March 19, 1957 S. D. VIGREN ET AL 2,786,163

ELECTROMAGNETIC SWITCHING DEVICES

Filed June 21, 1951 2 Sheets-Sheet 1

Fig. 1

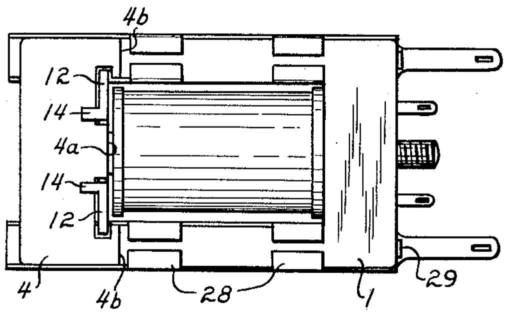


Fig. 4

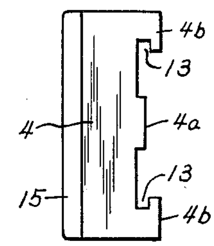


Fig. 2

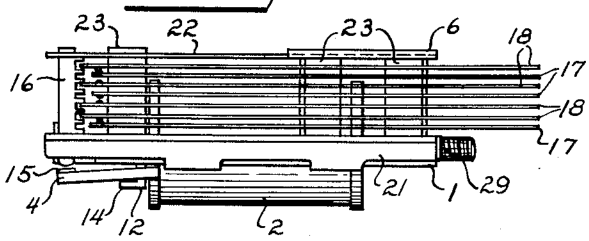


Fig. 5

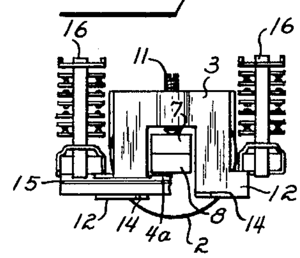


Fig. 3

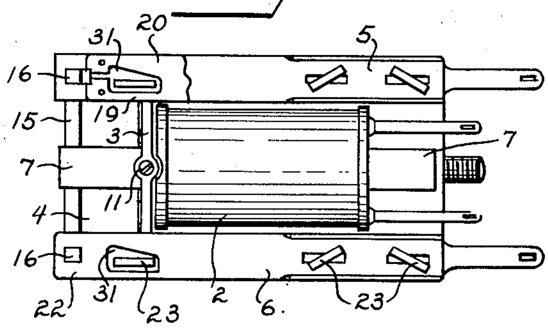
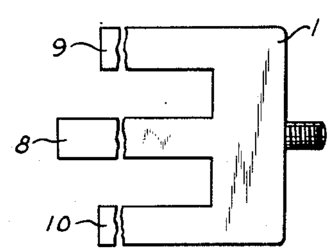


Fig. 6



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ELECTROMAGNETIC SWITCHING DEVICES

Filed June 21, 1951 2 Sheets-Sheet 2

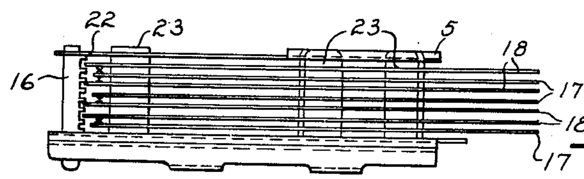

Fig. 7

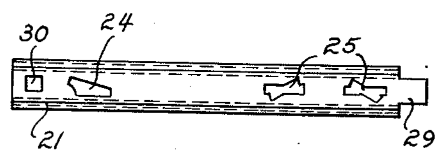

Fig. 8

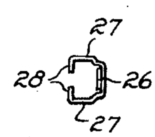

Fig. 9

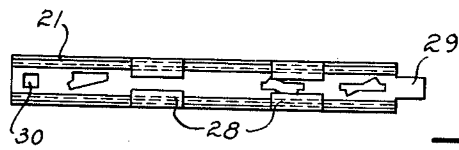

Fig. 10

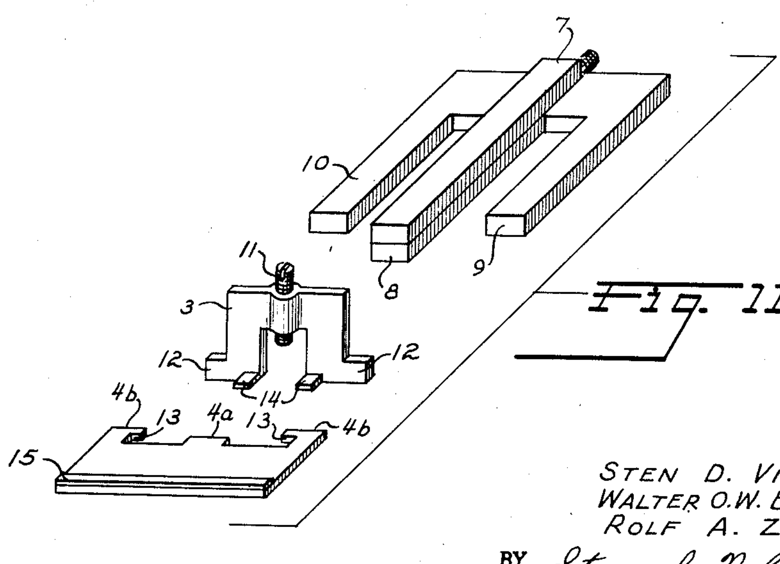

Fig. 11

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ELECTROMAGNETIC SWITCHING DEVICES

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Application June 21, 1951, Serial No. 232,722

Claims priority, application Sweden June 22, 1950

17 Claims. (Cl. 317—176)

This invention relates to electromagnetic switching devices of the type having a bar-like electromagnetic core and a substantially flat armature pivoted on frame portions laterally disposed in relation to the core, the pole face of the core being situated in a plane substantially parallel with the longitudinal axis of the core.

It has proved to be possible to produce electromagnets of this kind, which are extremely sensitive by making the armature length, measured in the longitudinal direction of the core, very short so that the distance between the attracting surface of the armature in non-operated condition and the pole face of the core increases from a very small amount near the pivotal axis of the armature to a comparably large amount at the outer edge of the armature or core respectively. An air gap of this shape may be obtained if the total length of the air space between the pole face of the core and the attracting surface of the armature measured in the longitudinal direction of the core is at least equal to, preferably materially greater than, the distance from the pivotal axis of the armature to the adjacent boundary line of the same. By way of example it may be mentioned, that an electromagnetic relay has been produced having in non-operated condition a "minimum air gap" of 0.25 mm. (in operated condition 0.04 mm.) and a "maximum air gap" of 0.95 mm., and in this relay the required number of ampere turns for operation was reduced by more than 50% as compared with corresponding relay structure of a conventional type. The amount of the said "minimum air gap" is critical and a rather small deviation from the optimum value will cause a substantial increase of the required number of ampere turns. As will be understood it is rather difficult to keep the structural clearances in the manufacture within the required small tolerances so as to obtain the optimum value of the said "minimum air gap."

The present invention is applicable to the improved type of relays described above. It is not restricted thereto, however, but may also be used in conventional flat-type relays.

The main object of the invention is to provide a device, in which adjusting facilities are provided so as to make it possible to impart to the electromagnet maximal sensitivity or to adapt it to various requirements such as operation rapidity, etc. without the need of any particular accuracy in the manufacture.

According to the invention, adjusting means are provided for adjusting the position of the pivotal axis of the armature relative to the pole face of the core.

According to a preferred embodiment of the invention applied to a core forming part of an E-shaped member or supporting frame, the middle leg of which forms the core and the side legs of which support the armature so as to define its pivotal axis, one or several adjustable distance members are inserted between the side legs or each side leg respectively on one hand and the middle leg on the other hand so as to render the pivotal axis

of the armature displaceable in a direction substantially perpendicular to the pole face of the core. The core and the side legs are made resilient, thereby enabling such a displacement by elastic deformation, so the reluctance of the iron path of the magnetic circuit may be kept at an unchanged minimum value regardless of the adjustment.

Another object of the invention is to provide an improved mounting structure of the contact spring assemblies of the switching device. In known devices of the contemplated type an electromagnetic armature acts directly or by the intermediary of selecting fingers or the like on one or more spring groups fixed to a base or supporting frame structure including a so-called bridge of magnetic material integral with or magnetically coupled to the core of the device having, in addition to its supporting function, the task of forming a return path of the magnetic flux.

In devices hitherto known it has been a practice to fix the contact spring groups by means of screws passing through threaded holes in the bridge or supporting frame. These holes, however, cause local constrictions of the flux conducting area of the bridge and supporting frame resulting in an increased reluctance and, sometimes, in unfavorable saturation conditions. This is particularly true in relays having U- or E-shaped bridge or supporting frame members, wherein the shanks are comparably narrow in a direction perpendicular to the axial direction of the screw holes. Another factor which should not be disregarded in this connection is that the magnetic properties of the supporting frame structure may be unfavorably effected by mechanical working of heat treatment subsequent to the normal annealing operation. From the foregoing it will be understood, that the fixation of the spring groups makes a problem which is far from being negligible.

By the invention, however, the above-mentioned drawbacks and difficulties have been entirely overcome. According to the main feature of the invention one or more contact spring groups form a separate unit being fixed to the said bridge or supporting structure by fixing means embracing edge portions of said bridge or supporting structure.

The invention will be better understood in connection with the annexed drawing, in which:

Figure 1 is a plan view from underneath, illustrating a relay according to the invention;

Figure 2 illustrates the same relay in side view;

Figure 3 illustrates the same relay in plan view as seen from above;

Figure 4 is a detail plan view of the relay armature;

Figure 5 illustrates the same relay in front view with the right half of the armature cut away;

Figure 6 is a detail plan view of the integral core and side legs;

Figure 7 is a detail side elevation view of a spring assembly unit of the relay;

Figure 8 illustrates the base piece of the spring assembly unit in a plan view as seen from above;

Figure 9 illustrates the same base piece in cross section;

Figure 10 illustrates the same base piece in plan view as seen from underneath; and

Figure 11 is a perspective exploded view of the supporting frame member, the yoke and the armature.

In the embodiment shown in the drawing the relay has a bridge, forming part of an E-shaped member **1** having a central core leg **8** and two side or bridge legs **9**, **10**. The distance between the core leg and the side legs is so chosen, that the magnetic stray flux will not be detrimental. The armature **4** (Figure 4) is E-shaped and the side arms are hooked or L-shaped to provide recesses 13, with which lugs 12 of a yoke member 3, made of non-magnetic material and transversely arranged in front of the winding coil 2, are in engagement, whereby the position of the armature in the longitudinal direction of core leg 8 is determined. The side arms of the armature abut against the lower surface of side legs 9 and 10 respectively, and the non-operated angular position of the armature is determined by the armature hooked arms embracing the rear face of the yoke and by the supporting lugs 14 extending from the yoke member 3 and engaging the under side of the armature. The central extension member of the E-shaped armature faces the pole face of the core leg 8, and the transverse edge line *4a* of this extension is situated at such a distance from the transverse edge lines *4b* of the side shanks of the armature as counted in the longitudinal direction of the core leg 8, that an extremely small air gap will exist between the edge line of the said extension and the pole face. In order that this air gap shall be adjustable and not require too high a degree of accuracy during manufacture, the yoke member 3 is interengaged with the side legs 9 and 10 and is provided with an adjusting screw 11 for applying a force to the core leg 8 via a bar or strip 7 of magnetic material. Bar or strip 7 is provided to increase the area of the core as clearly shown at the right hand side of Figure 5, the lugs 12 of the yoke member 3 abut against the underneath side of the side legs 9 and 10 whilst the adjusting screw 11 abuts against the upper side of strip 7, whereby the adjusting screw acts against the inherent resilience of the member 1, and the yoke 13 is kept in its position by the spring force of legs 8, 9 and 10. Preferably the core leg 8 is somewhat bent beforehand to form a small angle upwards against the common plane of the side legs 9 and 10. As will be understood the desired small air gap may be readily obtained by turning the screw 11 until the distance between the pole face of core leg 8 and the edge *4a* of the central extension of the armature 4 is the desired value.

The armature 4, at its front edge is provided with a pole plate 15 of non-magnetic material determining the angular position of the armature in operated condition.

Figure 11 discloses, in perspective exploded view, the preferred construction of the E-shaped bridge or supporting frame member 1 with core leg 8 and side legs 9 and 10; the U-shaped yoke member 3 having depending legs with side lugs 12 and transverse lugs 14 on the lower edges of the legs; and the E-shaped armature 4 with hooked or L-shaped side arms having end surfaces *4b* in a plane parallel to and offset from the plane of the central member end surface *4a*.

To enable a clearer understanding of the relationship between the various components, reference is made to Figure 11, viewed in conjunction with Figures 1, 2 and 5 which will show that in assembly of the supporting frame member, coil, yoke and armature units, the yoke 3 is placed with its depending legs between the side arms and central member of armature 4. The armature 4 is moved down yoke 3 to rest on lugs 14 with armature recesses 13 loosely embracing a portion of yoke side lugs 12. With the yoke and armature in this relationship, the hooked ends of the armature's L-shaped side arms bear on rear surface of yoke legs 12 and limit downward pivotal movement of the armature.

Bar 7 is placed on top of core leg 8 and coil 2 slipped over the core leg 8 and bar 7. Yoke 3 and armature 4 are placed into the open end of E-shaped supporting frame 1, with the depending legs of the yoke 3 between supporting frame side legs 9 and 10 and straddling center core leg 8 and bar 7, with the armature 4 and yoke side lugs 12 beneath the supporting frame legs, and with the rear face of the yoke abutting or closely adjacent the front face of coil 2. Adjusting screw 11 is tightened to bear against bar 7 and create a spring force between side legs 9 and 10 of the bridge and core leg 8 to hold the yoke in position.

With the unit so assembled, end surfaces *4b* of the armature side arms abut the lower surfaces of bridge side legs 9 and 10 and determine, in cooperation with yoke lugs 14, the inclination of the armature in the inoperative condition.

Assuming screw 11 is so adjusted to place the lower surfaces of the three legs 8, 9 and 10 of the bridge in a common plane, the transverse edges of the armature side legs, bearing on the lower surfaces of the bridge side legs, will lie in that common plane and the armature central member, being shorter than the side legs will have its transverse edge *4a* spaced a short distance from the lower face or pole face of core leg 8 to thus form the small desired air-gap hereinbefore mentioned.

In operative condition the armature will pivot about the transverse edges *4b* toward the pole face of core leg 8. Pole plate 15 on the front edge of the top surface of armature 4 will abut the lower surface or pole face of core leg 8 and maintains a small clearance between the armature and the lower surface of the core leg.

The spring assemblies 5 and 6, which are identical with each other, are in the form of separate units, one of which is shown in Figure 7, provided with fixing means making it possible to secure the spring assemblies to the side legs 9 and 10 without the need of any holes through the side legs, which would increase the magnetic resistance and reduce the sensitivity of the relay.

The base piece of each spring assembly consists of a sheet-metal slide 21 having a cross section as shown in Figure 9. The two bend-down edges 27 extend along the sides of the respective side leg and guide the slide in lateral direction, the slide is fixed in its position by bottom lugs 28 and end lug 29, the end lug 29 being bent down in assembly as in Figure 2. At its top the slide is provided with an elevated portion forming a space 26 (Figure 9) for receiving the fixing means of the contact springs as will be described below.

As will be seen from Figures 8 and 10, showing slide 21 from above and underneath respectively, there are apertures 24, 25 and 30 through the slide. All the contact springs, the stationary ones 17 as well as the movable ones 18, and also a pressing spring 22 at the top of the spring assembly are provided with apertures similar to 25. At the assemblage of the spring pile-up the springs and the slide are placed in the desired relative positions in a guiding tool or the like and flat pieces 23 of insulating material are put through the respective vertical rows of apertures 25 and turned around into a position as shown in Figure 3, the edges of the apertures 25 then cutting into the edges of the pieces 23 so as to fix the springs mutually and to the slide 21. The stationary springs 17 are provided with apertures similar to aperture 24 and have their contact ends fixed in relation to the slide 21 in a similar way by an additional insulating piece 23. The movable springs 18 and the pressing spring 22 are provided with apertures 31 (see Figure 3) that permit them to move freely.

The aperture 30 of the slide 21 receives the lower end of the actuating stud 16.

It is of course also possible to use screws for the fastening of the contact springs, and in this case the heads of the fastening screws may be received by the space 26 in slide 21, or the screws may be fixed to the slide 21 by welding or soldering.

Due to the small moment of inertia of the armature its movement will be very rapid, and due to this fact special steps are taken in order to avoid contact vibrations. Thus the movable springs forming part of the make contacts are arranged for so-called indirect operation, i. e. they are pre-tensioned so as to effect the contact closure by their own spring force, the actuating stud 16 holding them in non-operated position through the action of pressing spring 22. The actuating stud 16 is provided with evenly spaced teeth forming a pair of opposing abutting surfaces for each space between any two neighboring spring positions in the assembly. By this arrangement the make and break contacts and also contacts containing three springs, such as change-over contacts, may be positioned arbitrarily within the spring assembly with the use of one and the same type of actuating stud.

Furthermore, the movable contact springs have their tongues **19** and **20** (Figure 3) for carrying the twin contacts of different stiffness, the tongue **19** being more flexible than tongue **20**. Preferably tongue **19** is somewhat pre-bent in a direction towards the corresponding stationary contact spring, so that this tongue originally forms a small angle to the plane of tongue **20** but is straightened out when assembled by the abutment against the corresponding stationary contact spring or its abutting surface on the actuating stud **16** respectively.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. In an electromagnet comprising a core member including two magnetically interconnected portions extending side by side in a substantially common plane, a pole face on one of said portions substantially parallel with said common plane, and an armature swingably supported by the other of said portions in attractable relation to said pole face, means for adjustably flexing one of said portions relative to the other one in a direction substantially normal to said common plane.

2. In an electromagnet comprising a core member including a middle-leg, two side-legs, one on either side of said middle-leg, and a rear cross-piece interconnecting all the three legs, which extend in a substantially common plane, the electromagnet further comprising an operating winding on said middle-leg, a pole face forwardly of said operating winding extending substantially in said common plane, and a flat armature extending across the ends of all the three legs in attractable relation to said pole face and in operation swingably supported against said side-legs, a transversely disposed yoke piece engaging the side-legs so as to keep said yoke piece and side legs in a predetermined mutual relative position and means for adjusting the distance between said yoke piece and said middle-leg in a direction substantially normal to said pole face.

3. An electromagnet comprising a core member including a middle leg, two side legs, one on either side of said middle leg, and a rear cross piece interconnecting all the three legs, said legs extending in a substantially common plane, an operating winding on said middle leg, a pole face forwardly of said operating winding extending substantially in said common plane, and a flat armature extending across the ends of the three legs in attractable relation to said pole face and operatively swingably supported against said side legs, a transversely disposed yoke piece engaging the side legs whereby said yoke piece and side legs are maintained in a predetermined mutual relative position and means for adjusting the distance between said yoke member and said middle leg in a direction substantially normal to said pole face comprising a screw acting between said yoke member and said middle leg of the core member.

4. A device as claimed in claim 3 in which said screw is screw-threaded in said yoke member and abuts against the middle-leg of the core.

5. A device according to claim 4 in which said yoke member comprises projections extending on and loosely engaging one side of each of the side-legs of the core, and a transverse portion interconnecting said projections and extending on that side of the middle-leg of the core member which is opposite of the aforementioned side of each of the side-legs, said transverse portion having a threaded hole therein for receiving said screw, the middle-leg being pre-tensioned relative to the side-legs so as to resiliently press against the end of the said screw.

6. An electro-magnetic unit comprising a horizontal supporting frame means including resilient substantially parallel members, one member being a core and having a horizontal pole face adjacent one end thereof, a yoke means normal to and straddling the core member at the edge of the pole face remote from said one end of the core, a first and second set of lugs on the yoke means, each set being aligned parallel to the pole face, an armature having on one edge thereof hook means loosely encompassing the yoke means and thereby enabling said armature to rest on the first set of lugs, others of said parallel members bracketing the yoke means and resting on said second set of lugs and means adjustably connected to said yoke means and abutting the top edge of said core member for shifting the pivotal axis of the armature toward or away from the core pole face.

7. An electro-magnetic unit comprising magnetic supporting frame means including resilient substantially parallel members, one of said members having a horizontal pole face adjacent one end thereof, a non-magnetic means normal to and surrounding the top and sides of said one member at the edge of the pole face remote from said one end of the core, a first and second set of lugs on the non-magnetic means, each set being aligned parallel to the pole face, a substantially flat magnetic armature having thereon hook means losely encompassing the non-magnetic means and thereby enabling said armature to rest during inoperative condition on the first set of lugs, others of said parallel members bracketing the non-magnetic means, resting on said second set of lugs and engaging said armature in a pivotal manner and adjustable means interconnecting said non-magnetic means and said core member for changing the relationship between the resilient members to thereby shift the pivotal axis of the armature toward or away from the core pole face.

8. In an electro-magnetic unit as set forth in claim 7, said armature means comprising a flat E-shaped member with the central portion shorter in length than the side arms and the side arms comprising said hook means.

9. In an electro-magnetic unit a supporting frame member comprising a plurality of resilient elongated substantially parallel magnetic members, one of said parallel members being a core and having a pole face adjacent one end thereof lying in a plane parallel to the core longitudinal axis; a U-shaped frame mounted normal to and straddling the core member, a set of lugs on the side edges of the U-shaped frame transverse to said core member axis; others of said parallel members bracketing the legs of the U-shaped frame and resting on said set of lugs; magnetic armature means pivotally held between said U-shaped frame and said supporting frame member; and adjustable distance means between the cross-bar of the U-shaped frame and the top edge of said core member, adjustment of said screw member thereby shifting the pivotal axis of the armature toward or away from the core pole face.

10. In an electro-magnetic unit as set forth in claim 9, said armature means comprising a flat E-shaped member with the central portion shorter in length than the side arms.

11. In an electro-magnetic unit, a supporting frame member comprising a plurality of resilient substantially parallel magnetic members, one of said parallel members being a core and having a longitudinal pole face adjacent one end thereof; a non-magnetic U-shaped frame mounted

normal to and straddling the core member at the edge of the pole face remote from said one end of the core, a first set of lugs on the lower edge of the U-shaped frame, a second set of lugs on the side edges of the U-shaped frame; a flat magnetic armature having at the rear edge thereof two L-shaped arms with their free ends in facing relation, said armature freely encompassing said U-shaped frame within said arms and resting on the first set of lugs in inoperative condition; others of said parallel members bracketing the sides of the U-shaped frame with their lower surfaces abutting said second set of lugs and means adjustably connected to said U-shaped frame and abutting the top edge of said core member for shifting the pivotal axis of the armature toward or away from the core pole face.

12. In an electro-magnetic unit, a supporting frame member comprising a plurality of resilient elongated parallel magnetic members, one of said parallel members being a core and having a pole face adjacent one end thereof lying in a plane parallel to its longitudinal axis; a non-magnetic yoke frame mounted normal to and straddling the core member at the edge of the pole face remote from said one end of the core, a first set of lugs on the lower edge of yoke frame extending toward the said one end of the core, a second set of lugs on the side edges of the yoke frame transverse to said core member axis; a flat magnetic armature having recesses in the rear edge forming two L-shaped arms having their free ends in facing relation, said armature freely encompassing the yoke frame within said recesses and resting in the first set of lugs; others of said parallel members bracketing the side edges of the yoke frame resting on said second set of lugs and in abutting relation to the rear edges of said L-shaped arms to form therewith a pivot axis for the armature; and a screw member threaded into the top edge of the yoke frame and abutting the top edge of said core member, adjustment of said screw member thereby shifting the pivotal axis of the armature toward or away from the core pole face.

13. An electromagnetic device comprising: a bar-like electromagnetic core with its pole face situated in a plane substantially parallel with the longitudinal axis of the core; a magnetically conductive resilient frame portion rigidly fixed to and disposed in off-set substantially parallel relation to said core whereby said core and frame portion form an E-shaped member, the middle leg of which comprises the core and the side legs of which comprise said frame portion; a substantially flat armature pivoted on said side legs; and adjusting means, for resiliently displacing said side legs relative to said middle leg to displace the pivotal axis of the armature relative to said pole face of said core, inserted between said side legs and said middle leg.

14. An electromagnetic device as defined in claim 13, wherein said adjusting means comprises a yoke member and an adjusting screw member threaded in said yoke member with one of said members engaging said side legs and the other of said members engaging said middle leg.

15. An electromagnetic device as defined in claim 14 wherein said adjusting screw member abuts with its end against the middle leg and the yoke member abuts said side legs in opposed relation to the abutment of said screw member, the relative resilience of the side legs and middle leg being restrained by the relative rigidity of said adjusting screw member and yoke member within the range of screw adjustment.

16. An electromagnet comprising a core member including at least two resilient portions magnetically interconnected adjacent one of their ends and extending side by side in a substantially common plane, a pole face on one of said portions adjacent its free end substantially parallel with said common plane, an armature operatively swingably supported by the other of said portions closer to its free end than to its interconnected end in attractable relation to said pole face, and means acting between said two portions for adjustably flexing one of said portions relative to the other one in a direction substantially normal to said common plane.

17. An electromagnet comprising a core member including a plurality of magnetically interconnected bar shaped portions extending side by side in a substantially common plane, said plurality of bar portions being connected adjacent one of their ends, a pole face on one of said portions substantially parallel with said common plane, and an armature operatively pivotally supported closer to the other ends of others of said plurality of bar shaped portions than the connected ends in attractable relation to said pole face, and means for adjustably flexing said one bar shaped portion relative to said other bar shaped portions in a direction substantially normal to said common plane.

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