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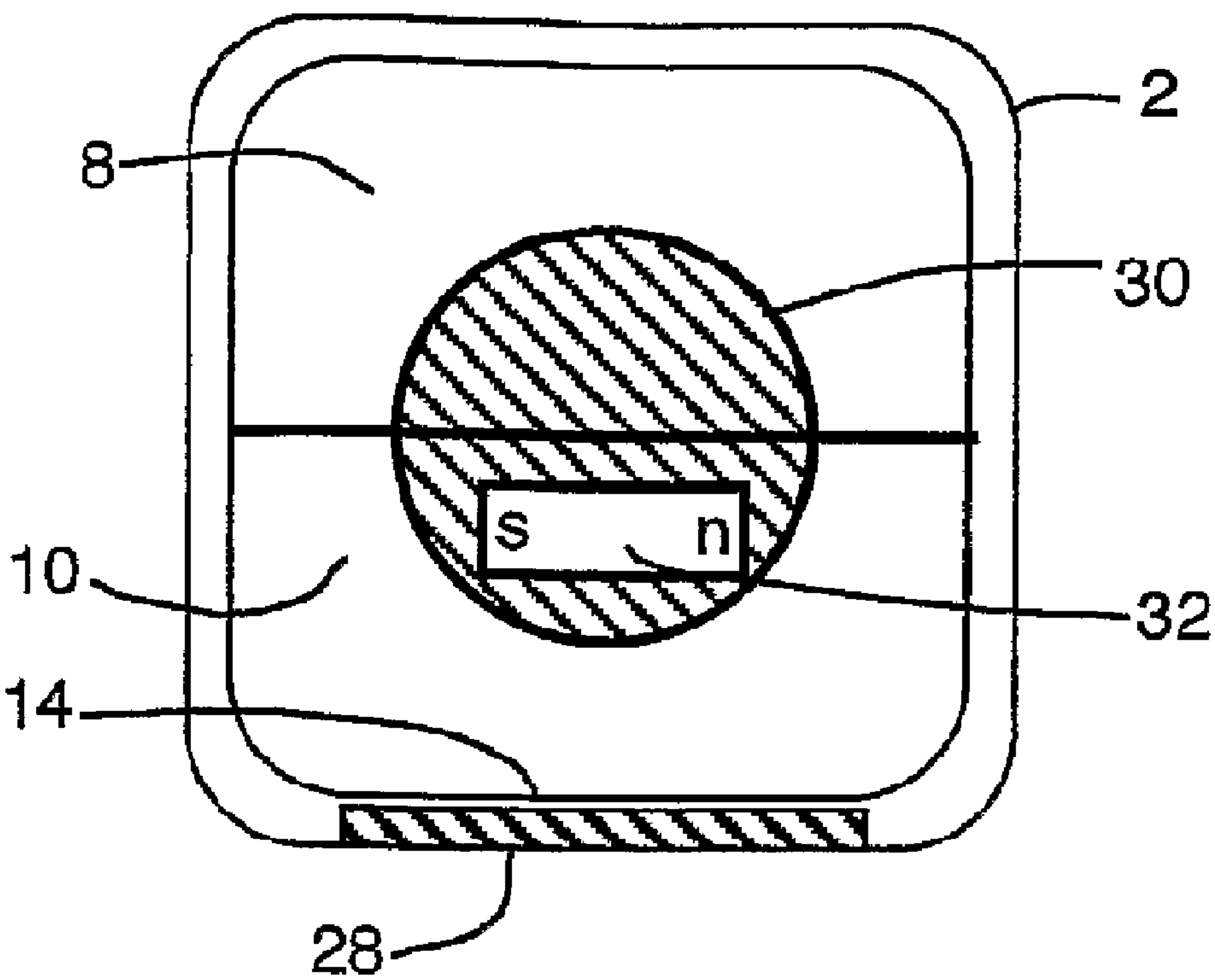
(54) **Titre :** CORPS A AUTOROTATION EN SUSPENSION DANS UN LIQUIDE ET PROCEDE
(54) **Title:** FLUID SUSPENDED SELF-ROTATING BODY AND METHOD



(57) **Abrégé/Abstract:**
In a display device where a moving object is immersed in a fluid filling a transparent sealed, vessel (72) and is rotated by an internal electrical mechanism that derives it power from a photo cell (128) and its counter torque from an internal compass (140), the index of refraction of the fluid is adjusted by addition of water to match the index of refraction of the vessel material. The formula of the fluid is also tailored to minimize absorption of ambient moisture into the vessel. In one embodiment of the electrical spinning mechanism, the magnet acts both as a biasing compass and as a magnetic field generator for the motor. In a second embodiment of the spinning mechanism, the stator is constituted by a multipole ring-shaped magnet (120) that does not interfere with the operation of the biasing compass magnet (140). Multiple windings in the electrical spinning mechanism are energized through a split-ring and brush commutator (92) that use the mechanism shaft (122) as conductor.

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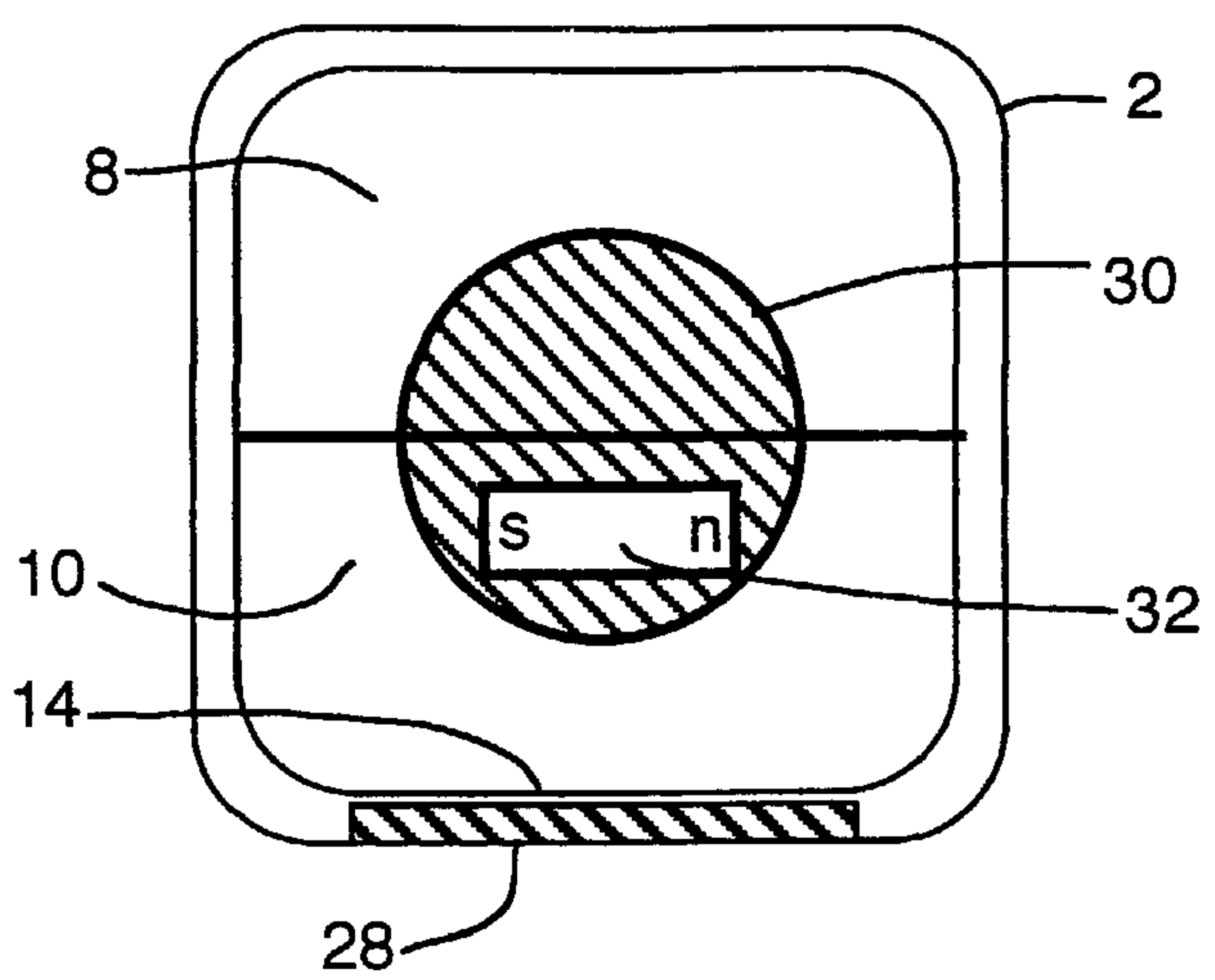
(54) Title: FLUID SUSPENDED SELF-ROTATING BODY AND METHOD



(57) Abstract: In a display device where a moving object is immersed in a fluid filling a transparent sealed, vessel (72) and is rotated by an internal electrical mechanism that derives it power from a photo cell (128) and its counter torque from an internal compass (140), the index of refraction of the fluid is adjusted by addition of water to match the index of refraction of the vessel material. The formula of the fluid is also tailored to minimize absorption of ambient moisture into the vessel. In one embodiment of the electrical spinning mechanism, the magnet acts both as a biasing compass and as a magnetic field generator for the motor. In a second embodiment of the spinning mechanism, the stator is constituted by a multipole ring-shaped magnet (120) that does not interfere with the operation of the biasing compass magnet (140). Multiple windings in the electrical spinning mechanism are energized through a split-ring and brush commutator (92) that use the mechanism shaft (122) as conductor.

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Field of the Invention

The instant invention relates to self-starting and self-powered display devices, and more particularly, to self-spinning globes powered by radiated energy.

Background of the Invention

Various types of novelty structures which move with either no apparent support, drive mechanism, or power input are often used as toys, decorative conversation pieces or advertising media. Various embodiments of such structures have been disclosed in U.S. Patent No. 5,435,086 Huang et al., Japanese Patents Nos. 10137451, 101431101, and 10171383, all by Hirose Mamoru, Japanese Patents Nos. 7210081, 7219426, and 7239652 all to Taragi Hiroshi and German Patents Nos. DE19706736 Fushoellier, DE3725723 Steinbrinck, and DE 41377175 Lang. Most prior embodiments are not totally free of external connection. If they are not firmly anchored to an outer support, they require complex and bulky countertorque-producing mechanisms such as fan blades or other internal heavy and complex systems that consume a great deal of electrical power.

The countertorque-producing mechanisms and their supports are very evident to an observer, and do not create any interest or appreciation of ambient energy fields.

U.S. Patent No. 4,419,283 discloses the use of a combination of two or more immiscible fluids to buoyantly support small objects. This patent does not address the avoidance of bubbles resulting from the expansion of the container and problems created by excessive internal pressure resulting from absorption of ambient moisture.

The present invention results from an attempt to devise and intriguing and educational moving structure that requires a very low level of power derived from an ambient field of electro-magnetic radiation, and avoid the creation of bubbles in the supporting fluid of some displays as well as deformation of the container due to excessive internal pressure.

Summary of the Invention

The principal and secondary objects of this invention are to provide the simplest and least power-demanding rotating display that can operate for extremely long periods of time without any apparent driving mechanism, input of power, or support bearing, and that may be suitable for use as a toy, advertising medium, novelty, or robotic component of a remote space or underwater installation.

In the preferred embodiment of the invention, these and other valuable objects are achieved by floating a sealed and hollow object spinning in a volume of fluid held within a transparent sealed container.

The container is suspended or otherwise supported by a tripod or other like structure. The internal drive mechanism is anchored, in other words, derives its spinning force in co-reaction with, or biased by, either the earth's magnetic field or another man-made magnetic field. Power for the motor or electromagnets is obtained by collecting light waves that impinge upon the enclosure throught the use of photovoltaic cells.

Various commutating mechanisms for selectively and sequentially enabling the electromagnets are disclosed.

The preferred embodiment of the invention will be perceived as a replica of the planet earth floating in space and spinning forever in a stately way.

The fluid supporting the enclosure is a combination of liquids that are formulated to resist absorption of ambient moisture.

The drive mechanism is compact and self-contained, that is, housed within the object, if not the container.

Brief Description of the Drawing

Figure 1a is a side sectional view of a preferred embodiment of the invention;

Figure 1b is a top view thereof;

Figure 2 is a side sectional view of a first alternate embodiment;

Figure 3 is a side sectional view of a second alternate embodiment;

Figure 4a is an expanded side sectional view of the drive of the second alternate embodiment;

Figure 4b is a top sectional view of the drive of the second alternate embodiment;

Figure 5 is a side sectional view of a third alternate embodiment;

Figure 6a is a side sectional view of a fourth alternate embodiment;

Figure 6b is a top view thereof;

Figure 7a is a side sectional view of a fifth alternate embodiment;

Figure 7b is a top view thereof;

Figure 8a is a side sectional view of a sixth alternate embodiment;

Figure 8b is a top view thereof;

Figure 9 is a side sectional view of a seventh alternate embodiment;

Figure 10 is a graph of the Propylene Glycol weight percentage necessary in Propylene Glycol/water mixtures to be at equilibrium with the water vapor in air as a function of the relative humidity of the air;

Figure 11 is a graph of the indices of refraction of various mixtures of Gylcols and water as a function of the weight percentage of the Glycol in the mixture;

Figure 12 is a chart of the average relative humidity over a two year period for various cities in the USA;

Figure 13a is a side, sectional view of the preferred embodiment of the drive mechanism;

Figure 13b is a top view of key elements thereof;

Figures 14a, 14b and 14c are top views of a commutation sequence for said mechanism;

Figure 15 is a side, sectional view of a first alternate embodiment of the mechanism;

Figure 16 is a side, sectional view of a second alternate embodiment of the mechanism;

Figure 17 is a side, sectional view of a third alternate embodiment of the mechanism;

Figure 18a is a side, sectional view of a fourth alternate embodiment of the mechanism;

Figure 18b is an expanded top view of the commutator rings and brushes for the fourth alternate embodiment;

Figure 18c is an electrical schematic view of the connections between coils and commutator segments of the device of Figure 18a;

Figure 19a is a side sectional view of a drive mechanism for the preferred embodiment of Figure 1;

Figure 19b is a top view thereof with the motor top removed;

Figure 20a is the motor magnet and the compass magnet of the device of Figure 19a a particular relative angular orientation;

Figure 20b is the motor magnet and the compass magnet of the device of Figure 19a in a different relative angular orientation;

Figure 21 is a side sectional view of how the drive mechanism of Figure 19a mounted within a ball;

Figure 22a is a top view of the armature structure of Figure 19b in a particular starting orientation with respect to the ring magnet of Fig. 1b;

Figure 22b is an expanded view of the split ring assembly and brushes of Figure 21a; and

Figures 23a, 23b, 23c, 23d, 25a and 25b are progression of relative angular orientations of the a armature structure and the ring magnet and brushes as the ring magnet and brushes are driven to rotate in a counterclockwise direction.

Description of the Preferred Embodiment of the Invention

Referring now to the drawing, there is shown in Figures 1a and 1b, a display device comprising a transparent case **2** containing a ball **4** floating near the interface **6** of a lighter fluid **8** such as *NOPAR* 12 and a heavier fluid **10** such as Propylene Glycol. The ball **4** can be driven to rotate by internal mechanisms as described below, and preferably has graphic features on

* Trade-mark

its surface such as the features of the earth. The lighter fluid **8** and the heavier fluid **10** are immiscible and, preferably both transparent. The density of the ball **4** is made to be such that it is between the density of the lighter fluid **8** and the heavier fluid **10**, so the ball will float in the absence of any mechanical link with either the top inside surface **12** or the bottom inside surface **14** of the case **2**.

The enclosure or case **2** is shown as being one monolithic part, but it would actually be formed from at least two parts that would be fitted around the ball **4**, and then be bonded together, preferably in a way that leaves a bond line **3** that is either invisible or difficult to see. For example, acrylic can be bonded together by the well-known process of solvent bonding, and the resulting bond line is very hard to see. If the case **2** were made of glass, then the bond could be formed using one of the common adhesives with a similar index of refraction to glass, or the glass could be bonded by heating the surfaces to be bonded to soften them, prior to pressing them together. A low temperature bonding glass could be used to allow a lower temperaturee process.

Preferably, the indices of refraction of the lighter fluid **8** and the heavier fluid **10** are close enough in value so that the interface **6** is not noticable to an observer. It is further preferable that the index of refraction of the case 2 material be about the same as the index of refraction of the fluids 8 and 10, so that the interface between the fluids and the case will not be noticeable. It is further preferable that the fluids 8 and 10 and the case 2 material have reasonably similar transmission properties such as color and transparency, so that an observer will not be able to distinguish any difference in the appearance of the block when looking down line of sight **A**, as compared to looking down line of sight **B**. Preferably, the volume between the ball 4 and the case 2 is completely filled with fluid, with no bubbles to give an observer any cue that the case is not a solid block of material.

The fluid combination is advantageous for many reasons, and both can have an index of refraction of 1.421 at 20°C, if the proper amount of water is mixed with the Propylene Glycol.

The index of refraction of acrylic can be as low as 1.46 in *Plaskolite Optix R* Acrylic Sheet made by Plaskolite, Inc. of Columbus, OH. While this is not identical to the value for fluids, it is close enough to make the fluid-case interface very difficult to notice, particularly if well-known principles of optical design are employed in designing the overall shape of the case. For example, all corners and edges are rounded and the case is made reasonably thin. The degree of light

* Trade-mark

transmission is advantageously similar to this fluid combination and acrylic.

A better match of index or refraction to the NORPAR 12/Propylene Glycol fluid combination can be made by using *Ausimont XPH-353* Fluoropolymer, made by Ausimont S.p.A. of Milan, Italy, which has an index of refraction of 1.434.

The top view of Figure 1b shows the ball **4** in a central location within the case **2**. The forces of surface tension between the fluids **8** and **10**, the inside of the case at the interface **16**, and the surface of the ball **2** can function to make this central location the equilibrium location for the ball **4** when it is not moving. For example, if the case **2** is made of acrylic, and the lighter fluid is NORPAR 12 and the heavier fluid **10** is a mixture of 15% by weight water and 85% by weight Propylene Glycol, and if the ball **4** is made of acrylic and coated with a surfactant, such as Sailkote ™ made by McGee Industries, Aston, PA, then the ball **4** will tend to float at an equilibrium position out of contact with the inside of the case at the interface **16**. Regardless of the location of the ball when it is not rotating, it will tend to move toward the central location due to liquid shear forces when the ball starts rotating, as it will with subjected to an ambient field of energy, as described in the related applications.

The display device can present an observer with

* Trade-mark

several intriguing aspects. First, if the observer does not notice the interface **6**, because of the close similarity of the index of refraction of the fluids **8** and **10**, then the observer will not have any clues as to how the ball **2** is supported for rotation. Even if the interface **6** were visible, the observer would have no clues as to what could be causing the ball **4** to rotate. And, if the case **2** is made as described, then the observer will have no clue as to how the ball **4** could rotate within a seemingly solid block of plastic.

In an alternate embodiment illustrated in Figure 2, the support for the ball **4** is provided by a shaft **20** fixedly attached to the case **2**, and connected to the rotor or stator of an electric motor **22**, which is powered by ambient energy incident on a solar cell **24**, connected to the motor **22** by wires not shown. Bearings, not shown, within the motor **22**, allow the motor **22** to rotate with respect to the shaft **20**. The ball **4** is powered and driven to rotate by the various means described below and supported for rotation by means of bearings between the shaft **20** and the ball **4**. The shaft **20** is perferably made of a small diameter and of a material, such as described above, that closely matches the index of refraction of the fluid **26**.

The ball **4** is now supported by the shaft **20**, so there is no need to use the lighter fluid **8** and the heavier fluid **10** shown in Figure 1, to stablize the height of the ball **4**. Now the fluid **26** can be only NORPAR 12, and the density of the ball **4** can simply be made a reasonably close match to that of NORPAR 12.

In a second alternate embodiment, as shown in Figures 3-4b, a motor assembly **28** embedded in the lower part of the case **2** drives a ball **30** by means of magnetic interactions. This embodiment used a lighter fluid **8** and a heavier fluid **10** to support the ball **30** well above the bottom surface **14**. A magnet **32** is contained within the ball **30** for interfacing with a rotating magnetic field generated by the motor assembly **28**, thereby causing the ball **3** to rotate.

An electric motor **34** is supported by means of a shaft **36** fixedly attached to the motor assembly case. The case of the motor **34** is fixedly attached to the bar magnet **40** with **N** and **S** poles oriented orthogonally to the shaft **36** of the motor as shown. A solar cell **42** is mounted within the motor assembly **28** above the motor, as shown in Figure 4a. The case **2** and fluids **8** and **10**, and the motor assembly case are all made of materials that are transparent enough to allow a substantial amount of light to reach the solar cell **42**. The motor **34** is intended to be a type of motor that is powered by electric current delivered to the motor shaft **36**. The wires that connect the solar cell **42** to the motor shaft **36** are not shown, for clarity. The solar cell **42** is not shown in the top view of Figure 4b, for clarity in showing the motor **34** and the magnet **40**, but the solar cell **42** can be the same shape as the motor assembly **28** and cover much of its area.

In operation, the motor **34** is powered to rotate, which induces rotation of the bar magnet **40**, and the magnet interaction between the parallely oriented bar **40** magnet and ball magnet **32** induces rotation of the ball **30**. The strength and size of the bar magnet **40** and the magnet **32** are selected, by principles well-known in the art, to have a sufficiently strong magnetic interaction to allow the rotation of the ball to be driven, but not so strong that the ball **30** will be pulled downward into contact with the bottom surface **14**.

An observer of the embodiment illustrated in Figures 3 and 4 enjoys all the same illusions as described for the embodiment of Figure 1, except the case **2** is not completely transparent, owing to the opacity of the motor assembly **28**. Nevertheless, an observer can still be fooled into seeing the case as a solid block of plastic, as described for Figures 1a and 1b. This motor assembly is preferably made thin and can be imprinted on its upper surface **44** iwth various semi-transparent graphic features such as logos to allow the object to be used as an advertising premium.

Magnetic interactions between the object's magnet **32** and the motor's magnet **40** tend to maintain the ball **30** in a central location of the enclosure **2**.

The structure and operation of a third embodiment, shown in Figure 5, are similar to the embodiment of Figure 3, except the ball **30** and the fluid **26** are similar to their counterparts shown in Figure 2. Thus, a motor assembly **28** drives the rotation of the ball **3**, that is immersed in a fluid **26** and supported by a pillar **20**, the rotor of the motor being secured to the pillar.

Figures 6a and 6b show a fourth embodiment, which includes a satellite assembly **46**, comprising a satellite ball **48** embedded within a satellite shell **50**. A ball assembly **52** comprises a ball **4** embedded within a ball shell **54**. The satellite assembly **46** and the ball assembly are both supported by the buoyant forces of a lighter fluid **8** and a heavier fluid **10**, to float near the fluid interface **6**. The satellite shell **50** and the ball shell **54** are preferably both made of a material having an index of refraction substantially similar to those of the fluids and enclosure that will be essentially not visible to an observer, by virtue of the same optical principles described for the embodiment of Figure 1.

Figure 6b shows the ball assembly **52** and the satellite assembly essentially in contact and floating roughly in the center of the case **2** as would occur due to surface tension with the proper choice of fluids and materials. For example, the satellite shell **50** and the ball shell **52** can be made of acrylic, and the heavier fluid can be 15% by weight water and 85% by weight of Propylene Glycol and the lighter fluid can be NORPAR 12.

The ball surface **4** and the satellite ball **48** preferably have graphic features on their surfaces, such as earth features for ball **4** and moon features for satellite ball **48**, that are consistent with their relative sizes and relative motions.

In operation, the ball **4** will be driven to rotate by the same kind of mechanisms described below in Figure 21, and this will cause counterclockwise rotation **56** of the ball shell **54**. Because of the proximity of the ball shell **54** and the satellite shell **50**, a force **58** will tend to drag the satellite assembly along in the counterclockwise direction **56**. The liquid shear force **60** will create a force coupled with the force **58** that will cause the clockwise rotation **61** of the satellite assembly **46**.

An observer will see the ball **4** rotating, with no apparent support, and no apparent drive mechanism, apparently within a solid block of plastic, while the spinning satellite ball orbits around it.

A fifth alternate embodiment is shown in Figure 7a where a ball **4** fixedly attached near the center of a transparent disk **62**. Both ball **4** and transparent disk **62** are supported for rotation by a lighter fluid **8** and a heavier fluid **10** within a case **2**. A satellite ball **64** is supported for rotation on a shaft **66** fixedly attached to the transparent disk **62**, shaft **66**, and vanes are preferably made of a material that is transparent and has an index of refraction close enough to the index of refraction of the fluids, **8** and **10**, so as to be essentially invisible. The vanes **68** are shaped and positioned to cause spinning of the satellite ball **64** when the disk **62** and ball **4** are spun.

In operation, as shown in Figure 7b, the ball **4** is driven to rotate as described for previous embodiments. The courterclockwise rotation **56** of the transparent disk **62** causes the satellite ball **64** to move through the lighter fluid **8**, and the vanes **68** cause clockwise rotation **61** of the satellite ball **64**. An observer will be presented with the same visual effect as described for the display of Figures 6a and 6b.

A sixth alternate embodiment is shown in Figures 8a and 8b, where a ball **4** is supported for rotation by a shaft **20**. An arm **70** is fixedly attached to ball **4** for, and a shaft **66** fixedly attached to the arm **70** supports a satellite ball **72** for rotation. The case **2**, filled with fluid **26**, includes a cylindrical wall **74** made to be in close proximity to the satellite ball as ball **4** rotates.

In operation, ball **4** is driven to rotate in the counterclockwise direction **56**, as described for previous embodiments, and ball **72** is moved through a circular path, in a counterclockwise direction, in proximity to the cylindrical wall **74**. Liquid shear forces between the satellite ball **72** and the cylindrical wall **74** drive the clockwise rotation **61** of the satellite ball **72**. The display presents an observer with a similar sight as described for Figures 6a and 6b.

Figure 9 shows a seventh alternate embodiment, which can be very similar to the embodiment shown in Figure 2, or to other embodiments. A thick walled case **76** has a cavity **78** inside, which conforms to the shape of the ball **4**. When the layer of fluid **26** is thin as shown, and when the index of refraction of the fluid **26** is greater than the index of refraction of the material that the case **78** is made of, then, according to well-known optical principles, graphical features on the surface of the ball **4** will be magnified and appear to be on the inside surface of the cavity **78** and so the cavity will not be visible to an observer.

The above-described embodiments and their features and parts can be combined in the art. The motor assembly **28** could create a rotating magnetic field not by rotating a bar magnet **40**, but rather by the appropriate application of electric currents to electromagnets within the motor assembly **28** as explained below. The various drive mechanisms could be powered by internal batteries or power derived from the mains, rather than from ambient energy. All of the designs could include more than one of balls like ball **4** and the designs such as in Figures 6, 7 and 8 could clearly include more than one satellite ball. In most of the embodiments, the objects that rotate need not be a ball shape, indeed, they can have virtually any three-dimensional form, and the case **2** can be made in virtually any shape, such as a cylinder, box, cone, pyramid, or even irregular forms.

A wide range of materials for the fluids and cases can be considered, based on factors such as the index of refraction, clarity, cost, chemical resistance, and toxicity. For example, cane sugar can be mixed with water in various proportions to create a liquid with an index of refraction between 1.33 and 1.5. The list below includes some further examples of fluids and solids that can be used. This list is given to show examples of materials that are appropriate, but should not be taken to limit the choice to only these, because there are many appropriate materials, well-known to those skilled in the art.

Name	Index of refraction
Benzyl acetate	1.523
Anisole	1.518
Various vegetable oils	1.48 (approx.)
castor oil	1.48
Solid materials:	
Fused quartz	1.459
Pyrex glass	1.48

Name	Index of refraction
Butyrate	1.475
Methylpentene (Mitsui) Chemicals America, Inc.	1.463

In any one of the previously described embodiments of the display device, the lighter fluid **8** can be a pure paraffinic oil, or a mixture of similar hydrocarbons such as NORPAR 12, sold by Exxon, Houston, Texas, USA. The heavier fluid is a solution of Propylene Glycol and water, 88% Propylene Glycol and 12% water, by weight. The lighter fluid **8** fills about 85% of the enclosure **2**, and the heavier fluid **10** fills about 15%.

A bubble can form within the enclosure **2** when volume of the enclosure is greater than the total volume of the fluid, and such a bubble can provide a clear indictaion to an observer that the whole object is not rotating. For this reason, care should be taken that the bubbles not form. The total fluid volume and the volume of the enclosure **2** can change with temperature,a nd with the amount of water absorbed by the materials of the enclosure **2** and inner ball **4**. Various sequences of environmental exposure can result in conditions that will cause a bubble to form. A general way to prevent this is to fill the enclosure **2** to a slight over-pressure, under the conditions least likely to form a bubble. This can be done during the manufacturing process.

However, over time, and with exposure to extreme temperatures, for example, all plastics will, to some degree, creep and essentially change their shape. Thus, a ball and shell with a sufficient over pressure to withstand the formation of a bubble at 20^{O}C, can develop an essentially bigger fluid cavity **6** after exposure to a higher temperature, such as 40^{O}C, for an extended period. In this case, lowering the temperature back to 20^{O}C would now precipitate the formation of a bubble.

The use of a humectant liquid within the enclosure, in this case the Propylene Glycol/water solution, can help overcome this problem of creep because such a liquid can absorb water from the surrounding atmosphere and essentially increase the total amount of fluid within the enclosure. The liquid combinations that have been used in the past, such as the NORPAR 12 and PFPE 5060 absorb very little moisture and could not do this effectively.

Propylene Glycol will absorb wter from an ambient atmosphere until a limit is reached, which depends on the relaive humidity of the ambient atmosphere. This relationship is shown in Figure 10 for data published by the Dow Chemical Co., Midland, MI. This graph shows that when water and Propylene Glycol are mixed at a weight percent of 88% Propylene Glycol and 12% water, then this mixture is at equilibrium with air at 35% relative humidity ("RH").

When a humectant liquid is contained within a volume, such as the enclosure **2**, the rate at which moisture will diffuse from the ambient atmosphere **18** through the material of the outer shell **2** is proportional to the humidity difference between the ambient atmosphere **18** and the equilibrium humidity value corresponding to the particular Propylene Glycol/water mixture on the inside. For example, in the case of the proposed 88/12% mixture, all things being equal, if the humidity of the ambient atmosphere **18** were 70% RH, then moisture would diffuse from the ambient atmosphere **18** and into the enclosure **2** at half the rate that it would if the humectant liquid were pure Propylene Glycol, since the 88/12% mixture of Propylene Glycol and water is at equilibrium at 35% relative humidity, so the effective humidity difference is 35% and not 70%. As moisture diffuses into the Propylene Glycol/water mixture, the relative weight percentages of Propylene Glycol and water change, generally leading to slower and slower rates of diffusion.

This absorption of water causes a buildup of pressure within the enclosure **2**. Plastics can slowly change their dimensions by the process of creep, as mentioned already, but the likelihood that the plastic will actually fracture is greatly reduced if the rate of strain and the total magnitude are reduced. In the case of 70% ambient humidity, starting off with 88/12/5

Propylene Glycol to water cuts the rate of absorption in half and also cuts in half the totla amount of water that will finally be absorbed.

The graph in Figure 12 shows data from Allied Chemical, Minneapolis, MN on the average relative humidity for a group of cities in the USA over a two year period. The average value is 475. Denver was the direst at 35% RH, while Miami was the wettest at 63% RH. Clearly, there are bit variations at all these locations throughout the year, but the process of water diffusion is slow, and the absorption is reversible, so the ball-in-shell will not swing wildly fromseason to season. A ball-in-shell made with the preferred 88/12% solution of Propylene Glycol and water would not from a bubble in Denver, and would slowly absorb water and expand in the other cities, again avoiding the formation of a bubble.

The amount of water that the ball-in-shell will eventually absorb is also proportional to the total amount of the humectant fluid within the fluid cavity. For this reason, it would seem a good idea to use a very small amount of the heavy fluid **10**. However, the two fluids work together most effectively to stablize the height of the inner ball **4** with temperature changes when there is an equal amount of each fluid. The ability of the two fluid combination to regulate the floating height of the inner ball is completely gone when the percentage of either the heavier fluid **10** or the lighter fluid **8** is set at zero. The choice of how much of the heavier fluid to use is a compromise between the need for effective height regulation and the need to reduce the total amount of water that will eventually diffuse into the enclosure **2**.

The effectiveness of the ball-in-shell illusion is also very much improved if the indices of refraction for the two fluids are essentially similar. This makes the interface between the fluids hard to notice and thereby eliminates another cue to observers about the true nature of the object. The indices of refraction of PFPE 5060 and NORPAR 12 are 1.251 and 1.416, respectively, at 25^{O}C. The index of refraction of pure Propylene Glycol is seen on the chart of Figure 11 to be 1.431, which is a better match to NORPAR 12 than PFPE 5060, but the proposed 88/12% per volume solution of Propylene Glycol and water has an index of 1.423. The ratio of the refractive index of pure Propylene Glycol to NORPAR 12 1.005, which is twice as close to the ideal value of 1.

One example of a display device consisting of a ball within an outer spherical container exhibit the following characteristics:

1) The container and inner ball **4** are made of acrylic.

2) The inner ball **4** outer diameter is 150 mm, and is 3mm thick.

3) The outer shell inner diameter is 156 mm and is 3mm thick.

4) The container is completely filled with fluid at 10^{O}C at atmospheric pressure. The lighter fluid **8** fills about 85% of enclosure **2**, and the heavier fluid **10** fills about 15%.

5) The mass **14** of the drive is set so that a 20^{O}C the inner ball **4** floats at a vertical height of 3mm from contact with the outer shell **2**.

The invention shows just one example of how the instant invention can be applied. Objects of other sizes and shapes could clearly be made. materials other than acrylic could be used. The relative amounts of the two fluids in the fluid cavity cn be changed to achieve a different trade-off between height regulation and the amount of water that will be absorbed. There are many humectants known to those skilled in the art that can be used according to teachings of the instant invention, and other fluids that can be used in place of paraffinic oils.

The exact ratio of Propylene Glycol to water can be shifted to other values, and even adding small percentages of water to the Glycols helps. For example, if it is known that a particular ball-in-shell will be operating in a very humid environment, such as Miami at 63%, then the volume ratio of Propylene Glycol to water could be set at 75% Propylene Glycol and 25% water. It would also be possible to choose the ratio of Propylene Glycol 78% and water 22% to achieve a virtually perfect match of the indices of refraction at 25°C This 78/22 ratio would be at equilibrium with an ambient atmosphere of 53% RH, which is close to the USA average of 47%. Objects made with this 78/22 ratio would start off with a virtually invisible fluid interface and would lose water, on average in the USA and in much of the world, at a very slow rate. Mixtures of different humectants can clearly be made to achieve a wide range of humectant/water solutions that can match the index of refraction of NORPAR 12 perfectly over a reasonable range of equilibrium relative humidity values, and paraffin oils with different indices of refraction can be chosen to increase the range of relative humidity values that cn be matched.

Other hydrocarbon Glycerin alcohols beyond those shown in Figure 11 may be conveniently mixed with water to adjust the index of refraction of the solution, and the degree of moisture absorption into the enclosure.

The following component drive mechanisms are intended for use as motors in the previously described display devices.

Figure 13a shows a side sectional view of a non-magnetic motor case **72** containing the drive mechanism. An axle **74** is mounted in a vertical orientation, supported by a bearing comprising a ball **76** supported by a sapphire cup **78**, said cup being constrained laterally by brackets 8 that can be part of the motor case **72**. The axle **74** is constrained laterally near its top by a cylindrical journal **80** which can be a molded part of the motor case. A disk **82** made of magnetically permeable material such as soft iron is fixedly attached to the axle **74**, perpendicular to said axle. The disk **82** has a central part 14 that has been formed to be above the outer parts of said disk. Two half-ring shaped permanent magnets, magnet **MA** and magnet **MB**, are mounted fixedly to the disk **84**, as shown in Figure 13a and the top view of Fig 13b. The magnets are coaxial with the axle or shaft **74**. The entire top surface of magnet **MA** is magnetized to be a N pole, and he entire top surface of magnet **MB** is magnetized to be a S pole.

The axle **74** with the disk **82** and the magnets **MA** and **MB** mounted as described, comprise a compass assembly **86**, so long as the axle **74** is roughly in a vertical orientation, and said compass assembly will align itself with the ambient magnetic field, which can be simply the earth's magnetic field, and keep the axle in a fixed rotational position.

A group of **73** coils of wire, coil A, coil B, and coil C mounted proximate the magnets are clearly seen of Figure 13b. The side sectional view shows side view of coil A and the dashed lines show where coils B and C are . All these coils, A, B and C, are fixedly attached to the inside upper surface of the motor case **72**.

Electrical potentials are delivered to the group of coils, as shown in Figure **13a**, from an external source by means of a axle brush **88** rubbing on the axle **74**, and a ring brush **90** rubbing on a slip ring **92**, said slip ring being cylindrical in shape, concentric with the axle **74**, and electrically insulated from said axle. The axle **74** is electrically conductive. The external source of electrical potential is not shown, but could be a battery or a solar cell mounted on the top outside of the motor case, or elsewhere. For simplicity, the wires connecting the potential source to the brushes **88** and **90** are not shown.

A split-ring assembly **94** is also mounted on the axle **74**. This consists of two halves, a negative half **96** and a positive half **98**, seen clearly Figure 13b. Each ring is a 180° segment of a cylinder and is mounted on the axle **74** so that the central axis of each segment is coincident with the central axis of the axle **74**. The positive half **96** is electrically connected to the axle **74** and the negative half **98** is electrically connected to the slip-ring **92**, by wires not shown for clarity. The external source of electrical potential is connected to supply a positive potential to brush **88** and a negative potential to brush **90**.

Three conductive brushes, brush **BA**, brush **BB**, and brush **BC**, are seen clearly in the top view of Figure

13b. The side view in Figure 1a only shows one of these brushes, brush **BC**, for clarity. These brushes are connected by wires not shown to the coils, A, B, and C. The said brushes are mounted on brush holders **100** which are fixedly attached to the motor case **72**, as seen for brush **BC** in Figure 13a.

Figure 14a shows a schematic view of the objects in Figure 13b, with the split ring assembly **94** enlarged for clarity. The two wires that come from each coils are marked with + and - signs to indicate similar terminals of the coils. Electrical wires **95** shown in Figure 14a connect brush **BA** to coil A - and coil B +, brush **BB** to coil B - and coil C +, and brush **BC** to coil C - and coil A +.

The compass assembly 16 in Figure 14a is shown with its N pole on the left and S pole on the right, as it would align itself if the earths magnetic N pole were to the right, and S pole to the left. Other ambient magnetic fields can add to the earth's field, but this will not effect operation unless the net field becomes essentially zero.

With the initial conditions shown in Figure 14a, current through coil A would flow in a direction that would urge coil A to move in a counter clockwise direction, coil B could have no current flow because brushes **BA** and **BB** are shorted together by the positive half **96** of the slip ring assembly **94**, and coil C have current flowing in it, but would generate little torque because it is in a region of almost uniform magnetic field. The torque experienced by the coils is transferred to the motor case and the entire case is urged to rotate counter-clockwise. The magnet assembly is at the same time urged to rotate clock-wise, but its interaction with the ambient field hinders this rotation. If the motor case is free to rotate, because it is mounted within a floating object such as described above, then it will begin to rotate counter-clockwise.

After rotating about 30° the orientation shown in Figure 14b is reached. Here coil A and coil B are both receiving current that urges continued counter-clockwise rotation, while coil C has become shorted and generates no torque. After rotating another 30° counter-clockwise, the orientation shown in Figure 14c is reached. Here coil B is generating counter-clockwise torque, coil A is receiving current, but would generate little torque because it is in a region of almost uniform magnetic field, and coil C is receiving no current because it is shorted. Continued counter-clockwise rotation continues to apply currents to the coils to urge continued counter-clockwise rotation.

Figure 15 shows a drive that is very similar to the drive of Figure 13, but a top iron disk **102** has been added, fixedly attached to the axle **74**, in close proximity of the coils and parallel to the disk **82**. The coils A,B and C, cannot be mounted directly on the motor case **72** now, so standoffs **104** serve to mount a coil holder bracket **106** to the motor case **72**. With this arrangement, the magnetic flux from the magnets **MA** and **MB** will be more concentrated within the area that coils A, B, and C move in, and so the torque generated by the coils will be higher. It is recognized that a tradeoff must be made between this desirable effect, and the weakening of the field that is created by the compass assembly **86** and that aligns it with the ambient magnetic field. An optimum design allows just enough flux to escape the compass assembly to stop the rotation of the compass during the operation of the drive in whatever environment has the weakest ambient field that the drive is designed to work in. The amount of flux that escapes depends on many well known principles of magnetic circuit design. A top iron disk **192** that is bigger in diameter, thicker, closer to disk **82**, and made of a material with a higher saturation magnetization will hold more flux in the coil area.

Figure 16 shows a design like Figure 13, except the disk **82** in Figure 13a has been replaces by a fixed disk **106** that is fixedly attached to the motor case **72** proximate the magnets and on opposite side of it from the coils.

The magnets A and B are now fixedly attached to the axle **74** by means of a non-magnetic bracket **108**. The gap between the fixed disk **106** and the magnets **MA** and **MB** should be as small as reasonably possible to facilitate flux transfer between the fixed disk **106** and the magnets A and B. The fixed disk **106** should be made of a soft magnetic material with a very low magnetic hysteresis do reduce the magnetic drag between the fixed disk **106** and the magnets **MA**, and **MB**. The advantage of this drive is that it reduces the load between the ball **76** and sapphire cup **78**.

Figure 17 shows a drive similar to that of Fig 15, except a solar cell **110** has been fixedly attached to the to the top of the axle **74**. The solar cell **110** can be a disk shape with a hole in the center to allow the axle to pass through. The source of electrical current is on the axle **74** itself, so the axle brush **88**, ring brush **90**, and slip-ring **92** of Figure 15 have been eliminated. This allows the disk **82** to be a flat disk **112**.

Figures 18a and 18b show an alternate commutation structure. A brush mounting bar **114** fixedly attached near the top of the axle **74** as shown. Brushes **BD** and **BE** are fixedly attached to the brush mounting bar **114** and the brushes **BD** and **BE** are positioned to rub on a three-segment split-ring assembly **116**, which is fixedly attached to the motor case **72**.

The three-segment split-ring assembly **116** is shown in closer detail in the top view of Figure 18b. The axel **74** is shown as a hollow tube, constrained laterally by a tube **118** that forms the inside of the three-segment split-ring assembly **116**. An insulating layer **120** surrounds the tube **148** and three slip-ring segments 122, each spanning a little less that 120° of the circimference of the three-segment split-ring assembly **116** are mounted on the outside of the layer of insulating material **120**.

Electrical potential is supplied to conductors on the axle **74** as described for Figure 13 and that potential is then conducted, by wires not shown fo clarity, to the brushes **BD** and **BE**, and through the sliding contact to the three-segment split-ring assembly **116** and then to the coils, A, B, and C. Figure 18c shows an elelctrial schematic diagram of how the coils A, B and C are connected by conductors **95** to the theee slip ring segments, **122**.

The structures shown in Figures 18a, 18b and 18c are new, but the the sequence of commutation that finally occurs is very well known in the art and will not be described here.

The various motor designs can be combined and and modified in many ways. For example, the design of Figure 15 could be combined with the concept illustrated in Figure 17, and the solar cell **110** could be mounted on the top iron disk **102**.

The magnets **MA** and **MB** and the disk **82** could be replaced with a one piece disk shaped magnet made of isotropic magnetic material and magnetized to act like a compass.

The top iron disk **102** could be mounted on the motor case in the same way that disk **82** became disk **106** in Figure 16. In this case, the magnetic attraction of the magnets A and B would tend to lift up the axle **74** and reduce the load on the bearing between the ball **76** and sapphire cup **78**.

The spinning object in the center of the display device may be constituted by the motor case **72** itself. Alternately, the motor case may be attached inside the spinning object such as the ball **4** of Figure 1 as illustrated in Figure 21.

The following drive mechanism uses a quadrapole magnet that is able to generate torque by means of an interaction with an ambient magnetic field, such as the geomagnetic field, wherein said drive mechanism does not suffer from magnetic cogging, and wherein the armature of the said drive mechanism can be made of light weight materials to minimize the friction in the bearing that supports the armature for relative rotation.

As illustrated in Figures 19a- 25b, Figure 19a a motor case **72** comprises a disk-shaped motor top **114** , a disk-shaped motor bottom **116**, and a cylindrical wall **118**. A ring shaped magnet **120** is contained within the motor case assembly **72**. Said ring-shaped magnet **120** is coaxial with the shaft **122** and is magnetized parallel to its thickness direction and in a pattern that results in four regions of magnetization on its top surface, TNa, TSa, TNb, and TSb, as seen from the top in Figure, 19b. The "T" in these labels means the magnetic poles referred to are on the top of the ring shaped magnet **120**, and the "N" and "S" mean magnetic north and south poles, respectively. The "a" and "b" letters denote which of the two pairs of north south poles is being referred to. Figure 19a makes it clear that the ring-shaped magnet **120** also has a set of opposite poles on its bottom surface, shown as BSa (opposite TNa), BNa (opposite TSa). Not shown are BSb (opposite TNb) and BNb (opposite TSb).

The motor case **72** is made of magnetically soft, ferromagnetic metal, such as soft iron, and serves to provide a return path for magnetic flux generated by the ring-shaped magnet **120**. The optimum thickness of the various parts of the motor case **72** is determined by very well known laws of magnetism, and depends on the exact geometry of the structure and on the properties of the ring-shaped magnet **120**, and on the saturation flux density of the material that the motor case is made of. The object of the design is to create a strong magnetic field shown by the arrows M in the region between the top of the ring-shaped magnet **120**, and the bottom surface of the motor top **114**.

As an example, a motor was made with a soft iron motor case assembly with a motor top .12" thick and 3.7" in diameter. The motor bottom was .125" thick with the same diameter as the top, and the cylindrical shell was .05" thick. The ring shaped magnet **120** was made of grade 5 ferrite from A-L-L Magnetics, of Placentia, CA ,33" thick with an OD of 2.8" an ID of 1.2" The gap between the top of the ring shaped magnet 5, and the bottom surface of the motor top 2 was .175" and the peak magnetic field strength was 2.1 kg.

The drive mechanism further comprises the shaft **122** supported for rotation on the bottom by a ball-shaped end **76** resting in a jewel bearing cup **78**. Said shaft is constrained near its top by a journal bearing formed by the top part of shaft **122** and the inside surface of a hole **124** in the center of the motor top **114**. A compass magnet **140**, comprising a rod of permanently magnetized material such as NdFe, is attached to the bottom part of the shaft **122** with its NS axis perpendicular to the axis of the shaft. The drive mechanism is generally oriented with the shaft vertical so that the compass magnet is able to align itself orthogonally to the shaft with any ambient magnetic field, such as the geomagnetic field. The shaft **122** passes through a hole **126** in the motor bottom, and is attached to a slip ring assembly **92**, and to a coil assembly **128** by means of a flange **130**.

Electrical brushes **134** and **138** are mounted on the top surface of the motor bottom **126** by means of insulating mounting brackets **132** and **134**. Electrical brush **134** makes contact with shaft **122** as it rotates, and electrical brush **138** makes contact with slip-ring assembly **92** as it rotates.

The coil assembly **128** is shown in cross section in Figure 19a, but is much clearer in Figure 19b with the motor top removed. This coil assembly comprises three-disk shaped coils of wire, C1, C2, and C3 attached to the flange 13 which is mounted on shaft **122** the coils are equally spaced apart around the axis of the shaft. Figure 19b and subsequent figures show these coils as simply one turn of wire for simplicity, but is understood that they are actually made up of many turns in the same direction. Coils made for a the test motor described above were about 1.7" OD X .69" ID X .100" thick and each had about 6000 turns of #44 gauge wire, thermally bonded to form a self-supporting coil.

Figures 20a and 20b show a top view of the ring-shaped magnet **120** and the compass magnet **140** mounted on the shaft **122** for the purpose of illustrating why there is virtually no torque generated about the axis of the shaft due to magnetic interactions between the compass magnet and the ring shaped magnet. Since all the magnetic poles of the ring shaped magnet **120** are the same size and strength, then the magnetic attraction between Pole TNa and the S pole of compass magnet **140** , is exactly equal and opposite to the magnetic attraction that exists between Pole TSa and of the ring-shaped magnet and the N pole compass magnet; thus, these interactions generate no net torque. Similarly, the magnetic repulsions of poles TSb with the S pole of compass magnet **140**, and the of pole TNb with the N pole result in no net torque. Furthermore, for similar reasons, magnetic interactions between poles TNa and TSb with the N pole of compass magnet produce no net torque, and the magnetic interactions between poles TSa and TNb with the S pole produce no net torque.

These same arguments can be applied when the orientation between the compass magnet **140** and the ring-shaped magnet **120** is at any arbitrary orientation as shown in Figure 20b. In Figure 20a pole S of the compass magnet **140** is now slightly closer to pole TSb of the ring-shaped magnet **120**, and slightly further away from pole TNa; the net torque is still essentially the same, and is still opposite to that generated by poles TSa and TNb interacting with the N pole of the compass magent **140**. Similar arguments can be made for the interactions of all the other pairs of poles, including the interactions of poles BNa, BSa, BNb, and BSb with the N and S poles of the compass magnet **140**. Thus, in this idealized case, there is never any magnetic interaction between the ring-shaped magnet **120** and the compass magnet **140** that tends to relatively rotate them about the axis if the shaft **122**.

The drive mechanism shown in Figures 19a and 19b can be mounted with in a ball **4** by mounting bracket **142** as shown in Figure 21 to cause the ball to rotate. The coil assembly **128** is provided with electric current by means of wires, not shown that connect a solar cell **144** to the electrical brushes **134** and **138**. It is assumed that the mass within the ball **76** is distributed in such a way that the while ball is bottom heavy and will float with the shaft **122** essentially vertical. The compass magnet **140** aligns itself with the ambient magnetic field AF, preferably the geomagnetic field. Currents applied to the coils C1, C2, and C3 will generate forces on the coils due to interactions with the magnetic fields produced by the ring magnet **120** to cause the ring magnet and everything attached to it to rotate. The coil assembly **128**, shaft **122**, compass magnet 1**140**, and slip-ring assembly **92** do not rotate.

Any magnetic interactions between the ring magnet **120** and the compass magnet **140** that would tend to prevent their relative rotation would interfere with the intended rotation of the ball. The description above makes it clear that the quadrapole design of the ring magnet **120** essentially eliminates any such cogging torques, even in the case where there is no motor case assembly is in place. Adding the motor case assembly **72** provides a return path for magnetic flux and greatly increases the strength of the magnetic field M in the region where the coils operate and thereby increases the torque the motor generates for any given current in the coils C1, C2, and C3. The motor case **72** also serves to magnetically shield the ring magnet **120** from the compass magnet **140** and thereby further eliminates any residual magnetic interactions between them that might occur because inconsistent magnetic properties in the various parts of the magnets, and imperfect geometry of the parts. Because of the intrinsic lack of magnetic interaction between the quadrapole ring-shaped magnet and the compass magnet, it is possible to design the motor case to be just thick enough to adequately provide a flux return path, and it is not necessary to make it significantly thicker and heavier, as would be necessary to shield the ring-shaped magnet and the compass magnet 18 if the magnetization pattern of ring shaped magnet 5 were a bipole, for example, and not a quadrapole.

The quadrapole ring-shaped magnet **120** also has virtually no cogging interaction with the ambient magnetic field, AF, for the same kinds of reasons that there is no cogging due to interactions with the compass magnet **140**.

Figures 22b, 23b, 24b and 25b show how the current is distributed to the coils C1, C2, and C3 as the ring-shaped magnet **120** and all that is attached to it, rotate counterclockwise as seen from the top. The "a" Figures show the relative orientations of the poles on the top of the ring-shaped magnet and the coil assembly **128**, and the "b" Figs. show an expanded top view of the region near the slip-ring assembly **92**.

Figure 22a shows coil C1 located symmetrically between poles TNa and TSa of ring-shaped magnet **120**. Flange **130** is not shown for simplicity. Figure 22b shows a greatly expanded view of the slip-ring assembly **92** comprising six segments, R1a, R2a, R3a, R1b, R2b and R3b, where C1+ is electrically connected to R1a and R1b, C2+ is electrically connected to R2a and R2b, and C3+ is electrically connected to R3a and R3b, by wires not shown for simplicity. The ends of coils C1, C2, and C3 denoted by C1g, C2g and C3g respectively, are all connected to the shaft 6 by wires not shown for simplicity. Electrical brush **134** is in contact with shaft **122** and electrical brush **138** is in contact with slip-ring segment R1b. The electrically negative terminal of solar cell **144** of Figure 21 is connected to electrical brush **134** and the electrically positive terminal of solar cell **144** is connected to electrical brush **138**, by wires not shown for simplicity. With these connections made and current flowing, the ring magnet will experience a force that will urge it to rotate counterclockwise.

Figures 23a and 23b show the relative orientation that is reached after the ring magnet **120**, and everything attached to it, has rotated 30° counterclockwise. It is assumed that the globe is free to rotate, and that the compass magnet **140** has held the coil assembly **128** in the fixed angular position as shown. In the 30° rotated orientation shown, slip ring segments R1b and R2a are momentarily both connected and provide current to coils C1 and C2 which both tend to drive the continued counterclockwise rotation of ring magnet **120**, which will result in coil C2 being energized for the next 60° of counterclockwise rotation.

Figures 24a and 24b show the relative orientation that is reached after the ring magnet **120** and everything attached to it has rotated 90° counterclockwise. In the 90° rotated orientation shown, slip ring segments R2a and R3a are momentarily both connected and provide current to coils C2 and C3 which both tend to drive the continued counterclockwise rotation of ring magnet, which will result in coil C3 being energized for the next 60° of counterclockwise rotation.

Figures 25a and 25b show the relative orientation that is reached after the ring magnet **120** and everything attached to it has rotated 150° counterclockwise. In the 150° rotated orientation shown, slip ring segments R3a and R1a are momentarily both connected and provide current to coils C3 and C1, which both tend to drive the continued counterclockwise rotation of ring magnet, which will result in coil C1 being energized for the next 60° of counterclockwise rotation. This commutation process continues as described, resulting in the continuous rotation of the ball **4**.

In an example of the display, a compass magnet comprises two NdFe cylindrical magnets .375" in diameter and .375" long, each mounted in the end of rod of soft iron .85" long for a total compass length of 1.6". This compass magnet was mounted on the shaft **122** with the center of the compass 2.27" below the lower surface of the motor case assembly 1. Magnetic cogging was insignificant.

It is clear that other commutation schemes could be arranged using different commutation ring structures. For example, starting in the orientation shown in Figure 122a, coil C1 could be turned off after 15° of rotation and coil C3 then energized for 30° of rotation with a current of opposite direction from the current that was flowing in coil C1. Then coil C2 would be energized for the next 30° of rotation, using the same current direction as was used in coil C1, and so on.

The quadrapole magnetization pattern could by replaced by higher order patterns such as an octapole pattern. As the number of poles goes up the problem of shielding the ring magnet from the compass magnet is reduced just because the fields emanating from small magnets placed close together do not have as great a spatial extent as do fields from larger magnets.

CLAIMS:

1. A display device which comprises:

an enclosure;

a transparent fluid contained within said enclosure; and

a movable first object surrounded by said fluid;

wherein said fluid includes:

a first liquid having a first density and a first index of refraction; and,

a second liquid immiscible with said first liquid;

said second liquid having a second density different from said first density and a second index of refraction substantially similar to said first index, wherein an interface between said first and second liquids is not noticeable to an observer; and

wherein the respective volumes of said first liquid and said second liquid are adjusted to buoy the first object in the absence of any mechanical link between the first object and the enclosure.

2. The device of Claim 1, wherein:

said first liquid comprises a solution of a humectant and water in a ratio adjusted to minimize absorption of ambient moisture through said enclosure.

3. The device of Claim 2, wherein said first liquid comprises a hydrocarbon glycerine alcohol.

4. The device of Claim 3, wherein said alcohol is taken from a group consisting of Ethylene Glycol, Diethylene Glycol, Triethylene Glycol, Propylene Glycol and Diproplene Glycol.

5. The device of Claim 3, wherein said second liquid comprises a paraffinic oil.

6. The device of Claim 2, wherein said enclosure is made of a material having an index of refraction substantially similar to said first and second indeces.

7. The device of Claim 2, wherein said enclosure is made of a transparent material having an index of refraction substantially similar to said first and second indeces.

8. The device of Claim 7, wherein said first liquid consists of Propylene Glycol and water, and said second liquid consists of NORPAR 12.

9. The device of Claim 8, wherein 88% of the weight of said first liquid is Propylene Glycol and 12% of the weight of said first liquid is water.

10. The device of Claim 7, wherein said material is selected from a group consisting of Pyrex glass, Acrylic, XPH-353 Fluoropolymer, Fused Quartz, Butyrate, and Methylpentene.

11. The device of Claim 1 which further comprises: a stationary pillar affixed to an inner section of said enclosure; an electrical motor having a rotor and a stator, one of said rotor and stator being secured to said pillar, and the other of said rotor and said stator being secured to said first object.

12. The device of Claim 11, wherein said motor is located within said first object.

13. The device of Claim 12, wherein said enclosure and pillar are made from a transparent material having a third index of refraction substantially similar to said first index.

14. The device of Claim 2 which further comprises: an electrical motor having

a shaft and being positioned below, and spaced apart from said first object; a first magnet having poles oriented orthogonally to said shaft and having a median section coupled to said shaft; and a second magnet secured to said first object and being positioned in an orientation parallel to said first magnet; whereby the rotation of said first magnet by the motor induces rotation of said second magnet and first object.

15. The device of Claim 14 wherein said motor is embedded in a wall of said enclosure.

16. The device of Claim 14 which further comprises a solar cell supplying electrical power to said motor.

17. The device of Claim 2 which further comprises: a second object; and a transparent member linking said second object to said first object.

18. The device of Claim 11 which further comprises: a second object; and a transparent member linking said second object to said first object.

19. The device of Claim 17, wherein said second object is rotatively attached to said member, and includes a series of peripheral vanes shaped and positioned to induce a spinning movement of said second object when said first object is spun.

20. The device of Claim 17 which further comprises: a transparent cylindrical wall surrounding said first and second object; and wherein said second object is rotatively attached to said member and includes a circular peripheral section in close proximity of said wall.

21. The device of Claim 2, wherein said first object comprises a sealed container and an electrical motor housed in said container and including:

a shaft oriented about a first axis and rotatively supported at either end by said container;

a bipolar magnet having poles oriented along a second axis perpendicular to said first axis and being fixedly attached at its center to said shaft;

whereby interaction of said bipolar magnet with a stationary ambient magnetic field keeps said shaft in a fixed rotational position;

said motor further including a ring-shaped magnet coaxial with said first axis, fixedly connected to said container, and having at least two pairs of positive and negative poles;

at least three coils proximate said ring-shaped magnet, fixedly attached to said shaft and circumferentially equally spaced apart around said first axis;

a source of electrical power; and switching means for alternately energizing said coils from said source of electrical power, and for inducing magnet torque forces between said coils and the poles of said ring-shaped magnet to cause said ring-shaped magnet and container to rotate about said shaft;

whereby the magnetic torque forces between said bipolar magnet and said ring-shaped magnet cancel one another and do not affect the movement of said container around said shaft.

22. The device of Claim 21, wherein said container comprises a hollow sphere.

23. The device of Claim 2, wherein said first object comprises a sealed container and an electrical motor housed in said container and including:

a shaft oriented about a first axis and rotatively supported at both ends by said container;

a first disk made of magnetically permeable material fixedly and axially connected to said shaft;

a pair of symmetrical, half-ring-shaped magnets positioned coaxially with said shaft upon said first disk;

whereby interaction of said magnets with a stationary ambient magnetic field keeps said first object in a fixed rotational position;

at least three coils proximate said magnets, said coils being fixedly attached to said container and circumferentially equally spaced apart around said first axis;

a source of electrical power; and

switching means for alternately energizing said coils from said source of power and for inducing magnetic torque forces between said coils and said magnet to cause coils and container to rotate about said shaft.

24. The device of Claim 23, wherein said motor further includes an iron disk axially positioned proximate said coils opposite said first disk.

25. The device of Claim 23, wherein said motor further includes a disk of soft magnetic material axially positioned proximate said magnet opposite said coils.

26. The device of Claim 23, wherein said source of electrical power comprises a solar cell attached to said container.

27. The device of Claim 23, wherein said switching means comprises: a split-ring mounted on said shaft and contact brush commutator, wherein: said split-ring comprises three segments, each segment being fixedly connected to a positive end of one coil and to a negative end of another coil; and wherein said commutator comprises two brushes connected to a pole of said source of power and contacting said split-ring at diametrically opposite points.

Fig 1a

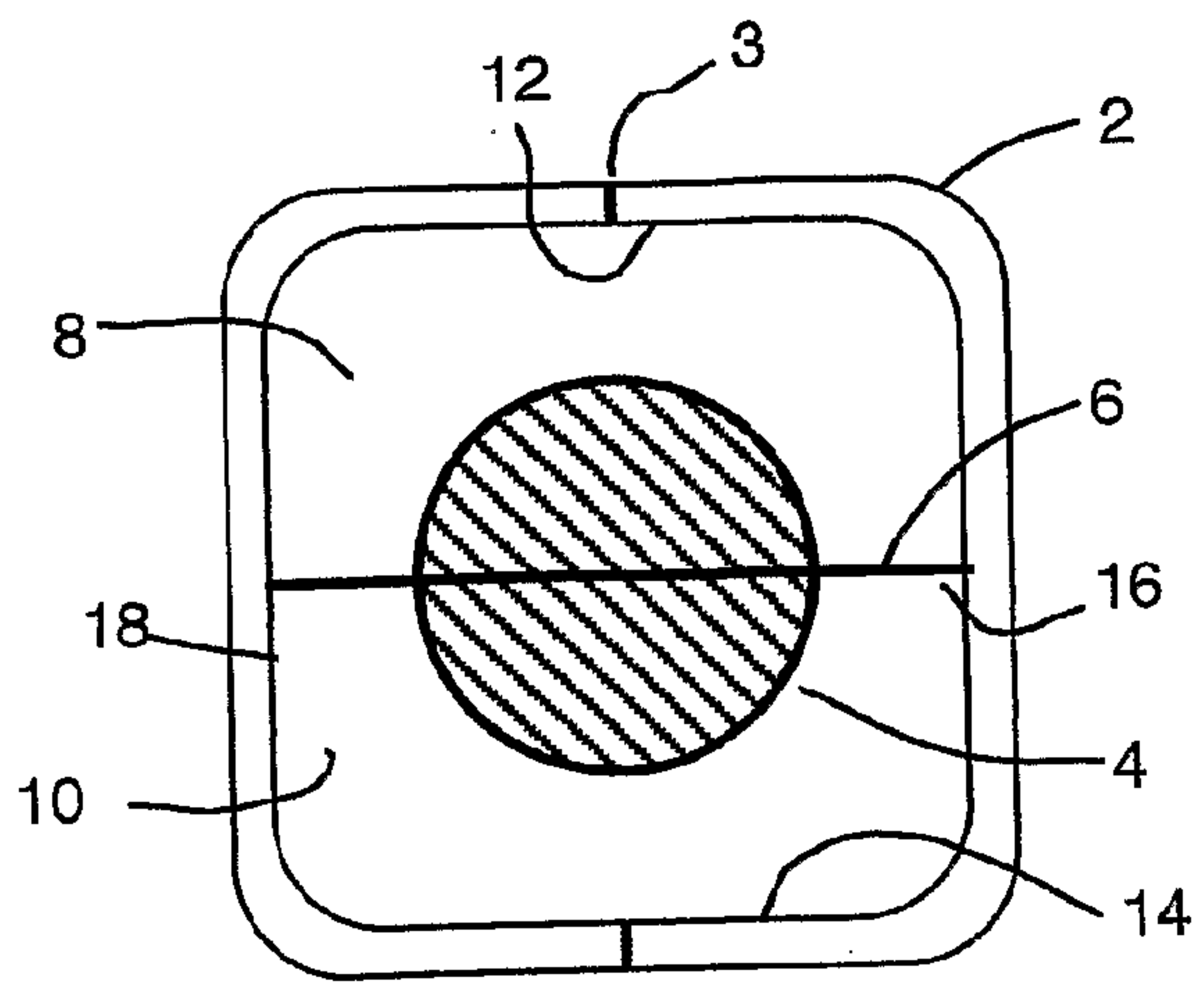


Fig 1b

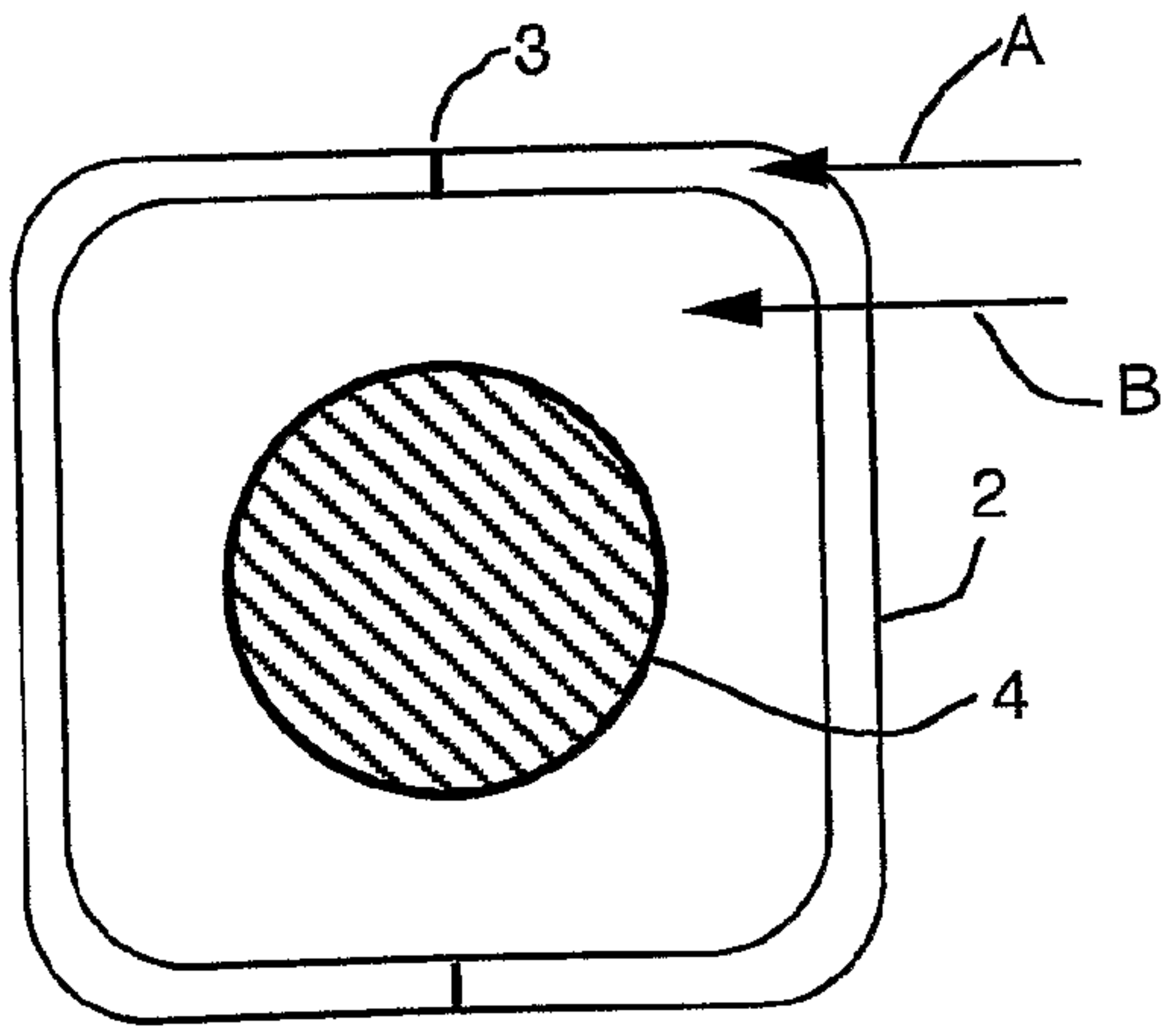


Fig 2

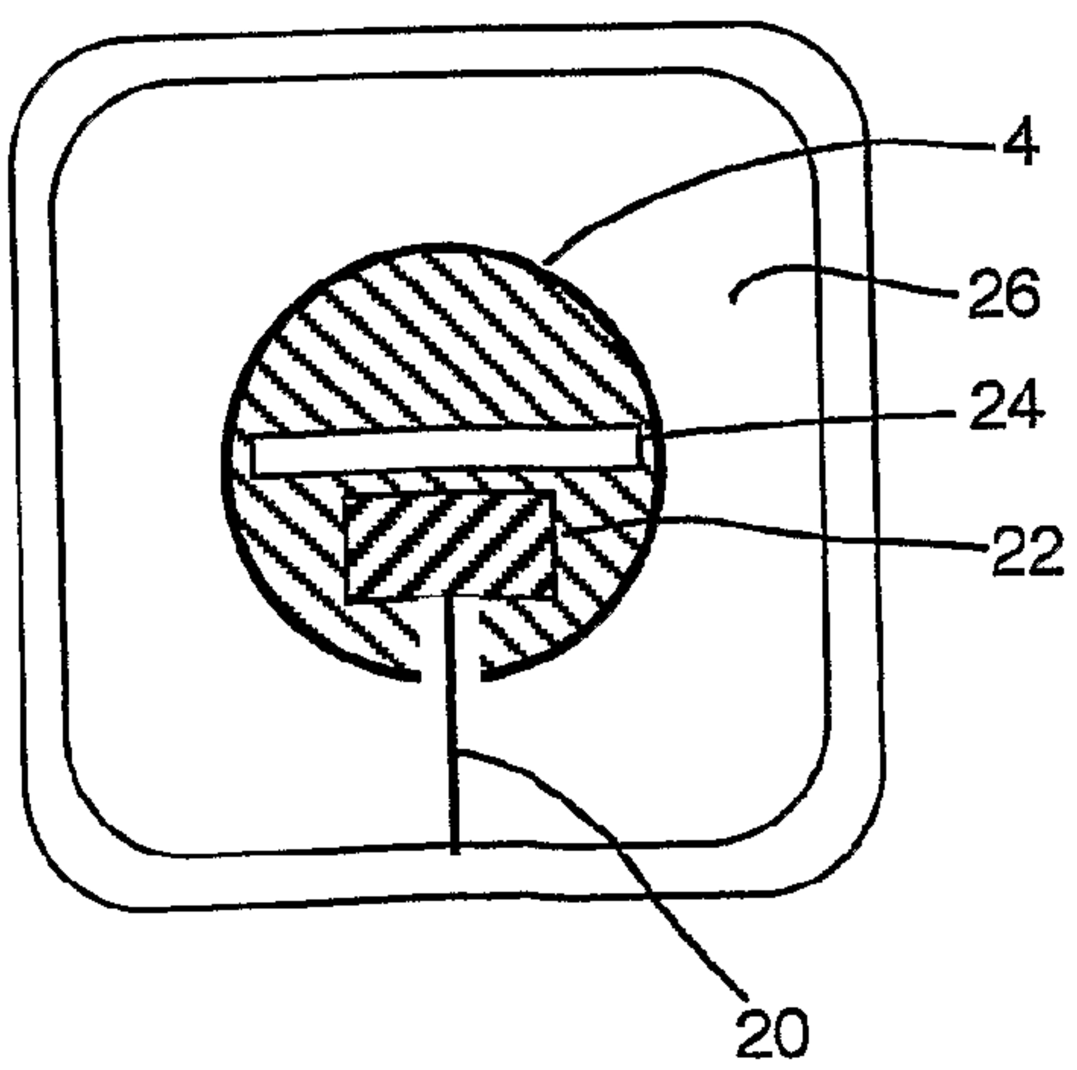


Fig 3

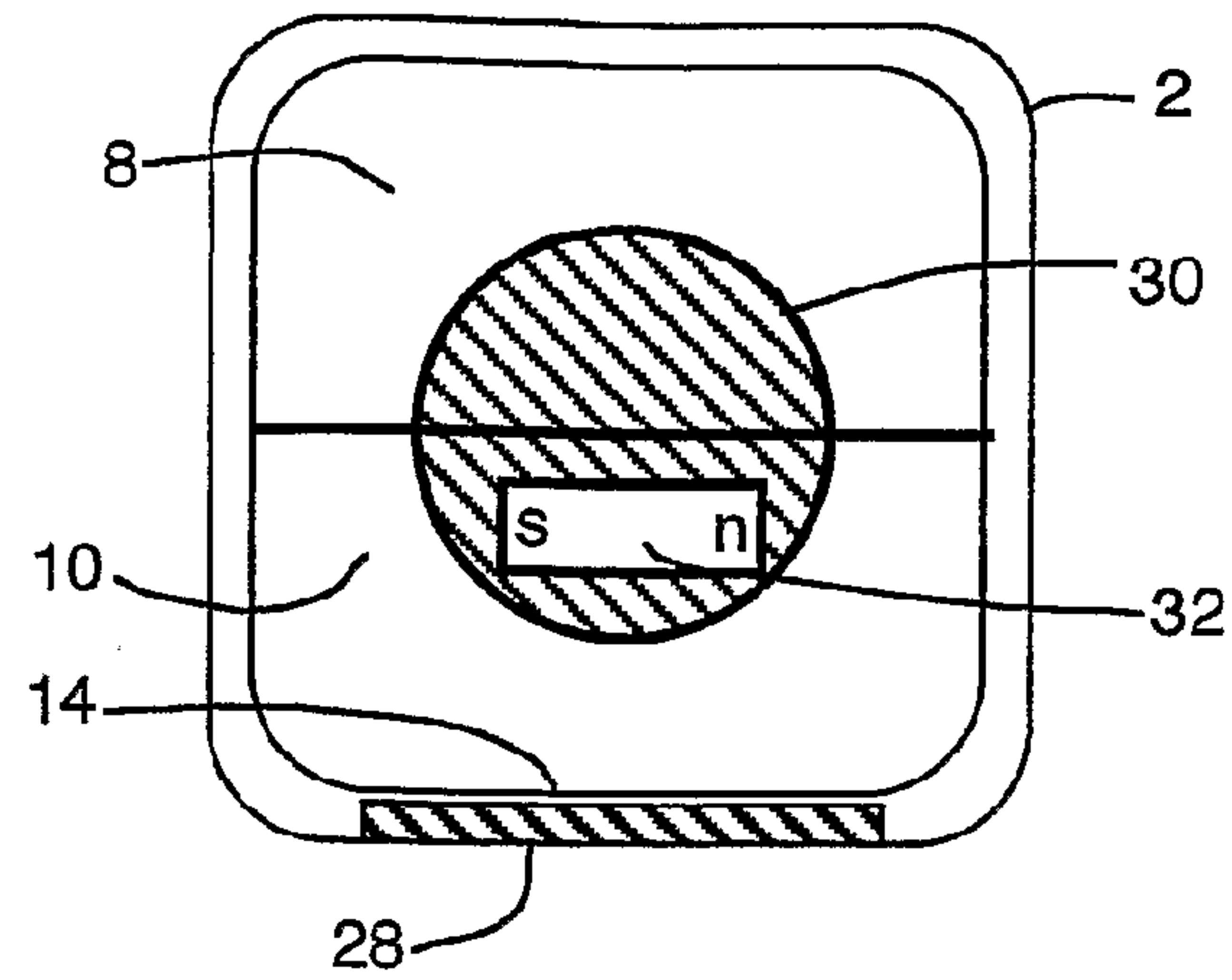


Fig 4a

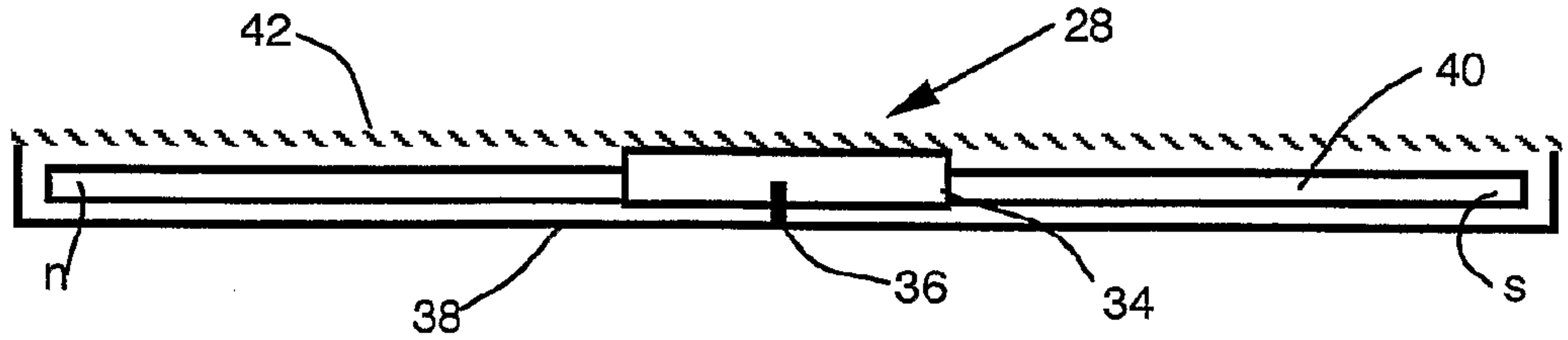


Fig 4b

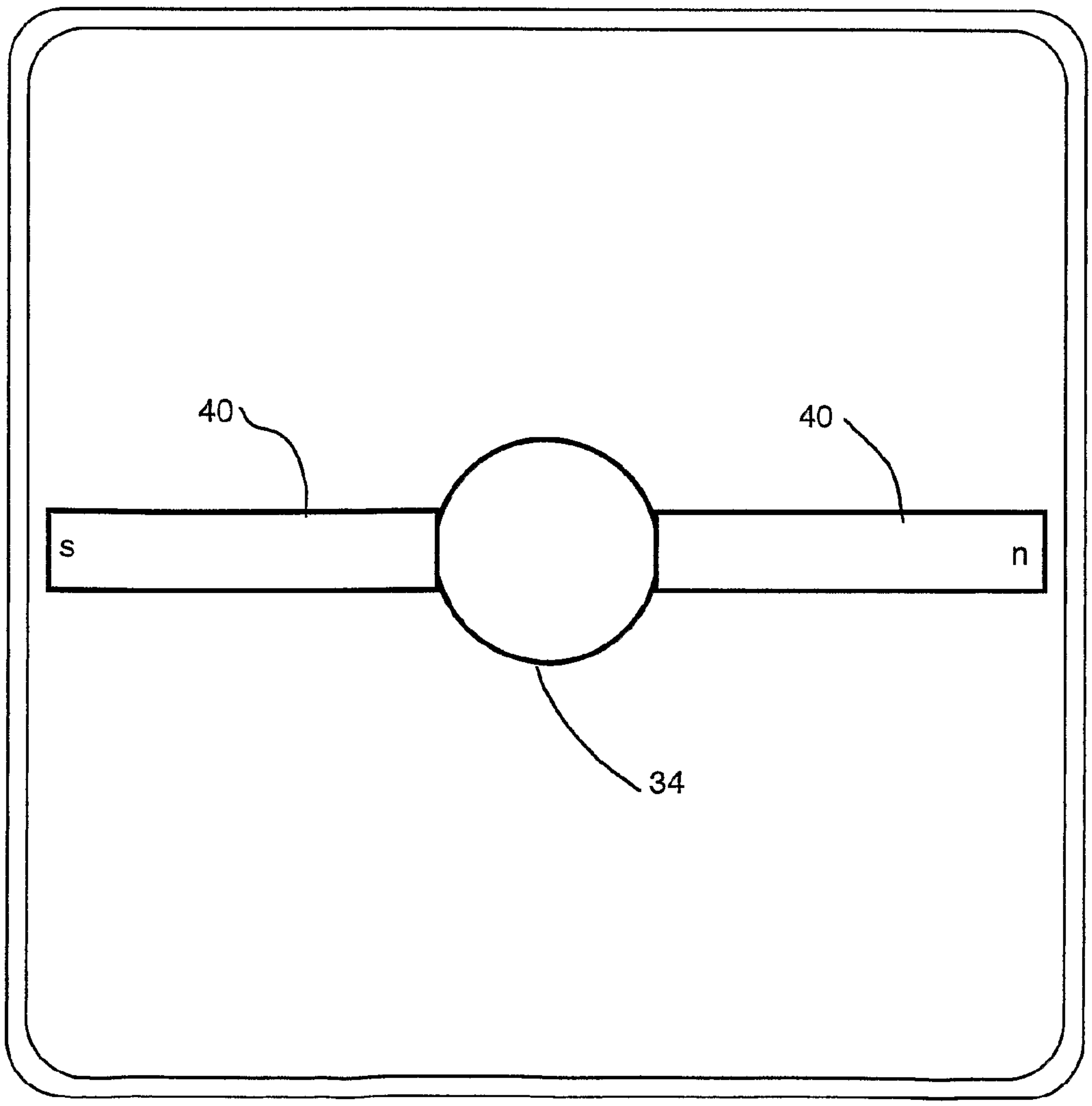
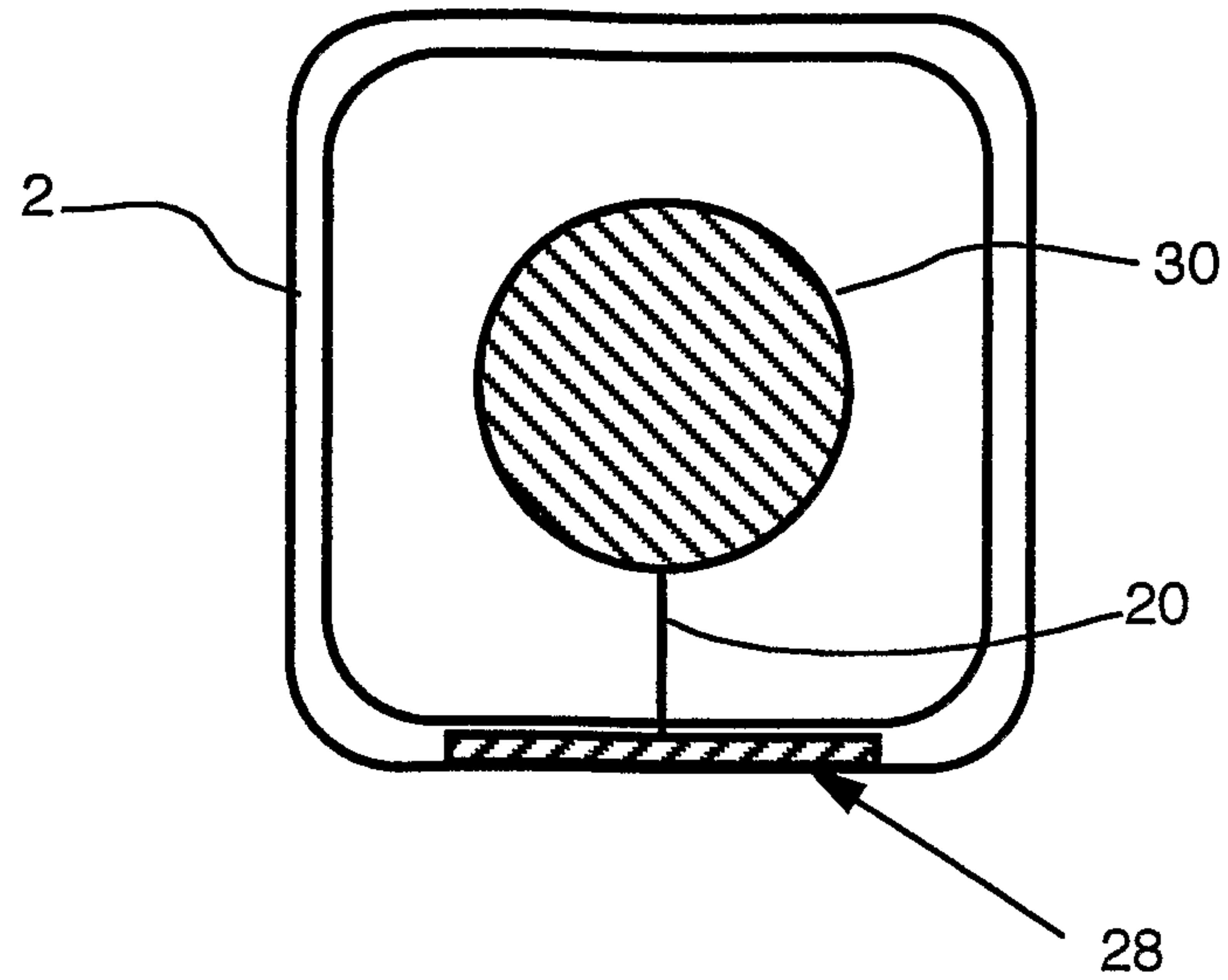


Fig 5



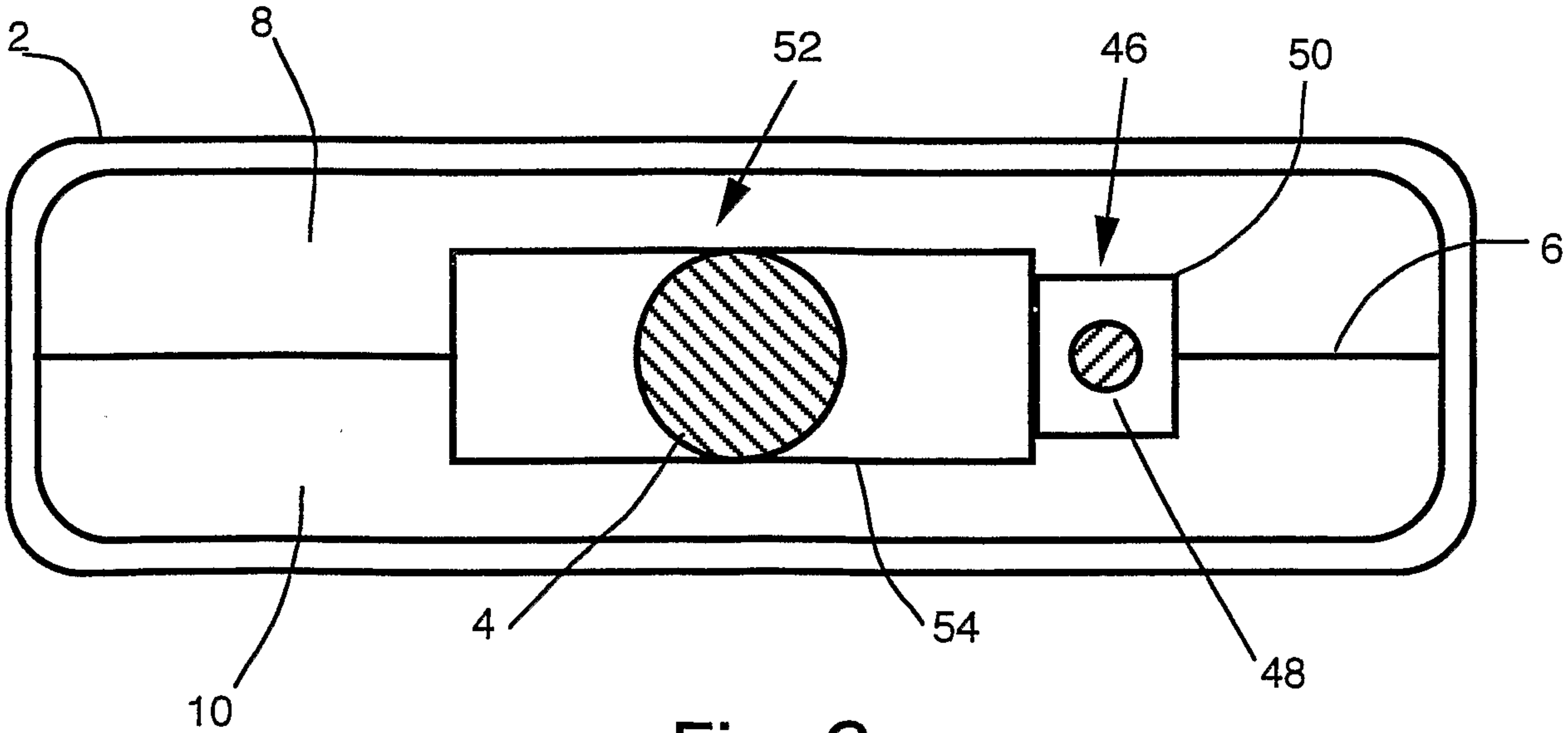


Fig 6a

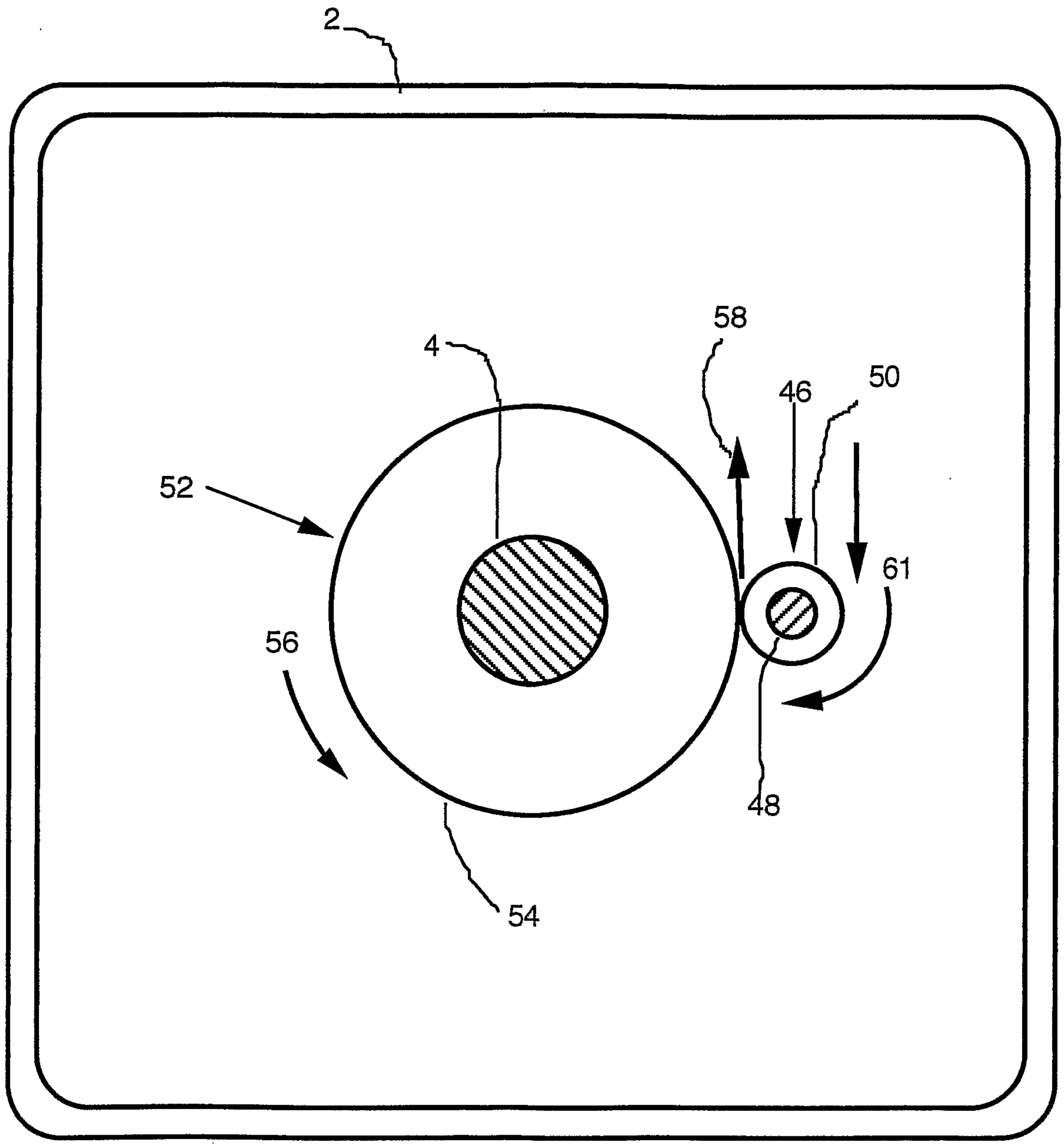


Fig 6b

Fig 7a

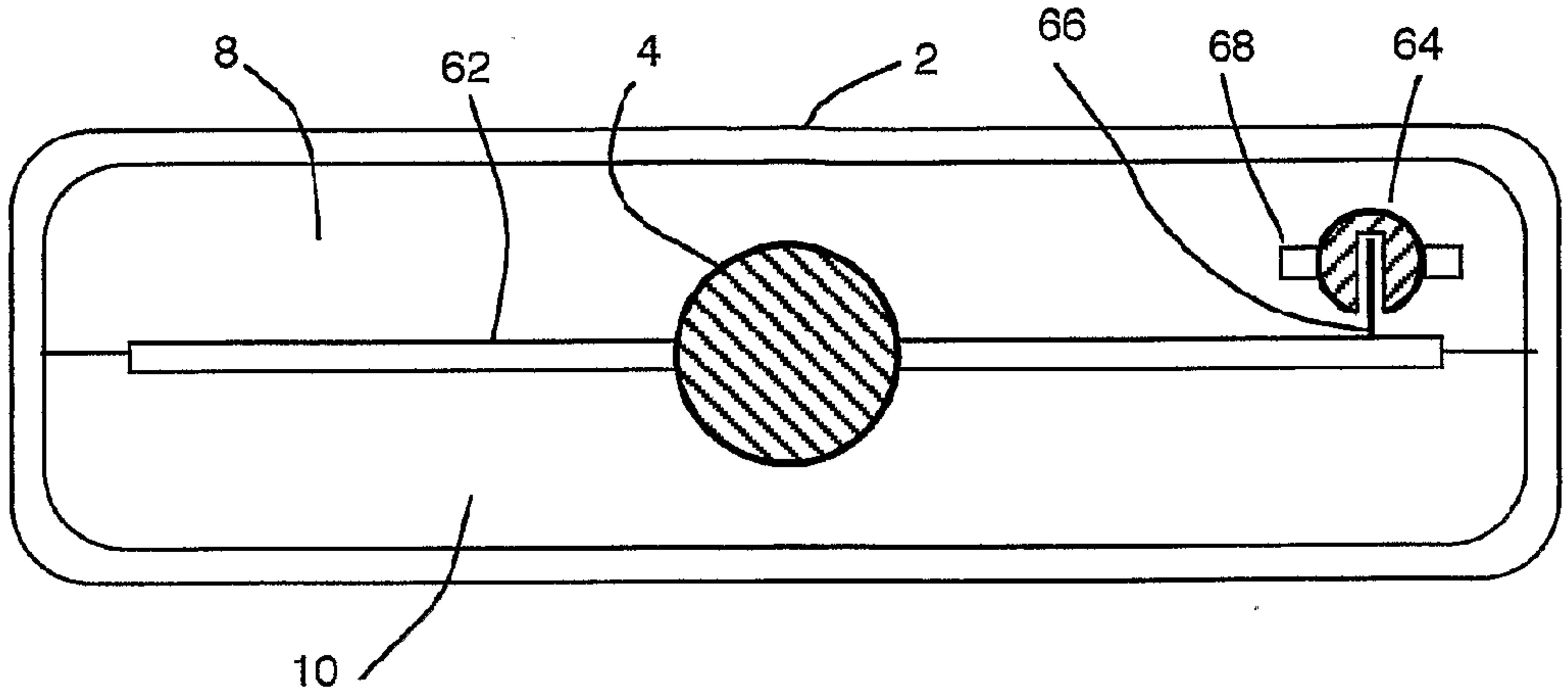


Fig 7b

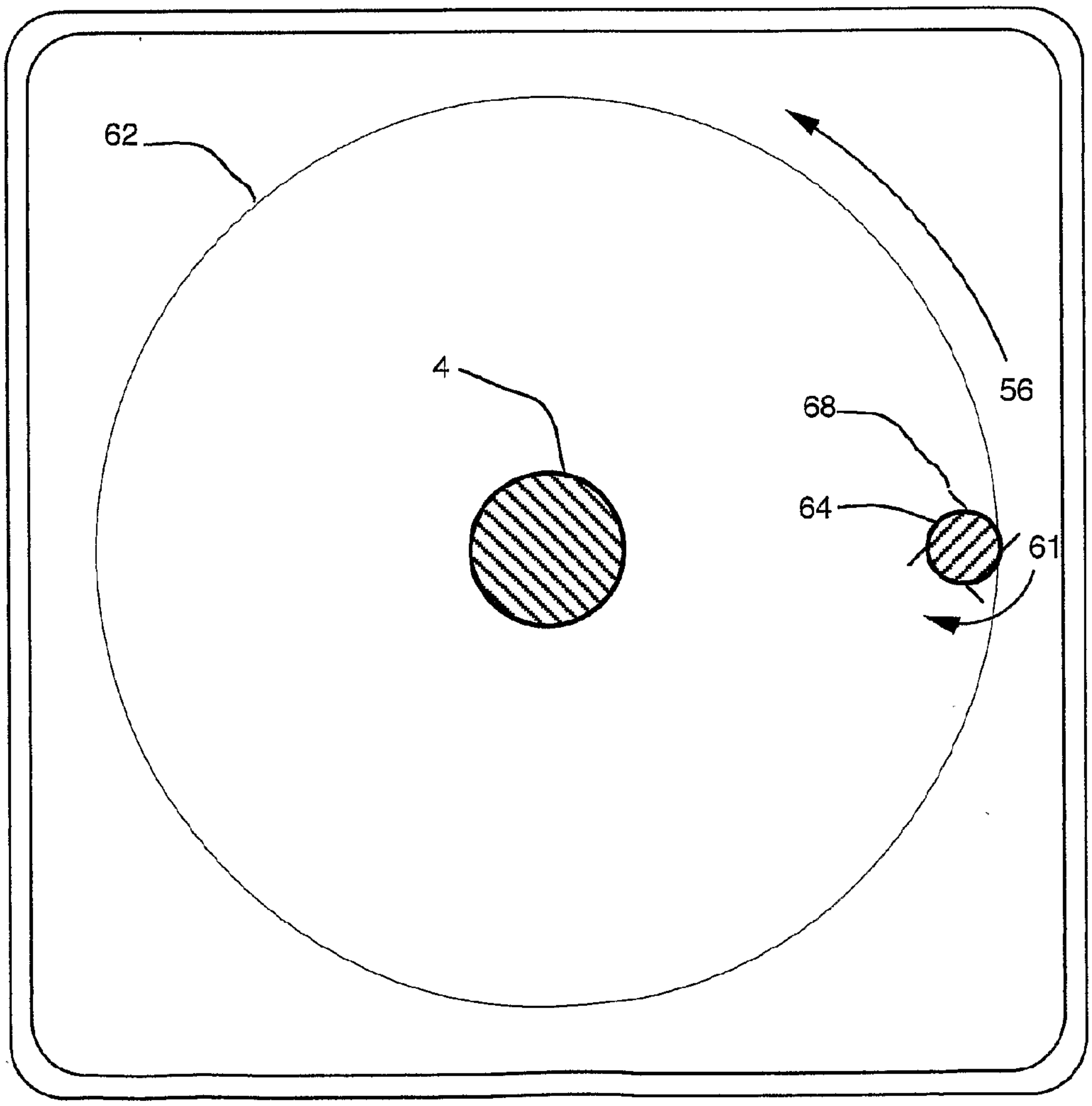


Fig 8a

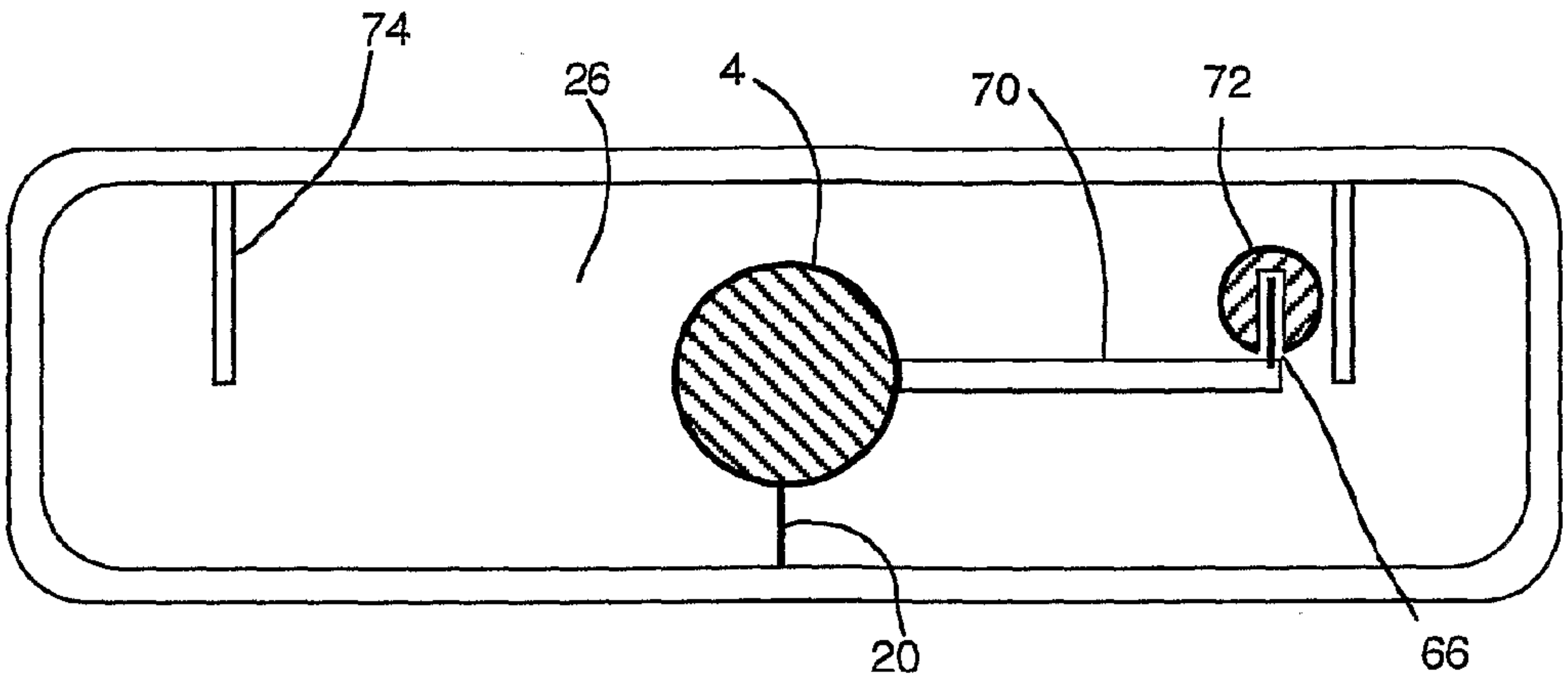


Fig 8b

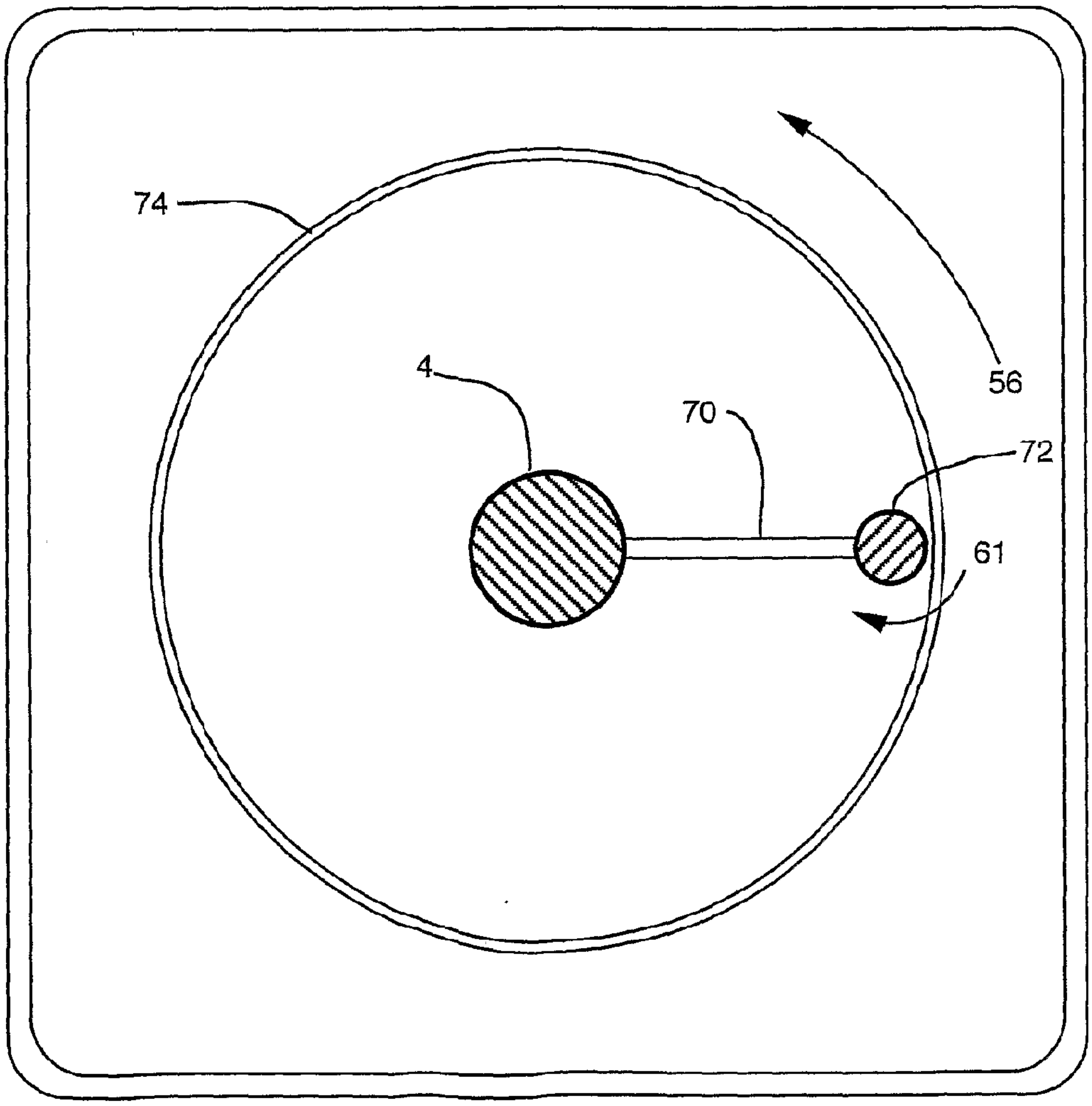


Fig 9

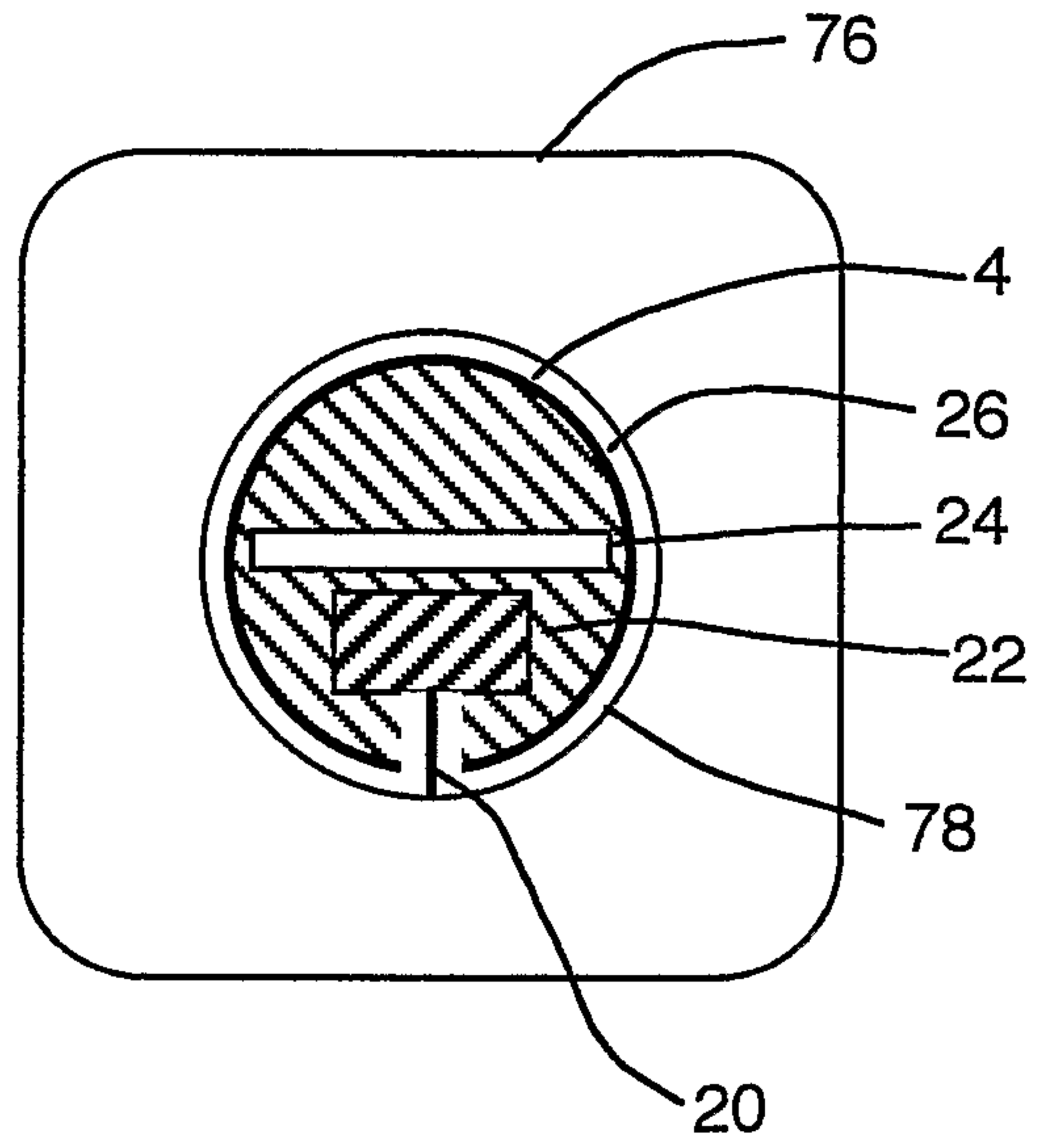


Fig 10

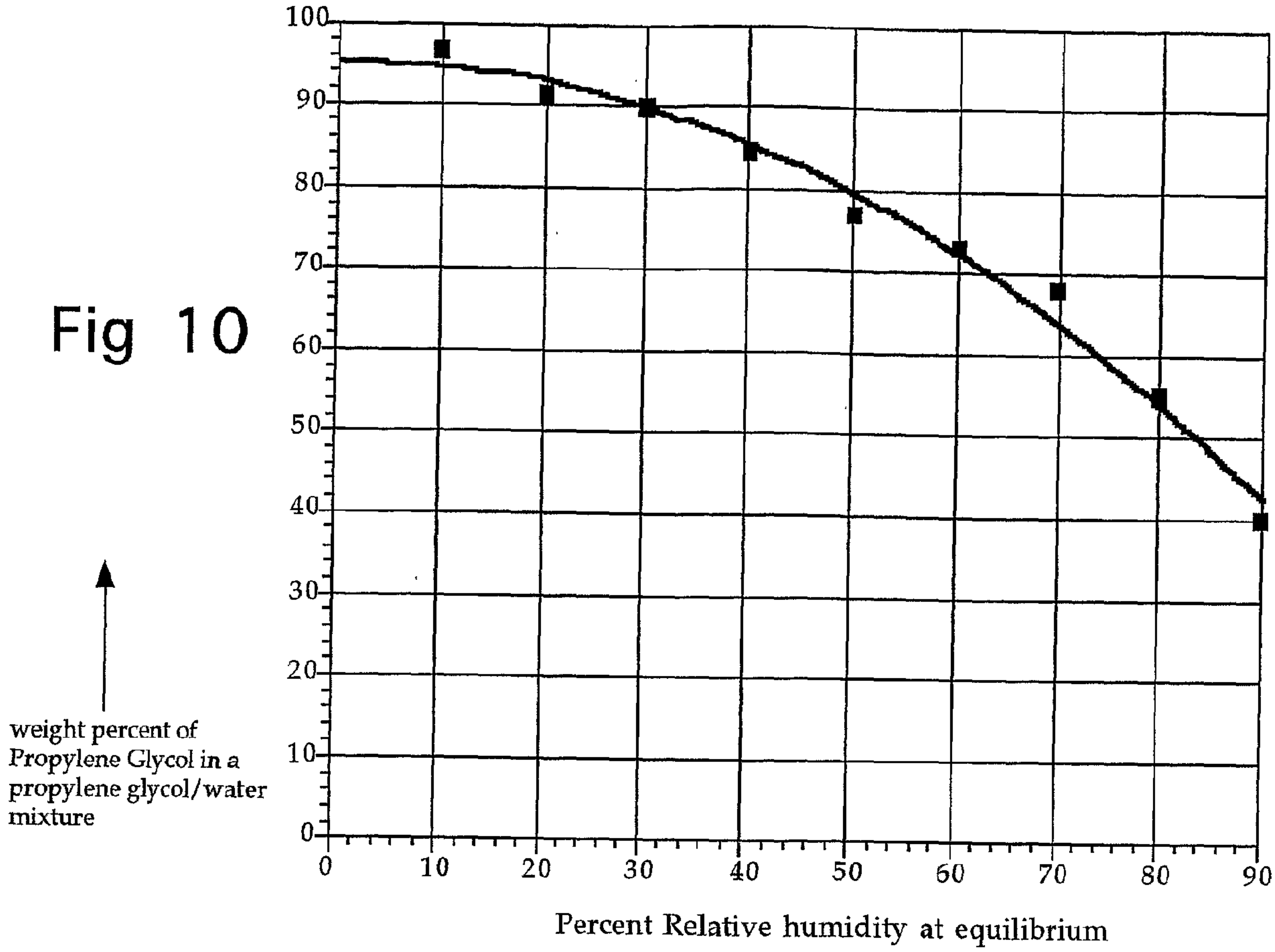
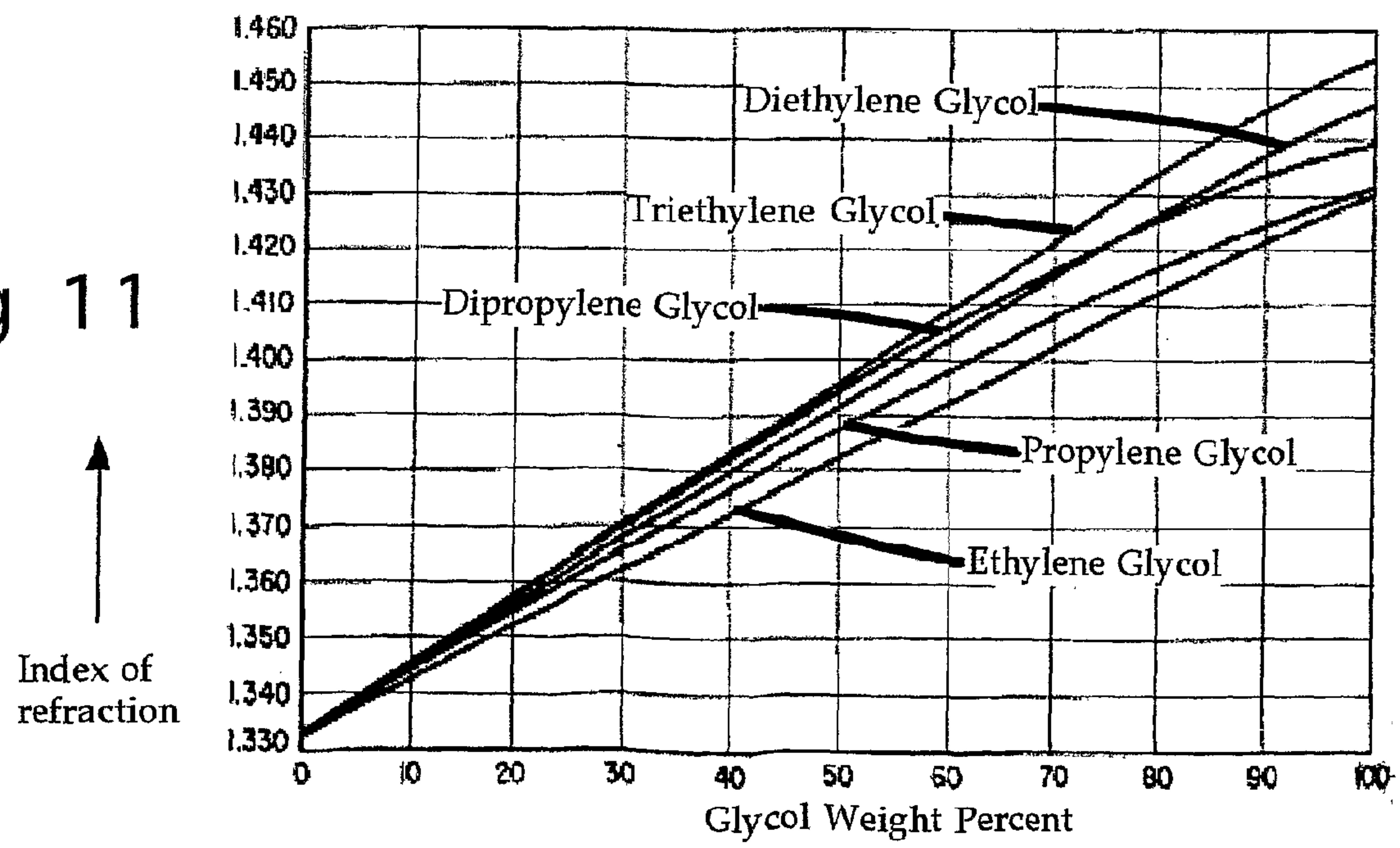

100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
90
weight percent of Propylene Glycol in a propylene glycol/water mixture
Percent Relative humidity at equilibrium

Fig 11


1.460
1.450
1.440
1.430
1.420
1.410
1.400
1.390
1.380
1.370
1.360
1.350
1.340
1.330
0
10
20
30
40
50
60
70
80
90
100
Diethylene Glycol
Triethylene Glycol
Dipropylene Glycol
Propylene Glycol
Ethylene Glycol
Index of refraction
Glycol Weight Percent

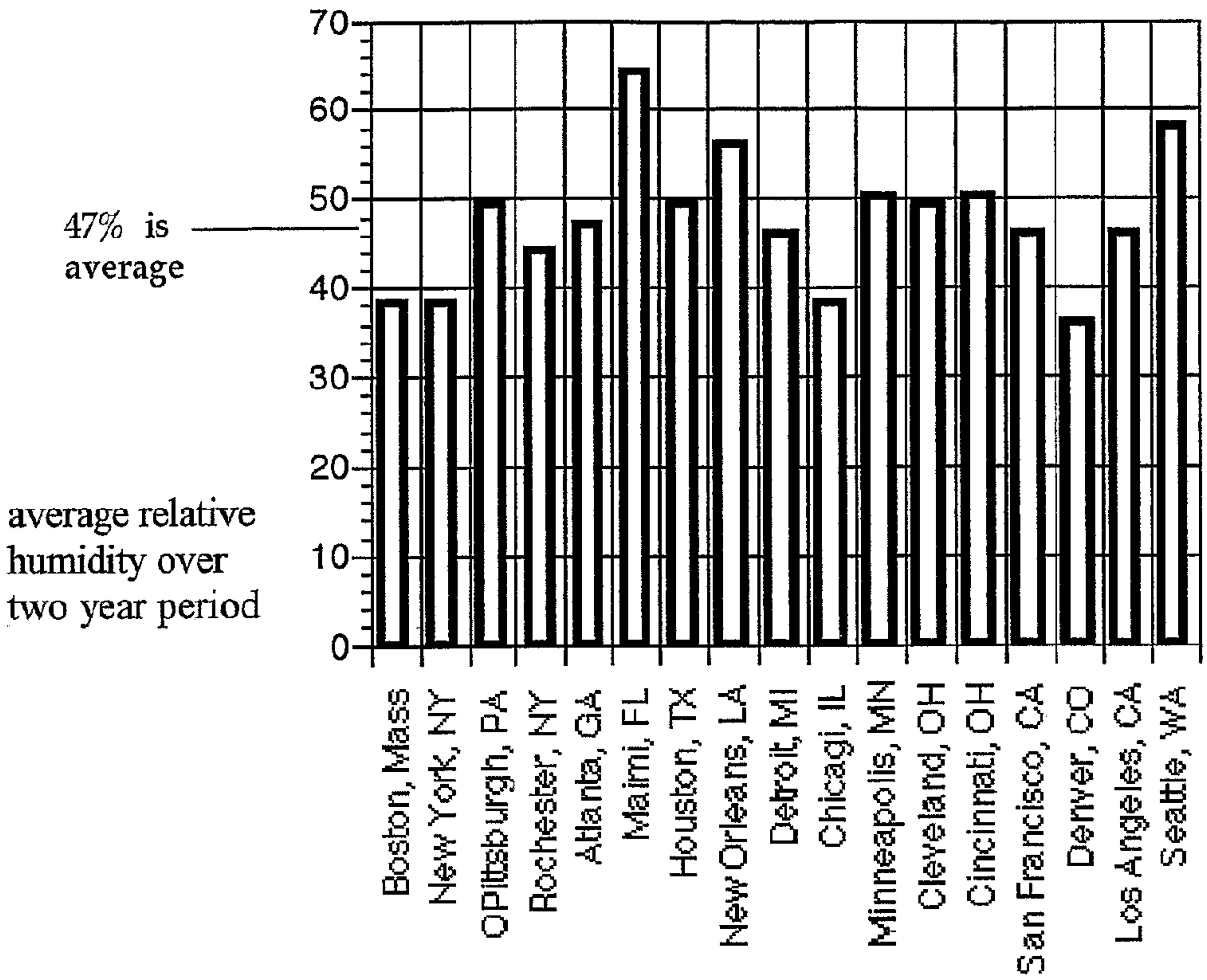

70
60
50
40
30
20
10
0
47% is average
average relative humidity over two year period
Boston, Mass
New York, NY
OPittsburgh, PA
Rochester, NY
Atlanta, GA
Maimi, FL
Houston, TX
New Orleans, LA
Detroit, MI
Chicagi, IL
Minneapolis, MN
Cleveland, OH
Cincinnati, OH
San Francisco, CA
Denver, CO
Los Angeles, CA
Seattle, WA

Fig 12

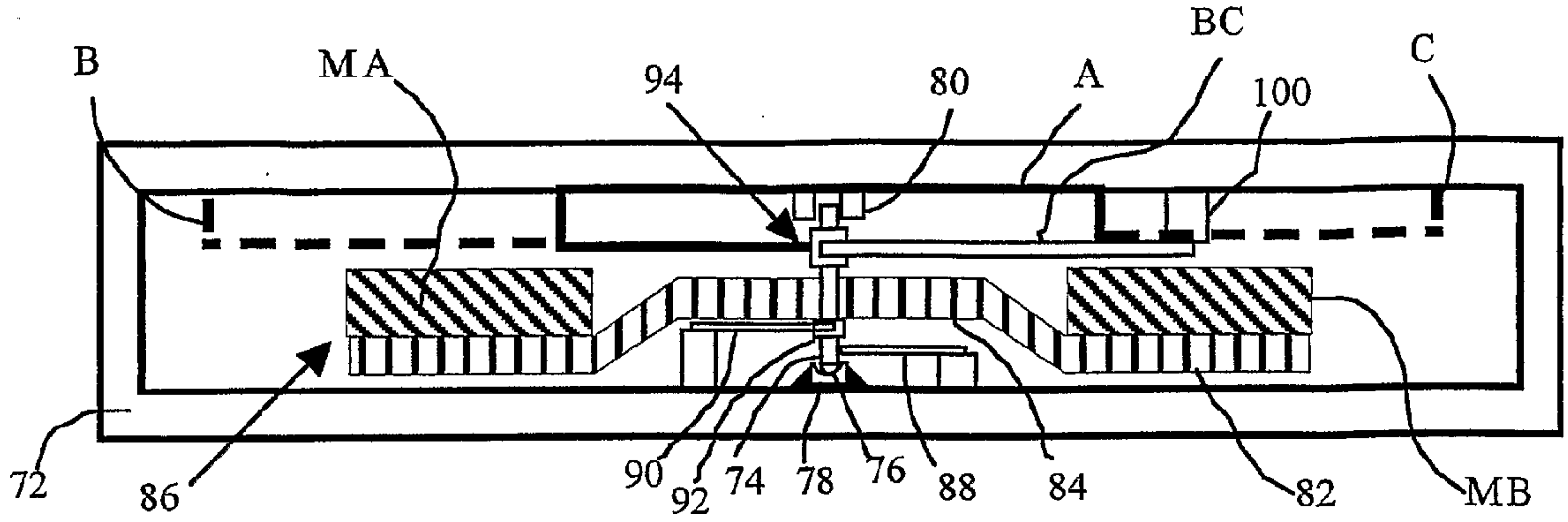


Fig 13a

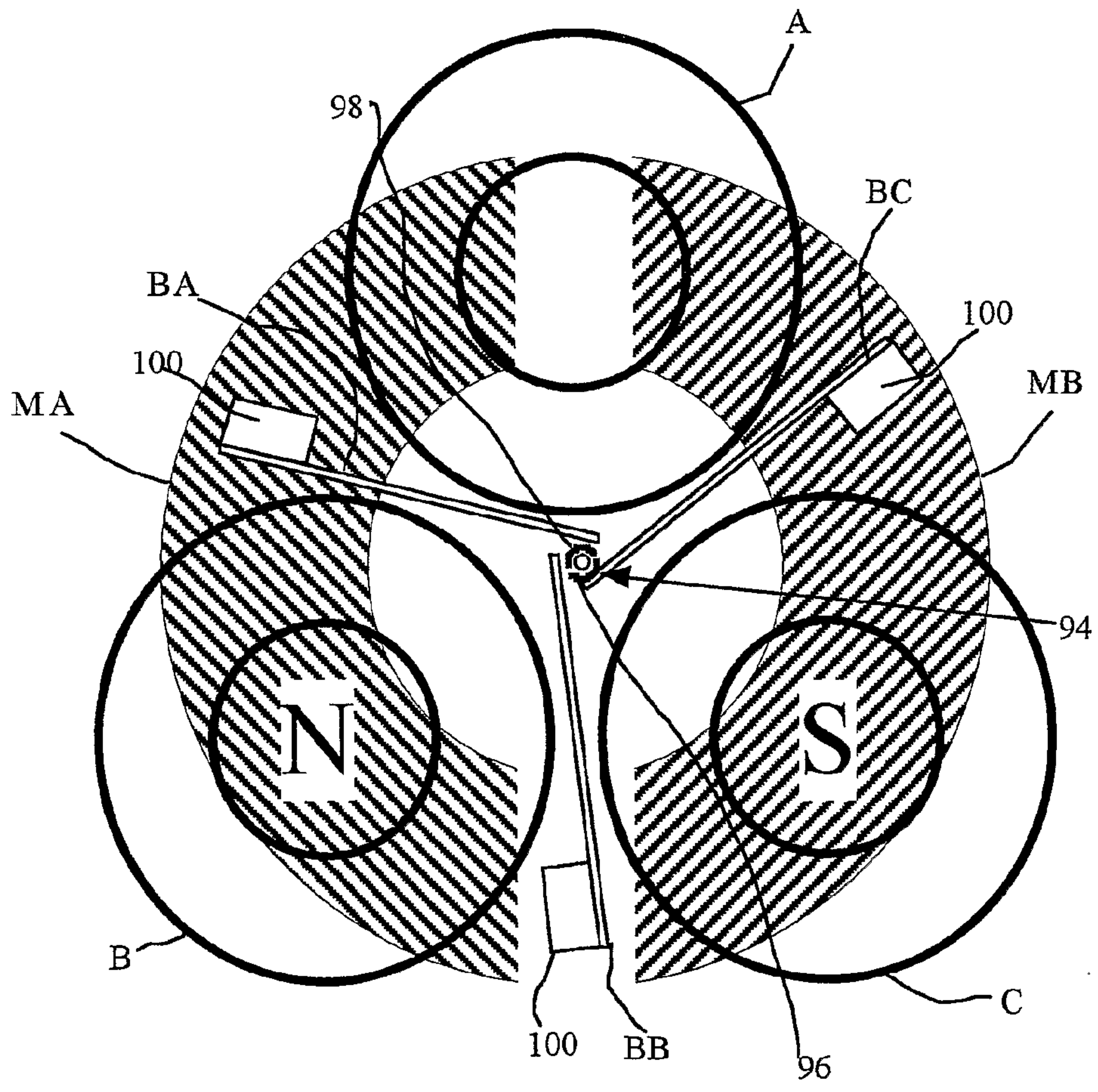


Fig 13b

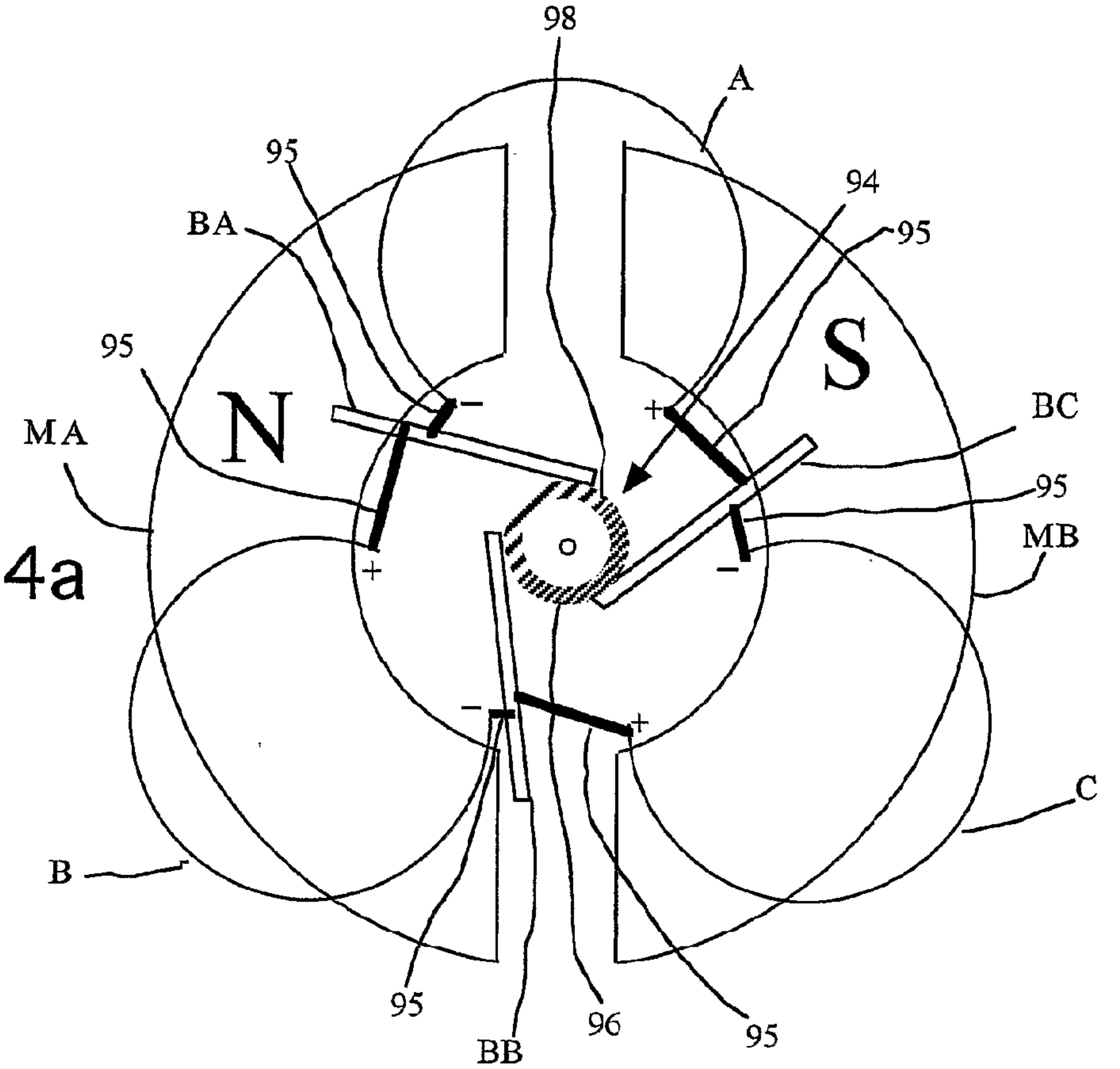


Fig 14a

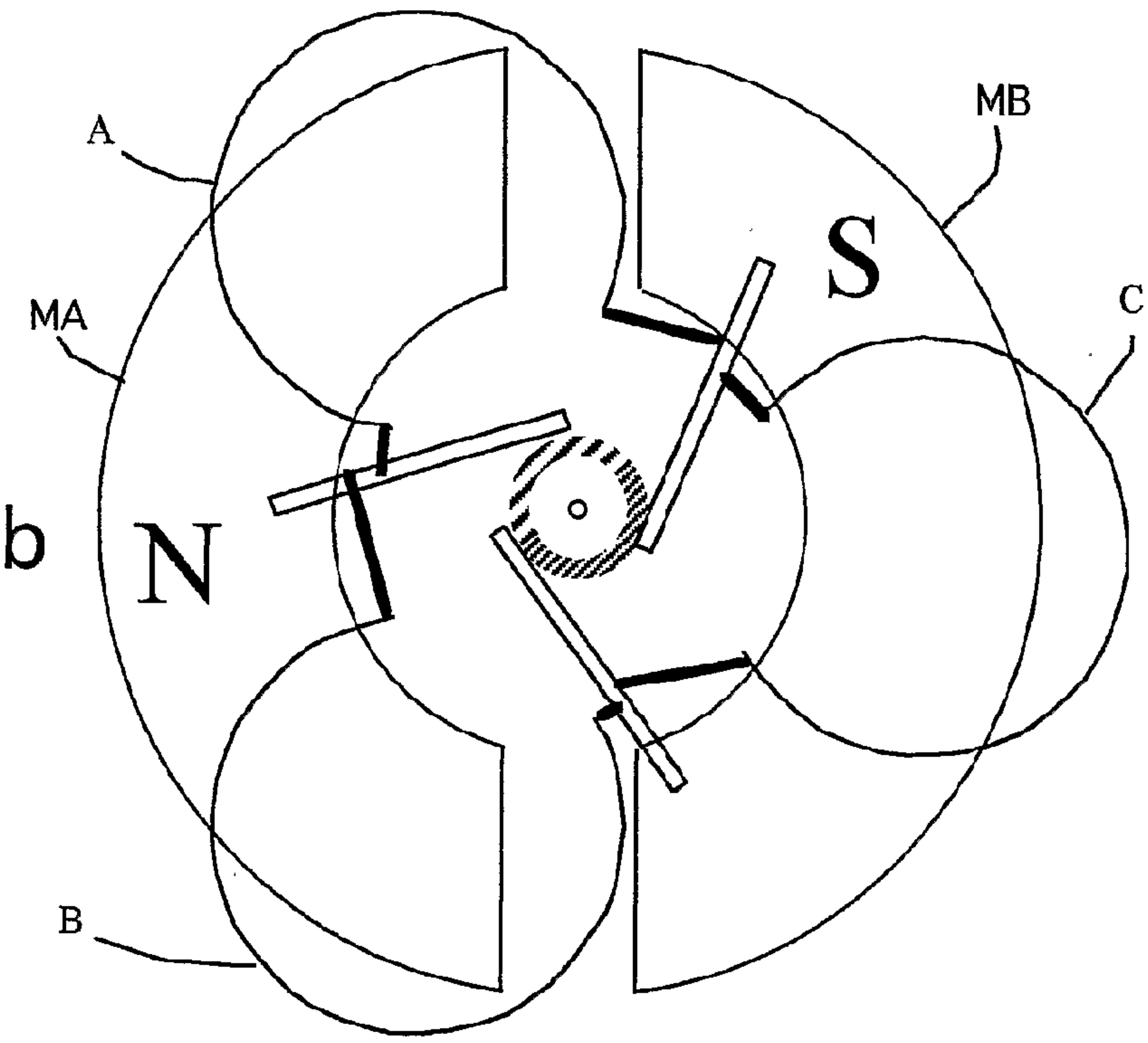


Fig 14b

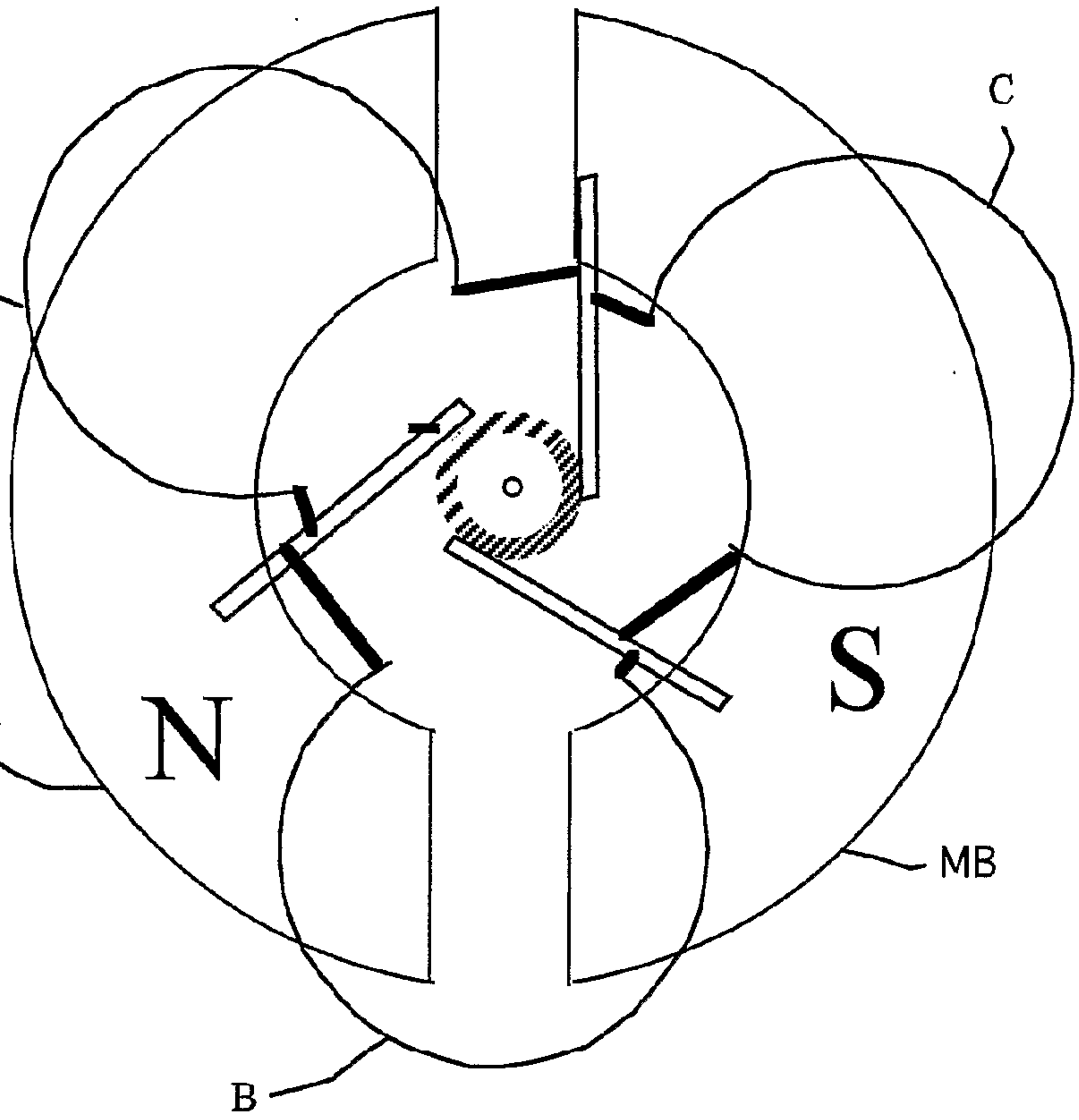


Fig 14c

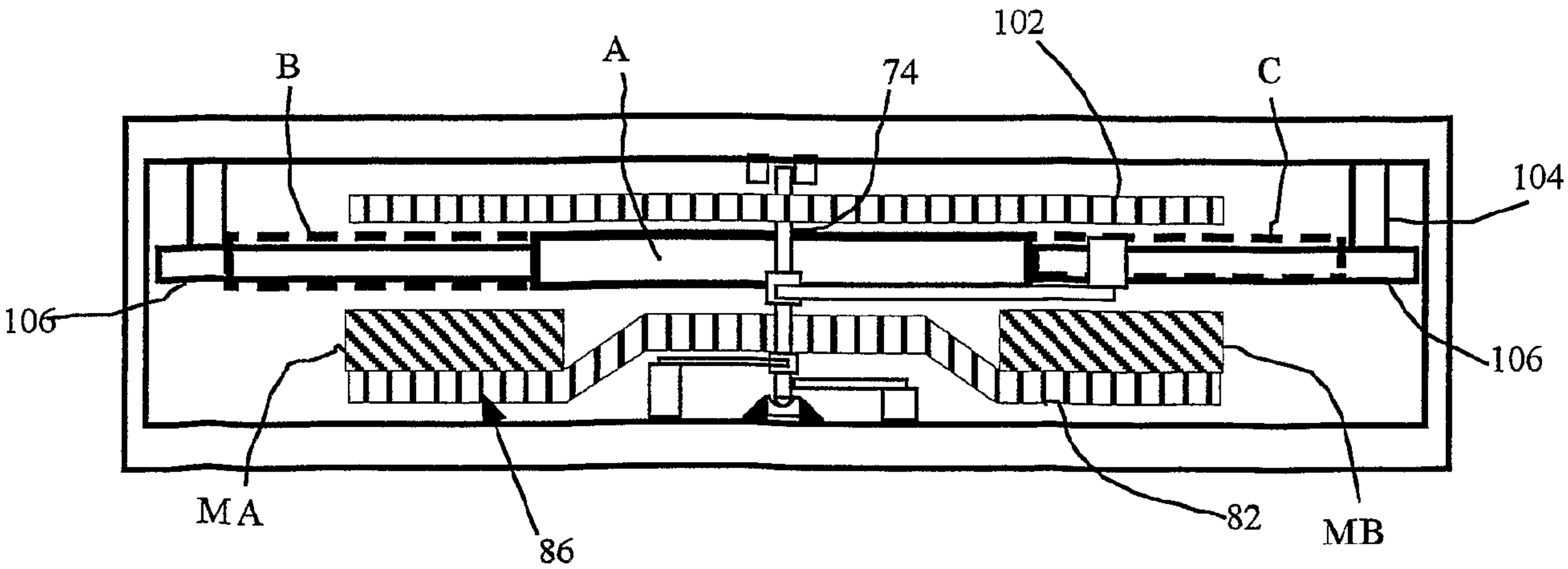


Fig 15

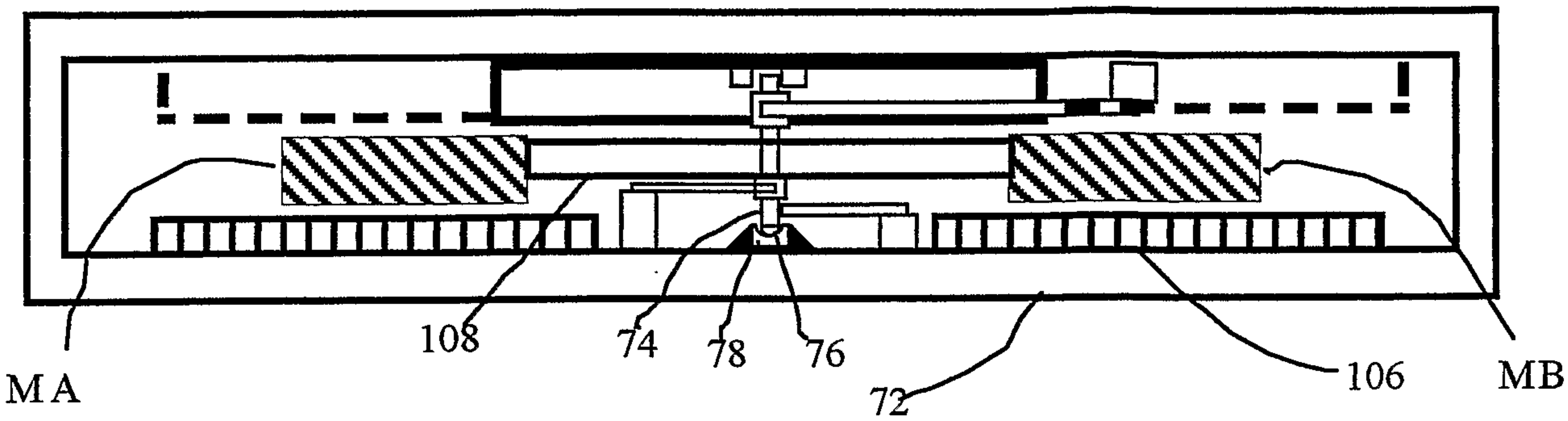


Fig 16

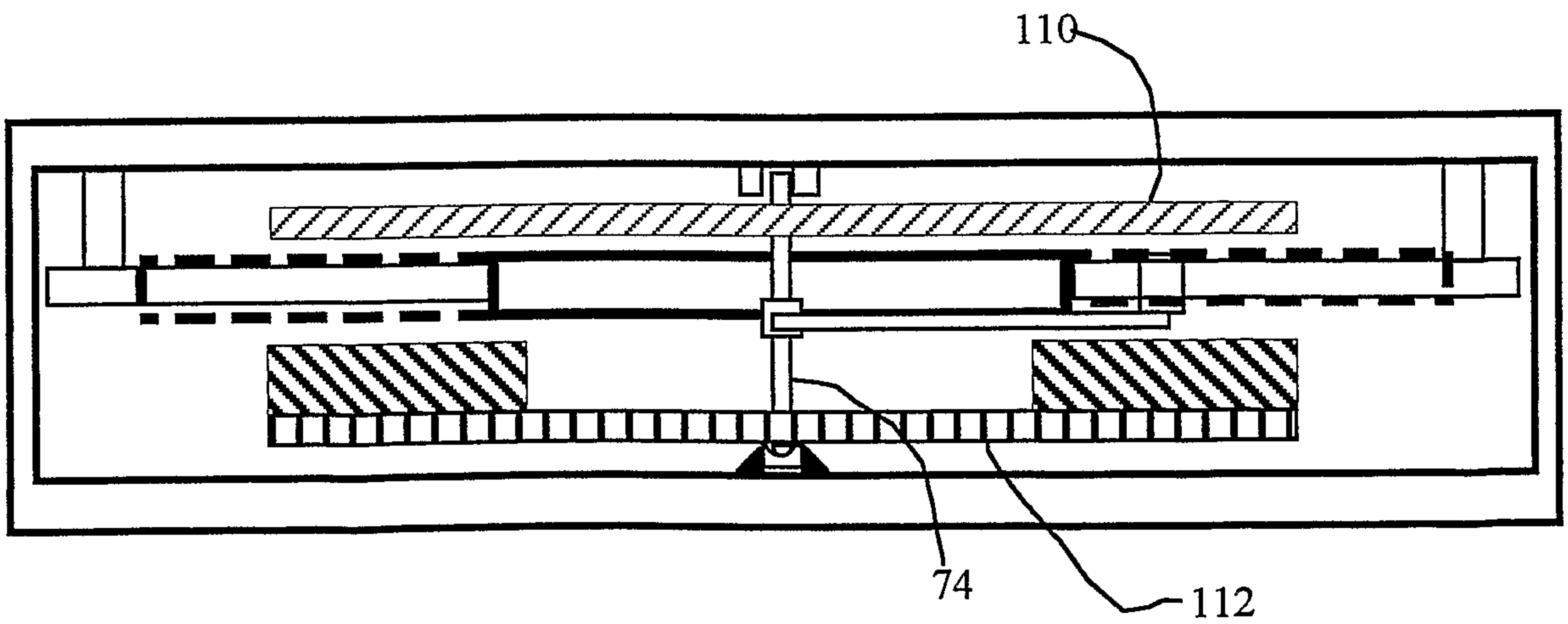


Fig 17

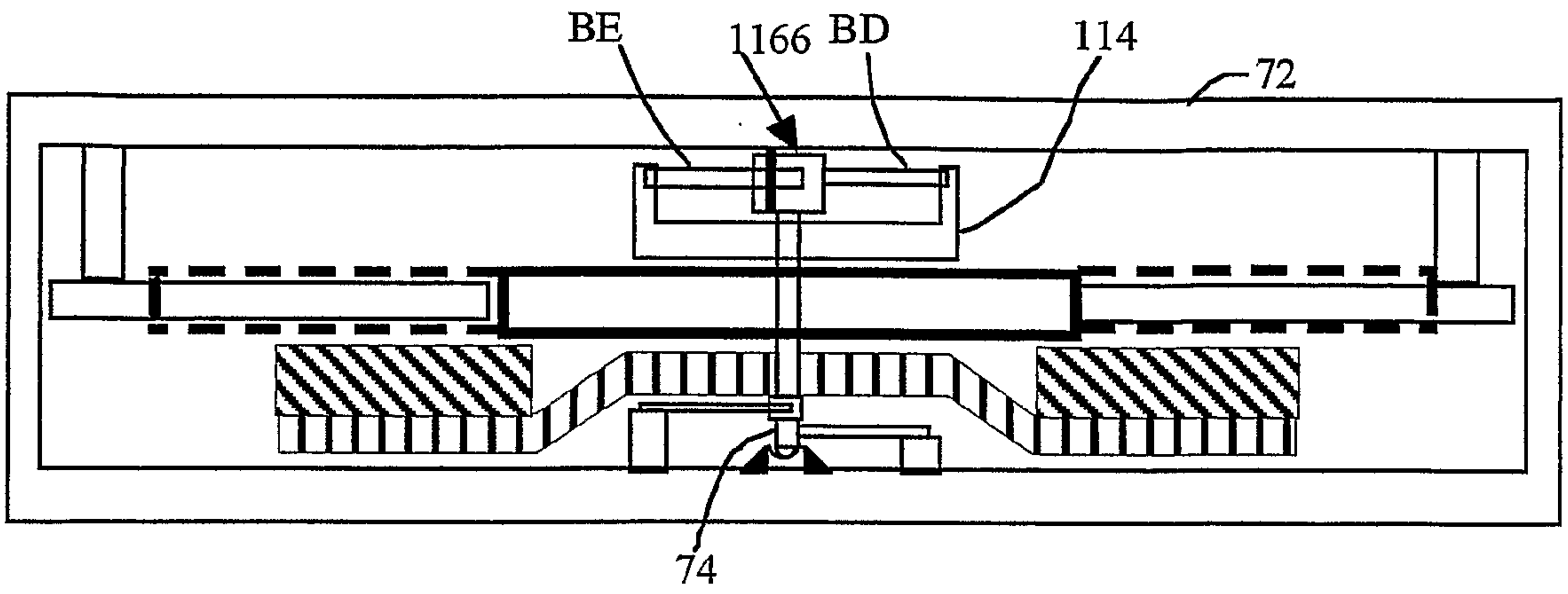


Fig 18a

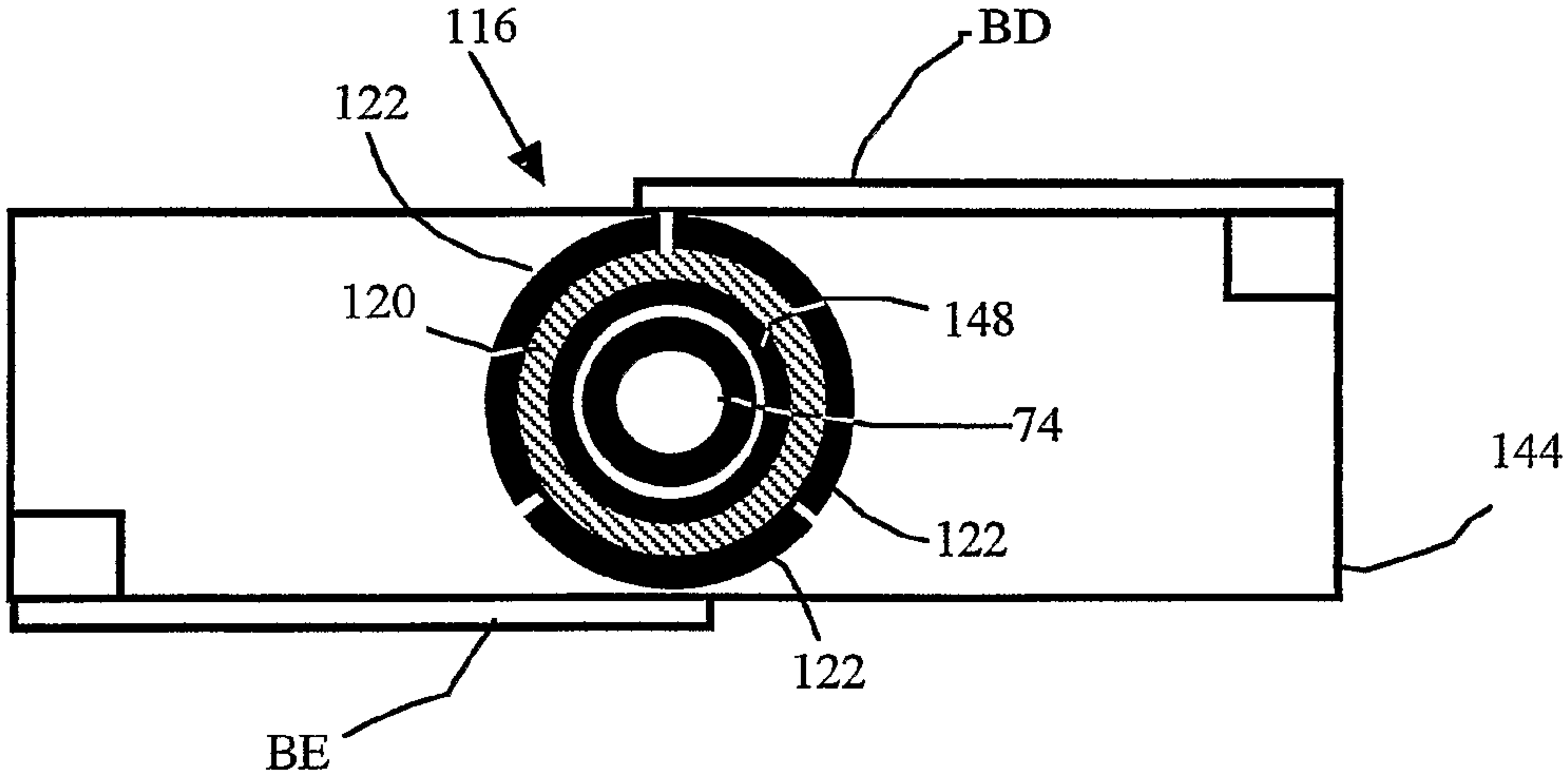


Fig 18b

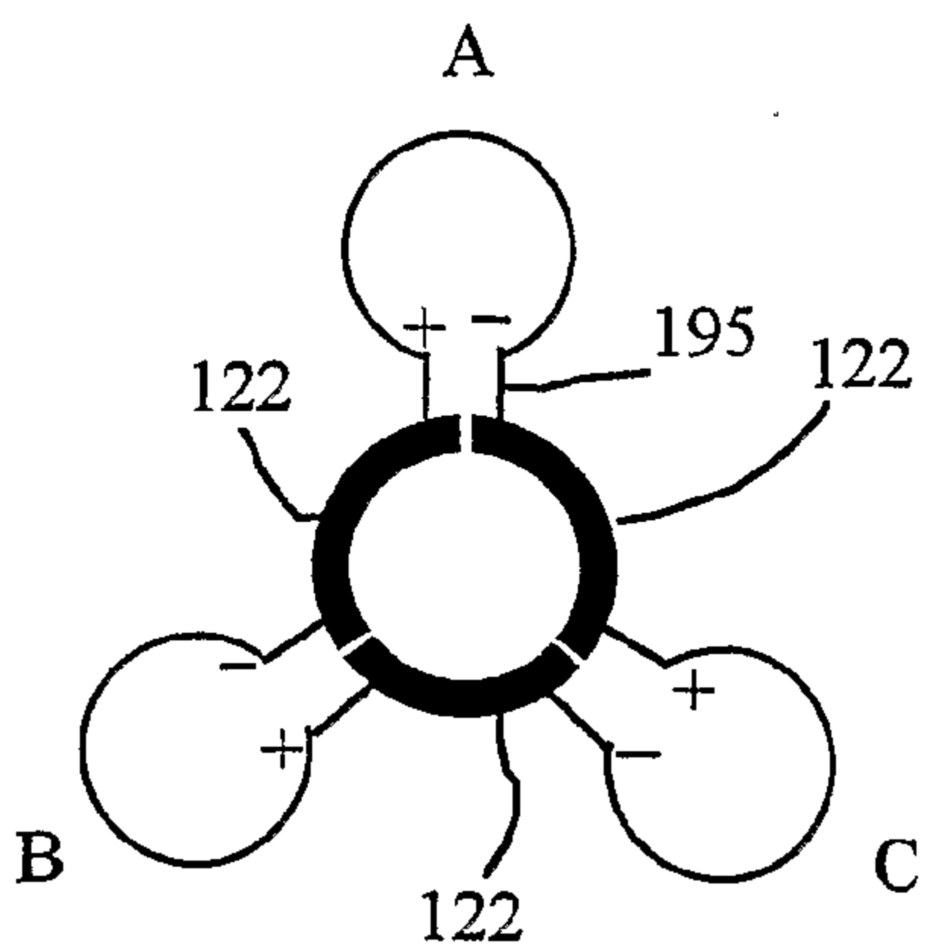


Fig 18c

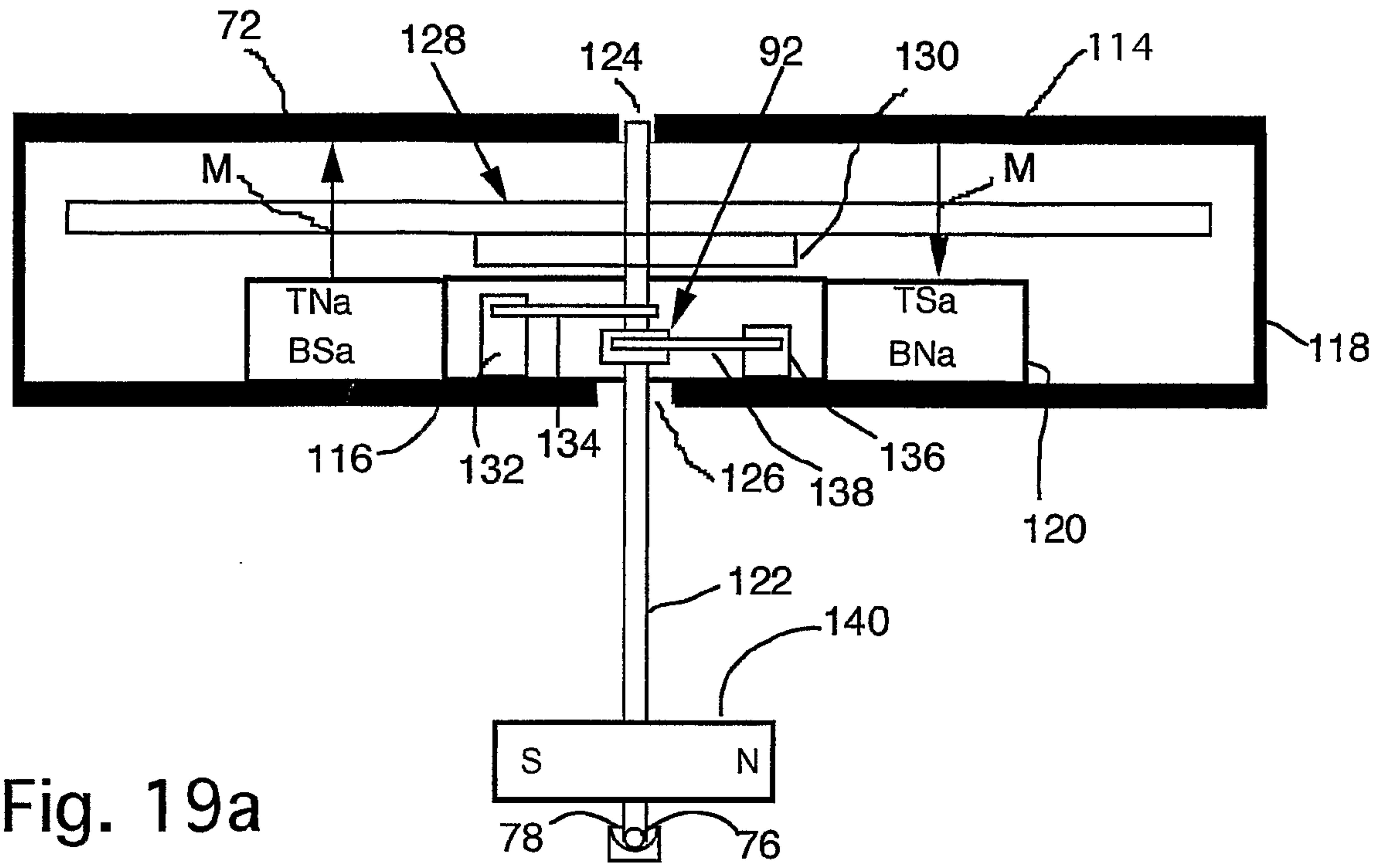


Fig. 19a

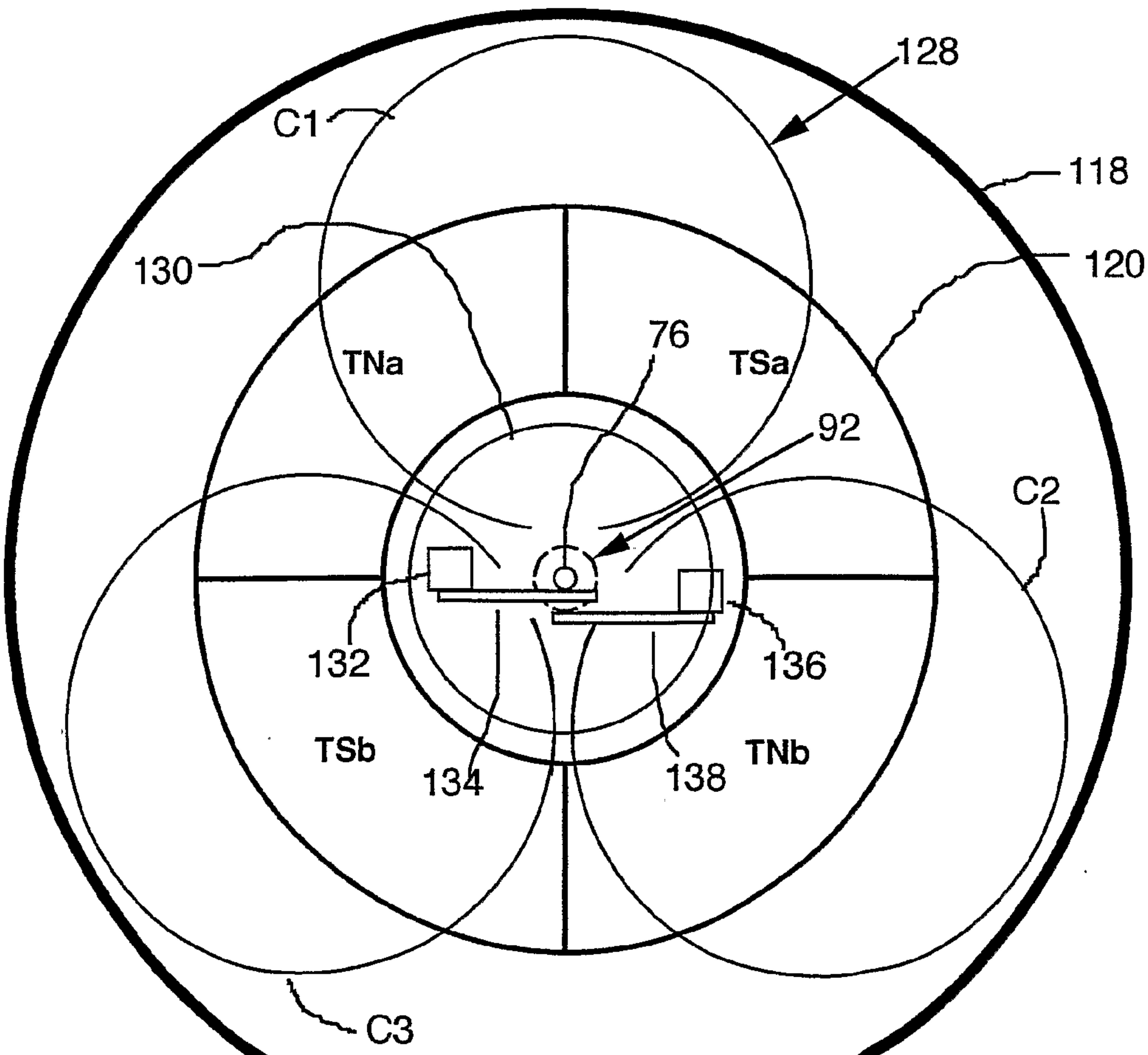


Fig. 19b

Fig. 20a

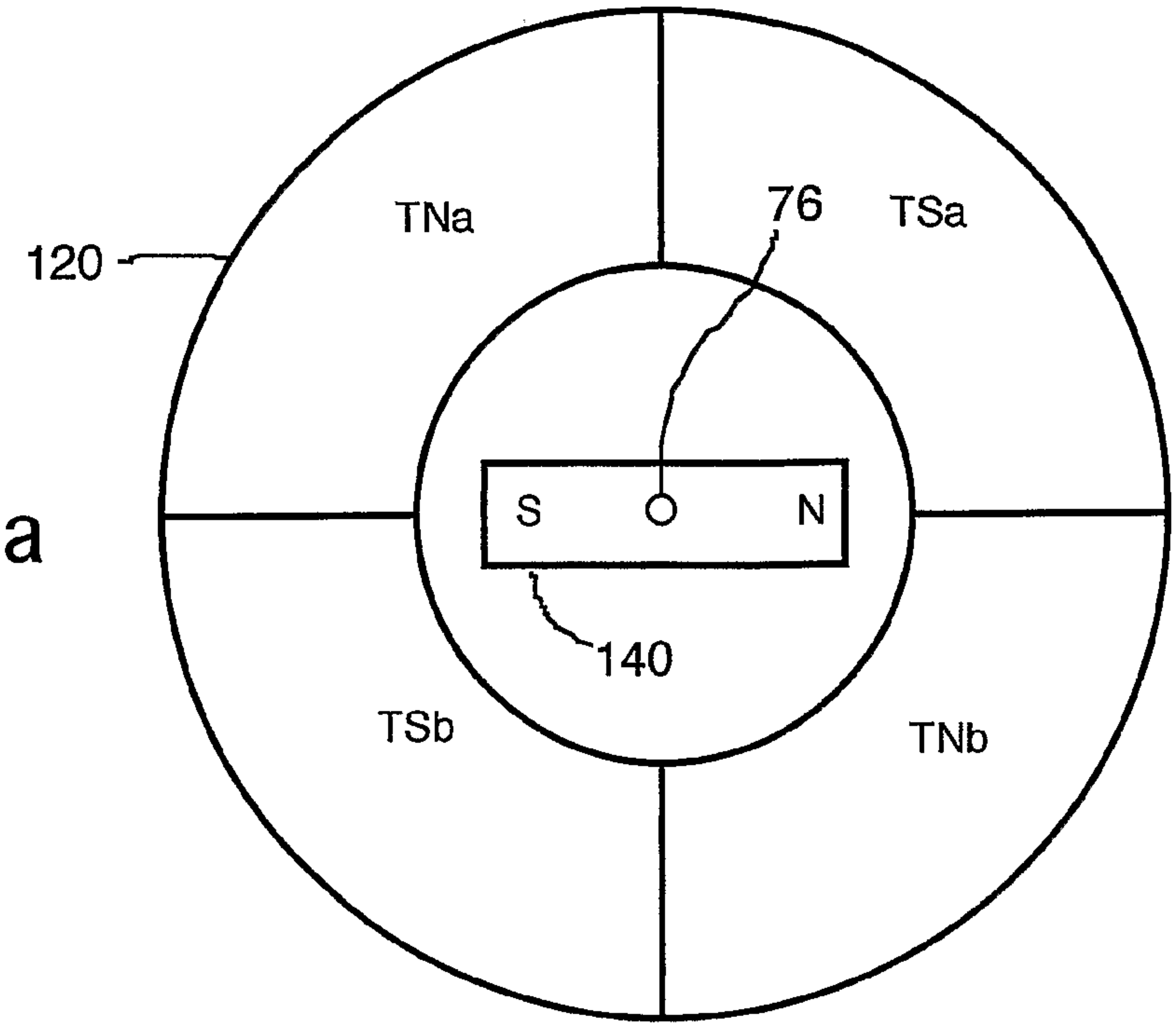
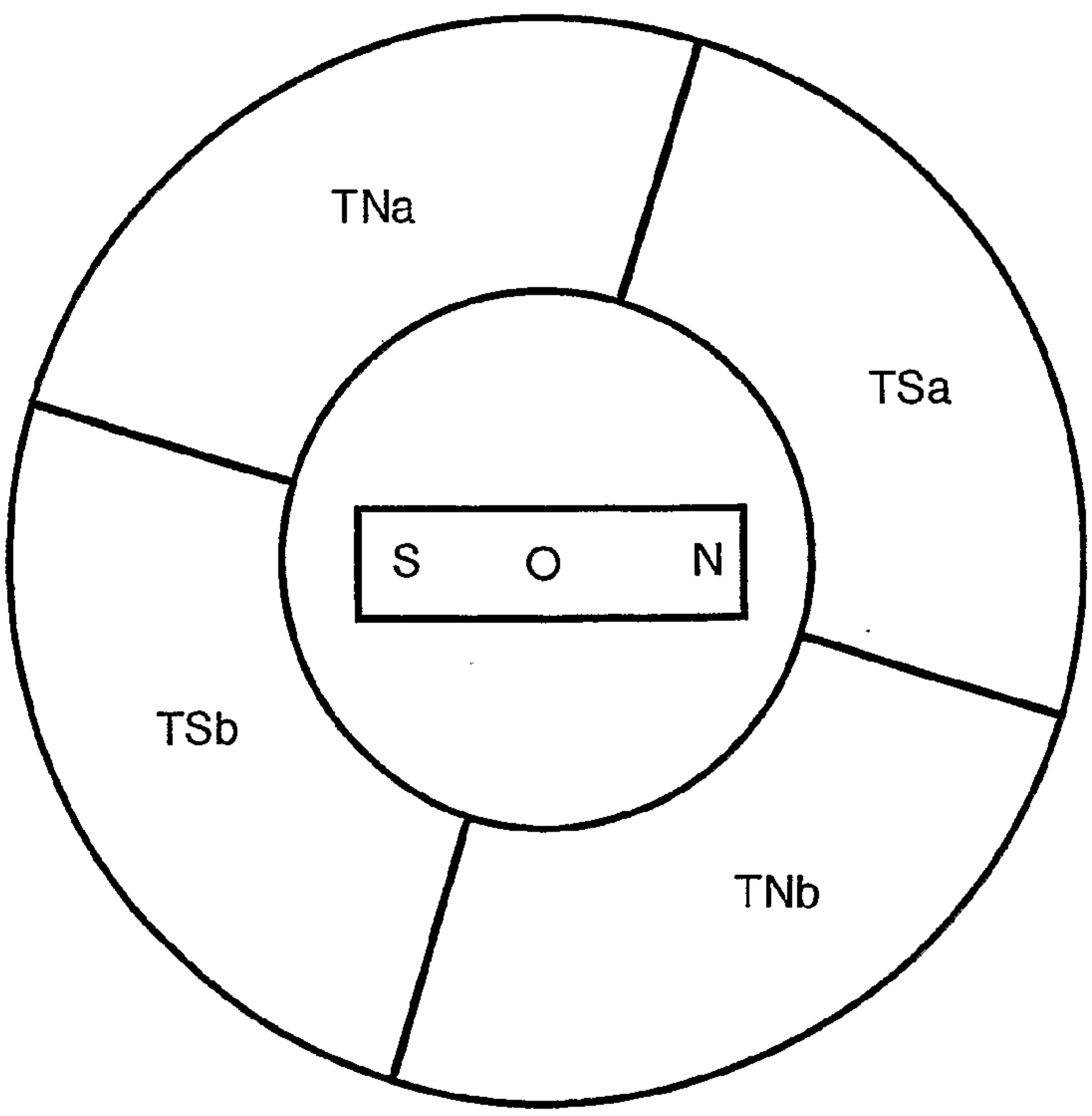


Fig. 2b



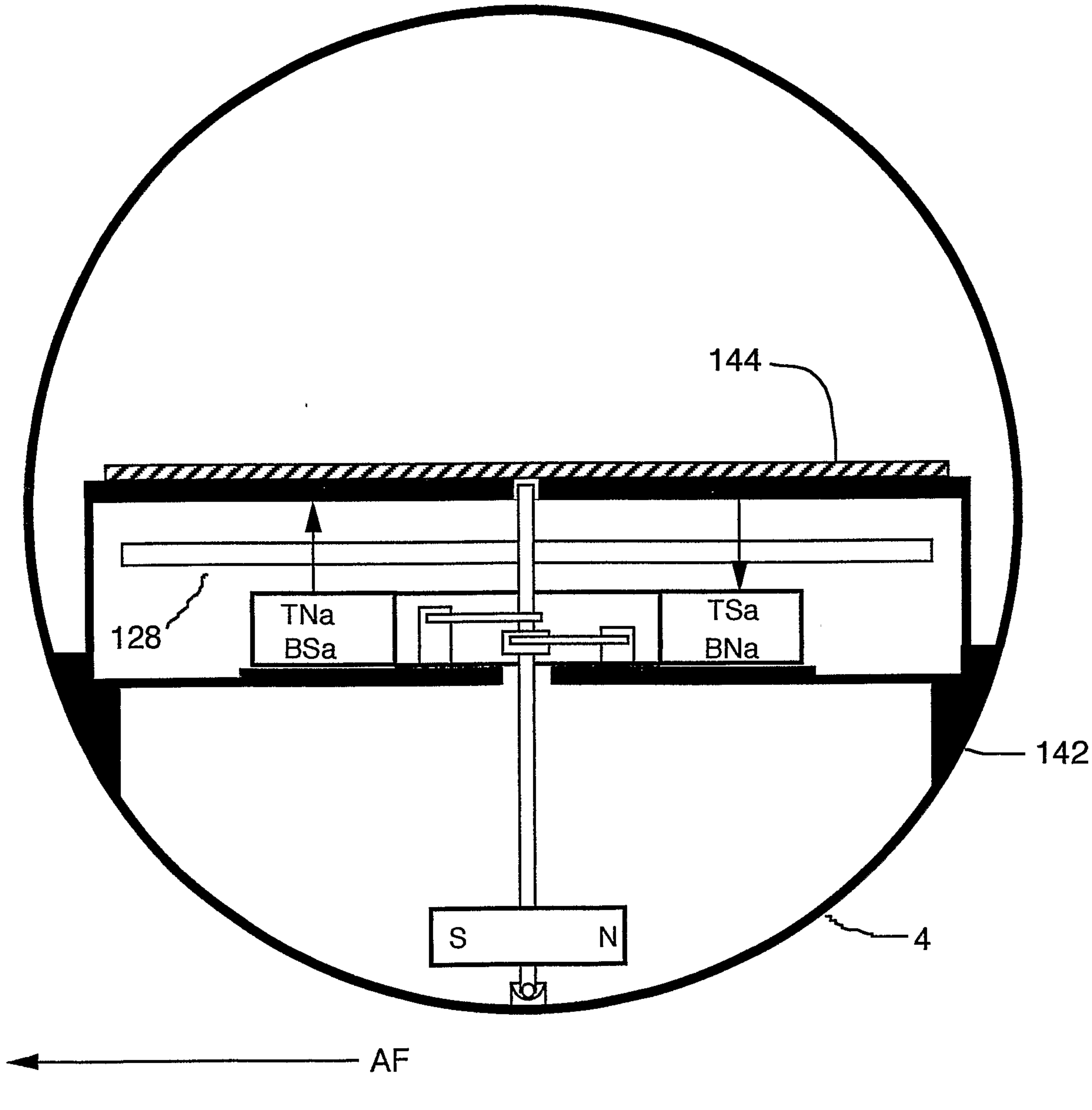
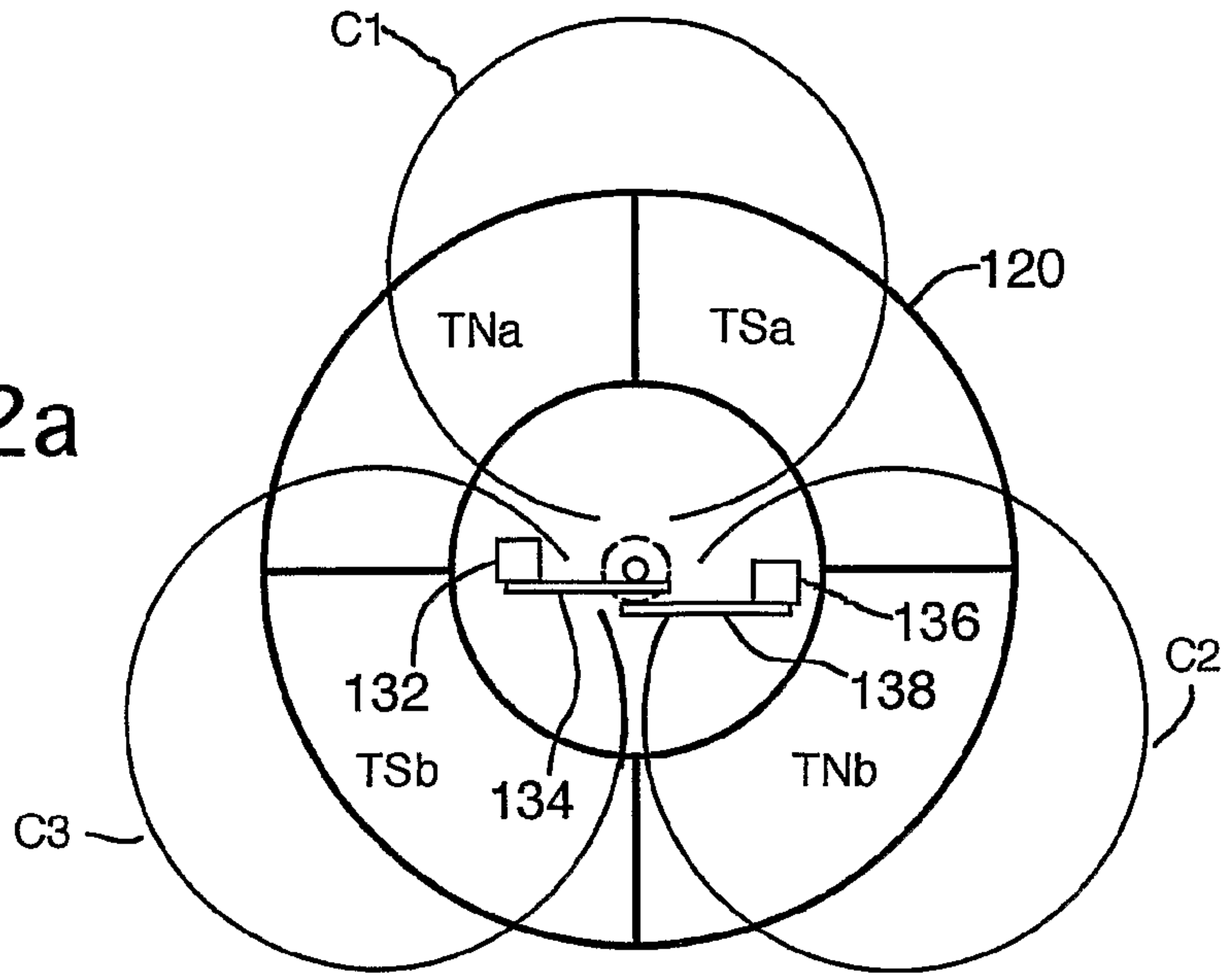


Fig. 21

Fig. 22a



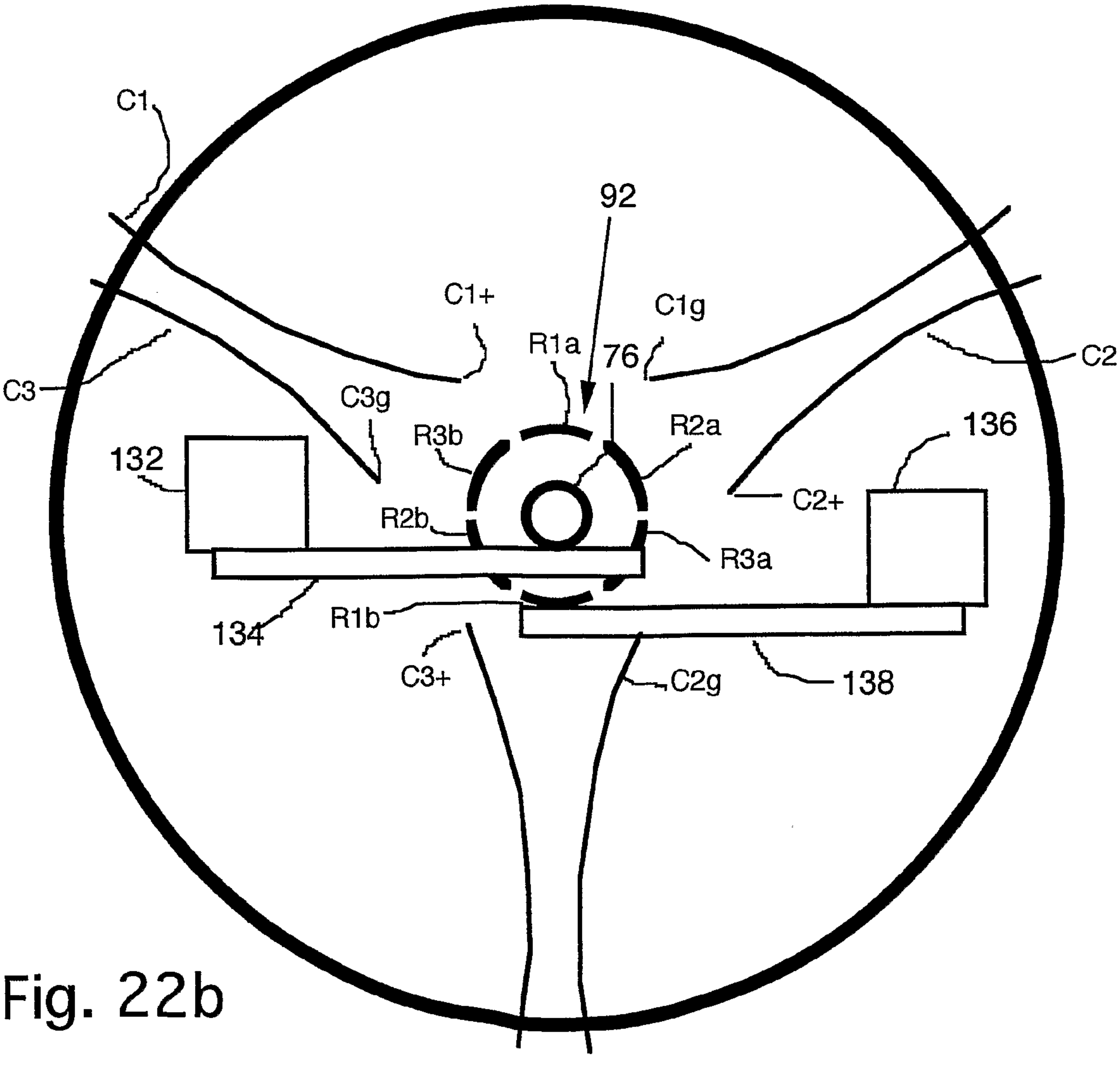


Fig. 22b

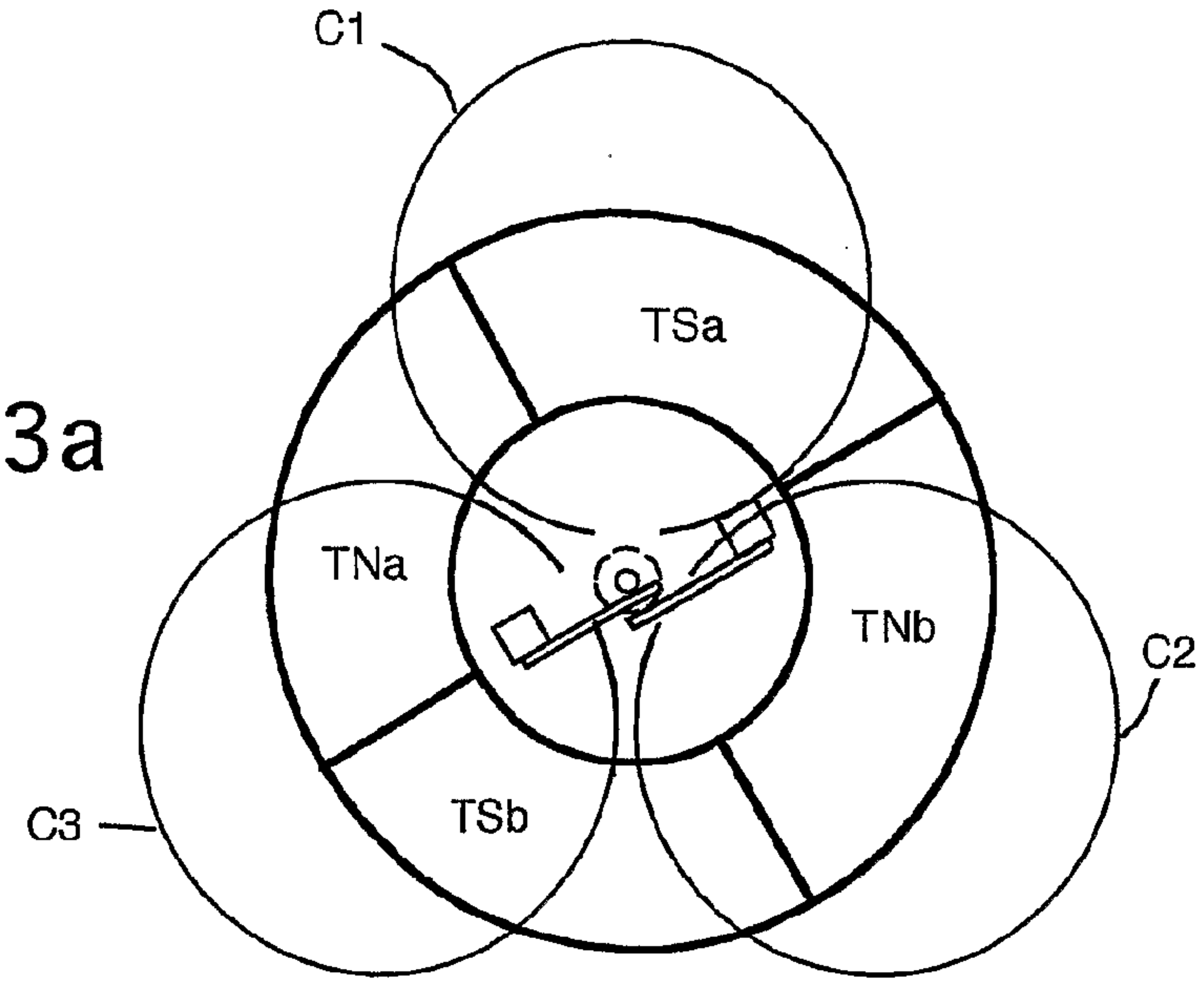


Fig. 23a

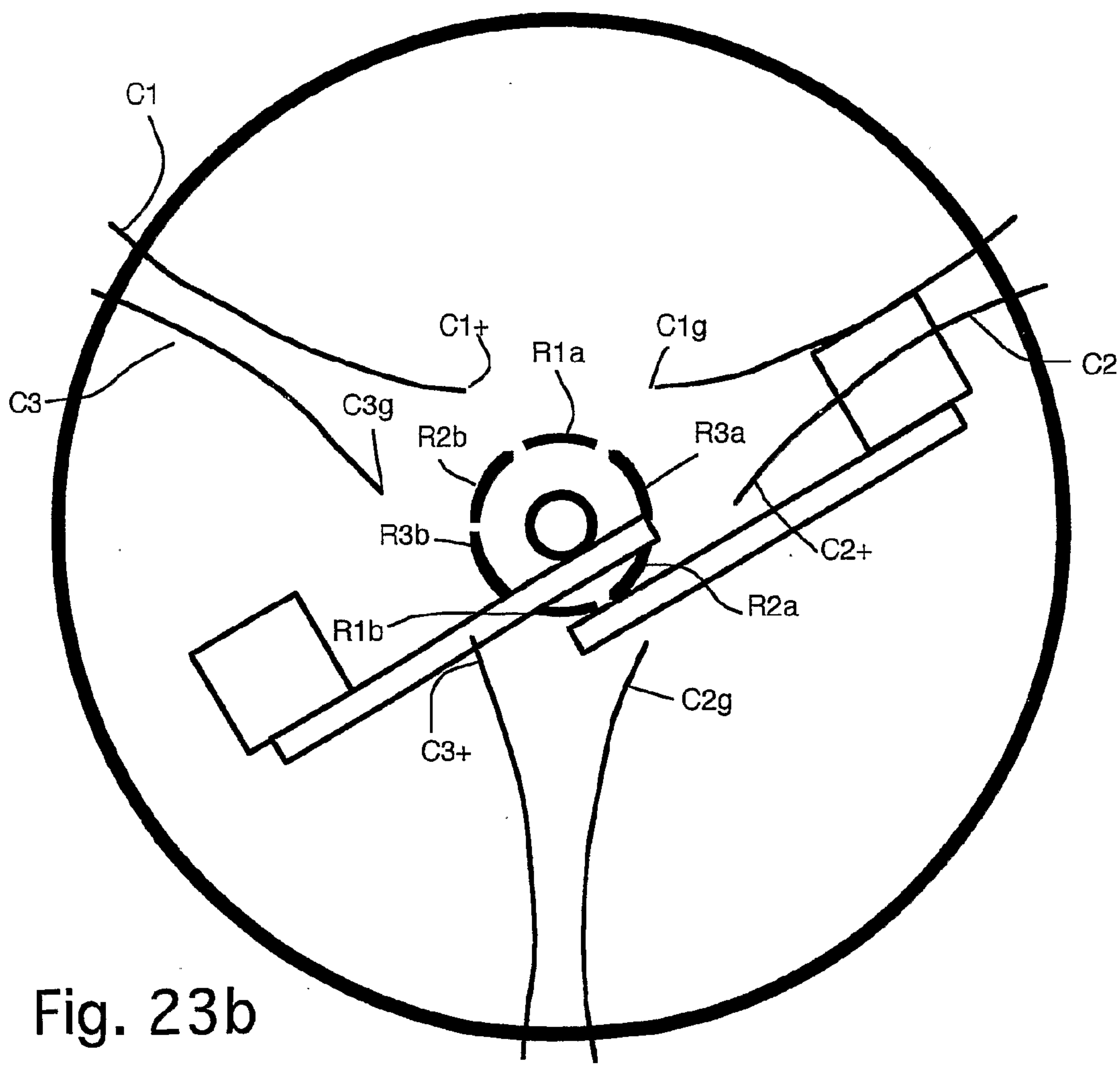


Fig. 23b

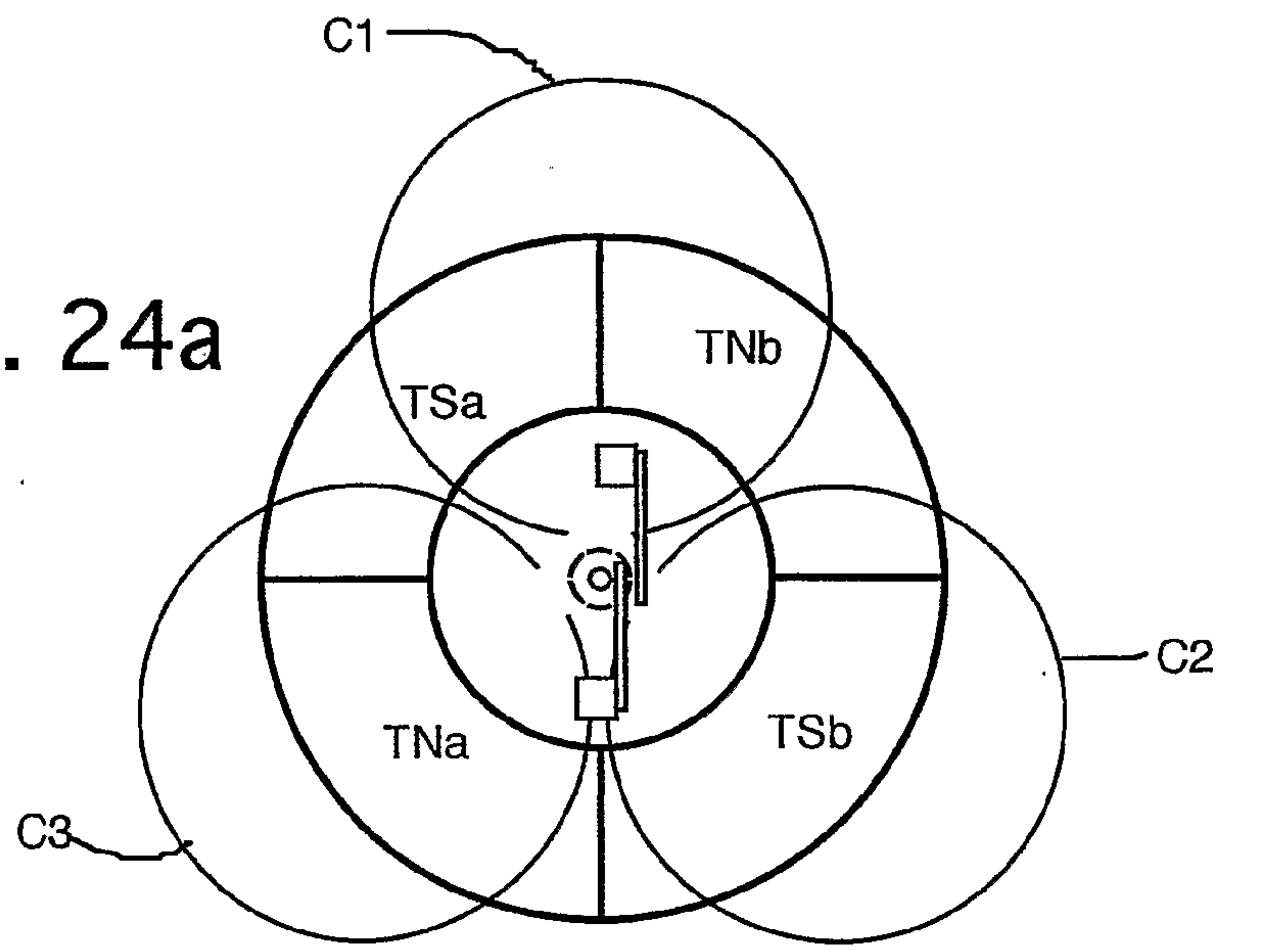


Fig. 24a

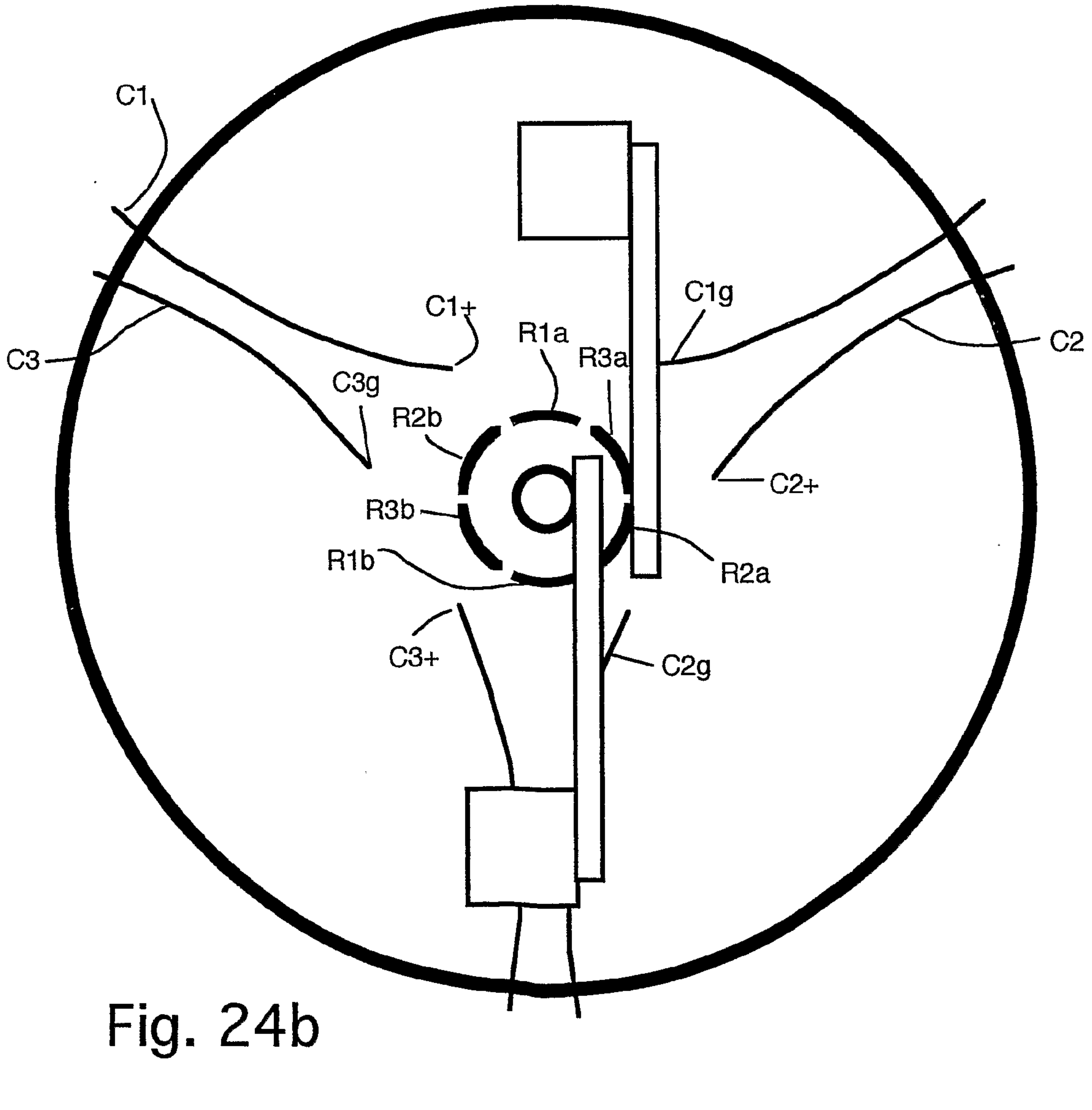


Fig. 24b

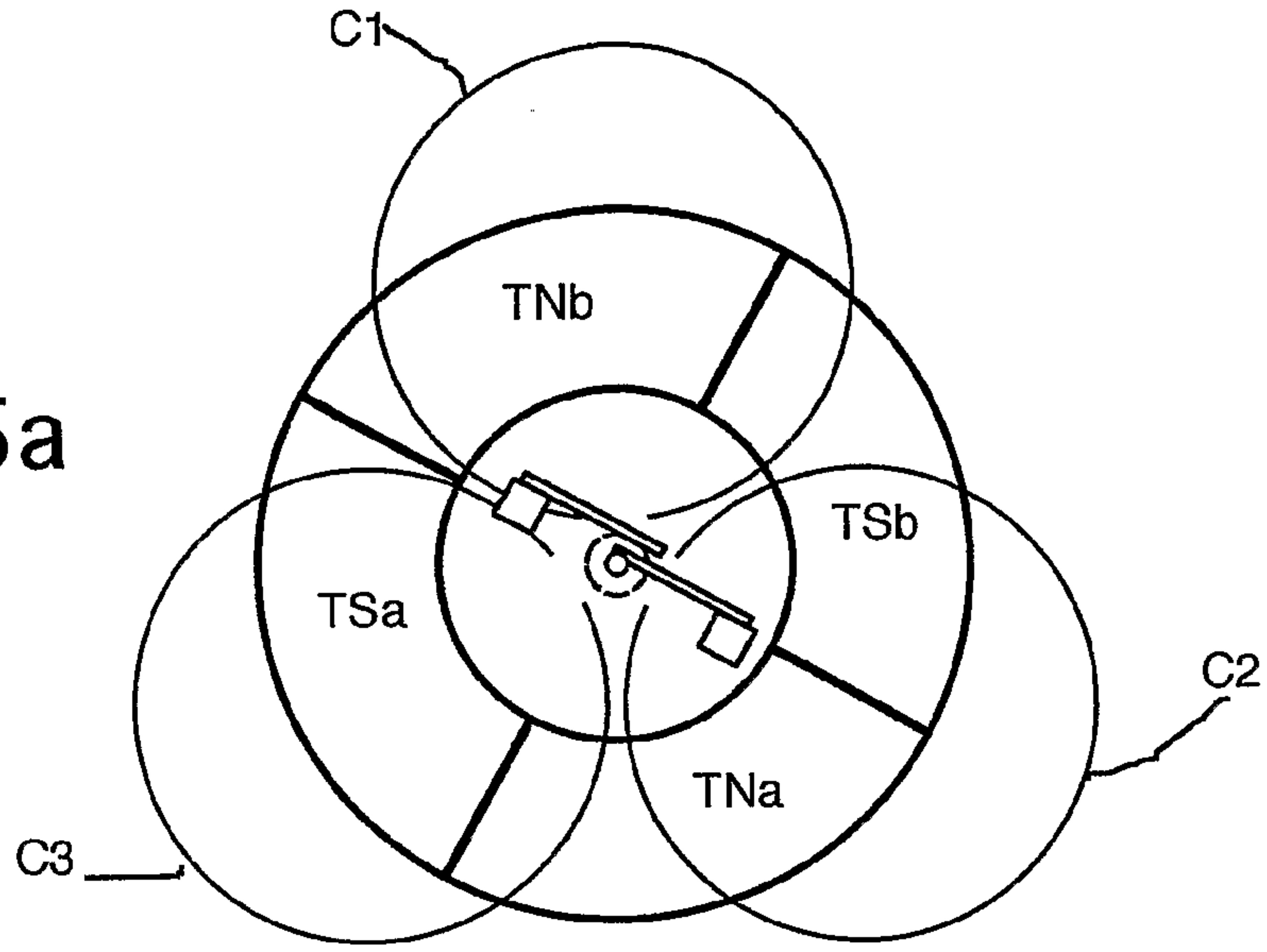


Fig. 25a

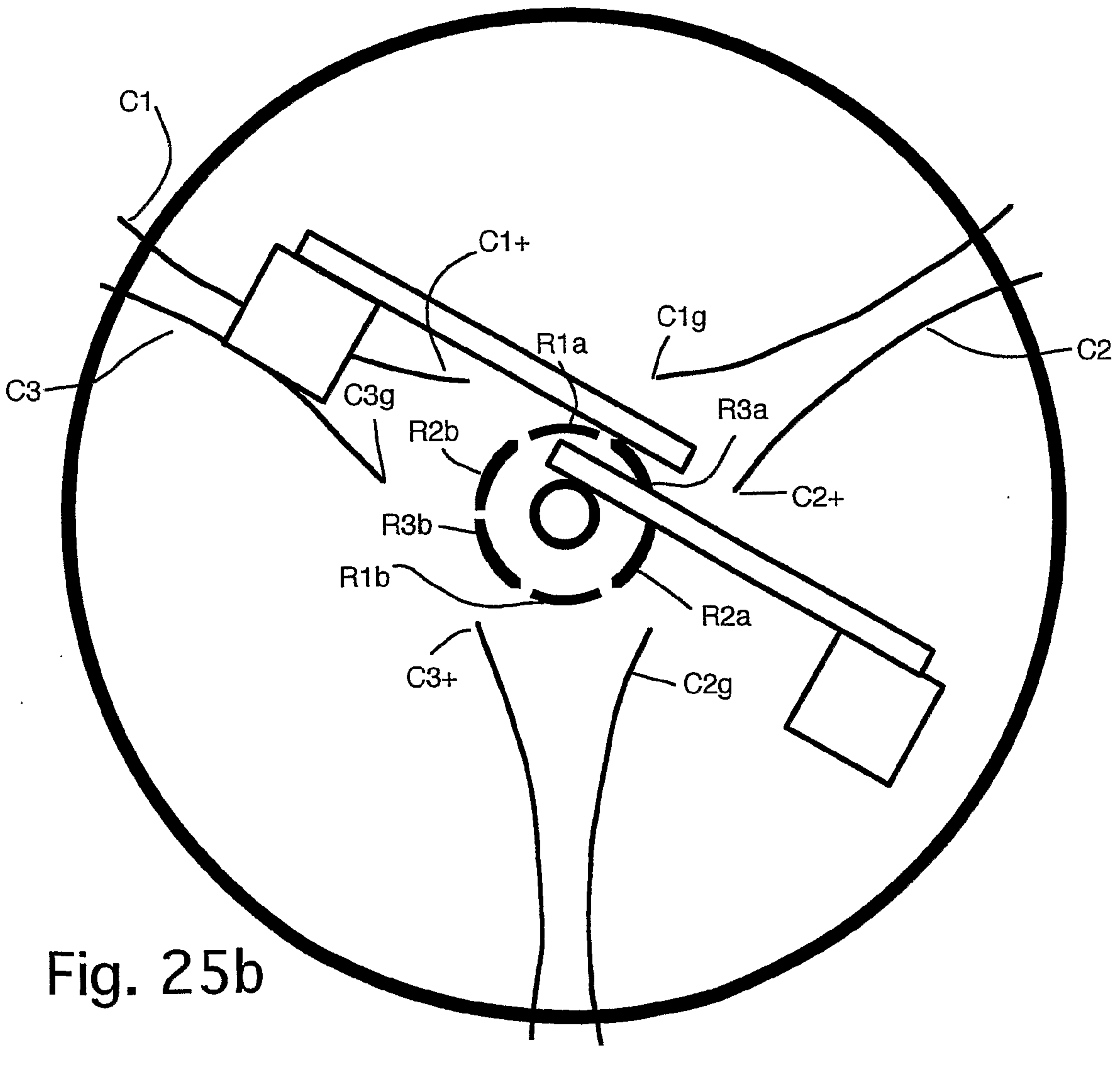
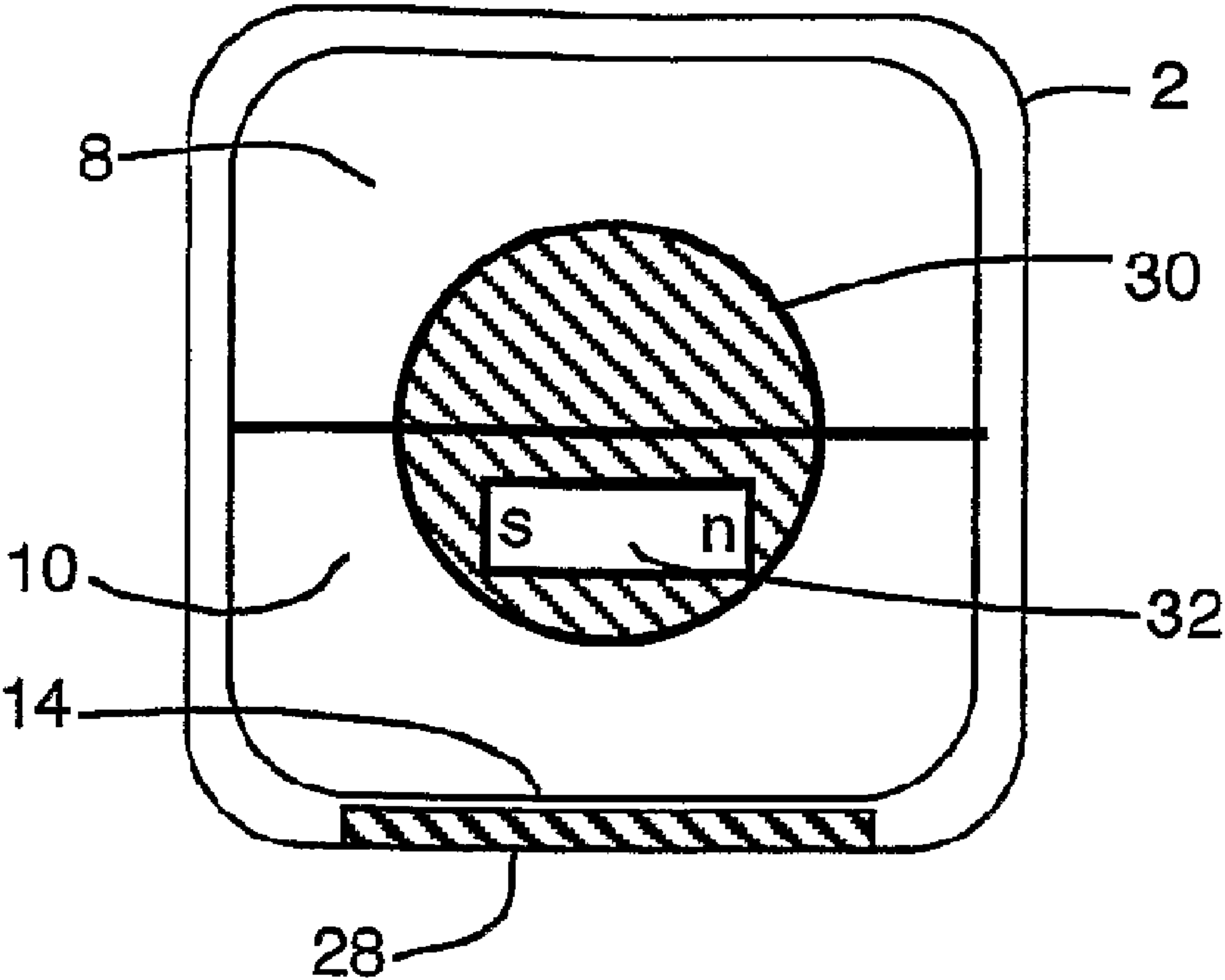


Fig. 25b


2
8
30
s
n
10
32
14
28