United States Patent

[11] 3,573,685

[72] Inventors Robert F. Klose
Blacklick;
Virgil L. Marsh, Reynoldsburg, Ohio
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[73] Assignee Western Electric Company, Incorporated
New York, N.Y.

[54] **ELECTROMAGNETIC SWITCHING DEVICE**
3 Claims, 7 Drawing Figs.

[52] **U.S. Cl.** **335/135**
[51] **Int. Cl.** **H01h 50/00**
[50] **Field of Search** 335/135, 133, 279, 281, 277, 249

[56] **References Cited**
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1,980,393	11/1934	Evans	335/249
2,715,199	8/1955	Bogue	335/249
3,290,629	12/1966	Jeanne	335/133
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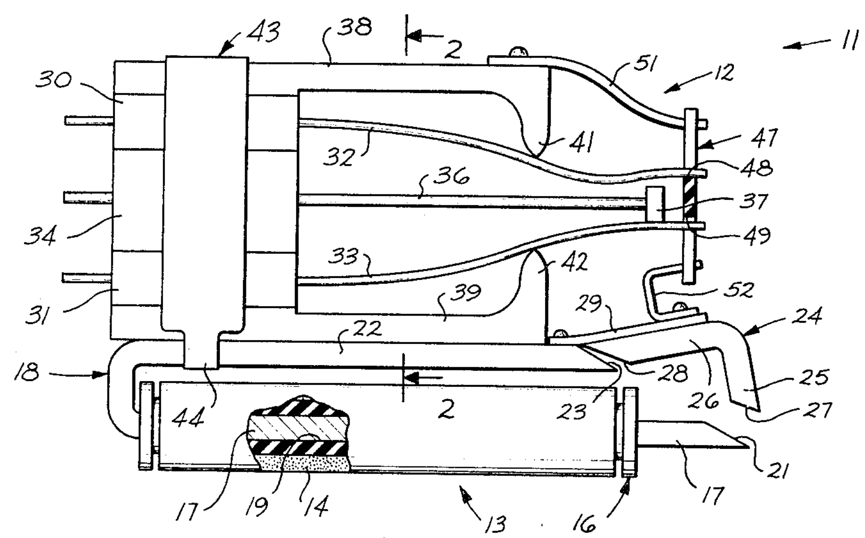
Primary Examiner—Harold Broome
Attorneys—H. J. Winegar, R. P. Miller and Don P. Bush

ABSTRACT: An electromagnetic switching device, such as a wire spring relay, includes a coil having one leg of a substantially U-shaped core inserted into a central bore of the coil. An L-shaped armature is hinged for movement to the core so that pole faces of the armature mate with associated pole faces of the core when an operating potential is applied to the coil. A plurality of groups of parallel wires are embedded in and extend from a plastic support block which is attached to one leg of the core. The ends of the wires are spaced apart and extend through openings in a card which is attached to the movable armature and a restoring spring. When the switching device is operated, the armature is moved so that the pole faces thereof mate with the associated pole faces of the core whereby the card is moved against the biasing of the restoring spring to bring together selected wires of the parallel groups of wires to facilitate electrical connections in external circuits connected to the opposite ends of the selected wires.



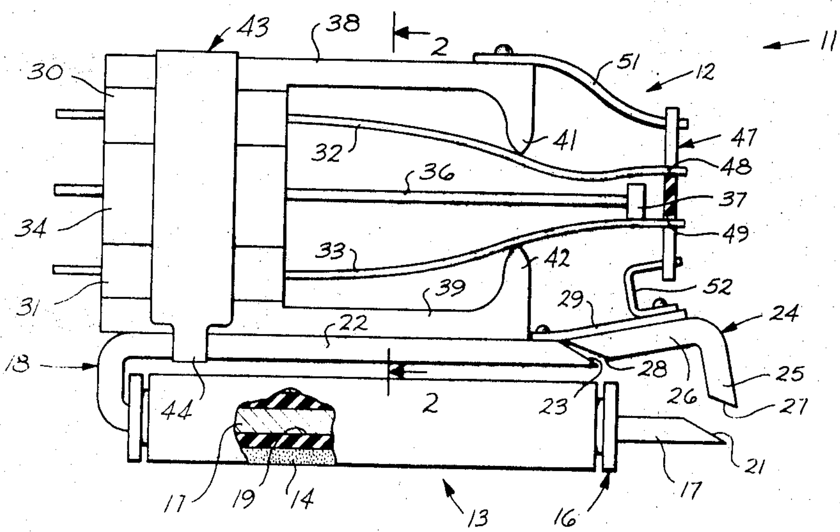


FIG. 1

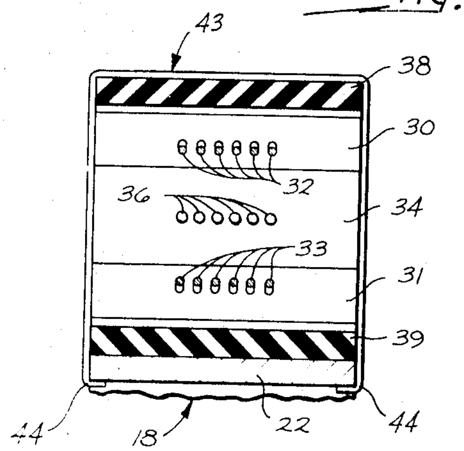


FIG. 2

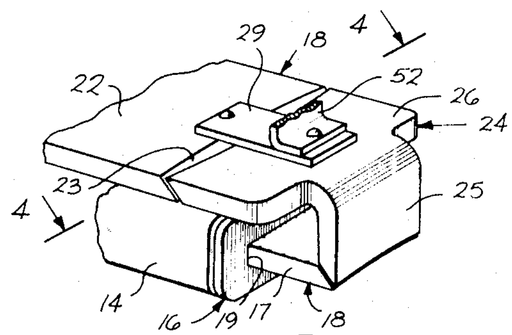


FIG. 3

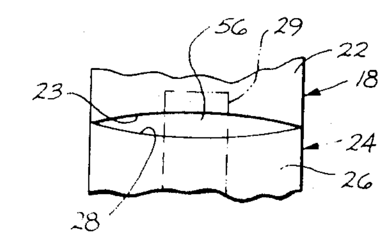


FIG. 4

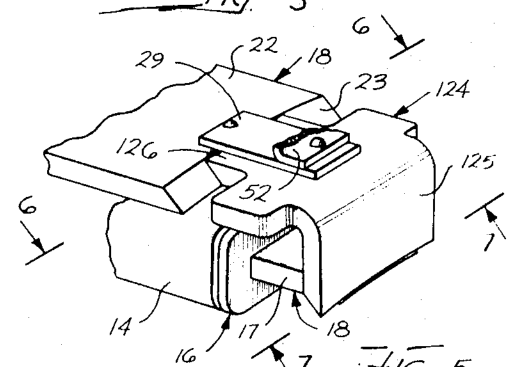


FIG. 5

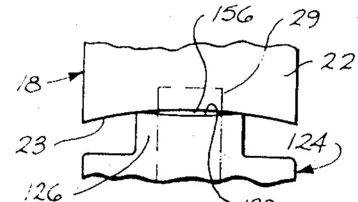


FIG. 6

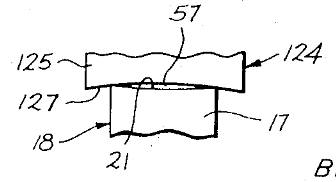


FIG. 7

INVENTORS
R.F. KLOSE
V.L. MARSH
BY
J.B. Hoofnagle Jr.
ATTORNEY

ELECTROMAGNETIC SWITCHING DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an electromagnetic switching device and particularly to miniature devices having plated elements of a magnetic circuit of the device which are mated during operation of the device.

2. Description of the Prior Art

In the manufacture of some types of electromagnetic switching devices, such as a wire spring relay of the type disclosed in U.S. Pat. No. 3,290,629, which issued to A. L. Jeanne on Dec. 6, 1966, a magnetizable core is positioned within a central bore of a coil with pole faces of the core being positioned to engage associated pole faces of an armature. When an operating potential is applied to the coil, a magnetic circuit is established to draw the pole faces of the armature into engagement with the associated pole faces of the core. The mechanical movement of the armature is utilized to manually close contacts of circuits which are not necessarily electrically associated with the coil of the switching device.

In order to reduce undesirable corrosion of and provide wear resistance for the core and armature, the core and armature are plated with corrosion resistant and hard wear materials, such as nickel and chromium, respectively, which enhance the operating properties of the electromagnetic switching device. However, a buildup of nickel and chromium occurs on the mating pole faces of the core and the armature in such a manner that, when the armature is drawn toward the core, the pole faces do not mate sufficiently to retain the switching device in the operated state when a normal level of holding current is passed through the coil. In addition, certain types of magnetic latching switching devices depend upon the retention properties of the core and armature for maintaining a sufficient magnetic field for holding the pole faces in the mated engagement after the operating potential has been completely removed from the coil. The buildup of the plating material usually occurs at the ends of the pole faces so that the pole faces have a bowed appearance. When an operating potential is applied to the coil of the switching device and the armature is moved toward the core, the areas of the plated buildup at the opposite ends of the pole faces mate leaving the remaining center portions of the mating pole faces spaced substantially apart thereby creating an airgap and a deficiency in the magnetic circuit of the switching device.

SUMMARY OF THE INVENTION

It is, therefore, an object of this invention to provide a new and improved electromagnetic switching device.

Another object of this invention is the provision of a new and improved electromagnetic switching device having plated magnetic circuit elements which prevent corrosion and provide wear surfaces of the elements and permit mating of the pole faces of the elements to complete the magnetic circuit.

Still another object of this invention is the provision of a new and improved electromagnet switching device wherein mating pole faces of a core and armature of the device are designed so that plated buildup areas of the mating pole faces are offset so that the mating pole faces may be positioned sufficiently close to each other to maintain the magnetic circuit in a state sufficient to retain the switching device in the operated condition.

An electromagnetic device illustrating certain principles of the invention may include a coil having a core of magnetic material positioned within an opening and extending from one end thereof. An armature made of magnetic material is hinged to the core for movement relative thereto and is formed with at least one pole face which mates with an associated pole face of the core when a magnetic field is developed by the coil upon the application of an operating potential thereto. The core and the armature then function as a linked flux path for the magnetic field. At least one of the pole faces is bowed along its length which results in an airgap between the armature and the core. To reduce the undesirable effects of the airgap, the pole faces of the core and the armature are formed with dissimilar length dimensions to permit the bowed pole face to move sufficiently close to the other pole face and thereby provide a sufficient flux path of magnetic material.

The core and the armature are plated with noncorrosive and wear resistant materials, such as nickel and chromium, respectively, and the pole faces are designed so that plated buildup areas on the pole faces do not mate when the pole faces are drawn together thereby minimizing any airgap deficiencies in the linked flux path and permitting sufficient mating engagement of the associated pole faces to retain the flux path in the linked state.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the present invention will be apparent from the following detailed description when considered in conjunction with the accompanying drawings in which:

FIG. 1 is an elevational view of a wire spring relay;

FIG. 2 is a sectional view taken along line 2–2 of FIG. 1 showing portions of wires of the wire spring relay;

FIG. 3 is a partial perspective view showing mating portions of the wire spring relay;

FIG. 4 is a partial end view showing mated pole faces of an armature and a core of the wire spring relay;

FIG. 5 is a partial perspective view showing a modified armature used with the wire spring relay in accordance with certain principles of the invention, and

FIGS. 6 and 7 are partial end views showing mated pole faces of the modified armature and the core of the wire spring relay.

DETAILED DESCRIPTION

Referring now to FIG. 1, there is illustrated an electromagnetic switching device, such as a wire spring relay, designated generally by the reference numeral 11, which is of the type disclosed in the aforementioned U.S. Pat. No. 3,290,629. The wire spring relay 11 includes a contact assembly, designated generally by the reference numeral 12, and a motor assembly, designated generally by the reference numeral 13. The motor assembly 13 includes a coil 14 wound on a bobbin, designated generally by the reference numeral 16. One leg 17 of a substantially U-shaped core, designated generally by the reference numeral 18, which is made of a magnetic material, is inserted into a central bore 19 of the bobbin 16. The free end of the leg 17 of the core 18 extends from one end of the bobbin 16 and is formed with a beveled pole face 21. Another leg 22 of the core 18 is parallel to the leg 17 and is spaced therefrom so that the leg 22 extends along an adjacent portion of the periphery of the coil 14. The free end of the leg 22 of the core 18 is formed with a bevel pole face 23.

The motor assembly 13 also includes a substantially L-shaped armature, designated generally by the reference numeral 24, which is made of a magnetic material and is formed with legs 25 and 26. The free ends of the legs 25 and 26 are formed with beveled pole faces 27 and 28, respectively. A hinge strap 29 extends between and is attached to portions of the core 18 and the armature 24 adjacent to the pole faces 23 and 28, respectively, so that the armature is mounted for hinged movement with respect to the core. Therefore, the core 18 and the armature 24 form a two element magnetic circuit for concentrating the magnetic flux developed when an operating potential is applied to the coil 14.

The contact portion 12 includes a pair of spaced, molded blocks 30 and 31 having intermediate portions of a plurality of parallel, spaced wire springs 32–32 (FIG. 2) and 33–33 (FIG. 2), respectively, embedded therein with remaining portions of the wire springs extending from opposite sides of the blocks. Another molded block 34 is positioned between the molded blocks 30 and 31 and has molded therein intermediate portions of a plurality of parallel, spaced wires 36–36 (FIG. 2) which extend from opposite sides of the block. One free end of each of the wires 36–36 is assembled with an associated contact block 37. The wire springs 32–32 and 33–33, the wires 36–36 and the contact blocks 37–37 are composed of suitable conductive materials. Outer plastic members 38 and 39 are positioned adjacent to the blocks 30 and 31, respectively, and are formed with inwardly projecting portions 41 and 42, respectively. The projecting portions 41 and 42 engage intermediate portions of the wires 32–32 and 33–33, respectively, to urge adjacent free end portions of the wire springs normally into engagement with associated portions of the contact blocks 37–37.

Referring to FIGS. 1 and 2, there is illustrated a U-shaped clamp, designated generally by the reference numeral 43, which is positioned over the stacked blocks 30, 31, 34 and the outer members 38 and 39 and is formed with a pair of tabs 44–44 which latch onto the leg 22 of the core 18 to secure the contact assembly 12 with the motor assembly 13.

Referring again to FIG. 1, a card, designated generally by the reference numeral 47, is provided with a pair of actuator surfaces 48 and 49 and is positioned so that the free ends of the wire springs 32–32 can engage the surface 48 and the free ends of the wire springs 33–33 can engage the surface 49. The upper end of the card 47 is attached to one end of a restoring spring 51 which extends from and is attached to the outer member 38 so that the card is urged normally upwardly. When the card 47 is urged normally upwardly, the surface 48 of the card engages and urges the free ends of the wires 32–32 upwardly and out of engagement with the associated contact blocks 37–37. In addition, the free ends of the wire springs 33–33 are permitted to engage adjacent portions of associated contact blocks 37–37 when the card 47 is urged normally upwardly.

The lower end of the card 47 is connected to one end of a bracket 52, the other end of which is secured to the hinge 29 and to one surface of the armature 24. When an operating potential is applied to the coil 14, a magnetic flux is developed within the core 18 and normally urges the armature 24 toward the core so that the mating pairs of pole faces 21 and 27, and 23 and 28 are mated in flush and overlapping engagement to establish a concentrated path in the form of a closed loop circuit for the magnetic flux. As the armature 24 is moved toward the core 18, the card 47 is moved downwardly against the biasing action of the restoring spring 51 whereby the surface 49 engages the free ends of the wire springs 33–33 and facilitates the movement of the free ends of the wire springs out of engagement with the associated contact blocks 37–37. In addition, the surface 48 of the card 47 is moved sufficiently downwardly to permit the free ends of the wire springs 32–32 to engage the associated contact blocks 37–37. In this manner, external electrical circuits, which can be connected to the opposite ends of the wire springs 32–32 and 33–33 and the wires 36–36, can be controlled by operation of the wire spring relay 11 to provide necessary switching functions for the external circuits.

In one type of the miniature wire spring relay 11, after the closed loop circuit for the magnetic flux has been completed by the mating of the pole faces 21 and 27, and 23, and 28, the amount of current required normally through the coil 14 to hold the armature 24 in the closed loop, magnetic circuit is less than the amount of current required to establish the circuit. Therefore, the current level can be reduced to a holding level so that power requirements are lowered. In a magnetic latching type of the wire spring relay 11, the retentivity properties of the core 18 and the armature 24 are sufficient to hold the pole faces 21 and 27 and 23 and 28, in mating engagement after the operating potential has been removed completely from the coil 14. In this manner, the relay 11 is in a latched condition and the card 47 is held in the downward position until a reverse potential is applied to the coil 14.

Referring now to FIG 3, there is illustrated the armature 24 having a structure previously used with the wire spring relay 11. The armature 24 is normally drawn adjacent to the core 18 to provide the closed loop magnetic flux path. The leg 17 of the core 18 is smaller in width than the leg 22 of the core to facilitate the insertion of the leg 17 through the opening 19 of the bobbin 16. To accommodate the reduced width of the leg 17, the leg 25 of the armature 24 is of the same width as the leg 17 so that the pole faces 21 and 27 of the legs 17 and 25, respectively, should be in completely overlapping and flush engagement. The leg 26 of the armature 24 is of the same width as the leg 22 of the core 18 so that the pole faces 23 and 28, of the legs 22 and 26, respectively, should mate in complete flush and overlapping engagement.

In order to enhance the operation of the motor assembly 13 (FIG. 1) and to reduce the possibility of corrosion to and provide hard wear surfaces for the core 18 and the armature 24, the core and the armature are plated with corrosion resistant and wear resistant materials, such as nickel and chromium, respectively. As a result of the nickel and chromium plating operation, a substantial buildup of nickel and chromium occurs at opposite ends of each of the pole faces 21, 23, 27 and 28 (FIG. 1). When the motor assembly 13 is operated and the armature 24 is drawn toward the core 18, the mating pole faces 21 and 27, 23 and 28 are prevented from moving into complete overlapping and flush engagement due to the nickel and chromium buildup at opposite ends of the mating pole faces.

Referring now to FIG. 4, there is illustrated portions of the core 18 and the armature 24 with the pole faces 23 and 28, respectively, in mating engagement. However, due to the nickel and chromium buildup on opposite ends on each of the pole faces 23 and 28, a substantial airgap 56 appears centrally between the mated pole faces. The same type of condition appears between the pole faces 21 and 27 (FIG. 1). The presence of the sizable airgaps in the magnetic flux path reduces the concentration of the flux within the circuit and necessitates a higher level of current to hold the armature 24 in a position adjacent to the core 18 so that the card 47 (FIG. 1) may be retained in the downward position. Therefore, the subsequent supplying of a normal level of holding current to the coil 14 is not sufficient to hold the armature 24 in the position to hold the card 47 in the downward position and the relay 11 will not function properly.

When attempts are made to remove the nickel and chromium buildup on the opposite ends of the pole faces 21, 23, 27 and 28 by various processes, such as an abrasive technique, the structure of the plated material is frequently disturbed. Also, it is difficult to remove accurately sufficient portions of the material buildup without exposing the original surface of the core 18 and armature 24 whereby corrosion and wear of the exposed unplated portions of the surface of the pole faces 21, 23, 27 and 28 will subsequently occur and interfere with the normal desired operation of the wire spring relay 11. In order to overcome the undesirable aspects of the buildup of the nickel and chromium at the opposite ends of the pole faces 21, 23, 27 and 28, the length dimensions of the pole faces 27 and 28 of the armature 24 are modified as illustrated in FIG. 5 so that these pole faces are no longer the same dimensions as the mating pole faces 21 and 23, respectively, of the core 18.

As illustrated in FIG. 5, the width of a leg 125 of a modified armature 124 is substantially wider that the leg 25 (FIG. 3) of the original armature 24 so that a pole face 127 at the free end of the leg 125 is longer than the pole face 27 of the armature 24. In addition, the width of a leg 126 of the modified armature 124 is substantially less than the width of the leg 26 (FIG. 3) of the original armature 24 so that a pole face 128 at the free end of the leg 126 is shorter in length than the pole face 28 of the armature 24.

Referring now to FIG. 6, there is illustrated the end of the leg 22 with the pole face 23 and the end of the leg 126 with the mating pole face 128. The width of the leg 126 is substantially less than the width of the leg 22 so that the pole face 128 is permitted to move relatively close to the pole face 23 when the armature 124 is moved adjacent to the core 18. Even though an airgap 156 exists between the pole face 23 and 128, the size of the airgap is substantially less than the airgap **56** (FIG. **4**) thereby minimizing the effect of the airgap in the magnetic circuit and concentrating substantially the magnetic flux between the leg **22** and the leg **126** of the core **18** and the armature **124**, respectively.

Referring now to FIG. **7**, since the width of the leg **125** of the modified armature **124** is substantially greater than the width of the leg **17** of the core **18**, the mating pole face **127** of the modified armature is permitted to move sufficiently close to the pole face **21** so that the magnetic flux is concentrated sufficiently for the relay **11** to function properly even though a small airgap **57** exists between the pole faces.

With the structure of the modified armature **124**, the corrosion and wear resistant materials can be plated onto the modified armature and the core **18** without any subsequent need for disturbing the plated material to maintain the relay **11** in an operable condition. The structure of the modified armature **124** then permits sufficient closing of the loop of the magnetic flux path so that the wire spring relay **11** can operate with a normal level of holding current after the relay has been operated. If the relay **11** is a magnetic latching type, the magnetic circuit loop is closed sufficiently to permit the relay to remain in a latched condition after the relay has been operated.

We claim:

1. An electromagnetic switching device, which comprises:
a coil;
two flux concentrating elements which are alignable to form a concentrated path for magnetic flux;
a first of said elements being arranged in a position adjacent to the coil to concentrate magnetic flux developed when an operating potential is applied to the coil;
a second of said elements being arranged to be moved toward the first of said elements when the operating potential is applied to the coil and having at least one mating portion thereof which engages an associated mating portion of the first of said elements to provide normally an alignment of the two flux concentrating elements;
the mating portion of at least one of said elements being plated with material which results in a buildup of plated material on the mating portion of the at least one of said elements, whereby the mating portion is bowed along the length thereof which results in an airgap being formed between the mating portions of the two elements when the portion of the second of said elements is moved into engagement with the mating portion of the first of said elements; and
the bowed mating portion of the one element having a length dimension different than the length dimension of the mating portion of the other element to permit the mating portions of the elements to move sufficiently close to each other so that any airgap caused by the bowed portion of the one element is insufficient to prevent the substantial engagement of the mating portions and alignement of the elements to form the concentrated path for the magnetic flux.

2. An electromagnetic switching device, which comprises:
a coil having an opening;
a core made of a magnetic material and extending through the opening of the coil to form a flux path of magnetic material for a magnetic field developed by the coil when an operating potential is applied to the coil;
the core being formed with at least one pole face at one end thereof;
an armature made of a magnetic material and hinged to the core for movement relative thereto;
the armature formed with at least one pole face at one end thereof which is arranged to mate with the associated pole face of the core when the magnetic field is developed to increase the flux path of magnetic material;
at least one of the pole faces being plated with material which results in a buildup of plated material on the pole face whereby the pole face is bowed along the length thereof; and
the pole faces of the core and the armature having dissimilar length dimensions to permit the bowed pole face to move sufficiently close to the other pole face so that any airgap between the pole faces is insufficient to create an undesirable deficiency in the flux path formed by the mated core and armature.

3. An electromagnetic switching device, which comprises:
a coil having a central opening;
a core made of a magnetic material and having a first leg extending through the opening of the coil and a second leg formed integrally with the first leg and extending parallel to the first leg adjacent to the outer surface of the coil to form a first portion of a flux path of magnetic material for a magnetic field developed by the coil when an operating potential is applied to the coil;
the core being formed with a pole face at each end thereof;
an armature made of a magnetic material and being hinged to one leg of the core for movement relative thereto to form a second portion of a flux path of magnetic material for the magnetic field;
the armature being formed with a pole face at each end thereof which are arranged to mate with associated ones of the pole faces of the core when the magnetic field is developed to form a substantially closed loop flux path of magnetic material for the developed magnetic field;
the core and the armature being plated whereby a buildup of plating material occurs on opposite ends of at least one of the pole faces thereof which results in the pole faces being bowed along the length thereof; and
the bowed pole faces of the core and the armature having dissimilar length dimensions to permit the mating bowed pole faces to move sufficiently close together so that any airgap between the bowed pole faces is insufficient to create an undesirable deficiency in the flux path formed by the mated core and armature.