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(71) Applicant: **CLIFFIELD INDUSTRIES LTD.**
Fo Tan, Shatin, New Territories (HK)

(72) Inventor: **TSANG, Koon Keung**
Fo Tan, Shatin New Territories.Hong Kong (CN)

(74) Representative: **Leale, Robin George**
Frank B. Dehn & Co.,European Patent Attorneys,
179 Queen Victoria Street
London EC4V 4EL (GB)

(54) Household appliance

(57) A household appliance of the type in which a cleaning, polishing, or massaging effect is obtained by a rotating head or tool is improved by splitting the cleaning, polishing, for massaging head or tool into concentric or parallel multiple heads or tools arranged for coaxial or side-by-side differential motion.

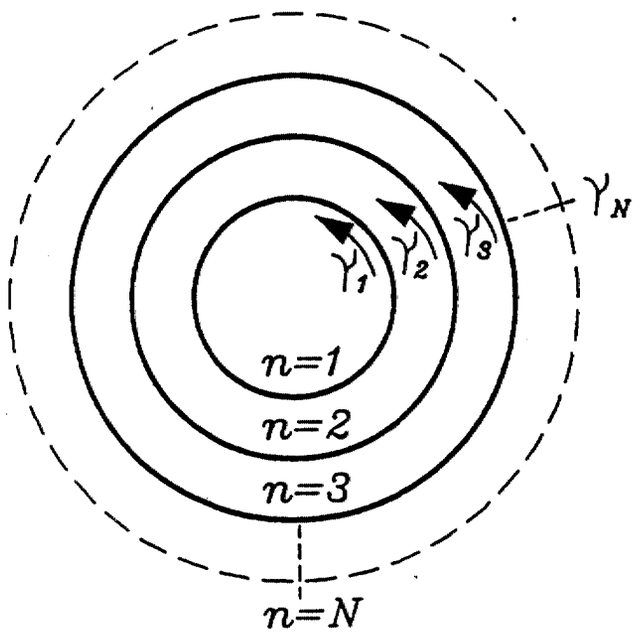

Fig. 1

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Description

[0001] This invention relates to a household appliance having rotating or reciprocating heads, such as a rotating or reciprocating cleaning brush, electric toothbrush, massager, or polisher.

[0002] The household appliances with which the present invention is concerned normally consist of a head or tool attached to directly to a shaft so as to rotate or oscillate therewith, in order to provide some sort of cleaning, brushing, polishing, or massaging effect.

[0003] While it would appear to be difficult to improve upon the brushing, cleaning, polishing, or massaging effect of these conventional household appliances, we have discovered that they have several disadvantages. These are (1) that any rotating device which is pressed against a surface to carry out its function will generate a counter-torque which increases with the power of the device, making the device difficult to handle, (2) when the surface is uneven, for example at a corner, the device will move erratically due to the lack of symmetry in the motion of the device, and therefore the torque keeps on changing, (3) in the case of a cleaning device, debris loosened by the cleaning device will tend to be pressed into the surface rather than removed, and (4) in the case of a brush having relatively long bristles arranged to extend into holes or crevices, for example if the bristles are longer than the circumference diameter of the outer ring of bristles, the bristles will tend to twist in one direction, thereby reducing the contact area of the bristles against surfaces of the hole or crevice.

[0004] The present invention is intended to increase the efficiency of such devices, by splitting the head or tool by which the function of the device is carried out into multiple heads or tools having a differential motion. This has the advantages of (1) offsetting or canceling out the counter-torque effect, thereby making the device easier to handle, (2) generally balancing the forces applied by the device to permit the device to be used on uneven surfaces, edges, and corners, (3) providing a cross- cleaning effect at the point where the different sections of the device move in different directions or at different speeds, and (4) reducing bristle twisting effect in the case of a brush having relatively long bristles.

[0005] The solution to the problem of counter-torque in a multiple head or tool device depends, as those skilled in the art might expect once the concept of multiple rotating heads or tools is understood, on the masses and angular velocities of the rotating heads or tools, with the counter-torque being minimized if the masses and velocities are such that the vector sum of the contributions from each of the individual heads or tools to the overall or net torque is zero. In addition, however, the inventor has found that the contact areas and materials of the contact surfaces of the various heads or tools, which contribute to the dynamic friction coefficients of the contact surfaces, also contribute significantly to the net torque, and must be taken into account in order to minimize the counter torque. Indeed, in many low speed applications, the contact area is the most influential factor, since the coefficient of friction is a constant in the operation speed range.

[0006] On the other hand, while elimination of counter-torque can be accomplished by any tool or head configuration in which the torques on individual heads or tools are caused to balance out or substantially add to zero, in the case of cleaning heads of tools such as brushes, cross-cleaning is most intense when adjacent heads are rotated such that the linear velocities (v) of respective points on relatively moving adjacent edges of the heads have equal magnitudes and opposite directions. This occurs when the "angular velocity" of each pair of adjacent counter-rotating heads has an equal magnitude (angular speed) and opposite direction, with the number of heads (and the width of the layers) determining the number of interfaces at which cross-cleaning effects are most intense.

[0007] Figures 1-1 and 1-2 of the accompanying drawings illustrate the relationship between "linear speed" and radius in a two layer counter-rotating brush assembly in which the counter-rotating brushes have the same angular speeds, while Figures 1-3 and 1-4 illustrate the relationship between "linear speed" and radius in a four layer counter-rotating brush assembly, and Figures 1-5 and 1-8 illustrate the relationship in an eight layer assembly. As is apparent from these Figures, the linear speed, which is the relative instantaneous speed between a bristle and the portion of the surface which is being contacted by the bristle; increases linearly across each of the brush heads while at the interface between brush heads, the linear speed of respectively adjacent bristles on the heads is exactly the same but opposite in direction.

[0008] Because cross-cleaning occurs between adjacent heads, improved cross-cleaning is obtained with each head added. In addition, as the number of heads increases, and the torque variations across the radii of the heads decreases, the balancing effect also improves, with perfect balance being achieved in theory by an infinite number of heads with infinitesimally small differences in radii across the heads (referred to as the infinitesimal balancing effect). While cost of construction will eventually limit the number of heads, the invention in theory enables cross-cleaning and balancing to be made as close to optimum as desired by increasing the number of heads.

[0009] It is known, of course, to provide small appliances such as electric toothbrushes with multiple heads or tools mounted on parallel shafts to rotate in opposite directions. While such appliances are in widespread usage, however, the use of completely separate heads or tools mounted on separate shafts does not optimize the cleaning to any significant degree, but rather simply increases the coverage of the device in order to reduce cleaning time.

[0010] In contrast, the present invention seeks to split a single tool or head into multiple heads or tools with differential movement, not in order to increase the area cover during one pass of the device, but to provide a variety of performance improvements, including increasing the intensity of the effect provided by the multiple heads in comparison with a conventional rotating or reciprocating device of like area.

[0011] The splitting of a single head or tool into concentric or parallel multiple heads or tools arranged for coaxial rotation or side-by-side oscillation according to the present invention not only solves the above-mentioned problems of conventional devices, but also does so without significantly increasing the complexity of the device, since according to preferred embodiments of the invention, a single drive shaft can be used (although the use of a single drive shaft is not necessary to the invention in its broadest form, since the advantages of easier handling and improved cleaning do not depend on the specific mechanical arrangement used to achieve the differential rotation effect).

[0012] The advantage of eliminating counter-torque increases with the power of the device. If an operator presses a small conventional rotating brush against a surface, his hands need to generate a counter torque opposite to the direction of rotation of the brush. If the counter torque is small the operator may hardly notice it. As power increases, however, a point is eventually reached where it will become impossible to hold the brush. By bifurcating the brush motion into two oppositely rotating sections, the problem of counter-torque will clearly be minimized even for very high power devices which could not ordinarily be handled by the average user. The balancing problem is especially apparent in devices intended to be used on uneven surfaces, such as a car polisher, where the counter torque changes from time to time, and also in devices such as floor buffers which have an odd number of heads, and therefore an inherently unbalanced torque.

[0013] The cross-cleaning advantage applies even in the case of ordinary linearly reciprocating electric toothbrushes, which one would expect to remove dirt effectively despite the lack of differential motion due to the reversal of motion at the ends of the oscillations. The problem is that either the amplitude of the oscillations is so small that the cleaning tip of the soft bristles will remain relatively stationary even as the brush head moves, or the amplitude will be sufficiently large that the brush head will have moved to another surface before it reverses direction, greatly reducing the cross-cleaning effect provided by the reversal of motion at the end of the oscillations.

[0014] According to the present invention there is provided a household appliance including a rotating head divided into a plurality of coaxially rotatable members having respective contact areas for contacting a surface, and further comprising means for driving at least two of said members at mutually different velocities, said velocities and contact areas of said coaxially rotatable members being selected such that the torques resulting from rotation of said members are substantially balanced, whereby to substantially balance said appliance.

[0015] When we say in this specification that the torques resulting from rotation of the said members are substantially balanced, we mean that, in particular, the contact areas of the respective members have been taken into account in order to balance the torques. The said torques are of course dependent on the friction between the members and a surface to which they are applied in use, and it has generally been believed that the amount of such friction between two bodies is independent of the apparent area of contact between them. Surprisingly, however, we have found that this is not true and that the forces of friction, and thereby the torques produced in the context of the present invention, depend to a large extent on the areas of contact between the respective members and a surface to which they are applied. Consequently, when we say in the appended claims that, inter alia, the contact areas of the members are selected such that the torques are balanced, we mean that the said contact areas are such as result from calculations of the kind which now follow and which, in the particular case of two concentrically arranged brushes made of the same material and arranged to rotate in opposite directions, result in the outside radius of the inner brush being approximately 0.8 times the outside radius of the outer brush.

[0016] Given a circular ring of radius R and very small thickness dR, the surface area of such a ring is given by:

$$(2\pi R)\,(dR)$$

[0017] Take now the case of two concentrically arranged brushes made of the same material and rotating in opposite directions, the outside radius of the inner brush being a and the outside radius of the outer brush being b, and the coefficient of friction between the brushes and the surface to which they are applied being μ. Assuming that the total normal force acting on these brushes is F, then the normal force acting on the aforementioned ring of very small thickness is:

$$\left[\frac{2\pi R)(dR)}{\pi b^2}\right] * F$$

where πb^2 is the total contact area of the two brushes.

[0018] The frictional torque of this ring of radius R is:

$$\mu * \left[\frac{2\pi R)(dR)}{\pi b^2}\right] * F * R$$

[0019] So, for the inner brush, the total frictional torque is obtainable by integration:

$$\int_o^a \frac{\mu F(2\pi R)R}{\pi b^2}\, dR$$

$$= \frac{2F\mu}{b^2} \int_o^a R^2 DR$$

$$= \frac{2F\mu}{3b^2} [R^3]_o^a$$

$$= \frac{2a^3 F\mu}{3b^2} \quad \ldots\ldots\ldots (1)$$

[0020] Similarly, for the outer brush, the total frictional torgue is:

$$\int_a^b \frac{\mu F(2\pi R)R}{\pi b^2}\, dR$$

$$= \frac{2F\mu}{b^2} \int_a^b R^2\, dR$$

$$= \frac{2F\mu}{3b^2} [R^3]_a^b$$

$$= \frac{2F\mu}{3b^2} [b - a^3]$$

$$= \frac{2Fb\mu}{3} - \frac{2Fa^3\mu}{3b^2} \quad \ldots\ldots\ldots (2)$$

[0021] Therefore, to balance the frictional torques due to the respective brushes:

(1) = (2), i.e.

$$\frac{2a^3 F\mu}{3b^2} = \frac{2Fb\mu}{3} - \frac{2F\alpha^3\mu}{3b^2}$$

$$\frac{4a^3F\mu}{3b^2} = \frac{2Fb\mu}{3}$$

$$2a^3 = b^3$$

$$a^3 = \tfrac{1}{2}b^3$$

$$a = \frac{1}{(2)^{1/3}}b$$

$$a = \textit{approximately } 0.8b$$

[0022] A similar method may be used to calculate the contact areas of three concentric brushes in an apparatus where the outside radius of the inner brush is a, the outside radius of the middle brush is b and the outside radius of the outer brush is c, with the middle brush rotating in the opposite direction to the inner and outer brushes, and all of the brushes having the same coefficient of friction with respect to a given surface, i.e. being made of the same material. Then the frictional torque of the inner brush is:

$$\int_o^a \frac{\mu F(2\pi R)R}{\pi c^2}\, dR$$

$$= \frac{2F\mu}{3c^2}(a^3) \quad \ldots\ldots\ldots (1)$$

The frictional torque of the middle brush is:

$$\int_a^b \frac{\mu F(2\pi R)R}{\pi c^2}\, dR$$

$$= \frac{2F\mu}{3c^2}(b^3 - a^3) \quad \ldots\ldots\ldots (2)$$

The frictional torque of the outer brush is:

$$\int_b^c \frac{\mu F(2\pi R)R}{\pi c^2}\, dR$$

$$= \frac{2F\mu}{3c^2}[c^3 - b^3) \quad \ldots\ldots\ldots (3)$$

For the torques to cancel out:

$$(1) + (3) = (2)$$

$$\left[\frac{2F\mu}{3c^2}(a^3)\right] + \left[\frac{2F\mu}{3c^2}(c^3 - b^3)\right] = \left[\frac{2F\mu}{3c^2}(b^3 - a^3)\right]$$

$$a^3 + (c^3 - b^3) = b^3 - a^3$$

$$b^3 = \tfrac{1}{2}(c^3 + 2a^3) \quad \ldots\ldots\ldots (4)$$

Thus, for an apparatus in which, say, a = ½c:

$$b = [\tfrac{1}{2}c^3(1 - 2 * 0.5^3)]^{1/3}$$

$$= 0.855c$$

[0023] Extending the above calculation to an apparatus having n concentric brushes, where R_i is the outside radius of the *i*th layer of the brush and R_{i-1} is the inner radius of the *i*th layer (the *i*th layer rotating in either direction), and again assuming that all of the layers have the same coefficient of friction, the equation of balanced torque is:

$$\sum_{i=1}^{i=n} (R_i^3 - R_{i-1}^3) = 0$$

[0024] Finally, consider a general equation for an n-layered brush, each layer with its own characteristic coefficient of friction. (For example, the coefficients of friction of the layers may vary as a function of their linear speeds of rotation, i.e. relative to radius). The coefficient of friction of the *i*th layer as a function of R is $f_i(R)$. The frictional torque of the *i*th layer is:

$$\int_{R_{i-1}}^{R_i} Normal\ Force * Coefficient\ of\ Friction$$

$$= \int_{R_{i-1}}^{R_i} \frac{F}{\pi R_n^2} * 2\pi R\,dR * R * f_i(R)$$

$$= \frac{2F}{R_n^2} \int_{R_{i-1}}^{R_i} R^2 f_i(R)\,dR$$

[0025] Then, the equation of balanced torque is:

$$\sum_{i=1}^{i=n} \int_{R_{i-1}}^{R_i} R^2 f_i(R)dR = O$$

[0026] The above described method of selecting the surface areas of the brushes of an apparatus according to the invention is that referred to in the appended claims as being "hereinbefore described".

[0027] Some embodiments of the invention will now be described by way of example and with reference to the accompanying drawings, in which:-

Figure 1 is a schematic diagram illustrating the principles of a household appliance having a tool or head made up of coaxial differentially rotatable assemblies according to a first embodiment of the invention;
Figures 1-1 to 1-6 are schematic diagrams illustrating further principles of the invention;
Figure 2 is a cross-sectional side view of a cleaning brush design constructed in accordance with the principles of a first embodiment of the invention;
Figure 2-1 is a cross-sectional side view of a variation of the brush design illustrated in Figure 2;
Figure 2-2 is a side view of the brush design illustrated in Figure 2-1;
Figure 2-3 is a cross-sectional side view of a variation of the brush design illustrated in Figures 2-1 and 2-2;
Figure 2-4 is a bottom view of the brush design variation illustrated in Figure 2-3;
Figure 3 is an end view of the cleaning brush design of Figure 2;
Figure 4 is a cross-sectional side view of a counter-rotating toothbrush head design constructed in accordance with the principles of the first embodiment of the invention;
Figures 5, 5-1, and 5-2 are perspective views of variations of the counter-rotating toothbrush head design illustrated in Figure 4;
Figures 5-3 and 5-4 are respective top views of the toothbrush designs illustrated in Figures 5-1 and 5-2;
Figure 6 is a cross-sectional side view of a three-dimensional variation of the cleaning brush design of Figures 2 and 3;
Figure 7 is a perspective view of a counter-rotating car polisher design constructed in accordance with the principles of the first embodiment of the invention;
Figure 8 is a perspective view of a counter-rotating floor polisher design constructed in accordance with the principles of the first embodiment of the invention;
Figure 9 is a perspective view of a counter-rotating shoe polisher design constructed in accordance with the principles of the first embodiment of the invention;
Figure 10 is a perspective view of a counter-rotating handheld massager design constructed in accordance with the principles of the first embodiment of the invention;
Figure 11 is perspective view illustrating an arrangement for providing linear movement at different velocities of a plurality of tools or heads arranged in side-by-side fashion according to a second embodiment of the invention;
Figure 12 is a perspective view illustrating an application of the design of Figure 11 to a brush;
Figure 13 is a perspective view of a shoe or cleaning brush arranged according to the principles illustrated in Figures 11 and 12;
Figure 14 is a perspective view of massager arranged according to the principles illustrated in Figures 11 and 12;
Figure 15 is a perspective view illustrating an arrangement for providing linear movement in opposite directions of a plurality of tools or heads arranged in side-by-side fashion according to another embodiment of the invention;
Figure 16 is a perspective view of a counter-reciprocating shoe brush arranged according to the principles illustrated in Figure 15;
Figure 17 is a perspective view of a counter-reciprocating massager arranged according to the principles illustrated in Figure 15;
Figure 18 is a plan view showing a variation of the preferred counter-rotating device having multiple counter-rotation heads;
Figure 19 is a cross-sectional view of a counter-rotating device having multiple drive shafts;
Figure 20 is a cross-sectional view of a fingernail cleaner which illustrates further principles of the invention;
Figures 20-1 and 20-2 are cross-sectional views showing the manner in which the cleaner of Figure 20 is utilized;
Figure 20-3 is a plan view of the cleaner of Figure 20;
Figure 21 is a perspective view illustrating the effect of twisting in the case of brushes having relatively long bristles; and
Figure 22 is a perspective view illustrating the effect of counter-rotation on the type of brush shown in Figure 21.

[0028] As illustrated in Figure 1, the first embodiment of the invention provides an appliance having a rotating. head or tool made up of concentric rotating discs and annular members each capable of rotating at a speed Vn where n=1,2,3,4,...,N. The speed Vn can be positive, negative (i.e., the reverse direction of positive), or zero (i.e., stationary). In most of the illustrated applications of this embodiment of the invention, except for the embodiment shown in Figure 5, n=2, V1=+ve, and V2=-ve, but it will be appreciated by those skilled in the art that n, V1, and V2 may be varied depending on the application, and the degree to which the various advantages of the invention are to be achieved.

[0029] In particular, for devices in which counter-torque is to be minimized by balancing the torques on individual rotating assemblies, so that vector sum of the torques is approximately zero, the number of assemblies or sections and the speeds and directions of individual assemblies or sections may be freely varied so long as the sum of the torques for all of the assemblies approaches the desired level. Since the torques on individual assemblies or sections depends also on the contact areas and materials of the contact surfaces, these factors must be taken into account when selecting the speeds and directions of the individual assemblies.

[0030] On the other hand, in the case of a cleaning device, where the cross-cleaning effect of counter-rotating devices is to be maximized, the preferred configuration is as discussed above to rotate adjacent assemblies in opposite directions at substantially the same angular speed, so that the linear speed at the boundaries between assemblies is approximately the same, and to increase the number of assemblies with the overall diameter or area of the contact surface to maximize the number or locations at which cross-cleaning can occur. In addition, where the assemblies are all rotating in opposite directions at generally the same speed, balancing will be improved for larger diameter contact surfaces if the number of assemblies or sections is increased, i.e., if the number "n" of layers is increased.

[0031] Thus, within the scope of the invention, the appliance may have a head or tool split into three or more assemblies or sections which all rotate coaxially but at different speeds and in the same or different directions. In addition, the directions of any individual assembly may be reversed periodically by an electrical or mechanical switching arrangement so that rather than rotating continuously, the individual assemblies may rotate back and forth, and by extending the principles of the first embodiment to "rotating" assemblies in which the radius is infinitely large, one can provide individual assemblies which move linearly in either different directions or at different velocities, as generally illustrated in Figures 11 and 15, discussed in more detail below.

[0032] Figures 2, 2-1, and 3 show a first example of the above principles, in which the household appliance having a rotating head is a cleaning brush 1. In these examples, the power input is provided by a rotating shaft 2 or equivalent rotating shaft 151 driven by a motor (not shown). Those skilled in the art will appreciate that any motor can be used, and that details of the motor form no part of the invention.

[0033] Referring specifically to the variation shown in Figure 2, shaft 2 is supported by appropriate bearings in a housing 3, to which is affixed bearing members 4-7, bearing member 4 being preferably affixed to housing 3 by an additional sleeve 6'. Both shaft 2 and an outer bristle supporting member 8 are rotatable relative to bearing members 4-7.

[0034] The brush assembly of the counter-rotatable cleaning brush of this variation of the first embodiment of the invention includes an inner circular bristle 9 and an outer annular bristle assembly 10 arranged to rotate in opposite directions and supported, respectively, by cylindrical support member 11 and the above-mentioned support member 8. Support member 11 is preferably directly affixed to and rotated by shaft 2, while the counter-rotation effect for support member 8 and the second bristle assembly 10 is provided by a planetary gear system made up of a drive gear 12 affixed to the motor shaft 2, a ring gear 13 affixed to support member 8, and at least one idler gear 14 rotatable about a pin 15 secured to the bearing members 4-6 so as to prevent the idler gears 14 from revolving around the drive gear 12.

[0035] As a result of this structure, a brush is provided in which the outside bristles rotate in a direction opposite that of the inside bristles, thus providing an improved brushing effect without the need for a second motor or additional main shaft, or for significant modifications of the existing motor, drive shaft, and housing structure (although the improved brushing effect could also be achieved even if a second motor and/or shaft are provided). The only additions to the conventional structure which are required are a ring gear, idler gears, a drive gear on the shaft, and an additional support member for the outer bristle assembly.

[0036] In an especially efficient variation of the structure shown in Figure 2, as illustrated in Figure 2-1, the single ring and idler gear mechanism is replaced by a double ring gear mechanism made up of a first ring gear 150 driven by and secured to motor-driven shaft 151 to rotate therewith, at least one pinion 152, 153 rotatably connected to reversing brush module housing 154 by a pin 155,156 and bushing 157,158 and in engagement with first ring gear 150 to rotate in response to rotation of the first ring gear, and a second ring gear 159 rotatable relative to shaft 151 in a direction opposite the direction of rotation of the first ring gear 150 in response to rotation of the at least one pinion 155,156.

[0037] Because the inner and outer assemblies in this variation of the first embodiment rotate in opposite directions at the same speed, the cross cleaning effect is optimized. Further, balancing is easily achieved by appropriate selection of the contact areas of the respective assemblies, taking into account the coefficients of the assemblies if the materials of the bristles between the inner and outer bristles is different, while both balancing and cross-cleaning can be improved, in this and the other variations of the illustrated embodiment, by increasing the number of rotating assemblies, i.e., by using a larger number n of layers.

[0038] In this variation of the first embodiment, the inner brush head 160 is affixed to the first ring gear 150 by means of a locking screw 161, with the first ring gear and inner brush head forming a bearing surface 162 for permitting counter-rotation relative to the second ring gear 159. In addition, the second ring gear is affixed to outer brush head 163 by, for example, location pins 164. As a result, the inner brush head 160 rotates with shaft 151 and outer brush head 163 rotates in an opposite direction relative to the shaft to obtain a counter-rotation effect for the respective inner

bristles 165 and outer bristles 165'.

[0039] Attachment of the counter-rotating brush assembly to the motor unit is achieved by a sleeve 166 having latch arms 167 arranged to be inserted into and engage a central opening in a main housing 168 that contains the motor and gear trains required to drive shaft 151, thereby securing the brush assembly to the main housing as the shaft 151 is inserted or snapped into a bushing provided in the first ring gear 150.

[0040] In this design, sleeve 166 extends to form a cover for the brush head, with the cover portion 166' including openings for receiving locating splines 169 for orienting the brush head module thus formed with the main housing 168, resulting in a particularly convenient modular design which permits the brush head assembly to be easily removed for replacement or cleaning, as illustrated in Figure 2-2. Of course, the modular design illustrated in Figure 2-2 can be used with gear arrangements other than that shown in Figure 2-1, including the gear arrangement shown in Figure 2, as well as in other types of brushes employing the counter-rotation principles of the invention, and also in connection with the generalized form of the present invention in which there are n members and adjacent members rotate at different speeds and/or directions, as described above in connection with Figure 1.

[0041] Figures 2-3 and 2-4 show a variation of the design shown in Figures 2-1 and 2-2, in which the number of brush heads is increased from two to four. Instead of the double ring gear mechanism of the embodiment shown in Figures 2-1 and 2-2, the mechanism of this embodiment is made up of first ring gear 250 driven by and secured to motor-driven shaft 251 to rotate therewith, idle gears 252-254 mounted for rotation by means of pins 256 secured in bushings 257 in the brush module housing 258 and engaged with respective brush units 259-262 such that idle gears 252 are rotated by ring gear 250, causing brush unit 260 to rotate at the same angular speed in an opposite direction to the direction of rotation of the ring gear, the rotation of brush unit 260 causing rotation of idle gears 253 and counter-rotation of brush unit 261, the counter-rotation of brush unit 261 causing rotation of idle gears 254 and rotation of brush unit 262. The first or inner brush unit 259 is directly connected to shaft 251 such that each adjacent brush unit rotates at the same angular speed and opposite direction.

[0042] Because the adjacent brush units in this embodiment rotate in opposite directions at the same speed, the cross cleaning effect is again obtained. Further, by increasing the number of brush units, balancing and cross-cleaning are improved according to the principles discussed above.

[0043] In this variation of the preferred embodiment, the inner brush unit 259 is affixed to ring gear 250 by means of a locking screw 264, with the inner brush unit including a bearing surface 265 for permitting relative rotation of the second brush unit 260, the second brush unit including a bearing surface 266 for the third brush unit 261, and the third brush unit including a bearing surface 267 for the fourth brush unit 262. Preferably, each of the brush units can be snap fit into the brush module housing 258.

[0044] Attachment of the brush module housing 258 to the motor unit may be achieved, in a manner similar to the embodiment of Figures 2-1 and 2-2, by a member 267 having latch arms 268 arranged to be inserted into and engage a central opening in a main housing 269 that contains the motor and gear trains required to drive shaft 251, thereby securing the brush assembly to the main housing as the shaft 251 is inserted or snapped into a bushing provided in the ring gear 250.

[0045] While the above embodiments of the invention are disclosed in a very specific manner, those skilled in the art will appreciate that the broadest concepts of the invention are applicable to numerous multiple rotating head arrangements other than the illustrated ones, including arrangements in which the heads of a particular device have different radii, materials, and even functions. By changing the gear ratios of the respective gears, e.g., by adding gears, a differential speed between inner and outer brushes moving in the same or opposite direction can also be obtained to meet the requirements of different applications and situations. In addition, the principles of the invention can also be adapted to different applications and situations by varying the total contact areas of the inner and outer bristles, and/or by axially offsetting the inner and outer differentially rotating members.

[0046] Furthermore, as illustrated in Figure 6, the respective "inner" and "outer" bristle support members 16,17 of a cleaning brush 18, which may otherwise correspond to the one shown in Figures 2 and 3, need not necessarily be concentrically arranged, but rather may be arranged in a three dimensional configuration to provide axially spaced but still coaxially rotatable bristle assemblies 19 and 20. AS illustrated, the gear arrangement of this example may be identical to that shown in Figures 2 and 3, with the only difference being that the bristle support members are extended in a cylindrical configuration, although other gear arrangements could of course also be used with this offset configuration, including the gear arrangement shown in Figure 2-1.

[0047] In a further variation of the structure shown in Figures 2 and 3, as illustrated in Figure 4, the cleaning brush is in the form of a toothbrush 21 having an outer bristle assembly 22 which rotates in a first direction and an inner bristle assembly 23 which rotates in a second direction. Because the toothbrush 21 must be perpendicular to the drive shaft 24, a different gear arrangement is used. In this variation, a bevel drive gear 25, or similar gear such as a crown gear, is connected to the drive shaft. The motor (not shown) and drive shaft 24 may be of an identical construction to conventional rotary toothbrushes, including appropriate bearing supports 26 in a housing 32. The bristle assemblies of the toothbrush are supported by concentric inner and outer support members 27 and 28, the outer support member

28 being connected directly to a second bevel gear 29 or similar gear such as a crown gear, and the inner support member 27 being connected via a second shaft 30 to a third bevel gear 33 or similar type of gear positioned such that both of gears 29 and 33 engage the drive gear 25 and rotate in response thereto to drive the inner and outer bristle supporting members 27 and 28 in opposite directions.

[0048] As a result of this improved electric toothbrush structure which employs the principles of the first embodiment of the invention, a more stable brush action, more intense cross cleaning, and a generally better cleaning effect relative to conventional electric toothbrush designs is achieved. In addition, it is anticipated that an even more effective cleaning effect can be obtained achieved by periodically reversing the direction of shaft rotation, for example, by including a flip flop in the motor control circuit.

[0049] In a variation of the toothbrush design shown in Figure 5, a third non-rotatable bristle assembly or ring 35 depending from a housing 38 is added to the first and second bristle assemblies 36 and 37 of an electric toothbrush 34. Those skilled in the art will recognize that this structure is still in accordance with the general concept described in connection with Figure 1, except that for this example, n=3, V1=+ve, V2=-ve, and V3=0. The stationary outer ring has the advantage of providing a more gentle massaging effect for the gums and to reduce splashing from the inner bristles.

[0050] In another variation of the toothbrush design shown in Figure 5, the gear arrangement of Figure 5 is replaced by a drive gear 170 connected to shaft 171 and rotatable therewith, as shown in Figures 5-1 and 5-3, drive gear 170 in turn engaging a first ring gear 172 and a second gear 173, which as a result are driven by gear 170 to rotate in opposite directions. In this embodiment, first ring gear 172 is connected by means of, for example, a snap fitting 172A to an inner brush assembly 174 which thereby rotates in the direction of rotation of the first ring gear, and the second ring gear 173 is constructed to be integral with the outer brush assembly 175, thereby causing the bristles of the respective inner and outer brush assemblies to rotate in opposite directions to provide improved balance, counter-torque, and cross-cleaning effects. As in the first toothbrush embodiment, it will be appreciated by those skilled in the art that the toothbrush body 176 will include appropriate bearing surfaces for the various moving components, as well as means for assembling the body and shaft to a motor unit.

[0051] In yet another variation of the above-described toothbrush embodiments, two of each of elements 172-175 are provided, with the second set of elements 172-175 being indicated in Figures 5-2 and 5-4 by reference numerals 172'-175', to form a double head toothbrush. In this variation, power is transmitted from ring gears 172 and 173 to ring gears 172' and 173' by means of an intermediate drive gear 177. Those skilled in the art will appreciate that additional sets of counter-rotating heads could be added to the same drivetrain simply by adding addition intermediate gears corresponding to intermediate gear 177.

[0052] Figure 7 shows an application in which the bristles of the various brush designs are replaced by polishing or buffing discs to obtain a hand-held polisher 39 of the type used to polish automobiles. As discussed above, the problem of balancing forces is especially critical in a car polisher due to the problem of controlling the polisher when the polishing wheel is applied to corners of the automobile. The structure of the transmission mechanism for driving the two oppositely rotating polishing heads using via a common motor and drive shaft may be the same as shown in Figures 2 and 4, although variations of the above will undoubtedly occur to those skilled in the art. The illustrated car polisher includes a handle 40 in the housing 41, making it important to minimize the space taken up by the motor and transmission mechanism. Also shown is a power cord 42 for the motor. As illustrated, members 43 and 44 correspond respectively to bearing members 4 and 7 shown in Figure 2, with the bristle assemblies 23 and 22 shown in Figure 2 being replace by polishing wheels or discs 45 and 46.

[0053] Figure 8 shows a variation of the polisher illustrated in Figure 7, in which the basic structure of the first embodiment of the invention is adapted for use as a floor polisher 51 having a pivotable handle 47, main housing 48, and respective counter-rotatable inner and outer polishing discs 49 and 50 . Aside from the larger polishing heads and motor, details of this variation of the first preferred embodiment of the invention can be identical to those of the variation shown in Figure 7.

[0054] Finally, Figures 9 and 10 show further applications of the principles of the first embodiment of the invention. Figure 9 shows a hand-held battery operated shoe brush or polisher 52 having oppositely rotating bristle or polishing heads 53 and 54, and Figure 10 shows a hand-held battery operated massager 55 of the type including a plurality of massaging balls 56 mounted on oppositely rotating heads 57 and 58. The respective housing assemblies 62, 63, and 64 of the respective devices shown in Figures 9 and 10, including battery compartment covers 65 and 66 , handle 67, and on-off switches or trigger controls 68 and 69 are conventional and therefore need not be further described herein.

[0055] Figure 11 shows the more general situation in which the linear movable members do not oscillate, but rather move continuously. This embodiment is essentially a generalization of the first preferred embodiment of the invention in which the radii are taken to infinity, with side-by-side members n=1 to N being in the form of belts 70 driven by pulleys 71, the pulleys being connected to each other and to a drive shaft 72 by means of gears 73 having different gear ratios in order to achieve different velocities V1 to Vn.

[0056] As shown in Figure 12, for example, the linearly movable members may support bristles 74 of a brush, which

may take the form of a shoe or cleaning brush having a housing 75 in which the mechanism of Figure 12 is mounted, as illustrated in Figure 13. similarly, the linearly movable members may support the massaging balls 76 mounted in the housing 77 of a massager, as illustrated in Figure 14. Those skilled in the art will appreciate that the improved balance and cleaning, brushing, or massaging advantages of the embodiment illustrated in Figures 1-10 will also be obtained in the embodiment of Figures 11-14 due to the differential motion between the side-by-side tools or heads. In addition, it will be appreciated by those skilled in the art that the mechanism illustrated in Figures 11-14 may also be applied to polishers, sanders, and similar household appliances or tools.

[0057] In addition to providing for continuous linear motion, as illustrated in Figures 11-14, the invention can also take the form of a household appliance or personal grooming device in which the side-by-side tools or heads are caused to reciprocate or oscillate in order to obtain the advantages of improved balance and cleaning effect, as well to reduce the effort needed to manipulate the appliance since the reaction force caused by a tool moving in one direction will be countered by the force of a tool moving in the opposite direction to provide a linear analogue of the counter-torque effect.

[0058] For example, as illustrated in Figure 15, the invention may be embodied by an arrangement 90 for converting the rotation of a shaft 91 into linear oscillations of a plurality of members 92, illustrated as carrying bristles 93 but which may also carry massage massaging balls, sponges, or the like, with each member being 180° out of phase in the path of movement relative to a neighbouring member. The oscillations are achieved, for example, by a crankshaft 94 to which are pivotally attached a plurality of connecting rods 95, which in turn are pivotally connected to the tools or heads 92 which carry out the function of the apparatus. As was the case with the first embodiment of the invention, it should be appreciated by those skilled in the art that numerous other mechanical arrangements for converting rotational to linear reciprocating motion may be substituted for the illustrated crankshaft arrangement, and that the invention lies not in the use of a crankshaft per se, but in application to a cleaning or personal grooming device, as illustrated in Figures 16 and 17.

[0059] Figure 16 shows a cascade-type brush 96 which utilizes the mechanism 90 shown in Figure 15. The linearly oscillations produced thereby have advantages over the counter-rotating brush in a number of applications. For example, the counter-rotating brush cannot be used as a hair brush, head massager, or head washing device of the type intended to simulate human fingers for use during shampooing because the hair will become entangled. The linear oscillating or reciprocating brush with counter oscillations solves this problem. In addition, the linearly reciprocating brush can be used as a shoe cleaning or polishing device which provides a cross-cleaning effect with minimal vibration due to the canceling moments of inertia. Finally, as shown in Figure 17, the linear reciprocation principles of this embodiment can be applied to a massager 97, which is similar to the rotary massager shown in Figure 10 in that it includes a plurality of massaging balls 98 and results in a crossmassaging effect with minimal undesired vibration.

[0060] Figure 18 illustrates a variation of the counter-rotation illustrated in Figures 1-10, in which two heads 103 and 104 are provided, the principles of the invention of course being applicable to any desired number of heads, while Figure 19 illustrates a variation of the mechanisms illustrated in Figures 1-10, in which dual shafts 105 and 106 are provided to drive the differentially rotating sections 107 and 108, the principles of the invention being applicable. to numerous different shaft and gearing combinations.

[0061] Finally, to illustrate a further advantage of the cross-cleaning provided by the invention, Figures 20, 20-1, 20-2, and 20-3 depict a fingernail cleaning device in which the two rotating heads 180 and 181 are arranged coaxially, each of the heads being in the form of a cylinder having radially inward facing bristles. This embodiment solves a number of problems which prevent effective cleaning of fingernails by a device having only a single rotation direction. The problems result in part from the shape of a fingernail and in particular the presence of a recess on both sides of the fingernail where it is embedded into the skin. If only a single cylinder were provided and the rotation were in one direction, it would be very difficult and sometimes even impossible to clean both sides of the fingernail in the regions close to the position where the fingernail is embedded into the skin and forms a recess because, as the bristles swipe past the fingernail surface, while the approaching bristle tips can wipe into the recess, the trailing bristles tend to have their shanks slide over the recess with little chance of wiping into the recess. In addition to the problem of inadequate wiping by the trailing bristles, devices having only a single rotating direction have the disadvantages that fingernail polish removed from the front portion tends to be pressed into the trailing recess, causing the polish to accumulate in the trailing recess, and that, because of variations in the shapes of individual fingers, the approaching and trailing contact geometry between the nail and the bristles is different, which may cause one edge to be cleaned less than the other. To overcome these problems, the counter-rotating brushes of this embodiment allow first one edge and then the other to be completely cleaned as the finger is pushed into the device in the manner illustrated in Figures 20-1 and 20-2.

[0062] As illustrated in Figure 20, the rotating heads 180 and 181 of this embodiment may be driven by a gear arrangement similar to that of Figure 2-1, but the shaft arrangement differs in this device in that a detachable coupling made up of engaging coupling elements 182 and 182' is included to permit the rotating head section to be detached from a main drive unit for cleaning. Coupling element 182' is fixed to a main drive shaft 183 to rotate therewith, and is further coupled to the first ring gear 184 and to an intermediate shaft 185 by a locking nut 186. Intermediate shaft 185 is in turn fixed to rotating head 180 via-separate inner cylinder 180A while the second ring gear 187 is fixed to an outer

cylinder 188 which in turn is fixed to second rotating head 181, the second ring gear being driven to rotate in a direction opposite that of the first gear by pinions 189,190 engaged with both ring gears and rotatable about pins 191,192 supported by bushings 193,194 in support member 195, which is attached by locking screws 196 to outer casing 197.

[0063] As is apparent from Figure 20, casing 197 can be made separable from the main unit 198, for example by means of a twist off coupling 198', and both of the rotating heads 180 and 181 can be separately removed for cleaning or replacement by first detaching head 181 from cylinder 188 and then detaching head 180 from cylinder 180A. The main unit 198, best illustrated in Figure 20-3, includes the motor, additional gearing (not shown), and an on/off switch 199.

[0064] Figures 21 and 22 are intended to illustrate the effect of eliminating twisting of brushes having relatively long bristles. Figure 21 shows a single head brush in which the bristles twist as the head is rotated, while Figure 23 shows a counter-rotating head device according to any of the above embodiments in which twisting is minimized due to the effect of the counter-rotation.

[0065] Those skilled in the art will appreciate that numerous analogous cleaning devices, such as electric toothbrushes, can also use the linear differential motion or linear oscillation motion principles of the invention, and that the differential rotation principles of the invention can also be generalized to a variety of different head or tool configurations, and to appliances other than the ones illustrated herein. For example, Figure 18 shows a variation of the counter-rotation mechanism illustrated in Figures 1-10, in which two heads are provided, the principles of the invention being applicable to any desired number of heads, while Figure 19 illustrates a variation of the mechanisms illustrated in Figures 1-10, in which dual shafts 105 and 106 are provided to drive the differentially rotating sections 107 and 108, the principles of the invention being applicable to numerous different shaft and gearing combinations.

Claims

1. A household appliance including a rotating head divided into a plurality of coaxially rotatable members having respective contact areas for contacting a surface, and further comprising means for driving at least two of said members at mutually different velocities, said velocities and contact areas of said coaxially rotatable members being selected such that the torques resulting from rotation of said members are substantially balanced, whereby to substantially balance said appliance.

2. A household appliance as claimed in claim 1, wherein the number of said members is two, and said two members are concentrically arranged to rotate in opposite directions.

3. A household appliance as claimed in claim 1, wherein said members are concentrically arranged and each of said concentrically arranged members carries a plurality of bristles to form a counter-rotating brush, wherein said means for driving said members drive at least two of said members in opposite directions so as to provide a cross-cleaning effect between said at least two of said members.

4. A household appliance as claimed in claim 3, wherein the number of said members is two, and said means for driving said members comprises a ring gear, a rotating shaft, a motor, an appliance housing, at least one idler gear, and a drive gear, wherein an outer one of said two concentrically arranged members is affixed to the ring gear, wherein an inner one of said two concentrically arranged members is driven directly by the rotating shaft, wherein the rotating shaft is driven by the motor, wherein the ring gear is driven by the at least one idler gear, said idler gear being fixed with respect to the housing, and wherein the drive gear is attached to and rotatable with the rotating shaft.

5. A household appliance as claimed in claim 3, wherein an outer one of said two concentrically arranged members is affixed to a first ring gear, wherein an inner one of said two concentrically arranged members is affixed to a second ring gear, and wherein the first ring gear is driven by a motor-driven shaft, the first ring gear causes at least one pinion to rotate, and rotation of the pinion causes the second ring gear to rotate in a direction opposite to the direction of rotation of the first ring gear and at an angular speed equal to an angular speed of the first ring gear, an axis of rotation of the pinion being perpendicular to axes of rotation of the first and second ring gears.

6. A household appliance as claimed in claim 5, further comprising a sleeve having latch arms arranged to be inserted into and engage a central opening in a main housing that contains said motor and gear trains arranged to drive said shaft, thereby securing said rings to said housing as the shaft is inserted into a bushing provided in the first ring gear.

7. A household appliance as claimed in claim 3, wherein said brush is an electric toothbrush.

8. A household appliance as claimed in claim 7, wherein said means for driving said members comprises a first gear attached to a first of said at least two of said members, a second gear attached to a second of said at least two of said members, and a third gear for driving said first and second gears in opposite directions, said third gear being rotatable about an axis perpendicular to a common axis of rotation of said first and second gears.

9. A household appliance as claimed in claim 7, wherein said means for driving said members comprises a first ring gear attached to a first of said at least two of said members, a second ring gear attached to a second of said at least two of said members, and a third gear for driving said first and second ring gears in opposite directions, said third gear being rotatable about an axis perpendicular to a common axis of rotation of said first and second ring gears.

10. A household appliance as claimed in claim 9, further comprising third and fourth members each having bristles attached thereto and coaxially rotatable about an axis parallel to an axis of rotation of said first and second of said at least two of said members, said third and fourth members being respectively attached to fifth and sixth ring gears, said fifth and sixth ring gears being respective driven in opposite directions by a shaft having at opposite ends seventh and eighth gears, said seventh gear engaging said first and second ring gears and said eighth gear engaging said fifth and sixth ring gears to transmit power from said first and second of said at least two of said members to said third and fourth members and drive said third and fourth members in opposite directions, thereby forming a double headed electric toothbrush with counter-rotating members in each head for optimal cross-cleaning effect.

11. A household appliance as claimed in claim 2, wherein said means for driving said members comprises a ring gear, a rotating shaft, a motor, an appliance housing, at least one idler gear, and a drive gear, wherein an outer one of said two concentrically arranged members is affixed to the ring gear, wherein an inner one of said two concentrically arranged members is driven directly by the rotating shaft, wherein the rotating shaft is driven by the motor, wherein the ring gear is driven by the at least one idler gear said idler gear being fixed with respect to the housing, and wherein the drive gear is attached to and rotatable with the rotating shaft.

12. A household appliance as claimed in claim 2, wherein an outer one of said two concentrically arranged members is affixed to a first ring gear, wherein an inner one of said two concentrically arranged members is affixed to a second ring gear, and wherein the two ring gears are driven by at least one pinion in engagement with both ring gears, said pinion being connected to and driven by a motor driven shaft.

13. A household appliance as claimed in claim 12, further comprising at least one additional pair of concentrically arranged members, at least one additional pair of ring gears for driving said additional pair of concentrically arranged members, and an intermediate gear for transmitting power from said first and second ring gears to said additional pair of ring gears.

14. A household appliance as claimed in claim 2, wherein an outer one of said two concentrically arranged members is affixed to a first ring gear, wherein an inner one of said two concentrically arranged members is affixed to a second ring gear, and wherein the first ring gear is driven by a motor-driven shaft, the first ring gear causes at least one pinion to rotate, and rotation of the pinion causes the second ring gear to rotate in a direction opposite to the direction of rotation of the first ring gear and at an angular speed equal to an angular speed of the first ring gear, an axis of rotation of the pinion being perpendicular to axes of rotation of the first and second ring gears.

15. A household appliance as claimed in claim 14, further comprising at least one additional pair of concentrically arranged members, at least one additional pair of ring gears for driving said additional pair of concentrically arranged members, and an intermediate gear for transmitting power from said first and second ring gears to said additional pair of ring gears.

16. A household appliance as claimed in claim 2, wherein each of said concentrically arranged members carries a polishing head.

17. A household appliance as claimed in claim 2, wherein each of said concentrically arranged members carries massaging balls.

18. A household appliance as claimed in claim 2, wherein each of said concentrically arranged members carries bristles having a length which would cause twisting of the bristles in the absence of counter-rotation.

19. A household appliance as claimed in claim 1, wherein said members are axially spaced but coaxially rotatable bristle supporting members.

20. A household appliance as claimed in claim 19, wherein said bristle supporting members are arranged to clean fingernails.

21. A household appliance as claimed in claim 20, wherein each of said bristle supporting members is in the form of a cylinder having radially inward facing bristles.

22. A household appliance as claimed in claim 21, wherein a first of said two sleeves is affixed to a first ring gear driven by said motor, wherein a second of said two sleeves is affixed to a second ring gear, and further comprising at least one pinion in engagement with both ring gears, said pinion transmitting power from said first ring gear to said second ring gear, whereby said two ring gears rotate in opposite directions and at a same speed.

23. A household appliance as claimed in claim 22, wherein said first ring gear is connected to the motor via a detachable coupling arranged to permit said sleeves to be detached from a main motor-housing drive unit for cleaning.

24. A household appliance as claimed in claim 19, wherein at least one of said bristle supporting members is in the form of a cylinder having radially outward facing bristles.

25. A household appliance as claimed in claim 1, wherein the number of said members is three.

26. A household appliance as claimed in claim 25, wherein two of said three members are oppositely rotatable, and wherein the third of said three members is stationary.

27. A household appliance as claimed in claim 26, wherein said members are arranged to support bristles of an electric toothbrush.

28. A household appliance as claimed in claim 1, wherein said appliance is a handheld electric mixer.

29. A household appliance as claimed in claim 1, wherein said two mutually differentially driven members are supported by a module detachable from a main housing of the appliance.

30. In a personal grooming device of the type including a head, the improvement wherein the head is divided into a plurality of parallely movable members, at least two of said members being mutually differentially driven.

31. A personal grooming device as claimed in claim 30, wherein said parallely movable members are bristle supports.

32. A personal grooming device as claimed in claim 30, wherein said parallely movable members support massage massaging balls.

33. A personal grooming device as claimed in claim 30, wherein said parallely movable members are driven by a crankshaft attached to a motor driven shaft, via connecting rods pivotally connected between said crankshaft and said parallely movable members.

34. A personal grooming device as claimed in claim 30, wherein said parallely movable members are reciprocating members.

35. An appliance as claimed in any of the preceding claims, wherein the said members are brushes concentrically arranged, the contact areas of the said brushes being such as result from the method of calculation hereinbefore described.

36. An appliance as claimed in claim 35, wherein the number of said brushes is two and they are arranged to rotate in opposite directions, the outside radius of the inner brush being a, the outside radius of the outer brush being b, and a being approximately 0.8 time b.

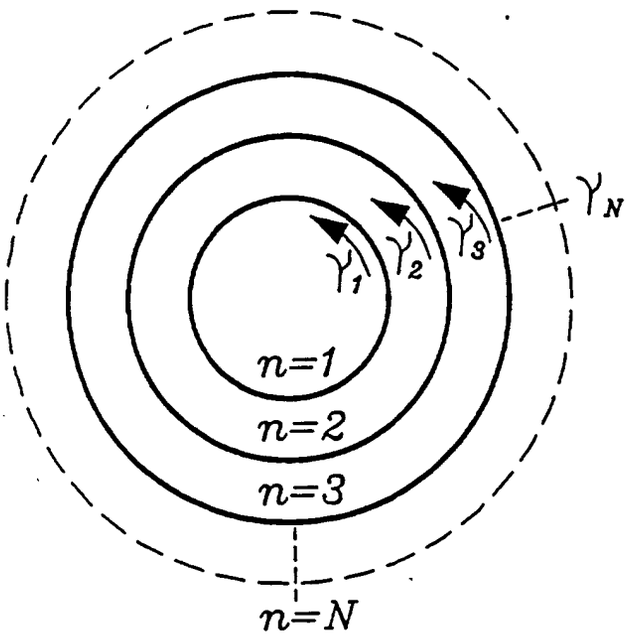

Fig. 1

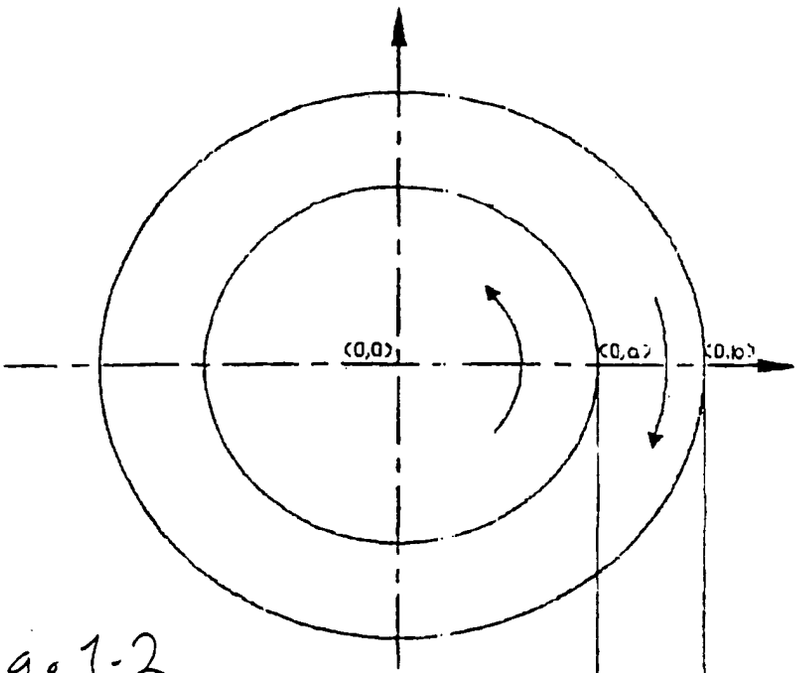

Fig. 1-2

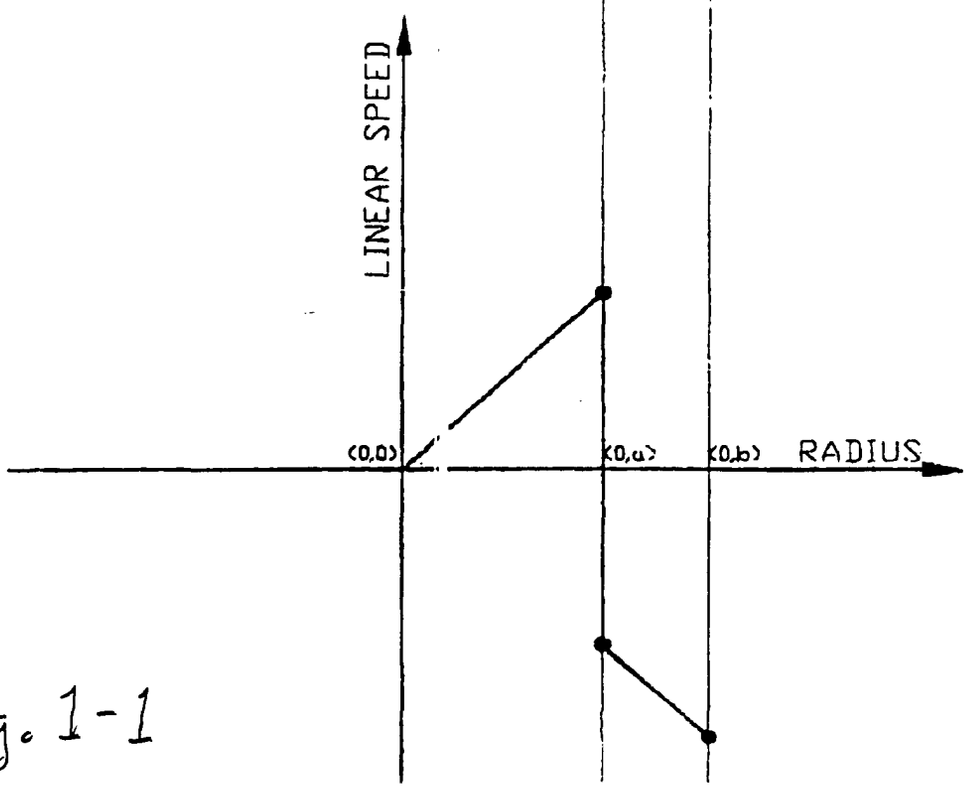

Fig. 1-1

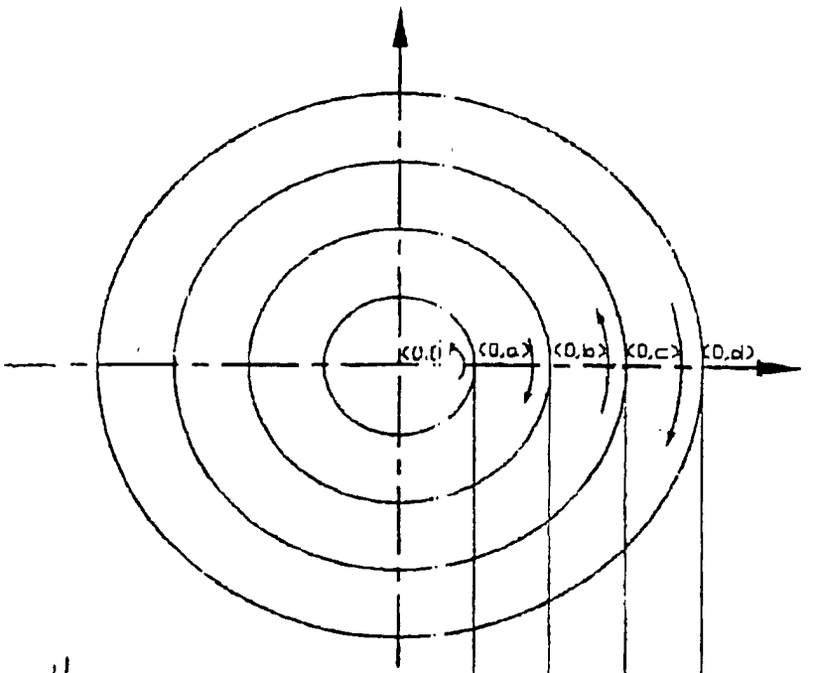

Fig. 1-4

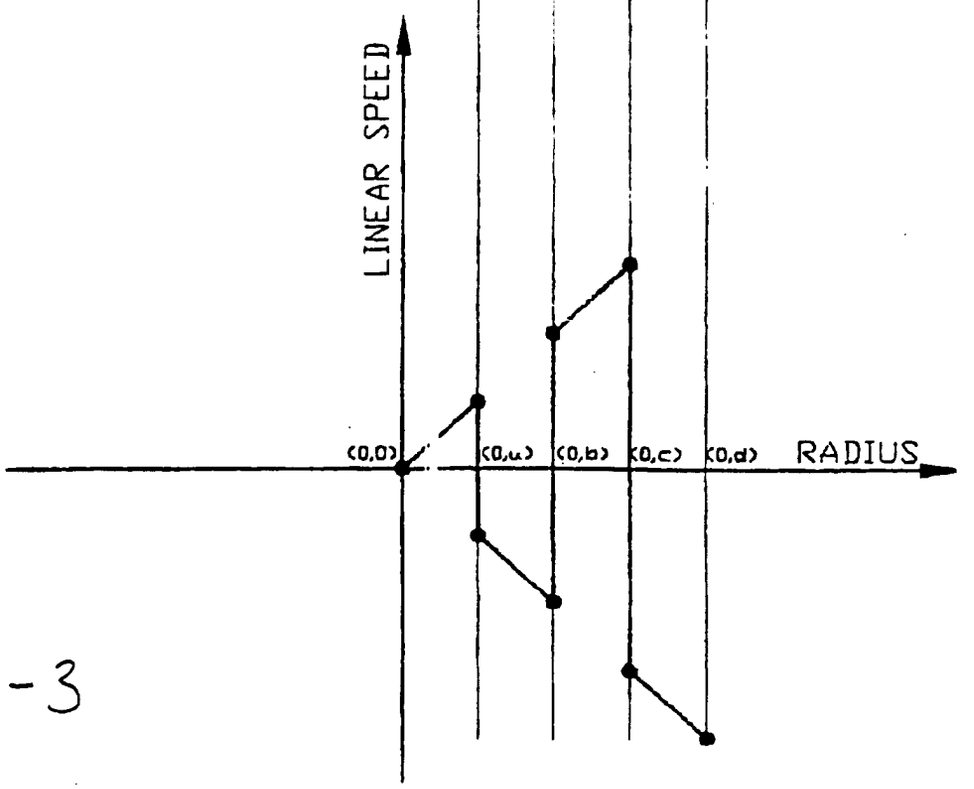

Fig. 1-3

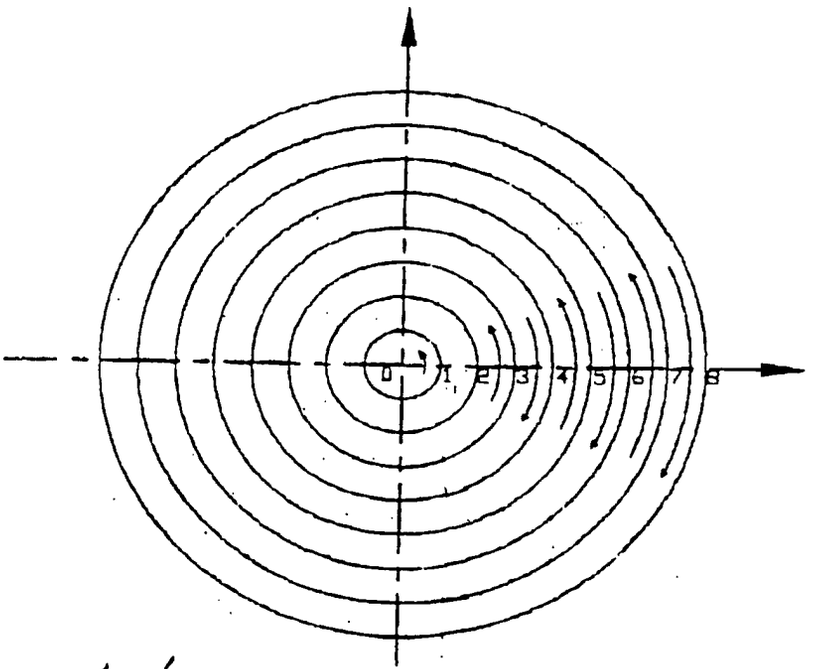

Fig. 1-6

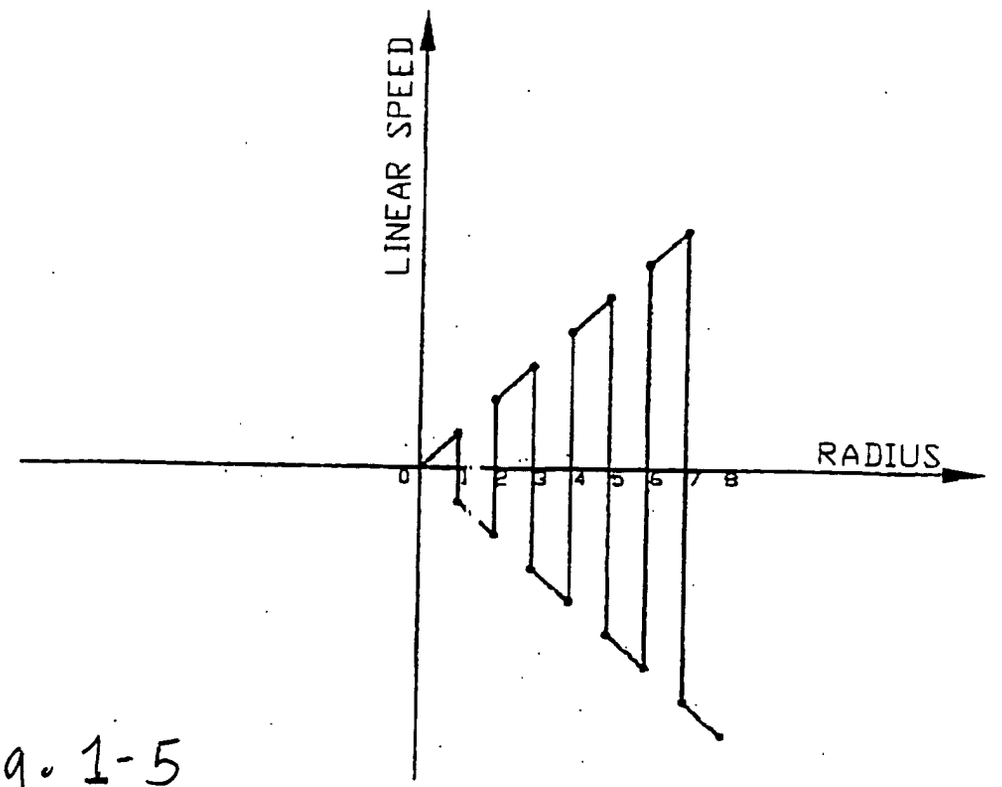

Fig. 1-5

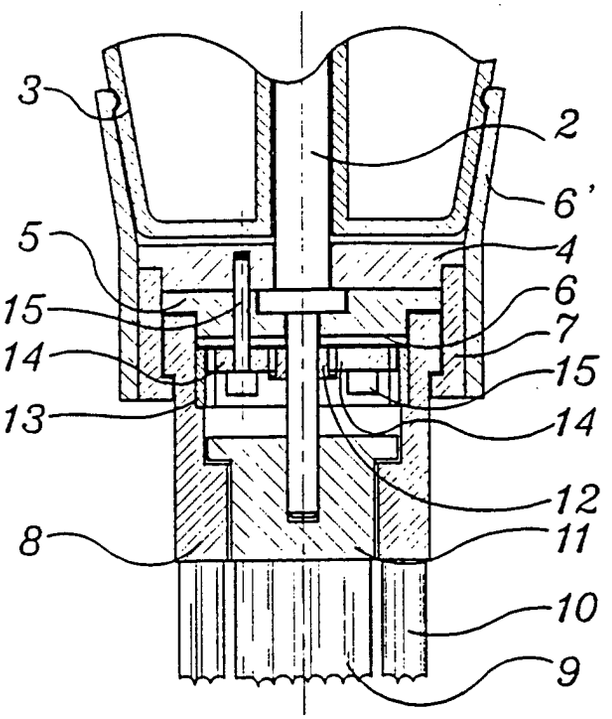

Fig. 2

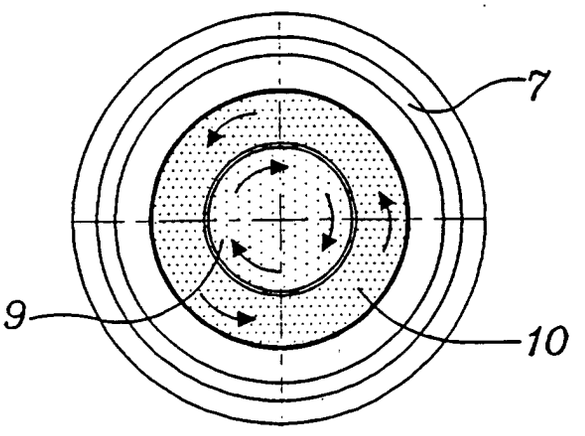

Fig. 3

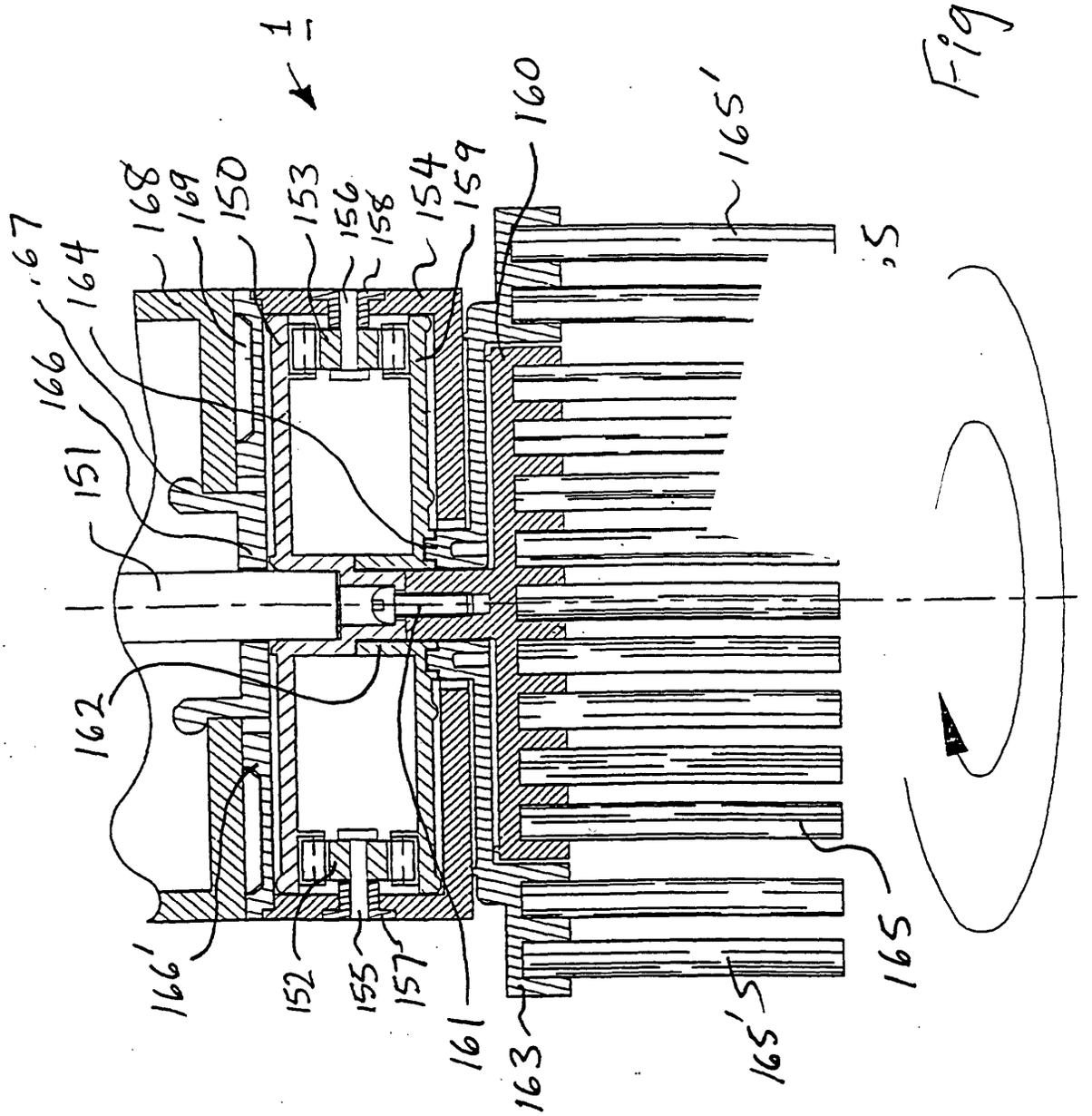
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Fig. 2-1

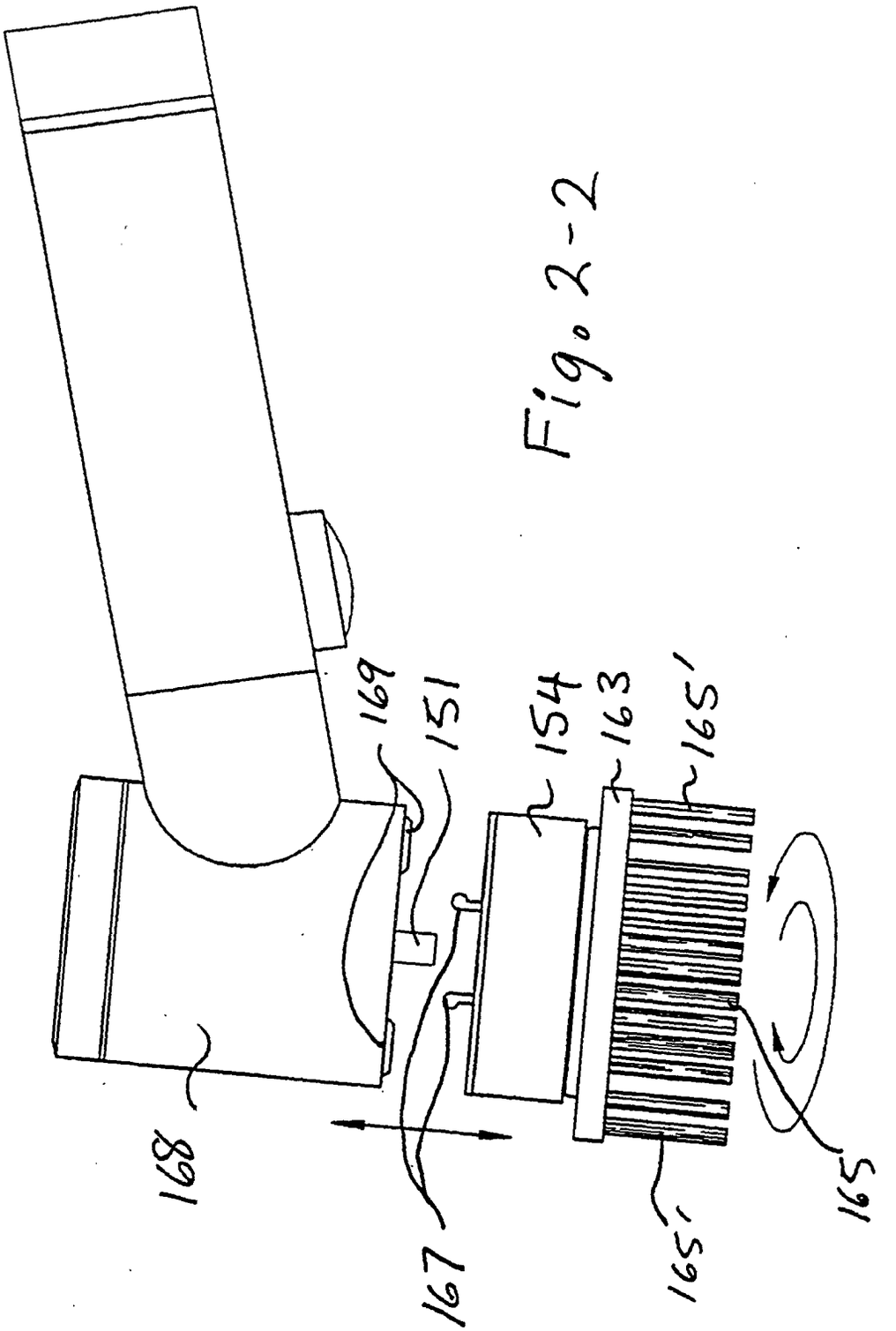

Fig. 2-2

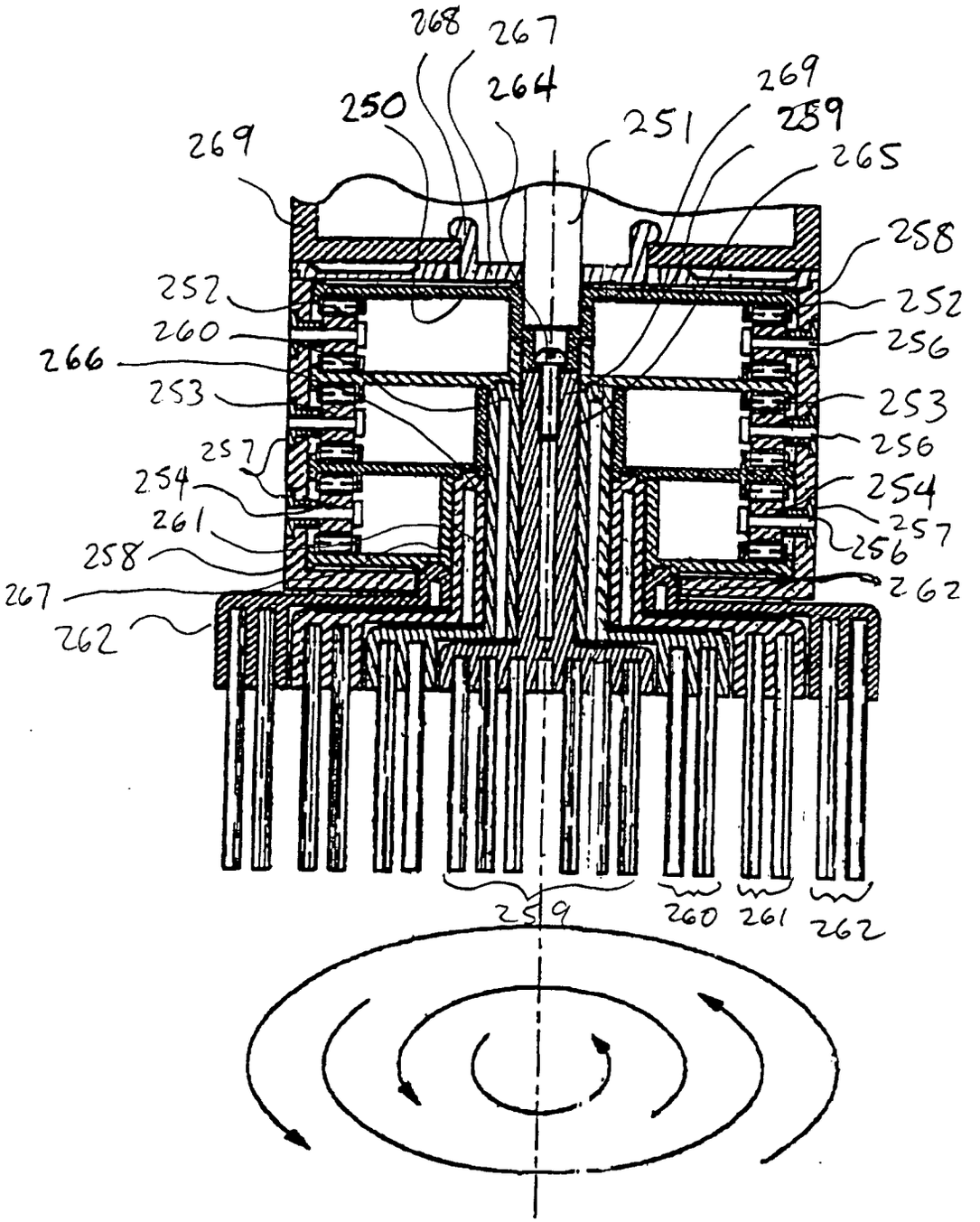
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Fig. 2-3

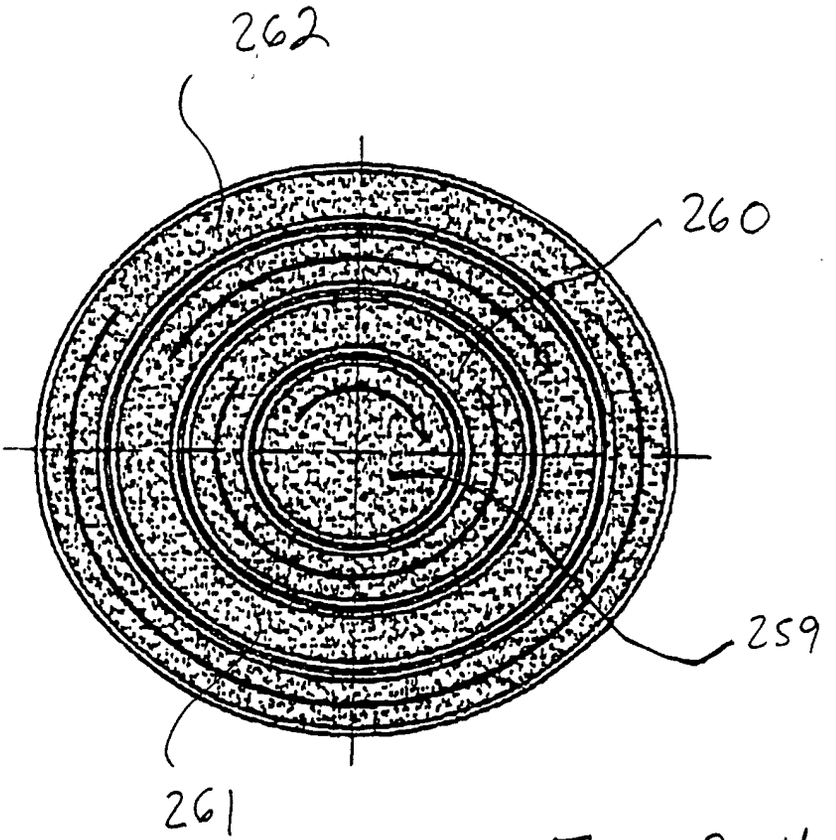


Fig. 2-4

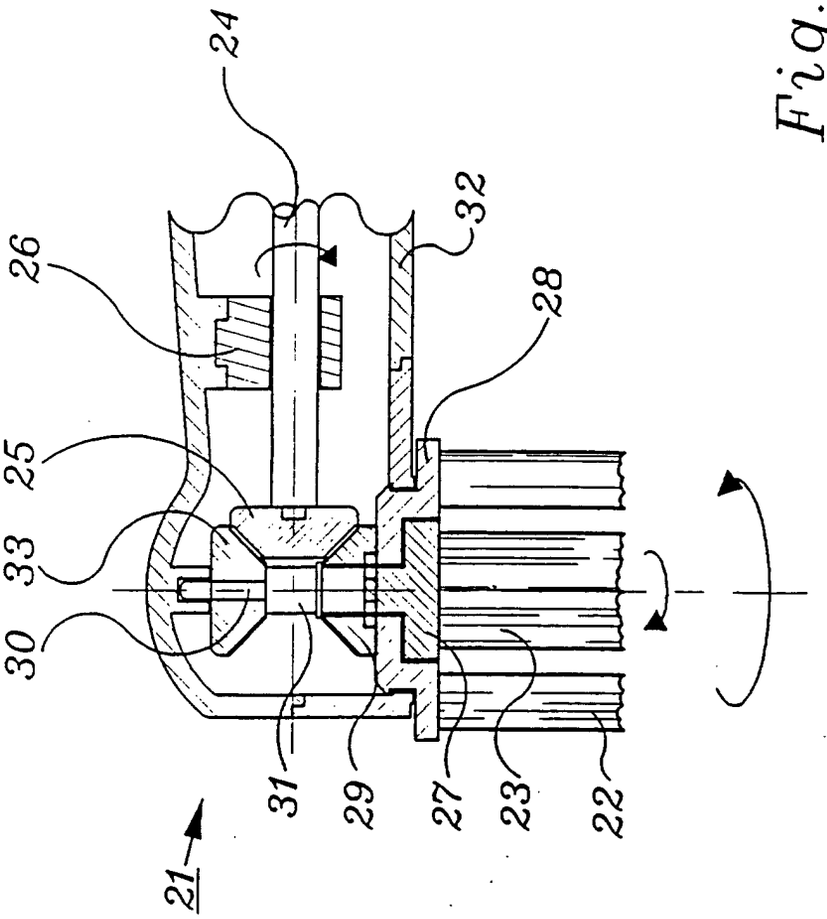


Fig. 4

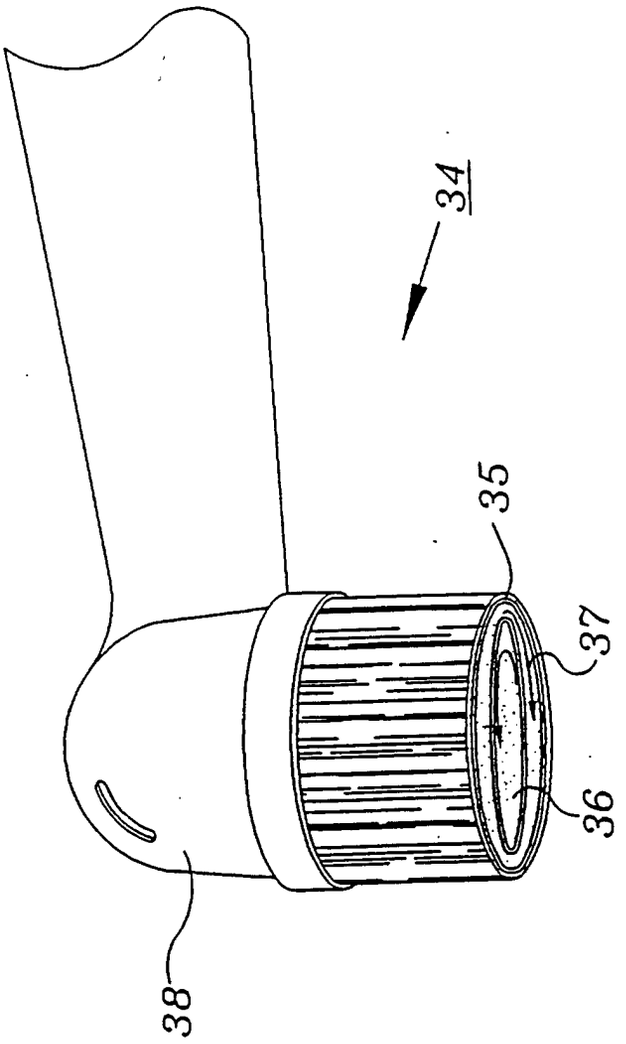


Fig. 5

Fig. 5-3

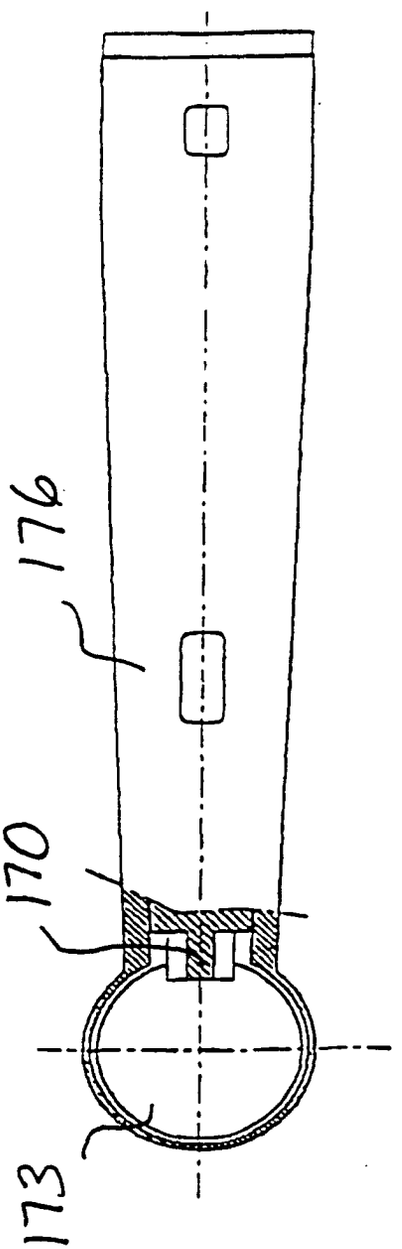
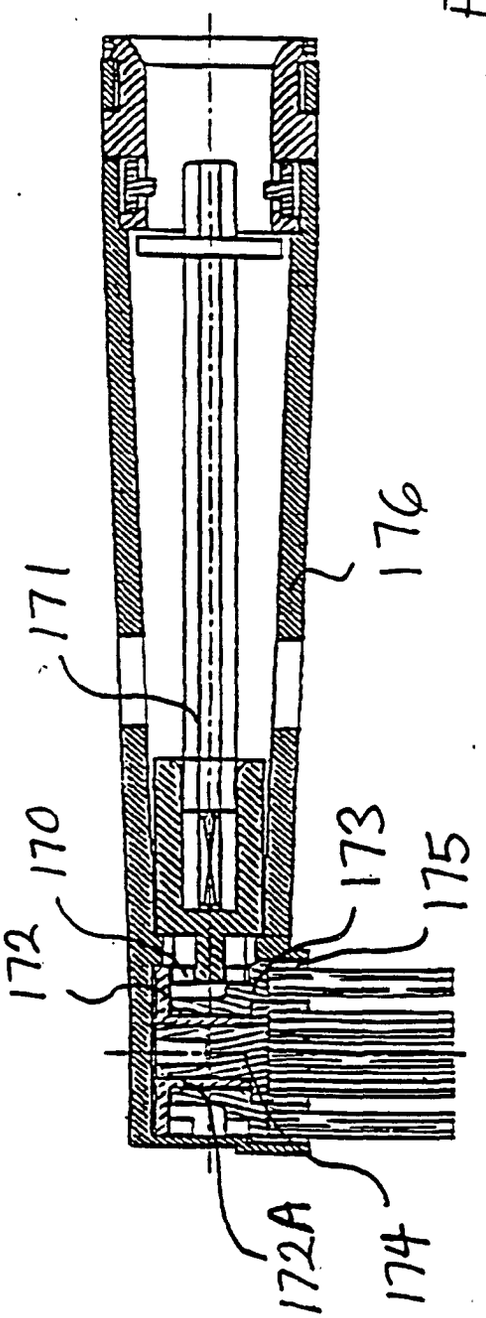


Fig. 5-1



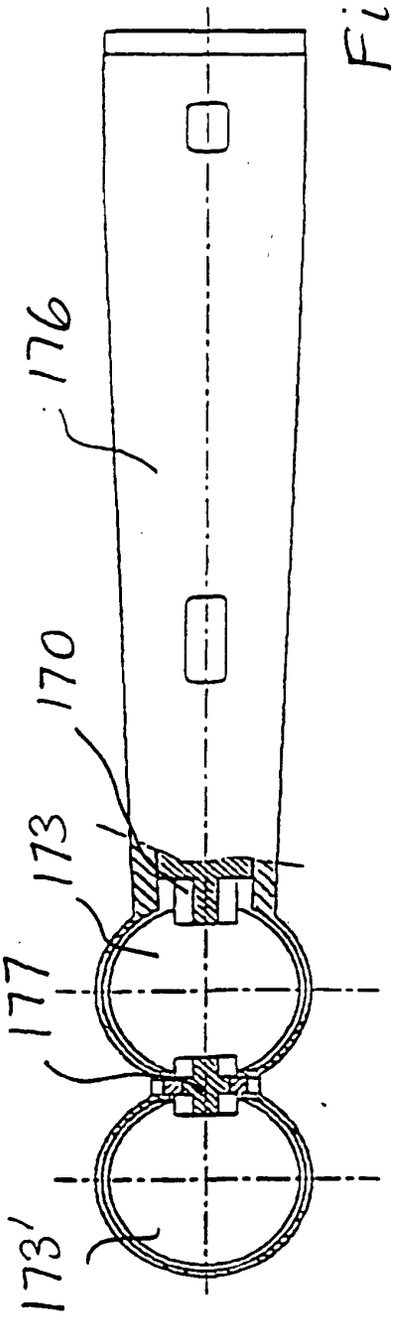

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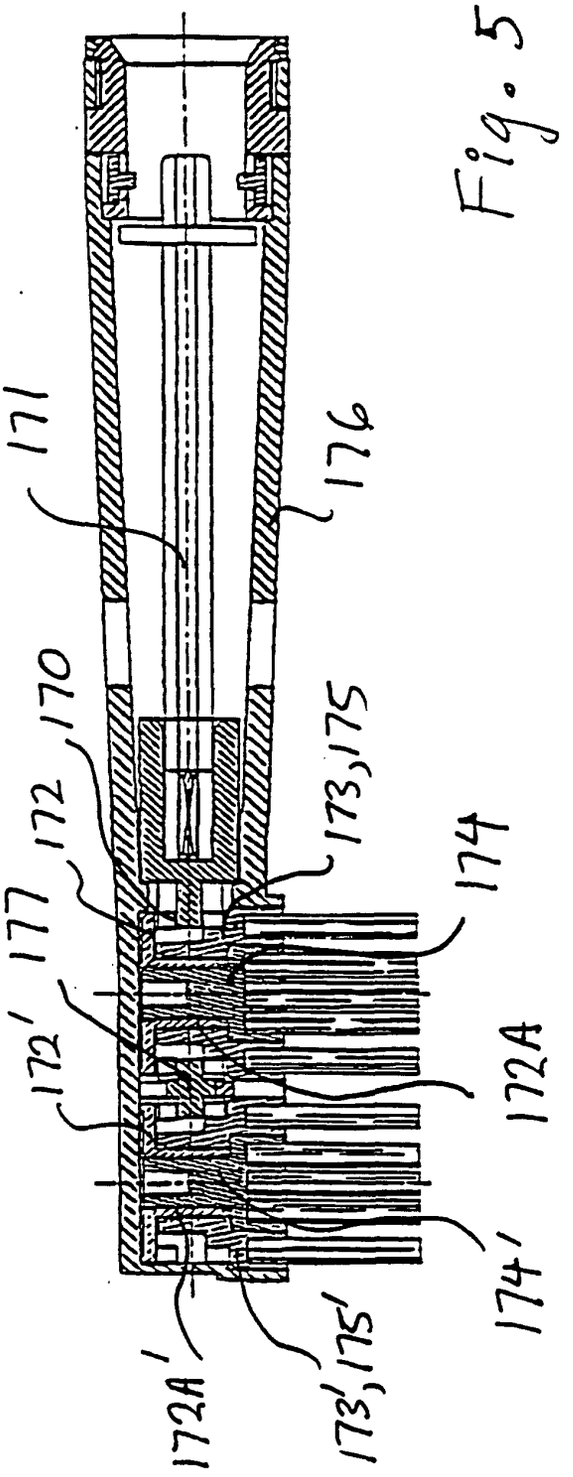
Fig. 5-4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173',175'

Fig. 5-2

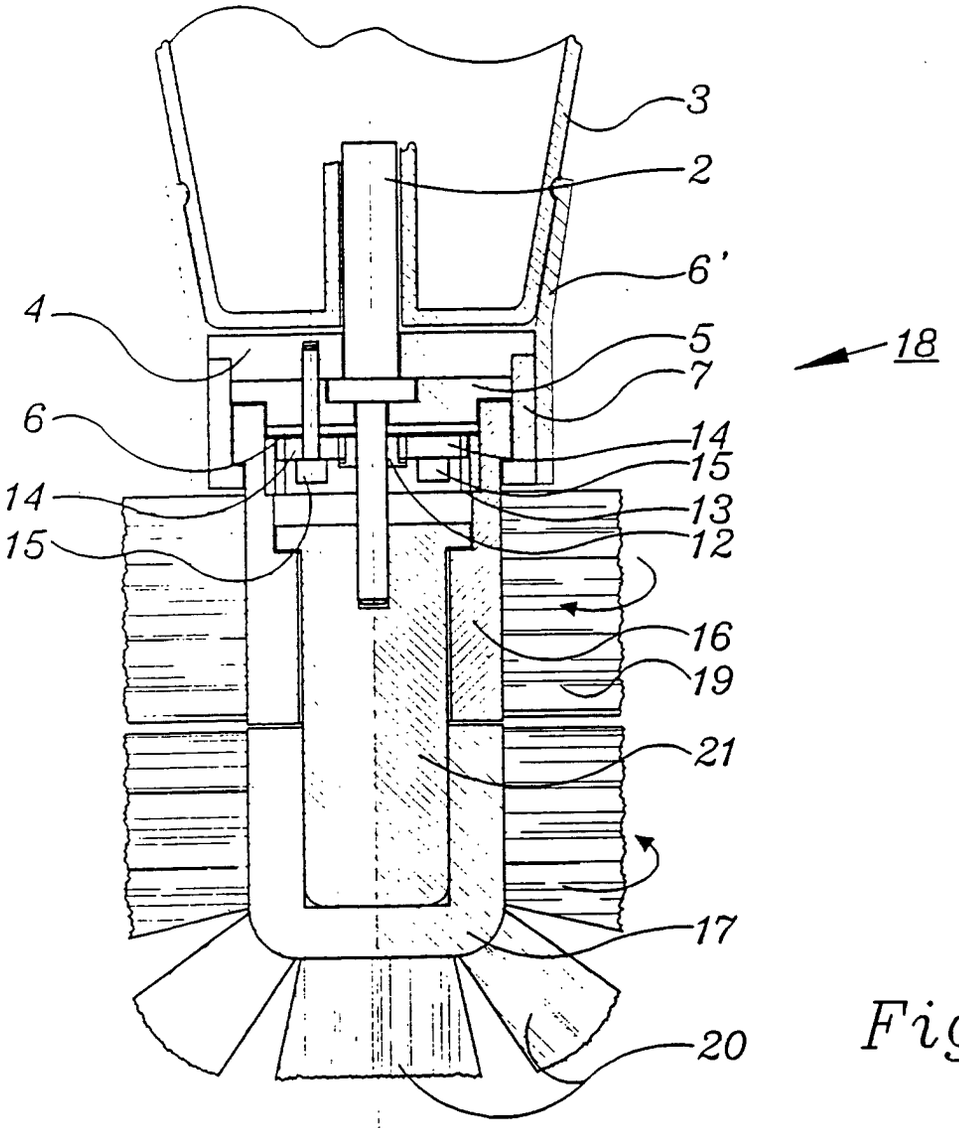

Fig. 6

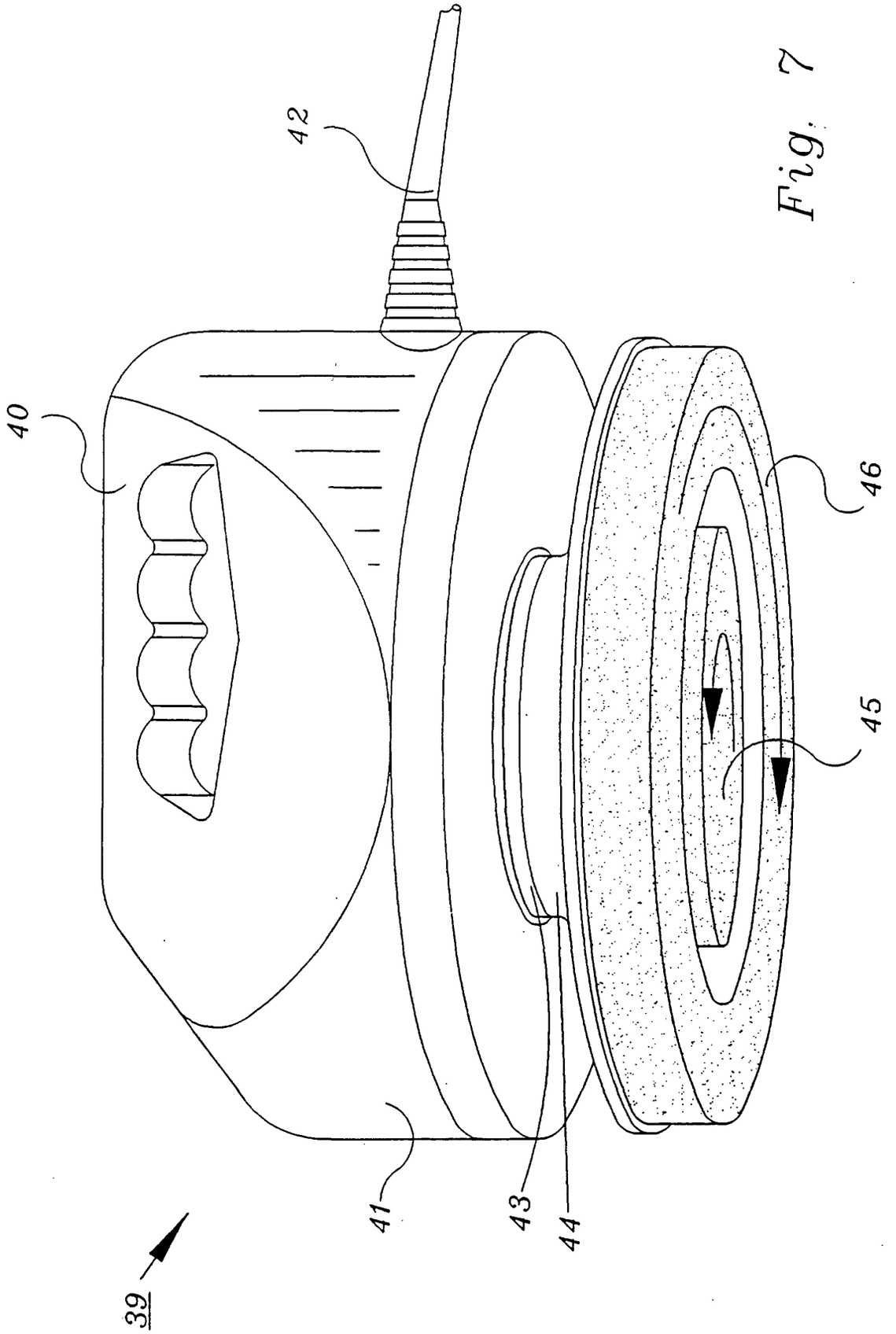

Fig. 7

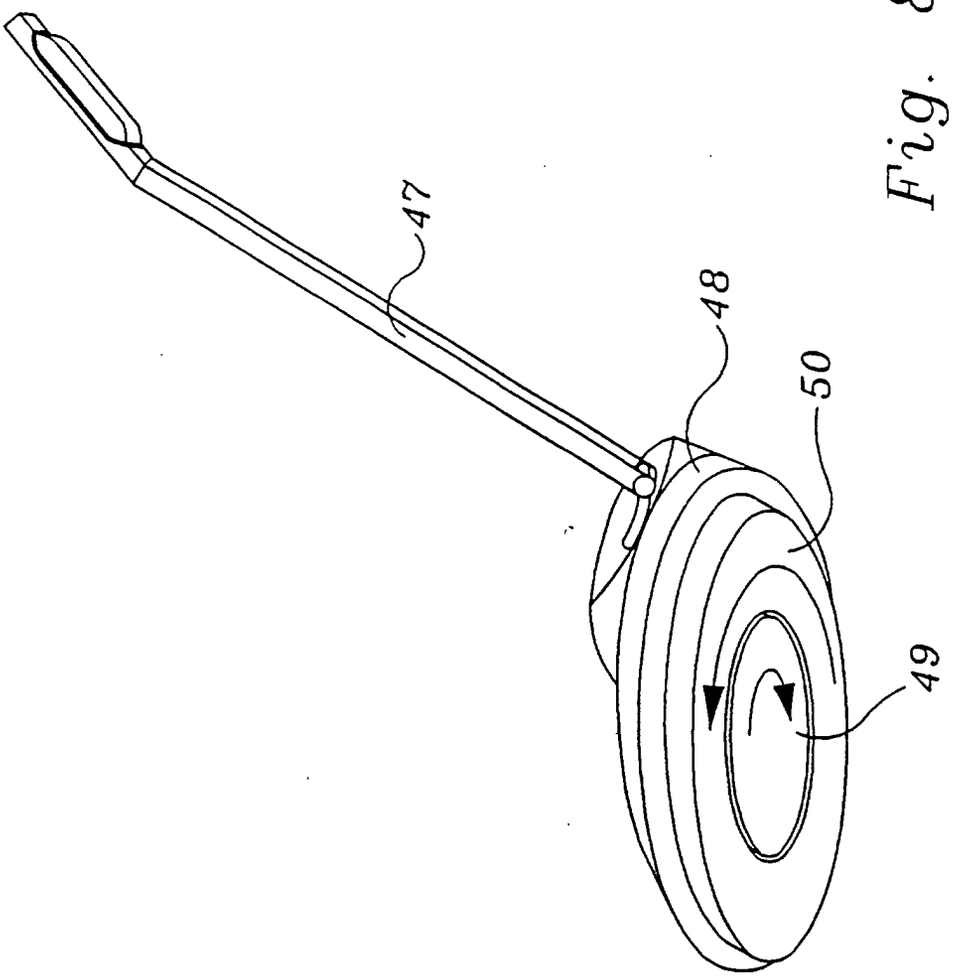

Fig. 8

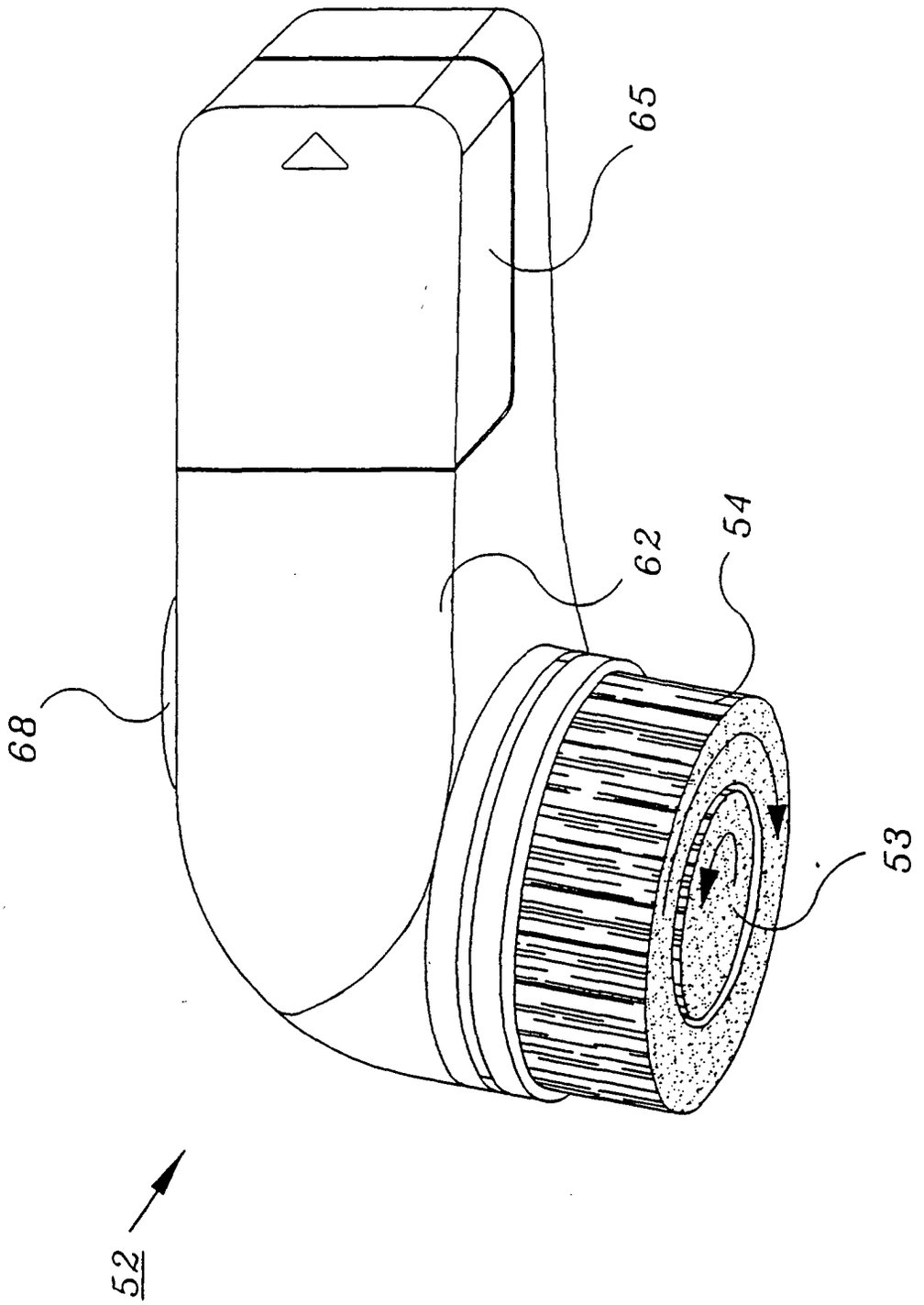

Fig. 9

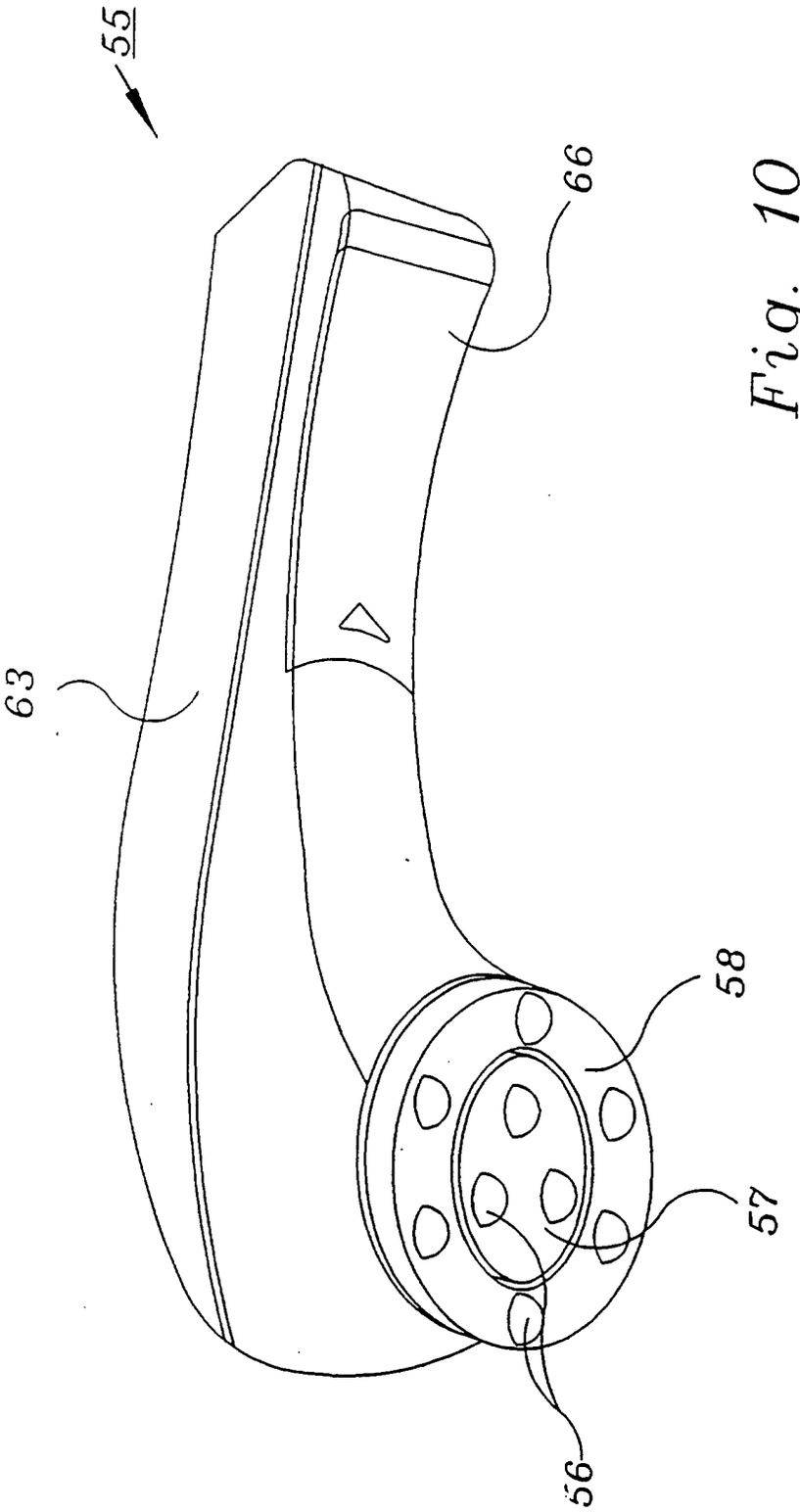

Fig. 10

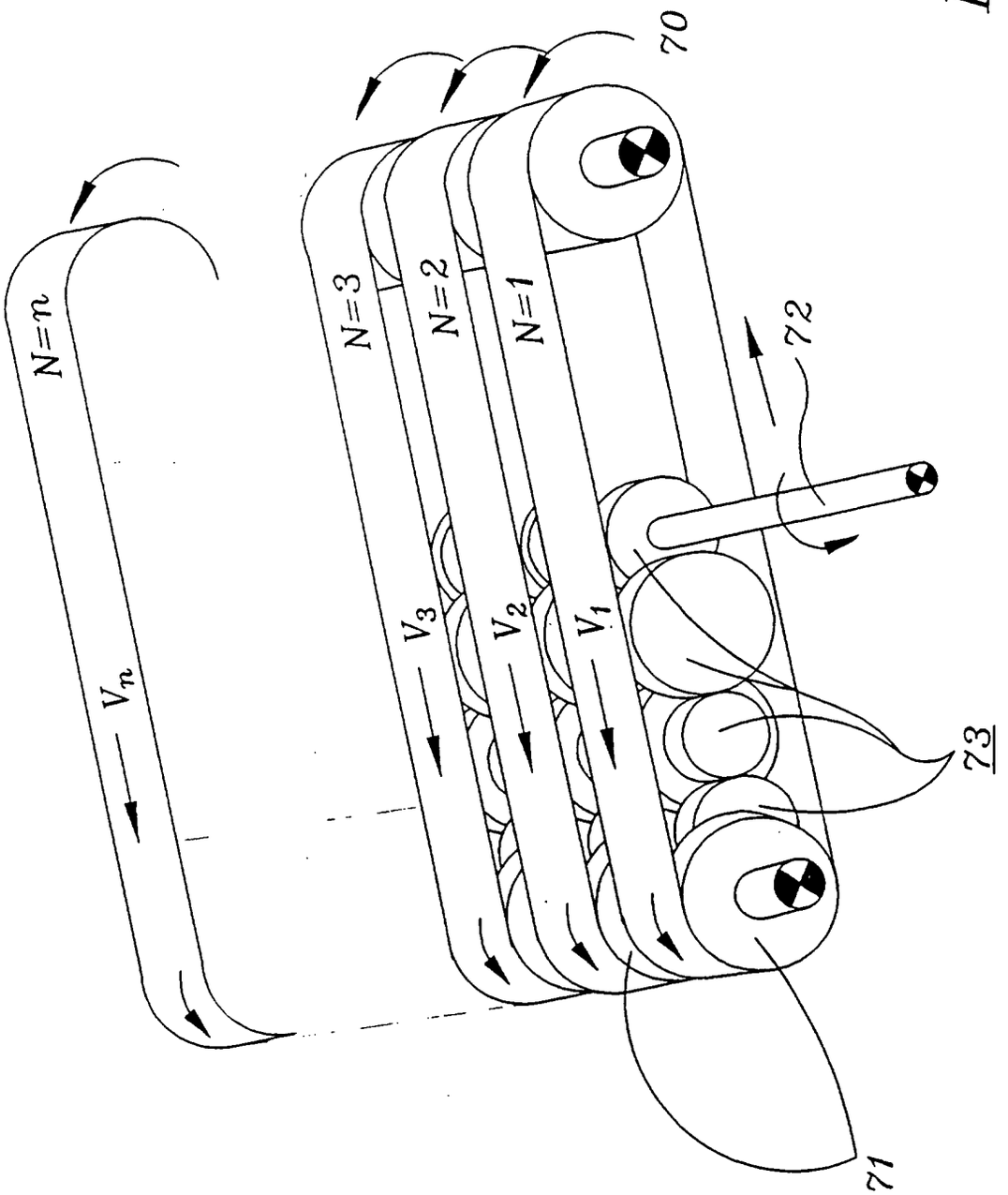

Fig. 11

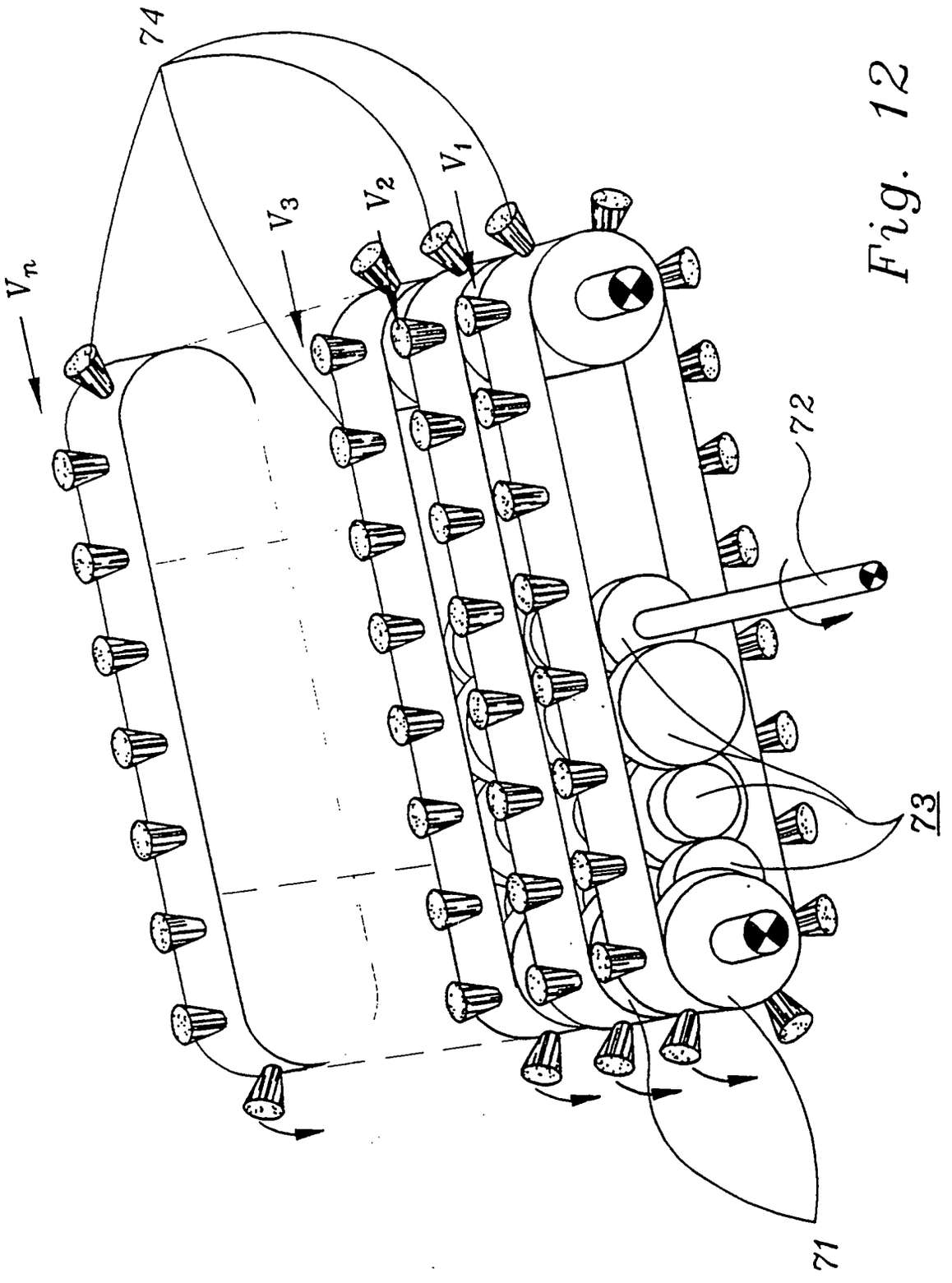

Fig. 12

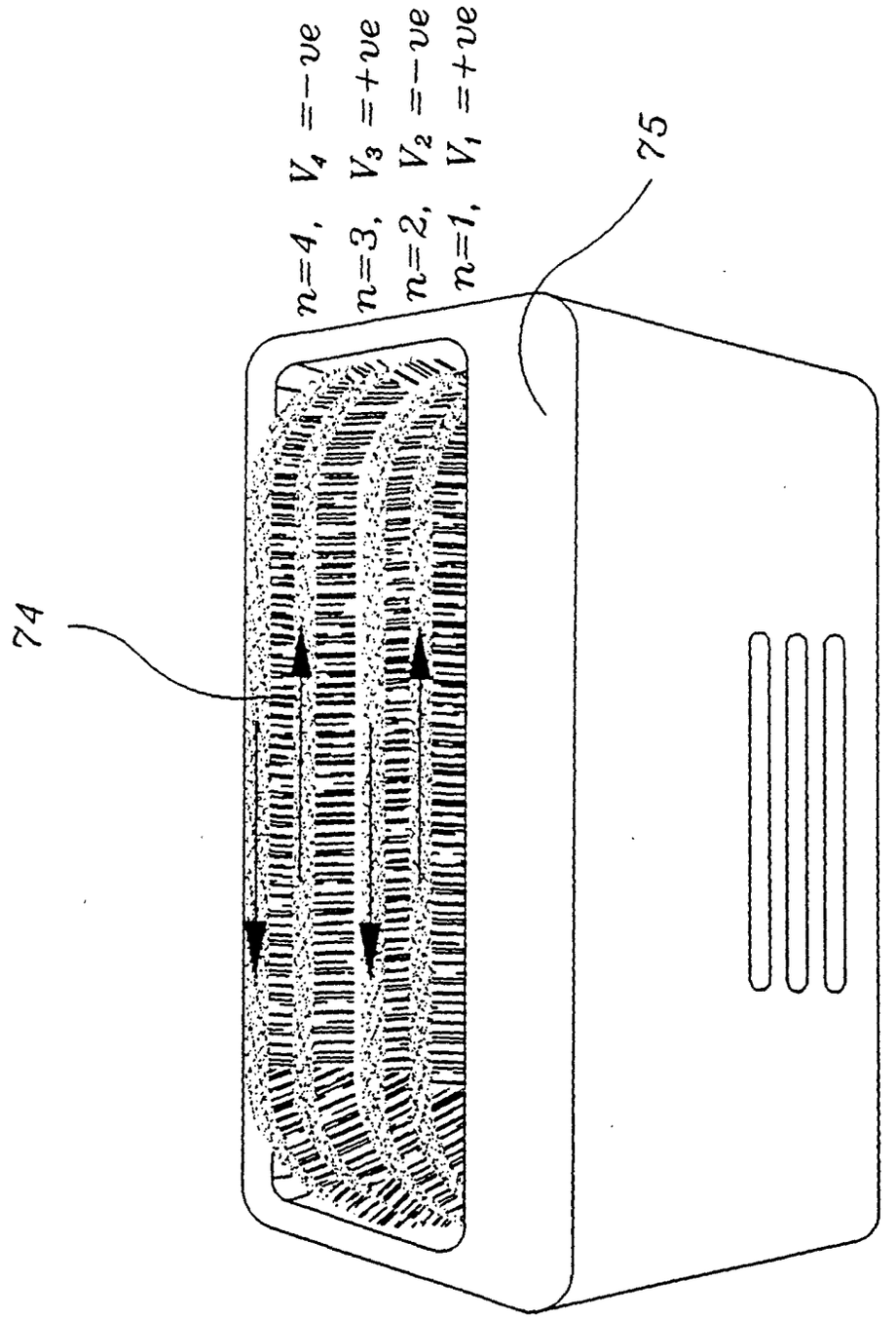

Fig. 13

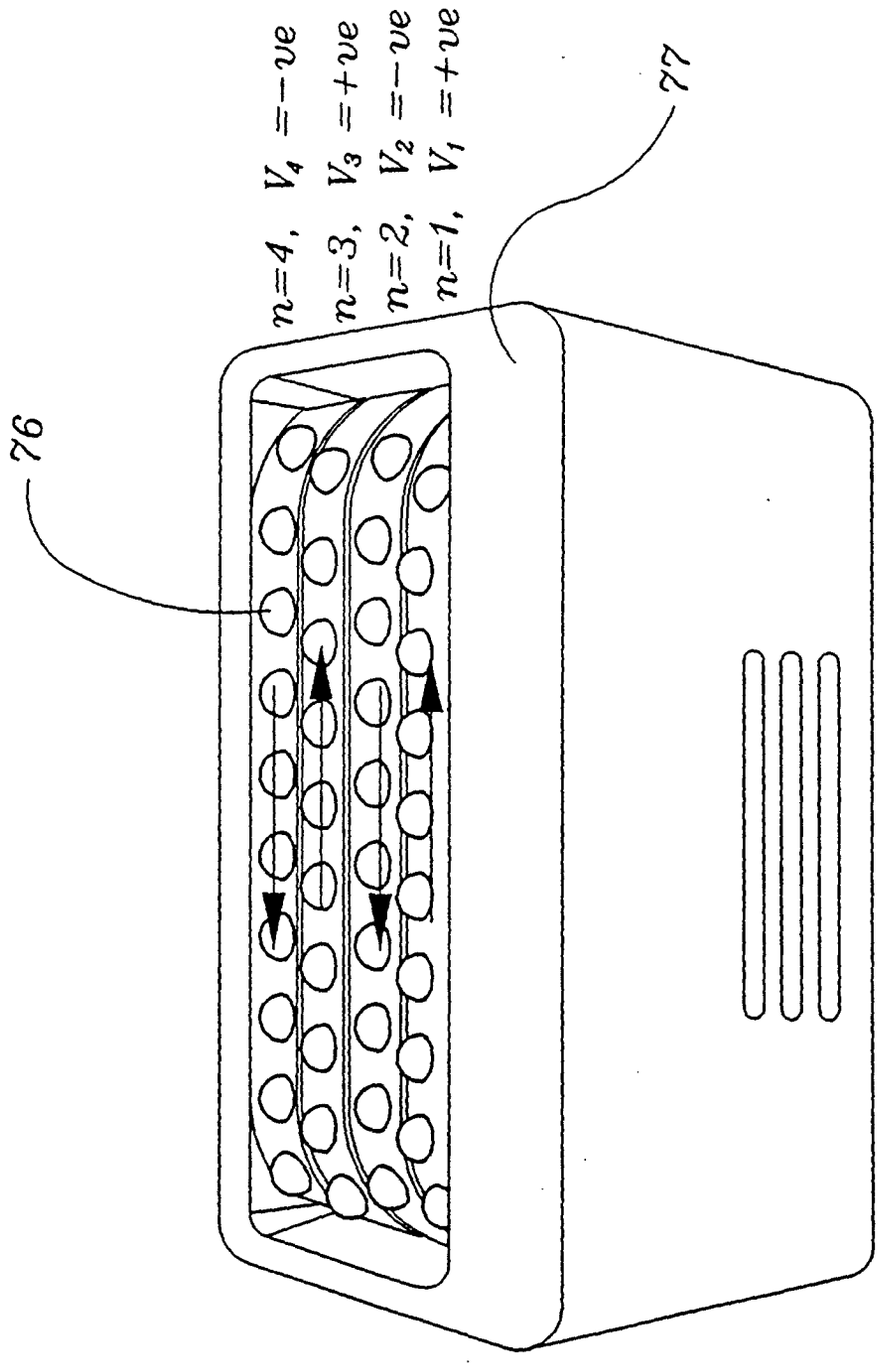

Fig. 14

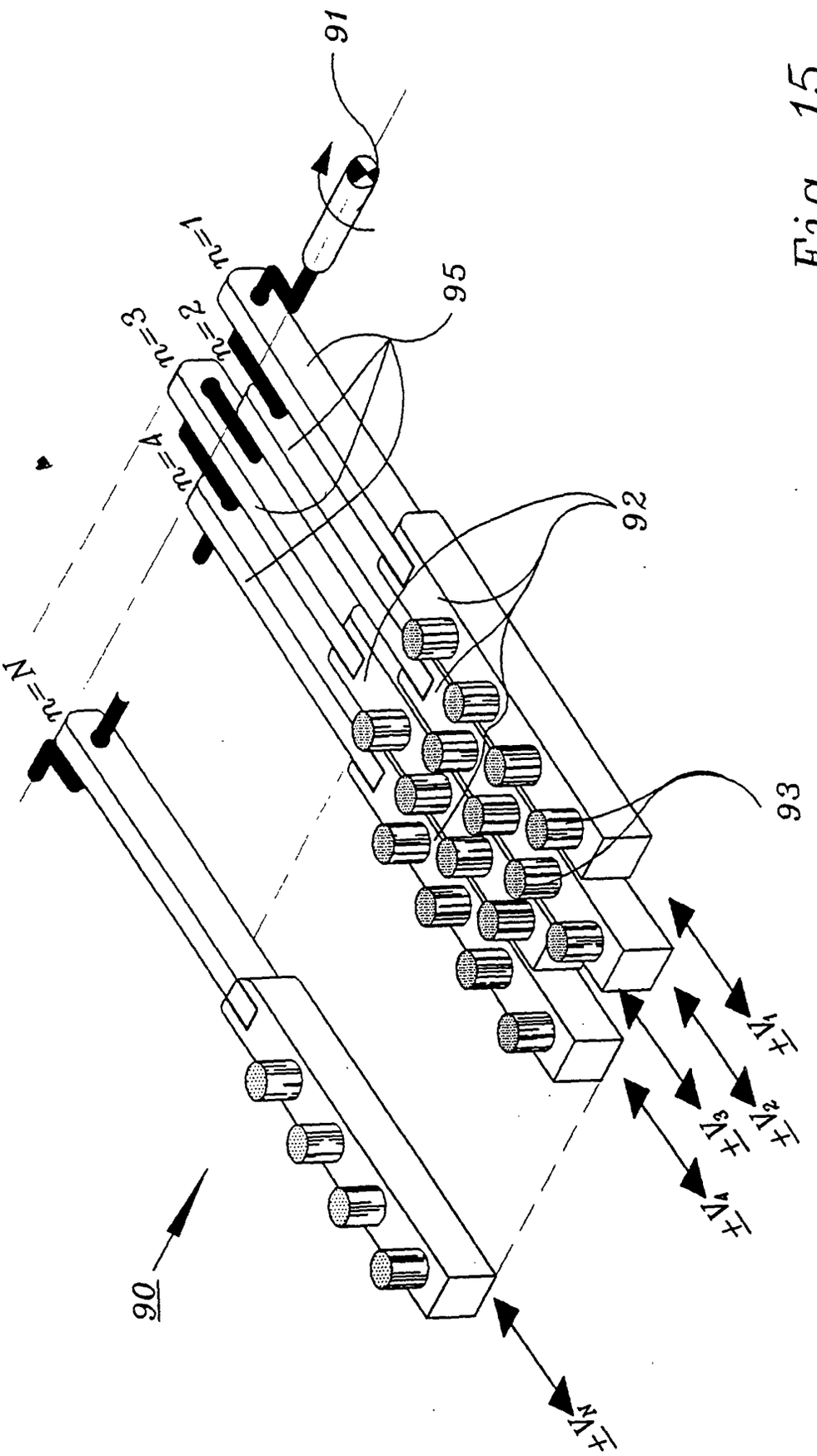

Fig. 15

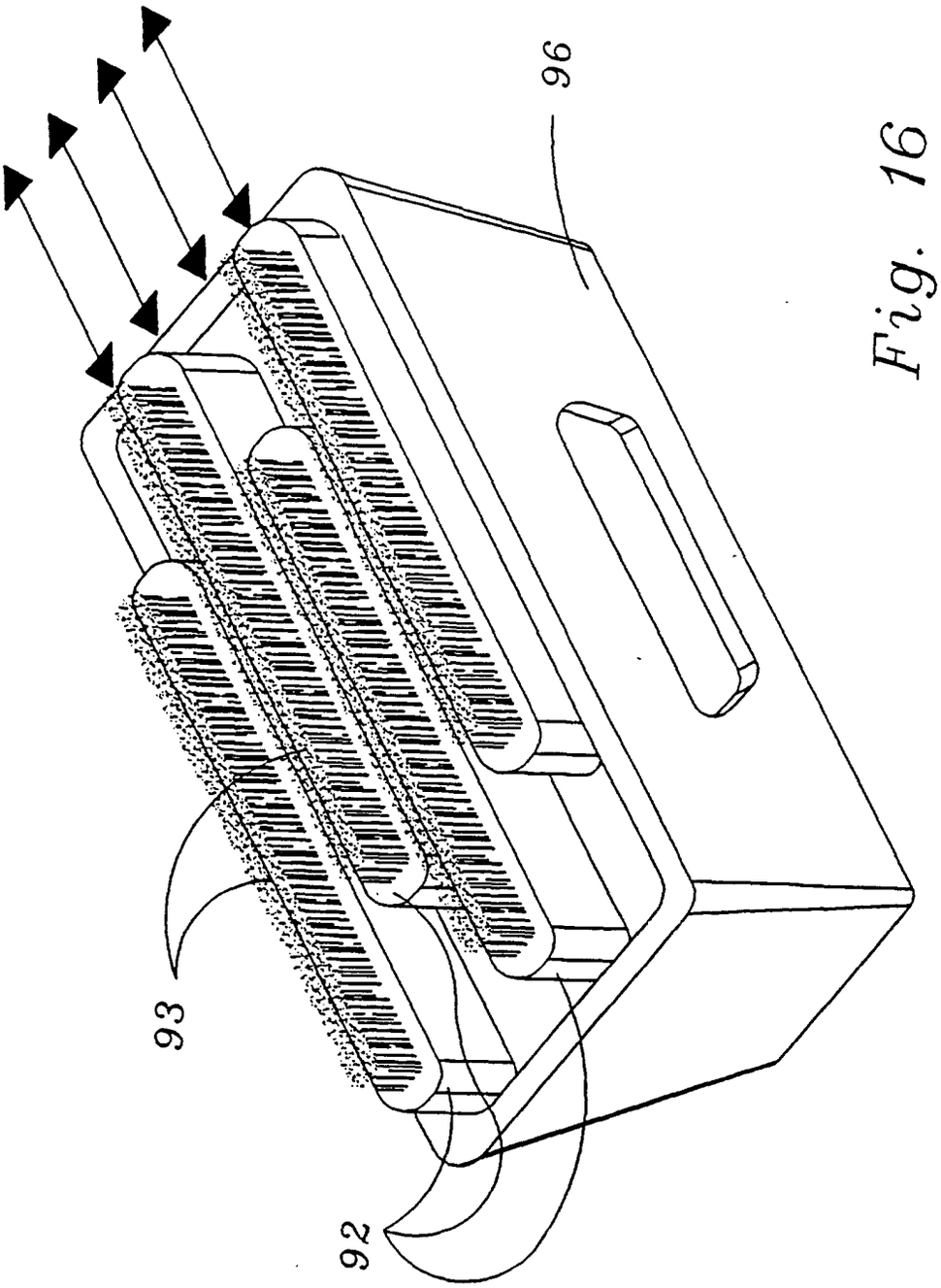

Fig. 16

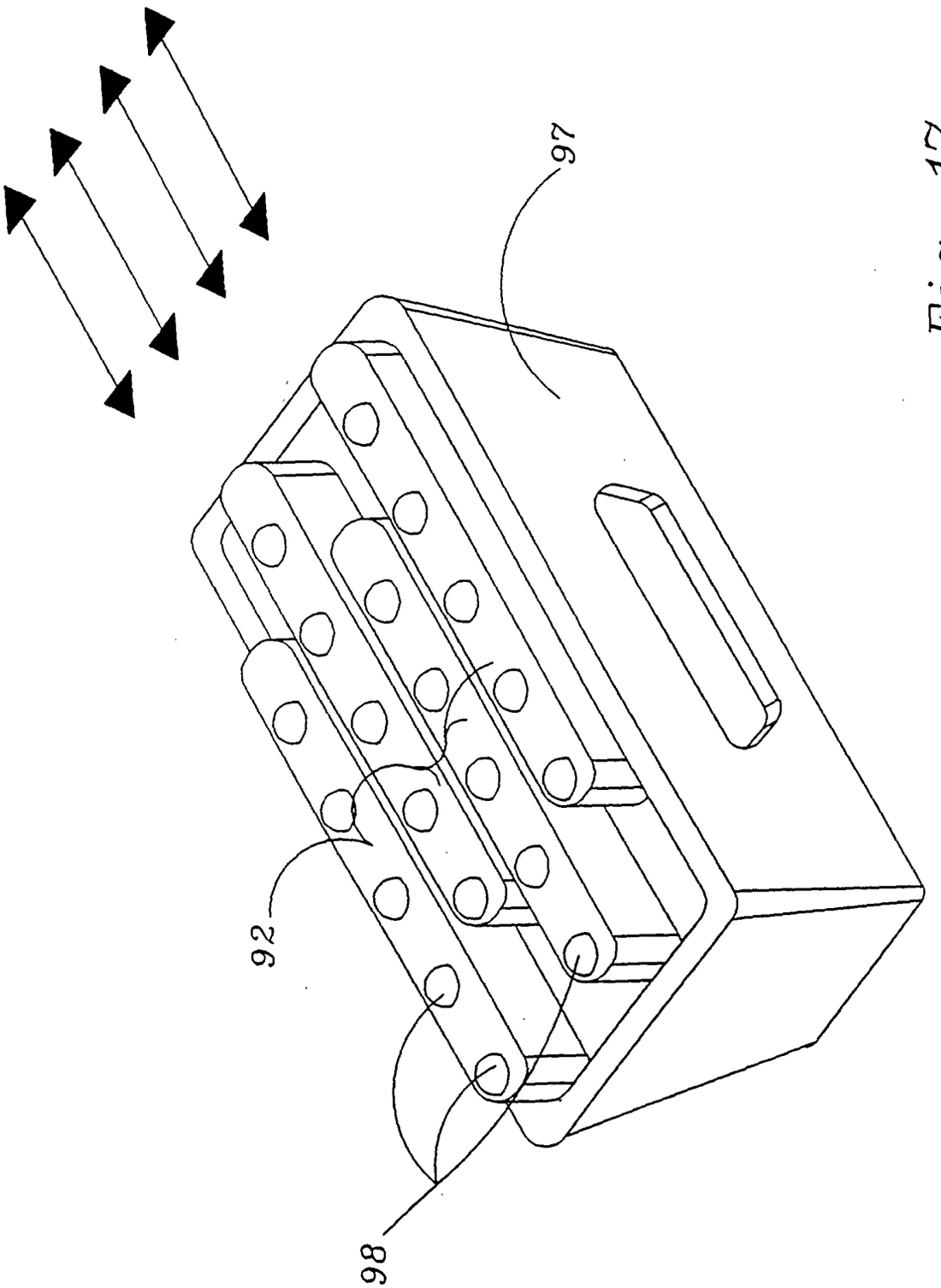

Fig. 17

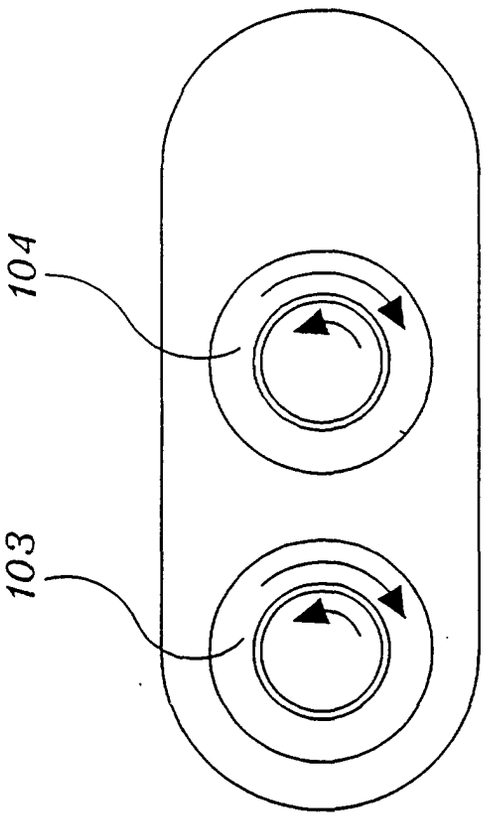

Fig. 18

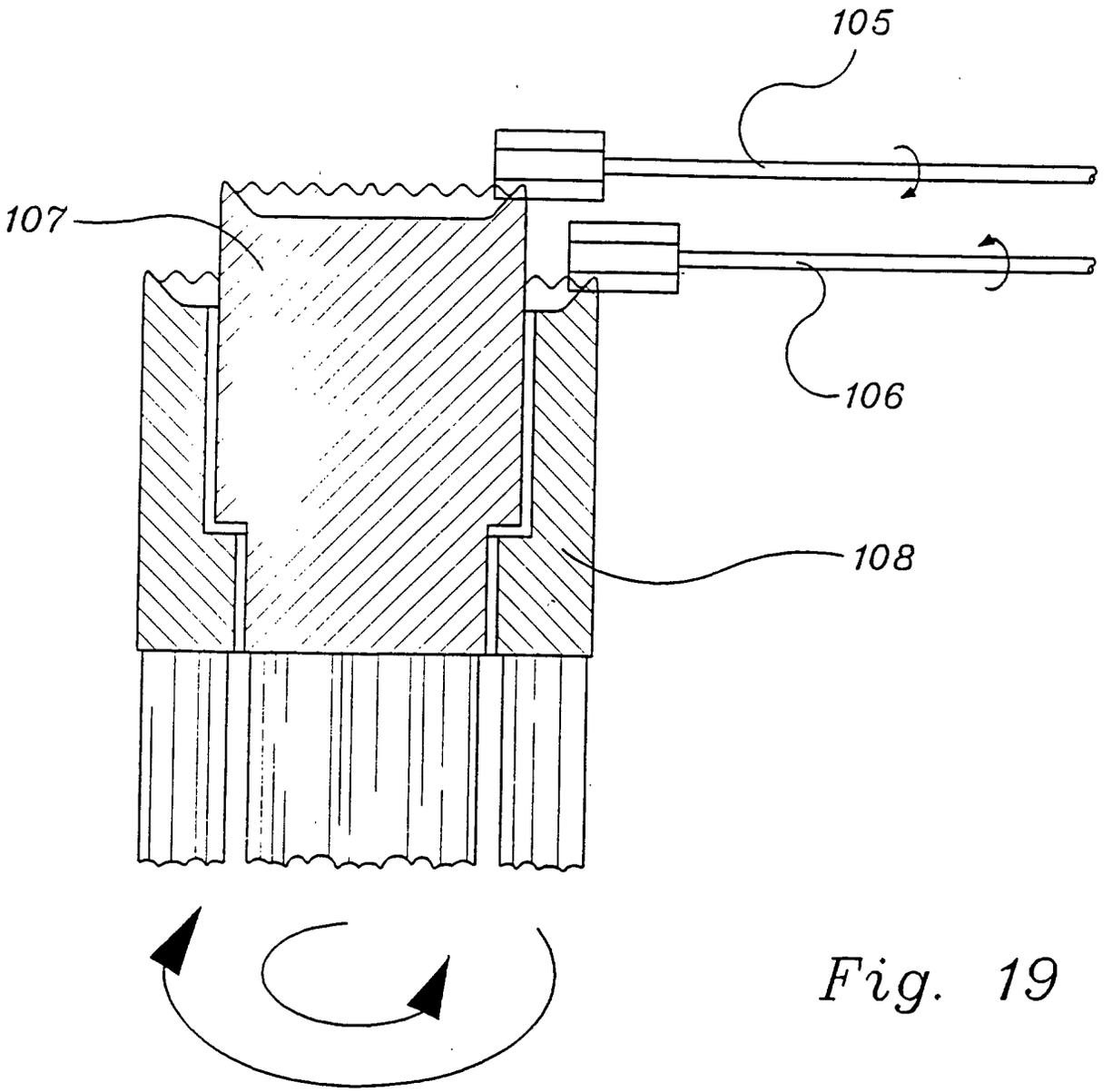

Fig. 19

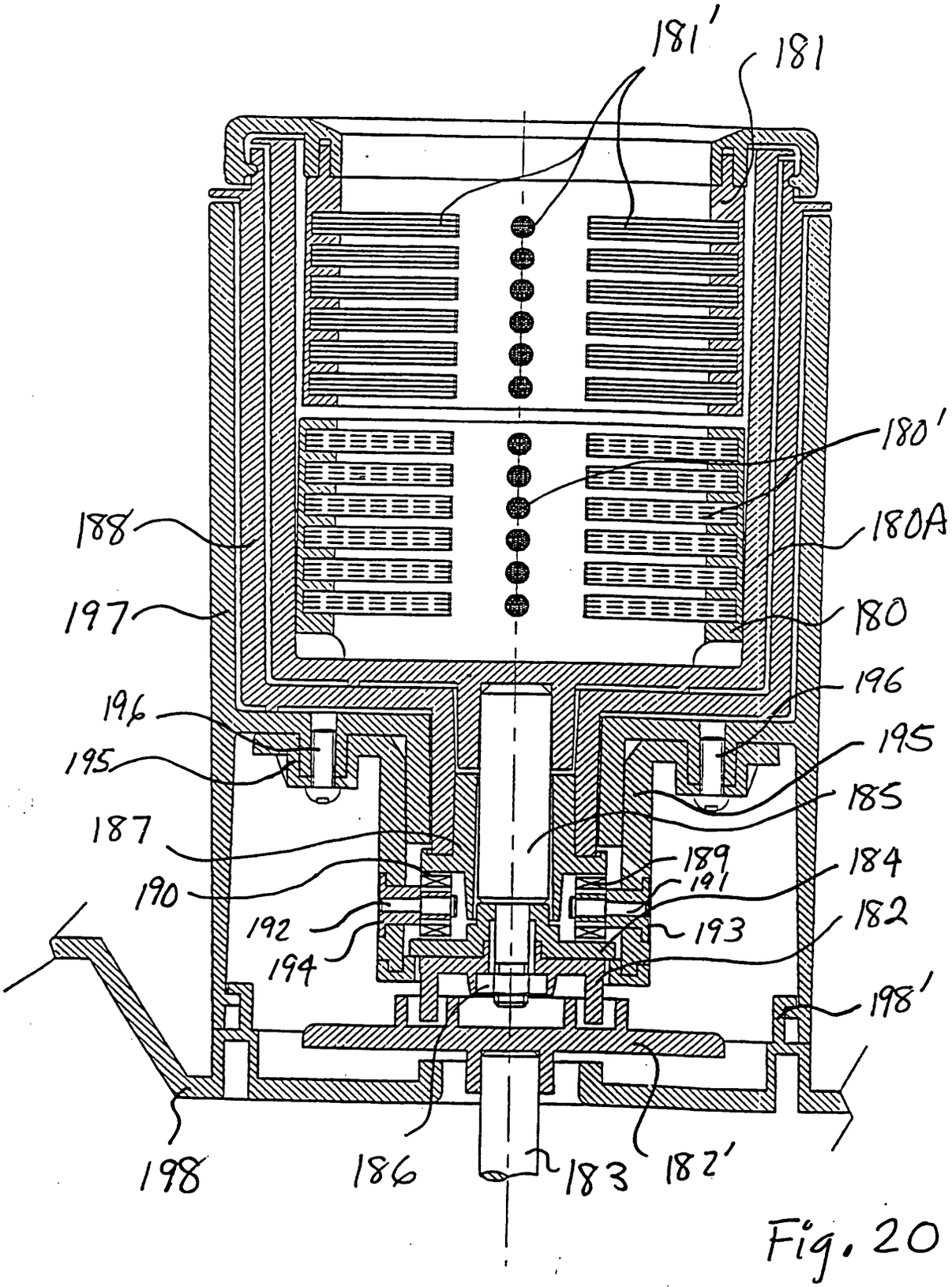
181'
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Fig. 20

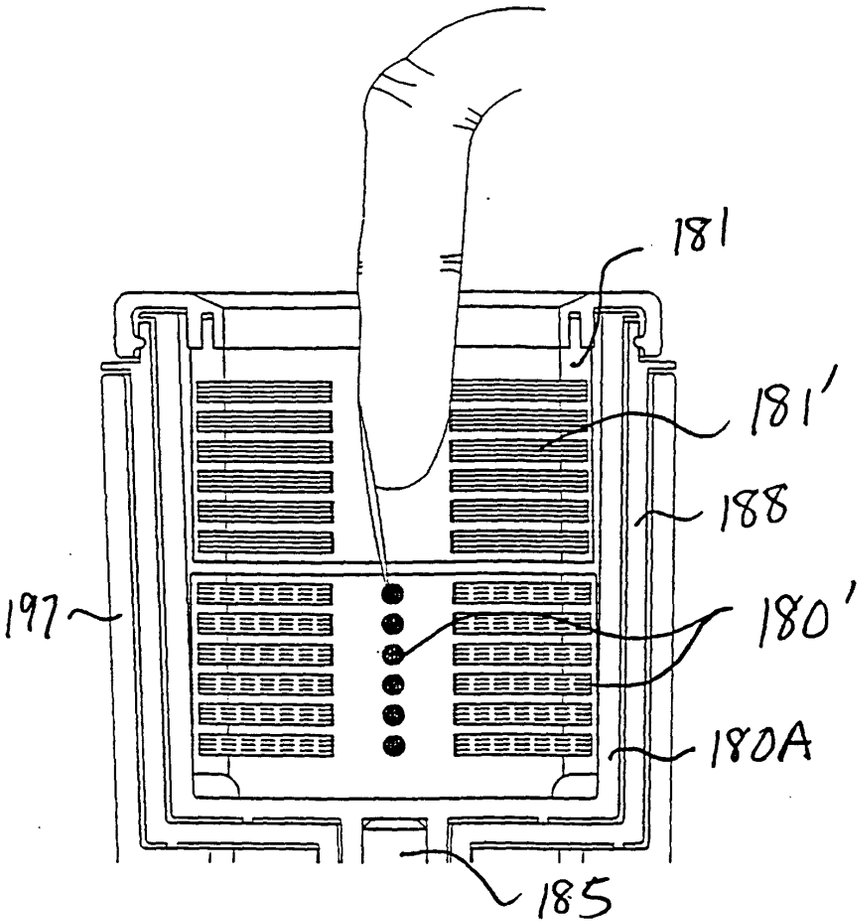

Fig. 20-1

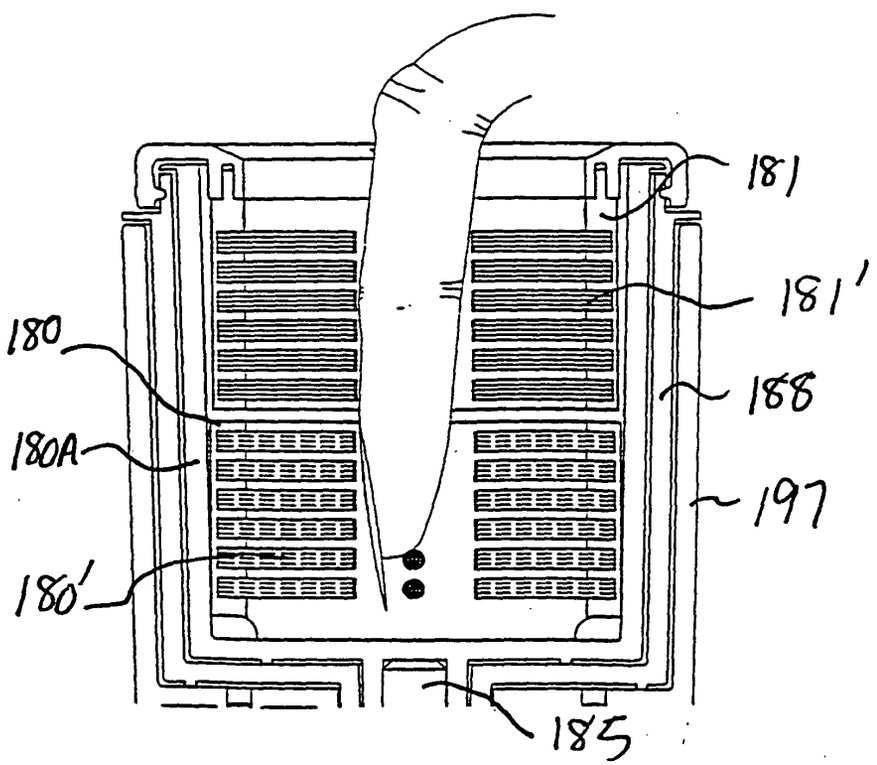

Fig. 20-2

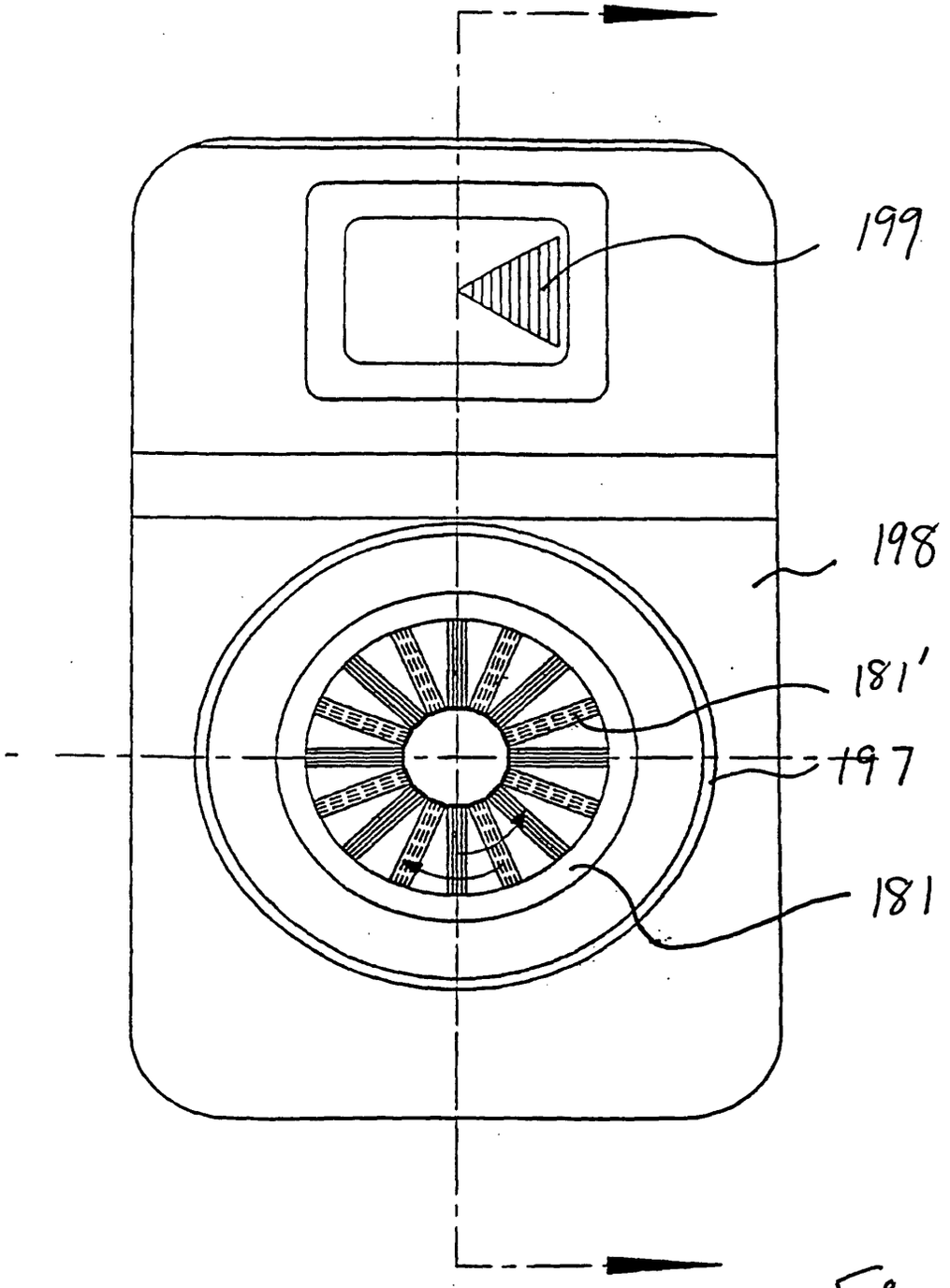

Fig. 20-3

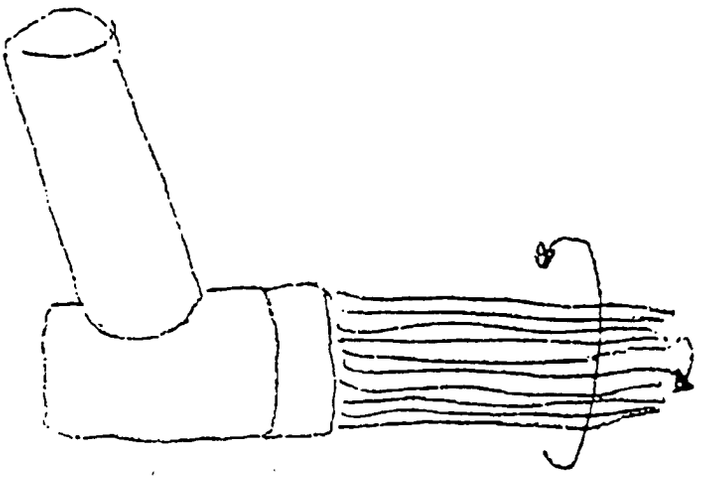

Fig. 23

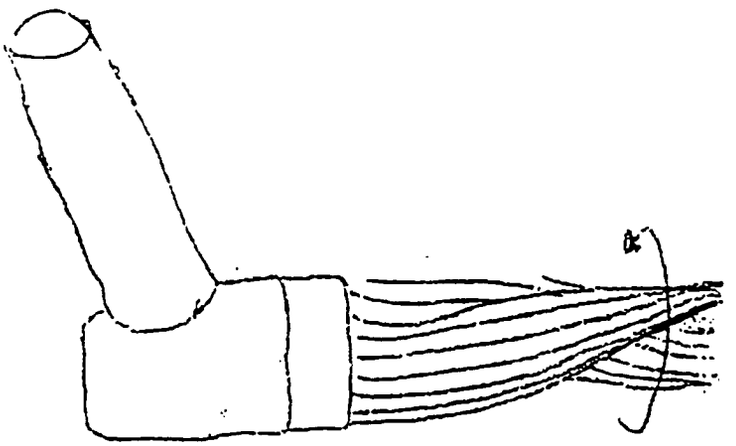

Fig. 22

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 30 1834

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	EP 0 744 139 A (CLIFFIELD IND LTD) 27 November 1996 (1996-11-27) * the whole document *	1-29,35, 36	A46B13/02
X	US 4 158 246 A (MEADOWS ROBERT J ET AL) 19 June 1979 (1979-06-19) * abstract * * column 1, line 66 - column 2, line 13 * * figure 11 *	1-4	
A		5-29,35, 36	
A	DE 34 43 124 A (COLUMBUS PROFIVAC GMBH) 28 May 1986 (1986-05-28) * abstract; figures *	1-29,35, 36	
A	PATENT ABSTRACTS OF JAPAN vol. 008, no. 140 (M-305), 29 June 1984 (1984-06-29) & JP 59 037357 A (MATSUSHITA DENKO KK), 29 February 1984 (1984-02-29) * abstract *	1-29,35, 36	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			A46B

~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
THE HAGUE	7 July 2000	Ottesen, R

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

European Patent Office

Application Number
EP 00 30 1834

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-29,35,36

European Patent Office

LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 00 30 1834

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. Claims: 1-29 35 36

   A household appliance including a rotating head divided into a plurality of coaxially rotatable members.

2. Claims: 30-34

   A personal grooming device of the type including a head, the improvement wherein the head is divided into a plurality of parallely movable members.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 00 30 1834

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

07-07-2000

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0744139 A	27-11-1996	CN 1150896 A	04-06-1997
		JP 9168496 A	30-06-1997
		US 6032313 A	07-03-2000
US 4158246 A	19-06-1979	NONE	
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EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82