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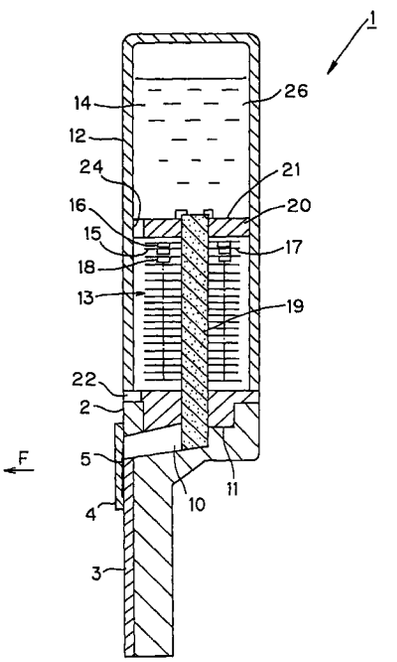
(54) INK RESERVOIR MEMBER AND INK JET RECORDING APPARATUS AND WRITING INSTRUMENT USING THE SAME

(57) An ink reservoir member is equipped with all the constituents necessary for the ink reservoir and moreover, mitigates the limit of the thickness of a blade portion, increases an ink reserving quantity and improves functionality. Further, this member is not particular in selecting the materials of sheet-like members and can use all the water base inks and the oil base inks by using an axially stretched material of polyester films, for example. Therefore, the ink reservoir member can be produced easily and economically. An ink jet recording apparatus and a writing instrument use this ink reservoir member. The ink reservoir member (13) is constituted by laminating a plurality of flat-spread sheet members (15) and a plurality of protuberance portions (16) are formed on the surface of each sheet-like member (15) with suitable gaps between them by embossing or printing. Laminated sheet-like members are positioned substantially parallel to one another with preset intervals by the protuberance portions (16) in such a fashion as to define slits (18), and all the sheet-like members (15) are in contact with a ink conduit (19).

FIG. 4



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Description

Technical Field

[0001] The present invention relates to an ink collector (also referred to as an ink flow regulator, a collector or bellows) which is disposed in a printing portion between an ink tank having an air replacement hole and a printer head or an ink-jet head, and which can be manufactured easily producing beneficial functions as well as being able to secure a large ink capacity. The present invention also relates to an ink-jet recording apparatus using this ink collector.

[0002] Further, the present invention relates to a writing implement, and in particular relates to a writing implement for ejecting and applying a cosmetic liquid etc., or for drawing and/or writing, which includes: an ink conduit path for supplying ink within the ink tank to the pen tip; an ink collecting for retaining the overflow ink when the ink from the ink tank overflows due to pressure variations caused by environmental changes of the interior and exterior of the ink tank; and an air replacement hole formed in the ink tank.

Background Art

[0003] Conventionally, concerning an ink-jet printer which ejects ink droplets from the nozzle so as to cause the ink to transfer and adhere onto the recording paper, a proposal 'an ink-jet head' has been already disclosed in Japanese Patent Application Laid-Open Hei 2 No. 293,153. The technology of this publication is understood from the written contents to use an ink collector which is formed by an integral molding technique.

[0004] In general, a writing implement needs to be configured so that a proper amount of ink will continuously move from the ink tank to the pen tip. For this purpose, there is a type which has an ink collector (or ink collecting portion) for retaining overflow ink. An ink collector is used for many types of writing implements which hold fluid ink, such as a fountain pen, small-tube type writing implement, felt-tipped pen, water-base ball-point pen, cosmetic applicator, etc.

[0005] An ink collector is generally called a collector, bellows, or a flow regulator. The ink collector will also be referred to as a collector in the description hereinbelow.

[0006] A collector, in general, is produced as an integrated mold by injection molding using synthetic resin.

[0007] A typical configuration of a writing implement having such a collector is shown in Figs.1 and 2. The writing implement a shown in Figs.1 and 2 includes: a writing implement body b having an ink tank b1 defined in the inner peripheral portion thereof for storing ink and having an opening at its axial end; a collector c, having multiple plate-like vanes c1 arranged axially and integrally molded in parallel to each other at intervals (laid out in a comb-like manner in a side sectional view) and inserted inside writing implement body b, for temporarily retaining ink in comb-like grooves c2 between vanes c1; a front barrel d fitted to the front outer periphery of collector c; a pen core e having pen tip e1 fitted inside front barrel d; and a rear barrel f attached to writing implement body b so as to accommodate the rear part of writing implement body b. This writing implement is a type of which front barrel d is press fitted into writing implement body b and is usually called as a felt pen. Ink tank b1 has an air replacement port g for conducting air into ink tank b1 and flowing the overflow ink into collector c.

[0008] In the fields of ink-jet printers and writing implements, the collector which is practical and producible in the present technology is limited by the structural configuration of the metal die for integral injection molding or by the technical conditions of injection molding, so that the dimensions of collector c for the best functions are specified as follows: the parallel clearance (the clearance between comb-like teeth in the vertical section; this parallel clearance between the vanes will be called 'slit width' hereinbelow) of vanes c1, arranged like a comb, viewed in the vertical section of collector c and forming the ink retaining portion is 0.2 mm. minimum; the depth of vane c (the distance from the periphery to the root of the comb-like teeth in the vertical section) is 3 mm. maximum; and the thickness of vanes c1 (the comb-tooth width in the vertical section) is 0.3 mm. minimum.

[0009] On the other hand, Japanese Utility Model Publication Hei 6 No.38,711 discloses another type of collector which is formed as an assembly of multiple parts, differing from the above collector of an integral molding type.

[0010] In accordance with this technology disclosed in Japanese Utility Model Publication Hei 6 No.38,711, as illustrated in the figure, a planiform element (1) forming a comb-like tooth of the ink collecting portion having a comb-like vertical section of the conventional collector has a projection (3) and a hollow (4) in the center thereof with the thickness in the central part, i.e., the difference in thickness of the projection and the hollow, defined greater than the thickness of the peripheral portion. That is, this planiform element has a difference in thickness in its parts, and this thickness difference is used to create the comb-like shape for the ink collecting portion by laying multiple pieces of the elements in layers with their projections fitted in the adjacent hollows.

[0011] As is apparent from the drawings in the same publication, the comb-like shape in the vertical section of this configuration has a so-called cantilever structure in terms of the structural mechanics. Although no illustration is provided, the publication also refers to provision of an equivalent clearance-forming configuration to that formed by laying multiple planiform parts in layers, by fitting two types of discs having different diameters in an alternate manner into a

straight pipe element. From this viewpoint, this publication is considered to disclose a layered type comb-like collector characterized with the cantilever structure.

[0012] The actions or functions of a collector are described in 1) to 3).

1) Mainly, the collector is provided to prevent ink blotting from the ink-jet head or the pen tip due to the pressure difference between the interior of the ink tank and the outside air. No problem will occur when the tank is filled up with ink without leaving any space, but the ink inside the tank is replaced by outside air as the ink is consumed by printing or writing, forming a space inside the tank. Due to the pressure difference between the tank interior and exterior, or specifically, when the outside air pressure lowers or when the pressure within the tank increases by gas expansion due to increase in temperature in the ink tank, ink overflow from the tank will occur until the internal pressure within the ink tank becomes balanced with the outside air pressure. This overflow ink is retained in the collector to thereby prevent ink blotting from the head or the pen tip.

2) When the internal pressure within the ink tank lowers relative to the outside air pressure, outside air will enter the tank until the pressure within the tank becomes balanced with the outside air pressure, in an opposite manner to the above case 1). In this case, however, while ink is retained in the collector, the ink being retained within will necessarily return first into the tank, thereafter air will be initially taken into the tank through the air replacement hole if the pressure within the tank is still low.

3) When ink is consumed with some ink residing in the collector, the ink within the collector will be consumed (reduced) before the ink within the tank, thereafter the ink within the tank will be used.

[0013] As described above, there is a minimum limit to the slit width of the ink collecting portion in manufacturing the collector by integral injection molding of synthetic resins according to the existing technology, due to the limitation determined by the fabrication of the metal die and the molding process. Therefore, when ink overflow occurs, there is a limit in providing capillary forces for the slits to retain the ink within the collector so that the ink will not blot from the ink-jet head or the pen tip. Further, there is a limit to the thinning of the vane's thickness while it is not reasonable to excessively increase the number of collector vanes which amounts to an excessive increase in length of a writing implement. Therefore, the collector's amount of ink retainability is limited. Practically, the volume of ink retained by the collector according to the existing technology is as small as 0.4 ml (milliliter).

[0014] As stated in 1), if the volume of the ink tank is enlarged, the retaining capacity of the collector necessarily needs to be greater. If there is a limit to this ink retaining capacity, the volume of the ink tank will be also limited. In particular, if a collector is used for a writing implement for drawing thin lines such as a fountain pen, it can provide an ample writing distance even with a lower amount of ink within the ink tank, so that the existing collector is effective enough in retaining the ink for practical applications.

[0015] However, due to recent diversified demands for writing implements and/or development of inks etc., some types of writing implements such as underline markers and cosmetic applicators, which need an ample supply of ink (or paint) for drawing, produce the problem of needing frequent ink refill, and hence practical applications are limited to a certain range.

[0016] The technology disclosed in Japanese Utility Model Publication Hei 6 No.38,711 suffers from some problems. It is presumed from the description, that the disc-like planiform element has a slit cut from the rim to the center in the disc-like portion, so that the disc portion is formed in a C shape or in a ring shape with an open part. Accordingly, the disc-like portion is separated with respect to the circumferential direction, so it is liable to deform because it has a lower rigidity with respect to a force acting in the diametric direction than that of the full-disc configuration, which is apparent from the viewpoint of structural mechanics. To secure the rigidity presents an obstacle in reducing the thickness of the disc. So, this limits the thickness in spite of the necessity of a further thinner disc, and hence the practical applications are limited to a certain range.

[0017] Further, all the discs need to be put with their slits cut therein in alignment with each other. For this purpose, as shown in Figs.1 and 2 of the aforementioned publication, the circular projection (3) and the hollow (4) formed with a notch in part are fitted to each other, while the slit width between the vanes is adapted to be formed by the difference in thickness between the projection and hollow. Here, when a collector is formed with parts of synthetic resin, upon the formation of slits having a width for retaining ink it is very difficult to form planiform elements having a greater vane area with a thin vane thickness whilst preventing the vanes from being deformed and securing their flatness. Therefore, the selection of resin materials and/or the cycle and number of taking injection molds are limited greatly, which brings about technical difficulties and obstacles to the reduction in cost. Resultantly, the product will have the problem of being expensive and produce difficulties in securing an ample ink retaining amount.

[0018] Further, suppose that in the conventional collector configuration having a comb-like vertical section, the vanes are made thinner or the depth of the slits is made greater than the above limited dimensions. In this case, when, with ink existing in the collector, a head of fluid is applied between the ink ejecting port or pen tip and the collector, the slits between vanes around which ink is present are temporarily kept parallel with each other, but the vanes are drawn

together in blocks due to the action of ink's surface tension with the passage of time, falling into an equilibrium state. Therefore, the slits become narrowed within the block while adjoining blocks become parted from each other by one slit width plus the sum of differential widths of the narrowed slits.

[0019] Since the widened slits cannot perform the function of collector to hold ink, if all the vanes are formed into blocks, the retained amount of the collector lowers proportionally to the reduction of the ink retaining capacity. This will cause ink blotting or forward leakage of ink from the ink ejecting port or pen tip. Further, in the case of a writing implement, if the cap is on, the ink accumulates within the cap, producing the critical defect of ink spilling when the cap is taken off. In view of the volume of the collector portion, the volume capacity of ink retention is reduced by the total volume of the widened portions. Thus, in spite of careful designing of the collector, the function reduces, producing critical defects.

[0020] The present invention is to solve the above problems of the prior art, and it is an object of the invention to provide an ink collector in which the limit to the thinning of the vane's thickness is loosened so as to enlarge the ink retaining capacity in the collector while the functionality is improved, and which can be easily manufactured at a low cost using a material for the sheet elements from wide variations (for example, if a biaxially extended film of polyester is used, the product can be used for all types of ink including oily base or water base ink), as well as providing an ink-jet recording apparatus and a writing implement using this ink collector.

Disclosure of the Invention

[0021] The present invention is configured as follows in order to attain the above object.

[0022] In accordance with the invention of Claim 1, an ink collector for temporarily retaining overflow ink from the ink tank, includes: sheet elements extending flat, piled in layers, the sheet element having a plurality of raised portions formed on the surface thereof at appropriate spans, and is characterized in that the raised portions keep adjacent sheet elements piled in layers, in approximately parallel at a desired distance to create clearance for retaining overflow ink, and all the sheet elements constituting the clearance are in contact with the ink conduit path.

[0023] In accordance with the invention of Claim 2, the ink collector defined in Claim 1, is characterized in that the raised portions are formed by a printing method.

[0024] In accordance with the invention of Claim 3, the ink collector defined in Claim 1 or 2, is characterized in that the sheet elements are formed of plastic film.

[0025] In accordance with the invention of Claim 4, the ink collector defined in Claim 1 or 2, is characterized in that the sheet elements are formed of metal sheet.

[0026] In accordance with the invention of Claim 5, the ink collector defined in any one of Claims 1, 2, 3 and 4, is characterized in that the ink conduit path is formed of felt or nonwoven fabric, a fabric bundle of long or short fibers, a flocculent material, continuous porous material, continuous porous foamed material, or the like. In accordance with the invention of Claim 6, the ink collector defined in any one of Claims 1, 2, 3 and 4, is characterized in that the ink conduit path is formed by a plastic mold by extrusion or injection molding and retains and leads ink by capillary force.

[0027] In accordance with the invention of Claim 7, an ink-jet recording apparatus having an ink-jet head with an ink collector for temporarily retaining overflow ink from the ink tank, is characterized in that the ink collector is composed of sheet elements, extending flat, piled in layers, and having a plurality of raised portions formed on the surface thereof at appropriate spans, and the raised portions keep adjacent sheet elements piled in layers, in approximately parallel at a desired distance to create clearance for retaining overflow ink, and all the sheet elements constituting the clearances are in contact with the ink conduit path.

[0028] In accordance with the invention of Claim 8, the ink-jet recording apparatus defined in Claim 7, is characterized in that the ink collector is one of those defined by Claims 2 through 6.

[0029] In accordance with the invention of Claim 9, the ink-jet recording apparatus defined in Claim 7, is characterized in that the ink collector is integrated with the ink-jet head.

[0030] In accordance with the invention of Claim 10, the ink-jet recording apparatus defined in Claim 7, is characterized in that the ink collector and the ink tank are integrated into a cartridge.

[0031] In accordance with the invention of Claim 11, the ink-jet recording apparatus defined in Claim 7, is characterized in that the ink tank has a removable configuration with respect to the ink collector.

[0032] In accordance with the invention of Claim 12, the ink-jet recording apparatus defined in Claim 7, is characterized in that the ink collector has a multiple number of sheet elements put in layers in a container and the gap between the inner surface of the container and the sheet elements are set greater than the slit width between the sheet elements.

[0033] In accordance with the invention of Claim 13, the ink-jet recording apparatus defined in Claim 7, is characterized in that the sheet elements are arranged in layers with the normal to their planes set horizontally.

[0034] In accordance with the invention of Claim 14, a writing implement having an ink conduit path and an ink collector for retaining overflow ink between an ink tank having an air replacement hole therein and the drawing point, is characterized in that the ink collector is composed of sheet elements, extending flat, piled in layers, and having a plu-

rality of raised portions formed on the surface thereof at appropriate spans, and the raised portions keep adjacent sheet elements put in layers, in approximately parallel with a desired distance to create clearance for retaining overflow ink, and all the sheet elements constituting the clearances are in contact with the ink conduit path.

[0035] In accordance with the invention of Claim 15, the writing implement defined in Claim 14, is characterized in that the raised portions are formed by a printing method.

[0036] In accordance with the invention of Claim 16, the writing implement defined in Claim 14 or 15, is characterized in that the sheet elements are formed of plastic film.

[0037] In accordance with the invention of Claim 17, the writing implement defined in Claim 14 or 15, is characterized in that the sheet elements are formed of metal sheet.

[0038] In accordance with the invention of Claim 18, the writing implement defined in any one of Claims 14, 15, 16 and 17, is characterized in that the ink conduit path is formed of felt or nonwoven fabric, a fabric bundle of long or short fibers, a flocculent material, continuous porous material, continuous porous foamed material, or the like.

[0039] In accordance with the invention of Claim 19, the writing implement defined in any one of Claims 14, 15, 16 and 17, is characterized in that the ink conduit path is configured integrally with the pen tip by the extension from the pen tip toward the rear up to the ink tank and is formed of a fabric bundle of long or short fibers.

[0040] In accordance with the invention of Claim 20, the writing implement defined in any one of Claims 14, 15, 16 and 17, is characterized in that the ink conduit path is a trunk core formed by using a sintered core of plastic.

[0041] In accordance with the invention of Claim 21, the writing implement defined in any one of Claims 14, 15, 16 and 17, is characterized in that the ink conduit path is configured integrally with the pen tip by the extension from the pen tip toward the rear up to the ink tank and is formed using a sintered core of plastic.

[0042] The principle of the invention will be described hereinbelow.

[0043] In the ink collector for use in an ink-jet recording apparatus or in a writing implement, when overflow ink is held in equilibrium within the collector, this indicates that ink is tied from the ink tank to the printer head or ink-jet head, or to the pen tip (including the ink conduit path and the collector). This will be called 'ink column' hereinbelow. A force corresponding to the vertical height of the ink column, including the printer head or pen tip and the ink conduit path, from the position of the printer head or pen tip to an arbitrary point (for example, the position from which the surface of a vane opposing another forming a slit pulls up ink by capillary force (to be referred to as the upper end, hereinbelow)), or the head of fluid as mentioned in terms of fluid mechanics, will act downward.

[0044] More specifically, the head of fluid is zero at the upper end while the head of fluid becomes equal to the vertical height of the liquid column itself at the position of the printer head or pen tip. On the other hand, the capillary force at the upper end acts from the ink conduit side toward the outer periphery of the vane to hold the overflow ink within the collector. When noting the pressure distribution inside the liquid column from the upper end to the printer head or pen tip, the difference obtained by subtracting the force corresponding to the liquid column at an arbitrary point in the liquid column to the upper end, or the head at that point, from the capillary force, will act as the negative pressure at that point within the liquid column with respect to the outside air pressure.

[0045] At the upper end, the capillary force itself is the negative pressure, which will act in such a direction as to narrow the intervals between vanes for slits in the collector. More strictly speaking, when the surface of the vane is kept horizontal so as to make the head constant throughout the slit, this state is equivalent to a condition where uniform load is acting on the entire surface of the vane defining the slit width.

[0046] The conventional collector written in Japanese Utility Model Publication Hei 6 No.38,711 has a structure in which each vane is fixed on one side thereof extending like the eaves or projecting overhang, and is referred to as a so-called cantilever structure in terms of the structural mechanics. Here, if the vanes are made thinner and/or if the distance from the fixed end in the section of the comb-like structure is made greater than the limitation, the vanes warp in accordance with the thickness of the vanes and the cantilever length so as to narrow the slit width. This situation is the same as the case where a flat plate having a cantilevered side in a 'flat-plate structure' in terms of strength of materials warps when a load exceeding a certain level is applied to cause stress within the plate. That is, the capillary force acts on the portion containing ink as the negative force applying uniform load on the portion where ink is held. When vanes are formed into blocks, the number of vanes within one block will be determined catastrophically depending upon the incidental direction in which adjacent vanes begin warping. When stabilized, the situation will fall into the equilibrium stated above.

[0047] In the conventional collector structure having a cantilevered structure in terms of structural engineering, there are limitations and constraints against solving the above problems, but the present invention solves those problems by providing a collector which has a continuous beam structure in terms of structural engineering and which can be fabricated easily at low price.

[0048] This continuous beam structure of the present invention is devised by simulating the relationship of the floor framing between the base and floor surface, in which base elements are laid out with adequate intervals so as not to produce any warp in the floor surface in a building. That is, when the vanes are made thinner and/or when the area of the sheet element is made greater, supporting points regulating the slit width are formed by bumps so that the vanes

will not be deformed by bending stress attributed to capillary forces and head of fluid, the supporting points are separated away from each other with long enough distance within the range which will not cause any warp in vanes, while a required or sufficient number of bumps are formed on the surface of the vanes, to thereby attain the object and complete the present invention.

(1) In accordance with the present invention, the collector which is composed of layered sheet elements having bumps formed by embossing or other method, can be made large as to the size of the sheet elements, hence increasing the volume of the collector retaining overflow ink. Therefore, it is possible to provide a greater ink tank and thereby increase the amount of ink for use.

(2) Concerning the slits retaining ink, bumps are formed appropriately apart by embossing or the like so as to maintain the slits opposing the capillary force tending to make the slit width narrower, to thereby keep the slit width constant. Thus, this configuration can produce stable connector functions.

(3) The sheet elements can be made thinner, so that it is possible to improve the volume efficiency of the ink retaining space in the total volume of the ink collector.

(4) The sheet elements are optimally processed as to wettability with ink when they are in a flat sheet, so this permits a variety of ink to be used, such as water-based, oil-based ones, etc.

[0049] Based on the above principles, the present inventor has devised an ink collector or an ink collector (also called a collector) for an ink-jet recording apparatus and for a writing implement, which has a large capacity of retaining ink and improved in its functionality.

[0050] If the slits in an integrally molded collector are cross-sectionally cut, the vanes are separated into individual sheets . In accordance with the present invention, sheet elements similar to the above sheets as to shape and structure can be fabricated and accumulated in layers so as to produce the same functions as the conventional collector. In addition, each sheet element extends in a plate-form in contact with the ink conduit path without gap. Therefore, differing from the conventional vanes in which a cutout (slit) is formed, there is no restriction on the thickness, so that it is possible to easily fabricate a collector having a large retaining capacity.

[0051] When the width of the slit (the gap between adjacent vanes) is to be considered, the bumps mentioned in (2) above may be formed on the sheet elements by an embossing process or by creating steps, so that it is possible to easily produce a desired slit width by designating the bump features.

[0052] This fact not only produces great flexibility in design for an ink collector, or an ink-jet recording apparatus or writing implement, but also enables the product to response speedily to the environmental change so as to eliminate drawbacks of ink seepage or blotting and hence improve the functionality as the flow regulator.

[0053] Further, since the conventional collector is integrally molded with a multiple number of vanes put in layers, the thickness of the vanes and the slit width have limitations in the manufacturing process, imposed by the structural restrictions of the metal die and/or by the functional restrictions in injection molding.

[0054] In contrast, since the sheet elements of the present invention can be molded one by one, the thickness of the vanes has no limitation in manufacturing unlike the above so that the vanes can be easily made thinner, whereby it is possible to reduce the total volume of the collector. Besides, since the total thickness of the vanes can be reduced, the total length of the collector when the sheet elements are put in layers (the length in the direction of the layers) can be lessened. Accordingly, the head of fluid from the ink ejection end (for example the ink-jet front or the pen tip of a writing implement) to the slit portion can be made smaller, so that it is possible to increase the retaining capacity and reducing the dead space to improve the volume efficiency as well as to improve the functionality as the flow regulator and reduce the cost.

[0055] Concerning the structure of the sheet elements to be accumulated in layers, when the sheet elements are piled one over another, the spaces (slits) configured by upper and lower sheet elements forming vanes for retaining overflow ink from the tank need to be formed in approximately parallel across the whole span. The structure further needs to have bumps (also referred to as gap keepers) for space keeping, formed thicker than the vanes, or formed integrally with the vanes.

[0056] In addition, the sheet elements arranged in layers have a conduit formed of holes or cutout therein for fluid communication with each other, so as to allow for the supply of ink from the ink tank to the nozzle in the ink-jet head or pen tip of the writing implement through this conduit.

[0057] Here, for example, bumps may be formed by providing raised mass over the vane in approximate center or around the periphery, with respect to the flat direction, of the sheet element.

[0058] Further, the sheet elements may have ink flowing channels which are formed continuously from the ink conduit path toward the sheet element surface to allow for ink communication between the ink conduit path and the slit when the sheet elements are put in layers. Since this configuration enables the overflow ink from the tank to go from the sheet elements into the ink conduit and vice versa through the ink flowing channel, ink can overflow continuously and uniformly into the slits from the inner side to the outer side, to thereby make it possible for the slits to retain ink without loss.

[0059] In the present invention, there is no limitation on the shape of the sheet elements. For example, it is effective for the retaining capacity if the size of the sheet elements (with respect to the directions in which the vanes extend) is successively increased or reduced along the layered direction of the sheet elements. However, the size of the sheet elements may be changed stepwise at any position along the layered direction.

[0060] Further, the planer shape of the sheet elements may be of a square, circle, a polygon or others.

[0061] The sheet elements forming slits for retaining ink do not need to be of a flat plane, but can be of a curved surface as long as the opposing faces of the adjoining sheet elements are kept parallel or approximately parallel when they are piled.

[0062] Moreover, the sheet elements may be formed by any material as long as it does not dissolve, swell, deform or will not be affected by the used ink, paint and the like and as long as it does not cause ink or the like to leak even if it might even cause degradation of the ink or the like. Accordingly, in contrast to the conventional collector which could use only limited materials such as ABS resin or the like in order to attain the desired functions, various types of resins (such as polypropylene, POM, PVC, PET, etc.) may be used in the present invention, which enables cost reduction of the material.

[0063] It should be noted that in order to generate capillary forces, the angle of contact with the used ink needs to be smaller than 90 degrees in any case.

[0064] In this invention, the structure allowing for ink communication between sheet elements by forming an ink flowing slit for enabling ink flow between the sheet elements may or may not be provided.

[0065] As the ink conduit path with which the slits exchange overflow ink on the path of ink passage from the ink tank to the nozzle of the ink-jet head or the pen tip of the writing implement, a part which leads the ink inside the ink tank may be fitted in. In this case, a formed part for fluid communication which can retain and lead ink by capillary forces may be fitted into the aforementioned ink conduit path. Other than such formed articles, so-called fabric core formed of a bundle of fibers, a trunk core, an element without outer cover used as the sliver, and the like may be used.

[0066] As an example, when, in the present invention, the outside shape of the sheet element and the inside peripheral shape of the conduit hole are formed of concentric circles when viewed in the vertical direction, there is no need to consider the placement of the sheet elements with respect to their circumferential direction. In this case, the conduit path formed of a fabric core can be imparted with appropriate elasticity so that it can come in close contact with the sheet elements, presenting beneficial functionality without fluctuations.

[0067] Ink flow passage formed in the sheet elements basically has no limitation as to its number, size and shape, but it needs to be designed so that the effective portion of the gap keepers for forming slits (the portion where a raised portion is formed in the center of the vanes, or where a separate spacer is inserted, or the like) will not be reduced and hence disturb the stability in forming the slit clearances when the sheet elements are put in layers. It is also necessary to form the ink flow passage in the number and size in conformity with the volume of the slit formed between a pair of vanes (the product of the vane area multiplied by the gap width).

[0068] It is preferred that the ink flow path should not have a smaller capillary force than that of the slit gap. Otherwise, the ink held in the slit breaks at this ink flow path and remains therein without capable of returning to the ink conduit path.

[0069] The raised portions in the sheet elements for forming slits may be formed on both sides of the sheet elements so as to put them without considering their orientation. It is also possible to provide a required structure on one side without forming anything on the other side.

[0070] When an ink collector is put in the container for an ink-jet head or writing implement and the ink collector is configured with a multiple number of sheet elements filled within a cylinder, the gap between the inner surface of the cylinder and the outer periphery of the sheet elements can be set greater than the gap between the adjacent sheet elements. By this setting, the capillary force of the gap between the inner surface of the cylinder and the outer periphery of the sheet elements will be weaker than the capillary force of the slits, so that the ink retained within the slits can be prevented from being left between the inner surface of the cylinder and the outer periphery of the sheet elements.

Brief Description of the Drawings

[0071]

Fig.1 is an illustrative view of a conventional writing implement;
Fig.2 is an enlarged illustrative view showing the writing implement shown in Fig.1;
Fig.3(a) is an illustrative view showing an ink-jet printer in accordance with the first embodiment of the present invention, especially an illustration of an ink-jet head;
Fig.3(b) is an illustrative view showing a supporting plate with a nozzle plate of the ink-jet head removed;
Fig.4 is a sectional view of Fig.3 cut along a IV-IV line;
Fig.5 is an illustrative view showing sheet elements of an ink collector;

Fig.6(a) is a plan view showing a sheet element of an ink collector;

Fig.6(b) is a vertical sectional view of the sheet element of the ink collector, cut along an A-A line in Fig.6(a);

Fig.6(c) is a detailed sectional view showing the B-portion of Fig.6(b);

Fig.7 is an illustrative view showing an ink-jet head of the first variation of an ink-jet printer in accordance with the first embodiment;

Fig.8(a) is an illustrative view showing an ink-jet head of the second variation of an ink-jet printer in accordance with the first embodiment;

Fig.8(b) is an illustrative view showing an ink-jet head of the third variation of an ink-jet printer in accordance with the first embodiment;

Fig.9 is an overall sectional illustrative view showing a writing implement in accordance with the second embodiment of the present invention;

Fig.10(a) is a plan view for illustrating a sheet element used in the writing implement in accordance with the second embodiment;

Fig.10(b) is a sectional view cut along a line A-A of Fig.10(a), for illustrating the sheet element of the writing implement in accordance with the second embodiment;

Fig.10(c) is an enlarged sectional view showing the B-portion of Fig.10(b), for illustrating the sheet element of the writing implement in accordance with the second embodiment; and

Fig.11 is an illustrative view showing the sheet elements put in layers.

The Best Modes of the Embodiments of the Invention

[0072] The first embodiment of the present invention will hereinbelow be described in detail with reference to the drawings.

[0073] Figs.3 through 6 are illustrative views of an ink-jet head 1 in an ink-jet printer (corresponding to ink-jet recording apparatus) in accordance with the first embodiment of the present invention. Fig.3 is an external illustrative view of ink-jet head 1; Fig.4 is a sectional view cut along a line IV-IV in Fig.3; and Fig.5 is an illustrative view of sheet elements (in which the dimension in the axial direction is magnified about 100 times).

[0074] As shown in Figs.3 and 4, ink-jet head 1 mainly comprises an externally cylinder-shaped ink tank 12 for reserving ink and a support base 2 having an approximately Γ-shape in its section, fixed to the lower part of ink tank 12. This support base 2 is fitted or engaged in some way, into the corresponding portion of an unillustrated ink-jet printer body so as to attach ink-jet head 1 to ink-jet printer body.

[0075] In this ink-jet head 1, a board 3 is attached on the front face (indicated by F) of support base 2. Junctioned to the front side of this board 3 is a nozzle plate 4 with an appropriate clearance 5 kept therebetween. This board 3 has a plurality of heat resistance elements 6 laid out, for example, in the vertical direction. Each heat resistance element 6 is connected to a corresponding contact 8 by an interconnection 7. Nozzle plate 4 has nozzle elements 9 arrayed and formed opposing respective heat resistance elements 6.

[0076] Formed on the top part of support base 2 is an ink tank fitting hollow 11 of an approximately cup-shape with an ink channel 10 which communicates with clearance 5 formed between board 3 and nozzle plate 4. Ink tank 12 has an ink collector 13 in its lower half and an ink reserving portion 14 above the ink collector 13, and the lower end of ink collector 13 is fitted in a watertight manner to ink tank fitting hollow 11 of the top face of support base 2.

[0077] Detailedly, as shown in Fig. 3, in ink-jet head 1 of this embodiment, an ink conduit path 19 and ink collector 13 for retaining overflow ink are provided between ink reserving portion 14 inside ink tank 12 made of resin and nozzle plate 4 while an air vent 22 is formed in ink tank 12.

[0078] Ink collector 13 is configured of sheet elements 15 extending in substantially flat plate forms. Each sheet element 15 has a multiple number of bumps (corresponding to raised portions) 16 of almost the same height embossed or printed on the surface of the flat plate portion (designated at 17) at appropriate spans. These bumps 16 keep layered, adjacent sheet elements 15 parallel with each other at desired intervals between the flat plate portions 17, 17, thus forming slits (clearances) 18 for retaining overflow ink. Here, all the sheet elements 15 defining slits 18 are formed in contact with ink conduit 19.

[0079] Figs.5 and 6 show sheet elements 15. Figs.6(a), 6(b) and 6(c) are a plan view, an A-A sectional view of (a) and an enlarged view of the B-portion in (b), respectively.

[0080] As shown in Figs.5 and 6, sheet element 15, generally is a flat-plate of a circular shape in its plan view. The sheet element has bumps 16 on the surface thereof which were embossed, i.e., pressed with male and female dies. The sheet element has a center hole 15a bored therein allowing for provision of ink conduit path 19. Bumps 16 are arranged along the periphery of center hole 15a and the rim of sheet element 15, in three rows, or on inner, middle and outer circles. As a specific example, sheet element 15 has a diameter D_1 of 20 mm, a thickness t_1 of 0.1 mm and a central bore having a diameter D_2 of 5 mm. Bump 16 is projected with an outside diameter D_3 of 1 mm and a height t_2 of 0.1 mm. The bumps in the inner row are arranged at six sites on a circle about the center axis (15e) having a radius R_1

of 3.5 mm (7 mm in diameter), equi-angularly 60° apart from each other; the bumps in the mid row are arranged at twelve sites on a circle about center axis 15e having a radius R_2 of 6 mm (12 mm in diameter), equi-angularly 30° apart from each other; and the bumps in the outer row are arranged at eighteen sites on a circle about center axis 15e having a radius R_3 of 9 mm (18 mm in diameter), equi-angularly 20° apart from each other.

[0081] It should be understood that sheet elements 15 are not limited to the above disc shape but they may be formed in an appropriate shape such as square. In the embodiment, bumps (raised portions) 16 are arranged equi-angularly and concentrically, but the present invention will not be limited to this. For example, bumps on the sheet elements may be provided at random so that raised portions will not sink into recessed portions of the embossment. In manufacturing the sheet elements, the whole part of a large sheet or a sheet roll may be formed with bumps by embossing or printing, and thereafter the sheet may be punched to the sheet element shape to produce the sheet elements.

[0082] The above sheet elements 15 may be formed of a plastic film or of a metal plate.

[0083] Bumps 16 of sheet elements 15 may be formed by a printing method, other than embossing. In this case, bumps may be formed by heaping the print ink into a raised mass of a desired height by flexographic press or the like, or may be formed by heating after printing so that the printed portions of ink may produce foams of a raised mass.

[0084] Although it is preferred that sheet elements 15 put in layers are held in parallel with desired intervals by means of bumps 16, the sheet elements are considered to be good enough if they are arranged in approximately parallel with each other as long as they can provide the designated performance as an ink collector.

[0085] Ink conduit path 19 can be configured of a trunk core which is formed with felt, nonwoven fabric or a bundle of long or short fibers (fabric bundle). This trunk core is a so-called fabric core of a fabric bundle with no outside cover, which is generally used for the writing core element of felt pens etc., trunk core element, sliver and the like, and preferably has an appropriate elasticity.

[0086] Other than the above, ink conduit path 19 may be of a bar-shaped resin molded core with slits on the side thereof, or may be of a sintered, inorganic or organic compound, or of any material having the same functions. Preferably, ink conduit path 19 should be of a trunk core formed of a sintered compound of plastic.

[0087] In the above ink-jet printer, as shown in Figs.3 and 4, air vent 22 is provided on the side face at the bottom of ink tank 12. This air vent 22 is adapted to communicate with ink reserving portion 14 above ink collector 13 via the space between the outer peripheral portion of sheet elements 15 of ink collector 13 and the inner wall of ink tank 12 and air replacement hole 24.

[0088] The lower end of ink conduit path 19 of ink collector 13 is connected to ink channel 10 of support base 2. This ink conduit 19 is configured of the aforementioned trunk core. The interior of ink reserving portion 14 above ink collector 13 is filled with ink 26.

[0089] Ink tank 12 is formed of a transparent material (for example, transparent plastic) so that the amount of ink can be checked externally.

[0090] Ink collector 13 is composed of multiple sheet elements 15 accommodated in layers in the lower half of cylindrical ink tank 12 having an air replacement port 24 on the top and is arranged so that the space between the inside peripheral surface of ink tank 12 and sheet elements 15 is wider than the width of slits 18 between sheet elements 15. By this configuration, the capillary force acting on the clearance between the inside peripheral surface of ink tank 12 and the outside periphery of sheet elements 15 is set weaker than that acting on slits 18, whereby it is possible to prevent ink retained within slits 18 from remaining between the inside peripheral surface of ink tank 12 and the outside periphery of sheet element 15.

[0091] Reference numeral 20 designates a rib part which presses the topmost sheet element 15 of the layers so as to keep the gap between sheet elements 15 constant, and is disposed with its top surface 21 facing ink reserving portion 14. The periphery of rib part 20 is fitted in close contact with the inside periphery of ink tank 12 with the aforementioned air replacement hole 24 formed at an appropriate position with an appropriate shape allowing capillary force to occur.

[0092] The capillary forces acting on ink 26 of ink-jet head 1, are set so that those acting on nozzle 9 > those on ink conduit 19 > those on air replacement hole 24 > those on slit 18. The capillary force of slit 18 in ink collector 13 is greater than the head of fluid from its position to nozzle 9. Naturally from the above inequality, the capillary force of air replacement hole 24 is also greater than the head of fluid from its position to nozzle 9.

[0093] The slits 18 may have an identical width. When nozzle 9 is laid out at the lower position, ink 26 overflowed and retained within slits 18 is affected by gravity acting on ink 26 itself (because ink 26 forms a water column). That is, if all the slits 18 have the same width, the closest slits 18 to nozzle 9 will retain the most amount of ink. Therefore, if the height of bumps 16 are reduced to make the width of slits 18 narrower (to thereby enhance the capillary force) as they are located higher, it is possible to reserve ink more efficiently.

[0094] Next, the operation of the embodiment will be described.

[0095] In the embodiment of ink-jet 1, ink 26 is supplied from ink reserving portion 14 to ink channel 10, passing through ink conduit 19 in the central portion of ink collector 13. The ink is further fed from ink channel 10 to clearance 5 between nozzle plate 4 and board 3. As a printing information signal is supplied, a thermal pulse is issued from a heat

resistance element 6. As a result, ink 26 within clearance 5 changes in its state when the thermal pulse is imparted and ejects from a nozzle 9 positioned opposing the heat resistance element 6 to adhere to the recording paper, thus effecting printing.

[0096] As the ejection of ink 26 onto the recording paper from nozzles 9 continues during printing, the ink within ink channel 10 reduces, but this will be compensated by the supply of ink 26 from ink reserving portion 14 of ink tank 12 through ink conduit path 19. Resultantly, ink 26 within ink reserving portion 14 reduces so that the internal pressure in ink reserving portion 14 lowers. Outside air is introduced from air port 22 into ink collector 13, so the pressure inside ink collector 13 is at atmospheric pressure.

[0097] When, as printing is continued, the difference of the internal pressure from atmospheric pressure exceeds the predetermined value, that is, the capillary force of air replacement hole 24 (more strictly speaking, the difference produced by subtracting the head of fluid from the position of air replacement hole 24 to the position of nozzle 9, from the capillary force of air replacement hole 24), the air within ink collector 13 enters ink reserving portion 14 through air replacement hole 24.

[0098] When the ambient environment around ink-jet head 1 changes, for example, the pressure lowers, or when the temperature inside ink tank 12 (ink reserving portion 14) rises due to use of the ink-jet printer, these conditions produce the same effects as the internal pressure inside ink reserving portion 14 has risen. As a result, ink 26 flows into ink conduit path 19. When the volume of ink therein exceeds the capacity thereof, ink 26 overflows to ink collector 13 and goes into slits 18 where the ink is retained by the capillary action of slits 18.

[0099] When the ink-jet printer is used with ink 26 temporarily held in ink collector 13 as stated above, the ink within ink channel 10 and ink conduit path 19 reduces. The reduction of the ink is replaced with the ink retained within slits 18 which are weaker in capillary force, so that the ink within slits 18 is first used. Then, as the ink within slits 18 is used up, ink 26 within ink reserving portion 14 is used, which lowers the internal pressure in ink reserving portion 14. When the reduction of the internal pressure in ink reserving portion 14 exceeds the capillary force of air replacement hole 24, air enters reserving portion 14 and ink 26 in ink reserving portion 14 lessens.

[0100] In accordance with the first embodiment, ink collector 13 which is formed of layered sheet elements 15 with embossed bumps 16 can be made larger by enlarging the size (the area of flat portions 17) of sheet elements 15, thus allowing ink collector 13 to retain a greater volume of overflow ink and hence making it possible to provide an enlarged ink tank 12 capable of reserving a greater amount of ink for use. Further, in slits 18 retaining ink, capillary forces tending to make slit 18 width narrower are opposed by bumps 16 arranged in appropriate spans to keep each slit with the constant width and thereby provide the stable functions of ink collector 13. Further, since the sheet elements 15 can be thinner, it is possible to improve the volume efficiency of the ink retaining space in the total volume of ink collector 13. Sheet elements 15 can be optimally processed as to wettability with ink when they are in a flat sheet, so this permits a variety of inks to be used, such as water-based, oil-based ones, etc.

[0101] Next, specific examples of the present invention and their actions will be described.

[0102] Examples (example 1 to 4 of the present invention) of the sheet elements to be used for the ink collector of the present invention will be described.

1.

(1) Material

Material(a) (about 100 μm in thickness) :
Tetron film #100S (a product of Teijin Limited)
Material(b) (about 188 μm in thickness) :
Tetron film #188S (a product of Teijin Limited) Material(c) (about 100 μm in thickness) :
Stainless steel sheet (sus304)
Material(d) (about 100 μm in thickness) :
Tetron film #100S (a product of Teijin Limited)

(2) Dimensions of the doughnut-shaped sheet elements:

Outside diameter ∅20 mm, inside diameter ∅5 mm

(3) Embossed positions (with respect to the center of the film) :

Equi-angularly arranged (20°) on a circle of radius R_3 = 9 mm, outside diameter ∅1 mm x 18 sites
Equi-angularly arranged (30°) on a circle of radius R_2 = 6 mm, outside diameter ∅1 mm x 12 sites
Equi-angularly arranged (60°) on a circle of radius R_1 = 3.5 mm, outside diameter ∅1 mm x 6 sites

(4) Embossed height : 0.1 mm

For material (d), dots of ∅1 mm and 0.1 mm high were printed by flexographic printing (at the equal sites as the embosses)

(5) Number of sheet elements used

: 50 sheets (about 10 mm high for the cases of materials (a), (c) and (d), and about 14.5 mm high for the case of material (b).

2.

Ink conduit path : Fabric bundle of polyester sliver without outside cover.

3.

Ink tank capacity: 4.2 ml (milliliter)

[0103] In order to confirm the actions and effects of the ink-jet printer of the present invention, the inventor hereof prepared the sheet elements having a configuration shown in Figs.5 and 6 by injection molding.

[0104] In this case, a trunk core composed of a bundle of fabric cores was formed as an ink conduit path (19) with an outside diameter equal to the diameter of central conduit hole of the sheet elements and the ink tank, which was prepared separately, was filled with 50 pieces of the sheet elements, with their front and reverse sides aligned in the same direction. The trunk core was fitted into the central hole of the sheet elements to complete an ink collector (13).

[0105] Then, the ink tank (12) composed of the ink collector (13) and an ink reserving portion (14) was assembled into an ink-jet head (1). The thus prepared ink-jet head was tested as to the items required for a fresh ink type ink-jet printer.

[0106] The thus configured ink-jet printer of the present invention and of the conventional product (with a fresh ink type ink-jet head on the market) were tested and the test results are shown as follows:-

	Printer of the present invention	Conventional product
Sheet vane's number	50	50
Ink retaining volume (ml)	1.5	0.39
Effective length of ink collector (mm)	15	25
Slit width of ink collector (mm)	0.1	0.3
Ink volume within ink tank (ml)	4	1

[0107] A print test was performed by forcibly causing ink to overflow into the ink collector by changing the outside temperature (tested by leaving the specimens in room temperature after exposure to low temperatures) and by changing the outside atmospheric pressure (tested by leaving the specimens in the normal pressure room after exposure to the reduced pressure room). As a result, the ink within the ink collector was used up completely before the ink in the ink tank (ink reversing portion), then ink was consumed from the tank.

[0108] Further, even when both the ink heads were left with ink fully overflowed within the ink collectors by heating them or reducing them in pressure with the head of fluid between the ink-jet head and tank-side ink collector end (the highest end of the ink collector, farthest from the ink-jet head) set appropriately, no ink leakage to the head and to the ink collector front was found for either case. Under the same conditions, heating and cooling were repeated so as to fill up the ink collector with ink and return the ink into the tank. Also in this case, no ink leakage to the head and to the ink collector front was found.

[0109] Accordingly, despite the fact that the product of the present invention uses the same number of sheet elements as the conventional product, a greater amount of ink can be retained with a shorter effective length of the ink collector, thus attaining a compact configuration. As a result, according to the present invention, it is possible to provide a high-performance, compact ink-jet head.

[0110] The above first embodiment is merely one of the preferred modes of the present invention, so that the present invention will not be limited to the first embodiment.

[0111] Actually, in the above first embodiment, the ink tank is integrated with the ink collector so as to be a disposable cartridge. But the present invention is not limited to this, and various modifications can be made within the scope of the present invention. For example, the ink collector may be integrated with the head so as to be disposable, or as in the first variational example shown in Fig.7, ink tank 27 may be provided so as to be attached to, and detached from, ink-jet head 1 of the above embodiment.

[0112] In variational example 1, a case 28 incorporating ink collector 13 has a small-diametric rear part 28a on which the front part of ink tank 27 is externally fitted. The rear part 28a may be formed with a slit-shaped air replacement hole 29. Other configurations are the same as the first embodiment so that like components are allotted with the same reference numerals with no description.

[0113] Further, as in the second variational example shown in Fig.8(a), ink collector 30 may be formed with sheet elements 15 laid out with the normal to their planes set horizontally while ink reserving portion 31 and ink collector 30 are arranged side by side within ink tank 32 with the former closer to board 3 and nozzle plate 4 than the latter

[0114] It is also possible to provide an ink conduit path 33, composed of a sliver stretched flat or formed of a cylindrical trunk core without outer cover, under ink collector 30 so as to lead ink from ink collector 30 into ink reserving portion 31.

[0115] In the third variational example shown in Fig.8(b), a configuration in which the ink collector is arranged vertically with an ink conduit path 19 arranged not in the center of sheet elements 15 but in the edges of the planes of sheet elements 15 is also included within the scope of the ink collector and the ink-jet recording apparatus of the invention.

[0116] Moreover, other than the configurations in which the ink tank is arranged adjacent to the ink collector (those shown in Figs.3 and 8(a) and the like), a configuration in which the ink tank is provided separately from the ink collector with an appropriate passage therebetween is also contained within the scope of the invention.

[0117] The second embodiment of the present invention will hereinbelow be described in detailed with reference to the drawings.

[0118] Fig.9 is a writing implement in accordance with the second embodiment, and Fig.10 shows illustrations of sheet elements, where (a) is a plan view, (b) is a sectional view cut along line A-A in (a) and (c) is an enlarged view showing the B-portion. Fig.11 is an illstructive view showing sheet elements provided in layers.

[0119] As shown in Fig. 9, a writing implement 101 of this embodiment has an ink conduit path 114 and an ink collector 116 retaining overflow ink between an ink tank 110 incorporated in an outer barrel cylinder 108 and a pen core (corresponding to the drawing element) 112 while ink tank 110 is provided with an air replacement hole 118. Ink collector 116 is configured of sheet elements 120 extending in flat plate forms. Each sheet element 120 has a multiple number of bumps (corresponding to raised portions) 122 of almost the same height embossed or printed on the surface thereof at appropriate spans. These bumps 122 keep layered, adjacent sheet elements 120 parallel with each other at desired intervals, thus forming clearances 124 for retaining overflow ink. Here, all the sheet elements 120 defining clearances 124 are formed in contact with ink conduit path 114.

[0120] A further detail will be described. Outer barrel cylinder 118 is, as a whole, of an approximately cylindrical shape, and constitutes a handgrip for holding writing implement 101. This outer barrel cylinder includes: a cylindrical main part 108a incorporating the aforementioned ink tank 110 and ink collector 116; a step 108b provided at the front end forming a shoulder of this main part 108a; and a pen core holder 108c, of a cylindrical shape having a diameter smaller than main part 108a, connected through step 108b and projected forward for internally holding pen core 112. The rear open end of main part 108a is fitted with a tail plug 126. In this embodiment, the front indicates the pen core 112 side and the rear indicates the tail plug 126 side.

[0121] Ink tank 110 is a container for storing liquid ink for writing or application and has an opening 110b at the front end of a main part 110a having a diameter smaller than the inside diameter of outer barrel cylinder 108. Integrally formed around the rim of opening 110b is a large-diametric skirt portion 110c, which is folded up toward the rear to cover main part 110a halfway, like a skirt or a lampshade, with an outside diameter corresponding to the inside diameter of outer barrel cylinder 108 so that this skirt portion 110c fits on the inner peripheral portion of main part 108a of outer barrel cylinder 108. In addition, opening 110b is fitted with a covering member 128, which has an inner sleeve 128a, at the center thereof, cylindrically extending toward the rear to some extent for fitting and holding ink conduit 114. The covering member further has an outer sleeve 128b which is formed near the rim thereof extending rearwards so as to be tightly fitted into the aforementioned opening 110b.

[0122] Pen core 112 may be formed of a fiber material, felt, foamed resin or sintered compound, including a plastic molded pen core, a writing element of natural or synthetic resin, and the like. In this embodiment, a fiber-bundle core or sintered core is used. This pen core 112 is of a bullet shape as a whole, or a pointed cylinder comprising a tip (point) 112f tapered toward the front end and a cylinder from the mid portion to the rear end (112r). Integrally or separately joined to rear end 112r of pen core 112 is ink conduit 114 of a cylindrical shape. Pen core 112 is fitted projectively at the front end (the point) from pen core holder 108c.

[0123] Ink collector 116 is accommodated within a space 130 which is enclosed by the front inner periphery of main

part 108a of outer barrel cylinder 108 and the front part of covering member 128 at the front end of ink tank 110 so that a multiple number of sheet elements 120 are arranged in layers in the axial direction (indicated by reference numeral 120e in Figs.10 and 11) with ink conduit path 114 commonly fitted through the center of the sheet elements. The front end of space 130 is confined with sheet elements 120 supported by the projected rib-like inner peripheral surface at the shoulder-like step 108b of outer barrel cylinder 108.

[0124] At the front part of writing element 1, a cap part 132 which covers tip 112f of pen core 112 projected from pen core holder 108c of outer barrel cylinder 108 is externally fitted on pen core holder 108c.

[0125] Air replacement hole 118 is composed of a portion 118a formed of an air path channel formed between the pen core and rib-formed inner peripheral surface of pen core holder 108c to connect outside air to the aforementioned space 130, a clearance 118b between the outer periphery of sheet elements 120 in space 130 and the inner peripheral surface of the main part of outer barrel cylinder 108, and a clearance 118c between covering member 128 and ink conduit path 114. Here, air replacement hole 118 may be formed at any other position as appropriate.

[0126] As shown in Fig.10, sheet element 120, generally is a flat-plate of a circular shape in its plan view. The sheet element has bumps 122 on the surface thereof which were embossed, i.e., pressed by male and female dies. The sheet element has a center hole 120a bored therein allowing for provision of ink conduit path 114. Bumps 122 are arranged along the periphery of center hole 120a and the rim of sheet element 120, in three rows, or on inner, middle and outer circles. Since specific sheet element 120 may be formed in the same features and dimensions with the same material by the production method as sheet element 15 shown in Fig.5 or Fig.6, only the illustrations are provided in Figs.10 and 11. In this case, the dimensions : diameter D_1, central bore diameter D_2, outside diameter D_3, sheet thickness t_1, bump 122 height t_2, inside bump circle radius R_1, middle circle radius R_2, and outside circle radius R_3 and the like may be altered as appropriate.

[0127] It should be understood that sheet element 120 is not limited to the above disc shape but it may be formed in an appropriate shape such as square. In the embodiment, bumps (raised portions) are arranged equi-angularly and concentrically, but the present invention will not be limited to this. For example, bumps on the sheet elements may be provided at random so that raised portions will not sink into recessed portions of the embossment. In manufacturing the sheet elements, the whole part of a large sheet or a sheet roll may be formed with bumps by embossing or printing, and thereafter the sheet may be punched to the sheet element shape to produce the sheet elements.

[0128] The above sheet elements 120 may be formed of a plastic film or of a metal plate.

[0129] Bumps 122 of sheet elements 120 may be formed by a printing method, other than embossing. In this case, bumps may be formed by heaping the print ink into raised mass of a desired height by flexographic press or the like, or may be formed by heating after printing so that the printed portions of ink may produce foams into raised mass.

[0130] Although it is preferred that sheet elements 120 put in layers are held in parallel with desired intervals by means of bumps on sheet elements 120, the sheet elements are considered to be good enough if they are arranged in approximately parallel with each other as long as they can provide the designated performance as an ink collector.

[0131] Ink conduit path 114 can be configured of a trunk core which is formed with felt, nonwoven fabric or a bundle of long or short fibers. Other than the above, ink conduit 114 may be of a bar-shape provided with slits on the side thereof.

[0132] Further, ink conduit 114 may be provided in the form of the extension from pen core 122 toward the rear up to ink tank 110 by using a bundle of long or short fibers so as to form an integrated configuration of pen core 112 and ink conduit 114.

[0133] Ink conduit 114 may be of a trunk core produced using a sintered core of plastic. Further, ink conduit 114 may be provided in the form of the extension from pen core 122 toward the rear up to ink tank 110 by using a sintered core of plastic so as to form an integrated configuration of pen core 112 and ink conduit 114.

[0134] In accordance with the above embodiment, ink collector 116 which is formed of layered sheet elements 120 with embossed bumps 122 can be made larger by enlarging the size of sheet elements 120, thus allowing ink collector 116 to retain a greater volume of overflow ink and hence making it possible to provide an enlarged ink tank 110 capable of reserving a greater amount of ink for use. Further, in slits retaining ink, capillary forces tending to make slit width narrower is opposed by bumps 122 arranged in appropriate spans to keep each slit with the constant width and thereby provide stable functions of ink collector 116. Further, since the sheet elements 120 can be thinner, it is possible to improve the volume efficiency of the ink retaining space in the total volume of ink collector 116. Sheet elements 120 can be optimally processed as to wettability with ink when they are in a flat sheet, so this permits a variety of ink to be used, such as water-based, oil-based, etc.

[0135] Next, specific examples of the present invention and their actions will be described.

[0136] Examples (example 1 to 4 of the present invention) of the sheet elements of the present invention will be described.

1.

(1) Material

Material(a) (about 100 μm in thickness) :
Tetron film #100S (a product of Teijin Limited)
Material(b) (about 188 μm in thickness) :
Tetron film #188S (a product of Teijin Limited)
Material(c) (about 100 μm in thickness) :
Stainless steel sheet (sus304)
Material(d) (about 100 μm in thickness) :
Tetron film #100S (a product of Teijin Limited)

(2) Dimensions of the doughnut-shaped sheet elements:

Outside diameter ∅20 mm, inside diameter ∅5 mm

(3) Embossed positions (with respect to the center of the film) :

Equi-angularly arranged (20°) on a circle of radius R_3 = 9 mm, outside diameter ∅1 mm x 18 sites
Equi-angularly arranged (30°) on a circle of radius R_2 = 6 mm, outside diameter ∅1 mm x 12 sites
Equi-angularly arranged (60°) on a circle of radius R_1 = 3.5 mm, outside diameter ∅1 mm x 6 sites

(4) Embossed height : 0.1 mm

For material (d), dots of ∅1 mm and 0.1 mm high was printed by flexographic printing (at the equal sites as embosses)

(5) Number of sheet elements used

: 50 sheets (about 10 mm high for the cases of materials (a), (c) and (d), and about 14.5 mm high for the case of material (b).

2.

Pen core (e) : Fabric bundle core
Pen core (f) : Sintered core

3.

Ink conduit (g) : Fabric bundle of polyester sliver without outside cover.
Ink conduit (i) : Extension toward the rear from pen core (e)
Ink conduit (j) : Extension toward the rear from pen core (f)

4. Ink tank capacity (for both the examples of the present invention and comparative examples)

: 4.2 ml (milliliter)

5.

Specifications of comparative example (k) (material = (a))

: Doughnut-shaped sheet elements
Outside diameter ∅20 mm,
Inside diameter ∅5 mm

Specifications of comparative example (1) (material=(b))
: Doughnut-shaped sheet elements

Outside diameter ∅20 mm,
Inside diameter ∅5 mm
Specifications of comparative example (m) (material =(a))
: C-shaped slit spacers having an outside diameter of ∅10 mm and an inside diameter of ∅5 mm with a cutout of 1 mm wide.
Specifications of comparative example (n) (material =(b)) : C-shaped slit spacers having an outside diameter of ∅10 mm and an inside diameter of ∅5 mm with a cutout of 1 mm wide.

[0137] The test results of the examples of the present invention and of the comparative examples are shown in Table 1 below.

[0138] In these tests, the ink collector of the writing implement was formed by placing an ink conduit path in the center, with the sheet elements laid in layers in the examples of the present invention, while with spacers interposed between the sheet elements in the comparative examples. Fifty sheet elements were used as shown in 1. (5). In Table 1, specifications of writing implements (A) to (D) are shown with their test results.

Table 1

Specifications and test results of writing implements of the examples of the present invention and of the comparative examples:							
		The present invention				Comparative	
		Example 1	Example 2	Example 3	Example 4	Example 1	Example 2
Sheet element material and fabrication		(a)	(b)	(c)	(d)	(k) (n)	(l) (m)
Specifications of writing implements	(A)=(e)+(g)	No.1	5	9	13	17	21
	(B)=(i)	2	6	10	14	18	22
	(C)=(f)+(g)	3	7	11	15	19	23
	(D)=(j)	4	8	12	16	20	24
Test results (note)	(A)	O	O	O	O	X	X
	(B)	O	O	O	O	X	X
	(C)	O	O	O	O	X	X
	(D)	O	O	O	O	X	X
*(note) Overflow ink retaining stability test in the collector Pen was left with the pen tip down and overflow ink retained within the collector, and the behavior of retained ink was observed to test the stability. (Each cell corresponds to a type of specifications of a writing implement) O : Stable after one month X : Forward leakage from the pen tip within 30 min.							

[0139] As shown in Table 1, all writing implements of specifications (A) to (D) of the present invention were stable after one month, presenting beneficial performances. In contrast, all the comparative examples of writing implements of specifications (A) to (D) presented ink leakage (forward leakage) from the pen tip within 30 minutes, presenting deficiency of use such as ink blotting.

[0140] Consequently, it was confirmed that the present invention was effective in providing a stable ink collector.

Industrial Applicability

[0141] As the present invention is configured as described above, it is possible to produce an ink collector having a large amount of retaining ink easily at low cost by loosening the limit to the thinning of the vanes without any technical restriction. Thus, the amount of printing can be increased; in particular, this configuration is effective when four color heads which need a large space, are used in the case of color copy.

[0142] Further, since a material from wide variations can be used for the sheet elements, when an appropriate material, for example, a biaxially extended film of polyester, is selected for use, all hydrophilous and oily based inks can be

used, which makes it possible to make the manufacture simple and at low cost.

[0143] In addition, it is possible to provide an ink-jet recording apparatus which is free from ink leakage from the head and the ink collector front due to temperature changes.

[0144] Further, this configuration simplifies handling such as replacement of an ink-jet head or an ink collector.

[0145] Moreover, in accordance with the present invention, the limit to the thinning the vanes is loosened so as to enhance the ink retaining capacity of the collector and improve the functionality thereof. Further, since any material can be used for the sheet elements, when, for example, a biaxially extended film of polyester, is used, all oily based and water-based inks can be used. Thus, the present invention can produce excellent effectiveness in manufacturing collectors of writing implements easily at a low cost.

Claims

1. An ink collector for temporarily retaining overflow ink from the ink tank, comprising:

   sheet elements extending flat, piled in layers, the sheet element having a plurality of raised portions formed on the surface thereof at appropriate spans, wherein the raised portions keep adjacent sheet elements piled in layers, in approximately parallel at a desired distance to create clearance for retaining overflow ink, and all the sheet elements constituting the clearance are in contact with the ink conduit path.

2. The ink collector according to Claim 1, wherein the raised portions are formed by a printing method.

3. The ink collector according to Claim 1 or 2, wherein the sheet elements are formed of plastic film.

4. The ink collector according to Claim 1 or 2, wherein the sheet elements are formed of metal sheet.

5. The ink collector according to any one of Claims 1, 2, 3 and 4, wherein the ink conduit path is formed of felt or nonwoven fabric, a fabric bundle of long or short fibers, a flocculent material, continuous porous material, continuous porous foamed material, or the like.

6. The ink collector according to any one of Claims 1, 2, 3 and 4, wherein the ink conduit path is formed by a plastic mold by extrusion or injection molding and retains and leads ink by capillary force.

7. An ink-jet recording apparatus having an ink-jet head with an ink collector for temporarily retaining overflow ink from the ink tank, wherein the ink collector is composed of sheet elements, extending flat, piled in layers, and having a plurality of raised portions formed on the surface thereof at appropriate spans, and the raised portions keep adjacent sheet elements piled in layers, in approximately parallel at a desired distance to create clearance for retaining overflow ink, and all the sheet elements constituting the clearances are in contact with the ink conduit path.

8. The ink-jet recording apparatus according to Claim 7, wherein the ink collector is one of those defined by Claims 2 through 6.

9. The ink-jet recording apparatus according to Claim 7, wherein the ink collector is integrated with the ink-jet head.

10. The ink-jet recording apparatus according to Claim 7, wherein the ink collector and the ink tank are integrated into a cartridge.

11. The ink-jet recording apparatus according to Claim 7, wherein the ink tank has a removable configuration with respect to the ink collector.

12. The ink-jet recording apparatus according to Claim 7, wherein the ink collector has a multiple number of sheet elements put in layers in a container and the gap between the inner surface of the container and the sheet elements are set greater than the slit width between the sheet elements.

13. The ink-jet recording apparatus according to Claim 7, wherein the sheet elements are arranged in layers with the normal to their planes set horizontally.

14. A writing implement having an ink conduit path and an ink collector for retaining overflow ink between an ink tank having an air replacement hole therein and the drawing point, wherein the ink collector is composed of sheet ele-

ments, extending flat, piled in layers, and having a plurality of raised portions formed on the surface thereof at appropriate spans, and the raised portions keep adjacent sheet elements put in layers, in approximately parallel with a desired distance to create clearance for retaining overflow ink, and all the sheet elements constituting the clearances are in contact with the ink conduit path.

15. The writing implement according to Claim 14, wherein the raised portions are formed by a printing method.

16. The writing implement according to Claim 14 or 15, wherein the sheet elements are formed of plastic film.

17. The writing implement according to Claim 14 or 15, wherein the sheet elements are formed of metal sheet.

18. The writing implement according to any one of Claims 14, 15, 16 and 17, wherein the ink conduit path is formed of felt or nonwoven fabric, a fabric bundle of long or short fibers, a flocculent material, continuous porous material, continuous porous foamed material, or the like.

19. The writing implement according to any one of Claims 14, 15, 16 and 17, wherein the ink conduit path is configured integrally with the pen tip by the extension from the pen tip toward the rear up to the ink tank and is formed of a fabric bundle of long or short fibers.

20. The writing implement according to any one of Claims 14, 15, 16 and 17, wherein the ink conduit path is a trunk core formed by using a sintered core of plastic.

21. The writing implement according to any one of Claims 14, 15, 16 and 17, wherein the ink conduit path is configured integrally with the pen tip by the extension from the pen tip toward the rear up to the ink tank and is formed using a sintered core of plastic.

FIG. 1

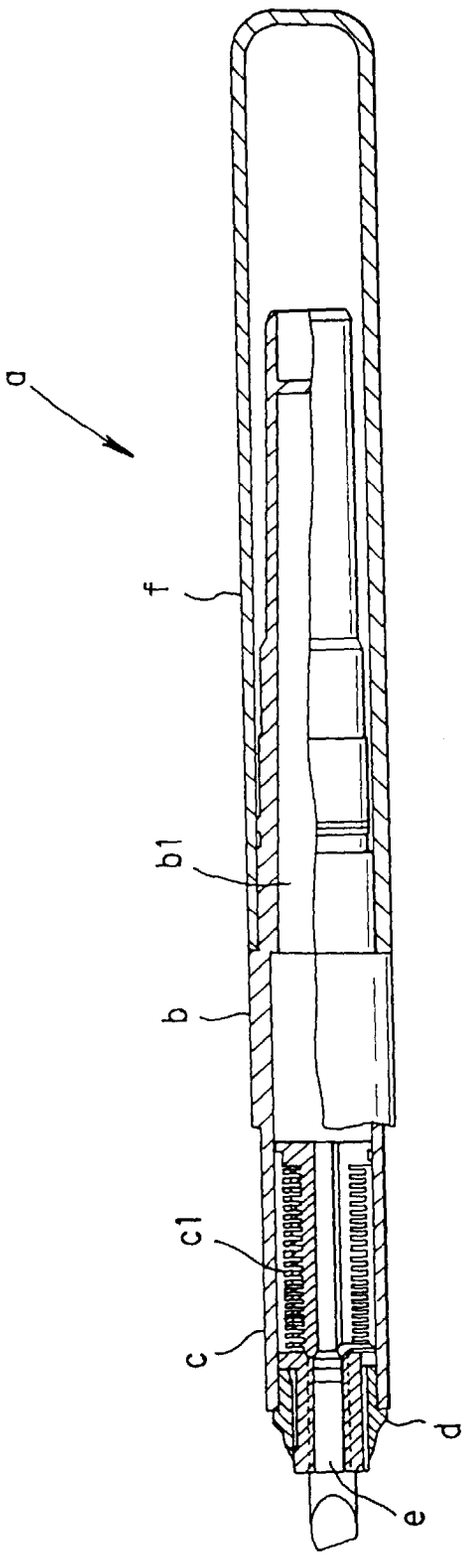


FIG. 2

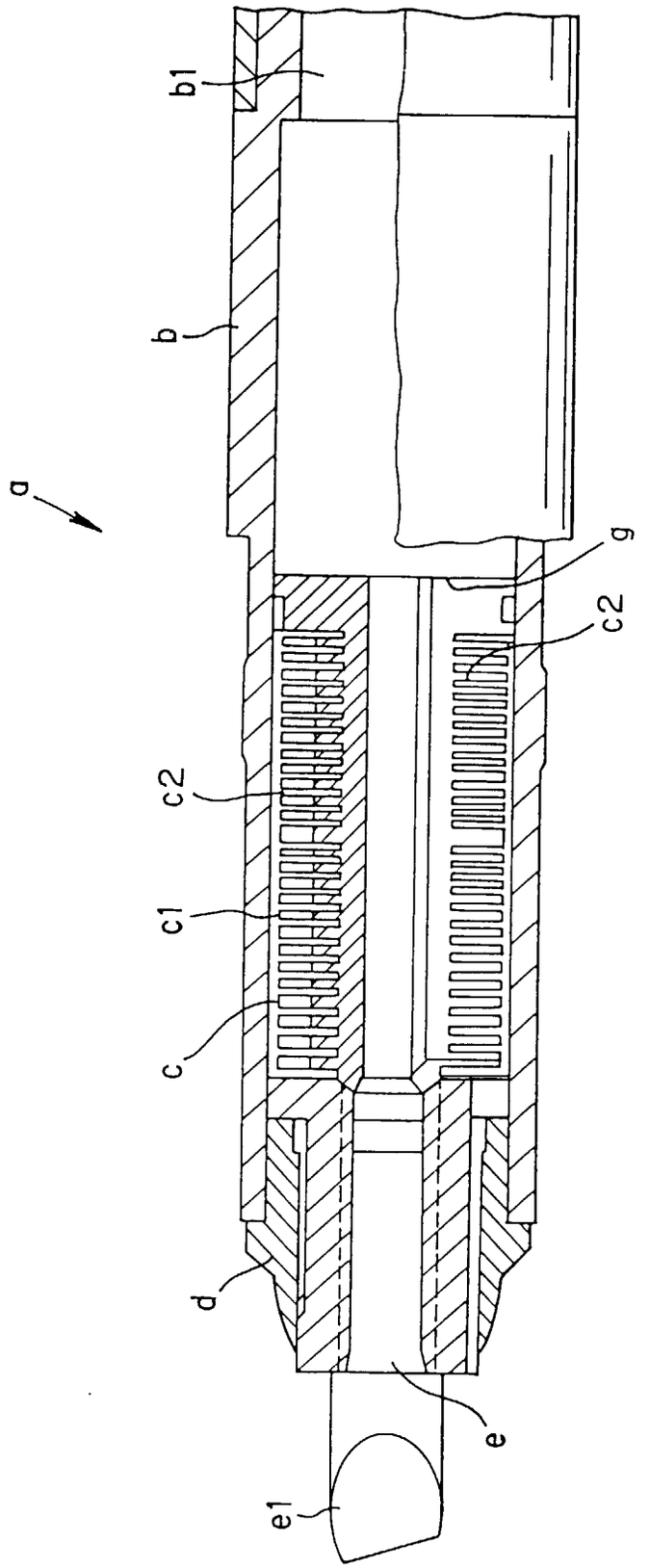


FIG. 3

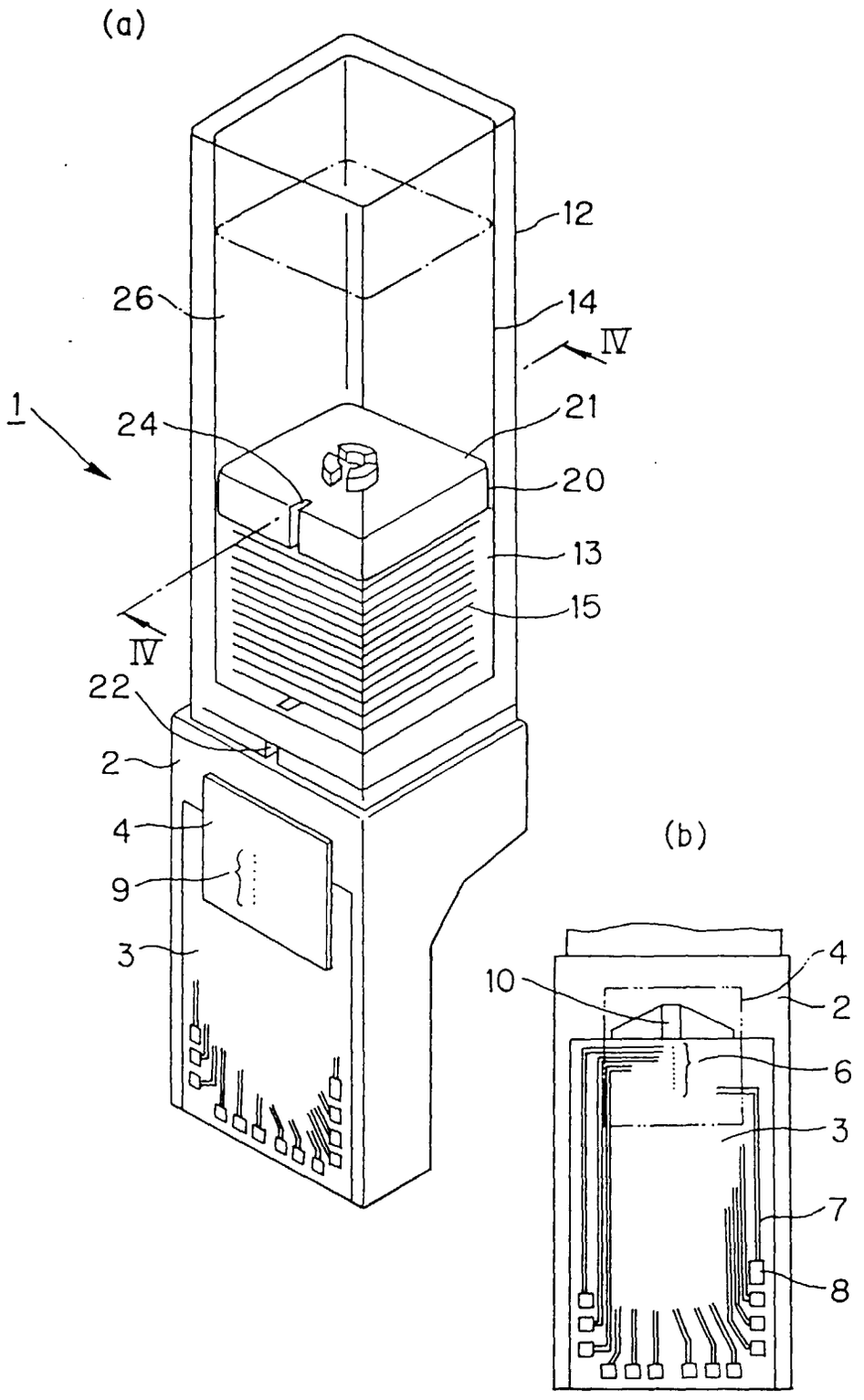


FIG. 4

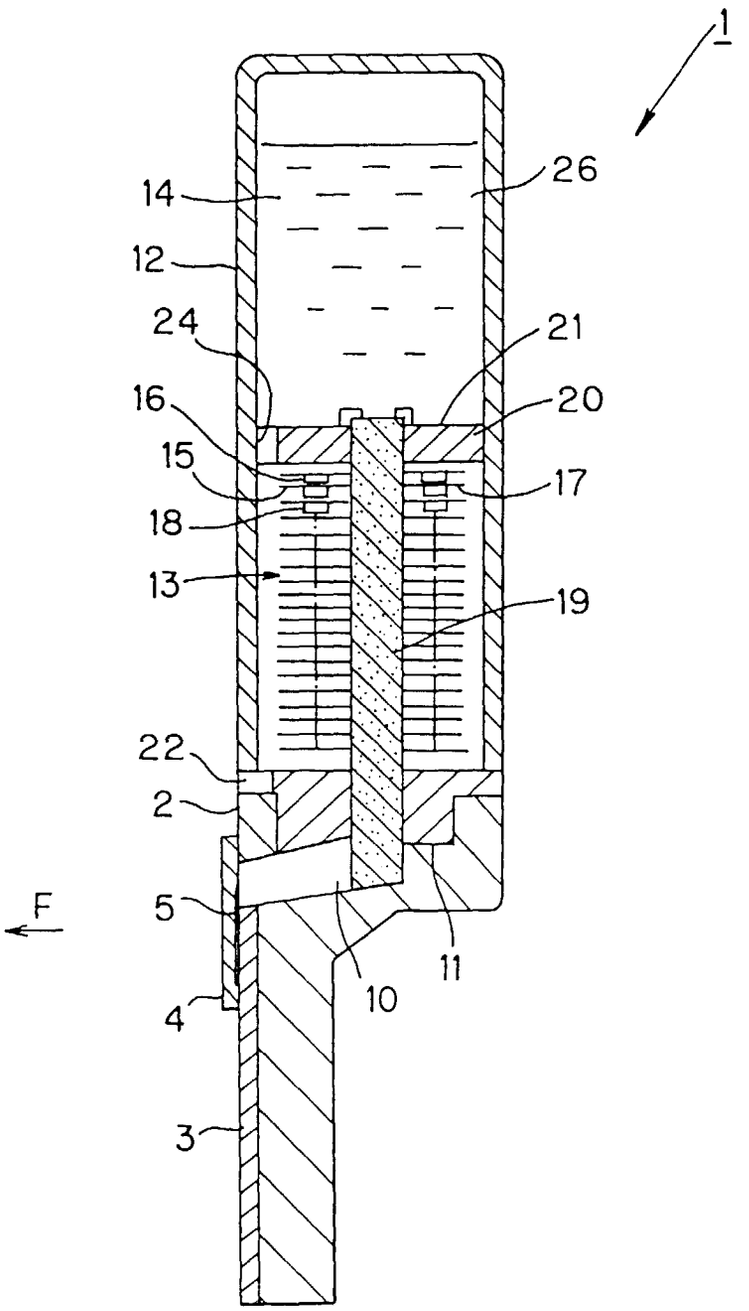


FIG. 5

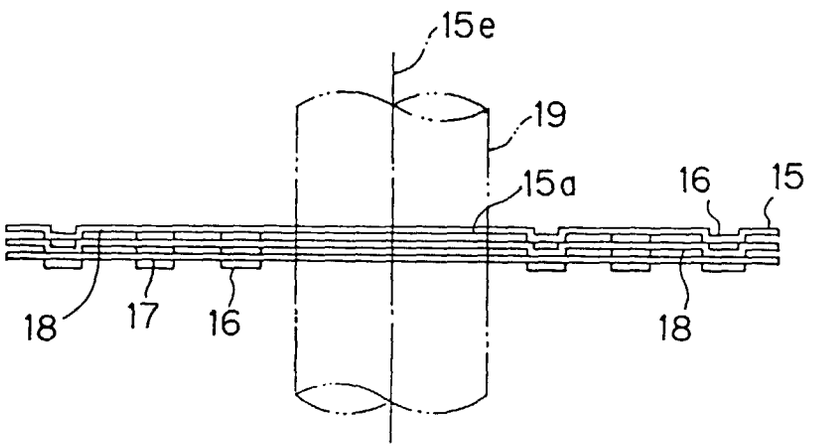


FIG. 6

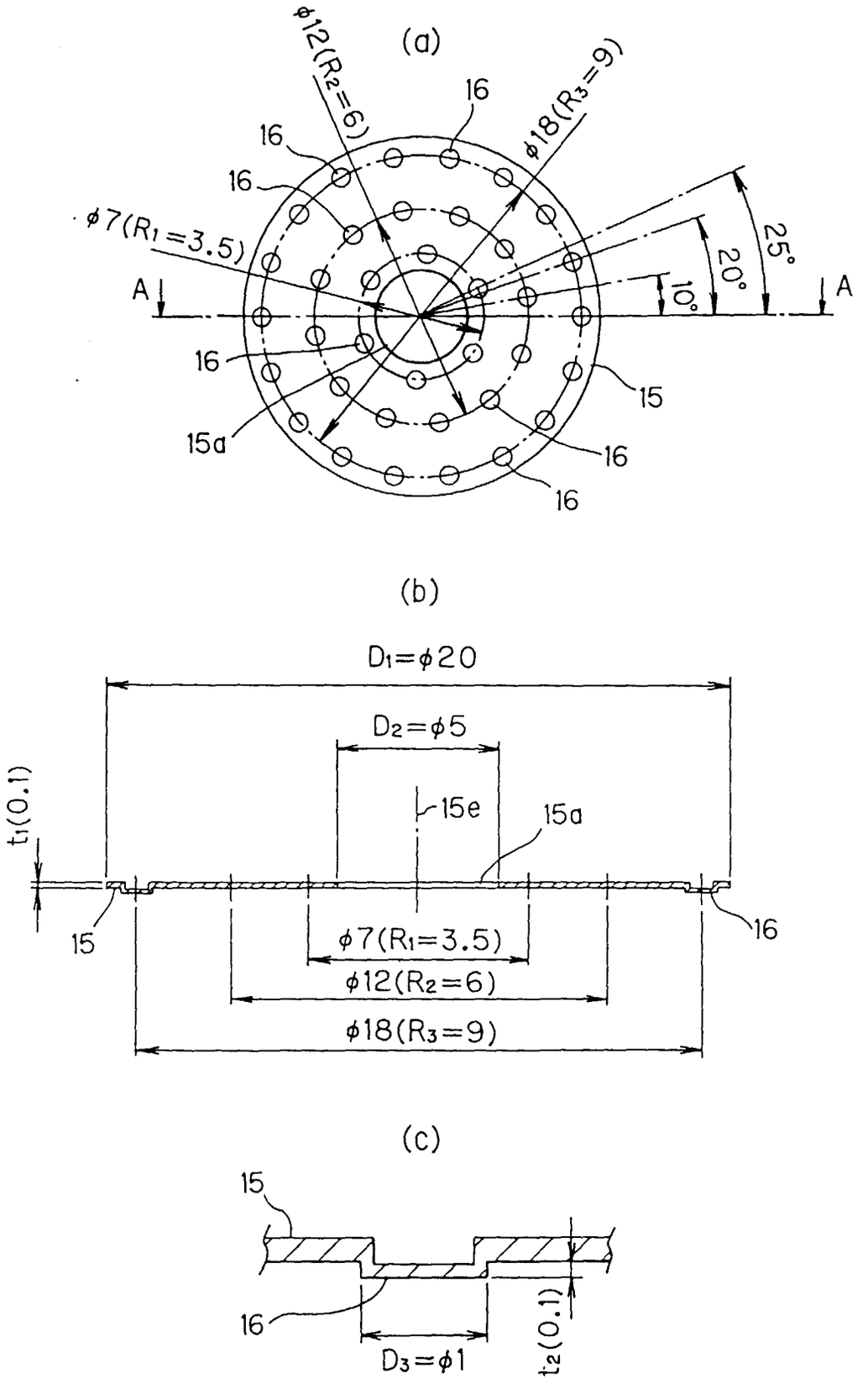

(a)
φ12(R2=6)
φ18(R3=9)
φ7(R1=3.5)
16
15
15a
A
A
25°
20°
10°
(b)
D1=φ20
D2=φ5
15e
15a
t1(0.1)
15
16
φ7(R1=3.5)
φ12(R2=6)
φ18(R3=9)
(c)
15
16
D3=φ1
t2(0.1)

FIG. 7

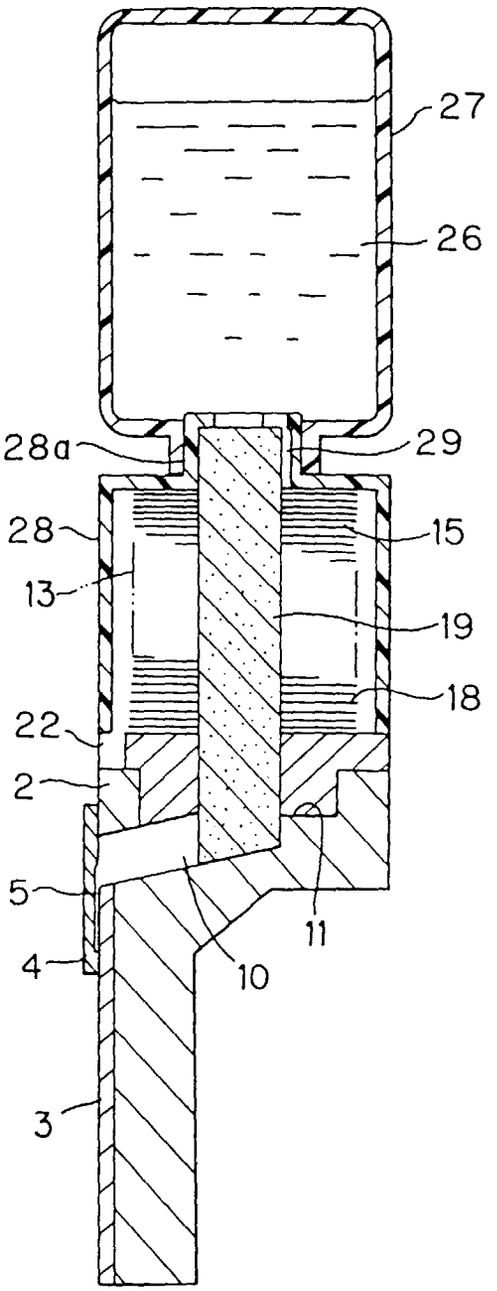
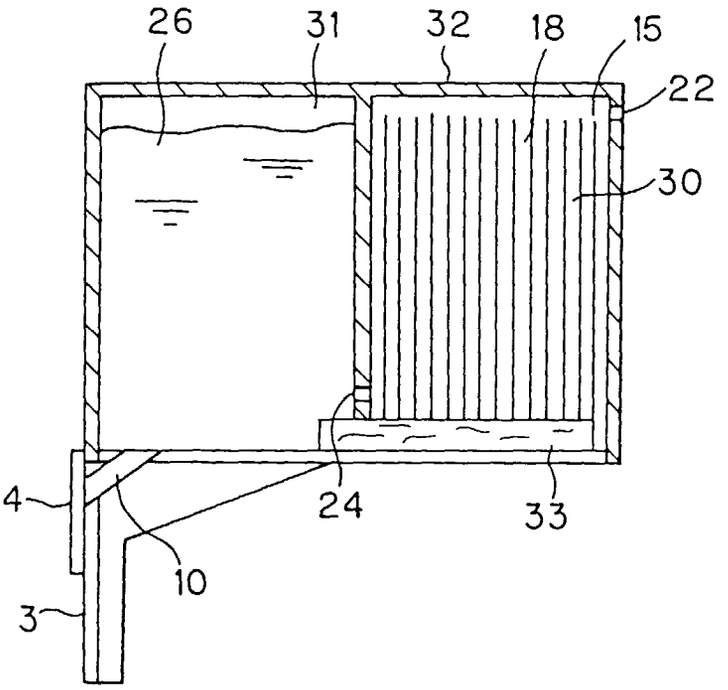


FIG. 8

(a)



(b)

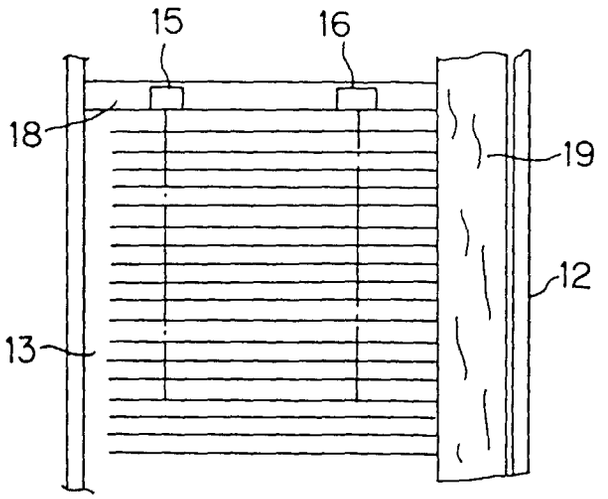
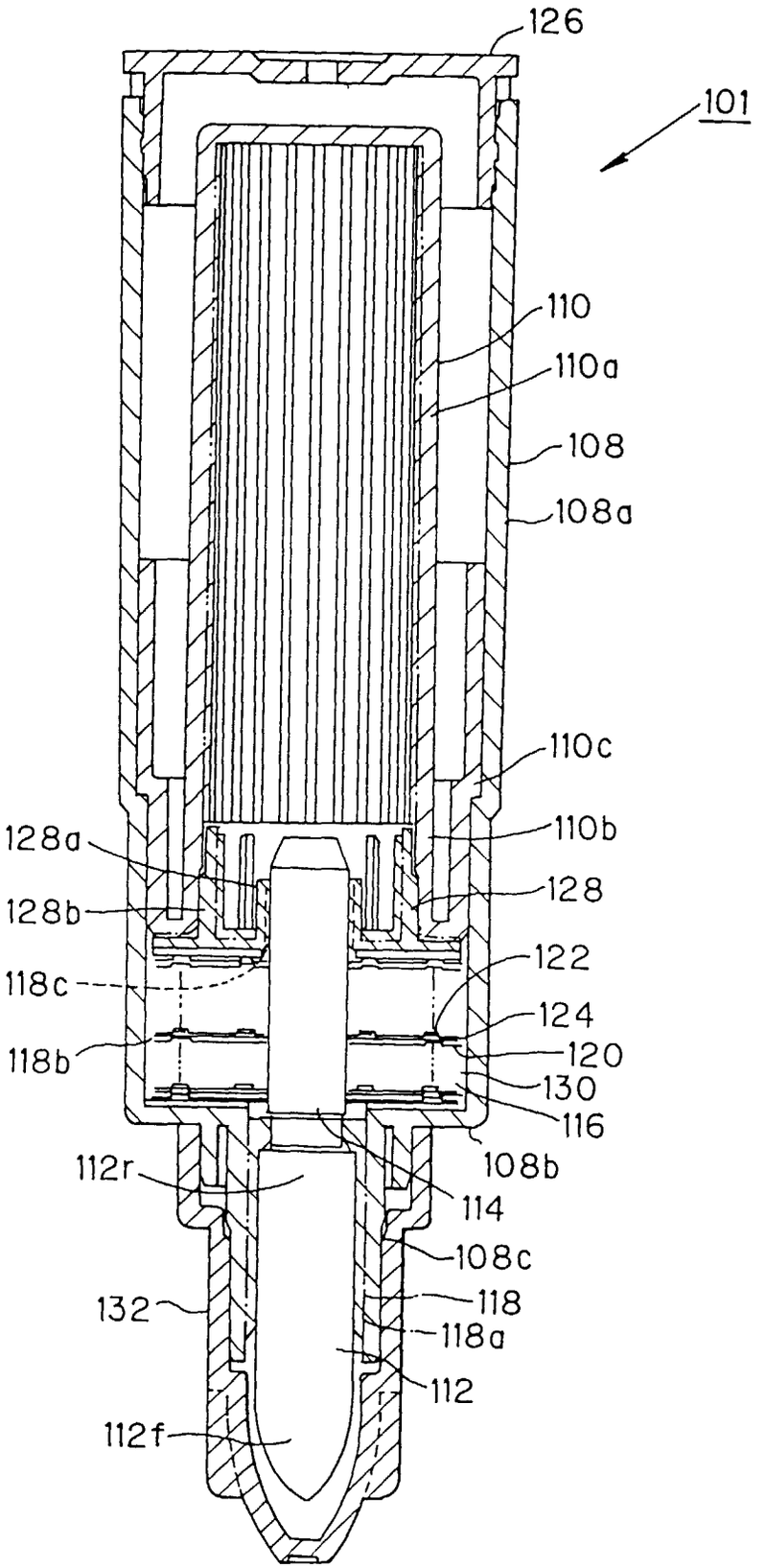


FIG. 9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108a
110c
110b
128a
128
128b
122
118c
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118b
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116
112r
108b
114
108c
132
118
118a
112
112f

FIG. 10

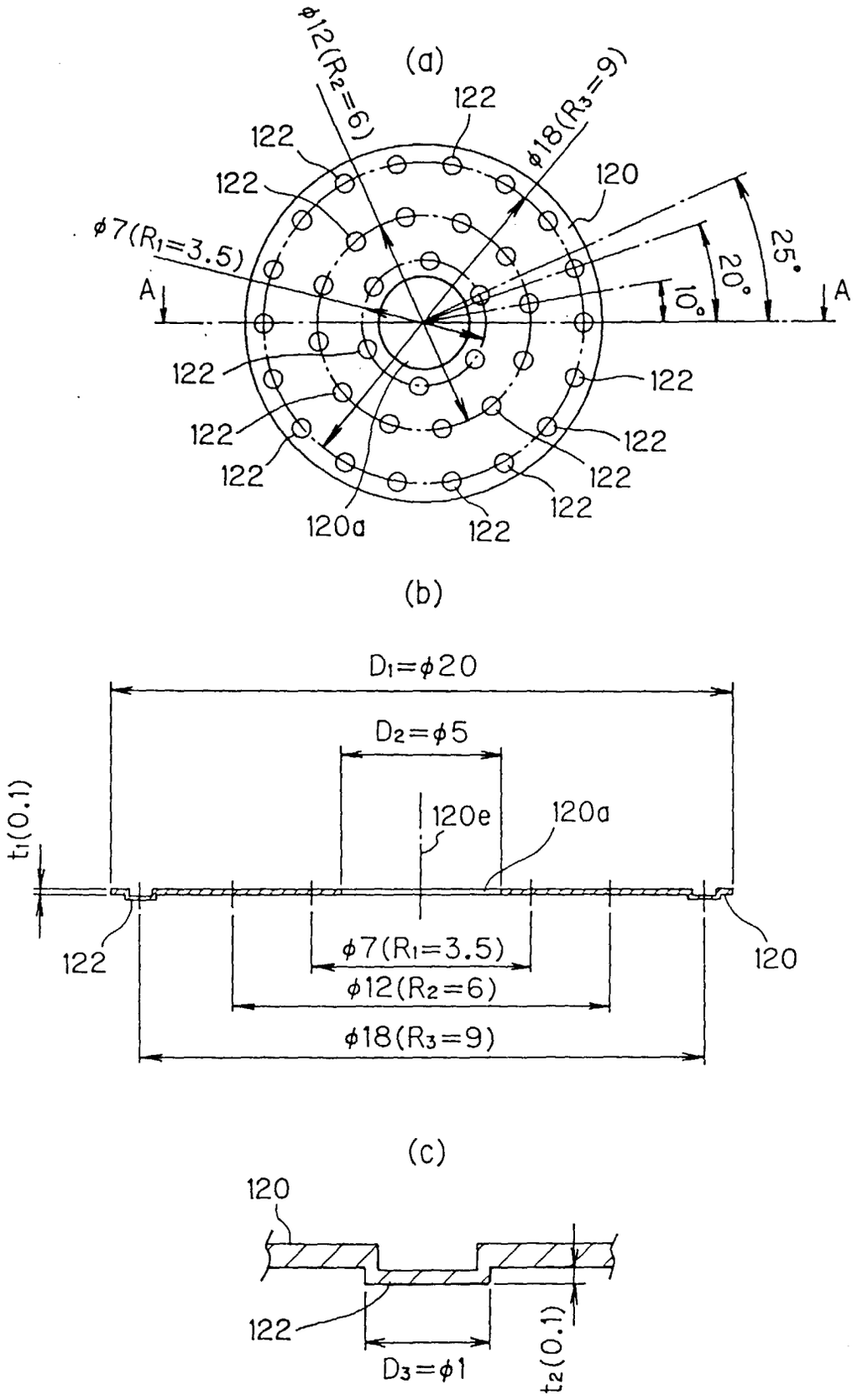
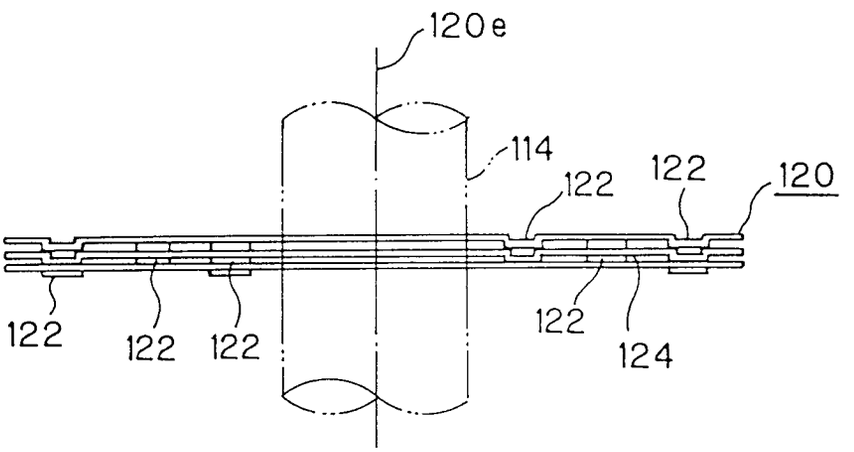

(a)
φ12(R2=6)
φ18(R3=9)
φ7(R1=3.5)
122
120
120a
A
A
25°
20°
10°
(b)
D1=φ20
D2=φ5
120e
120a
t1(0.1)
122
120
φ7(R1=3.5)
φ12(R2=6)
φ18(R3=9)
(c)
120
122
D3=φ1
t2(0.1)

FIG. 11



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP97/02777

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl^6 B41J2/175, B43K8/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl^6 B41J2/175, B43K8/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922 - 1997
Kokai Jitsuyo Shinan Koho 1971 - 1997
Toroku Jitsuyo Shinan Koho 1994 - 1997
Jitsuyo Shinan Toroku Koho 1996 - 1997

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP, 04-179554, A (Canon Inc.), June 26, 1992 (26. 06. 92)(Family: none) (Refer to page 5, lower right column, line 9 to page 6, lower left column, line 2; Figs. 2, 3)	1 - 13
Y	JP, 03-180357, A (Hewlett-Packard Co.), August 6, 1991 (06. 08. 91) & US, 5010354, A (Refer to page 5, upper right column, line 16 to page 6, upper left column, line 1; Figs. 3 to 6)	1 - 21
Y	JP, 04-250062, A (Hewlett-Packard Co.), September 4, 1992 (04. 09. 92) & US, 5047790, A	1 - 21
Y	JP, 06-4944, Y (Pentel Co., Ltd.), February 9, 1994 (09. 02. 94)(Family: none)	14 - 21
Y	JP, 06-14839, Y (Pentel Co., Ltd.), April 20, 1994 (20. 04. 94)(Family: none)	14 - 21

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
October 27, 1997 (27. 10. 97)	November 5, 1997 (05. 11. 97)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP97/02777

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 03-169563, A (Mitsubishi Pencil Co., Ltd.), July 23, 1991 (23. 07. 91)(Family: none)	1 - 13

Form PCT/ISA/210 (continuation of second sheet) (July 1992)