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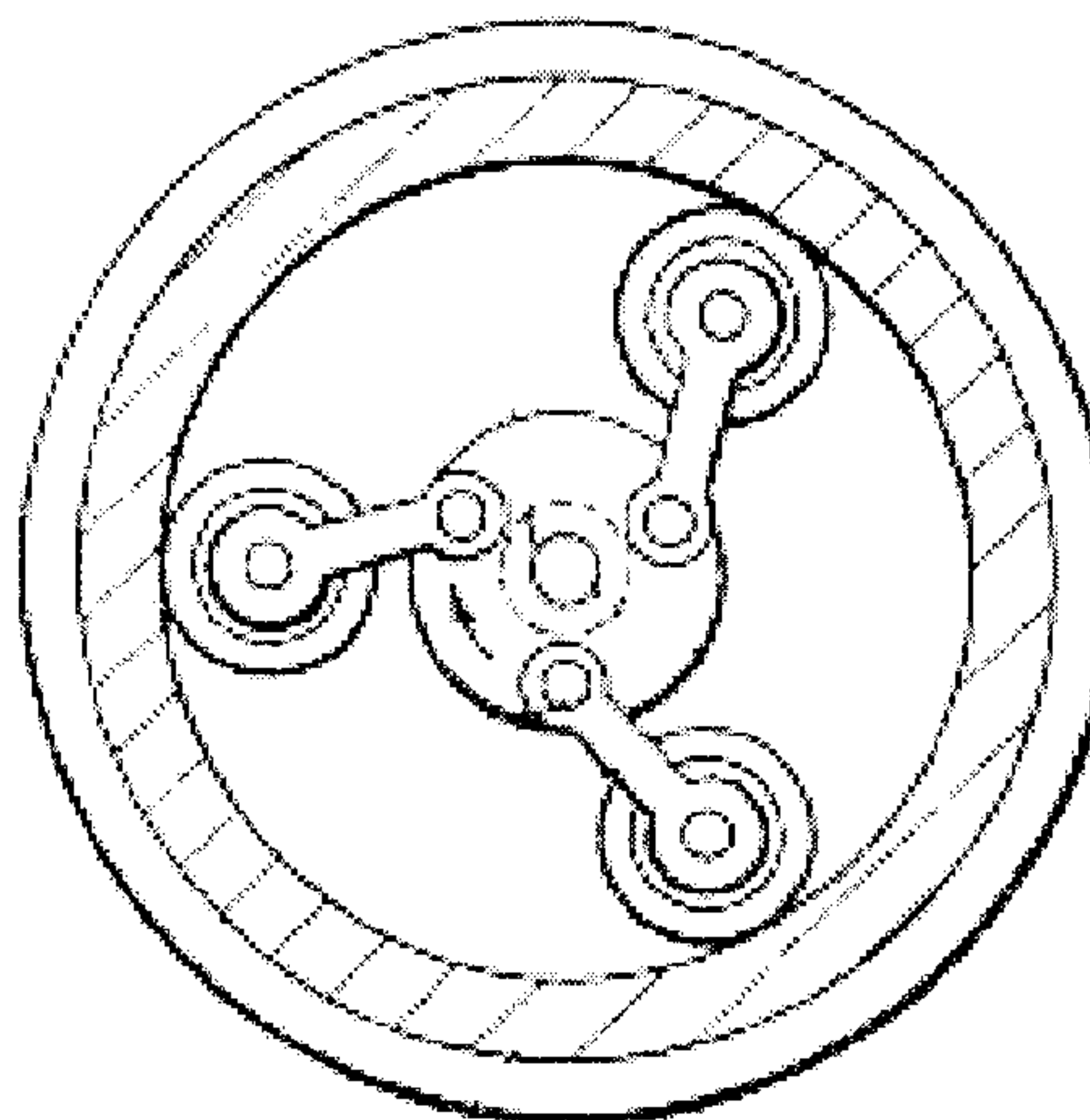
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(54) Titre : LAMINOIR VERTICAL EQUIPE A ACTIONS DE FRAGMENTATION COMBINEES ET PIECES MODULAIRES
INTERCHANGEABLES

(54) Title: VERTICAL ROLLER MILL WITH COMBINED COMMINUATION ACTIONS AND INTERCHANGEABLE
MODULAR PARTS



(Ref) - Original Szego
Mill device, Canadian Patent
#974,956

(57) **Abrégé/Abstract:**

This invention relates to a modular vertical roller mill which may be used for applying multiple types of comminuting action to varying degrees of coarseness of particulates or varying lengths of fibrous material, with the ability to interchange parts quickly and easily

(57) **Abrégé(suite)/Abstract(continued):**

so as to apply the most effective comminuting actions to the materials as needed for a given application, while avoiding common problems of binding (stoppage of rollers), sliding (slippage of rollers), and build-up or overheating of materials.

1 **Abstract:**

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3 This invention relates to a modular vertical roller mill which may be used for applying multiple
4 types of comminuting action to varying degrees of coarseness of particulates or varying
5 lengths of fibrous material, with the ability to interchange parts quickly and easily so as to
6 apply the most effective comminuting actions to the materials as needed for a given
7 application, while avoiding common problems of binding (stoppage of rollers), sliding
8 (slippage of rollers), and build-up or overheating of materials.

Vertical Roller Mill With Combined Comminution Actions And Interchangeable Modular Parts

The present invention described herein adds a series of improvements to the Szego Mill, a grinding machine found in patents #974,956, #1,068,662 #1,134,336, and #1,249,986, specifically to the rollers, roller mounting body and methods, and vertical grinding body, while also addressing binding, slippage and other design issues with elements described in those patents, additionally presenting methods and their mechanical elements for new comminution actions, cooling techniques and their mechanical elements, and methods and their mechanical elements for adjustment and control of grinding parameters which, when taken together, create a novel system of interchangeable modules for the assembly and use of a grinding machine. Thus is created in the present invention a new vertical roller mill with combined comminution actions and interchangeable modular parts.

Background Of The Invention and Prior Art

A grinding mill known in certain academic circles as the Szego Mill was invented by Laszlo L. Szego in the 1960's, and granted Canadian Patent #974,956 issued Sep. 23 1975 to General Comminution Inc. entitled "Ultrafine Pulverizer". The mill was improved upon generally in Canadian Patent #1,068,662 issued Dec. 25 1979 to General Comminution Inc. entitled "Comminution Device", and further improved upon in Canadian Patent #1,134,336 issued Oct. 26 1982 to General Comminution Inc. entitled "Multiple Stage Comminution Device", and subtly further in Canadian Patent #1,249,986 "Method of Separating Solids by Simultaneous Comminution and Agglomeration", issued Feb. 14 1989.

Summary Of The Invention

Specific improvements in the present invention relate to the shape and action of the rollers, the mounting of the rollers, and the main body of the previous invention in such a way as to overcome mechanical and functional limitations of the previous invention which have been discovered over time; enable more economically effective and quicker cleaning, replacement, and maintenance of components of the mill; and allow use of variations of components of the

mill in combinations suited to the specific grinding application so as to create a new type of modular mill system.

5 The Szego Mill is a vertically oriented roller mill used for the comminuting and transporting of materials axially through the mill by an assembly of vertical rollers spinning inside a main vertical body cylinder of the mill, using centrifugal forces to push the rollers against the interior surface of the main body cylinder in order to effect a crushing force against particulate matter caught between the rollers and the interior surface.

10 The rollers are helically lathed with a square-profile groove running down the length of the roller, which catches material and traverses it downwards in a screw movement.

In the previously described invention, an effective comminution action is obtained on material which can be sheared into flakes such as mica or copper, or ground into granules such as
15 other minerals, metals or food additives. However, research has found that pulpy fibrous material tends to shear into strands of a size not desirable for most commercial applications.

Additionally, the embodiments described in the previous patents have been found to cause a binding action due to the adhesion forces of the paste-like pulp material as it builds up in the
20 grooves of the rollers due to the roller groove shapes described by the previous invention. This binding-up of material causes the rollers to stop their shearing action as friction against the inside wall of the main body cylinder of the Mill is reduced and the rollers begin to slip rather than rotate as the roller assembly spins inside the body.

25 The present invention provides an improvement to the shape of the rollers of the previous invention whereby the groove is shaped in an upwards curve similar to a logarithmic curve, rising internally above the lower wall limit of the roller face, then sloping somewhat parabolically downwards towards the top edge of the next lower roller face.

30 This allows a stronger centrifugal force to be acted upon the matter inside the roller groove, increasing the potential for centrifugal ejection of the matter to overcome the potential for adhesion of the matter to the wall, thus preventing the slippage.

Additionally, the shape of this curve naturally adds a knife-edge to the grinding face of the roller. This knife-edge is then optionally notched rotationally along the helix of the roller, thus adding both a cutting action as the roller turns and the helix pushes the material downwards, and a ripping action as the roller turns and the material is passed laterally along the knife-edge. This is in addition to the shearing forces of the rollers, allowing a combination effect of comminution methods to be acted upon the material in order to produce a more controlled length and shape of resulting material to better fit the needs of the grinding application at hand.

The roller described in an embodiment of the present invention can optionally have a taper from a mid-point towards the top of the roller, in order to set a larger maximum particle size and gradually decrease said size as the material progresses lower towards an ultimate maximal size determined by the largest diameter of the roller.

Improvements in the method and equipment for providing an axle for the roller increase the strength and reliability of the roller while also providing both additional grinding force due to centrifugal movement, and fine control of the particle size by limiting contact pressure.

The present invention also provides an improvement to the grinding body of the previous invention whereby the grinding body can hold interchangeable sleeves of varying construction as needed for a given application; be replaced by a body with a taper inverse to that described above allowing larger coarse material to be ground progressively finer to an ultimate size; be replaced by a body having an integrated heat exchange system; or any combination of these embodiments, creating a modular mill system which allows the user to choose from interchangeable components best suited for the grinding task.

Overview Of The Drawings:

Detailed features of the invention will appear from the descriptions below, taken with the accompanying drawings, in which:

Fig. 1 is a top view used for reference of the original device as shown in Canadian Patent #974,956 showing an assembly of three grinding rollers mounted by a wire rope on three individual arms, the entire assembly rotating on a central shaft inside a cylindrical grinding body;

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Fig. 2 is a perspective view of the roller assembly of Fig. 1 of a Szego Mill, with a square-profile helical groove lathed axially along the length of the roller, and held by an upper and lower roller mounting plate, as shown in Canadian Patent #1,249,986;

10 Fig. 3 is a schematic profile view, partly in section, showing an embodiment of the present invention, as an improvement to the rollers of Figs. 1-2;

Fig. 4 is a sectional rendering of the Fig. 3 device, showing an embodiment of the present invention, as an improvement to the rollers of Figs. 1-2;

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Fig. 5 is a representative drawing showing the improvements of additional comminuting actions effected by the roller device of Figs. 3-4 onto fibrous or other material as it rotates, and improvements in ejection of material;

20 Fig. 6 is an alternate embodiment of the device of Figs. 3-5 having a rigid mounting in accordance with the present invention, as an improvement to the rollers of Figs. 1-2;

Fig. 7 is an alternate embodiment of the sliding mount guide on the end of the shaft of the Fig. 6 device.

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Fig. 8 is an alternate embodiment of the roller of the Fig. 6 device, said roller having a taper from a midpoint towards the upper edge.

Fig. 9 is an internal view of the Fig. 6 device, showing the mounting of the roller of Figs. 3-8,
30 as an improvement to the rollers of Figs. 1-2;

Figs. 10-14 are top views of various embodiments of the mounting of a plurality of the rollers of Figs. 3-9 in an assembly of Fig. 6 devices for rotation on a central shaft inside a cylindrical body, as an improvement to the rollers and assemblies of Figs. 1-2;

- 5 Figs. 15-22 are cutaway views showing a number of alternate embodiments of the cylindrical bodies in which the Figs. 10-14 assemblies rotate, as an improvement to the cylindrical body of Fig. 1.

Detailed Description Of The Invention:

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Reference is first made to Fig. 1, which shows the original device of Canadian Patent #974,956 having a cylindrical grinding body. The body has an interior surface which is vertically parallel and symmetrical about the central axis of the device. A central axle is provided, from which the grinding rollers are held and impart their force centrifugally upon the
15 interior surface.

This will give an understanding of the general invention which is being improved upon by the present invention.

20

Reference is further made to Fig. 2, which shows a profile of a grinding roller as a cylinder in which a square-profile helical groove is lathed axially along the length of the roller.

This will aid visualization of the problem of binding of material due to adhesion forces within the groove, which is being reduced by the present invention.

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In the general use of the Szego Mill, coarse particulate material is fed from the top as the internal assembly rotates at high speed. This causes the rollers to spin in the opposite direction of the assembly due to their friction against the interior surface of the grinding body. When the material is of an oily or sticky nature, as is often the case with organic material such
30 as grains, seeds, and wood or paper pulp, the material tends to bind within the grooves of the rollers.

This is due to the build-up of pulverized material against the interior surface of the grinding body, causing the grinding rollers shown in Figs. 1 & 2 to be pushed by their outermost faces to the limit of their movement inwards towards the central axis of the machine. The roller binds on the wire rope axle described in the original patents, causing damage to the roller.

5 This in turn causes slippage of the rollers due to the lack of friction against the oily material, and further material is then only able to move into the groove areas. Without centrifugal forces being acted upon the material, it cannot overcome the adhesion forces and is not ejected from the grooves.

10 Fig. 3 shows an improved groove profile for lathing a helical groove into the cutting roller, in that the groove is curved (4), not polygonal. The curve can be described as having a height (3) extending from the top edge of a lower face extending up beyond the lower edge of an upper face, and a depth (5) into the body of the roller from the outer face (1) towards its central axis. The depth profile moves upwards and inwards in a somewhat logarithmic spiral
15 towards the highest point of the groove height, then back downwards and outwards towards the bottom edge of the upper face. The resulting shape is similar to the symmetrical half of a commonly-drawn "heart", This causes a knife-edge shape (6) to be made from the lower edge of the upper face, and a smoothly curved surface flowing outwards towards the bottom of the helical lathing. This profile is then polished for smoothness.

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Fig. 4 shows a rendering of the curve in which can be seen notches (7) cut into the knife-edge (6), at various spacings (8). Other features of these notches will be described below.

Fig. 5 describes a number of actions of the roller during it's rotation, including a centrifugal
25 ejection of material (11) from the groove. As the roller is spun at operating speed, material caught or pushed into the groove (9-11) is acted on by a much stronger centrifugal force than with the square or polygonal grooves of previous inventions. The gullet of the curve, having no corners or angles, allows much less packing of material than a polygonal shape. Even with typical adhesion forces of oily material, the material will be prone to sliding downwards due to
30 the momentum of the driving force of the helical groove (rotating as a downward screw) and outwards as it follows the smoothness of the curve towards the ejection point of the material,

at the lowest point of the curve where the material once again meets the interior surface of the cylindrical body - refer to (11).

5 An additional cause of the binding problem inherent in the use of oily or sticky materials in the mill is the limited comminution actions acted upon the material. In the previous invention, material is flattened against the interior surface by the face of the roller. Because certain materials are softer than they are brittle, they tend to be spread flat and "squished" rather than crushed, adding to the packed smoothness of the material against the interior surface and contributing to the slippage of the roller. This is shown in Fig. 5 as a shearing action (9) in 10 the direction of the arrows. The material is then pushed down into the groove due to the downwards screw motion of the roller, as shown by the curve of the material in the diagram.

By lathing the roller with the profile (4) described in the present invention, the knife-edge (6) which is created pushes down through the material brought into the groove, cutting it and 15 separating the cut portion from the fibre or flattened material still remaining between the interior surface and the roller - refer to (10), showing a knife-edge cutting action in the direction of the arrow. This cutting action now adds a second comminution action to be acted upon the material in the mill, that of cutting (10) in addition to shearing (9).

20 As the roller now has a fine knife-edge helically along its body, a third comminution action can be created by creating nicks or notches of various sizes and shapes (7) at regular or irregular intervals (8) along the knife edge (6). The sections (8) of the knife-edge (6) between the notches (7) become teeth as in a ceramic cutting disc, spaced as widely or narrowly (8) as needed for a given application. These notches catch material as it is pulled into the groove, 25 causing a third comminution action to be acted upon material in the mill, that of ripping of fibres or other types of material into shorter lengths, shown in (12) as a tooth-notch ripping action.

The presently described roller is now capable of crushing, shearing (9), cutting (10) and 30 ripping (12) material while reducing binding of material in the roller and actively assisting in its ejection from the roller (11) so as to prevent slippage.

In order that material which does inevitably remain in the grooves be easily cleaned, and to facilitate quick removal, maintenance, and exchange of rollers of different sizes and profiles for use in the same mill unit, the present invention contains an improvement to the mounting of the grinding rollers as described in the original patents (Figs. 1-2).

5

Whereas the original patented design of Fig. 1 shows three rollers permanently mounted on swing-arms to a central mounting disc, with the patent describing a flexible wire rope as the axle of the roller, a later improvement shown in Fig. 2 has the rollers permanently mounted directly on the mounting disc (the arms are no longer present), with the rollers held in place
10 vertically by the mounting discs at top and bottom, and axially by a flexible shaft around which the roller floats in order to move laterally as the assembly spins.

Fig. 6 shows an embodiment of the improved roller of the present invention (15a) mounted on a solid cylindrical shaft (14) having a rectangular (13a), concave (13b in Fig. 7), or similar
15 profile cut from the shaft at top and bottom, acting as a sliding mount guide to be inserted in a suitable groove or slot (18a/b), described below.

Fig. 7 shows an embodiment (13b) of the sliding mount guide (13a) of Fig. 6, whereby the concave rounded ends of the shaft engage in a matching v-shaped groove (18b) of Fig. 13, at
20 a depth which holds the shaft captive in one direction perpendicular to the groove length, but allows movement laterally across the groove thus sliding towards the interior grinding surface of the mill as centrifugal forces increase. The shaft (14) of the roller assembly (15a/b) of Figs. 6-9 is thus limited in its travel inwardly by the stopped end of the groove and outwardly by the interior grinding surface, yet the roller assembly is easily removed when the entire assembly
25 of Figs. 10-14 is lifted out of the mill, as there is no longer an outward limit.

Associated to Fig. 7 is an embodiment (17c) of the roller mounting assembly shown in Fig. 13. This embodiment again allows easy replacement, cleaning, and maintenance while potentially allowing more efficient mounting assembly manufacture, be it by 3D printing of a honeycomb
30 matrix mesh (as shown by the patterning in Fig. 13), or by lessened overall thickness of the disc by tapering towards the outer edge (32), due to downwards force of the roller being

placed directly on the face of the disc, such force being transferred inwards towards the thicker center of the disc by the shape of the taper of the bottom face.

Fig. 8 shows an embodiment of the improved roller (15b) of the present invention mounted similarly to (15a) of Fig 6, whereby the roller tapers from a midpoint inwards towards the top in order to effect a larger gap between the roller face (1) and the interior wall of the grinding body (24) or grinding sleeve (26) (both described below). This presents a method whereby the maximum particle size of material accepted by the mill can be increased to suit the size of the gap at the upper limit of the taper, as the material will be reduced as it traverses downwards along the roller in increasing proximity to the grinding surface. As rollers are easily interchanged in the present invention of a modular mill system, this embodiment of the roller shape presents a method and mechanical elements for allowing flexible particle size maxima as best suits the grinding operation requirements.

Fig. 9 shows the internal assembly of the roller mount, having two ball bearings (16) mounted around the shaft (14) over which the roller itself (15a/b) slides so that the roller spins on the outer race of the ball bearing while the shaft spins in the inner race. This improves upon the design of the original roller of Figs. 1-2 by allowing for removal and replacement of the roller without need for replacing the shaft itself and without special tools, a much more economical and easily maintainable solution. For longer rollers a plurality of bearings (16) may be employed on a longer shaft (14) as necessary.

Figs. 10-14 show a number of possible embodiments of an improved mounting disc (17a-d) (ref. Fig. 2 for comparison) in which the sliding mount guide (13a) is inserted in a mounting slot (18a) cut into the disc (17a, b, d) circumferentially at 120° in order to accommodate three rollers (Fig. 10), or at 90° (Fig. 11) in order to accommodate four rollers. Multiple rollers may be incorporated in alternate embodiments by reducing the angle and adjusting the diameter of the disc or roller to fit, such as an additional possible embodiment of a mounting disc (17d) accommodating multiple rollers, shown in Fig. 14. One mounting disc is necessary at each the top and bottom of the overall assembly, similarly to Fig. 2.

The open-ended mounting slot (18a), cut slightly wider than the sliding mount guide (13a), allows the roller-and-shaft assembly of Figs. 6 and 8 to float laterally in order to exert outward pressure against the interior surface of the grinding body by the centrifugal force of the rotation of the assembly, and thus enact comminution of the material in the mill.

5

Similarly, Fig. 13 shows an alternate embodiment of the roller mounting body (17c) using an alternate embodiment of the mounting slot (18b) whereby the slot is now a diagonal or convex carving in the Z plane of the surface of the roller mounting body, made to fit an alternate embodiment of the roller shaft sliding mount guide, (13b, shown in Fig. 7). This embodiment
10 uses a concave rounded end of the shaft to fit into the slot and freely slide in a lateral fashion with the centrifugal forces present during mill operation. The shaft end and groove (13b and 18b) would be of sufficient depth to hold the roller shaft (14) within the groove.

By not keeping the roller-and-shaft assembly of Figs. 6 and 8 firmly captive in the mounting
15 assembly of Figs. 10 et. al., the rollers are easily removed for maintenance, exchange, or cleaning. This is a significant productivity improvement (resulting in time and cost savings) over the original patents which require complex disassembly using tools, and again adds to the overall novelty of the present invention of a mill using interchangeable modular parts.

Fig. 12 shows an alternate embodiment of the roller mounting assembly (17b) in which the
20 rollers are held at a fixed distance from the centre of the mounting assembly (19) by a set screw (20) or other locking mechanism, giving an adjustable gap (21) between the sliding mount guide (13a/b) and the innermost surface of the mounting slots (18a). This allows specific fine control of the particle size by limiting the pressure of the rollers against the
25 interior surface of the grinding body while not impairing the rotational ability of the roller. Material would only be ground as coarse as allowed by the resulting gap between the roller face and the interior surface of the grinding body.

An additional issue with the design of the original patents which has been discovered over
30 time is that certain conditions within the mill cause rollers to bind, thereby scraping against the interior surface of the grinding body rather than freely rotating as the overall assembly of rollers spins. This causes wear spots on the bound roller. It would be theoretically possible to

encounter this same condition with the fixed-shaft roller mounting of Fig. 12, if the roller were pressed too firmly against the interior surface of the grinding body, or due to the rollers no longer being allowed to move inwards to accommodate larger particles.

- 5 An added benefit of the improvement shown earlier in Fig. 9 is that by using ball bearings (16) encased in rubber (readily available), the roller has some play laterally with which to overcome larger sized particles that may otherwise cause this binding.

10 As described earlier, alternate methods of holding such rollers, such as the example of a wagon-wheel shape shown in Fig. 14, would allow increased numbers of rollers for scale-up of internal grinding body diameter, while maintaining strength and keeping overall weight as low as possible.

15 The entire roller assembly of Figs. 6-14 (referred to as (25) in Figs. 15-21) is held on a central shaft (referred to as (22) in Figs. 15-21) which traverses the mounting assembly (17a-d) through a hole and locking key (19).

20 The combination of improvements in the present invention shown in Figs. 6-14 create an entirely new structure of the roller internals of the mill, having the added flexibility over the previous design of controllable particle size combined with a lessened overall risk of damage to the rollers, and easier, more economic cleaning and maintenance.

Figs. 15-22 show a series of improvements to the grinding body of the previous patents (compare with Fig. 1).

25

Fig. 15 describes a tapering (23) of the upper portion of the interior surface of the grinding body (24) until a specific taper limit, at which point the grinding body walls become parallel. This tapering section allows the mill to accommodate larger particles. Contrast with the earlier description of (15c) in Fig. 8, which is the inverse of this embodiment, enacted in the roller rather than the body – although these two embodiments can be combined for very large particles. These particles would have contact with the rollers only as they fall to a point whereby the width of the particle is equal to the distance between the interior surface of the

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grinding body and the grinding face of the roller, at which point a comminuting action would be effected upon the particle allowing it to fall lower until ultimately the particle is at a sufficient fineness to be permitted transport below the taper limit and traverse the remaining distance of the roller.

5

Fig. 16 shows an embodiment of the main body of the mill which is an improvement to the modularity and flexibility of the mill by enabling a removable or exchangeable cylindrical grinding sleeve (26) to be inserted into the grinding body (24). This sleeve can be made of various materials such as tungsten carbide, manganese steel, ceramic or ceramic-metal alloys, or other materials as suited to the specific hardness or roughness needs of the grinding application. The sleeve would be locked from rotating by a set-pin (31) or any similar mechanism so as not to rotate within the grinding body by the friction induced by the rollers.

10

Fig. 17 shows an alternate embodiment of an inner cylindrical grinding sleeve (26), tapered to match the taper (23) of the grinding body described in Fig. 15 in order to achieve a proper fit.

15

The use of an inner grinding sleeve (26) removes the need for the grinding body (24) to be made from hardened steel, and to be made as thick as would need be without a sleeve, as the main grinding body is now acting merely as a support body and not as a surface which will be worn from pressure and abrasion. This allows the main body to be built from a cheaper metal, alternately 3D printed, alternately made of a plastic matrix network having enhanced stability and rigidity, alternately being made of a metal which better transfers heat from the sleeve, or any combination of such techniques. This significantly reduces manufacturing cost of the mill, an improvement over the previous patents allowing a modular grinding body system suited to the economics of the required mill specifications.

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When grinding material with a sensitivity to heat, such as rubber, certain plastics, food additives, grains or other foods, or certain other materials, the heat induced by the friction of the grinding rollers can alter the structure and substance of the material being ground. This can adversely affect the quality of the material including its capability to be comminuted at all. The grinding body of the previous patents, being made of hardened steel, is not an effective

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conductor of heat away from the grinding body and material, even when contained in a cooling sheath.

5 Figs. 18-20 show an alternate embodiment of the grinding body, made possible by the present invention of the inner cylindrical grinding sleeve (26) introduced in Fig. 16, whereby the grinding body (24) is mated with an inner (28) and outer (27) copper cylinder or other effective heat-conducting material, each of a thickness sufficient to absorb a significant amount of heat. The inner and outer cylinders are joined through the rigid cylindrical body (24) by a pattern of holes drilled in the rigid body and filled with copper slugs (29) or other effective
10 heat conducting material, shown in face view in Fig. 19.

An alternate embodiment of the main grinding body, as described above, would allow a cheaper material such as an aluminum honeycomb matrix, plastic matrix allowing the slugs (29) to be inserted and the mating surfaces (27-28) pressed into place by snapping a
15 matching pattern of holes in the mating surfaces into the slugs, or other methods whereby the heat of the grinding sleeve is transferred to an external, more readily heat-conductive surface.

Fig. 20 shows an alternate embodiment of the cooling sheath assembly of Fig. 18 which is fitted to match the taper of the inner tapered cylindrical grinding sleeve of Figs. 15 and 17.
20

Figs. 21-22 show an alternate embodiment of the cooling assembly of Figs. 18-20 whereby the cooling is effected by a coil of tubing (30) countersunk into a mating lathed profile in the main body (24) and wrapped helically around the body, through which a heat-transfer agent such as water, Freon, liquid nitrogen, propylene glycol, or other coolant may be circulated.
25 The coil is shown around a body in which a grinding sleeve (26) is inserted, but may also be used without a sleeve so long as the thickness of the body (24) remains sufficient for support when lathed with the mating profile.

Fig. 22 shows a cutaway view of the cylindrical body (24) with turns of the cooling coil (30)
30 wrapped tightly around it, into the lathed mating profile.

The embodiment of Figs. 21-22 provides a more economical manufacturing alternative to the embodiment of Figs. 18-20, with different cooling properties as may be desired for the specific needs of a given grinding application.

- 5 The entire set of combinations of multi-layer body assembly of Figs. 16-17, consisting of a main rigid body (24) and an inner grinding sleeve (26); or Figs. 18-20, consisting of an outer cooling cylinder, an inner rigid cylinder (which no longer requires the costs of hardening), an inner cooling cylinder, and an inner grinding cylinder made of appropriate material for acting as a grinding surface, all cylinders being fitted concentrically in the order described, may now
10 be housed in a further outer cylinder acting as a cooling sheath for liquid or gas circulation. The same applies to the use of an alternate grinding body wrapped in cooling coil of Figs. 21-22 rather than inner and outer mated cooling cylinders; or to the singular grinding body of Fig. 15.
- 15 The various embodiments of the present invention of a modular grinding roller assembly of Figs. 3-9, mounted in an embodiment of a modular roller mounting assembly of Figs. 10-14, and inserted in one or more concentrically assembled cylindrical bodies for rotation against the interior surface of a straight or tapered rigid grinding body or grinding sleeve of Figs. 15-22, cooled as necessary by either of the cooling systems described, allows complete
20 modularity for all components of the mill: roller, roller mount, grinding body, optional inner sleeve, and optional cooling system, thus creating the novel modular vertical grinding mill of the present invention, which is not only a significant set of improvements on the concepts and execution of the original Szego Mill patents #974,956, #1,068,662, #1,134,336 and #1,249,986, but stands as a novel concept in the assembly of grinding machines in and of
25 itself.

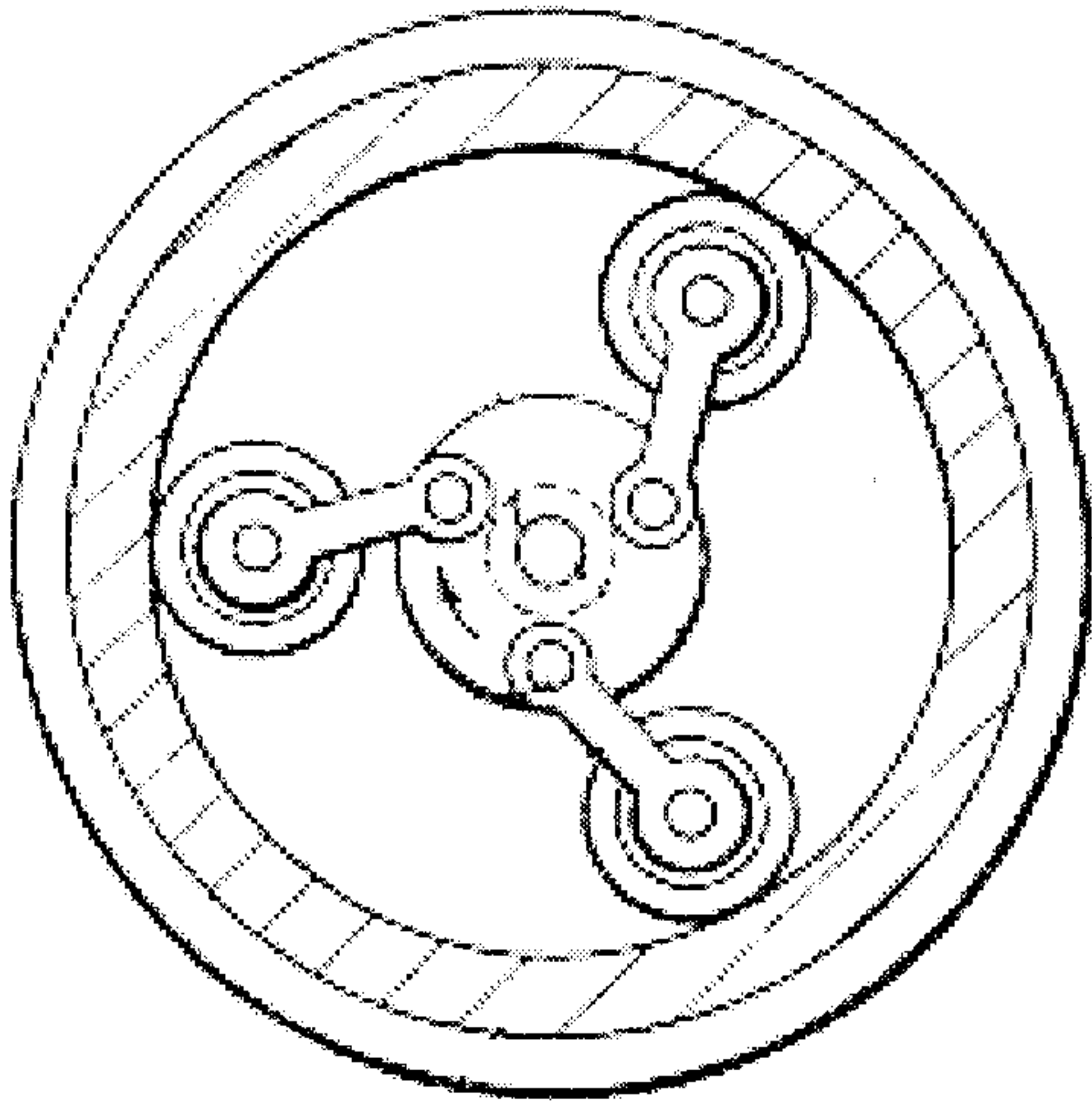


Fig. 1 (Ref.) - Original Szego Mill device, Canadian Patent #974,956

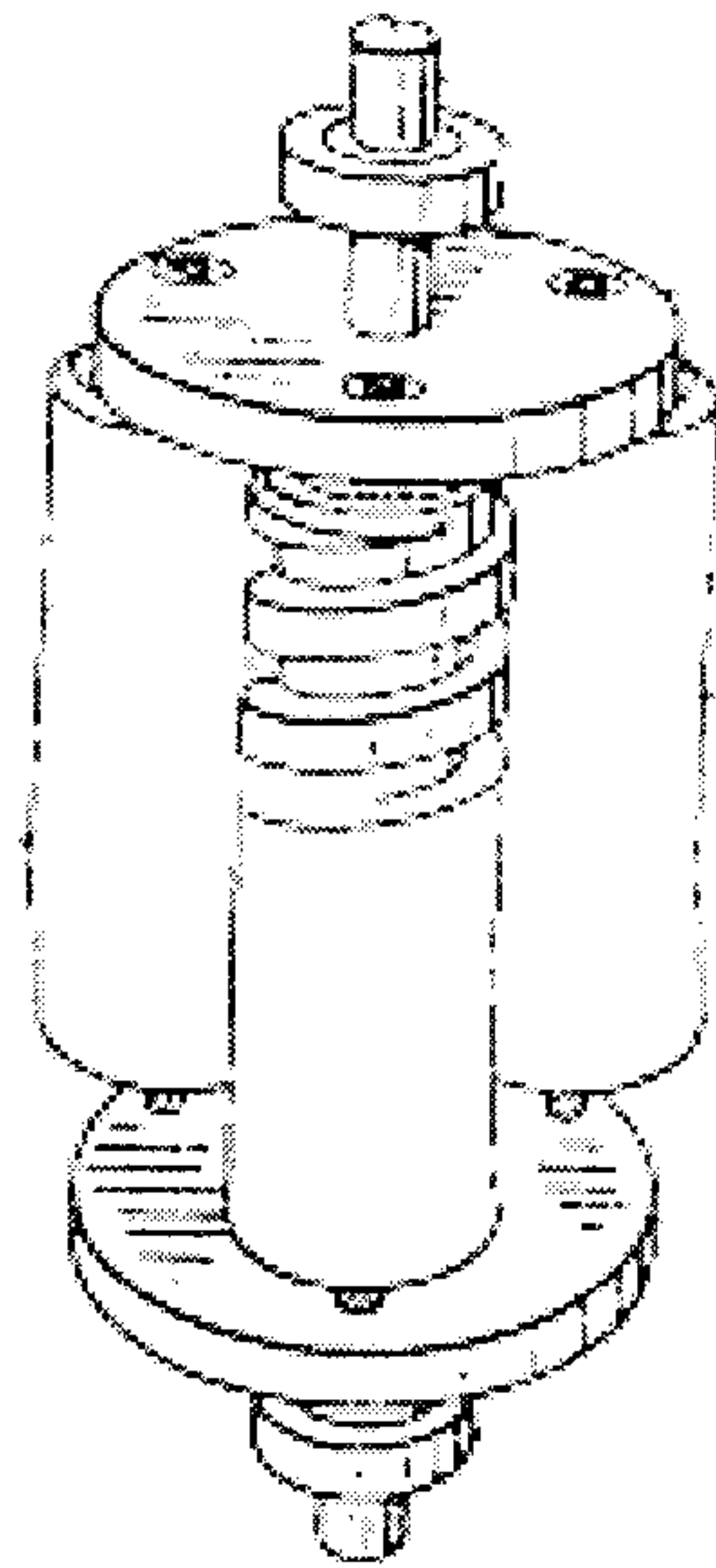


Fig. 2 (Ref.) - Roller with square groove lathed helically, Canadian Patent #1,249,986

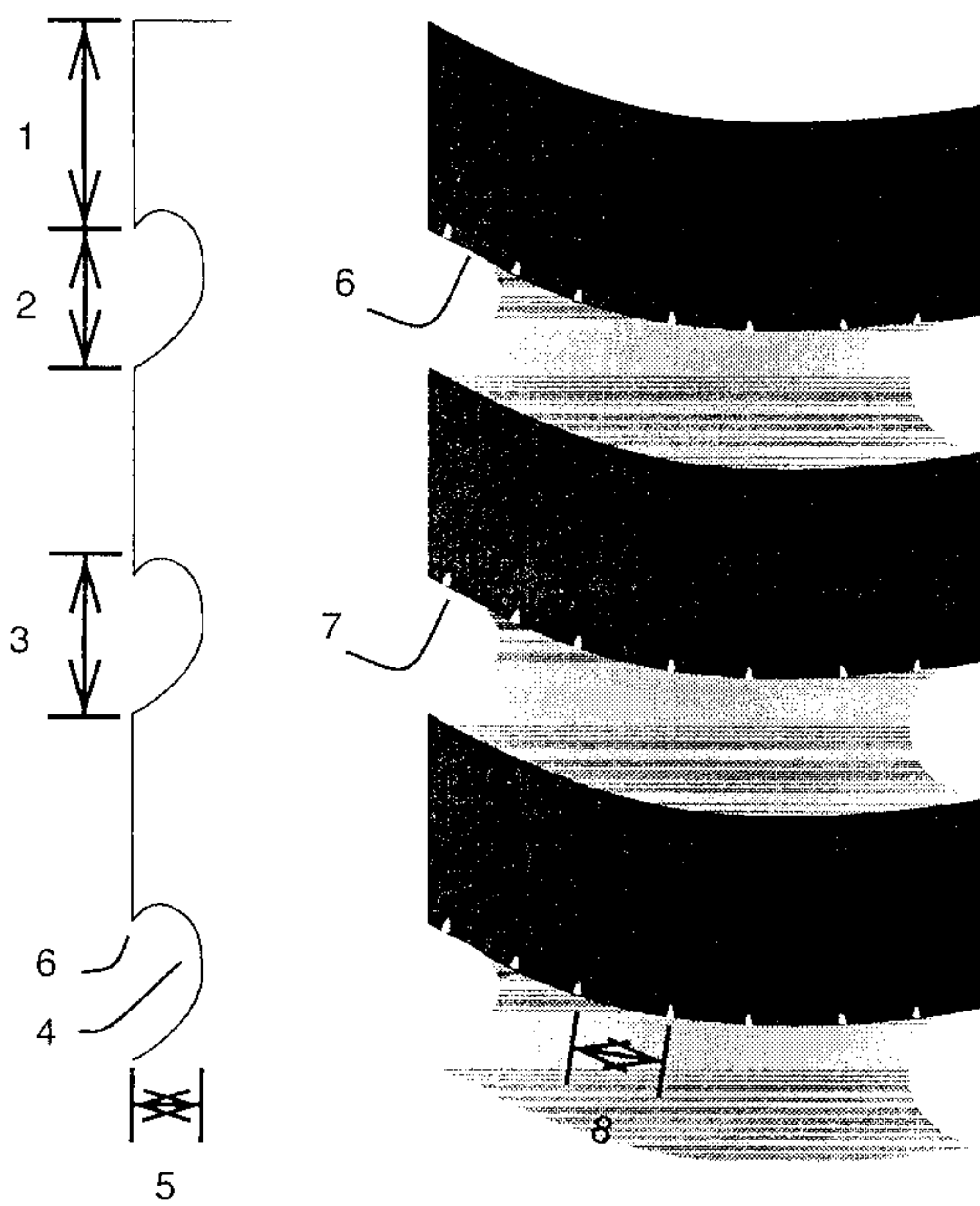


Fig. 3

Fig. 4

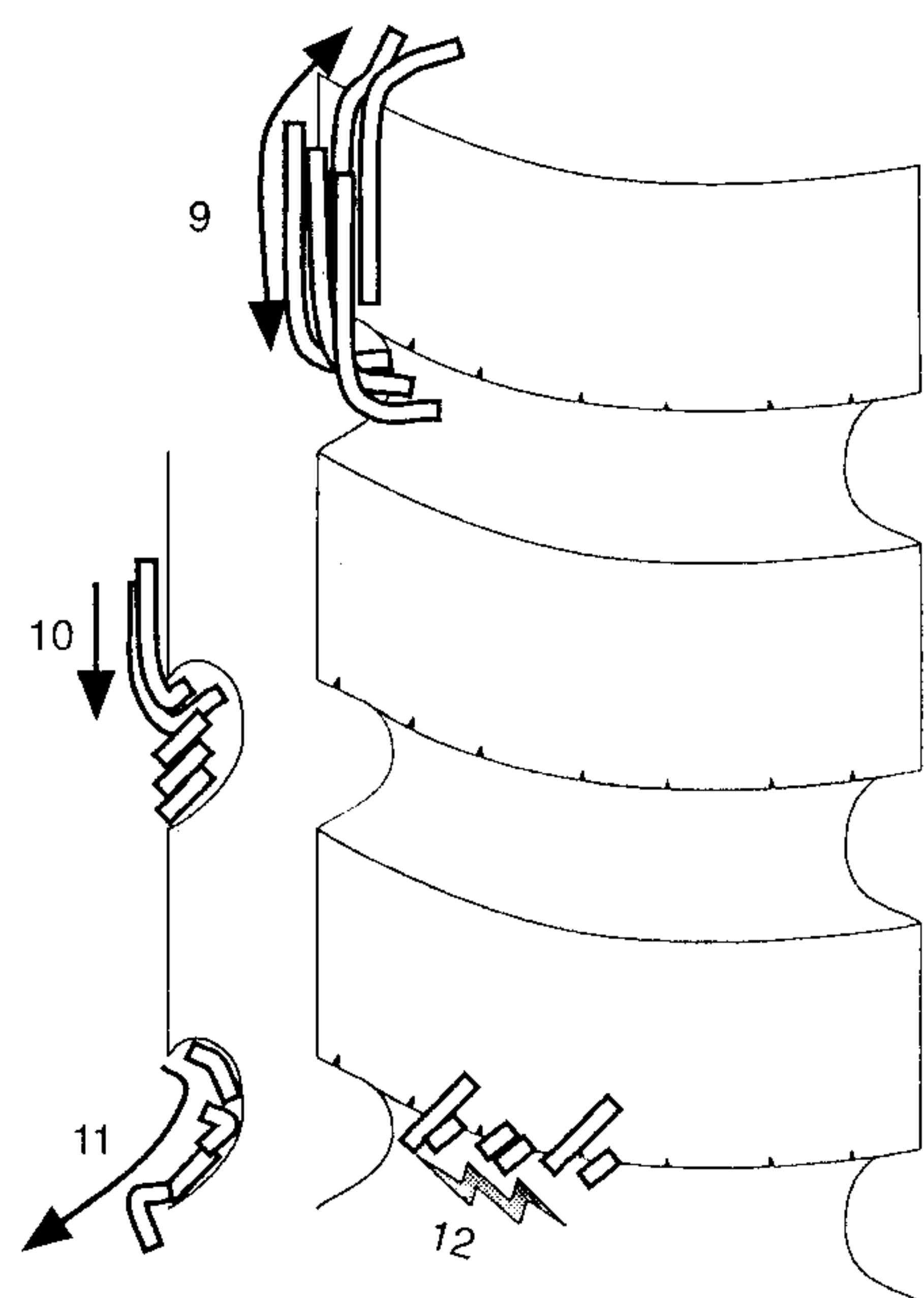


Fig. 5

Vertical Roller Mill With Combined Comminution
Actions And Interchangeable Modular Parts
Inventor - David J. Szego

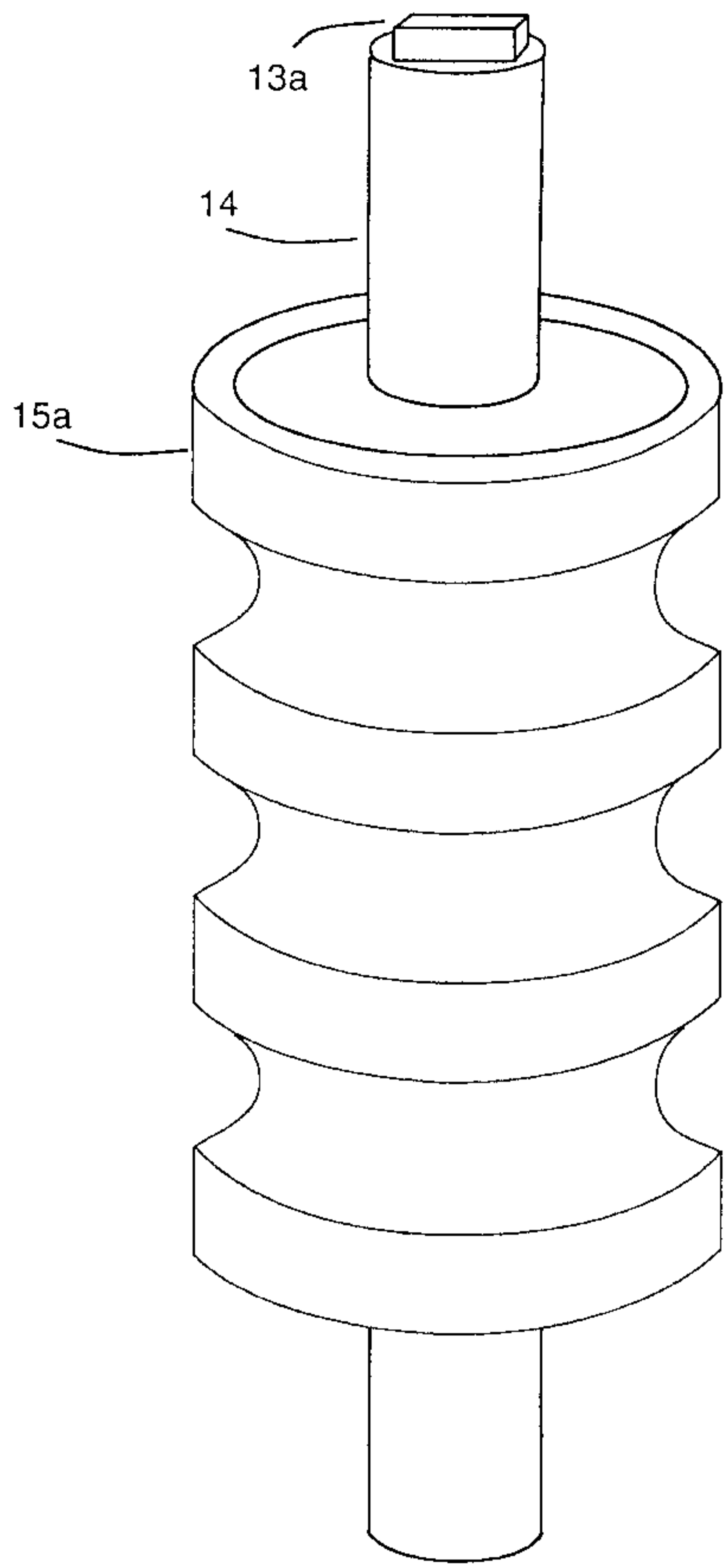


Fig. 6

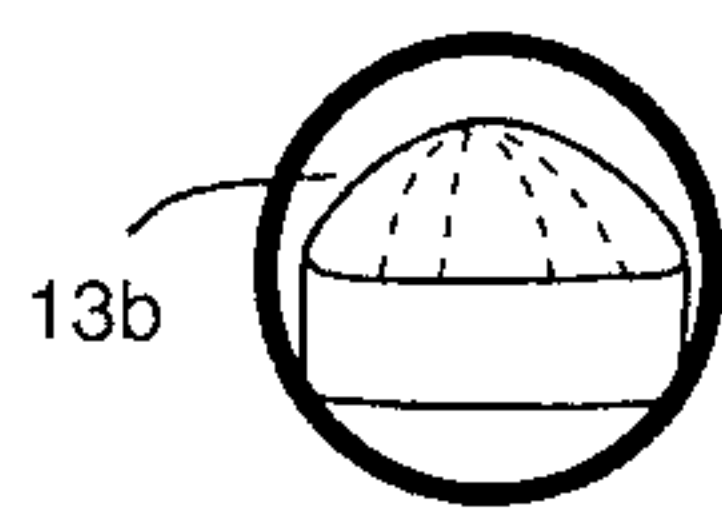


Fig. 7

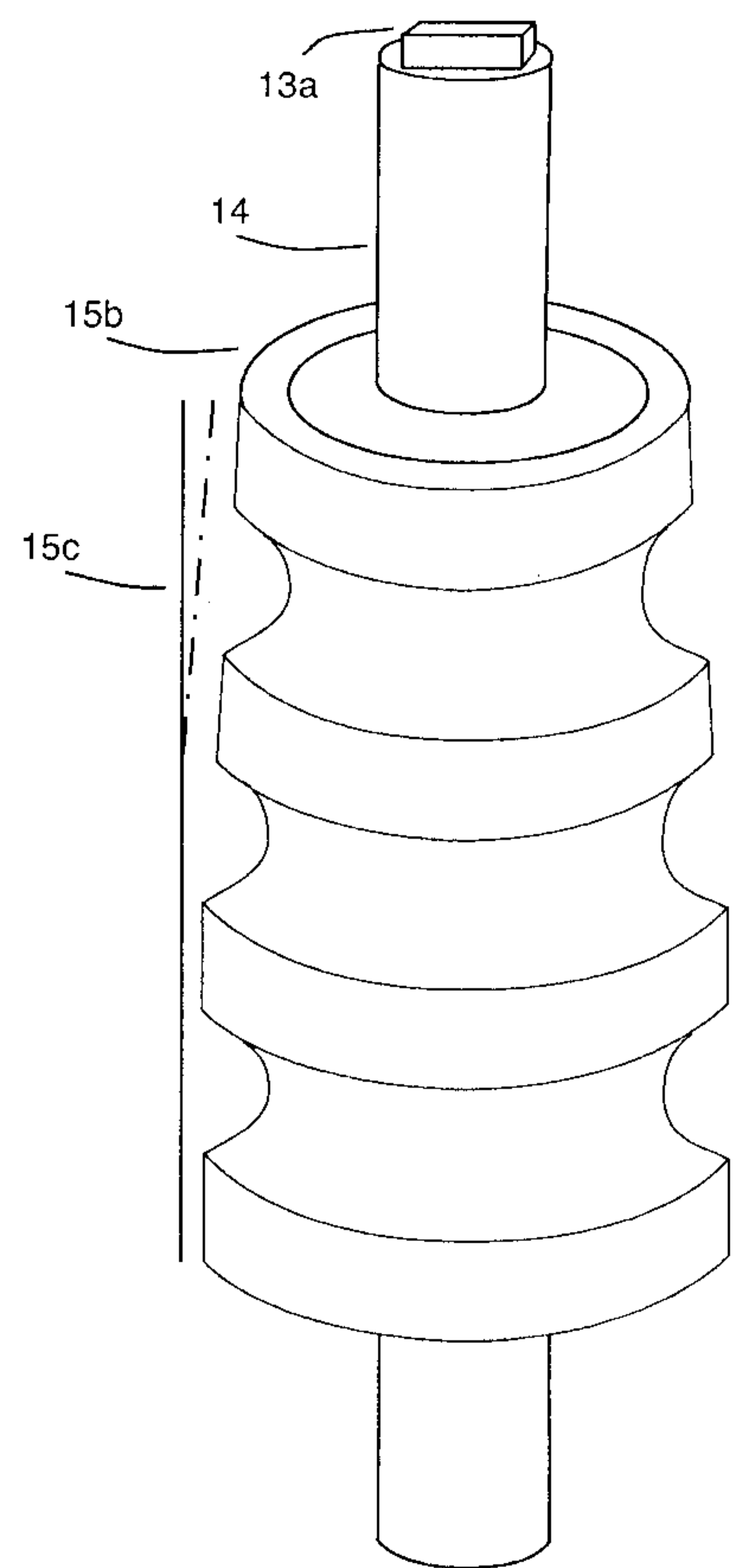


Fig. 8

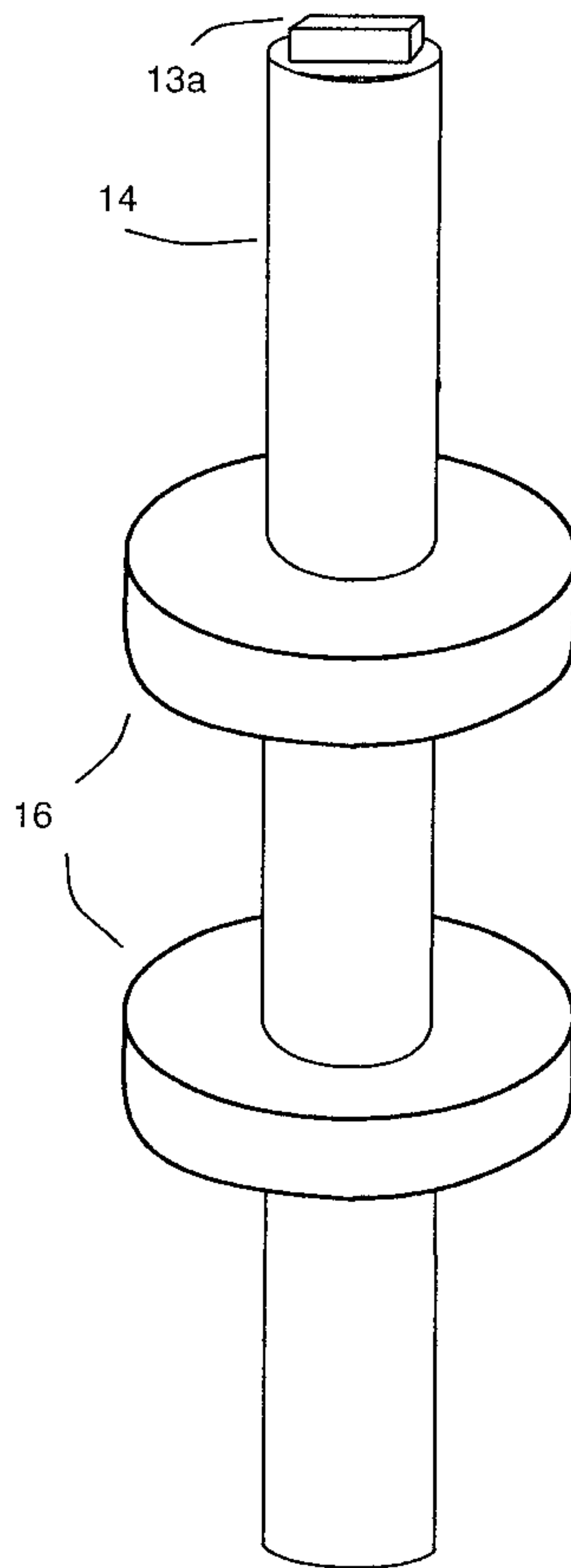


Fig. 9

Vertical Roller Mill With Combined Comminution
Actions And Interchangeable Modular Parts
Inventor - David J. Szego

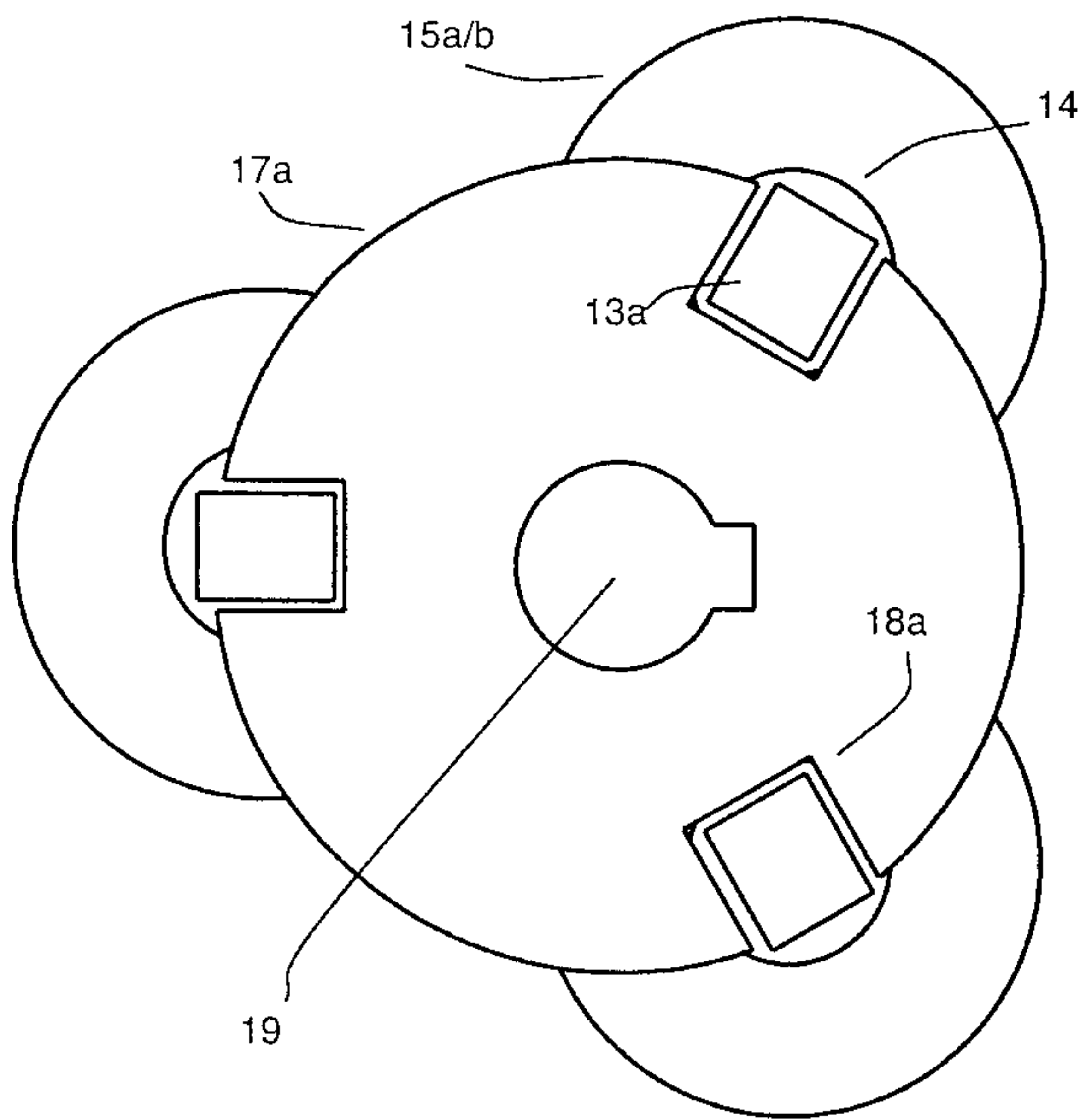


Fig. 10

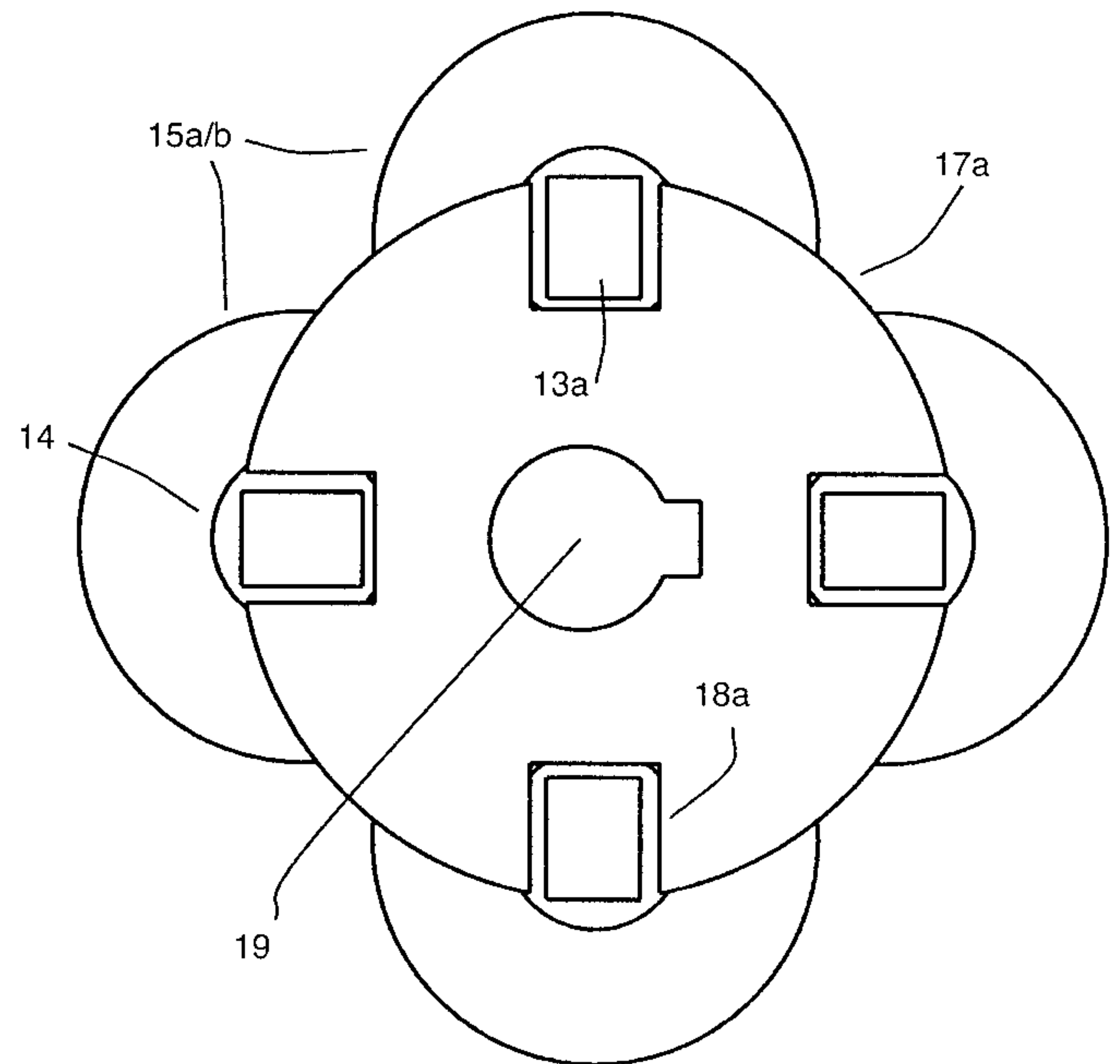


Fig. 11

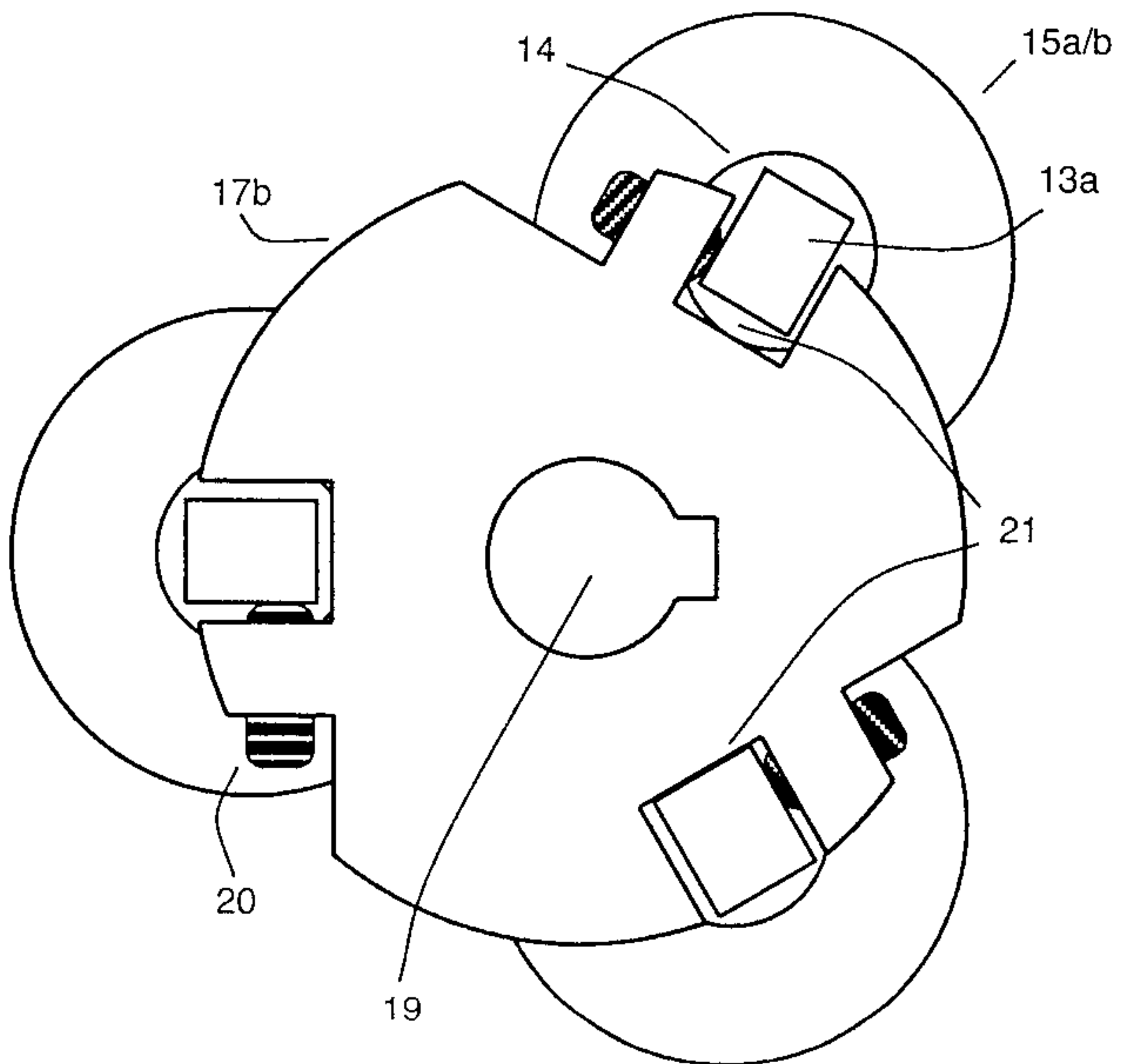


Fig. 12

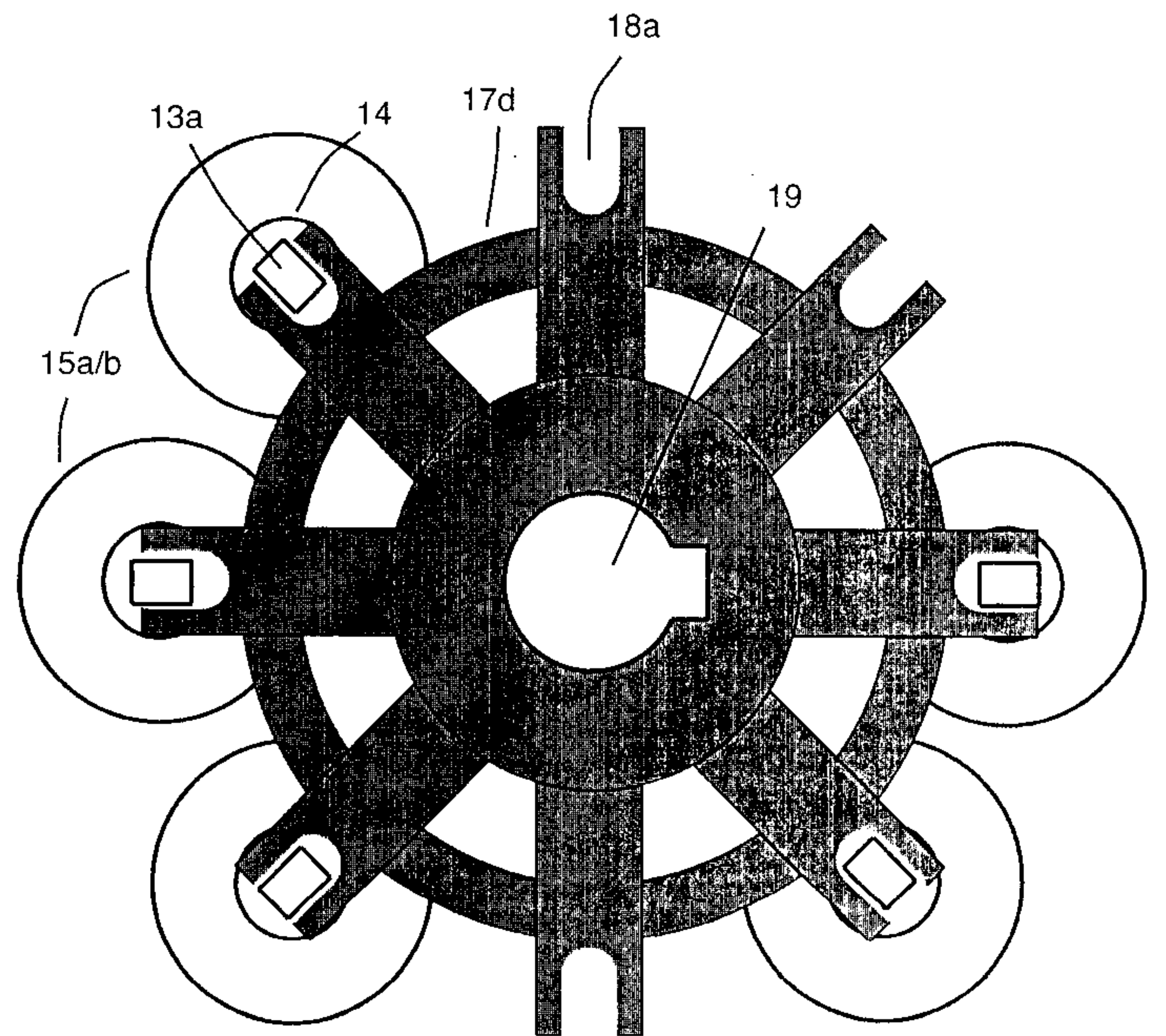


Fig. 14

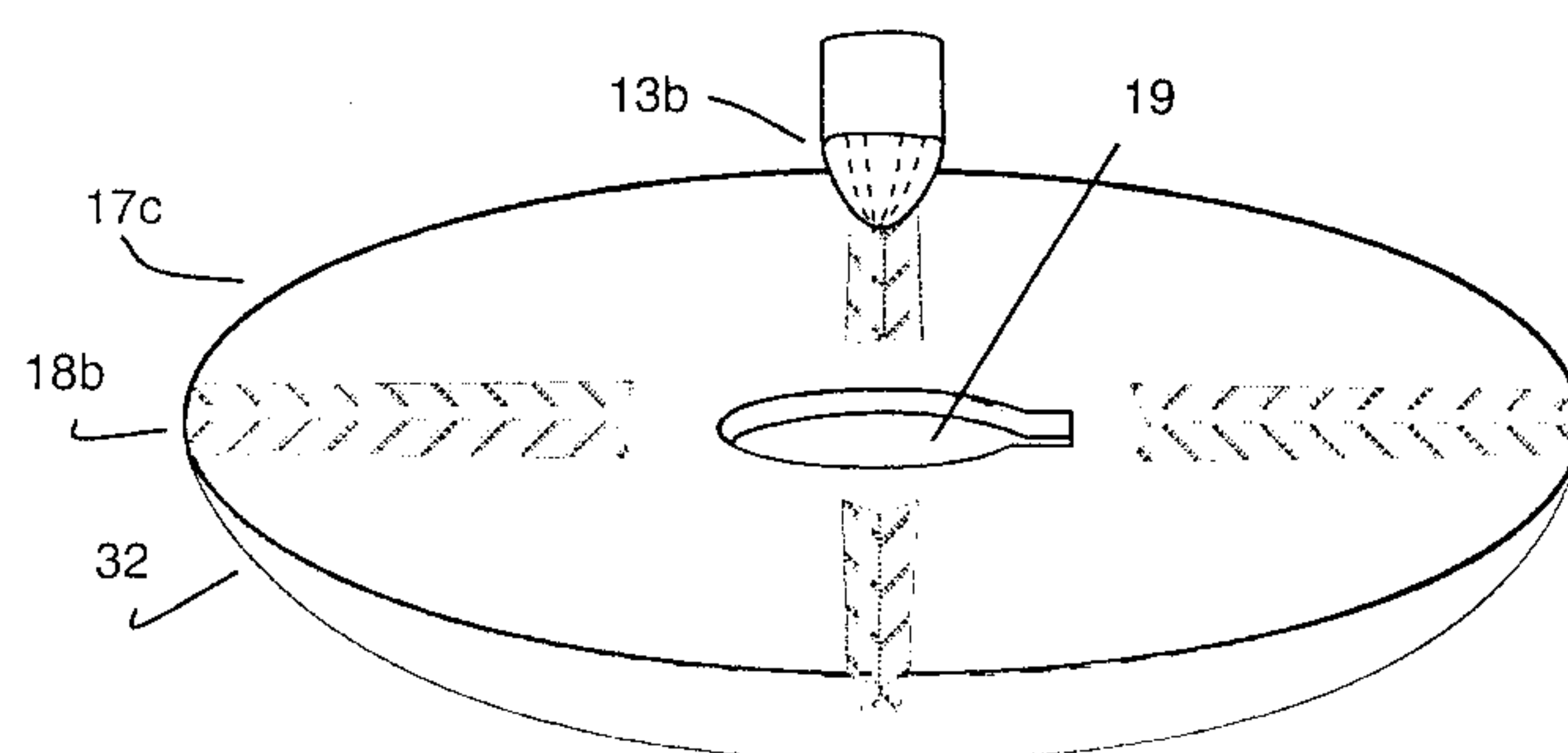


Fig. 13

Vertical Roller Mill With Combined Comminution
Actions And Interchangeable Modular Parts
Inventor - David J. Szego

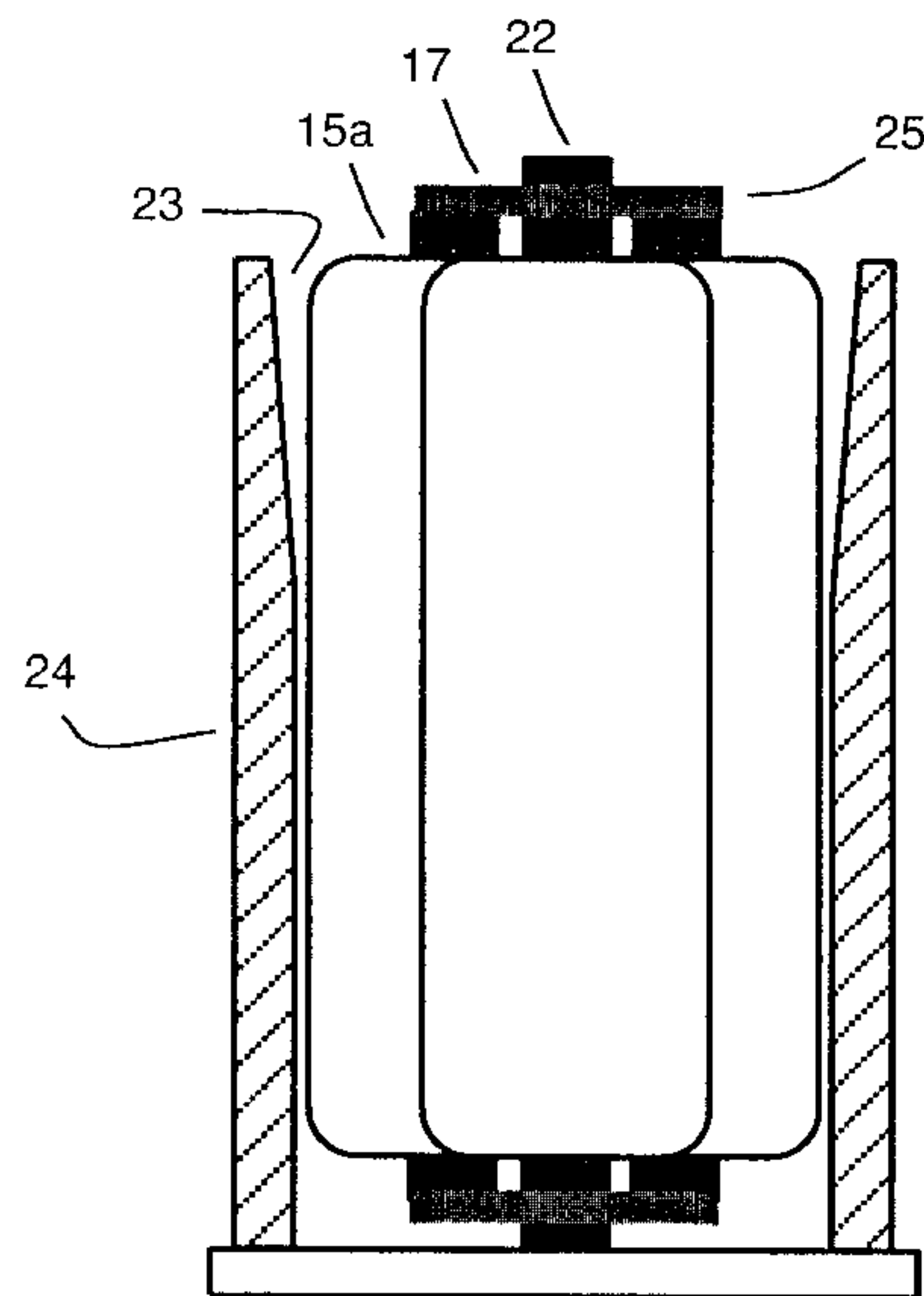


Fig. 15

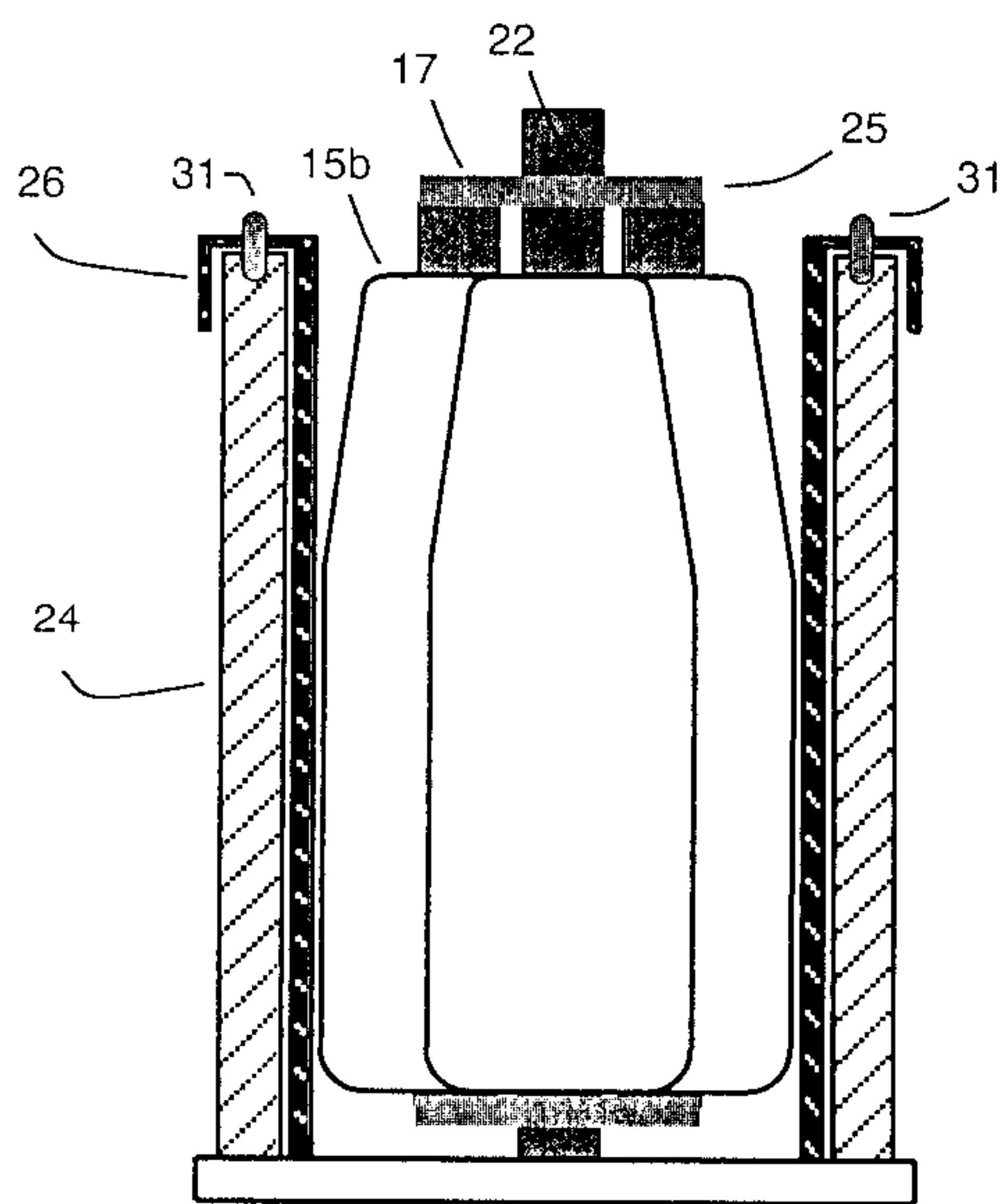


Fig. 16

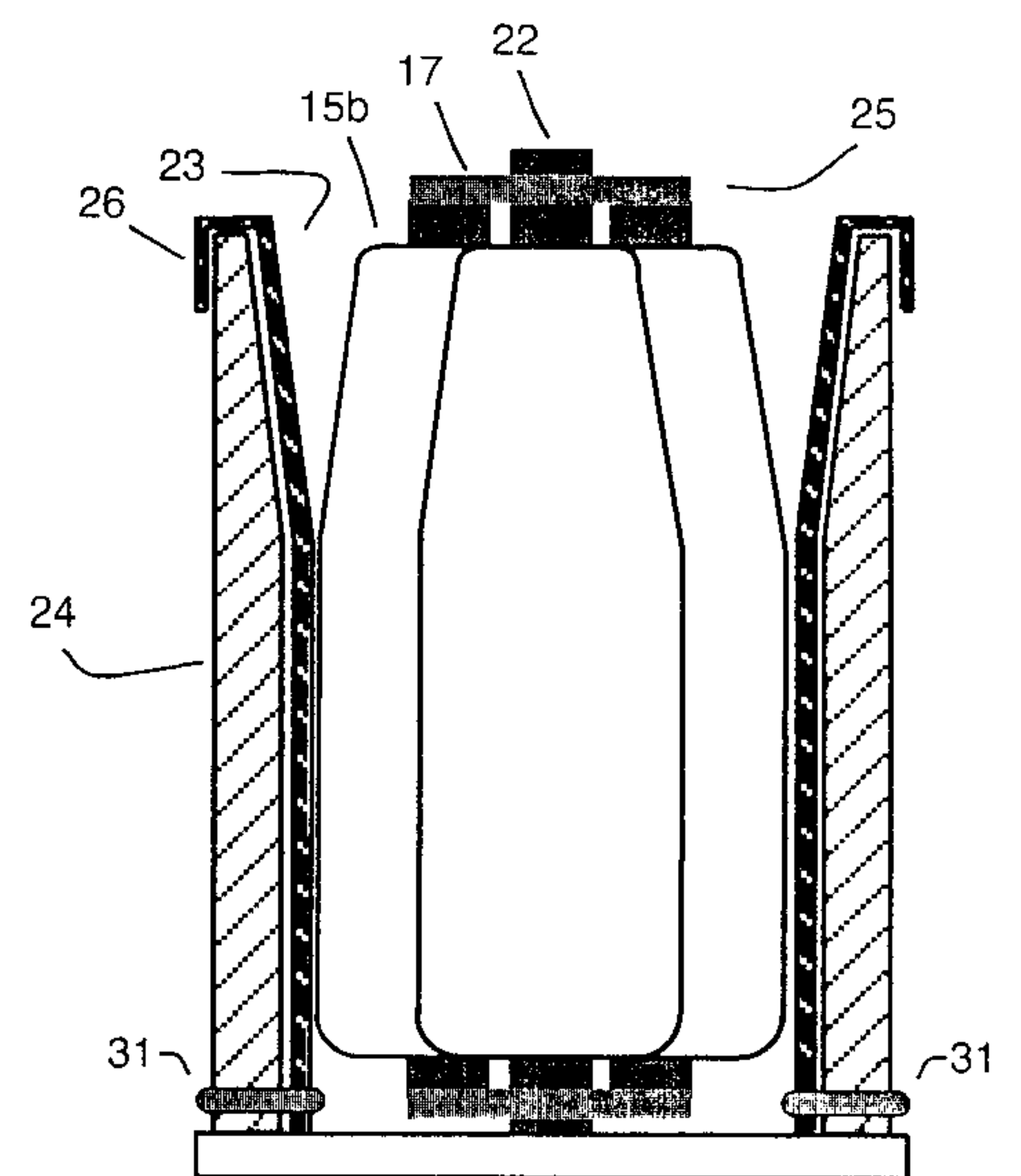


Fig. 17

Vertical Roller Mill With Combined Comminution
Actions And Interchangeable Modular Parts
Inventor - David J. Szego

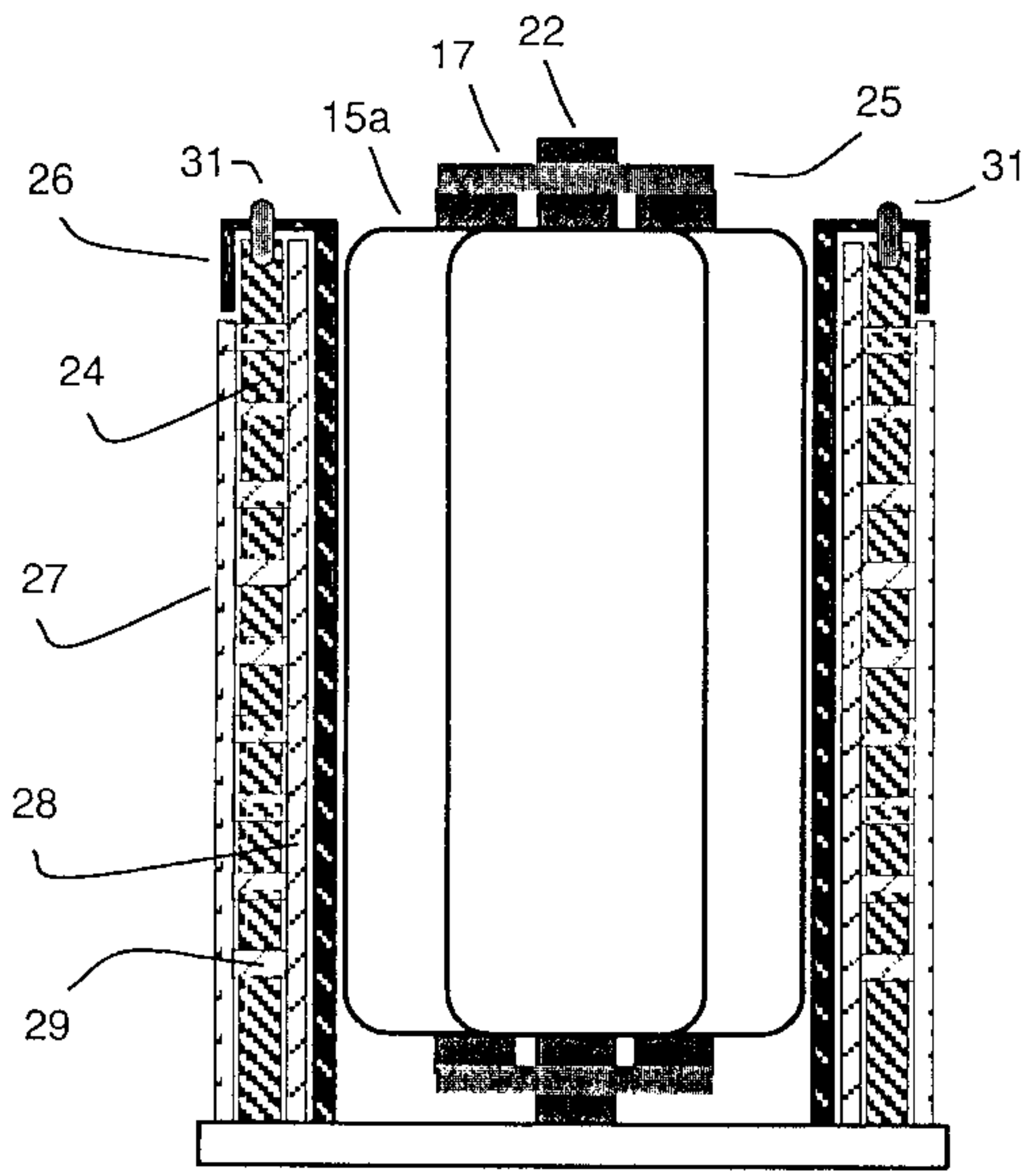


Fig. 18

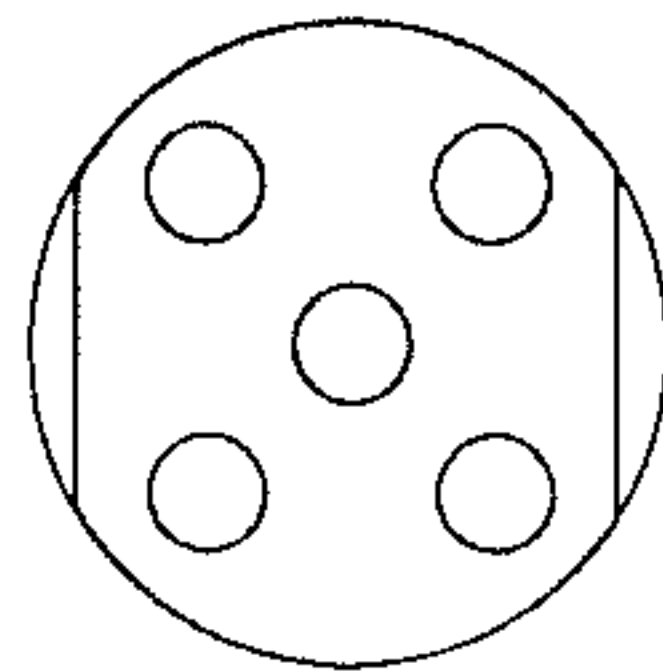


Fig. 19

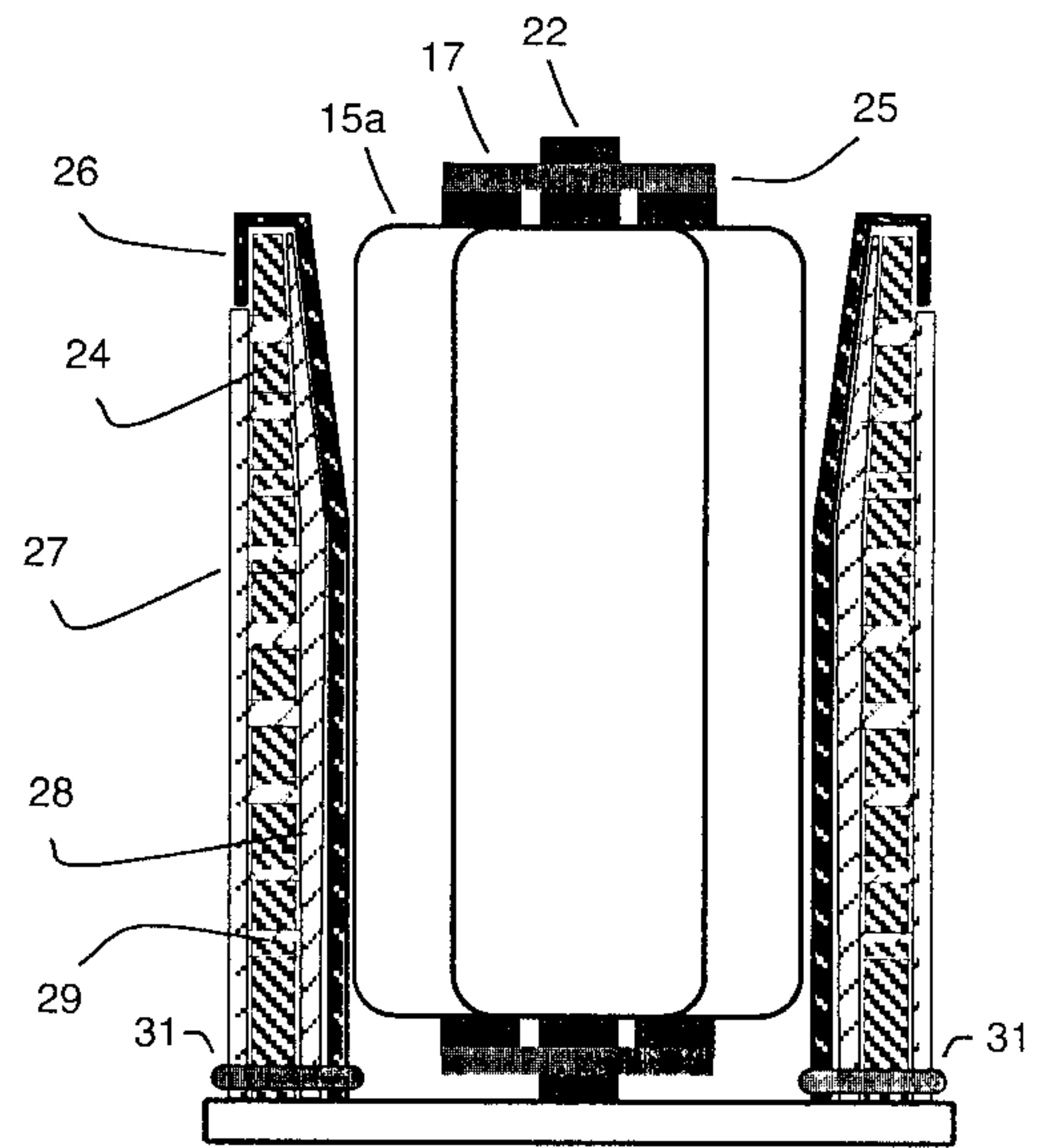


Fig. 20

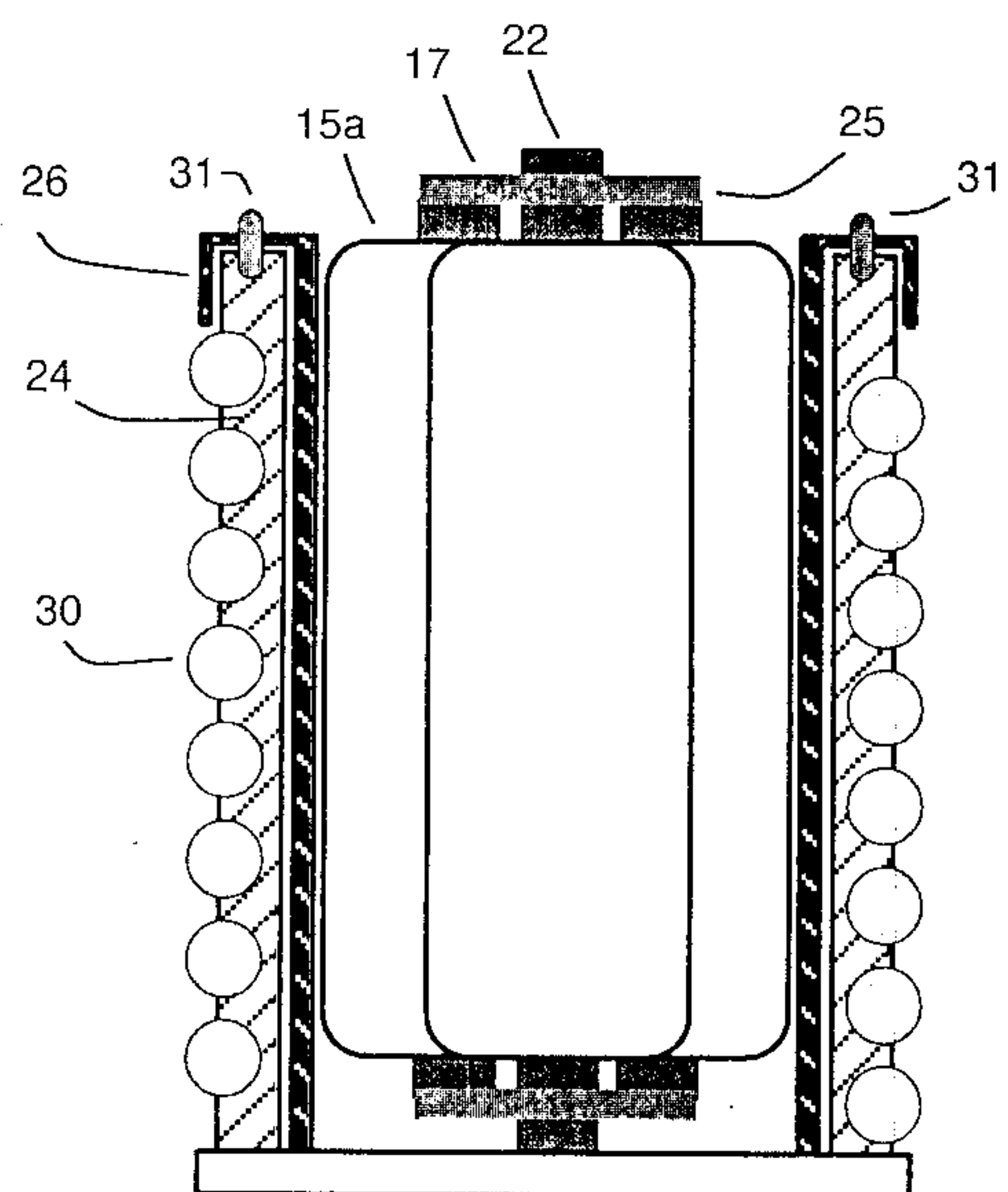


Fig. 21

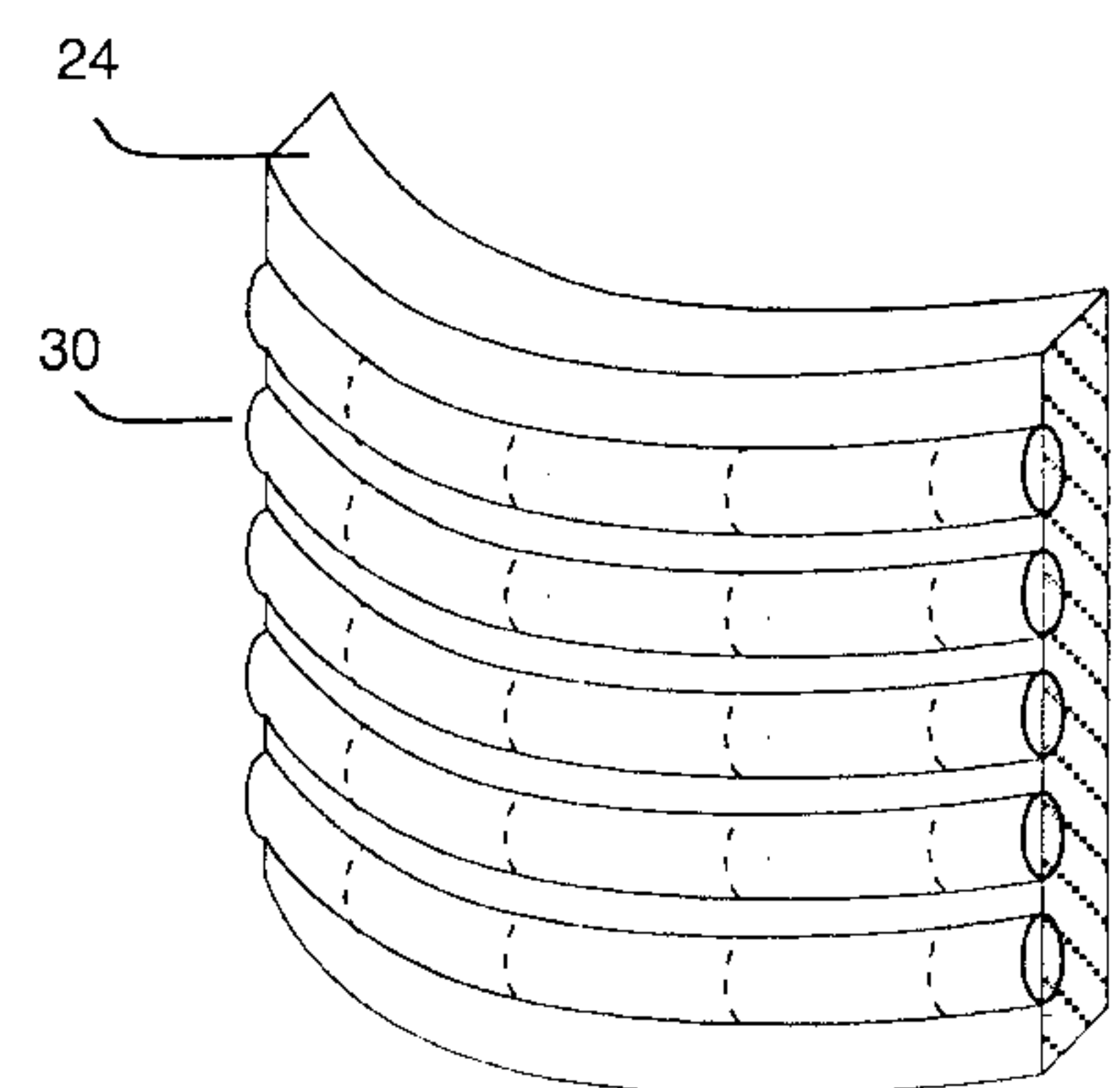
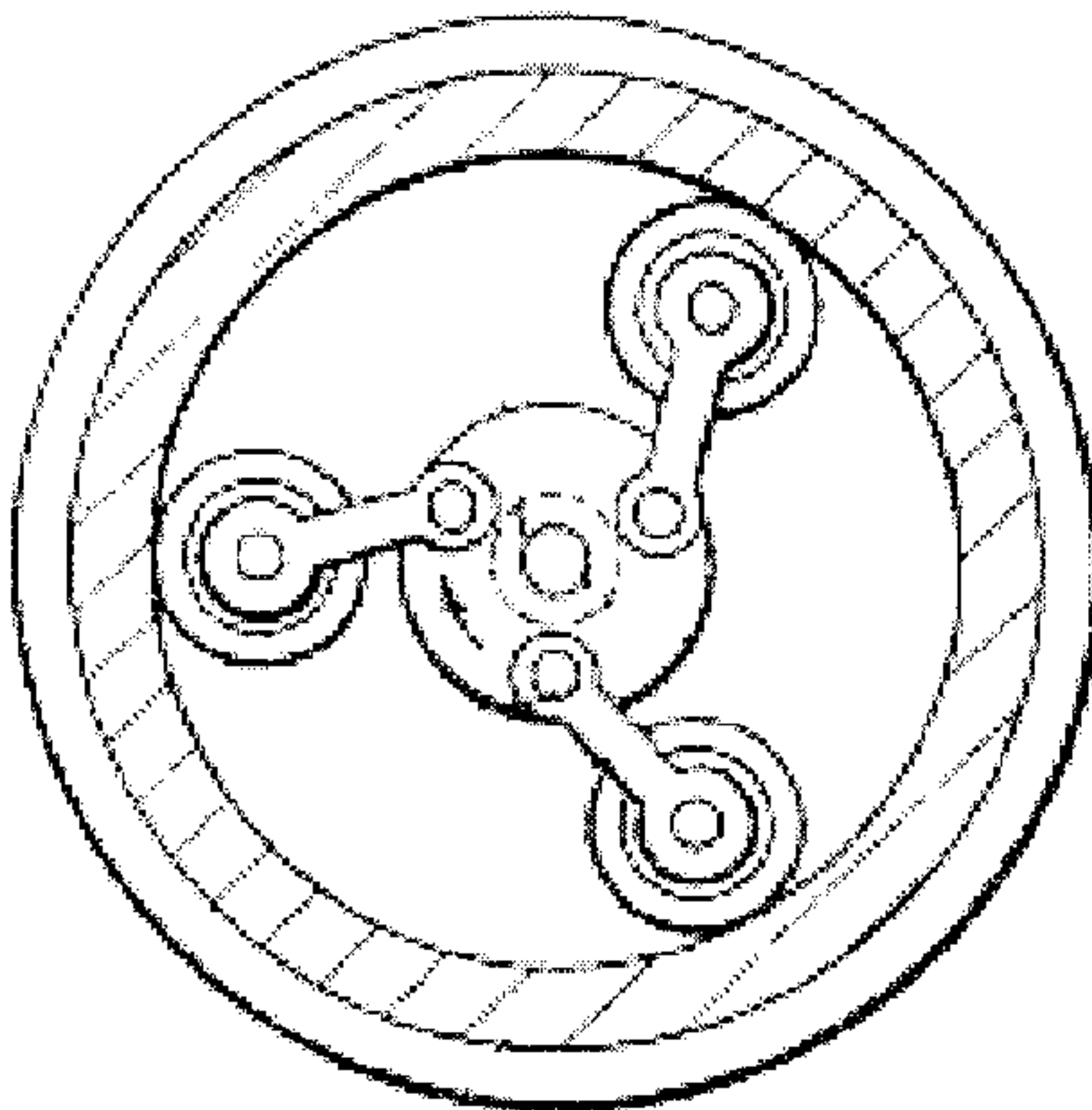


Fig. 22

Vertical Roller Mill With Combined Comminution
Actions And Interchangeable Modular Parts
Inventor - David J. Szego



(Ref) - Original Szego
Mill device, Canadian Patent
#974,956