March 19, 1963 W. R. BAUER Re. 25,351

ELECTROMAGNETIC RELAY AND ARMATURE THEREFOR

Original Filed Sept. 4, 1959

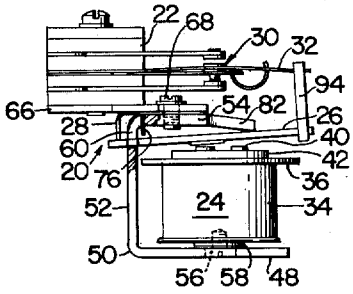


Fig. 1.

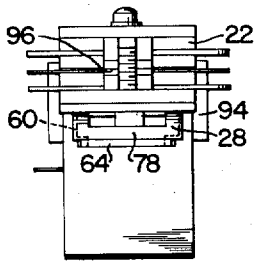


Fig. 2.

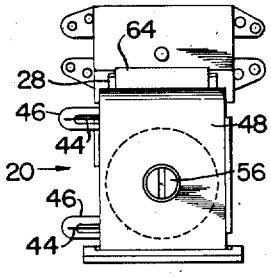


Fig. 3.

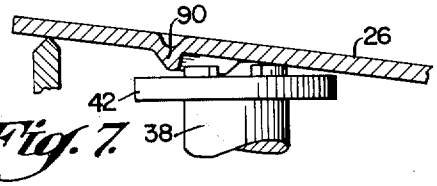


Fig. 7.

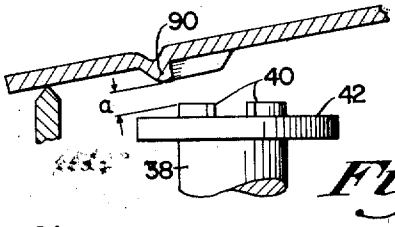


Fig. 8.

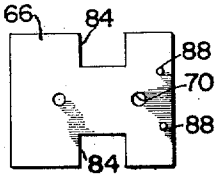


Fig. 4.

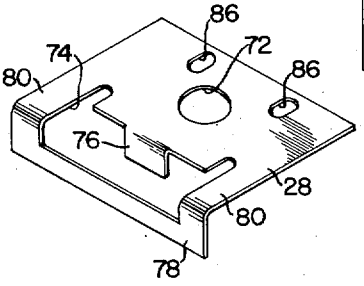


Fig. 5.

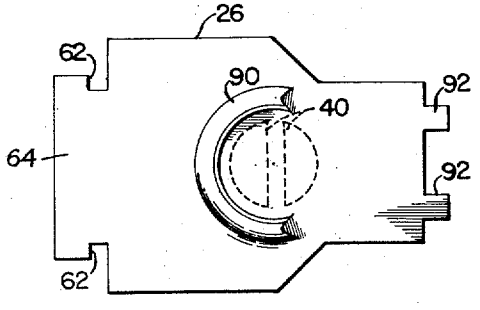


Fig. 6.

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ELECTROMAGNETIC RELAY AND ARMATURE THEREFOR

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12 Claims. (Cl. 200—87)

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

This invention relates to electromagnetic relays.

An electromagnetic relay is customarily comprised of a switch means which is movable between controlling positions in response to energization and deenergization of an electromagnet or solenoid. The electromagnet attracts an armature to cause movement of the switch means. To increase the attractive force acting upon the armature without increase in the energizing current, or to decrease the energizing current and hold the attractive force constant, it is desirable to reduce the resistance of the magnetic circuit in its most effective portion, e.g., the air gap. One method of accomplishing this would be to move the armature closer to the core of the coil assembly; however, this is not desirable in many instances since it might also reduce the amount of armature travel below that amount necessary to actuate the switch means. Accordingly, it is an object of this invention to reduce the magnetic resistance by reducing the air gap without adversely affecting mechanical movement of the armature.

Another object of this invention is to allow the attractive force to remain the same and yet reduce the energizing current.

Another object of this invention is to develop a better contact pressure by reducing the possibility of oscillations, which would normally be developed when using a coil spring for biasing the armature.

A further object of this invention is to allow the contact pressure to be adjusted so that the armature is balanced.

Still another object of this invention is to prevent side loading of the armature and biasing means from affecting the operation.

Other objects and advantages of this invention will be apparent from the following description taken in connection with the accompanying drawing wherein:

FIG. 1 is a front elevational view, with portions removed, of an embodiment of this invention;

FIG. 2 is an end elevational view of the device shown in FIG. 1;

FIG. 3 is a bottom plan view of the device shown in FIG. 1;

FIG. 4 is a bottom plan view of a detail;

FIG. 5 is a perspective view, on an enlarged scale, of another detail;

FIG. 6 is a bottom plan view on an enlarged scale, of still another detail; and

FIGS. 7 and 8 are somewhat schematic views of a portion of the device.

Referring now to the drawing and more particularly to FIGS. 1–3, a relay, indicated generally by reference numeral **20**, generally comprises a stacked switch assembly **22** operatively connected to be actuated by an electromagnet or solenoid **24** embodying an armature **26** and a spring **28**. Switch assembly **22** may include switch means of many forms. By way of example only and for the purposes of illustration, the switch means may take the form of one which operates on the principle

of the snap-acting device disclosed in U.S. Patent 2,558,258, Kohl, to which reference may be made for a more detailed description of the theory and principle of operation. As shown, switch assembly **22** includes an adjacent pair of such switch means, **30**, **30** disposed on both sides of switch assembly **22**. Each switch means **30** is a single pole, double throw, snap-acting switch which is movable between controlling positions in response to movement of an actuating lever **32**.

Coil assembly **24** is shown, by way of example only and for the purposes of illustration, in the form adapted to be energized by an alternating current. Coil assembly **24** comprises a coil **34** wound upon a plastic bobbin **36** into which a core **38** (FIGS. 7 and 8) is inserted. Core **38** is formed at its upper end into a pair of D-shaped pole pieces **40**. As illustrated by the dotted lines in FIG. 6, pole pieces **40** are separated slightly and are disposed in a back-to-back relationship. A shading coil **42** is provided with a pair of D-shaped apertures (not shown). During assembly, pole pieces **40** are inserted into these apertures and the corner portions of pole pieces **40** are upset to affix coil **42** to core **38**. The wire ends **44**, **44** of coil **34** are staked to terminals **46**, **46** mounted upon a portion of bobbin **36**.

Coil assembly **24** is attached to leg **48** of a metallic, U-shaped, magnetic frame **50**, comprising a medial section **52** and an upper leg **54**, by a screw **56** which extends through an aperture formed in leg **48** and which is screwed into a threaded aperture formed in the bottom end of core **38**. A brass washer **58** is disposed between leg **48** and core **38** to reduce residual magnetism.

Leg **54** intersects medial portion **52** at substantially a right angle. At this intersection, portion **52** is formed with a widened T-shaped aperture **60** which extends across a substantial portion of the width of portion **52**. Armature **26** is disposed within this aperture so that the reduced wall portion of the T-shaped aperture fits into a pair of slots **62**, **62** formed on the sides of armature **26** adjacent to the reduced width end **64**, to prevent longitudinal movement of armature **26**, yet permit armature **26** to pivot about frame **50**.

Switch assembly **22** includes a base plate **66** which is mounted upon frame **50** by a screw **68** which extends through an aperture **70** formed in base plate **66** and through an aperture **72** formed in spring **28** and which is screwed into a threaded aperture formed in leg **54**. Spring **28** is thus sandwiched between plate **66** and leg **54** and is formed with an aperture **74** so as to define a tab **76** and a U-shaped cantilever leaf spring having a tip **78** connected by side legs **80**, **80** to the main body portion.

As best seen in FIG. 5, tab **76** is bent at a right angle and extends downwardly towards armature **26** but terminates short thereof to provide means for preventing armature **26** from being separated from frame **50**. Legs **80**, **80** are also bent downwardly at right angles so that tip **78** engages end **64** to bias armature **26** counterclockwise, as viewed in FIG. 1, against stop means in the form of a tab **82** formed from leg **54**. Base plate **66** is formed with side slots **84**, **84** which overlie legs **80**, **80** to allow these legs to move upwardly upon clockwise movement of armature **26** from the position shown in FIGS. 1 and 8.

The width of tip **78** is greater than that of end **64**, as best seen in FIG. 3, to provide substantially a line contact whereby there will be an even application of armature **26** on frame **50**, even with side loading thereon. Spring **28** is thin and provides a short moment arm having a relatively small unsupported mass so that oscillation is held below that which would occur if a coil spring were used. To allow adjustment of this contact pressure, spring **28** is formed with a pair of slots **86**, **86**

into which a pair of lugs **88**, **88** formed on the underside of plate **66**, extend. By loosening screw **68**, spring **28** can be slid within limits to the desired position.

Armature **26**, as best seen in FIGS. 6–8, is formed with air gap reducing means in the form of an arcuate, preferably semi-circular, projection or ridge **90** which extends downwardly from the underside of armature **26** towards pole piece **40**. As shown in FIG. 8, armature **26** is in the unattracted position. Dimension "a" represents the air gap in the magnetic circuit. Ridge **90** is movable in an arcuate path but does not engage pole piece **40** to interfere with or hinder movement of armature **26**. When armature **26** is horizontal, an upward projection of pole piece **40** would intersect the armature substantially as shown by the dotted lines in FIG. 6.

In one embodiment, and by way of illustration only, the air gap is .023", as opposed to an air gap of .036" for similar armatures not provided with ridges. Ridge **90** is formed in a die so that, although it distorts the grain somewhat, it does not destroy the grain so as to change the magnetic flow. In the attracted position shown in FIG. 7, the lower portion of ridge **90** is below the level of the upper surface of pole piece **40** so as to partially encompass the same.

Armature **26** is provided with a pair of tabs **92**, **92** which are inserted through apertures formed in a connector **94** and which are upset to affix connector **94** to armature **26** for movement therewith. Connector **94** is constructed from relatively rigid insulation material and is also formed with a slot **96** (FIG. 2) into which the ends of actuating levers **32** are inserted.

In operation, the terminals of relay **20** are connected to the circuits to be controlled. When coil assembly **24** is deenergized, armature **26** is biased counterclockwise by spring **28**, as shown in FIG. 1, against tab **82**.

Subsequent energization of coil assembly **24** causes armature **26** to pivot clockwise until, as shown in FIG. 7, the underside of armature **26** engages the right hand portion of pole piece **40**. This movement causes end **64** to move tip **78** so that legs **80**, **80** move upwardly into slots **84**, **84**. This movement also causes connector **94** to move actuating lever **32** downwardly to cause switch means **30** to snap between positions. When coil assembly **24** is subsequently deenergized, spring **28** moves armature **26** and connector **94** so that switch means **30** snaps to its normal position.

It will be apparent that many changes may be made in the details of construction and arrangement of parts without departing from the scope of the invention as defined in the appended claims.

I claim:

1. A relay comprising: a U-shaped frame; a coil assembly mounted on one of the legs of said frame and extending towards the other leg but terminating short thereof; an armature pivoted on a portion of the medial section of said frame and extending between said coil assembly and said other leg, said armature being formed with air gap reducing means; a switch assembly including a base plate mounted on said other leg, said switch assembly further including switch means operatively connected to said armature; and spring means sandwiched between said other leg and said base plate and including a portion which abuts said armature to bias the same to a controlling position.

2. A relay comprising: a frame including first and second portions joined together to form a right angle, said portions being formed with an aperture; an armature having an end portion which extends through said aperture and being cooperable with said first portion to allow said armature to pivot and to restrain said armature from longitudinal movement; a base plate mounted on said second portion; a leaf spring mounted between said base plate and said second portion and being operatively connected to bias said armature in one direction, said spring including a tab which extends through said aperture and

prevents said armature from being separated from said frame.

3. The device of claim 2 wherein said base plate is formed with a pair of lugs and said spring is formed with a cooperating pair of apertures into which said lugs extend, said apertures being substantially larger than said lugs to allow said spring to be moved.

4. A relay comprising: a U-shaped frame; a coil assembly mounted on one of the legs of said frame and extending towards the other leg but terminating short thereof; an armature pivoted on a portion of the medial section of said frame and extending between said coil assembly and said other leg, said armature being formed with a semi-circular ridge which cooperates with said coil assembly to reduce the air gap and magnetic resistance; a switch assembly including a base plate mounted on said other leg, said switch assembly further including switch means operatively connected to said armature; and spring means operatively connected between said switch assembly and said frame and being constructed from relatively thin, flat spring material, said spring means being formed with a main body portion, a tab extending away from said main body portion and being adapted to prevent said armature from being removed from said frame, said spring means being formed with apertures therein for adjusting the position of said spring means, and said spring means having two narrow legs extending from said main body portion with each leg bent toward said armature at a point removed from said main body portion, a third leg joining the ends of said narrow legs removed from said main body with an edge of said third leg engaging said armature for biasing said armature toward a controlling position.

5. A relay comprising a coil, a core, a pole piece assembly on said core projecting axially from one end of said coil, an armature overlying said one end of said coil, means supporting said armature for pivotal movement toward and away from said one end of said coil between an unactuated position spaced from said pole piece assembly and an actuated position in contact with said pole piece assembly, switch means operatively coupled to said armature for actuation by said armature, and an air gap reducing ridge projecting from said armature toward said one end of said coil at a location such that said ridge partially encompasses said pole piece assembly in spaced relationship therewith when said armature is in said actuated position, said ridge defining the path of least magnetic resistance between said pole piece assembly and said armature when said armature is in said unactuated position.

6. A relay as defined in claim 5 wherein said means supporting said armature for pivotal movement comprises a frame, and means on said frame cooperable with means on said armature to support said armature for pivotal movement about an axis normal to the axis of said coil at a location spaced from one side of said coil at said one end thereof, said air gap reducing ridge being located between said axis and said pole piece assembly when said armature is in said actuated position.

7. In a relay having a frame, and a relay coil mounted on said frame; a relay armature having a flat portion at one end thereof, cooperating means on said frame and said armature supporting said armature for pivotal movement toward and away from one end of said coil about an axis extending transversely of said armature and parallel to the general plane of said flat portion at a location spaced inwardly of said armature from said one end thereof, a leaf spring member having a fixed end and a free end, said free end of said spring member terminating in a straight edge having a length at least equal to the transverse width of said flat portion of said armature, and means mounting said fixed end of said spring member upon said frame to locate said straight edge of said spring member in contact with said flat portion of said armature along a line extending transversely across said armature in parallel relationship to said axis at a location between said axis and said one end of said armature, the portion

of said leaf spring member intermediate said fixed end and said free end being constructed and arranged to resiliently bias said armature away from said one end of said coil.

8. A relay comprising a coil, a core, a pole piece assembly on said core projecting axially from one end of said coil, an armature overlying said one end of said coil, means supporting said armature for movement toward and away from said one end of said coil between an unactuated position spaced from said pole piece assembly and an actuated position in contact with said pole piece assembly, a device operatively coupled to said armature for actuation by said armature, and an air gap reducing ridge projecting from said armature toward said one end of said coil at a location such that said ridge encompasses a portion of said pole piece assembly in spaced relationship therewith when said armature is in actuated position, said ridge defining the path of least magnetic resistance between said pole piece assembly and said armature when said armature is in said unactuated position.

9. A relay as defined in claim 8 wherein said means supporting said armature for movement comprises a frame, and means on said frame cooperable with means on said armature to support said armature for pivotal movement about an axis normal to the axis of said coil at a location spaced from one side of said coil at said one end thereof, said air gap reducing ridge being located between said axis and said pole piece assembly when said armature is in said actuated position.

10. A relay as defined in claim 8 in which said ridge is formed in a die on said armature so it does not destroy the grain sufficiently to change the magnetic flow.

11. A relay comprising a coil, a core, a pole piece assembly on said core projecting axially from one end of said coil, an armature overlying said one end of said coil, means supporting said armature for movement toward and away from said one end of said coil between an unactuated position spaced a relatively large distance from said pole piece assembly and an actuated position in which said armature is in relatively close relationship to said pole piece assembly, a device operatively coupled to said armature for actuation by said armature, and an air gap reducing ridge projecting from said armature toward said one end of said coil at a location such that said ridge overlaps a portion of said pole piece assembly when said armature is in actuated position, said ridge defining the path of least magnetic resistance between said pole piece assembly and said armature when said armature is in said unactuated position.

12. A relay comprising a coil, a core, a pole piece assembly on said core projecting axially from one end of said coil, an armature overlying said one end of said coil, means supporting said armature for movement toward and away from said one end of said coil between an unactuated position spaced a relatively large distance from said pole piece assembly and an actuated position in which said armature is in relatively close relationship to said pole piece assembly, and an air gap reducing ridge on said armature extending toward said one end of said coil at a location such that said ridge overlaps a portion of said pole piece assembly when said armature is in actuated position, said ridge defining the path of least magnetic resistance between said pole piece assembly and said armature when said armature is in said unactuated position.

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