May 11, 1954 F. O. SMELTZ 2,678,412

ELECTROMAGNETIC RELAY WITH ADJUSTABLE MAGNETIC SHUNT

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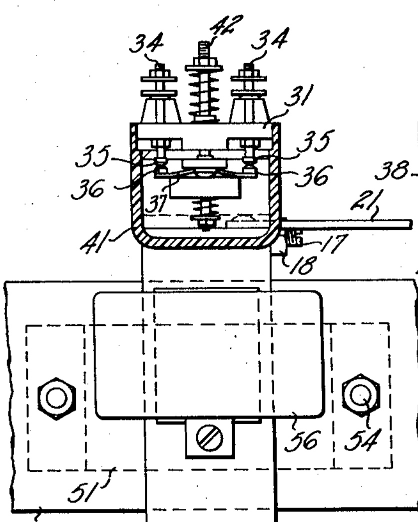

Fig. 2

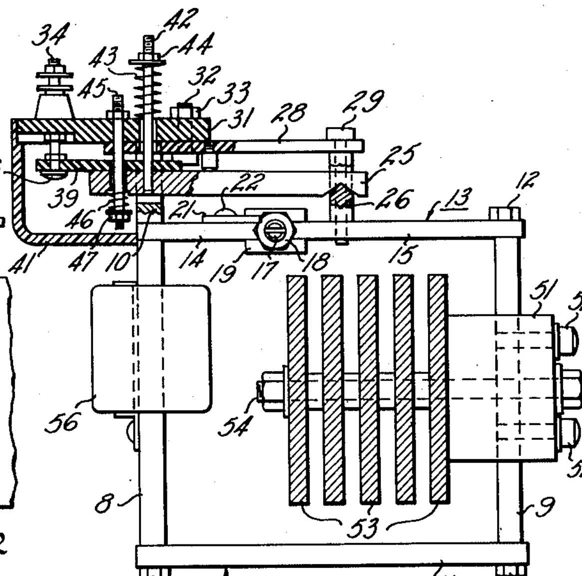

Fig. 1

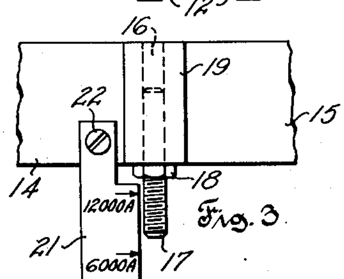

Fig. 3

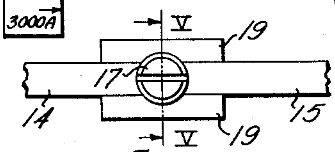

Fig. 4

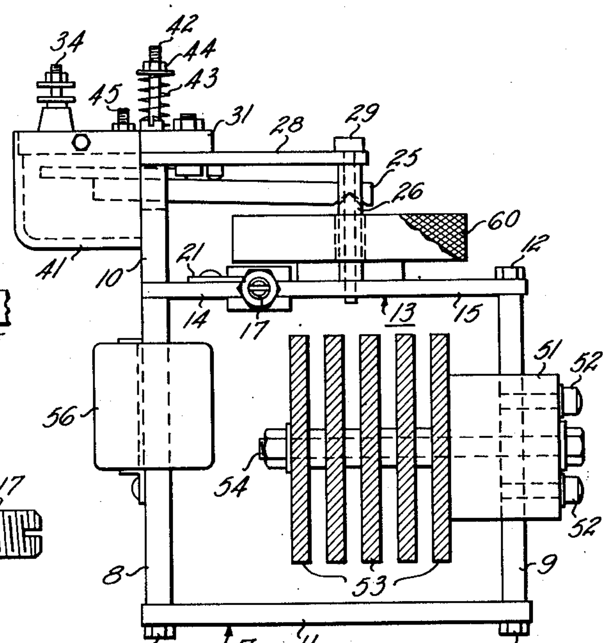

Fig. 6

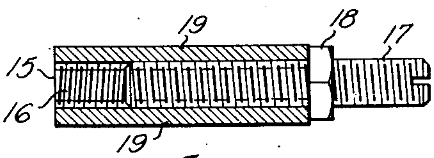

Fig. 5

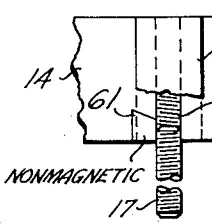

Fig. 7

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ELECTROMAGNETIC RELAY WITH ADJUSTABLE MAGNETIC SHUNT

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6 Claims. (Cl. 317—177)

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This invention relates in general to electromagnetic relays and in particular to electromagnetic relays utilizing magnetic shunts.

It is well known in electromagnetic relays to utilize an adjustable magnetic member in shunt with the magnetic working gap for the purpose of causing the relay to operate or trip at any prescribed value of magnetomotive force within the adjusting range of the relay. However, magnetic shunts differ in physical construction and method of reluctance adjustment. Ordinarily reluctance adjustment of the shunt is accomplished by changing the length of an included shunt magnetic air gap. In simple form such shunts comprise a magnetic member having a plane surface movable in a direction which is essentially parallel to the direction of shunted flux. That is, the shunting member is movable toward or away from a pole piece of the relay. Such construction has the disadvantage that the fineness of adjustment obtainable is very limited, since if the shunting member is quite distant from the pole piece with respect to the shunted member, the position of the shunting member is without appericable effect on the division of flux between the shunting member and shunted member. Conversely, if the shunting member is quite close to the pole piece with respect to the position of the shunted member, a small change in the position of the shunting member produces a very large change in the division of flux between the shunting member and shunted member. This results generally in insensitive control and an undesirable, nonlinear relationship between the travel of the shunting member and the total actuating magnetomotive force, thereby rendering calibration of the relay difficult.

This disadvantage may be overcome by utilizing a relay in which the magnetic shunt comprises a member of adjustable magnetic cross section normal to the direction of shunted flux. Such a magnetic shunt depends upon the saturation of the member of adjustable cross section to control the division of flux between the shunting and shunted members. Such a magnetic shunt in addition, may utilize an included, adjustable magnetic air gap to aid in controlling the division of flux between the shunting and shunted members. Thus, a relay may be utilized which comprises a magnetic shunt providing a very wide range of reluctance adjustment relative to the reluctance of the shunted member, providing a very precise control of shunt reluctance and thus a precise control over total relay actuating magnetomotive force, and having an adjustment characteristic which is substantially linear.

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It is therefore an object of this invention to provide an improved electromagnetic relay having an adjustable magnetic shunt.

It is a further object of the present invention to provide an electromagnetic relay having an adjustable magnetic shunt which produces a substantially linear relationship between the movement of a shunting member and an operating characteristic of the relay.

It is a further object of the present invention to provide an electromagnetic relay having an adjustable magnetic shunt which provides for a high sensitivity of adjustment over a very wide range of total adjustment.

It is an additional object of this invention to provide an improved electromagnetic relay having an adjustable magnetic shunt provided with indicating means for indicating an operating characteristic of the relay.

Objects and advantages other than those set forth above will be apparent from the following description when read in connection with the accompanying drawing, in which:

Fig. 1 is a side elevation, partly in section, of one embodiment of the invention utilizing an electromagnetic biasing coil in the main magnetic path;

Fig. 2 is a front view of the relay shown in Fig. 1 with a portion of the contact cover broken away;

Fig. 3 is a plan view of a portion of the relay illustrating the indicating device;

Fig. 4 is an enlarged side view of a portion of the adjustable magnetic shunt;

Fig. 5 is a vertical section taken along the line V—V of Fig. 4;

Fig. 6 is a side elevation of an alternate embodiment of the invention utilizing an electromagnetic biasing coil in a shunted magnetic path; and

Fig. 7 is a view of a portion of an additional alternate embodiment of the invention utilizing an included shunt air gap.

Referring more particularly to the drawing by character of reference, the preferred embodiment of the invention illustrated in Figs. 1 to 5, comprises a U-shaped magnetic yoke 7 having two spaced legs 8, 9 and a base member 11. The yoke 7 is held together by suitable screws 12. Extending across the upper ends of legs 8, 9 is a magnetic briding member 13 comprising a pair of magnetic members 14, 15 secured to legs 8, 9, respectively, and separated by an air gap 16 (Fig. 3).

Suitable adjustable magnetic means are provided to vary the reluctance of the magnetic path including member 14 and a portion of member 15 to vary operating characteristics of the relay, and such means may comprise a magnetic screw 17. If screw 17 is utilized, the end of members 14, 15 adjacent air gap 16 are tapped to provide a tapped opening in which screw 17 moves to vary the reluctance between magnetic members 14 and 15. Screw 17 may be provided with a lock nut 18 to prevent undesired movement of the screw. If additional rigidity of members 14, 15 is desired, pieces or blocks 19 of suitable nonmagnetic material, such as brass, may be secured to the ends of members 14, 15 adjacent air gap 16 by any suitable means such as resistance welding. Blocks 19 are preferably tapped in conjunction with members 14, 15 to provide tapped top and bottom walls for the tapped opening between members 14, 15.

A suitable calibrated scale 21 is associated with screw 17 to indicate variations in an operating characteristic of the relay in dependence upon the position of screw 17. As shown, scale 21 is secured to member 14 by a screw 22 and is calibrated in terms of the current required to operate the relay.

The relay further comprises an armature 25 having one end thereof disposed adjacent to, and attractable toward, the pole piece formed by an extension piece 10 mounted on bridging member 13 in alignment with leg 8. Suitable pivot means are provided to pivotally support armature 25, and such means may comprise a knife edge member 26 secured to member 15 between core leg 9 and magnetic screw 17. A support member 28 of nonmagnetic material is secured to member 15 through a nonmagnetic spacer by screws 29 and is secured to leg 8 by suitable means (not shown) to provide support for a terminal board 31. Terminal board 31 is secured to support member 28 by bolts 32 and nuts 33 and is provided with at least two stationary terminal studs 34 to be connected to a circuit to be controlled and having at the lower ends thereof fixed contacts 35.

Contacts 35 are adapted to engage a pair of movable contacts 36 carried by a flexible conducting member 37 secured to the end of armature 25 by a screw 38 and an insulating support member 39. The fixed and movable contact assemblies may be enclosed in any suitable dust-tight member, such as a transparent cover 41 secured to terminal board 31. A stud 42 having a spring 43 compressed between board 31 and an adjusting nut 44 extends loosely through terminal board 31 and is secured to armature 25 to control the pickup characteristics of the relay. A similar stud 45 having a spring 46 compressed between armature 25 and an adjusting nut 47 extends loosely through an opening in armature 25 and is secured to terminal board 31 to control the drop-out characteristics of the relay. When the armature 25 is not attracted toward extension 10, spring 46 is not compressed, so that only spring 43 holds armature 25 in the deenergized position. When armature 25 is attracted toward the pole piece formed by extension 10, spring 46 is compressed so that the force of this spring is added to the force exerted by spring 43 to produce the desired combined spring characteristic.

The relay may be mounted in any suitable manner, and if the relay is to be utilized as a through conductor relay, a mounting bracket 51 secured to core leg 9 by screws 52 may be provided. Bracket 51 is secured to a conductor or conductors, represented by bus bar sections 53, by an insulated bolt 54. Bus bar sections 53 provide parallel paths for the current which it is desired to control and represent energizing means for producing flux in the relay core. If desired, an electromagnetic coil 56 may be provided on the relay core to produce a biasing magnetomotive force in addition to the magnetomotive force produced by the current in bus sections 53.

In operation as a through current relay, the relay is secured to bus sections 53 which carry the current to be controlled. The flux produced in the relay travels through leg 9, member 11 and leg 8 and then comes to a junction providing two parallel magnetic paths. The first such path includes the extension 10 of leg 8, the working air gap between this extension and armature 25, armature 25 and pivot means 26 to member 15. The second magnetic path includes the adjustable magnetic shunt and comprises member 14, the air gap 16 and screw 17 between members 14 and 15 to member 15.

The division of flux between these two magnetic paths depends upon the relative permeances of the paths, and by adjusting the position of screw 17 in the air gap, the permeance of the second magnetic path may be varied over a wide range. As screw 17 is advanced in the threaded opening, the permeance of the second path is increased to increase the flux in the second path. Thus, by adjustment of screw 17, the current in bus sections 53 or coil 56 at which armature 25 is attracted toward leg 8 is varied to produce operation of the relay at any desired value of magnetomotive force. Screw 17 advances in a direction transverse to the direction of flux in members 14 and 15 increasing the effective cross sectional area of the magnetic path across air gap 16 so that the permeance of the shunt path varies substantially linearly with respect to the advance of screw 17. Thus a substantially linear relationship exists between the travel of the screw 17 and the net magnetomotive force acting upon the relay core at which armature 25 is attracted. The portion of the screw 17 which is engaged in the air gap 16 forms the saturable section of variable cross section mentioned above.

Fig. 6 illustrates an alternate embodiment of the invention in which coil 56 of Fig. 1 has been replaced or supplemented by a coil 60 encircling pivot means 26. Pivot means 26 and extension 10 have been increased in length so as to accommodate coil 60 between armature 25 and member 13.

The effect on the relay shown in Fig. 6 of a given number of ampere turns in coil 60 is greater than the effect of the same number of ampere turns in bus sections 53 or of coil 56 in Fig. 1, since in Fig. 6 coil 60 is in the working magnetic circuit which is traversed by only a portion of the flux produced by the current in bus sections 53 or coil 56. The relay shown in Fig. 6 will trip at a number of ampere turns in coil 60 which is substantially independent of the position of screw 17 and which is always equal to or less than the number of ampere turns in coil 56 or bus sections 53 at which the relay is tripped.

It will be obvious that by suitable modifications, coil 60 may be disposed in other suitable locations in the working magnetic path, such as on extension 10 or around armature 25.

Fig. 7 illustrates an additional alternate embodiment of the invention in which a piece or insert 61 of suitable nonmagnetic material, such as brass, is provided in a portion of the edge of member 14 adjacent air gap 16 and adjacent to the unadvanced position of screw 17. Insert 61 is utilized when it is desired to employ adjustment of an included shunt air gap in addition to adjustment of a magnetic cross section of a portion of the shunt path. Since screw 17 must be advanced a predetermined minimum distance in the tapped opening in order to retain the screw in the opening, use of insert 61 permits a lower permeance to be obtained at the predetermined minimum advance of screw 17.

Although but three embodiments have been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

It is claimed and desired to secure by Letters Patent:

1. An electromagnetic relay comprising a U-shaped magnetic core having first and second legs defining a passage for the insertion of a current carrying conductor, a magnetic bridging member secured across said core legs, a magnetic armature having one end thereof disposed adjacent to said first core leg, pivot means for pivotally mounting said armature on said bridging member, said armature and said pivot means forming a first magnetic path, the portion of said bridging member disposed between said first core leg and said pivot means forming a second magnetic path in parallel with said first path, and adjustable magnetic means in said bridging member for varying the magnetic reluctance of said second magnetic path to vary the division of flux between said first and second magnetic paths.

2. An electromagnetic relay comprising a U-shaped magnetic core having first and second legs defining a passage for the insertion of a current carrying conductor, a magnetic bridging member secured across said core legs, a magnetic armature having one end thereof disposed adjacent to said first core leg, pivot means for pivotally mounting the other end of said armature on said bridging member, said armature and said pivot means forming a first magnetic path, the portion of said bridging member disposed between said first core leg and said pivot means forming a second magnetic path in parallel with said first path, adjustable magnetic means in said bridging member for varying the magnetic reluctance of said second magnetic path to vary the division of flux between said first and second magnetic paths, and a calibrated scale associated with said magnetic means for indicating variations in an operating characteristic of said relay in dependence upon the position of said adjustable magnetic means.

3. An electromagnetic relay comprising a U-shaped magnetic core having first and second legs defining a passage for the insertion of a current carrying conductor, a magnetic bridging member secured across said core legs, said bridging member comprising a pair of magnetic members separated by an air gap, the ends of said members adjacent said air gap having tapped surfaces to provide a tapped opening, a magnetic armature having one end thereof disposed adjacent to said first core leg, pivot means disposed on said bridging member between said second core leg and said opening for pivotally mounting the other end of said armature, said armature and said pivot means forming a first magnetic path, the portion of said bridging member disposed between said first core leg and said pivot means forming a second magnetic path in parallel with said first path, and a magnetic ferrous threaded member engaged in said tapped opening to vary the effective cross sectional area of the ferrous magnetic path provided by said threaded member, whereby movement of said threaded member varies the permeance of said second magnetic path to vary the division of flux between said first and second magnetic paths.

4. An electromagnetic relay comprising a U-shaped magnetic core having first and second legs defining a passage for the insertion of a current carrying conductor, a magnetic bridging member secured across said core legs, said bridging member comprising a pair of magnetic members separated by an air gap, the ends of said members adjacent said air gap having tapped surfaces to provide a tapped opening, a magnetic armature having one end thereof disposed adjacent to said first core leg, pivot means disposed on said bridging member between said second core leg and said opening for pivotally mounting the other end of said armature, said armature and said pivot means forming a first magnetic path, the portion of said bridging member disposed between said first core leg and said pivot means forming a second magnetic path in parallel with said first path, a ferrous threaded member engaged in said tapped opening to vary the effective cross sectional area of the ferrous magnetic path provided by said threaded member in said air gap, whereby movement of said threaded member varies the magnetic permeance of said second magnetic path to vary the division of flux between said first and second magnetic paths, and a calibrated scale adjacent said threaded member for indicating variations of an operating characteristic of said relay in dependence upon the position of said threaded member.

5. An electromagnetic relay comprising a U-shaped magnetic core having first and second legs defining a passage for the insertion of a current carrying conductor, a magnetic bridging member secured across said core legs, said bridging member comprising a pair of magnetic members separated by an air gap, a pair of nonmagnetic blocks secured to the ends of said magnetic members adjacent said air gap to secure said magnetic members together, the portions of said blocks adjacent said air gap and the ends of said members adjacent said air gap having tapped surfaces to provide a tapped opening, a magnetic armature having one end thereof disposed adjacent to said first core leg, pivot means disposed on said bridging member between said second core leg and said opening for pivotally mounting the other end of said armature, said armature and said pivot means forming a first magnetic path, the portion of said bridging member disposed between said first core leg and said pivot means forming a second magnetic path in parallel with said first path, and a ferrous threaded member engaged in said tapped opening to vary the effective cross sectional area of the ferrous magnetic path provided by said threaded member in said air gap, whereby movement of said threaded member varies the magnetic permeance of said second magnetic path to vary the division of flux between said first and second magnetic paths.

6. An electromagnetic relay comprising a U-shaped magnetic core having first and second legs defining a passage for the insertion of a current carrying conductor, a magnetic bridging

member secured across said core legs, said bridging member comprising a pair of magnetic members separated by an air gap, a pair of nonmagnetic blocks secured to the ends of said magnetic members adjacent said air gap to secure said magnetic members together, the portions of said blocks adjacent said air gap and the ends of said members adjacent said air gap having tapped surfaces to provide a tapped opening, a magnetic armature having one end thereof disposed adjacent to said first core leg, pivot means disposed on said bridging member between said second core leg and said opening for pivotally mounting the other end of said armature, said armature and said pivot means forming a first magnetic path, the portion of said bridging member disposed between said first core leg and said pivot means forming a second magnetic path in parallel with said first path, a ferrous threaded member engaged in said tapped opening to vary the effective cross sectional area of the magnetic path provided by said ferrous member in said air gap, whereby movement of said ferrous member varies the magnetic permeance of said second magnetic path to vary the division of flux between said first and second magnetic paths, and a calibrated scale adjacent said ferrous member for indicating variations of an operating characteristic of said relay in dependence upon the position of said ferrous member.

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