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⑦① Applicant: **EAST ROCK TECHNOLOGY INC.**
2589 Richmond Terrace
Staten Island New York 10303(US)

⑦② Inventor: **Venezia, Joseph A.**
2580 Richmond Terrace Staten Island
New York 10303(US)

⑦④ Representative: **Barrett, James William et al,**
A.A. THORNTON & CO. Northumberland House 303-306
High Holborn
London WC1V 7LE(GB)

⑥④ **Process for the manufacture of a toroidal ballast choke and machine for use in such process.**

⑥⑦ A process is disclosed for the manufacture of a generally toroidal or annular choke (30), in which a magnetic core is provided with an insulative layer (36), *e.g.*, by an injection or other molding process, and divided into two parts (34). Each of the parts is then provided with a respective winding (32). The two chokes thus made can be electrically connected in series and mechanically joined to form a choke having the shape of the original core. Preferably, the original core is annular and each of the pieces is roughly semi-annular.

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PROCESS FOR THE MANUFACTURE OF A TOROIDAL
BALLAST CHOKE AND MACHINE FOR USE IN SUCH PROCESS

BACKGROUND OF THE INVENTION

The present invention pertains generally to the field of lighting fixtures, and pertains more particularly to a process for manufacturing a generally toroidal ballast choke and to a winding machine suitable for use in manufacturing a generally toroidal ballast choke.

As is well known, lighting fixtures intended for use with fluorescent and other bulbs of types with which a ballast choke is used are frequently larger than those for incandescent bulbs of comparable bulk. It is often desirable to reduce the size of such fluorescent and similar fixtures as much as possible, whether to save space, or for reasons of economy or esthetics.

It would also be desirable to have a device by means of which fluorescent bulbs, etc., could be used with ordinary incandescent lamp sockets. Adapters designed for such use have been proposed, as have fluorescent lamps specifically designed for use in incandescent lamp fixtures. For example, U.S. Patent 3,551,736 (Doehner) shows a fluorescent lamp in which a fluorescent bulb rests on a ballast unit and has electrical connector pins which extend through passages provided for them in the ballast unit. The ballast unit also receives electrical connector pins from a terminal contact base which is externally threaded to be screwed into a conventional incandescent lamp screw socket. In that patent, the ballast unit contains a toroidal ballast choke, with the connector pin passages extending through the hole of the torus. The starter and the capacitor are located in the screw base unit.

Conventional methods for manufacturing such devices are expensive because of the difficulty of mass-producing toroidal chokes, particularly because of the difficulty of forming a winding on a toroidal core.

It would be desirable to provide a convenient, simple, reliable and economical process for manufacturing a toroidal choke.

It would also be desirable to provide a simple winding machine for use in such a process.

SUMMARY OF THE INVENTION

Accordingly, it is the object of the present invention to provide a simple, reliable, convenient and economical process for manufacturing a generally toroidal choke suitable for use in a socket adapter or other lighting fixture.

It is another object of the present invention to provide a simple, reliable and convenient winding machine suitable for use in manufacturing a generally toroidal choke suitable for use in a socket adapter or other lighting fixture.

As set out in copending EPC application No. claiming priority of US patent application No. 681002 filed on December 13, 1984, a one-piece lighting fixture, which may be a socket adapter, in which such a choke can suitably be used comprises a one-piece housing having a recess formed therein for receiving the base of a light bulb, electrical circuitry including the ballast choke disposed in the housing, and electrical contact elements for connecting the electrical circuitry with an external power source. If the fixture is a socket adapter, it also has an external securing device for securing it to a socket. Preferably, the electrical circuitry at least partially surrounds the recess, and most preferably the ballast choke is toroidal and surrounds the recess.

According to the process of the present invention, such a ballast choke is manufactured by

providing a core made of a magnetic material, forming on the core a layer of an electrically insulative material, dividing the core into two pieces each of which bears a portion of the insulative coating, and wrapping a winding of an electrical conductor on each of the two pieces, with the coating insulating the winding from the core.

Preferably, the insulative layer is formed on the core by means of injection molding, or by placing the core in a mold made of a flexible material and introducing the insulative material into the mold, releasing the core by flexing the mold after the insulative material has set. The dividing step is preferably, but not absolutely necessarily, performed after the provision of the insulative layer. The two resulting chokes can be used separately, or can be electrically connected in series with or without a mechanical connection to form, in effect, a single choke having the shape of the original core.

According to another aspect of the present invention, a winding machine is provided comprising means for supporting a curved magnetic core, means for winding a filament around a portion of the core which portion is located at a predetermined position relative to a base supporting the winding means, and means for moving a core supported by the support means along a curved path through that predetermined position.

These and other objects and features of the invention will be more clearly and thoroughly understood from the following detailed description of the preferred embodiment, taken in conjunction with the accompanying drawings, in which like reference characters refer to like elements throughout.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 is a perspective view of a socket adapter of a type that can advantageously be made by means of the process of the invention, with a fluorescent bulb in place in the adapter.

Figure 2 is a front elevation view of a toroidal ballast choke used in the socket adapter of Figure 1.

Figure 3 is a top plan view of the choke of Figure 2.

Figure 4 is an exploded view of the ballast choke of Figure 2.

Figure 5 is a top view of a core from which the choke of Figure 2 is made.

Figure 6 is a schematic top view of a mold containing the core of Figure 5, to illustrate the formation of an insulative coating on the core by one version of the process of the invention.

Figure 6A is a top view of the core, e.g. that of Figure 5, after the formation of an insulative layer thereon.

Figure 7 is a cross-sectional view of the mold of Figure 6, taken from line 7-7 in Figure 6.

Figure 7A is a top view of one half of the core of Figure 6.

Figure 8 is a top view of the half core of Figure 7A after winding.

Figure 9 is a side view of one embodiment of a winding machine used in the preferred version of the process of the present invention.

Figure 10 is a schematic plan view of the machine of Figure 9, illustrating the movement of a core during winding.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows in perspective a socket adaptor 10 employing a toroidal choke of a type that can advantageously be made by the process of the present invention, with a typical fluorescent bulb of one type, shown by way of example only, in place in the adapter to illustrate the use of the latter. As can be seen, the adapter 10 has a one-piece housing 12, which in the embodiment shown has a cylindrical main portion 14 and depending therefrom a cylindrical base portion 16. A recess 18 formed in the top of the main portion 14 of the housing is shaped to detachably receive the base of the

bulb 20. The bulb 20 shown illustratively is a fluorescent unit having a U-shaped glass envelope in which light is fluorescently generated. Both ends of the envelope are mounted on a base which has the shape of a T as seen from the side, and from the arms of which extend downward two electrical connector pins. The recess 18 is shaped to receive substantially the entire base of the type of bulb for which the adapter in question is designed.

The ballast choke used with fluorescent and other types of bulbs is provided in the cylindrical portion 14 of housing 12, and in the adapter shown in Figure 1 is manufactured in the shape of a torus surrounding the recess 18. The starter and capacitor for the electrical circuitry of the adapter 10 are preferably housed in the cylindrical base 16, which is provided with a cylindrical electronically conductive sleeve 22 fitted over and secured in any suitable fashion to the lower end of the cylindrical base 16. The sleeve 22 has on its external surface threads to permit the adapter 10 to be screwed into a standard screw socket of the type used with incandescent lamps. The sleeve 22 serves to achieve electrical contact with such a socket. An additional electrical contact 24 is provided at the lower tip of the cylindrical base 16, protruding through an aperture in sleeve 22, from the conductive material of which it is spaced. In use, contact 24 is in electrical contact with the other contact of such a socket.

The recess 18 is formed with holes for receiving the connector pins of the bulb 20, in which holes are provided contact pieces 21 to make electrical contact with the pins.

The electrical connections of the circuit elements described (the choke, starter, capacitor, sleeve, tip contact, and contacts for the contact pins of the bulb) are well known to those skilled in the art. The external threaded sleeve 22 is connected to the winding of the choke, the other end of which is connected to a contact piece 21 that received one of the connector pins of the bulb 20. The other connector pin is received in engagement with a similar contact piece 21, which is connected to one terminal of each of the capacitor 23 and the starter 25. The other terminal of the capacitor and the starter is connected to tip contact 24 on the exterior of the housing 12.

The toroidal ballast choke 30 used in the socket adapter of Figure 1 is shown in Figures 2 through 4 and comprises conductive windings 32 on two magnetic cores 34, each of which in the embodiment shown defines approximately a hemi-torus. Each winding 32 is insulated from its respective core 34 by a layer of insulative material 36, which, as can be seen from the figures, does not extend all the way to either free end of the core 34. The reason for this feature is explained below.

One obstacle to the practical use of toroidal cores for ballast chokes in the past has been the difficulty of manufacturing toroidal chokes reliably and with reasonable economy. The illustrated choke, however, lends itself readily to simple, reliable and inexpensive manufacture (see Figures 5 through 10). Initially, a toroidal core of a suitable conventional magnetic material is provided. A steel tape-wound core is suitable. The toroidal core 34A is provided with a coating 36 of an electrically insulative material, which covers the top, bottom, inner and outer surfaces of the torus. However, only one surface, for example the inner surface 38 or perhaps better the outer surface is completely covered by coating 36 around the entire circumference of the torus. The other three surfaces are covered entirely except for two locations 40, preferably diametrically opposed, at which the core is left completely exposed except on the inner surface 38, or the outer surface, as the case may be. If desired, the core can be left exposed at 40 on all surfaces. The insulative layer 36 is preferably provided by means of injection molding, although any other suitable manner of formation can be substituted according to convenience.

The most preferred method of forming the insulative coating 36 is by injection molding the insulative material, which may suitably be nylon purely by

way of example, around the core in a mold shaped to leave the exposed areas 40 at the desired locations.

An alternative method is to pour the material into an open-topped mold with the core inside. In the latter case, the mold 64 is made of a flexible material such as silicone, by way of example, and is flexed by any suitable means to release the core 34A and insulative layer from the mold after setting of the insulative material. An example of such a mold is shown schematically in Figures 6 and 7, in which the mold portions 41 for forming exposed areas 40 are visible. The portions 41 also support the core above the bottom of the mold. If injection molding is used, as is preferred, the mold used will be similar to that shown in Figures 6 and 7 with modifications clear to those in the art.

According to another alternative, which is not preferred but is nonetheless within the scope of the invention, the insulative layer can be provided by dipping the original core into a bath of the insulative material, drying the resulting layer, for example in an oven, and blowing off excess liquid. After the cutting, dust of the insulative material is blown onto the core while the latter is at an elevated temperature, to round the edges to prevent damage to the winding when the latter is formed.

The toroidal core is then cut in two through the exposed locations 40, resulting in two hemi-toroidal cores 34 as shown in Figure 3. The cutting is preferably

effected by means of a milling machine, which has been found to do the cutting efficiently and with relatively low heat production, but any other method desired can be substituted and is within the scope of the invention, considered most broadly. Each of the cores 34 is then separately provided with its respective winding 32. Because each of the cores 34 has the shape (as seen from above) of a circular arc, i.e., has a center line that defines a semi-circle or other portion of a circle, the windings can be applied in a very simple and economical fashion. The arcuate core 34 is supported by being gripped at one end, and is rotated in the plane of the arc about the axis defining the center of the arc, viz., along the length of the core itself. As this movement is carried out, a wire is wrapped around the core, producing the desired winding 32. The ends of the wire 50 are secured during the winding process in any suitable fashion within the ordinary skill in the art. After the windings 32 have been wrapped, the ends thereof are permanently secured in place by known expedients to provide two hemi-toroidal chokes. If desired, the cores of the two hemi-toroidal chokes can also be joined, by fish paper or other suitable known materials, to form a complete torus again.

As shown in Figures 9 and 10, the preferred embodiment 60 of the winding machine preferably used in carrying out the process of the invention comprises as its

basic elements a support device 62 for supporting a curved, especially a hemi-toroidal, magnetic core 34, means 66 for winding a wire 50 around a portion of core 34 located at a predetermined position 68 relative to a base 69 on which the winding means is mounted, and means 70 for moving the core 64 supported by the support device 62 along a curved path (indicated by the broken line 72 in Figure 10). The path 72 has the same shape as the portion of the core 34 on which a winding is to be formed. In the example shown, the core is hemi-toroidal, as is path 72.

The support 62 comprises a gripper mounted on vertical bar 74, which is mounted on a horizontal bar 76 that constitutes part of the core movement means 70, as described below. The gripper comprises a first bar 78 fixed to bar 74, and a second, L-shaped bar 80 secured to bar 78 in such a manner as to be movable along the length of the latter, as indicated by arrow A in Figure 9. For example, bar 80 can be secured to bar 78 by means of a screw 82 passing through a slot 84. Loosening screw 82 permits bar 80 to be moved in the direction of arrow A to release an object held between bars 78 and 80 or to grip an object therebetween. Tightening of screw 82 secures a gripped object in place. In use, one end of the core 34 is releasably clamped in this fashion between bars 78 and 80.

The winding device 66 comprises an arm 90 having one end mounted on a base 92 for rotation about a

horizontal axis. Wire is drawn from a supply thereof (not shown), through the hollow interior of the arm 90 and out through an aperture 94 provided at the free end of the arm 90. The free end of the wire 50 is secured by any suitable known means to one end of the core, preferably the end gripped by the support 62. Rotation of the arm 90 by a motor system indicated schematically as block 96 winds the wire around the portion of the core located at position 68.

To form a winding along the length of a portion of the core, the support 62 is rotated about a vertical axis 98, while the arm 90 is rotating, to cause the portion of the core to be wound, to pass through position 68 to receive the wire from the arm 90. As is shown, bar 76 has one end supporting vertical bar 74 and the other end mounted for rotation about vertical axis 98. The length of bar 76 substantially equals the radius of curvature of the hemi-toroidal core. The motor system 96 powers the motion of bar 76. The motor system 96 includes means, within the skill in the art, to enable movement of bar 76 in either direction about axis 98.

The linear density (by which is meant herein the number of turns per unit length of core) of the winding formed on the core is determined, other factors being equal, by the ratio of the rotational speed of arm 90 and the speed with which the core movement 76 is rotated about axis 98. While this ratio can be permanently built into

the machine, it is preferable to make it variable, to render the machine capable of use not only for forming windings of different linear densities on cores of a given size and shape but also for providing windings on cores of different sizes or shapes or both. Such control can be provided in several ways. First, the motor system 96 can comprise two independently controllable motors at least one of which is variable in speed and reversible. Another approach is to use a single motor, which can be a variable-speed motor, and a variable-ratio system of camming and gearing or the equivalent. With either approach, a numerical control system can be provided if desired to control motor speed(s) and starting and stopping points for the respective movements of arm 90 and of bar 76. Suitable control systems and gearing systems and the like are within the ordinary skill in the pertinent arts.

It will be appreciated by those skilled in the art that the substantially radially symmetric design of the choke 30 is not essential to the invention. Less compact, but still practical, variations can be adopted depending upon the design convenience and esthetic considerations. In particular, the choke may be not only strictly toroidal but annular, i.e., polygonal or oval, or have other configurations. Also, it is not essential to the invention that the two exposed portions 40 of the original toroidal core be diametrically opposite, but that

location makes cutting the core into two pieces especially easy, and the winding process is simplified by making the two pieces of the original core substantially the same size and shape. However, either or both of the two cores 34 into which the original core is cut may, if desired, define less than 180 degrees of a circle, if the resulting manufacturing complexities are acceptable. Similarly, one core may be cut to less than 180 degrees while the other is cut to more than 180 degrees.

Also, the division of the original toroidal core into two pieces is preferably done after the provision of the insulative layer, and this sequence is necessary with a tape-wound core to preserve it intact. The reverse order is also within the scope of the invention, however.

While the present invention has been described in detail with reference to the preferred embodiments thereof, many modifications and variations thereof will not be apparent to those skilled in the art. Accordingly, the present invention is to be limited, not by the details of the embodiment illustratively described herein, but only by the terms of the appended claims.

WHAT IS CLAIMED IS:

1. A process for the manufacture of a choke, comprising the steps of:
providing a layer of an insulative material on a core of a magnetic material;
dividing the core into at least two pieces;
and
winding a wire of an electrically conductive material to form a respective winding on each of the pieces.
2. The process of Claim 1, further comprising the step of connecting the respective windings in series.
3. The process of Claim 2, wherein the core is toroidal, the process further comprising the step of mechanically joining the pieces to form a complete torus.
4. The process of Claim 1, wherein the layer-providing step is performed before the dividing step.
5. The process of Claim 1, wherein the dividing step is performed before the layer-providing step.
6. The process of Claim 1, wherein the layer-providing step comprises injection-molding the insulative material to form the layer.
7. The process of Claim 1, wherein the layer-providing step comprises introducing the insulative material into a flexible mold to form the layer, and flexing the mold to release the core after the insulative material has set.

8. The process of Claim 1, wherein the dividing step is performed by means of milling.

9. The process of Claim 1, wherein the core is annular.

10. The process of Claim 1, wherein said winding step is performed by means of an apparatus which has:

a base;

a support for supporting a core;

a winding device supported on the base, for winding a filament around a portion of a core supported by the support while that portion of the core is at a predetermined location relative to the base;

a core movement system for moving a core supported by the support in such a manner that the core moves along a curved path such that all points along at least a predetermined segment of the core pass in sequence through the predetermined location, while the winding device is operating; and

a motor system for powering the winding device and the core movement system, the core being moved by the core movement system in conjunction with operation of the winding device.

11. The process of Claim 10, wherein the core movement system is adapted to move a core along a circular-accurate path whose radius of curvature is equal to that of the predetermined segment of the core, the center of curvature of the path substantially coinciding

with that of the predetermined segment of the core when the core is supported by the support.

12. The process of Claim 10, wherein said support is adapted to releasably grip one end of a core.

13. The process of Claim 10, wherein the motor system comprises two motors, one of which powers the winding device and the other of which powers the core movement system.

14. The process of Claim 10, wherein the motor system comprises a motor that powers both the winding device and the core movement system.

15. The process of Claim 11, wherein at least one of the core movement system and the winding device is adapted to operate with a controllably variable speed relative to the other.

Fig. 1.

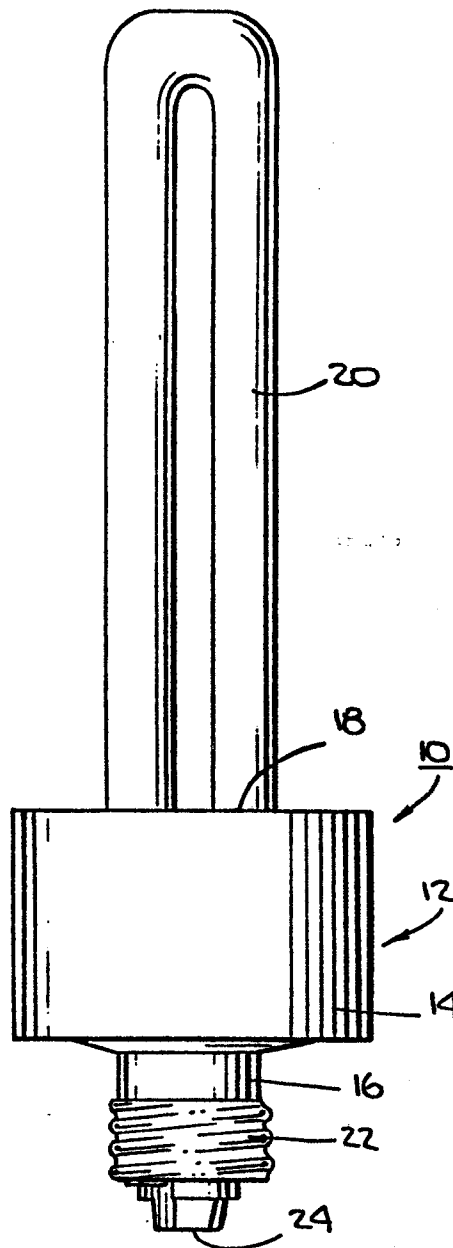


Fig. 2.

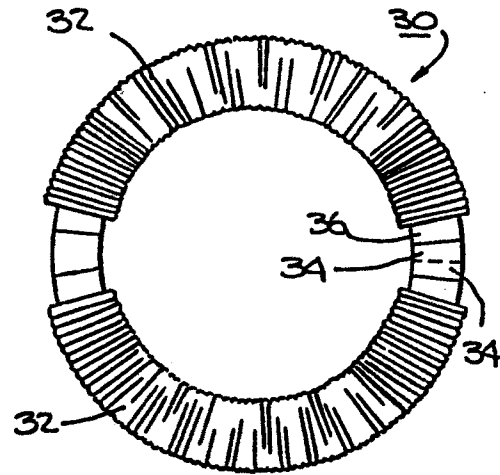


Fig. 3.

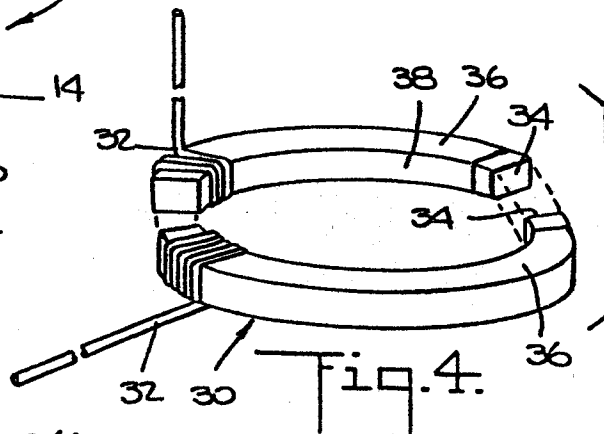


Fig. 4.

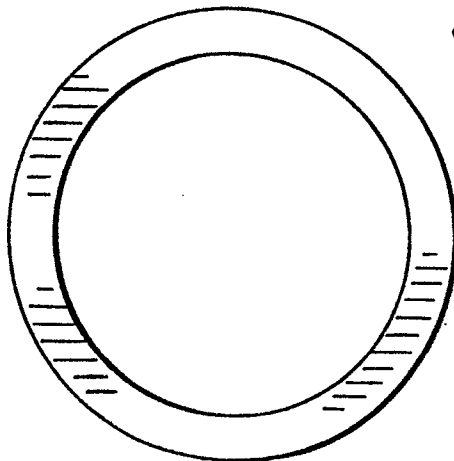


Fig. 5.

Fig. 6.

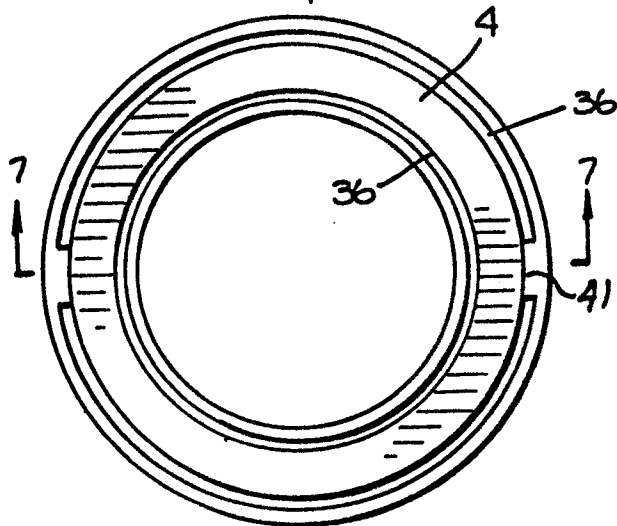


Fig. 7.

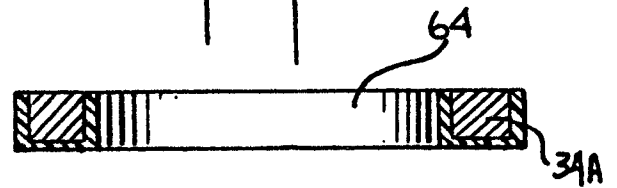


Fig. 6A.

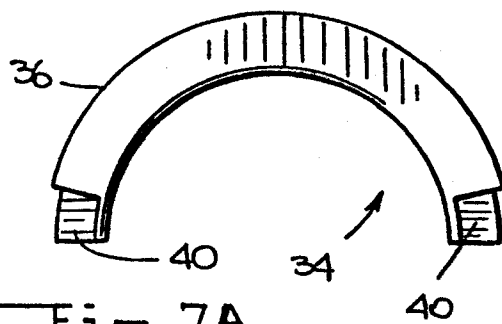
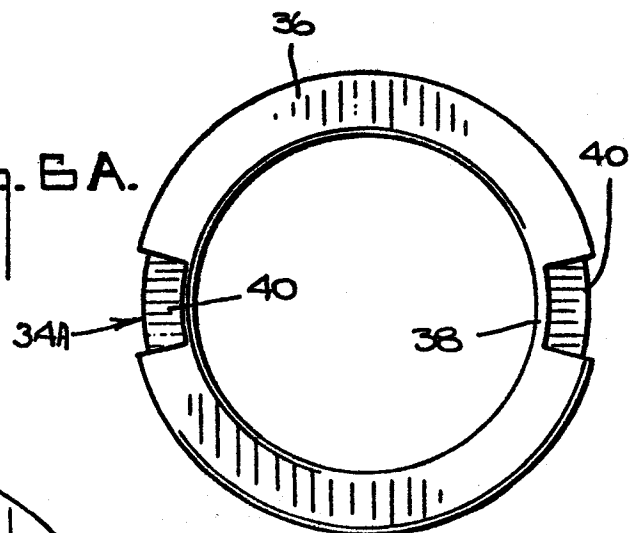
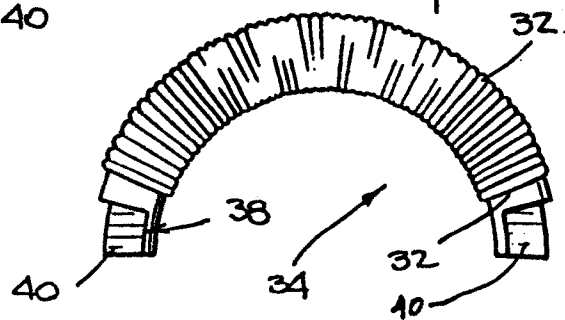
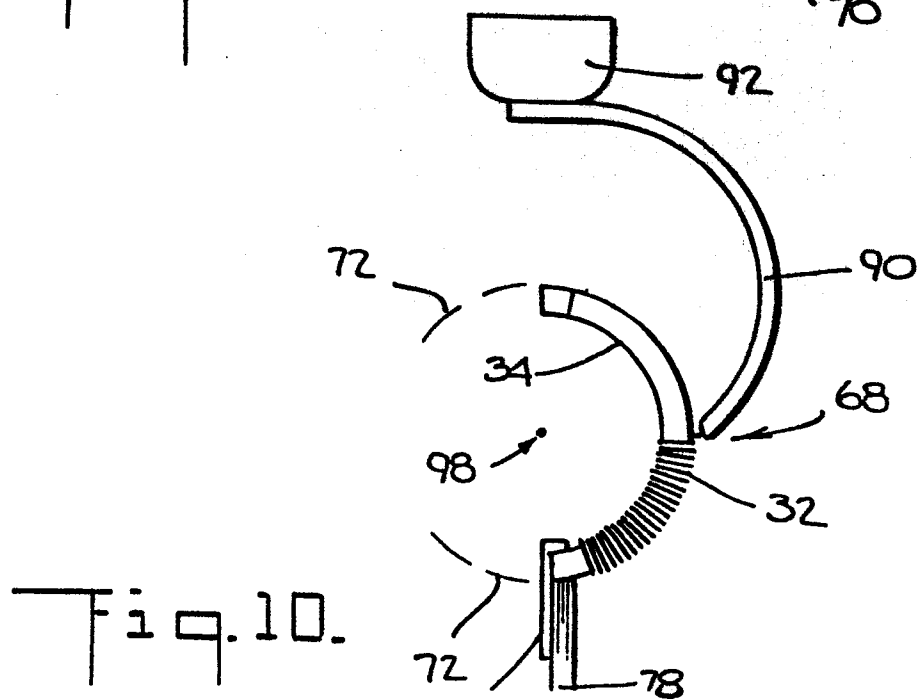
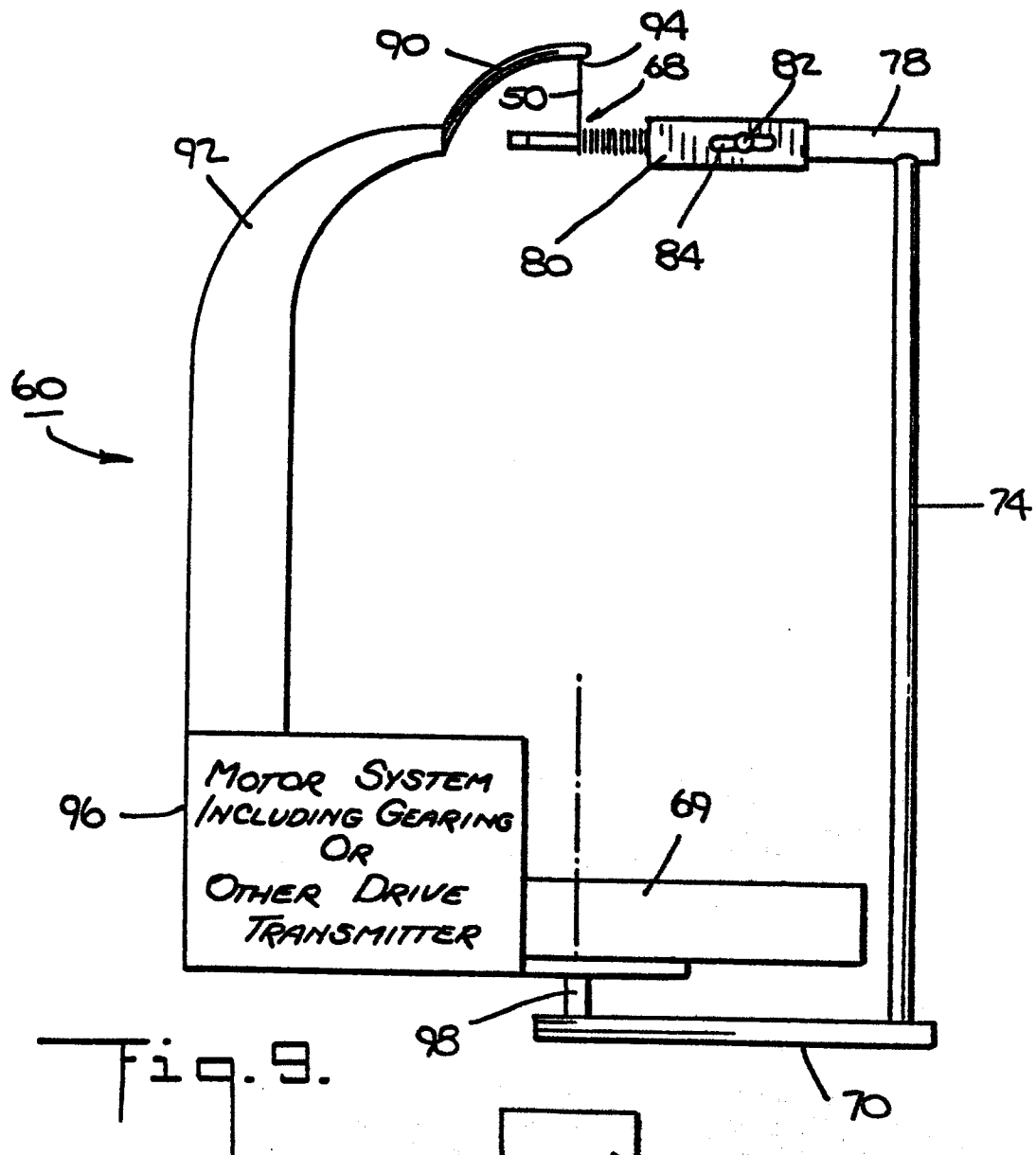


Fig. 7A.

Fig. 6B.







DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
Y	US-A-2 865 086 (WESTERN ELECTRIC CO.) * Column 2, lines 1-50 *	1	H 01 F 41/02 H 01 F 41/08
A	---	2, 3, 9	
Y	US-A-3 477 051 (IBM) * Column 5, line 33 - column 6, line 40 *	1	
A	---	6	
A	US-A-2 773 651 (WESTERN ELECTRIC CO.) * Column 2, line 27 - column 3, line 13 *	10-12	
	---		TECHNICAL FIELDS SEARCHED (Int. Cl. 4)
A	DE-C- 479 292 (AEG)		H 01 F 41/00 H 01 F 17/00
A	FR-A- 862 834 (LIGNES TELEGRAPHIQUES ET TELEPHONIQUES)		
A	DE-B-1 154 868 (TELEFUNKEN)		
A	US-A-3 032 729 (PHILIPS PETROLEUM CO.)		

The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 21-03-1986	Examiner VANHULLE R.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			