July 12, 1949. C. F. COAKE 2,475,819

MAGNETIC LIMIT SWITCH

Filed Feb. 24, 1945 2 Sheets-Sheet 1

Fig. 1.

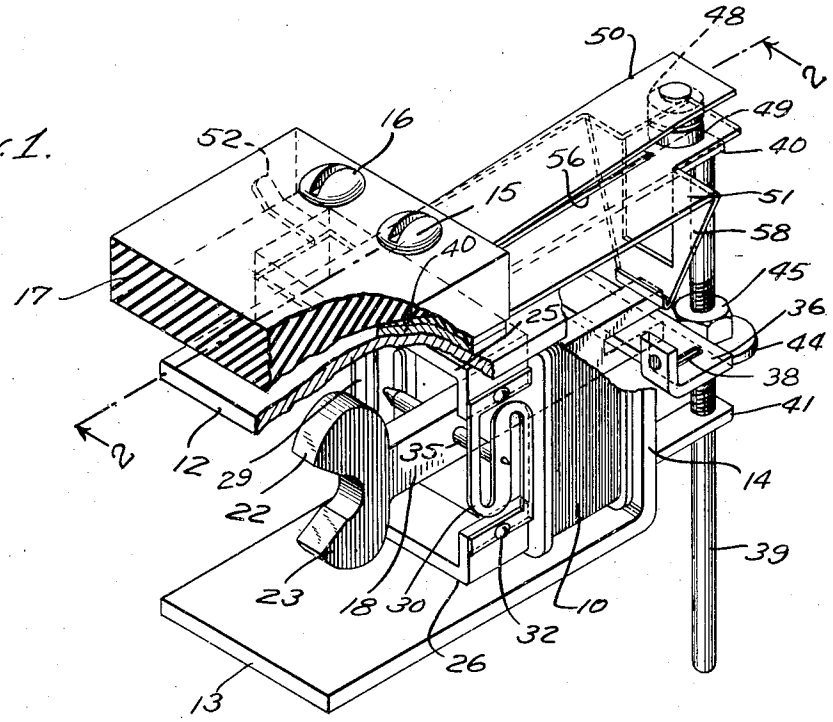
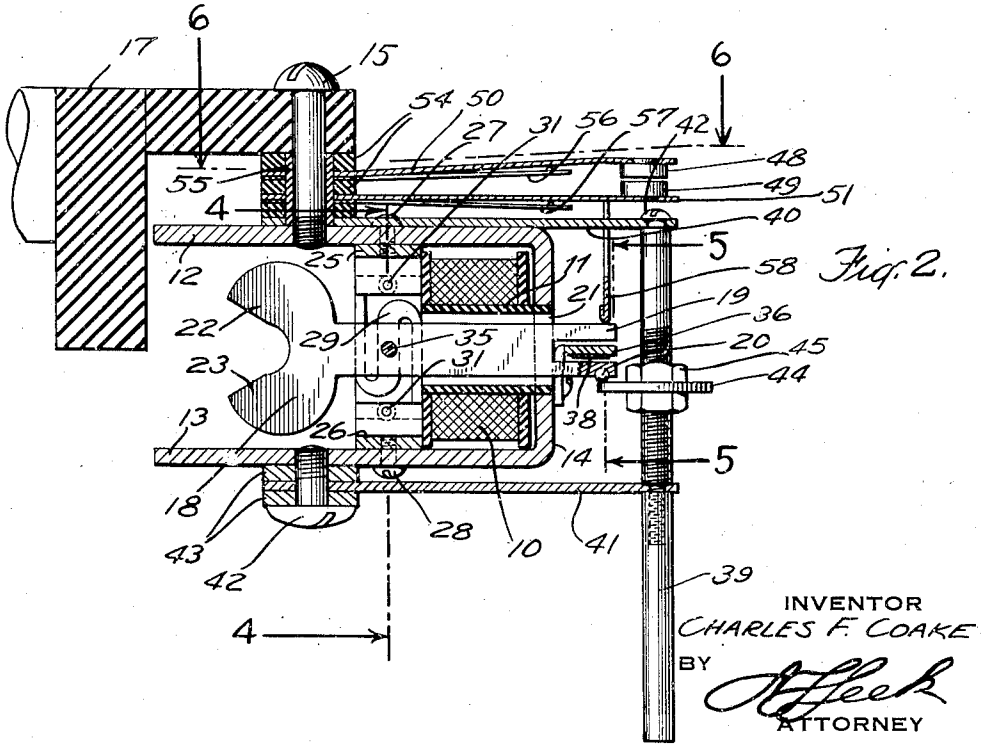


Fig. 2.



INVENTOR
CHARLES F. COAKE
BY
ATTORNEY

July 12, 1949. C. F. COAKE 2,475,819

MAGNETIC LIMIT SWITCH

Filed Feb. 24, 1945 2 Sheets-Sheet 2

Fig. 3.

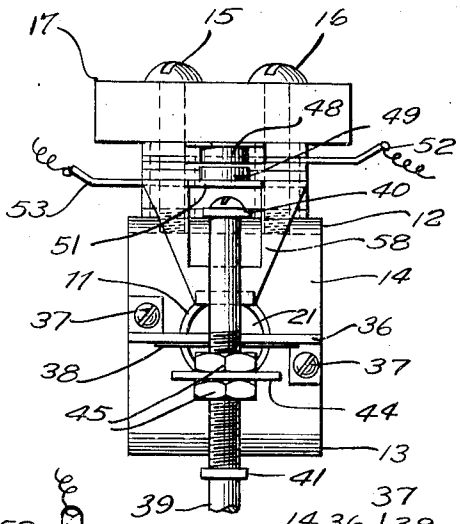
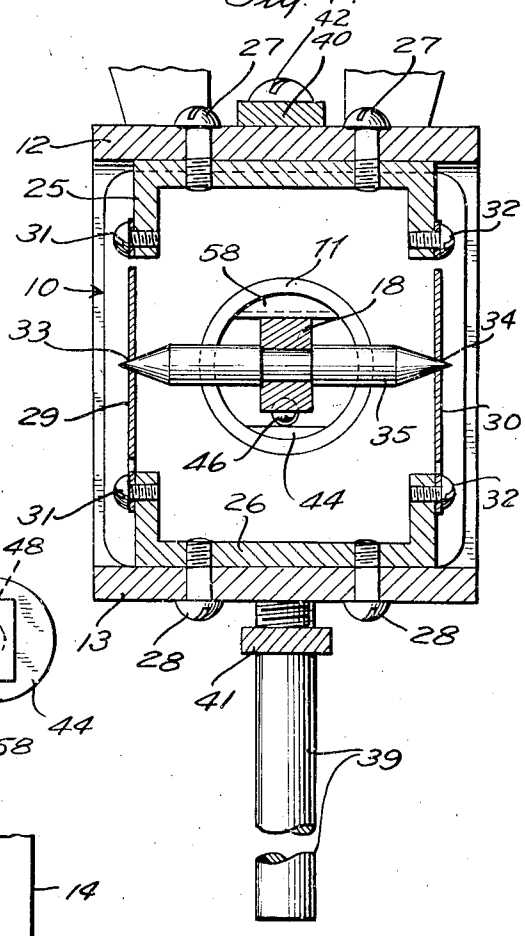


Fig. 4.



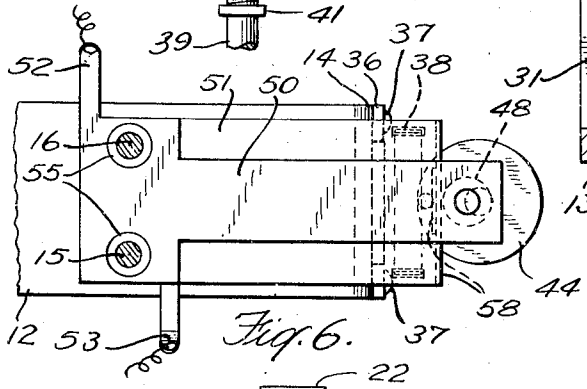


Fig. 6.

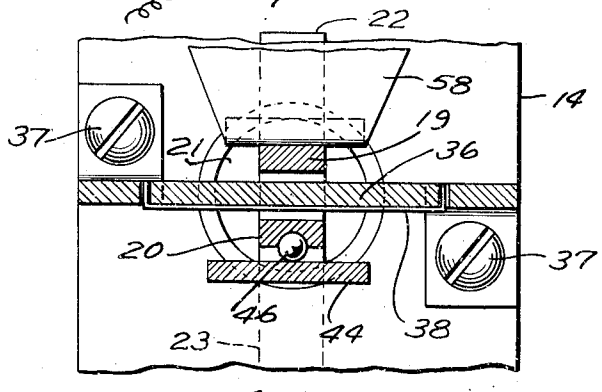


Fig. 5.

INVENTOR
CHARLES F. COAKE
BY
ATTORNEY

Patented July 12, 1949

2,475,819

UNITED STATES PATENT OFFICE

2,475,819

MAGNETIC LIMIT SWITCH

Charles F. Coake, Indianapolis, Ind., assignor to Senn Corporation, New Augusta, Ind., a corporation of Indiana

Application February 24, 1945, Serial No. 579,629

15 Claims. (Cl. 200—87)

1

This invention relates to a micro-gauge limit switch and it has for its object to provide a novel and improved device of this type.

Another object of the invention is to provide an extremely sensitive, positive-acting magnetic snap switch for detecting minute variations from a standard limit of comparison.

Another object is to provide a simple and efficient micro-gauge limit switch of the above type having novel and improved details of construction and features of operation.

Various other objects and advantages will be apparent as the nature of the invention is more fully disclosed.

The limit switch of my invention is particularly adapted for the testing of production items which must conform within a close limit of tolerance with a given standard of measurement. The switch disclosed herein to illustrate the invention includes a stylus which is adapted to be actuated by the item being tested and which is connected to close a snap contact in response to any variations beyond the predetermined limit of tolerance.

The micro-gauge limit switch itself preferably comprises a magnetic circuit containing an armature which is delicately balanced on self-adjusting bearings and cooperates with a magnetic frame which provides two normally balanced return paths for the magnetic flux passing through the armature. The gauge stylus is supported on springs in an upright position and is provided with an adjustable flange which is adapted to engage beneath the armature and to move the armature upwardly in response to movement of the stylus.

In one embodiment the armature is provided with a bifurcated end and a stationary cross bar forming a part of the magnetic return path extends between the upper and lower prongs of the forked armature. When the armature is in a position such that the prongs are spaced equally from this cross bar, the magnetic flux through the two prongs will be in a state of balance. However, when the gauge stylus rises ever so slightly it will cause a corresponding movement of the armature which will upset the magnetic balance and cause the armature to snap to a limiting position with the lower prong in engagement with the cross bar. A contact is actuated by the armature to close an indicator circuit which will inform the operator of the defect in the article under test. Production parts may thus be rapidly and accurately tested by an unskilled operator, the warning signal indicating that the part is to be discarded.

The contacts remain open until the magnetic balance is upset, whereupon they close with a snap action. Hence chattering or other uncertainty in operation is eliminated.

2

Although the novel features which are characteristic of this invention are set forth more in detail in the claims appended hereto, the nature and scope of the invention may be better understood by referring to the following description, taken in connection with the accompanying drawings forming a part thereof, in which a specific embodiment has been set forth for purposes of illustration.

In the drawings:

Fig. 1 is a broken perspective view of a micro-gauge limit switch embodying the invention;

Fig. 2 is a longitudinal sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is a front end elevation of the device;

Fig. 4 is an enlarged transverse sectional view taken on the line 4—4 of Fig. 2;

Fig. 5 is a transverse sectional view taken on the line 5—5 of Fig. 2; and Fig. 6 is a section taken on the line 6—6 of Fig. 2.

In the following description certain specific terms are used for convenience in referring to the various details of the invention. These terms, however, are to be interpreted as broadly as the state of the art will permit.

The micro-gauge limit switch shown in the drawings comprises an electromagnet coil 10 mounted on a hollow support 11 and secured to a U-shaped frame of magnetic material which has parallel upper and lower horizontal branches 12 and 13 joined by an end portion 14 and is supported by screws 15 and 16 on a suitable bracket 17.

An armature 18 is mounted centrally in the coil 10 and has its forward end bifurcated to provide spaced upper and lower prongs 19 and 20 extending outwardly through a circular opening 21 in the end portion 14 of the frame and having ears 22 and 23 at its rear end arranged in proximity to the branches 12 and 13, respectively, of the frame to form a part of the magnetic circuit. The support for the armature 18 includes a pair of flanged brackets 25 and 26 which are secured to the branches 12 and 13 of the frame by means of screws 27 and 28, respectively. The end flanges of these brackets face each other, and flat convoluted resilient springs 29 and 30 are secured to the opposed flanges by means of screws 31 and 32, respectively. The springs 29 and 30 are S-shaped to provide increased compliance and the central portions thereof contain aligned tapered conical indentations 33 and 34, respectively. In these indentations are journaled the pointed ends of a pintle or arbor 35 which is secured to and thus supports the armature 18. The springs 29 and 30 are flexed slightly toward each other so that the armature pintle 35 will maintain its delicately balanced mounting and will be self-adjusting to compensate for wear.

A flat stationary cross bar 36 is secured to the

frame of the electromagnet by screws 37 and extends between the upper and lower prongs 19 and 20 of armature 18 in such position that said prongs will be equidistant from said cross bar, as shown in Figs. 2 and 5 when the armature 18 is in its mid-position. The lower face of cross bar 36 has a facing 38 of non-magnetic material such as copper to prevent the lower prong 20 of the armature from sticking thereto due to residual magnetism.

A vertical gauge stylus 39 is flexibly supported by leaf springs 40 and 41 which are secured to the respective upper and lower branches 12 and 13 of the magnetic frame by screws 15, 16 and 42, the spring 41 being spaced from the magnetic frame by suitable washers 43 as shown in Figs. 1, 2 and 4. The stylus 39 carries a flange or washer 44 which is adjustably clamped thereon by threaded nuts 45, and this flange 44 engages a ball 46 which is secured to the underside of the lower prong 20 of the armature 18, as shown in Figs. 2 and 5.

The contact members 48 and 49 for closing the indicator circuit (not shown) are carried by contact springs 50 and 51 respectively, which are provided with T ends secured between bracket 17 and the upper branch 12 of the frame by the screws 15 and 16. Contact springs 50 and 51 are provided with terminals 52 and 53 respectively and are insulated from the frame by suitable insulating washers 54 and from the screws 15 and 16 by insulating bushings 55. The terminals 52 and 53 are connected to any suitable visual or audible signaling system. Stop members 56 and 57 may be associated with the contact springs 50 and 51 respectively, and may be adjusted for properly positioning same.

The lower contact spring 51 has a portion of its forward surface stamped out and bent downwardly to provide a depending lip 58 which lightly engages the top face of the upper prong 19 of the bifurcated armature 18, as best shown in Fig. 2. Accordingly, when the armature 18 is turned upon its pivot in a counter-clockwise direction as viewed in Fig. 2, until the lower prong 20 of the armature strikes the non-magnetic liner 38 of the stationary cross bar 36, the upper prong 19 of the armature will raise the depending lip 58 of contact spring 51, thus causing contact member 49 to engage the contact member 48 and close the energizing circuit of the alarm system. The magnetic attraction will hold the armature in this circuit closing position until forcibly returned or until the coil 10 is deenergized.

In operating the micro-gauge limit switch described above, let it be assumed that the stylus 39 is adjusted to gauge the thickness of a series of articles which are supposed to conform to a certain standard within "a predetermined" limit of tolerance. The micro-gauge in this instance is intended to pass all the articles which do not exceed the limit of tolerance, and to give a warning signal or alarm in the case of any article which does exceed the limit even to an infinitesimal degree so that such faulty article may be discarded. In carrying out the test, the articles are successively placed beneath the lower end of the stylus 39 in any suitable manner, not shown herein, and the gauge is adjusted by the nuts 45 or by setting the bracket 17 so that at the limit of tolerance the armature 18 is in balanced position with the prongs 19 and 20 spaced equally from the stationary cross bar 36 as shown in Figs. 2 and 5. In this position the magnetic flux set up by coil 10 flows from the armature 18 through both prongs 19 and 20 equally to the magnetic cross bar 36 and then through the upper and lower branches 12 and 13 of the frame which constitute magnetic return paths to ears 22 and 23 of the armature. At such time, therefore, the magnetic flux through the two paths will be in a state of balance, and this balance will not be disturbed when an article not exceeding the predetermined limit of tolerance is placed beneath the lower end of the stylus 39.

However, when an oversize article is placed beneath the lower end of stylus 39, even though the excess thickness of the article may be infinitesimal, it will cause the stylus to rise slightly beyond its mid-position and the stylus, through its flange 44 and contact ball 46, will cause a corresponding very slight tipping of the armature 18 in a counter-clockwise direction as viewed in Fig. 2. This movement will upset the magnetic balance of the gauge and the magnetic pull of the cross bar 36 becomes greater on the lower prong 20 and will cause the armature 18 to continue its movement with an instantaneous snap-action, bringing the lower prong 20 of the armature into contact with the non-magnetic liner 38 of stationary cross bar 36, and closing the contacts 48 and 49 with a snap action.

When the armature is displaced below its mid-position the magnetic effect will tend to pull the same downwardly but this effect is resisted by the stylus. On its upward movement it is able to leave the stylus as the ball 46 only rests lightly on the disc 44. Hence a controlled upward movement is obtained which becomes a snap-action as soon as the armature passes its mid-position.

The springs 40 and 41 are of sufficient strength to hold the stylus 39 firmly against the test article.

The stop members 56 and 57 may be adjusted to provide the desired spacing of the contacts 48 and 49.

It will be noted that the S shape of the springs 29 and 30 provides a much greater pliability than a straight spring of the same length. The elements may be made of suitable spring material such as Phosphor bronze which provides relatively high flexibility. Hence the pintle 35 is lightly but firmly held in a bearing having negligible friction.

The above described mechanism provides an extremely accurate limit switch which operates in response to minute variations in position of the stylus.

It is to be understood that the balanced magnetic paths may take other forms. For example the end of the armature could be mounted between upper and lower pole pieces instead of having bifurcation cooperation, with a single cross bar as shown, the essential feature being to provide a structure in which the magnetic pull is equalized when the armature is in its mid-position but causes the armature to snap to a limiting position when the balance is upset.

Although a specific embodiment has been shown and described herein for purposes of illustration, it will be evident to those skilled in the art that the invention is capable of various modifications and adaptations within the scope of the appended claims.

The invention claimed is:

1. An electromagnet comprising a pivoted armature having a bifurcated end forming two prongs, a stationary magnetic member positioned between said prongs and equally spaced there-

from to provide equal air gaps when said armature is in its mid-position, means forming a magnetic return path from said member to said armature, and means inducing a flux in said armature and in said return path to produce equal forces on said prongs when said armature is in its mid-position but to cause said armature to snap to a limiting position to close one of said gaps when said balance is upset by displacement of said armature from its mid-position.

2. A magnet comprising a pivoted armature having a bifurcated end forming two prongs, a fixed magnetic return path including a member extending between said prongs and lying equidistant from said prongs when said armature is in a mid-position, said armature carrying a magnetic flux flowing from said armature through both armature prongs equally to said member, said armature being mounted to snap to a limiting position when the magnetic balance is upset by slight displacement from its mid-position.

3. A magnet comprising a magnetic frame, a pivoted armature having a bifurcated end forming two prongs, a cross bar on said frame and extending between said prongs in position to lie equidistant from said prongs when said armature is in its mid-position, said armature carrying a magnetic flux flowing from said armature through both armature prongs equally to said cross bar and returning through said frame, said armature being mounted to snap to a limiting position when the magnetic balance is upset by slight displacement from its mid-position.

4. A magnet comprising a U-shaped magnetic frame having two parallel branches and a connecting end piece, a pivoted armature mounted between said parallel branches and having a bifurcated end forming two prongs projecting outwardly through an opening in said end piece, a cross bar secured to said end piece and extending between said prongs and lying equidistant from said prongs when said armature is in its mid-position, said armature carrying a magnetic flux flowing from said armature through both armature prongs equally to said cross bar and returning through the two branches of said frame, said armature being mounted to snap to a limiting position when the magnetic balance is upset by slight displacement from its mid-position.

5. A magnet comprising a U-shaped magnetic frame having two parallel branches and a connecting end piece, a pivoted armature mounted between said parallel branches and having a bifurcated end forming upper and lower prongs projecting outwardly through an opening in said end piece, a cross bar secured to said end piece and extending between said prongs and lying equidistant from said prongs when said armature is in its mid-position, and a stylus movably mounted on said frame to engage said armature to actuate same, said armature carrying a magnetic flux flowing from said armature through both armature prongs equally to said cross bar and returning through the two parallel branches of said frame, said armature being mounted to snap into a limiting position when shifted by said stylus from its mid-position.

6. A magnet comprising a magnetic frame having upper and lower parallel branches, a pivoted armature having a bifurcated end forming upper and lower prongs projecting outwardly beyond said frame, a cross bar joining said branches and extending between said prongs and lying equidistant from said prongs when said armature is in its mid-position, said armature carrying a magnetic flux flowing from said armature through both armature prongs to said cross bar and returning through the upper and lower branches of said frame, whereby displacement of said armature from its mid-position will upset the magnetic balance of said flux paths and cause said armature to snap to a limiting position.

7. A magnet comprising a magnetic frame having upper and lower parallel branches, a pivoted armature having a bifurcated end forming upper and lower prongs projecting outwardly beyond said frame, a cross bar joining said branches and extending between said prongs and lying equidistant from said prongs when said armature is in its mid-position, said armature carrying a magnetic flux flowing from said armature through both armature prongs to said cross bar and returning through the upper and lower branches of said frame, whereby displacement of said armature from its mid-position will upset the magnetic balance of said flux paths and cause said armature to snap to a limiting position, and a stylus movably mounted on said frame and having means engaging said armature to displace the same.

8. An electromagnet comprising a magnetic frame having upper and lower parallel branches and a connecting end piece, a coil secured to said end piece between the upper and lower branches of said frame, an armature extending through said coil and having a bifurcated end forming upper and lower prongs projecting outwardly through the end piece of said frame, a cross bar secured to said end piece and extending between said prongs and lying equidistant from said prongs when said armature is in its mid-position, the magnetic flux set up by said coil flowing from said armature through both armature prongs to said cross bar and returning through the upper and lower branches of said frame, whereby displacement of said armature from its mid-position will upset the magnetic balance of said flux paths and cause said armature to snap to a limiting position.

9. An electromagnet comprising a magnetic frame having upper and lower parallel branches and a connecting end piece, a coil secured to said end piece between the upper and lower branches of said frame, an armature extending through said coil and having a bifurcated end forming upper and lower prongs projecting outwardly through the end piece of said frame, a cross bar secured to said end piece and extending between said prongs and lying equidistant from said prongs when said armature is in its mid-position, the magnetic flux set up by said coil flowing from said armature through both armature prongs to said cross bar and returning through the upper and lower branches of said frame, whereby displacement of said armature from its mid-position will upset the magnetic balance of said flux paths and cause said armature to snap to a limiting position, and a stylus mounted on said frame and having means engaging said armature to displace the same.

10. A magnet comprising a U-shaped magnetic frame having upper and lower parallel branches and a connecting end piece, an armature mounted between said parallel branches and having an end projecting outwardly through said end piece, magnetic means secured to said frame and cooperating with the projecting end of said armature to produce balanced magnetic forces when said armature is in its mid-position, spring members mounted on said upper and lower branches of

said frame, a stylus carried by said spring members and means on said stylus engaging said armature to displace the same from its mid-position, the magnetic flux flowing from said armature to said end piece and returning through the upper and lower branches of said frame, whereby micro movement of said armature due to said stylus will upset the magnetic balance of said flux paths and cause said armature to snap to a limiting position.

11. In a relay having contacts, a magnet comprising a U-shaped magnetic frame having upper and lower parallel branches and a connecting end piece, an armature mounted between said parallel branches and having an end projecting outwardly through said end piece, magnetic means secured to said frame and cooperating with the projecting end of said armature to produce balanced magnetic forces when said armature is in its mid-position, spring members mounted on said upper and lower branches of said frame, a stylus carried by said spring members and means on said stylus engaging said armature to displace the same from its mid-position, the magnetic flux produced by said magnetic means flowing from said armature to said end piece and returning through the upper and lower branches of said frame, whereby micro movement of said armature due to said stylus will upset the magnetic balance of said flux paths and cause said armature to snap to a limiting position, and means actuated by said snap movement of said armature to close said contacts with a snap action.

12. In a relay having contacts, a magnet comprising a U-shaped magnetic frame having upper and lower parallel branches and a connecting end piece, an armature mounted between said parallel branches and having an end projecting outwardly through said end piece, magnetic means secured to said frame and cooperating with the projecting end of said armature to produce balanced magnetic forces when said armature is in its mid-position, spring members mounted on said upper and lower branches of said frame, a stylus carried by said spring members and means on said stylus engaging said armature to displace the same from its mid-position, the magnetic flux produced by said magnetic means flowing from said armature to said end piece and returning through the upper and lower branches of said frame, whereby micro movement of said armature due to said stylus will upset the magnetic balance of said flux paths and cause said armature to snap to a limiting position, a pair of spring members carried by said upper branch of said frame and carrying said contacts, and a link engaging said armature to close said contacts in response to said snap movement of said armature.

13. A magnet comprising a magnetic frame having upper and lower parallel branches, flat S-shaped resilient armature-supporting springs extending between said upper and lower branches of said frame on opposite sides thereof and containing aligned conical indentations therein, an armature-supporting pintle having corresponding conical ends journaled in said indentations, said spring being flexed toward each other to maintain their engagement with said pintle, an armature on said pintle extending between said branches, magnetic means on said frame forming poles exterting a balanced magnetic force on said armature when the armature is in its mid-position, and means for displacing said armature from its mid-position to cause said armature to snap to a limiting position in response to the unbalanced magnetic forces.

14. A micro-gauge limit switch having contacts, comprising a U-shaped magnetic frame having upper and lower parallel branches and a connecting end piece, a coil secured to said end piece between the upper and lower branches of said frame, a pivoted armature extending through said coil and having a bifurcated end forming upper and lower prongs projecting outwardly through said end piece, a cross bar secured to said end piece and extending between said prongs and lying equidistant from said prongs when said armature is in its mid-position, a stylus mounted for movement on said frame, a flange adjustably mounted on said stylus to engage the under side of said lower armature prong, and a link resting on the upper prong of said armature to close said contacts when said armature is in its upper limiting position, the magnetic flux set up by said coil flowing from said armature through both armature prongs to said cross bar and returning through the upper and lower branches of said frame, whereby displacement of said armature from its mid-position by said stylus will upset the magnetic balance of said flux paths and cause said armature to snap to its limiting position.

15. A micro-gauge limit switch having contacts, comprising a U-shaped magnetic frame having upper and lower parallel branches and a connecting end piece, a coil secured to said end piece between the upper and lower branches of said frame, a pivoted armature extending through said coil and having a bifurcated end forming upper and lower prongs projecting outwardly through said end piece, a cross bar secured to said end piece and extending between said prongs and lying equidistant from said prongs when said armature is in its mid-position, a stylus mounted for movement on said frame, a flange adjustably mounted on said stylus to engage the under side of said lower armature prong, and a link resting on the upper prong of said armature to close said contacts when said armature is in its upper limiting position, the magnetic flux set up by said coil flowing from said armature through both armature prongs to said cross bar and returning through the upper and lower branches of said frame, whereby displacement of said armature from its mid-position by said stylus will upset the magnetic balance of said flux paths and cause said armature to snap to its limiting position, and a spacing member of non-magnetic material interposed between said cross bar and said armature to prevent said armature from sticking thereto due to residual magnetism.

CHARLES F. COAKE.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
808,834	Goodrum	Jan. 2, 1906
890,220	Crane	June 9, 1908
1,085,721	Berdon	Feb. 3, 1914
1,693,313	Murphy	Nov. 27, 1928
2,119,450	Trautner	May 31, 1938
2,145,950	Persons	Feb. 7, 1939
2,260,813	Wilson	Oct. 28, 1941