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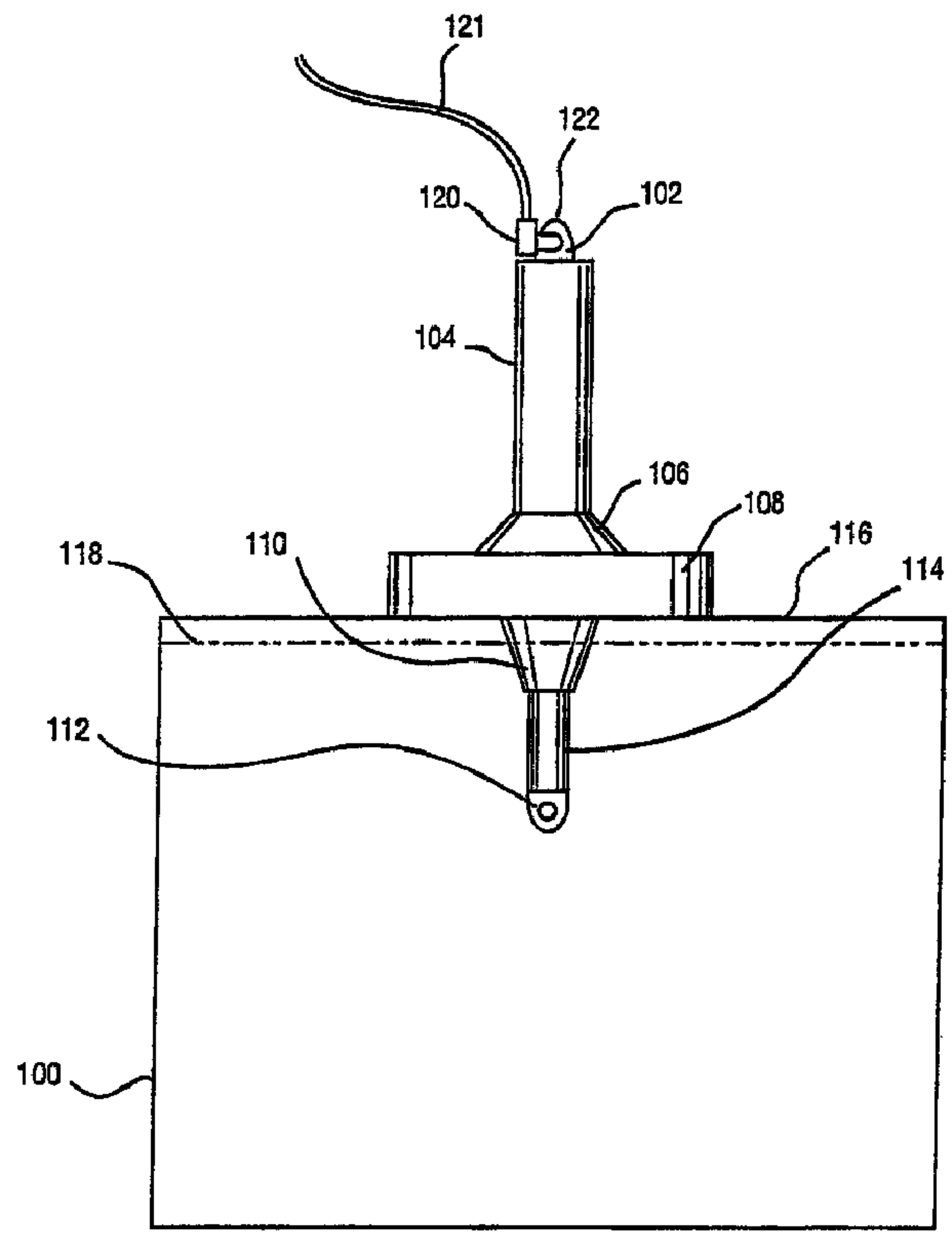
(54) Titre : METHODE ET APPAREIL POUR AUGMENTER LA VALEUR NOMINALE D'UN TRANSFORMATEUR
(54) Title: METHOD AND APPARATUS FOR INCREASING THE RATING OF A TRANSFORMER



(57) Abrégé/Abstract:
The voltage class rating of a transformer ie increased by increasing the rating of an off the shelf molded transformer bushing. Specifically, the voltage class rating is increased by increasing the distance from the non-insulated portion of a conductor of a

(57) **Abrégé(suite)/Abstract(continued):**
transformer bushing and the transformer wall. A conductive extension is connected to the conductor of the bushing. Insulating material in the form of mastic and heat shrink tubing is applied to the external portion of the conductor and the extension. When the modified transformer bushing is installed into a transformer, an internal end of the conductor is made to extend below the surface of the oil in the transformer. The level of the oil also covers an internal insulating shoulder of the bushing. The insulating values of the mastic and heat shrink tubing and the insulating value of the conductor immersed in oil combine to increase the voltage class rating of the off the shelf molded transformer bushing and thereby the transformer, with a nominal increase in costs.

METHOD AND APPARATUS FOR INCREASING THE RATING OF A TRANSFORMER

ABSTRACT

The voltage class rating of a transformer is increased by increasing the rating of an off the shelf molded transformer bushing. Specifically, the voltage class rating is increased by increasing the distance from the non-insulated portion of a conductor of a transformer bushing and the transformer wall. A conductive extension is connected to the conductor of the bushing. Insulating material in the form of mastic and heat shrink tubing is applied to the external portion of the conductor and the extension. When the modified transformer bushing is installed into a transformer, an internal end of the conductor is made to extend below the surface of the oil in the transformer. The level of the oil also covers an internal insulating shoulder of the bushing. The insulating values of the mastic and heat shrink tubing and the insulating value of the conductor immersed in oil combine to increase the voltage class rating of the off the shelf molded transformer bushing and thereby the transformer, with a nominal increase in costs.

METHOD AND APPARATUS FOR INCREASING THE RATING OF A TRANSFORMER

CROSS-REFERENCE TO RELATED APPLICATIONS

The present invention claims the benefit of the filing date of US Patent Application Serial No. 09/850,657, filed on May 7, 2001, now US Patent No. 6,787,704, issued on September 7, 2004, which has a priority filing date of May 9, 2000.

BACKGROUND OF THE INVENTION

Technical Field:

The present invention generally relates to transformers and in particular to bushings utilized within transformers. Still more particularly, the present invention relates to a method and apparatus for increasing the rating of a transformer via enhancements to the bushing utilized within the transformer.

Description of the Related Art:

In the oil-filled transformer industry, transformer capacity is determined based on how much voltage the transformer can safely handle. The amount of voltage a transformer can handle depends on several factors, including the electrical connections of the bushing utilized within the transformer, i.e., the bushing terminals. Bushing terminals are used to hold the electrical conductors and transfer current from outside of the transformer to windings or coils on the inside of the transformer without shorting out on the transformer wall.

Bushing terminals (or bushings) commonly comprise an insulating bracket, a conductor, and provision for mounting the bracket to the transformer to insulate the conductor from the transformer wall. Bushings are rated on how well they insulate the transformer wall from current flowing through the conductor. One factor that must be considered in the rating of bushing terminals is the presence of contaminants on the bushing. Contaminants on the bushing provide a conductive path, which can cause electricity to leak out onto the transformer wall and cause electrical arcing or striking. Arcing occurs when the difference in potential between the transformer wall and the conductor becomes sufficiently large. The air ionizes between the transformer wall and the conductor, and this creates a path of relatively low resistance through which current can flow. The resulting blast of electricity can cause a short circuit to occur and severely damage the transformer.

Another factor used to rate bushings is electrical "creepage" across the insulating bracket. Creepage is the electrical leakage on a solid dielectric surface. Creepage distance is the shortest distance on a dielectric surface between two conductive elements. The current will essentially track or crawl across the insulating bracket onto the transformer wall. The onset of creepage can produce similar effects to contamination in that a short circuit to the transformer wall can occur and cause damage to the transformer itself.

One solution utilized to minimize these problems is the use of a material with a high insulating property such as porcelain to create the bushing. One such porcelain bushing is manufactured by Normandy Machine Co. Inc. of Troy, Missouri and is rated to 5 kV (5000 volts). However, porcelain is not durable and is easily broken. A broken or damaged bushing requires costly replacement and down time of the transformer. To make the insulating material more durable, plastic is often used. One such plastic bushing is manufactured by Central Moloney Inc of Pine Bluff, Arkansas under the trademark of Tuf Ex-Mount™.

Figure 4A is a line drawing of a Central Moloney Inc. Tuf Ex-Mount™ molded transformer bushing as cited above. Bushing **400** contains insulating mounting bracket **408** having a first shoulder **410** and second shoulder **406**. Extending from second shoulder **406** of insulating mounting bracket **408** is a threaded portion **402** of a conductor **404**. Conductor **404** extends from first shoulder **410** of insulating mounting bracket **408** and includes a front end **412** utilized for connecting to transformer windings. **Figure 4B** represents bushing **400** installed in an oil-filled transformer. Typically, bushing **400** is not immersed in oil **414** causing a reduction in voltage capacity.

When mounted, the inside and outside surfaces of Tuf Ex-Mount™ are rated at 1.2kV. In addition, the creepage and strike distances are also designed for use at 1.2kV. Notably, the molded 1.2kV bushing is designed and used such that the external hardware may be installed or exchanged in the field. The low voltage rating of the plastic bushing when compared to the porcelain bushing is primarily due to its smaller dimensions. Utilization of 1.2kV Tuf Ex-Mount bushing at a higher voltage than 1.2kV will result in higher incidents of arcing, striking, or creepage across the insulating bracket.

Therefore, the present invention recognizes that a need exists for a durable, cost effective method for reducing the external creepage and incidents of arcing when using transformer bushings.

SUMMARY OF THE INVENTION

It is therefore one object of the present invention to increase the voltage class of a transformer.

It is another object of the present invention to decrease the external creepage on bushings.

It is yet another object of the present invention to provide an increased strike distance from the conductor of the bushing to a transformer wall.

The foregoing objects are achieved as is now described. The voltage class rating of a transformer is increased by increasing the rating of an off the shelf molded transformer bushing. Specifically, the voltage class rating is increased by increasing the distance between the non-insulated portion of a conductor of a transformer bushing and the transformer wall. Insulating material is connected to the external insulating shoulder of the bushing and covers some of the external portion of the conductor. In the preferred embodiment, the insulating material comprises heat shrink tubing, and, in one variation of the preferred embodiment, mastic is applied beneath the insulating material.

When the modified transformer bushing is installed into a transformer, an internal end of the conductor is made to extend below the surface of the oil in the transformer. The level of the oil also covers an internal insulating shoulder of the bushing. The insulating values of the mastic and heat shrink tubing and the insulating value of the conductor immersed in oil combine to increase the voltage class rating of the off the shelf molded transformer bushing and thereby the rating of the transformer with a nominal increase in costs.

In one embodiment, a conductive extension is connected to the conductor of the bushing. The insulator is then extended beyond the conductor to also cover a portion of the extension. This provides an even longer distance between the exposed conductive end and the transformer wall, further reducing the occurrence and effects of arcing and electrical creepage.

The above as well as additional objectives, features, and advantages of the present invention will become apparent in the following detailed written description.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself however, as well as a preferred mode of use, further objects and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

Figure 1 is a block diagram of a transformer with a converted transformer bushing in accordance with a preferred embodiment of the present invention;

Figure 2A illustrates a converted transformer bushing in accordance with a preferred embodiment of the present invention;

Figure 2B illustrates a cross section of the converted transformer bushing of **Figure 2A** in accordance with a preferred embodiment of the present invention;

Figure 2C illustrates a detailed cross section of an extension attached to a bushing in accordance with a preferred embodiment of the present invention;

Figure 2D illustrates a detailed cross section of mastic and insulating material applied to a second shoulder of an insulating mounting bracket in accordance with a preferred embodiment of the present invention;

Figure 3 is a high-level block diagram exemplifying a method for improving a transformer rating in accordance with a preferred embodiment of the present invention;

Figure 4A is a molded bushing that is commonly used in the manufacture of oil-filled transformers;

Figure 4B is a molded bushing installed in a transformer as is commonly used in the art; and

Figure 5 is a table exemplifying the relationship between transformer rating and length of bushing according to one embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference now to the figures, and in particular with reference to **Figure 1**, a transformer in accordance with a preferred embodiment of the present invention is depicted. High voltage conductor **121** is connected to mounting point **122** of transformer **10** by external hardware connector **120**. Mounting point **122** is the connection point of the back end **102** of conductor **114**. Conductor **114** is covered by insulating material **104**, which extends from second shoulder **106** of insulating mounting bracket **108** to the back end **102** of conductor **114**. Insulating mounting bracket **108** is attached to transformer wall **116**. Conductor **114** runs through insulating mounting bracket **108** so as to extend from the outside to the inside of transformer wall **116**. Thus, conductor **114** is surrounded by insulating mounting bracket **108** at the point at which conductor **114** actually passes through transformer wall **116**. As further provided in the illustrative embodiment, first shoulder **110** of insulating mounting bracket **108** and front end **112** of conductor **114** are immersed in oil **118** within transformer casing **100**. Front end **112** of conductor **114** is utilized for connecting to transformer windings.

The invention provides an enhanced (i.e., higher rated) transformer utilizing an off-the-shelf transformer bushing and tubular insulating material. The bushing housing (i.e., insulating mounting bracket **108**) is extended by the use of an insulating tube (or material) **104** that is electrically sealed to the bushing body (i.e., the second shoulder **106** of the insulating mounting bracket **108**) and which covers a finite portion of conductor **114**, which is otherwise exposed. The utilization of the insulating tube **104** (referred to hereafter as insulating material) enhances the creepage resistance and the strike resistance of the bushing. Also, the internal portion of conductor **114** is provided with an insulation barrier, which involves, in the preferred embodiment, submerging the internal conductor and first shoulder in oil **118** as illustrated in **Figure 1**. In an alternate embodiment, insulating material, such as shrink tube may be utilized to cover the front end **112** of the conductor **114** to yield similar effects.

Referring now to **Figure 2A**, there is illustrated an enhanced bushing according to the preferred embodiment. Insulating material **104**, such as heat shrink tubing, is attached to the second shoulder **106** of the insulating mounting bracket **108**. The insulating material **104** is applied to the second shoulder **106** of the insulating mounting bracket **108** so that the insulating material **104** covers (or extends over) a portion of the back end **102** of the conductor **114** and a portion of the second shoulder **106** of the insulating mounting bracket **108**. In the preferred embodiment, insulating material is tubular to provide continuous coverage around and along the portion of the conductor **114** covered. This aids in reducing creepage and leakage along the insulating mounting bracket **108** as well as protecting against arcing from the conductor **114** to the transformer wall **116**. In one embodiment, insulating material **104** is also applied to cover a portion of the external hardware connector **120** attached to back end **102** of conductor **114**. This further increases strike distance and reduces creepage. However, by covering external hardware connector **120** with insulating material **104**, the flexibility to change external hardware connector **120** is then limited due to the need to compromise the integrity of the insulator if the attaching hardware is removed or replaced.

The actual length of the insulating material **104** is dependent on the length of the conductor **114**. However, it is not necessary that the insulating material extend to the back "end" **102** of the conductor **114**, although the provided embodiments are illustrated and/or described in this manner. Thus, the insulating material may cover only a portion of the conductor **114**. The utilization of the insulating material **104**, as provided by the invention, is based on the realization that the dielectric strength of the bushing wall greatly exceeds the dielectric strengths of either one of the creepage surfaces (external or internal) and the strike lengths. Therefore, the invention allows the substantial enhancement of the bushing rating by enhancing the interior and exterior portions of the bushing without further consideration required to address the bushing wall dielectric. Contrary to established Raychem literature, which states that the voltage class (i.e., rating) of transformer bushings cannot be enhanced by the use of the heat shrinking tubing utilized by the invention, the invention provides substantial enhancements in overall transformer ratings.

Referring now to **Figures 2B - 2D**, various illustrations of a detailed cross section of a converted or enhanced transformer bushing in accordance with a preferred embodiment of the present invention are illustrated. As illustrated, insulating material **104** connects only to second shoulder **106** of insulating mounting bracket **108** and extends over conductor **114** so as to leave a space **203** between conductor **114** and insulating material **104**. In the illustrative embodiments, prior to attaching insulating material **104**, a mastic **202** is applied. The mastic **202** is applied to the second shoulder **106** of insulating mounting bracket **108**. Mastic **202** is applied to this area because the insulating material **104** will cover a portion of the second shoulder **106** of the insulating mounting bracket **108** as well as the conductor **114**. The mastic **202** is one method of electrically sealing the insulating material **104** to the bushing housing. However, the invention recognizes that shrink tubing is commercially available with a treated interior surface that seals when heated. Thus, utilization of the mastic **202** is not a requirement for the correct operation of the invention, and other alternate sealing methods may be utilized.

In the preferred embodiment, the mastic is placed only between the shrink tubing and the second shoulder **106** of the insulating mounting bracket **108**. However, in an alternate embodiment and as illustrated, the mastic is applied to other areas including the conductor. Thus, as illustrated, the mastic **202** is also applied to cover up to back end **102** of conductor **114** (i.e., up to a mounting point **122** for external hardware). When, as described below, an extension **200** is connected, the mastic is also applied to the extension **200** and the threaded portion (bushing stud) **206** of the conductor **114** along with jam nut **204** so as to completely cover all conductive material from the second shoulder **106** of the insulating mounting bracket **108** to the back end **102** of the extension to the conductor **114**. Of course, mastic **202** is only applied to the portion of the conductor **114** (and extension) that is to be covered by insulating material **104**.

The utilization of a mastic **202** is not always required for the proper operation of the invention because the insulating material **104** by itself is able to reduce creepage as well as protect against arcing from conductor **114** to the transformer wall **116**. However, proper application of the mastic **202** to a portion of the second shoulder **106** of the insulating mounting bracket **108** is important to ensure there are no voids between the insulating material **104** and the second shoulder **106** of the insulating mounting bracket **108**. This further prevents creepage from the second shoulder **106** of the insulating mounting bracket **108** to the transformer wall **116**.

In bushing designs with a longer exposed or non-insulated conductor **114**, it is possible to insulate portions of the exposed conductor **114** to provide the increased distance from the exposed segment of the conductor **114** to the transformer wall **116**. In one embodiment in which the conductor length is shorter than desired, an extension is attached to the conductor **114** as illustrated in **Figures 2B** and **2C**. The conductive extension **200** is necessary when the required voltage enhancement tube (insulating material **104**) exceeds or almost exceeds the length of conductor **114**. The conductive extension is also necessary when a spade or eyebolt connector is required for external wiring.

In the exemplary embodiment, by way of illustration and not of limitation, an off-the-shelf molded transformer bushing similar to the one shown in **Figure 4A** is depicted with a conductor **114** that comprises a bushing stud **206** with a threaded portion at back end of conductor **114**. **Figure 4B** illustrates the off-the-shelf transformer bushing connected to the transformer casing with the threaded portion of the back end of the conductor **114** extending out from the casing. A conductive extension **200** is attached via the bushing stud **206**. In the preferred embodiment, the bushing stud **206** comprises male threading as shown in **Figures 2B-2D** and the conductive extension **200** comprises female threading to match the bushing stud's male thread. A jam nut **204** is utilized to lock the conductive extension **200** to the bushing stud. Anyone skilled in the art will recognize that there are other ways to attach an extension. Conductive extension **200** increases the distance between the back end **102** of the extended conductor and transformer wall **116**.

Any length of conductive extension **200** and associated insulating material **104** cover can be utilized to increase the standard bushing rating by a measurable amount, so long as the distance from a non-insulated portion of the conductor **114** (or conductive extension **200**) to transformer wall **116** is increased. The increase in distance means more air must ionize before the potential difference between the transformer wall 116 and the conductor 114 (or conductive extension 200) becomes sufficiently large enough to create a path through which current can flow. Therefore, the longer an extension, the greater the strike distance. In addition, external creepage is substantially minimized because the current has a significantly further distance to travel.

In one preferred embodiment, an analysis of the effects of the length of the conductive extension **200** and the length of the insulating material **104** to the transformer rating is completed and a chart is prepared that indicates the correlation between length and rating. **Figure 5** illustrates a sample rating chart that may be provided. It is understood that the chart is provided solely for illustrative purposes, and different rating charts may be compiled and utilized within the scope of the invention. By choosing the proper hardware and length of heat shrink tubing, external creepage can be substantially eliminated and the strike distance of the bushing assembly can be increased to the point at which arcing effects are negligible.

As shown, the bushing has an external portion located outside the transformer and an internal portion located inside the transformer. Once the rating on the external portion of the bushing is increased by the methods described above, the internal surface of the bushing becomes the lowest rated portion of the bushing. In the preferred embodiment, the rating on the internal surface of the bushing is increased by mounting the bushing with the internal surface submerged under oil 118. By immersing front end of conductor 112 and first shoulder 110 of insulating mounting bracket 108 in oil 118, the rating of the internal surface of the bushing can be significantly increased and thereby, the voltage class of the transformer is also increased. As provided above, utilization of an insulating tube to cover front end 112 of conductor 114 and first shoulder 110 of insulating mounting bracket 108 may also provide the increased rating of the internal surface of the bushing and hence the voltage class of the transformer.

Referring now to **Figure 3**, a high-level block diagram exemplifying a method for improving a transformer rating in accordance with a preferred embodiment of the present invention is illustrated. In order to further clarify this method, reference to **Figures 1, 2A - 2D and 4A** is encouraged and will be referred to throughout the following process steps. The process begins with step **300**, which depicts preparing a plastic bushing to receive a threaded conductive extension **200** and mastic **202**. The bushing may be similar to a 1.2kV Tuf Ex-Mount™ illustrated in **Figure 4A**. The process next passes to step **302**, which illustrates extension **200** being attached to the threaded portion of bushing stud **206** of the Tuf Ex-Mount™ plastic bushing similar to the one shown in **Figure 4A**. Anyone skilled in the art will recognize that there are other ways to attach an extension.

The process then proceeds to step **304** which depicts applying mastic **202**. The mastic **202** is applied to help the heat shrink insulating material **104** adhere to the insulated mounting bracket **108**. The mastic **202** is also applied to conductor **114** and extension **200** so as to completely cover back end **102** of conductor **114** as shown in **Figure 2A** from the second shoulder **106** of the insulating mounting bracket **108** to the back end **102** of the conductor **114**. Proper application of the mastic **202** to conductor **114** and a portion of the second shoulder **106** of the insulating mounting bracket **108** is important to ensure there are no voids between the insulating material **104** and the second shoulder **106** of the insulating mounting bracket **108**. This prevents creepage from the second shoulder **106** of the insulating mounting bracket **108** to the transformer wall **116**.

Returning to **Figure 3**, the process then proceeds to step **306** which illustrates applying heat shrink tubing or insulating material **104** to the conductor **114** and other connecting surfaces. An insulating material **104**, such as Raysulate BPTM and BBIT high-voltage insulating tubing, a product of Raychem, Menlo Park, CA, is installed from the second shoulder **106** of the insulating mounting bracket **108**, to the back end **102** of the conductor **114**. The heat shrink tubing, which has a high voltage insulating property is installed over the complete area covered by the mastic **202**. If the heat shrink tubing is factory installed, a wide variety of hot air ovens or infrared heaters can be used to shrink the tubing. If the heat shrink tubing is installed on a transformer bushing in the field, a clean-burning propane torch with a "bushy" flame can be used to shrink the tubing. In the preferred embodiment, the heat is applied until the heat shrink tubing shrinks onto and tightly conforms to the second shoulder **106** of insulating mounting bracket **108**. In another embodiment, the heat is evenly applied until the heat shrink tubing shrinks onto and tightly conforms to conductor **114**, insulating mounting bracket **108**, and any other surface being insulated. Insulating material **104** and mastic **202** can also be applied to cover a portion of the external hardware **120** attached to back end **102** of conductor **114**. This further increases strike distance and reduce creepage.

The process then continues to step **308** which depicts completing the installation of the bushing. When installed, the bushing has an external portion located outside the transformer and an internal portion located inside the transformer. By immersing front end conductor **112** and first shoulder **110** of insulating mounting bracket **108** in oil **118**, the rating of the internal surface of the bushing can be significantly increased and thereby, the voltage class of a transformer is also increased.

While the invention has been particularly shown and described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A method for improving a voltage rating of a transformer comprising:

providing a transformer bushing for use within a transformer, said bushing having an insulating mounting bracket with a first and second shoulder and a conductor which extends through and is molded into said insulating mounting bracket with a first portion for connecting to transformer windings and a second portion for connecting to an external circuit;

means for enclosing a portion of said second portion of said conductor and second shoulder of said insulating mounting bracket with an additional insulating material, wherein a distance along the surface of said transformer bushing between an un-insulated portion of said conductor and a wall of said transformer casing is greater than without said additional insulating material; and

means for extending said second portion of said conductor providing a conductor extension attached to said second portion, wherein said means for enclosing encloses both said second portion of said conductor and a portion of said conductor extension;

running a first segment of a conductor through the bushing; and

assembling said transformer by connecting said bushing to a transformer casing with said second shoulder located on the outside of said transformer casing.

2. The method of claim 1, wherein said assembling step further comprises immersing a second segment of said conductor and said first shoulder of said bushing in oil held within said transformer casing.

3. The method of claim 1, further comprising enclosing within an insulating material a portion of a second segment of said conductor from said first shoulder to increase a distance between an un-insulated portion of said second end of said conductor to an internal wall of said transformer casing.

4. The method of claim 1, further comprising:

connecting a conductive extension to an end of said first segment of said conductor; and enclosing all of said conductor and a portion of said conductive extension within said insulated material, wherein said insulated conductive extension further increases a distance from an un-insulated portion of said conductive extension to a wall of said transformer.

5. The method of claim 4, wherein when said conductor includes a threaded portion at said first end, said connecting step connects said extension utilizing a bushing stud of said conductor and a jam nut to lock the conductive extension to the bushing stud.

6. The method of claim 1, wherein said enclosing step further comprises:

applying a mastic to said second shoulder; and

subsequently connecting said insulating material to said second shoulder.

7. The method of claim 6, further comprising applying said insulated material over said mastic, wherein said insulated material is extended from said second shoulder of said insulating mounting bracket, and whereby electrical creepage is reduced and arcing is substantially eliminated.

8. The method of claim 7, wherein said applying step further applies said insulating material over an external hardware connection of said conductor.

9. The method of claim 8, wherein said insulating material is heat shrink tubing and said enclosing step includes:

connecting said heat shrink tubing to said mastic at said second shoulder; and

heating said heat shrink tubing to shrink said tubing to conform to a surface of said second shoulder.

10. The method of claim 8, further comprising immersing a first shoulder of said insulating mounting bracket of said bushing along with said second segment of said conductor in oil within a casing of said transformer.

11. A transformer comprising:

a transformer casing having an internal compartment and an external wall;

oil stored within said transformer casing; and a bushing connected to an open end of said transformer casing via an insulating mounting bracket through which runs a conductor, wherein said insulating mounting bracket has an internal shoulder and an external shoulder relative to said transformer casing, and said bushing includes an insulating material connected to and extending from said external shoulder to cover a portion of said conductor, which extends from said external shoulder, wherein a distance from an un-insulated portion of said conductor to said external wall is increased and a voltage rating of said transformer is improved.

12. The transformer of claim 11, wherein said bushing further comprises an extension connected to an externally positioned end of said conductor, wherein said insulating material extends to cover said conductor and a portion of said extension, wherein a voltage rating of said bushing is further increased by reducing effects of electrical creepage and arcing between an exposed end of said extension and said external wall.

13. The transformer of claim 11, wherein further said oil is capped at a height at which an internal end of said conductor and said internal shoulder of said insulating mounting bracket are submerged beneath said oil when said bushing is connected to said transformer casing.

14. The transformer of claim 11, wherein said insulating material is a heat shrink tube and is affixed to said external shoulder via a mastic.

15. An apparatus for improving a transformer voltage rating, comprising:

a transformer bushing having:

an insulating mounting bracket with a first and second shoulder;

a conductor which extends through and is molded into said insulating mounting bracket with a front segment for connecting to transformer windings and a back segment to connecting to an external circuit;

and

means for enclosing a portion of said conductor and said second shoulder of said insulating mounting bracket with an additional insulating material, wherein a distance along the surface of said transformer bushing between an un-insulated portion of said conductor and a wall of said transformer casing is increased.

16. The apparatus of claim 15, further comprising means for extending said second portion of said conductor to provide an extended second portion having a conductor extension attached to said second portion, wherein said means for enclosing encloses both said second portion of said conductor and a portion of said conductor extension.

17. A kit for improving a transformer voltage rating, comprising:

a transformer bushing having:

an insulating mounting bracket with a first and second shoulder;

a conductor which extends through and is molded into said insulating mounting bracket with a front segment for connecting to transformer windings and a back segment to connecting to an external circuit;

and

additional insulating material for enclosing a portion of said back segment of said conductor and said second shoulder of said insulating mounting bracket.

18. The kit of claim 17, further comprising:

a conductor extension made of conductive material for connecting to a the back end of said conductor; and

means for connecting said conductor extension to said back end of said conductor, wherein a total length of a resulting extended back end of said conductor is increased by the length of said conductor extension.

19. The kit of claim 18, further comprising a supply of mastic for applying to said second shoulder prior to attaching said insulating material.

20. The kit of claim 19, further comprising a rating chart, which indicates a length of said insulating material and a length of said conductor extension, if required, to connect to said second portion of said conductor of said bushing in order to obtain a corresponding rating of a transformer in which said bushing is utilized.

21. The apparatus of claim 15, wherein said conductor is a metallic, molded-in conductor.

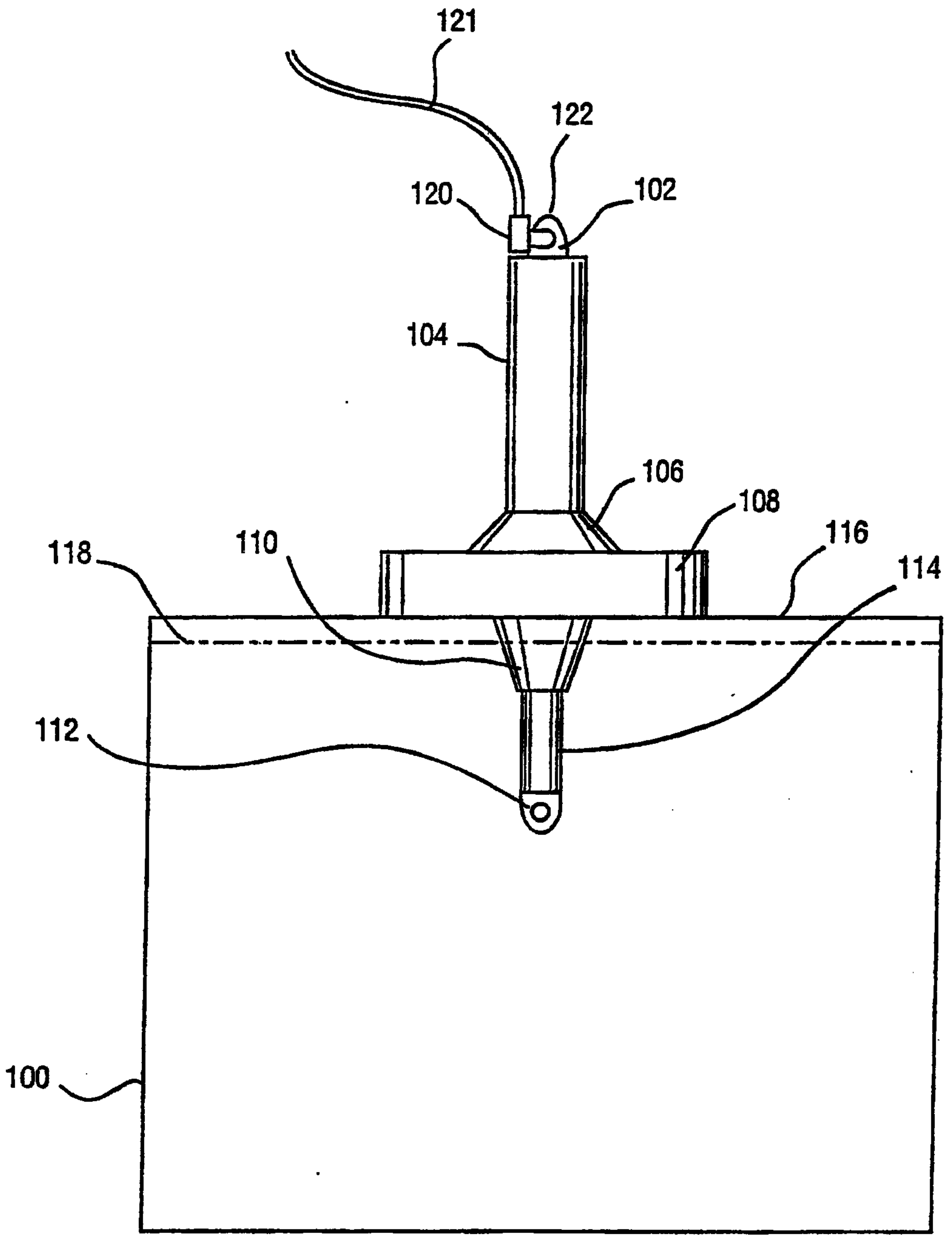


FIG. 1

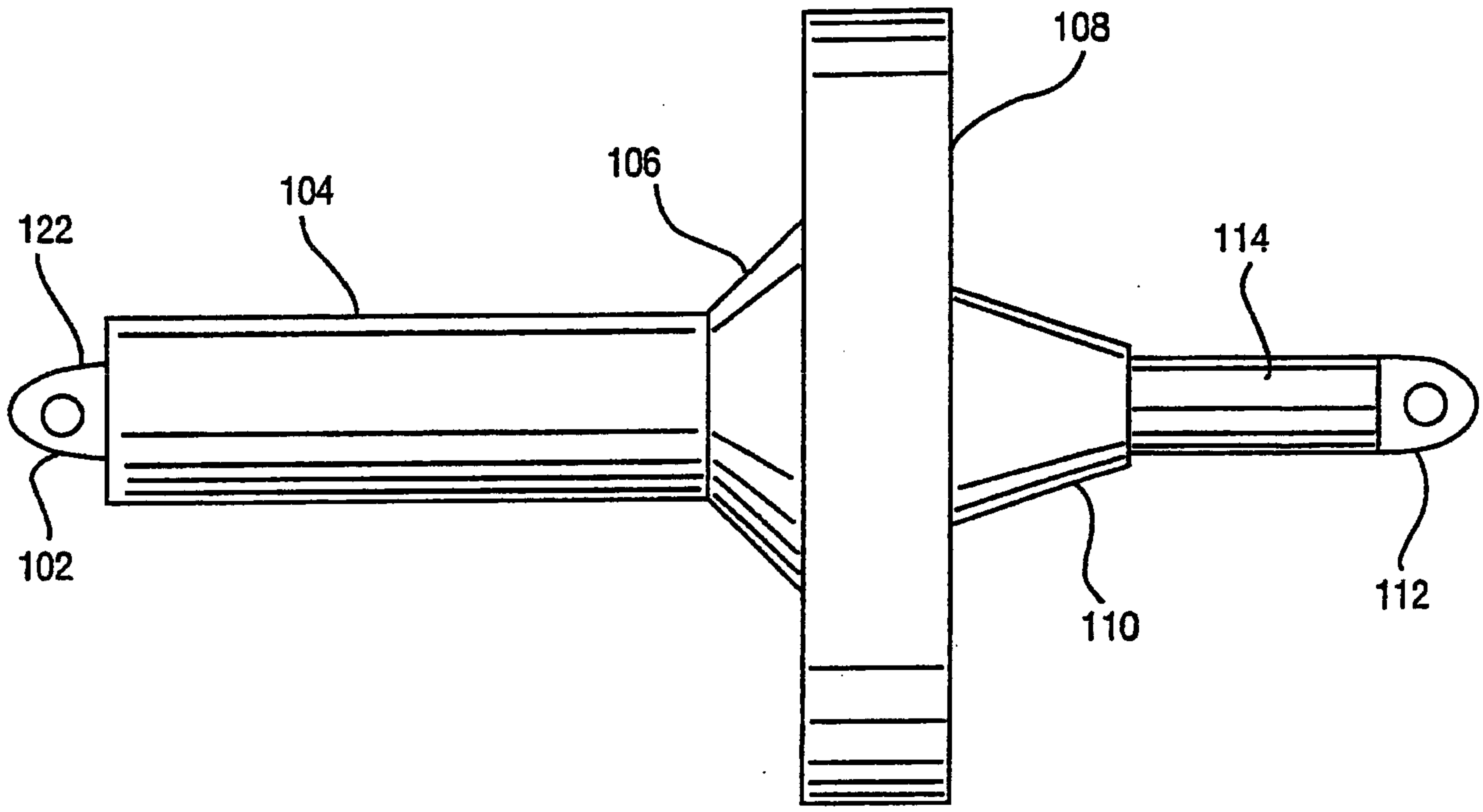


FIG. 2A

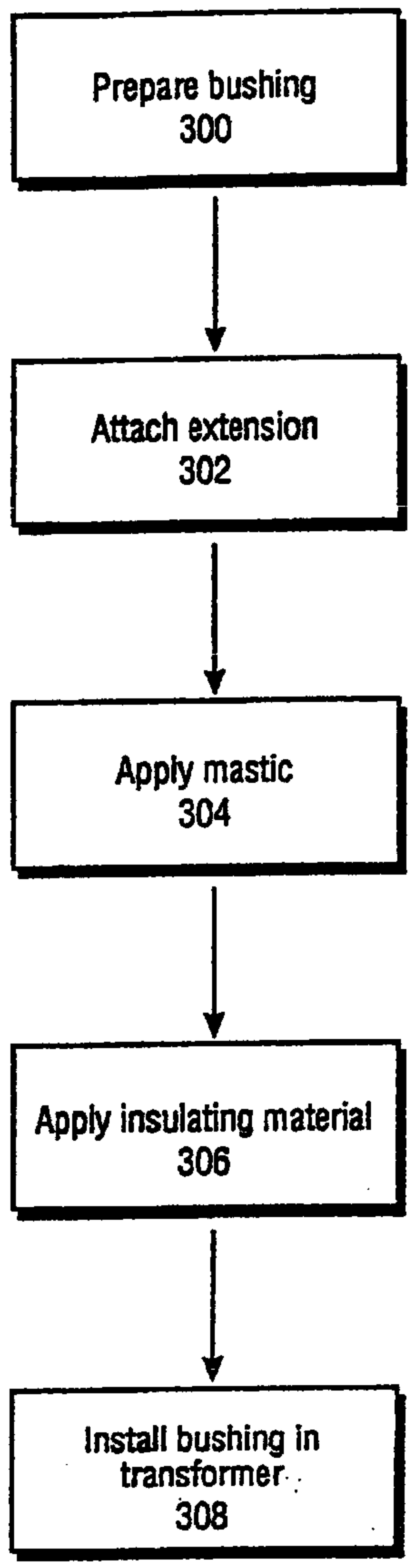

Prepare bushing
300
Attach extension
302
Apply mastic
304
Apply insulating material
306
Install bushing in
transformer
308

FIG. 3

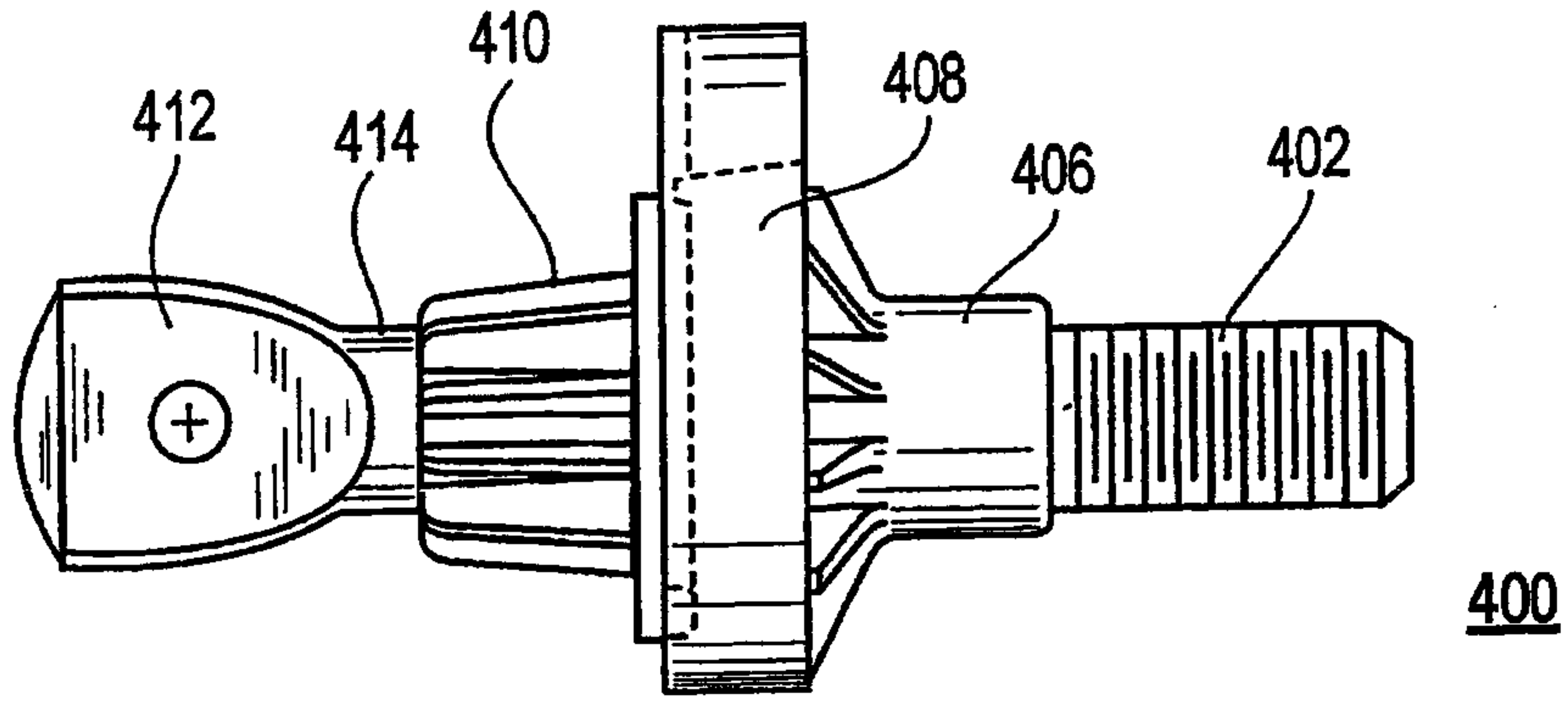


FIG. 4A
(Prior Art)

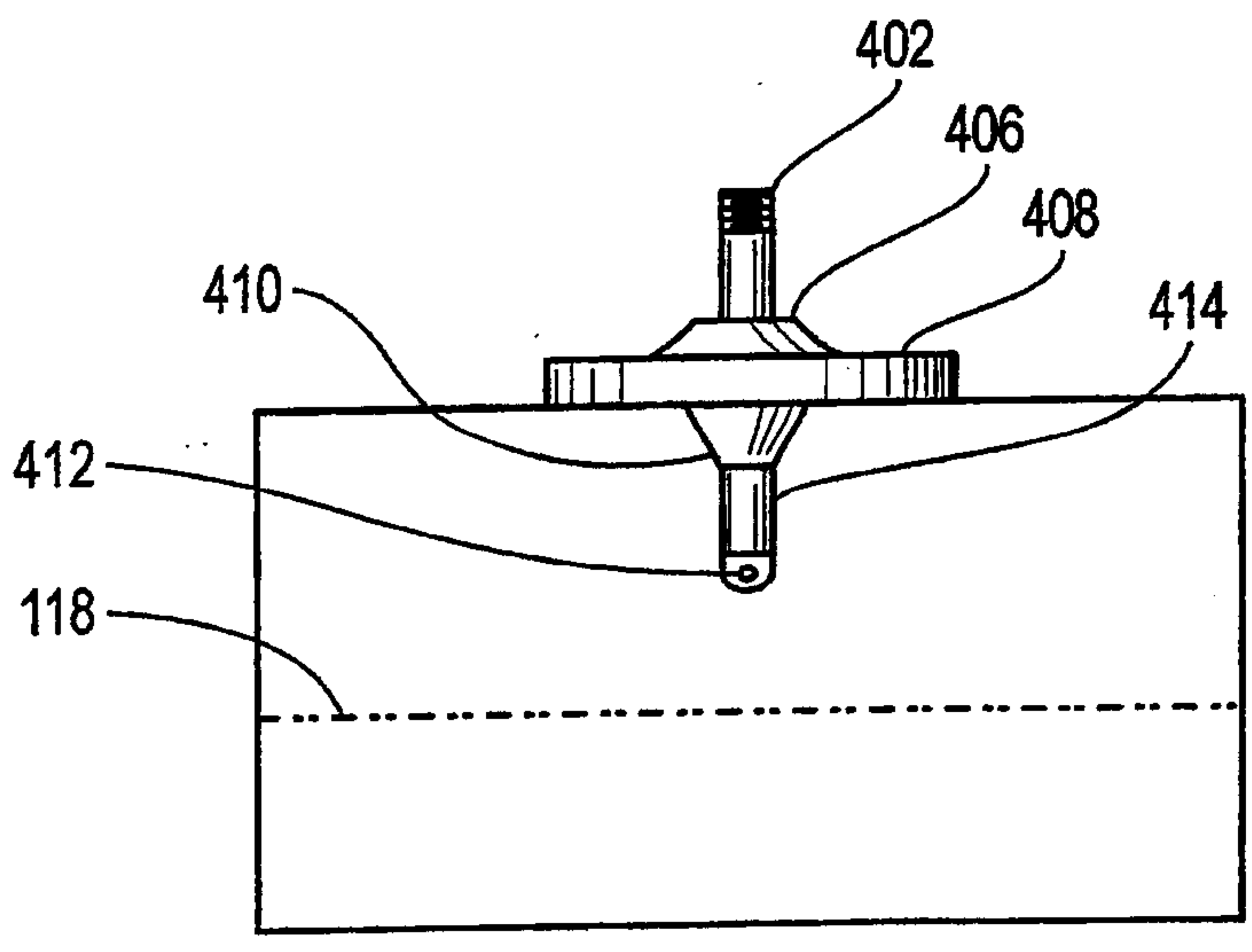
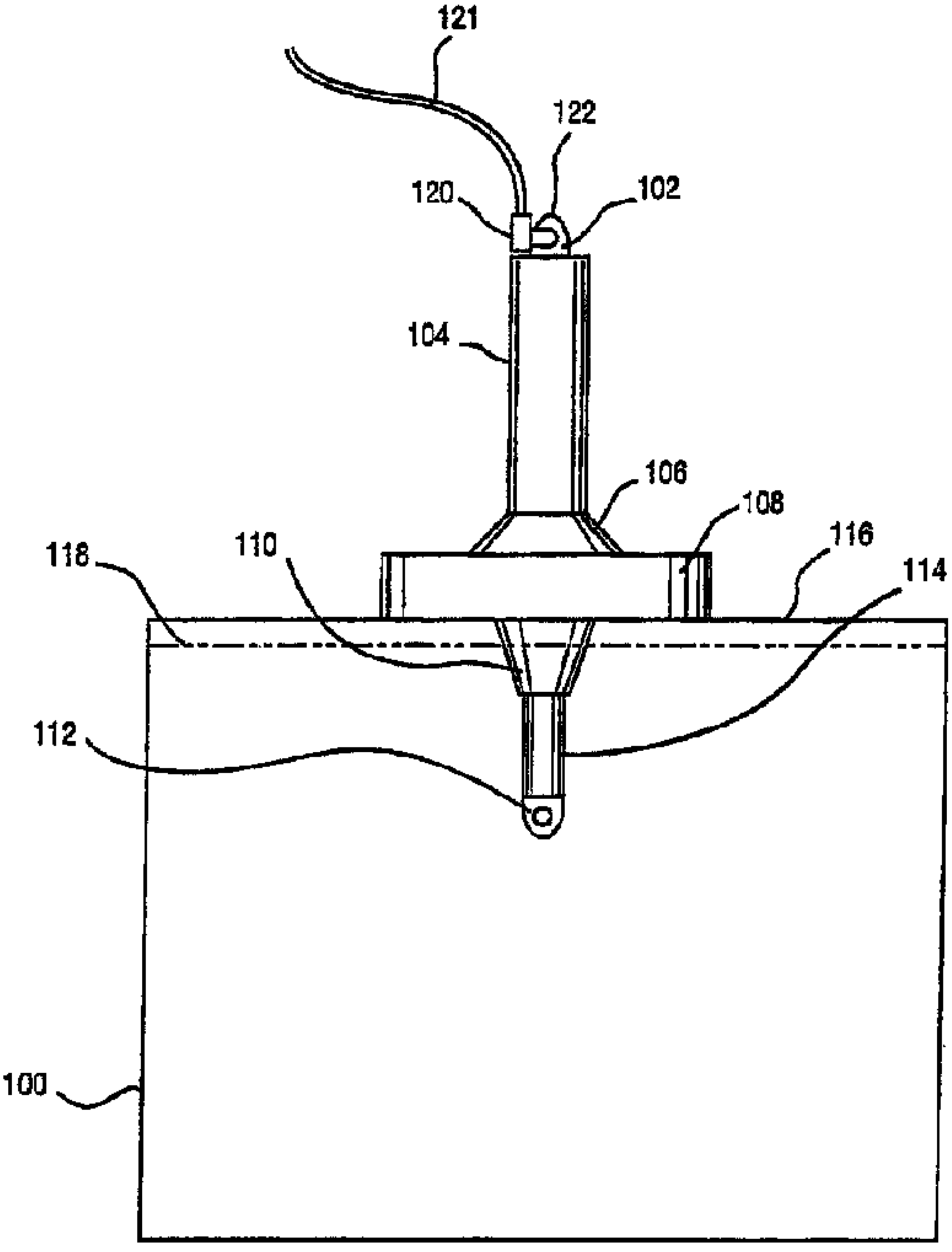


FIG. 4B
(Prior Art)

Length (Inches)	Voltage Rating (VAC RMS)
3.0	5000
3.5	5833
4.0	6667
4.5	7500
5.0	8333
5.5	9167
6.0	10000

FIG. 5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