April 6, 1943. W. M. BRADSHAW 2,315,587

ELECTRICAL INSTRUMENT

Filed Nov. 27, 1940 2 Sheets-Sheet 1

Fig. 1.

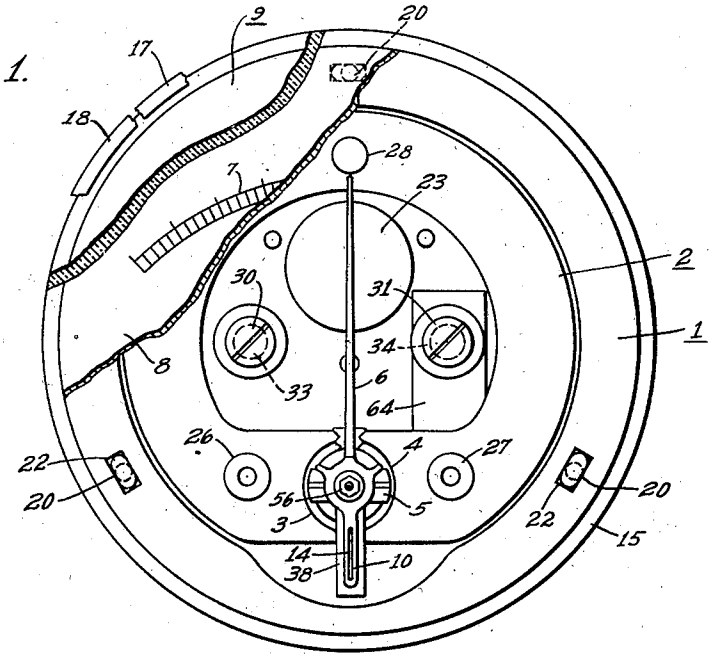
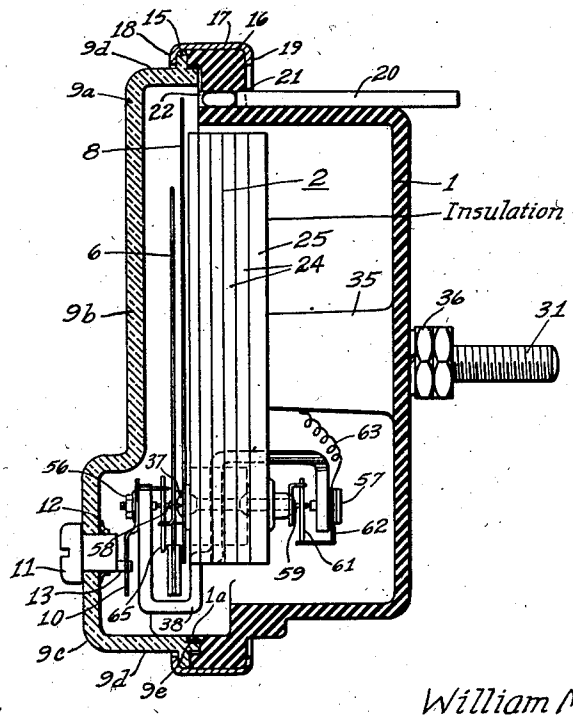


Fig. 2.



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ELECTRICAL INSTRUMENT

Filed Nov. 27, 1940 2 Sheets-Sheet 2

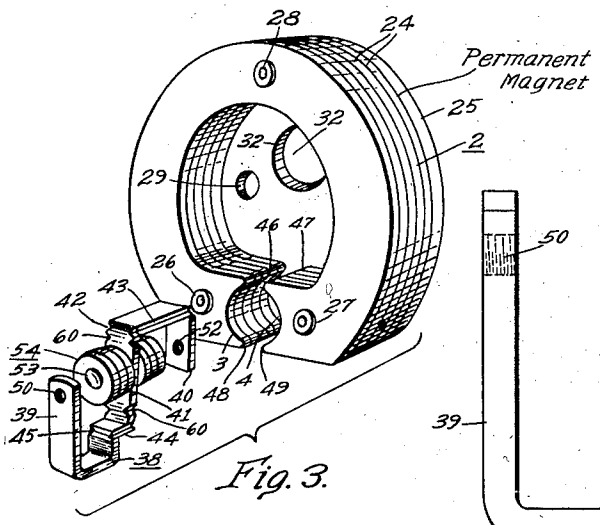
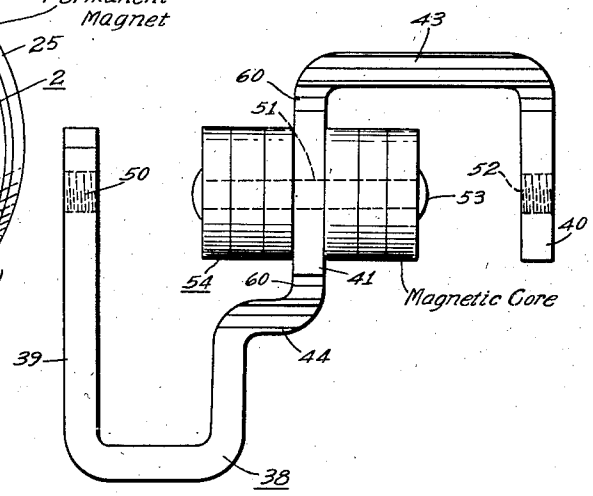


Fig. 3.

Fig. 4.



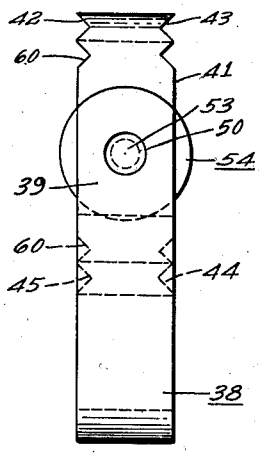


Fig. 6.

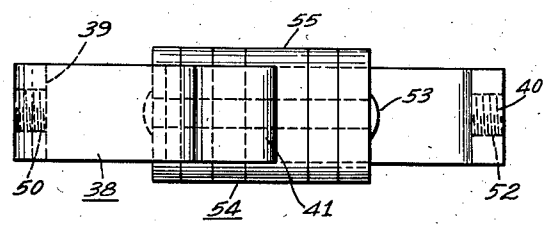


Fig. 5.

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UNITED STATES PATENT OFFICE

2,315,587

ELECTRICAL INSTRUMENT

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Application November 27, 1940, Serial No. 367,389

12 Claims. (Cl. 171—95)

This invention relates to electrical instruments, and it has particular relation to electrical measuring instruments of the permanent magnet moving coil type.

Permanent magnet moving coil measuring instruments are commonly known as D'Arsonval instruments. Such instruments are widely employed in the electrical arts for voltage and current measurements. As commonly constructed a permanent magnet having spaced arcuate pole faces is provided. Between the pole faces a cylindrical magnetic core is inserted to define an annular air gap. Within the air gap a coil is mounted for rotation.

It is customary to mount the various parts of a D'Arsonval instrument on the permanent magnet by means of brackets and bridges affixed to the permanent magnet by means of machine screws and rivets. Because of the extremely small size of the parts and because of the large number of independent parts which must be associated, it is extremely difficult to construct a D'Arsonval measuring instrument with accurate alignment of the various parts. Unusually small tolerances and extreme care in manufacture is required to assure satisfactory operation of such instruments.

In accordance with the invention, an entire armature assembly for a D'Arsonval instrument is maintained in position by the resiliency of a permanent magnet. In order to mount the armature assembly the pole faces of the permanent magnet are separated against the resiliency of the permanent magnet to permit the armature assembly to be inserted therebetween. The resiliency of the permanent magnet then is permitted to urge the pole faces towards the armature assembly, whereby the armature assembly is effectively clamped between the pole faces. It will be noted that the armature assembly is firmly gripped without recourse to rivets, machine screws, or bolts. At the same time the armature assembly serves to space the pole faces accurately.

Preferably the armature assembly includes a single homogeneous supporting member which may be substantially S-shaped. This supporting member has two ends connected by an intermediate connecting link. Parallel grooves are formed in the supporting member for receiving edges of the permanent magnet whereby the supporting member is clamped between the pole faces of the permanent magnet. Moreover the supporting member is provided with three aligned holes. A magnetic core which conveniently can be formed from magnetic disks or washers is riveted to the supporting member by a rivet passing through one of the holes. The remaining holes are employed for receiving bearing screws which rotatably position the moving coil in the gap between the magnetic core and the pole faces of the permanent magnet.

The extremely weak operating torques available in a D'Arsonval instrument require a light movement. One of the main sources of weight associated with the movement is the indicating pointer which generally is attached to the moving coil. In prior art instruments this pointer has been constructed with two right-angle bends for bringing the indicating portion of the pointer into proximity to the transparent cover of the instrument. Such proximity is desirable for convenience in reading the instrument.

Partly because of its right-angle bends, such a pointer adds to the weight of the moving coil assembly. Such an increase in weight is objectionable because of the increased wear on the small pivots employed for the instrument and because of the increased inertia of the moving assembly which retards the rate of response of the instrument.

In accordance with a further aspect of the invention, a straight pointer is employed for the moving coil assembly. In order to facilitate reading of the instrument, a transparent cover employed therefor is provided with a well over the armature assembly which provides adequate clearance therefor. The provision of the well permits the remainder of the cover to be placed in proximity to the straight pointer for convenience in reading.

In prior art instruments adjustments of the instrument have been effected by means of an adjusting element passing through the cover thereof. In accordance with the invention, such an adjustment element may be omitted by providing a readily detachable cover. Adjustment of the instrument then is effected by removing the cover.

It is, therefore, an object of the invention to provide a measuring instrument of improved and simplified construction.

It is a further object of the invention to provide a permanent magnet measuring instrument having an armature assembly positioned between pole faces of the permanent magnet by the clamping action of the permanent magnet.

It is another object of the invention to provide a permanent magnet measuring instrument

having an armature assembly mounted on a single homogeneous supporting member.

It is a still further object of the invention to provide a measuring instrument having a substantially S-shaped supporting member for supporting a magnetic core and a moving coil.

It is a further object of the invention to provide a permanent magnet instrument designed to clamp an armature supporting member between the pole faces of the permanent magnet and having a magnetic core and a coil mounted on the supporting member.

It is a still further object of the invention to provide a permanent magnet instrument having a readily detachable cover.

Other objects of the invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which:

Figure 1 is a view in front plan with portions broken away of a measuring instrument embodying the invention;

Fig. 2 is a view in cross section of an instrument substantially similar to that illustrated in Fig. 1;

Fig. 3 is an exploded view in perspective of an instrument movement suitable for the instruments of Figs. 1 and 2;

Fig. 4 is a detailed view in side elevation of a supporting member suitable for the instruments of Figs. 1 and 2;

Fig. 5 is a view in bottom plan showing a slightly modified form of the supporting member illustrated in Fig. 4; and

Fig. 6 is a view in any elevation of the supporting member illustrated in Fig. 4.

Referring to the drawings, Fig. 1 shows a permanent magnet instrument of the D'Arsonval type having a casing 1 for supporting a permanent magnet 2. This permanent magnet is provided with pole faces 3 and 4 defining an air gap within which a coil 5 is mounted for rotation. The coil 5 carries a pointer 6 which in rotating sweeps over a scale 7 carried by a dial plate 8. For protecting the instrument a light-permeable cover 9 encloses the open face of the instrument.

As is customary in D'Arsonval permanent magnet instruments, a zero adjuster is provided in the form of a lever 10 which may be actuated for varying the adjustment of the instrument. If the light-permeable cover 9 is readily detachable from the casing 1, the cover may be made continuous and adjustments effected by removal of the cover from the casing to expose the adjusting lever 10.

Fig. 2 discloses an instrument which is exactly the same as the instrument of Fig. 1 except for the provisions of an externally accessible adjustment device 11. This adjustment device is in the form of a pin extending through a light-permeable member 9a which otherwise is similar to the light-permeable cover 9 of Fig. 1. The pin is retained in position by means of an external head and a resilient ring 12 which is forced over the interiorly protruding portion of the pin. The pin also carries an eccentrically positioned lug 13 which extends into a slot 14 provided in the lever 10. From an inspection of Fig. 2, it will be noted that rotation of the adjustment device 11 operates to move the lever 10 and thereby to adjust the instrument.

The attachment of the light-permeable cover 9 or 9a to the casing 1 may be effected by providing the cover and casing with abutting flanges 15 and 16. To retain the cover in position on the casing, a split spring ring 17 having dependent flanges 18 and 19 is positioned to engage the flanges 15 and 16. By spreading the ring 17 and removing it from the flanges 15 and 16, the cover 9 or 9a may be removed readily from the casing 1.

Attachment of the instrument to a supporting panel is facilitated by the provision of cotter pins 20 spaced around the periphery of the instrument. Each of the cotter pins 20 extends through a snugly fitting hole 21 provided in the flange 16 of the casing. The hole 21 terminates in an enlarged slot 22 for receiving the head of the cotter pin. By extending the casing 1 which may be of cylindrical formation through a snugly fitted opening in a panel and spreading the cotter pins 20, the instrument may be maintained in position on the panel.

In permanent magnet instruments, it often is desirable to mount auxiliary equipment on or in the instrument. Such equipment may be mounted in the space provided within the permanent magnet 2 and is represented in Fig. 1 by an element 23 which may represent a multiplying resistance for determining the range of the instrument, or a contact rectifier for converting the instrument for alternating current operation.

The construction of the permanent magnet and armature assembly may be understood more fully by reference to Fig. 3. The permanent magnet 2 may be in the form of a conventional solid permanent magnet, but preferably this permanent magnet is of laminated construction. Although any suitable number of laminations may be employed, for the purpose of illustration, five laminations 24 are attached to a supporting base 25 which preferably is of non-magnetic insulating material. The attachment of the laminations to each other and to the base 25 may be effected by rivets 26, 27 and 28 which extend through the laminations. Preferably one of the rivets, as the rivet 26, does not extend through the base 25 in order that the pole faces 3 and 4 of the permanent magnet may be separated against the resiliency of the permanent magnet for reasons which will be set forth below. As indicated in Fig. 3, the base 25 may be provided with openings 29 for receiving terminal screws 30 and 31 and with additional openings 32, as desired.

The terminal screws 30 and 31 also may be employed for attaching the permanent magnet 2 to the casing 1. To this end the terminal screws have heads 33 and 34 which engage the insulating base 25, and extend through pillars 35 formed integrally with the casing 1. Suitable nuts 36 are provided for attaching the terminal screws in place and for establishing suitable electrical connections thereto. If desired, the rivets 26 and 27 may be internally threaded to receive machine screws 37 employed for attaching the dial 8 to the magnet 2.

The armature assembly for the instrument is carried by a supporting member 38, which preferably is of non-magnetic material such as brass. The supporting member may vary substantially in shape. Conveniently, this member may be generally of S-shape having two ends 39 and 40 joined by a connecting link 41. Either the permanent magnet or the supporting member may be provided with grooves for receiving tongues or edges formed on the other of these two structures. In the specific embodiment illustrated the material employed for the supporting member is sufficiently thick to receive a plurality of aligning surfaces in the form of

grooves 42, 43, 44 and 45. From an inspection of Fig. 3, it will be noted that these grooves are positioned to engage opposed edges 46, 47, 48 and 49 formed by extensions on opposite sides of the arcuate pole faces 3 and 4. The spacing between the grooves 42 and 43 and between the grooves 44 and 45 is slightly larger than that between the edges 46 and 47 and between the edges 48 and 49.

In order to insert the supporting member 38 between the pole faces 3 and 4 a jack or other suitable fixture is applied to the magnet 2 in order to force the pole faces 3 and 4 apart slightly against the resiliency of the magnet. Generally a movement of the order of 0.006 inch is adequate. With the pole faces separated in this manner, the supporting member 38 may be positioned to receive the edges 46, 47, 48 and 49 in the grooves 42, 43, 45 and 44. When the permanent magnet 2 is released, its resiliency forces the edges into the grooves to clamp the supporting member 38 securely in position.

It will be noted that the supporting member 38 operates as a spacer element for accurately spacing the pole faces 3 and 4. For this reason the rivets 26 and 27 need not be relied on to align the laminations accurately, nor need they grip the laminations firmly. Moreover, variations in the permanent magnets, such as those produced by warping thereof during heat-treatment, have no appreciable effect on the final spacing of the pole faces 3 and 4. It will be noted further that the grooves and edges provide interlocking formations which permit movement of the supporting member 38 only in a direction substantially parallel to the axis of the gap between the pole faces 3 and 4. Construction of the supporting member is shown somewhat more clearly in Figs. 4, 5 and 6.

The three portions of the supporting member 38 including the ends 39 and 40 and the connecting link 41 are provided with aligned openings 50, 51 and 52. The central opening 51 receives a rivet 53 for clamping to the supporting member a suitable magnetic core 54. This magnetic core may be of unitary construction but is illustrated in the form of a plurality of magnetic disks or washers positioned on each side of the connecting link 41. As shown in Fig. 5, one of the washers 55 may have a recess for receiving the connecting link 41. Such a construction extends the effective volume and surface of the magnetic core.

The openings 50 and 52 may be provided with threads for the reception of suitable bearings 56 and 57 (see Fig. 2). These bearings are positioned to receive stub shafts 58 and 59 carried by the movable coil 5.

It will be understood that the magnetic core 54 is maintained in position between the pole faces 3 and 4 to define therebetween an annular air gap. The magnetic structure including the permanent magnet 2 and the magnetic core 54 creates a magnetic field of high intensity in this annular gap. The coil 5 is mounted for rotation in the annular gap. If desired, notches 60 may be provided in the connecting link 41 to provide an increased path of travel for the coil 5.

In accordance with well-known practice, one terminal of the coil 5 may be connected through a flexible conductor or spring 61 to a lug 62 which is carried by the bearing 57 and which is insulated therefrom. The lug 62 is in turn connected through a suitable conductor 63 to one of the terminal screws 30. The remaining terminal screw 31 may be grounded to the permanent magnet by means of a suitable conducting strap 64. A spring 65 may be employed for connecting the remaining terminal of the coil 5 through the lever 10, which is pivoted on the bearing 56, to the permanent magnet 2. In accordance with standard practice, rotation of the lever 10 may be employed for varying the position of the spring 65 thereby to vary the adjustment of the instrument.

The construction of the supporting member 38 initially contemplates the formation of parallel surfaces on the connecting link 41. These parallel surfaces are intended to receive the magnetic washers employed for the core 54. After the parallel surfaces have been formed, the supporting member 38 is grasped, preferably by clamping the connecting link 41 in a suitable fixture, and the parallel grooves 42, 43, 44 and 45 are formed therein. At the same time, if desired, the notches 60 may be cut.

After the formation of the grooves, and while the supporting member 31 is still clamped at its connecting link 41, the holes 50, 51 and 52 are drilled therethrough, preferably in a single drilling operation. By this sequence of steps the grooves are accurately cut perpendicular to the surfaces of the connecting link 41, and the holes or openings 50, 51, or 52 are drilled accurately in alignment and along an axis perpendicular to the same surfaces of the connecting link 41. Because of this construction, it is not necessary that the ends 39 and 40 of the supporting member be parallel to each other or to the connecting link 41. Since the holes 50 or 52 are properly aligned for reception of the bearing screws, the exact inclination of the ends 39 and 40 is of minor importance.

It will be noted that the S-shaped member 38 performs a number of functions. In the first place it accurately aligns the laminations of the permanent magnet 2 and establishes an accurate air gap between the pole faces 3 and 4. In addition, the supporting member 38 carries the magnet core 54 and accurately positions it within the air gap between the pole faces 3 and 4. Furthermore, the supporting member accurately aligns the bearing screws 56 and 57 for supporting the coil 5 in proper position within the annular air gap between the magnetic core 54 and the pole faces 3 and 4.

As above indicated, it is customary in the art to provide a D'Arsonval instrument with a pointer having two right-angle bends. Such a pointer is illustrated for example, in the Bernarde Patent 2,157,845, issued May 9, 1939, and assigned to the Westinghouse Electric & Manufacturing Company. As pointed out in this patent, it is desirable to provide a light pointer construction. Because of the right-angle bends necessitated by the prior art constructions, the minimum weight for the pointer has not been obtained.

Referring to Figs. 1 and 2, it will be noted that the pointer 6 is a straight pointer adjacent the dial plate 8. For ease in reading, the cover 9 or 9a is provided with an offset portion 9b over the end of the pointer 6. Such a construction results in the formation of a well 9c over the armature assembly of the instrument for providing adequate clearance therefor. If desired, the cover 9 or 9a may be molded in one piece from a suitable light-permeable material such as glass or a translucid plastic such as a methyl methacrylate resin.

By reference to Fig. 2, it will be noted that

the cover 9 or 9a is provided with a cylindrical wall portion 9d surrounding the dial plate. When the instrument is illuminated by external light, the cylindrical wall portion 9d permits the entry of an increased amount of light for illuminating the dial plate 8 and the pointer 6.

The casing 1 conveniently may be formed from any suitable insulating material such as a phenol formaldehyde resin.

It is believed that the construction and operation of the instrument constructed in accordance with the invention is apparent from the foregoing description. Any suitable number of laminations of permanent magnet material may be formed into the desired shape, heat treated, aged, magnetized and assembled by means of rivets 26, 27 and 28 to each other and to the base 25. The supporting member 38 then is provided with flat parallel surfaces for the reception of magnetic washers which are attached thereto subsequently by means of the rivet 53. With the supporting member 38 grasped by its connecting link or central supporting portion, grooves 42, 43, 44 and 45 are cut therein perpendicular to the connecting link 41. Finally the holes 50, 51 and 52 are drilled through the ends and connecting link of the supporting member in alignment with each other and perpendicular to the surfaces of the connecting link 41. The ends 39 and 40 have their holes or openings threaded for the reception of bearing screws 56 and 57.

Because of the S formation of the supporting member, the coil 5 may be slipped readily over the supporting member with its shafts in position to engage the bearings 56 and 57. This permits the adoption of a single piece, homogeneous supporting member. When the armature assembly is completely assembled, the permanent magnet 2 may have its pole faces 3 and 4 separated against the resiliency of the permanent magnet by means of a suitable jack. The armature assembly may then be slid into position wherein the grooves 42, 43, 44 and 45 are positioned to receive the edges or extensions 46, 47, 49 and 48. When the permanent magnet 2 is released, the edges grip the supporting member 38 to retain the armature assembly firmly in operative position. The only points of contact between the armature assembly and the permanent magnet are the abutting portions or aligned surfaces contacting the edges 46, 47, 48 and 49.

The conductor 63 then may be attached to the lug 62, and the permanent magnet 2 together with its armature assembly may be mounted in the casing by means of the terminal screws 30 and 31. The desired dial plate is attached to the permanent magnet by means of the screws 37, and the cover 9 or 9a is attached thereover by means of the split spring ring 17 to complete the instrument assembly.

If desired, the cover may be provided with a notch 9e for the reception of a lug 1a carried by the casing 1. The lug and notch cooperate to prevent the mounting of the cover when the well 9c is displaced from its position over the armature assembly.

Although the invention has been described with reference to certain specific embodiments thereof numerous modifications are possible. Therefore, the invention is to be restricted only by the appended claims when interpreted in view of the prior art.

I claim as my invention:

1. In an electrical measuring instrument, a resilient, laminated magnetic structure having spaced integral pole faces defining an arcuate gap extending transversely to the laminations of said structure, said magnetic structure being effective for producing a magnetic field in said gap, the individual ends of the laminations forming said magnetic structure being unevenly aligned, a coil positioned in said gap, means mounting said coil for rotation in said gap relative to said magnetic structure with the sides of said coil in close proximity to said pole faces, and supporting means for supporting said mounting means comprising spaced, parallel ways on said magnetic structure respectively adjacent each of said pole faces and extending transversely to the laminations of said structure, said mounting means having a portion interposed between, and grasped by, said ways of sufficient width to spring apart the pole faces of said magnetic structure sufficiently to align said individual ends.

2. In an electrical measuring instrument, a laminated, resilient magnetic structure having spaced integral pole faces defining a cylindrical gap extending transversely to the plane of the laminations of said structure, and having spaced extensions respectively adjacent said pole faces, said magnetic structure being effective for producing a magnetic field in said gap, the individual ends of the laminations forming said magnetic structure being unevenly aligned, and a unitary armature assembly positioned between said pole faces, said assembly including a magnetic core cooperating with said pole faces for defining a substantially annular gap, a coil having a portion within said annular gap, and means mounting said coil for rotation, said armature assembly having a supporting portion interposed between said extensions, the spacing between said extensions being less with said armature assembly removed therefrom than the corresponding dimension of said supporting portion by an amount sufficient to spring apart and align the individual ends of the laminations forming the magnetic structure.

3. In an electrical measuring instrument, a laminated, resilient magnetic structure having spaced integral and arcuate pole faces for defining a cylindrical gap extending transversely to the plane of the laminations of said structure, said magnetic structure being effective for producing a magnetic field in said gap, the individual ends of the laminations forming said magnetic structure being unevenly aligned, and an armature assembly removably mounted in said gap comprising a supporting member having portions extending between the opposed edges of said pole faces proportioned for spreading said pole faces apart against the resiliency of said magnetic structure sufficiently to align the individual ends of the laminations forming said magnetic structure, a cylindrical magnetic core carried by said supporting member, said cylindrical magnetic core being positioned concentrically within said cylindrical gap for defining with said pole faces a substantially annular gap, a coil having portions positioned in said annular gap, and means mounting said coil on said supporting member for rotation relative thereto about the axis of said magnetic core.

4. In an electrical measuring instrument, a resilient, laminated permanent magnet having spaced, arcuate pole faces for defining a cylindrical gap, and having opposed, parallel edges bordering said pole faces, said permanent magnet being effective for producing a magnetic field in

said gap, and an armature assembly removably mounted as a unit in said gap comprising a supporting member having a pair of parallel surfaces disposed for engaging said parallel edges, said parallel edges being spaced apart by a dimension normally less than the corresponding spacing of said parallel surfaces, whereby insertion of said parallel surfaces therebetween causes said parallel edges to grip said supporting member, and said supporting member having first, second and third spaced portions extending generally at right angles to said parallel surfaces, said portions being spaced along the axis of said gap, and each of said portions having a hole aligned with said axis, a cylindrical magnetic core, first means passing through the hole in said first portion for attaching said core to said first portion, said magnetic core being positioned within said gap to define a substantially annular gap bounded by pole faces, a coil surrounding said magnetic core and having portions in said annular gap, and means associated with the holes in said second and third portions for mounting said coil for rotation about said axis.

5. In an electrical measuring instrument, a resilient, laminated permanent magnet having spaced, arcuate pole faces for defining a cylindrical gap, and having opposed, parallel edges bordering said pole faces, said permanent magnet being effective for producing a magnetic field in said gap, and an armature assembly removably mounted as a unit in said gap comprising a generally S-shaped supporting member having a pair of parallel surfaces disposed for engaging said parallel edges, said parallel edges being spaced apart by a dimension normally less than the corresponding spacing of said parallel surfaces, whereby insertion of said parallel surfaces therebetween causes said parallel edges to grip said supporting member, said parallel surfaces and edges having interlocking formations permitting movement of said supporting member relative to said permanent magnet only in a direction parallel to the axis of said gap, and said supporting member having first, second, and third spaced portions extending generally at right angles to said parallel surfaces, said portions being spaced along the axis of said gap, and each of said portions having a hole aligned with said axis, a plurality of magnetic washers assembled to form a cylindrical magnetic core, first means passing through the hole in said first portion for attaching said core to said first portion, said magnetic core being positioned within said gap to define a substantially annular gap bounded by pole faces, a coil surrounding said magnetic core and having portions in said annular gap, and means associated with the holes in said second and third portions for mountnig said coil for rotation about said axis.

6. In a magnetic circuit for an electrical instrument, a resilient laminated magnetic structure having integral opposed pole faces for defining a gap and having opposed, parallel edges bordering said pole faces and extending transversely to the plane of the laminations of said structure, said magnetic structure being effective for producing a magnetic field in said gap, and means for accurately spacing the laminations of said magnetic structure for defining a predetermined gap, said means comprising a non-magnetic spacer element spaced from said pole faces, said spacer element having parallel surfaces abutting said parallel edges, said parallel surfaces being spaced apart by a distance greater than the normal spacing of said parallel edges when said magnetic structure is free, whereby insertion of said spacer element between said edges accurately aligns the laminations of said structure and determines said gap.

7. In a magnetic circuit for an electrical instrument, a resilient laminated permanent magnet having integral arcuate opposed pole faces for defining a cylindrical gap, and having spaced pairs of opposed parallel edges bordering said pole faces, the axis of said gap extending at right angles to the plane of said magnet laminations, said magnet being effective for producing a magnetic field in said gap, the individual ends of the laminations forming said permanent magnet being unevenly aligned, and means for accurately spacing the pole faces for defining a predetermined gap, said means comprising a spacer element having parallel surfaces abutting only said parallel edges, said parallel edges and surfaces having interfitting surfaces permitting movement of said spacer element relative to said magnet only in a direction parallel to said edges and surfaces, the spacing of said parallel surfaces being greater than the normal spacing of said parallel edges when said permanent magnet is free by an amount sufficient to spring apart and align the individual ends of the laminations forming said permanent magnet.

8. In a magnetic circuit for an electrical instrument, a resilient laminated permanent magnet having integral arcuate opposed pole faces for defining a cylindrical gap, and having a pair of opposed parallel edges bordering said pole faces on each side of the axis of said gap, the axis of said gap and said parallel edges extending at right angles to the plane of said magnet laminations, said magnet being effective for producing a magnetic field in said gap, the individual ends of the laminations forming said permanent magnet being unevenly aligned, means for accurately spacing the pole faces for defining a predetermined gap, said means comprising a spacer element having parallel surfaces each abutting a separate one of said parallel edges, said parallel edges and surfaces having interfitting surfaces permitting movement of said spacer element relative to said magnet only in a direction parallel to said axis, the spacing of said parallel surfaces being greater than the normal spacing of each pair of said parallel edges when said permanent magnet is free by an amount sufficient to spring apart and align the individual ends of the laminations forming said permanent magnet.

9. In an armature assembly for an electrical instrument, a homogeneous non-magnetic supporting element comprising two substantially parallel, spaced outer members, and an intermediate member substantially parallel to said outer members, said intermediate member being connected to each of said outer members, a magnetic core affixed to said intermediate member and contacting said intermediate member over a surface parallel to said members, a coil positioned around said magnetic core, and means associated with said outer members for mounting said coil for rotation about said magnetic core.

10. In an armature assembly for an electrical instrument, an S-shaped non-magnetic supporting element having two outer ends and an intermediate connecting link for said ends, said supporting element having openings aligned along a common axis in said ends and in said intermediate link, a cylindrical magnetic core, means extending through said magnetic core and the

opening in said intermediate link for attaching said magnetic core to said intermediate link, first bearing means positioned in each of said openings in said ends, a coil positioned around sad magnetic core and proportioned to lie between said outer ends, and second bearnig means carried by said coil, said bearing means comprising shaft means cooperating with bearings for mounting said coil for rotation about said axis.

11. In an electrical instrument an armature assembly including a homogeneous non-magnetic supporting element comprising two substantially parallel spaced outer members, and an intermediate member substantially parallel to said outer memers, a magnetic core affixed to said intermediate member, a coil positioned around said magnetic core, and means associated with said outer members for mounting said coil for rotation about said magnetic core, said supporting element having a pair of portions on opposite sides of the axis of rotation of said coil, and a resilient magnetic structure clasping each of said portions to position said armature assembly relative to said magnetic structure, said portions and said magnetic structure having interfitting parts permitting movement of said armature assembly relative to said magnetic structure only parallel to the axis of rotation of said coil.

12. In an electrical measuring instrument, an armature assembly comprising an S-shaped non-magnetic supporting element having two outer ends and an intermediate connecting link for said ends, said supporting element having openings aligned along a common axis in said ends and in said intermediate link, a cylindrical magnetic core, means extending through said magnetic core and the opening in said intermediate link for attaching said magnetic core to said intermediate link, a bearing positioned in each of said openings in said ends, a coil around said magnetic core, and shaft means carried by said coil, said shaft means cooperating with said bearings for mounting said coil for rotation about said axis, said S-shaped supporting element having a plurality of pairs of spaced grooves in opposed surfaces thereof extending substantially parallel to said axis, said pairs of grooves being positioned on opposite sides of said axis, and resilient supporting means having a portion positioned in each of said grooves for resiliently clamping said armature assembly in mounted position.

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