United States Patent

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[73] Assignee **General Electric Company**

[54] **TAUT BAND SUSPENSION SYSTEM**
9 Claims, 8 Drawing Figs.

[52] **U.S. Cl.** ..... **324/154 R**
[51] **Int. Cl.** **G01r 1/00**
[50] **Field of Search** ..... 324/151, 151 A, 154, 156

[56] **References Cited**

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ABSTRACT: A taut band suspension system for an electrical measuring instrument including a taut band, an inner band anchor connected to an armature assembly and an outer band anchor connected to a frame member. The taut band is "welded" to tab portions formed integrally on each band anchor and located along the axis of rotation of the armature assembly. The taut band is thus welded along a portion of its length and directly along the axis of rotation of the armature assembly which it rotatably supports.

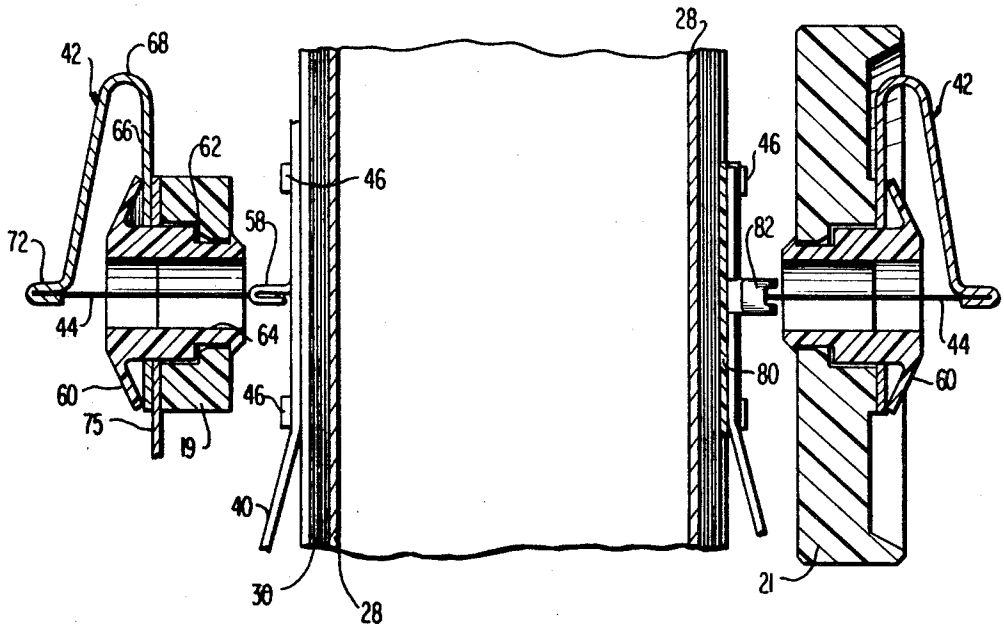


FIG1

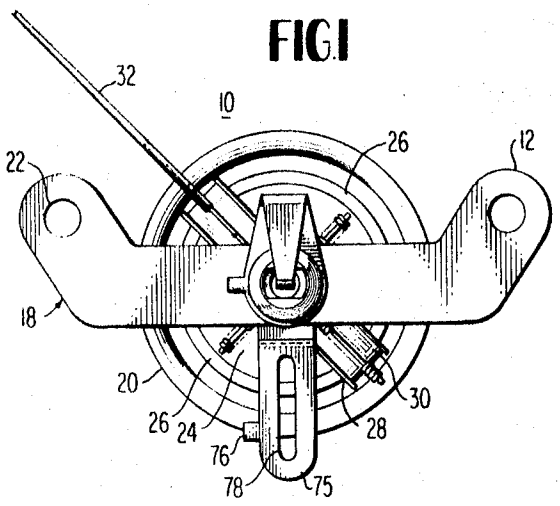
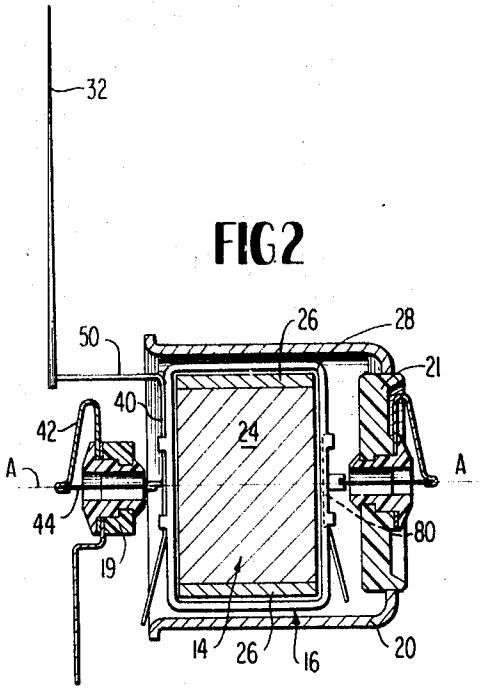


FIG2



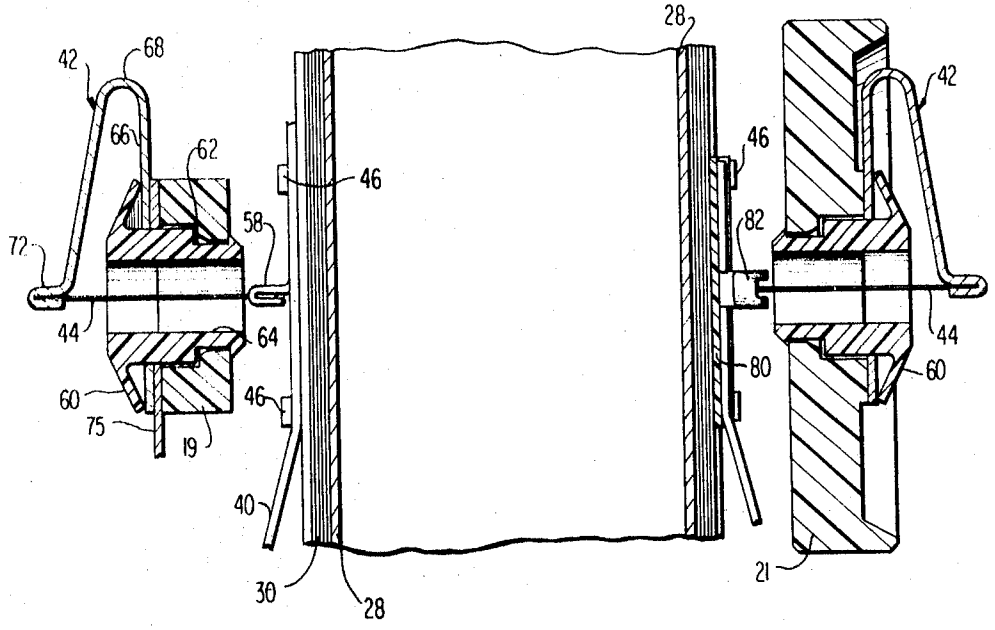


FIG3

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FIG.4

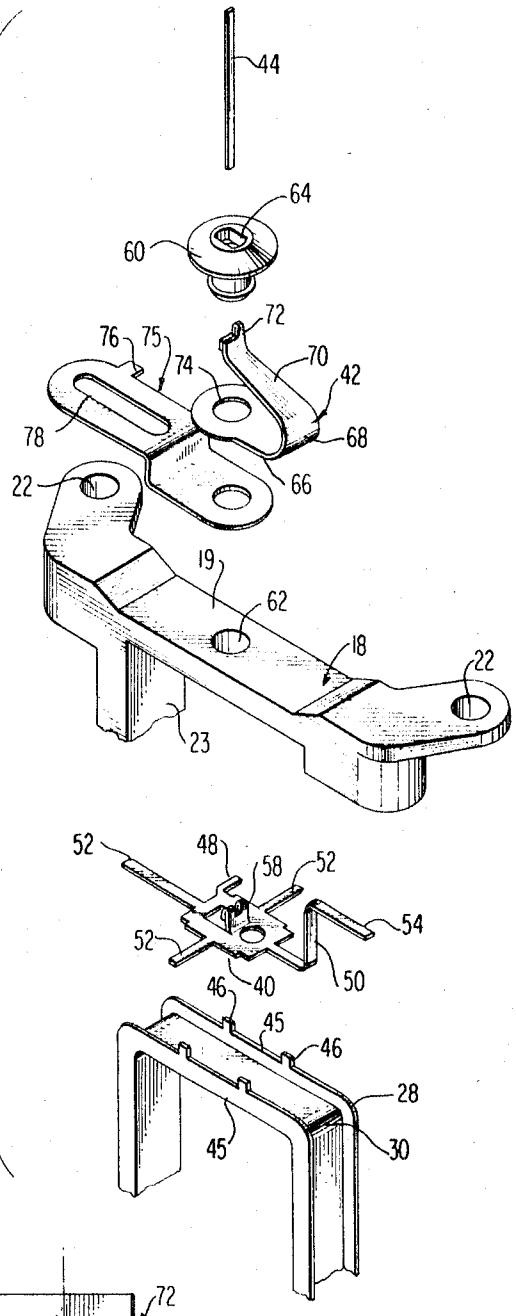


FIG.6A

FIG.5A

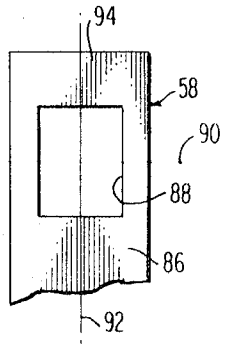


FIG.5B

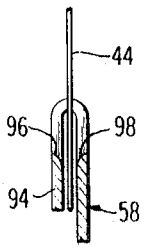
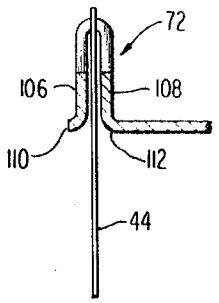


FIG.6B



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TAUT BAND SUSPENSION SYSTEM

BACKGROUND OF THE INVENTION

This invention relates generally to electrical instruments of the D'Arsonval type, and more particularly, to a taut band suspension system therefor.

Instruments of the D'Arsonval type include a moving armature or coil assembly which is mounted for rotation through the field of a permanent magnet assembly. When the armature assembly is energized by means of a current flowing therethrough, the resulting magnetic fields interact to produce a torque which rotates the armature assembly relative to the permanent magnet assembly. An instrument pointer is generally connected to the movable armature assembly to yield a readout with respect to a faceplate or scale mounted behind the pointer as the torque is a function of the current magnitude.

In the past, the movable armature assembly in D'Arsonval movement instruments has been supported by a rigid shaft having pivots which are rotatable in jewel bearings. Such support systems, commonly known as pivot-and-jewel systems, present substantial friction which increases with use and generates random errors due to axial and radial errors within the bearings.

Recently, taut band suspension systems have come into widespread use because they overcome the problem of bearing friction and wear. Taut band suspension systems are characterized by the suspension of the armature assembly on two extremely fine metal bands which are held in tension by resilient anchors supported on an instrument frame. Current is conducted to a coil on the armature assembly by the taut bands causing the the coil and instrument pointer to rotate through an angle related to the magnitude current in the coil. Countertorque is produced by the twisting action on the bands. This countertorque performs the function of coil springs in the pivot-and-jewel suspension systems to return the instrument pointer to its zero point.

Diverse arrangements for attaching taut bands to the armature assembly and frame have been evolved. The more widely used arrangements can be grouped into three categories:

1. Soldering the bands;
2. Clamping the bands between jaws; and
3. Connecting the bands to violin-type crosspiece attachments.

Soldering the bands does provide firm contact between the bands and points of attachment which guarantees a uniform current transfer. Soldering the bands, however, demands a great deal of skill, especially when used for extremely thin bands as poorly soldered bands result in almost immediate destruction of the suspension system.

Clamping the band between two jaws creates good electrical contact, but it also creates additional pressure on the band. Local stress peaks may also be created in connection with the abrupt change of cross section associated with this arrangement. The jaws thus have to be well rounded at the clamping area to eliminate this problem. Additionally, from a manufacturing standpoint, clamping is a tedious and time-consuming job.

Connecting the band to a violin-crosspiece attachment is the most widely used arrangement. However, it also generates the greatest number of problems. In this arrangement the taut band is generally led through a notch or groove in a rounded bridge crosspiece. Welding or soldering is done beyond the rounded bridge and results in a significant amount of wasted band material. In addition, this arrangement generally demands an anchor-to-band subassembly because it is not possible to work at the armature assembly adjacent the inner band anchor. The existence of this subassembly, especially with two fragile bands, constitutes a serious obstacle to automating the instrument assembly. The location of the effective band end, defined where the taut band just contacts the anchor, is extremely critical. Its location depends on a number of factors

including the band placement with respect to the notch or groove and the final position of the band anchor. Such positioning is susceptible to movement after calibration of the instrument; and such movement can destroy the instrument balance and accuracy. Further, the band is rectangular in cross section and may tend to bow slightly from the axis of rotation of the armature assembly when bent about the crosspiece.

It is an object of this invention, therefore, to provide a taut band suspension system which substantially eliminates the above-mentioned problems associated with prior suspension systems.

It is another object of this invention to provide a suspension system in which a band is welded directly along the axis of rotation of the armature member which it rotatably supports.

It is a further object of this invention to provide a suspension system which yields the advantages of a clamping system but which is less expensive to implement and more readily adapted for automation.

SUMMARY

Briefly stated, the objects of this invention are carried out by providing a suspension system which comprises a piece of taut band material welded to the inner and outer band anchors along the axis of rotation of the armature assembly.

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter of the invention, an understanding of the above and further objects of the advantages of this invention may be gained from the following detailed description of a preferred embodiment in connection with accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a top view of an instrument assembly utilizing the taut band suspension system of this invention;

FIG. **2** is a sectional view of the mechanism in FIG. **1**;

FIG. **3** is a partial side view similar to FIG. **2** showing the suspension system in enlarged detail;

FIG. **4** is an exploded view illustrating the details of the suspension system;

FIGS. **5A** and **5B** are detailed views of a portion of the suspension system; and

FIGS. **6A** and **6B** are detailed views of another portion of the suspension system.

DESCRIPTION OF AN ILLUSTRATIVE EMBODIMENT

In the FIGURES like numerals refer to like elements throughout. One example of an electrical indicating mechanism, generally designated by numeral **10**, which utilizes a suspension system incorporating this invention, is shown in FIGS. **1** and **2** prior to being placed within an instrument casing. The instrument mechanism **10** comprises basically a frame assembly **12**, a magnet assembly **14** and armature assembly **16**.

The frame assembly **12** includes a support member **18** and a combination flux cup and shield **20**. A top portion **19** and a bottom portion **21** of the support member **18** are connected together by a leg portion. Openings **22** in the top portion **19** permit attachment of the support member, and thus the instrument mechanism **10**, to the instrument casing. The support member **18** fits within and is engaged and restrained by the flux cup and shield **20**.

The magnet assembly **14** includes a cylindrical, compressed Alnico permanent magnet **24** and arcuate pole pieces **26** which are rigidly attached to the outer perimeter of the permanent magnet **24** as best shown in FIG. **1**. The pole pieces **26** may be formed of any suitable magnetic material such as steel. Other magnetic pole piece configurations are adapted for use in instruments utilizing this invention. Notwithstanding the configuration of the magnetic assembly **14**, it is important that the pole pieces **26** and the adjacent portions of the flux cup and shield **20** define a uniform air gap therebetween.

The armature assembly **16** comprises a coil support member **28** and a wound copper coil **30**. The coil support member **28**, which is generally rectangularly shaped with a U-shaped cross section, is formed to rotate freely in the air gap between the magnet assembly **14** and the flux cup and shield **20**, as best shown in FIG. **2**. Free rotation is possible when the armature assembly **16** is supported for rotation about an axis A—A by the suspension system to be described in detail. An indicating pointer **32** is rigidly coupled to the coil support member **28** for rotation therewith.

In operation, current in the copper coil **30** produces a magnetic field which interacts with the magnetic field generated by the permanent magnet **24** to rotate the armature assembly **16** with respect to the permanent magnet **24**. The angular displacement of the armature assembly **16** and the indicating pointer **32** with respect to an instrument faceplate located behind the pointer is directly related to the current magnitude.

One function of any taut band suspension system is supporting the armature assembly **16** for rotation about the permanent magnet **24**. Other functions of the taut band include electrically connecting the coil **30** to electrical input terminals and providing restoring torque to the armature assembly **16**. As shown in detail in FIGS. **3** and **4**, the taut band suspension generally comprises an inner band anchor **40**, a resilient outer band anchor **42** and a taut band connected between the inner band anchor **40** and the outer band anchor **42** which is generally rectangular in cross section.

One of the inner band anchors **40** is constructed of a rectangular, electrically conductive plated member approximately the same width as the coil support member **28**. The inner band anchor **40** lies upon and is supported by upstanding leg portions **45** (FIG. **4**) of the U-shaped support member **28**. It is rigidly connected to the coil support member **28** by crimping over a plurality of integral tabs **46** on the support member **28** as shown in FIG. **3**.

As best shown in FIG. **4**, a plurality of integrally formed arms **48**, **50** and **52** extend from the inner band anchor **40**. One end of the copper coil **30** is electrically connected to the arm **48**. The arm **50**, which extends from one end of the anchor **40** and includes a pair of right-angle bends and terminates with a portion **54**, supports the indicating pointer **32** after final assembly. The plurality of arms **52** balance the finally assembled moving portions of the instrument mechanism. Balance weights can be added to the arms **52** as necessary.

An integral tab **58**, located near the center of the flat plate portion of the inner band anchor **40**, serves a dual purpose. The primary function of the tab **58** is to anchor one end of the taut band **44** as described hereinafter. Its secondary function is to provide a shock stop by limiting the radial displacement of the armature assembly **16**. This stopping action occurs when the tab **58**, normally free within a snap-in bushing **60** is located in an opening **62** within the support member **18** is driven by shock to engage a bushing wall **64**.

A resilient outer band anchor **42**, which is of generally U-shaped configuration as best shown in FIGS. **3** and **4**, comprises a first leg portion **66**, a curved bight portion **68**, a second leg portion **70**, and a band anchor portion **72** which extends from the free end of the leg portion **70**. The first leg portion **66** includes a circular opening **74** which receives the snap-in bushing **60**, the bushing **60** thereby connecting the anchor **42** to the support member **18**.

A second member **75** is located between the support member **18** and one outer band anchor **42** and is connected to the support member **18** by means of the snap-in bushing **60**. The member **75** provides two functions. It serves as an electrical connection, by means of a tab **76**, for one of the lead-in lines to the meter. Secondly, an opening **78** in the member **75** is adapted to receive an arm of a zero reset button. When the zero reset button is rotated, the outer band anchor **42** is displaced thereby altering the taut band orientation. This alteration of the taut band orientation causes the indicated zero point of the instrument to change.

The suspension system located on the opposite end of the instrument mechanism **10** is identical to that described above with the exception that the inner band anchor **40** described above is replaced by an inner band anchor subassembly **80** (FIG. **3**) which comprises a small rectangular flap plate with an integral tab portion **82** and an insulating member **84**. The inner band anchor subassembly **80** is again connected to the support member **28** by crimping over tabs **46**. The insulating member **84** isolates the inner band anchor from the coil support member **28** so that the coil **30** is not short circuited.

The details of affixing the taut band to the band anchors along the axis of armature rotation can now be described. Normally the taut band is initially affixed to the inner band anchor. As specifically shown in FIG. **4**, the tab **58** is bent back on itself. As detailed in FIG. **5A**, the tab initially comprises a flat portion **86** having a rectangular opening **88** centered on a bending axis **90** and the centerline **92** of the tab **58**. The opening **88** is sufficiently wide to permit the taut band to pass therethrough when it is centered on the coil. When the inner band anchor is formed, the tab **58** is bent about the axis **90** to the configuration of FIGS. **4** and **5B**. As a result, the free end portion **94** of FIGS. **5A** and **5B** coacts with the base of the tab **58** to clamp the taut band **44** after it is fed through the opening **88** and properly located. Resistance welding or other appropriate techniques can then be used to clamp and bond the taut band to the tab **58** and thereby bond the taut band to the outer band anchor along the axis of armature rotation.

While the term "welded" is used in this specification to denote how the band and anchors are bonded, it is believed that a true weld does not exist. If the band and anchor were raised to a true welding temperature, the band characteristics and properties would be destroyed or adversely affected. In actual practice, the anchor and band are heated under pressure for a certain time period in a resistance welder. It is believed, however, that the plating on the anchor is merely flowed around the band to form the bond. However, for purposes of explanation, the term "welded" is used to denote this condition or property.

As shown in FIG. **5B**, the tab **58** is formed with radiused surfaces **96** and **98**. These surfaces eliminate local stresses which were encountered in the prior art clamping techniques. However, the clamping technique advantages are retained by this configuration of the inner band anchor while the additional problems of manufacture have been greatly simplified.

After the inner band anchor and taut band have been welded, the outer band anchor is deflected until the tab portion lies on the axis of armature rotation. Referring specifically to FIG. **6A**, the tab portion **72** is initially extended. A notch **100** is centered on a transverse bending axis **102**. The notch depth is controlled so that the taut band can be centered on the axis of armature rotation. After the notch **100** is cut, two clamping sections **106** and **108** are defined. The tab portion **72** is then bent about the axis **102** to the configuration shown in FIGS. **4** and **6B**. Radiused portions **110** and **112** also eliminate local stresses. After the taut band **44** is led through the space between the clamping sections **106** and **108**, the assembly is clamped and welded. When the outer band anchor is subsequently released, it remains on the axis of armature rotation and places the taut band **44** in tension. Further, in accordance with this invention, the taut band **44** has been bonded to the outer band anchor along the axis armature rotation. The taut band may be cut with a minimum of waste material.

By utilizing a suspension system constructed in accordance with this invention, the taut band material may be handled from a coil while positioning and welding. After welding it can be cut next to the weld with a minimum of band waste. Since bending the band about or beneath any other member is not required, the band material may be drawn straight from a reel thereby avoiding material kinking or breaking. As the band is welded along the axis of armature rotation, any bowing tendencies are substantially eliminated. Therefore, it should be readily apparent from the above description, that a suspension

system constructed in accordance with this invention has potential for taut band material savings and for instrument assembly automation.

While a preferred embodiment of this invention has been shown and described, it will be obvious to those skilled in the art that there are certain changes and modifications which may be made in the illustrative embodiment without departing from this invention in its broader aspects. For example, it is felt that modifications to the band anchors such as using separate weld pads to replace integral clamping portions can be incorporated in a taut band instrument without departing from the true spirit and scope of this invention as defined in the appended claims.

What we claim as new and desire to be secured by Letters Patent of the United States is:

1. In an electrical measuring instrument including a frame member, means for providing a magnetic field and an armature assembly, the improvement of means for suspending the armature assembly for rotation about an axis within the magnetic field comprising:

a. a taut band;

b. an inner band anchor including a flat plate connected to the armature assembly having an integral tab extending perpendicularly therefrom along the axis of rotation, one end of said taut band being bonded to said tab; and

c. an outer band anchor connected to the frame member having an integral tab extending along the axis of rotation, the other end of said taut band being bonded to said tab.

2. An electrical measuring instrument as recited in claim 1 wherein said inner band anchor additionally comprises clamping means welded to said tab and said taut band whereby said taut band is clamped between said tab and said clamping means.

3. An electrical measuring instrument as recited in claim 2 wherein said inner band anchor clamping means comprises an integral extension of said tab having an aperture formed therein, said extension being bent about an axis transverse to said tab and substantially centered on said aperture, said taut band passing through said aperture and being clamped and welded to said tab and said extension.

4. An electrical measuring instrument as recited in claim 3 wherein portions of said tab and extension adjacent said taut band of said aperture are radiused.

5. An electrical measuring instrument as recited in claim 1 wherein said outer band anchor comprises a generally U-shaped member including a pair of leg portions and a generally curved connecting bight portion and said integral tab extends from one of said leg portions.

6. An electrical measuring instrument as recited in claim 5 wherein said outer band anchor additionally comprises clamping means bonded to said tab and said taut band whereby said taut band is clamped between said tab and clamping means.

7. An electrical measuring instrument as recited in claim 6 wherein said outer band anchor clamping means comprises an integral extension of said tab having a transversely extending notch formed therein, said extension being bent about an axis transverse to said tab and substantially centered on said notch, said taut band passing through said notch and being clamped and welded to said tab and said integral extension.

8. An electrical measuring instrument as recited in claim 1 additionally comprising a second taut band, a second inner band anchor, a second outer band anchor, and integral tabs on said second inner and outer band anchors aligned on the axis of armature rotation, said integral tabs being bonded to said second taut band at the ends thereof and along the axis of armature rotation, said first and second inner band anchors being connected to opposite sides of the armature assembly and said first and second outer band anchors being connected to the frame member whereby the armature assembly is suspended from the frame member for rotation in the magnetic field.

9. An electrical measuring instrument as recited in claim 8 wherein said second inner band anchor is insulated from the armature assembly.