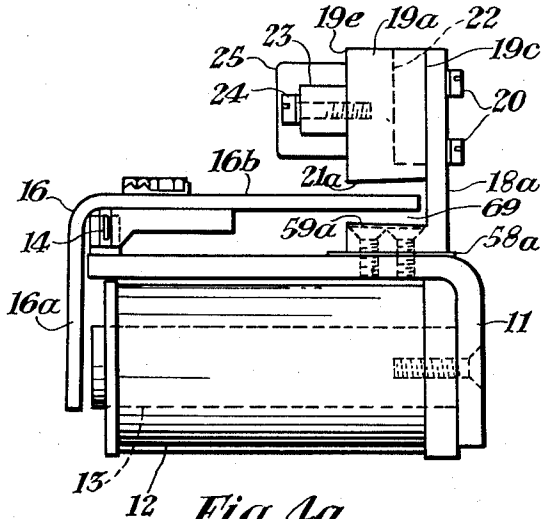


Fig. 4a.

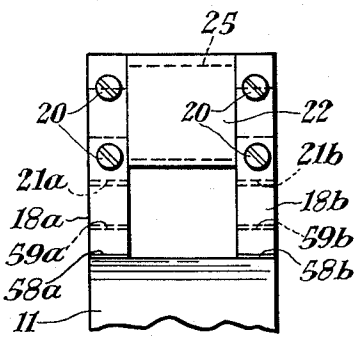


Fig. 4b.

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TRACTIVE ARMATURE RELAYS

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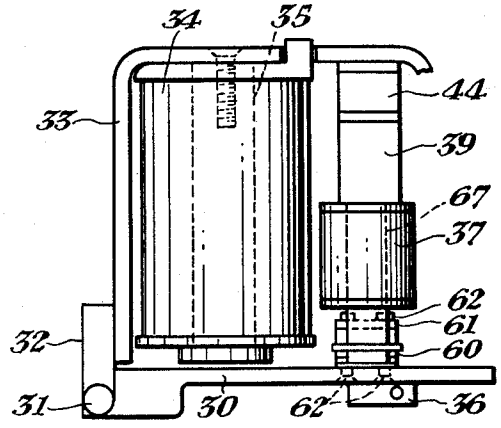


Fig. 5a.

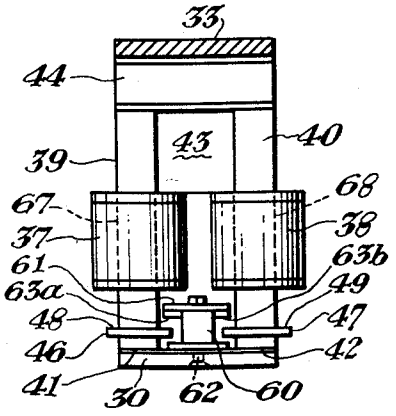


Fig. 5b.

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2,928,029

# TRACTIVE ARMATURE RELAYS

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Application October 7, 1957, Serial No. 688,715

9 Claims. (Cl. 317—187)

The present invention relates to tractive armature relays of a type, often known as "latched" relays, in which a latch arrangement acts, when the armature has been picked up to the energized position due to energization of the operating coil of the relay, to maintain or hold up the armature in that position upon deenergization of the operating coil unless and until the latch arrangement is rendered ineffective, whereupon the armature is free to assume the released position.

This application is a continuation-in-part of my copending application for Letters Patent of the United States, Serial No. 635,656, filed on January 23, 1957, entitled Magnetic Latch for Plug-in Relays, and now abandoned.

Heretofore, in a certain class of relays known as a two-position magnetic stick relay, it has been proposed to interpose a permanent magnet between the cores of two separate operating coils associated with a single armature. The permanent magnet sets up a magnetic flux in the magnetic circuit including the cores and the armature, and to pick up the armature to the energized position this magnetic flux is strengthened by electromagnetic flux set up by energization of the operating coils with current of the appropriate polarity. The reduction of the air gap between the cores and the armature by picking up of the latter to the energized position enables the permanent magnet to hold the armature in that position on subsequent deenergization of the operating coils and consequent removal of the strengthening electromagnetic flux. A disadvantage of the above type of relays is that in order to permit the return of the armature to the released position, it is necessary to energize the operating coils with current of opposite polarity to set up in the magnetic circuit an electromagnetic flux which opposes the magnetic flux due to the permanet magnet to thereby neutralize the holding force.

According to the present invention the above disadvantage is eliminated by providing, in a tractive armature relay, a latch arrangement comprising a permanent magnet mounted in fixed relationship to the relay frame and arranged to exert on the armature, in its energized position, an attractive force sufficient to hold the armature in that position, and an electromagnetic release coil or trip coil which is additional to the operating coil or coils of the relay and which is energizable to produce a magnetic force opposing the said attractive force to an extent sufficient to allow release of the armature.

More particularly, according to the present invention, a tractive armature relay is shown comprising a first magnetic circuit extending in part through the armature and including a core having an operating coil thereon. A second magnetic circuit is provided also extending in part through the armature, the remaining extent of the second circuit being at least in part separate from the first circuit and including a permanent magnet with a shunt path therefor. In the second circuit a core is provided having thereon a release coil additional to



the operating coil. The permanent magnet is effective, on the picking up of the armature to the energized position by energization of the operating coil, to hold the armature in that position on deenergization of the operating coil, and the release coil is energizable to allow release of the armature. It will be evident that the action of the latch arrangement in holding up and releasing the armature is independent of energization of the operating coil of the relay.

In one arrangement of the relay according to the present invention, a permanent magnet extends between a pair of spaced pole piece members of magnetizable material, which pole piece members are spanned by a further member of magnetizable material to establish the shunt path for the permanent magnet. A release coil may be wound either on the last-mentioned member, or may be wound as a single coil, or as separate coils on one or both of the pairs of spaced pole piece members. In the former case the redistribution of flux resulting from energization of the release coil has the effect of boosting the permanent magnet and therefore there can be no tendency to demagnetize the permanent magnet. In the latter case the effect is opposite but by using a permanent magnet having a high resistance to demagnetization and by proportioning the members of the magnetic circuit in accordance with well-known principles, demagnetization of the permanent magnet may be avoided.

The invention will be further described, by way of example, with reference to the accompanying drawings in which like reference characters refer to like elements throughout, and, in which:

Fig. 1*a* shows, in elevation view, one form of a latch arrangement in accordance with the present invention as applied to a small size relay of the plug-in type; only those parts of the relay concerned with the operation and mounting of the latch arrangement being shown in the figure;

Fig. 1*b* is a plan view of Fig. 1*a*;

Fig. 2*a* shows diagrammatically an elevation view of another form of latch arrangement in accordance with the present invention;

Fig. 2*b* shows an end view of Fig. 2*a*, as seen from the right-hand side thereof;

Fig. 3*a* shows, also diagrammatically, an elevation view, of another form of latch arrangement in accordance with the invention;

Fig. 3*b* shows an end view of Fig. 3*a*, as seen from the right-hand side thereof;

Fig. 4*a* shows, also digrammatically, an elevation view, of a modified form of the latch arrangement of Fig. 1*a*;

Fig. 4*b* shows an end view of Fig. 3*a* as seen from the right-hand side thereof; and

Figs. 5*a* and 5*b* are views corresponding respectively to Figs. 2*a* and 2*b*, of a modification of the arrangement of Figs. 2*a* and 2*b*, adapted to subject the armature to a holding force in the released position as well as in the energized position.

Referring to Figs. 1*a* and 1*b*, a heelpiece **11** of the relay frame supports the operating coil **12** wound about a core **13**. Pivotally mounted on the horizontally extending portion of the heelpiece by means of a split bearing pin **14** is an armature carrier **15** to which is fixed an L-shaped armature **16** having a dependent limb **16***a* cooperating with the core **13**, and a limb **16***b* extending substantially parallel to and spaced from the horizontally extending portion of the heelpiece **11**. The armature **16** is connected mechanically, by means which are not shown, with the movable contact or contacts of the relay. The armature **16** is balanced to gravitate to the released position shown in the drawing, the released position being determined by engagement of an adjustable set screw **17**

with the heelpiece 11. By means of the latch arrangement now to be described, the armature may also be retained in the energized position determined by engagement of the dependent limb 16*a* thereof with the core 13, even though the operating coil 12 is deenergized.

The latch arrangement is assembled as an independent unit on a bracket 18 of nonmagnetizable material, which when secured to the heelpiece 11 supports the latch arrangement above the free end of the limb 16*b* of the armature. The arrangement comprises two spaced apart pole pieces 19*a*, 19*b* secured by screws 20 to the bracket 18 to project therefrom in parallel relationship. The lower ends of the pole pieces present pole faces 21 cut at the angle assumed by the cooperating surface of the limb 16*b* when the armature is in the energized position so that a uniform air gap pertains between the faces and the armature when the latter is in the energized position. Sides 19*c*, 19*d* of the pole pieces 19*a* and 19*b*, respectively, abut the bracket 18. A permanently magnetized bar 22 is interposed between the pole pieces 19*a* and 19*b* with its oppositely polarized ends or poles in contact therewith; the bar 22 being fixed therebetween by bonding with a suitable substance and terminating short of the pole faces 21. Adjacent the other pair of sides 19*e*, 19*f* of the pole pieces 19*a* and 19*b*, respectively, there is a core piece 23 spanning the pole pieces; this core piece 23 being fixed to the pole pieces by screws 24 which act as a shunt path for the permanent magnet 22. The core piece 23 carries, over a middle portion thereof, a release or trip coil 25. The core piece 23 may be in direct contact with the pole pieces 19*a* and 19*b* as shown, or alternatively, shims of a nonmagnetizable material may be interposed between the pole pieces and the core piece to adjust the reluctance of the magnetic circuit through the latter. The electrical connections to the trip coil 25 are separate from those to the operating coil 12 of the relay so that these two coils can be energized independently.

When the armature 16 is in the released position, the air gap between it and the pole faces 21 is such that the attractive force of the permanent magnet 22 is insufficient to lift it. However, when the armature 16 assumes the energized position, the air gap is diminished to such an extent that the flux due to the permanent magnet 22 which now passes through the armature is sufficient to hold it in the energized position when the operating coil 12 is deenergized. The trip coil 25 is so adapted that when energized it produces a magnetic flux strengthening that already present in the core piece 23 due to the permanent magnet 22; and, since the core piece is in a magnetic circuit parallel to the circuit through the armature 16, the flux produced by the coil 25 reduces the flux in the armature circuit to such an extent that the armature is allowed to return to the released position. Thus when once the operating coil 12 has been energized to lift the armature 16 to the energized position, the armature is "latched" or is held in that position when the operating coil is subsequently deenergized unless and until the trip coil 25 is energized. Momentary energization of the trip coil 25 will, of course, suffice to allow release of the armature 16. To avoid energization of the trip coil for longer than is necessary it may be supplied through a front contact, not shown, of the relay.

It will be evident that in this case there is no tendency for the trip coil 25 to demagnetize the permanent magnet 22. Preferably, however, the permanent magnet 22 is made of a material such as that sold under the trade name "Alcomax III," which will maintain a fairly constant flux output with varying magnetomotive force. Otherwise energization of the trip coil 25 is likely to cause an increase in the flux of the permanent magnet 22 and the trip coil would be required to supply additional magnetomotive force to counteract the effect on the armature 16 of such an increase of flux.

While in the drawing, the latch arrangement is shown applied to a relay in which the armature 16 is returned to the released position by gravity, it is equally applicable where the return force is supplied by a spring biasing the armature towards the release position.

Referring to Figs. 2*a* and 2*b*, the latch arrangement shown therein is modified firstly to suit a different construction and disposition of the main components of the relay, the armature 30 being in this case in the form of a flat plate which is pivotally mounted at one end 31 to a fixture 32 on the heelpiece 33. The operating coil 34 and its core 35 are supported by the heelpiece on an axis perpendicular to the general plane of the armature 30 and there is provided on the armature a lug 36 to which is attached an arm (not shown) in turn connected to the movable contact or contacts of the relay.

The latching arrangement is constructed considerably longer in one dimension than in the others and is supported in fixed relationship with the heelpiece 33 with the longest dimension parallel to the axis of the operating coil 34. The trip coil is divided into two separate coils 37, 38 which are wound one about each of core sections 67, 68 formed on two spaced apart pole pieces 39, 40 presenting pole faces 41, 42 towards the armature. The coils 37, 38 are connected electrically either in series or in parallel so as to be energizable simultaneously. The permanent magnet, in the form of a magnetizable bar 43, is interposed, and fixed by a bonding agent, between the pole pieces 39, 40 on the side of the coils 37, 38 remote from the armature 30. Adjacent the permanent magnet 43 a yoke 44 of magnetizable material spans the ends of the pole pieces 39 and 40. Shims 50 of nonmagnetizable material are shown interposed between the yoke 44 and the adjacent ends of the pole pieces 39, 40, and between the yoke and the heelpiece 33. A shim 51, similar to shims 50 is inserted between the pole faces 41 and 42 and the armature 30, which shim, as illustrated, is attached to the armature by rivets 45. The shim 50 between the yoke 44 and the heelpiece 33 is such as to maintain the substantial magnetic isolation of the latch arrangement necessary in the illustrated example, while the remaining shims serve to adjust the reluctances in the various portions of the magnetic circuit formed by the latch arrangement.

The latch arrangement acts to hold the armature in the energized position in exactly the same way as the arrangement according to Figs. 1*a* and 1*b*, and, as previously, energization of the trip coils 37, 38 allows release of the armature 30. However, by virtue of the altered disposition of the trip coils 37, 38, such energization tends to produce a flux distribution which is demagnetizing in relation to the permanent magnet 43 but the yoke 44, forming a shunt path for the permanent magnet, accepts an increased amount of flux to thereby prevent the permanent magnet from being demagnetized. The permanent magnet is of a material having a high coercivity, such as that sold under the trade name "Alcomax III."

There are, of course, within the scope of the invention different ways of arranging the abovedescribed components of the latch arrangement. One which is notable is to have spaced apart, inverted L-shaped pole piece members 51*a* and 51*b*, see Figs. 3*a* and 3*b*, spanned between the upper surfaces of their horizontal limbs by the core member 52 having a release coil 53 thereon; the lower surfaces of these limbs being formed as pole faces 54*a* and 54*b* toward which the free end of the armature swings in moving to the energized position. A permanent magnet 55 is interposed between the vertical limbs of the pole piece members and is therefore situated beyond the free end of the armature extension 16*b*. The pole piece members 51*a* and 51*b* may each be extended by a further horizontal limb projecting in the same direction as, and spaced from, the first-mentioned horizontal limb so that, in elevation, each pole piece member resembles a channel 69. The upper surfaces of such ex-

tensions are then formed as pole faces **57***a* and **57***b* towards which the armature **16** swings in moving to the released position, the disposition of pole faces **57***a* and **57***b* being such that the magnetic flux passing by way of the faces through an adjacent transversely extending section of the armature **16** acts to hold the latter in the released position. The permanent magnet **55** is thereby utilized to exert a hold-down force on the armature in its released position.

As shown in Figs. 4*a* and 4*b*, the arrangement in accordance with Figs. 1*a* and 1*b* also lends itself to modification for the purpose of providing a hold-down force on the armature **16** in its released position. In this modification the bracket **18** may be constructed with legs **18***a* and **18***b* spaced apart in the same way as the pole pieces **19***a*, **19***b* and be of a material which is magnetizable. The legs **18***a* and **18***b* are separated from the heelpiece **11** by shims **58***a* and **58***b* of a thickness adequate to maintain the bracket in substantial magnetic isolation from the operating magnetic circuit. The upper surfaces of the portions of such legs which are substantially parallel to the armature **16** are then formed as pole faces **59***a* and **59***b* so disposed in relation to the armature in its released position as to cause a hold-down force to be exerted by the permanent magnet **22** in the manner previously outlined. The hold-down force is of such magnitude, in relation to the force acting on energization of the relay operating coil **12** to pick up the armature **16** to the energized position, that the hold-down force is overcome by the pickup force and movement of the armature to the energized position takes place in the normal way.

The latch arrangement in accordance with Figs. 2*a* and 2*b* may also be modified to obtain a hold-down force in the released position of the armature. This latter modification may be undertaken in a different way in order to avoid intrusion into the space below the armature **30** where contact stacks are accommodated. The modified arrangement is shown in Figs. 5*a* and 5*b*. The pole pieces **39, 40** are provided at correspondingly situated points along their lengths, just short of the pole faces **41, 42**, with collars **46, 47** of magnetizable material presenting pole faces **48, 49** directed oppositely to, and spaced apart from the pole faces **41, 42**. A lightweight fixture added to the armature **30** comprises a pillar support **60** and a plate **61**, both of magnetizable material, which are assembled to resemble a T. Support **60** and plate **61** are fixed to the main body of the armature by screws **62** in a position intermediate, and clear at their edges from, the pole pieces **39, 40**. The portions **63***a* and **63***b* of the underside of this plate **61** which overlap the pillar support are oblique to the upper surface of the main body of the armature **30** so as to be parallel with the pole faces **48, 49** when the armature is in the released position. Portions **63***a* and **63***b* constitute secondary surfaces of the armature which cooperate with the pole faces **48, 49**. When the armature **30** is in the released position defined by back stops (not shown), the air gap between the secondary surfaces **63***a* and **63***b* and the pole faces **48, 49** is such that flux due to the permanent magnet **43** passing by way of these faces through the plate **61** acts to exert on the armature **30** a force tending to hold it in the released position. This force supplements such similar acting force as may be applied by other agencies, for example, a return spring. However, on energization of the operating coil **34**, the pickup force acting on the armature is sufficient to overcome the hold-down force and the armature moves to the energized position in the normal manner.

While my invention has been described with reference to a particular embodiment thereof, it will be understood that various modifications may be made by those skilled in the art without departing from the invention. The appended claims are therefore intended to cover all such modifications within the true spirit and scope of the invention.

Having thus described my invention, what I claim is:

1. In an electrical relay having a tractive armature biased to a released position and movable to an attracted position, a magnetic latch for holding said armature in attracted position until magnetically released, comprising a permanent magnet having spaced apart pole pieces disposed to establish with the permanent magnet a magnetic circuit through the armature in the attracted position to magnetically latch it in such position, a core piece spanning the pole pieces to establish a magnetic circuit parallel to the magnetic circuit through the armature, and a coil on said core piece effective when energized to produce in the core piece a magnetic flux strengthening that set up there by the permanent magnet and sufficient to reduce the flux in the circuit through the armature to an extent allowing release thereof.

2. A magnetic latch for holding a pivoted relay armature in its attracted position following deenergization of the relay until electrically released, comprising in combination with a frame pivotally supporting the armature, a nonmagnetic bracket secured to said frame adjacent the free end of said armature, spaced apart pole pieces secured to said bracket in such a position that said armature swings toward said spaced apart pole pieces when moved to the attracted position, a permanent magnet bridging said pole pieces and having an attractive force sufficient to retain said armature in its attracted position, a core piece spanning said pole pieces to establish a magnetic circuit parallel with the magnetic circuit through the armature, and a trip coil mounted on said core piece and effective when energized to produce in said core piece a magnetic flux strengthening that set up in said core piece by said permanent magnet and sufficient to reduce the flux in the circuit through said armature to an extent sufficient to permit release of the said armature from its attracted position whereby there is no tendency to demagnetize said permanent magnet.

3. A tractive armature relay comprising a first magnetic circuit extending in part through said armature and including a core having an operating coil thereon, energization of said operating coil causing said armature to be actuated to an energized position, a second magnetic circuit also extending in part through said armature, the remaining extent of said second circuit being at least in part separate from said first circuit, a permanent magnet in said second circuit, a shunt path for said permanent magnet, a core in said second circuit, a release coil on said core, said permanent magnet being effective upon the actuation of said armature to the energized position to hold said armature in that position on deenergization of said operating coil, said release coil being energizable to allow release of said armature, two pole piece members, said permanent magnet extending between said pole piece members, said pole piece members disposed to establish for said permanent magnet a magnetic circuit through said armature, and a core piece spanning the pole piece members to establish a shunt path for said permanent magnet, said release coil being provided on said core piece.

4. A relay comprising a heelpiece having two legs disposed at right angles, a core secured at one end to the one leg and extending parallel to the other leg, an L-shaped armature pivotally attached to the free end of said other leg and having a first leg cooperating with the free end of said core, a second leg extending parallel to said other leg of the heelpiece, an energizing winding on said core, said armature being biased to a released position and movable to an attracted position in response to energization of said winding, a non-magnetic bracket secured to said heelpiece adjacent the free end of said second leg of said armature, spaced apart pole pieces secured to said bracket in such a position that said second leg of said armature swings toward said spaced apart pole

pieces when said armature is moved to its attracted position, a permanent magnet bridging said spaced apart pole pieces and establishing a magnetic circuit through the armature in its attracted position to magnetically latch it in such position, a core piece spanning the spaced apart pole pieces to establish a magnetic circuit parallel to the magnetic circuit through the armature, and a coil on said core piece effective when energized to produce in the core piece magnetic flux strengthening that set up therein by the permanent magnet and sufficient to reduce the flux in the circuit through the armature to an extent allowing release thereof.

5. In a tractive armature relay including a relay frame and an operating coil, a latch arrangement comprising a permanent magnet, spaced apart pole pieces abutting said magnet, said magnet exerting on the armature in its energized position an attractive force sufficient to hold said armature in that position, a core piece spanning said pole pieces to establish a magnetic circuit parallel with the magnetic circuit through the armature, an electromagnetic release coil mounted on said core piece which coil is additional to said operating coil and which is energizable to produce a magnetic flux in said core piece strengthening that flux set up in said core piece by said permanent magnet to an extent sufficient to allow release of said armature, two pole faces on each of said pole pieces, said pole faces on each pole piece being disposed on opposite sides of said armature, one pair of said pole faces cooperating with the upper surface of said armature in the energized position thereof and the other pair of pole faces cooperating with the lower surface in the released position thereof such that in either position said armature is subject to a holding force due to said permanent magnet, the holding force effective in the energized position being overcome by energization of said release coil and the holding force effective in the released position being overcome by the force which acts on said armature when said operating coil is energized.

6. In an electrical relay including a tractive armature, a latch arrangement comprising a permanent magnet and associated members of magnetizable material, a bracket adapted for mounting said permanent magnet and associated members in substantial magnetic isolation from said relay frame, said permanent magnet and associated members being mounted on said bracket together so as to constitute with said armature, a magnetic circuit including a shunt path for said permanent magnet, and a release coil on one of said associated members, said release coil being energizable to produce a magnetic flux opposing that due to the permanent magnet.



7. A magnetic latch comprising a non-magnetic bracket, a pair of spaced apart pole pieces secured to said bracket, a permanent magnet bridging the said pair of spaced apart pole pieces, a core piece spanning said spaced apart pole pieces, and a trip coil mounted on said core piece.

8. A magnetic latch comprising in combination a non-magnetic bracket, a pair of spaced apart pole pieces secured to said bracket, a permanent magnet bridging said spaced apart pole pieces, a core piece spanning said spaced apart pole pieces, and a trip coil mounted on said core piece and effective when selectively energized to produce in the core piece a flux strengthening that set up thereby the permanent magnet.

9. In a tractive armature relay including a relay frame and an operating coil, a latch arrangement comprising a pair of L-shaped bracket members mounted on said relay frame, magnetic isolation shims interposed between said bracket members and said frame, a pole piece member mounted on each of said L-shaped brackets such as to form a channel between the horizontal portion of said L-shaped bracket and said pole piece member, a portion of said armature extending into said channel, a permanent magnet extending between said pole piece members and arranged to exert on the armature in its energized position an attractive force sufficient to hold said armature toward the side of the channel formed by said pole piece members, a core piece mounted between said pole pieces to establish a magnetic circuit parallel with the magnetic circuit through the armature, an electromagnetic release coil additional to said operating coil mounted on said core piece, said release coil being energizable to produce in said core piece a magnetic flux strengthening that flux set up in said core piece by said permanent magnet and sufficient to allow release of said armature, and said permanent magnet providing an attractive force for said armature in its released position which force tends to hold said armature toward the side of the channel formed by said bracket.

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