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(54) **Ball-point pen including a ball ink valve**

(57) A ball-point pen or pen refill is provided that is particularly suitable for use with gel ink (16) or other low viscosity inks or inks including highly volatile solvents. The pen includes a tip assembly having a ball housing (36) that retains the ball (40) of the pen whilst allowing the ball to move back from the ball seat under writing force. The ball is forced against the ball seat by a single piece, plastic valve member (46). The valve member in-

cludes a compression spring (60) and pin (74) which pushes the ball against the ball seat, and a rear stop (48) that is used to positively locate the valve member with respect to the ball seat to ensure correct force is generated through compression of the spring. The result is a pen that writes smoothly, and that by using a one piece valve member is easily and economically manufactured.

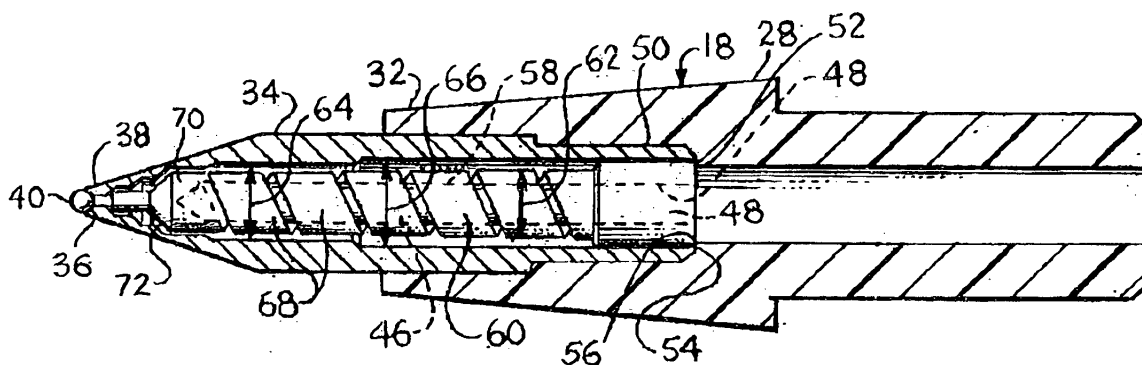


FIG. 2

Description

[0001] This invention relates to ball-point pens, especially pens with volatile ink that require no caps having valve mechanisms to prevent ink escape or drying.

[0002] In prior art ball-point pens that have: inks of low viscosity; extraordinary volatile solvents (such as correction pens; and gel ink pens, which have inks with non-linear shearing characteristics, there have been problems with ink flowing out of the pen point when the pen is not in use, causing blobs when the pen is again used or, worse, leaks that ruin clothes and furniture. Some prior art gel and similar inks are described in US-A-5,969,004; US-A-5,951,188; US-A-5,466,281; US-A-5,048,992; US-A-5,013,361; US-A-4,971,628; US-A-4,786,198; US-A-4,686,246; US-A-4,671,691; and US-A-4,545,818. In other cases, the ink dries in the tip, especially when a cap is not present for a long period of time, making the pen inoperative.

[0003] To prevent blobbing, leaking, and drying, some pens of this sort include an ink valve, including a spring trapped between an ink bypass disk and a plug, loaded by the spring into a sealing position with a rod extending to the ball. Writing pressure applied to the ball compresses the spring, breaks the seal and allows the freely rotating ball in the front portion of the point to transfer the ink to the writing paper by rolling the ball on the writing paper, thus allowing the user to write on the paper.

[0004] Normally, the valve structure includes: a metallic spring (which must be constructed of relatively expensive material to avoid corrosion from ink contact); a complex shaped rod member that extends from the spring to the ball; and a perforated plug against which the end of the spring opposite the ball is compressed to bias the spring against the rod, forcing the ball toward the end of the pen tip. The prior art valve structures are relatively expensive (in pens that sell retail in the billions for as little as ten US cents apiece, a tenth of a cent is a large cost), and difficult to form and install. Also, improper fitting between the end of the rod and the rotating ball, or a too strong spring needed to assure a valve seal, can make the pen feel undesirably scratchy, whereas good ball-point pen design attempts to achieve a ball that rotates smoothly as possible.

[0005] We have now found, surprisingly, that the problems referred to above may be reduced or eliminated by a ball-point pen employing a valve member construction in accordance with the present invention.

[0006] Accordingly, in a first aspect, the present invention provides a ball-point pen including:

a tip assembly including:

a ball housing having:

a ball seat; and

a ball retained in the ball housing for movement against the ball seat; and

a unitary valve member including:

a compression spring portion; and

a front pin portion connected to the compression spring portion extending to apply compression force from the compression spring portion to the ball to force the ball against the ball seat.

[0007] In a second aspect, the present invention provides a tip assembly for a ball-point pen including:

a ball housing having:

a ball seat; and

a first abutment wall spaced from the ball seat; and

a ball retained in the ball housing for movement between the ball seat and the first abutment wall in response to writing force on the ball; and

a unitary valve member including:

a compression spring portion;

a pin portion connected to the compression spring portion extending through the first abutment wall to apply compression force from the compression spring portion to the ball to force the ball against the ball seat.

[0008] The present ball-point pen is equipped with a ball, trapped in a ball housing located in the front portion of pen's point. The ball may be made of any suitable material, conventionally a metal or metal carbide, for example tungsten carbide. The ball has a diameter, for example, of less than 0.5 mm, preferably about 0.15 mm.

[0009] The ball housing may be made for example of stainless steel, and is so constructed relative to the diameter size of the ball as to retain the ball whilst allowing some free play fore and aft in the housing. The rear of the ball housing includes a capillary hole formed to connect the ink reservoir along the centre and rear portions of the pen so that ink can flow to the point. A unitary valve member forms a portion of the flow way from the ink reservoir to the point.

[0010] The valve member is constructed, and preferably moulded, in a single piece from synthetic resin or plastics material and includes a rear portion with an ink passageway therethrough. The rear may be press fit, screwed or glued in the hollow rear of the ball-point pen tip to retain the valve member in the desired location in the tip. A compression spring, preferably a hollow spiral spring, is formed extending from the rear portion tipward to a preferably frusto-conical tip, from which a rod axially extends. The rod extends through the capillary hole and is just small enough in diameter to allow ink to flow around the rod and through the hole. The ink acts to keep the rod generally centred in the capillary hole. The end of the rod engages the ball. The force created by

the spring causes the rod to push the ball into its seat to create a seal that prevents the ink from undesirably leaking out of the pen point and to prevent any solvent, if present, from passing the ball into the air, which would cause the ink to dry and stop flowing.

[0011] When the pen is in use, the force applied by the user causes the ball to move back, almost imperceptibly, to the back surface of ball housing. The friction between the ball and the end of the plastic rod is very low, so when the ball is moved over a writing surface, it rotates easily, picking up ink and transferring it to the paper. The result is a pen that provides a very smooth writing action. In addition, the valve member allows the use of gel inks having ingredients tuned for smooth writing, rather than compromised for slow drying or for overly viscous flow characteristics to prevent leaking.

[0012] When writing ceases, the force from the spring moves the ball forward against the front of the ball housing, stopping the flow of the ink. Being one piece, the valve member is easily manufactured and can be installed by relatively simple automated equipment.

[0013] Therefore, an advantage of the present invention is that it allows an economical pen to be provided for use with gel or other inks of low viscosity and/or volatile solvents. Another advantage of the present invention is that it permits the construction of a ball-point pen that will not leak. Furthermore, it allows the provision of a ball-point pen that can be left unsealed by a cap, such as a retractable point pen. Another advantage is that the present invention can provide an economical, easy to manufacture and install valve mechanism for a ball-point pen.

[0014] It will be appreciated that the present invention applies to both pens and pen refills. Therefore, by "ball-point pen" as used herein is meant a ball-point pen as such or a ball-point pen refill, unless otherwise indicated.

[0015] In a preferred embodiment according to the first aspect, a ball-point pen is provided that includes:

a tip assembly including:

a ball housing having:

a ball seat; and

a first abutment wall spaced from the ball seat; and

a ball retained in the ball housing for movement between the ball seat and the first abutment wall; and

a unitary valve member including:

a central compression spring portion; and

a front pin portion connected to the central compression spring portion extending through the first abutment wall to apply compression force

from the central compression spring portion to the ball to force the ball against the ball seat.

[0016] The present invention will be further understood by reference to the accompanying drawings, in which:

Figure 1 is a side cross-sectional view of an embodiment of the ball-point pen of the present invention; Figure 2 is an enlarged partial cross-sectional view of the tip of the ball-point of Figure 1 with the ink removed for clarity; and

Figure 3 is a highly enlarged partial cross-section of the ball housing and ball in the tip of Figure 2.

[0017] Referring to the drawings more particularly by reference numerals, numeral 10 in Figure 1 refers to a ball-point pen or ball-point pen refill. The pen 10 includes a hollow body tube 12 whose interior serves as an ink tank 14 for ink 16. A pen point assembly 18 is fixed to the front end 20 of the tube 12 while a plug 22 is at the rear 23 of the tube 12. When the preferred volatile gel ink 16 fills the tank 14, the plug 22 takes the conventional form of viscous silicone oil, which prevents drying of the ink 16 and moves with the back surface 24 of the ink to maintain a seal.

[0018] As shown in Figure 2, the pen point assembly 18 includes a hollow tubular case 26 whose outer surface 28 includes a shank portion 30 for sealably engaging with the front end 20 of the tube 12. The front 32 of the case 26 is shaped to sealably engage with a hollow ball-point case 34. The case 34 includes a ball housing 36 at its front 38 in which a conventional metal ball 40 is loosely trapped, the ball housing 36 being just long enough relative to the diameter of the ball 40, so that some free play of the ball 40, fore and aft in the housing 36 is allowed. The rear radial abutment surface 42 (Figure 3) of the ball housing 36 includes an axially located capillary hole 44 formed to define part of an ink path from the ink tank 14 to the ball 40. A unitary valve member 46 installed in the case 34 between the tube 12 and the ball 40 also forms a portion of the ink path from the ink tank 14 to the ball 40.

[0019] The valve member 46 is moulded in a single piece from synthetic resin and includes a rear portion 48 with an ink passageway 49 there through. The rear portion 48 is installed in the hollow rear 50 of the case 34, the rear portion 48 preferably including a radial abutment surface 52, which along with a rear radial abutment surface 54 of the case 34, engages a radial stop surface 56 of the case 26 to assure automatic positioning of the rear portion 48 of the valve member 46 with respect to the ball 40.

[0020] A centre portion 58 of the valve member 46 is formed into a spiral compression spring 60, whose outer diameter 62 is less than the inner diameters 64 and 66 thereof, so that ink 16 can flow through the ink passageway 49, and the coils 68 of the spring 60 to the cap-

illary hole 44 and hence to the ball 40.

[0021] The valve member 46 also includes a cylindrical front portion 70, shaped and sized with respect to the case 34 so that the ink 16 can flow therepast to the ball 40. The front portion 70 is reduced in diameter by one or more frusto-conical sections 72 and 73 until a pin 74 laying along the axis 76 of the valve member 46 results.

[0022] As shown in Figure 3, the pin 74 has an abutment end 78 that engages the ball 40, while its diameter 80 is smaller than the diameter 82 of the capillary hole 44 so that ink 16 can flow therepast to the ball 40. The surface tension of the ink 16 acts to keep the pin 74 generally centred in the capillary hole 44. The compression force generated by the hollow spiral spring 60 is applied to the ball 40 by the abutment end 78 of the valve member 48, which engages the ball 40. The force created by the spring 60 causes the pin 74 to push the ball 40 into its frusto-conical seat 84 to create a seal that prevents the ink 16 from undesirability leaking out of the pen 10 and to prevent solvents in the ink 16 from passing the ball 40 into the air, which would cause the ink 16 to dry and stop flowing, especially when the construction of the pen 10 includes no cap.

[0023] When the pen 10 is in use, the force applied by the user causes the ball 40 to move back, almost imperceptibly, to the rear radial abutment surface 42 which acts to stop motion of the ball 40 toward the ink tank 14 when the ball 40 is being pressed down on writing material to compress the spring 60 and allow transfer the ink 16 by the ball 40, thereto. The friction between the ball 40 and the end of the pin 74 is very low, so when the ball 40 is moved over a writing surface, it rotates easily, picking up ink and transferring it to the surface. When writing ceases, the force from spring 60 moves the ball 40 forward against the frusto-conical seat 84 of the ball housing 36, stopping the flow of the ink 16.

[0024] The result is a pen 10 that writes very smoothly, especially when gel ink 40 is used. In addition, the valve member 46 allows the use of gel inks 40 having ingredients tuned for smooth writing, rather than compromised for slow drying or for overly viscous flow characteristics to prevent leaking. Being one piece, the valve member 46 is easily manufactured and can be installed into the accurately controlled space in the case 34 by relatively simple automated equipment, so that consistent operation of the pen 10 can be obtained economically and automatically.

Claims

1. A ball-point pen including:

a tip assembly including:

a ball housing having:
a ball seat; and

a ball retained in the ball housing for movement against the ball seat; and

a unitary valve member including:

a compression spring portion; and
a front pin portion connected to the compression spring portion extending to apply compression force from the compression spring portion to the ball to force the ball against the ball seat.

2. A ball-point pen according to claim 1 wherein the unitary valve member is moulded or constructed in a single piece from synthetic resin.
3. A ball-point pen according to claim 1 or claim 2, wherein the unitary valve member further includes a rear portion connected to the compression spring portion, the rear portion defining an ink passage-way.
4. A ball-point pen according to claim 3, wherein the rear portion is hollow and the compression spring portion is centrally disposed.
5. A ball-point pen according to any preceding claim wherein the compression spring portion includes a coil spring having spaced coils, whereby ink can pass therethrough.
6. A ball-point pen according to any preceding claim, wherein the front pin portion of the unitary valve member further includes:
 - a solid cylindrical portion connected to the compression spring portion;
 - at least one frusto-conical portion connected to the solid cylindrical portion; and
 - a pin connected to the at least one frusto-conical portion opposite the solid cylindrical portion for contact with the ball.
7. A ball-point pen according to claim 6, wherein the pin includes a radial abutment surface for contact with the ball.
8. A ball-point pen according to any preceding claim, further including:

a first abutment wall spaced from the ball seat, whereby the ball is retained in the ball housing for movement between the ball seat and the first abutment wall, and the front pin portion connected to the compression spring portion extends through the first abutment wall to apply compression force from the compression spring portion to the ball to force the ball against the ball seat.

9. A ball-point pen according to claim 8 further including:

a hollow tube for retaining ink; and
a pen point assembly which in addition to the tip assembly includes: 5
a case having:

a rear portion for connecting to the hollow tube; and 10
a front portion for connecting to the tip assembly, the front portion including a stop surface,

the tip assembly further including a tip assembly case that is retained in the pen point assembly case,
the unitary valve member further including a rear portion connected to the central compression spring portion, the rear portion of the unitary valve member further including: 15

a rear portion abutment surface positioned to engage the stop surface to positively position the unitary valve member with respect to the ball housing, whereby the force produced by the compression spring portion to force the ball against the ball seat is accurately fixed. 20 25

10. A ball-point pen according to claim 8 or claim 9, wherein the front pin portion includes a pin sized to allow ink flow thereabout and through the first abutment wall into the ball housing. 30

11. A ball-point pen according to claim 10, wherein the pin includes a radial end abutment surface positioned to engage the ball. 35

12. A tip assembly for a ball-point pen including:

a ball housing having: 40

a ball seat; and
a first abutment wall spaced from the ball seat; and
a ball retained in the ball housing for movement between the ball seat and the first abutment wall in response to writing force on the ball; and 45

a unitary valve member including: 50

a compression spring portion;
a pin portion connected to the compression spring portion extending through the first abutment wall to apply compression force from the compression spring portion to the ball to force the ball against the ball seat. 55

13. A tip assembly according to claim 12, wherein the unitary valve member further includes a stop portion connected to the compression spring portion opposite the pin portion for establishing compression of the compression spring portion when the tip assembly is installed in a ball-point pen.

14. A tip assembly according to claim 12, wherein the unitary valve member further includes a stop surface operatively connected to the compression spring portion opposite the pin portion.

15. A tip assembly according to any of claims 12 to 14, wherein the unitary valve member is constructed in a single piece from synthetic resin.

16. A tip assembly according to any of claims 12 to 15, wherein the unitary valve member further includes a rear portion connected to the compression spring portion, the rear portion defining an ink passageway.

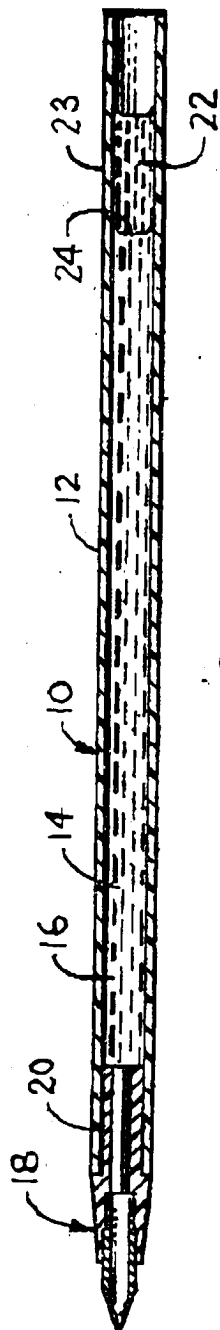


FIG. 1

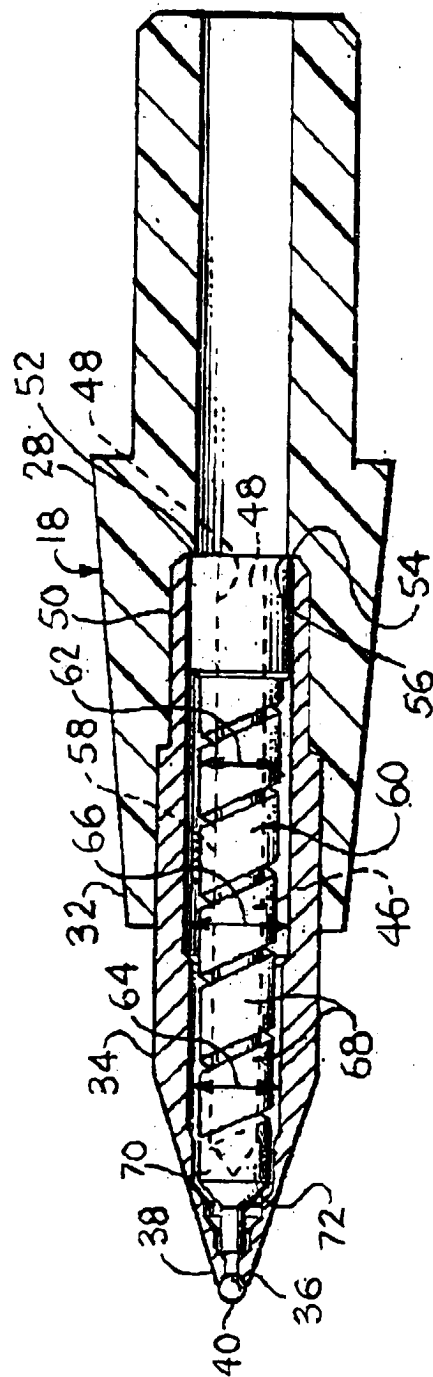


FIG. 2

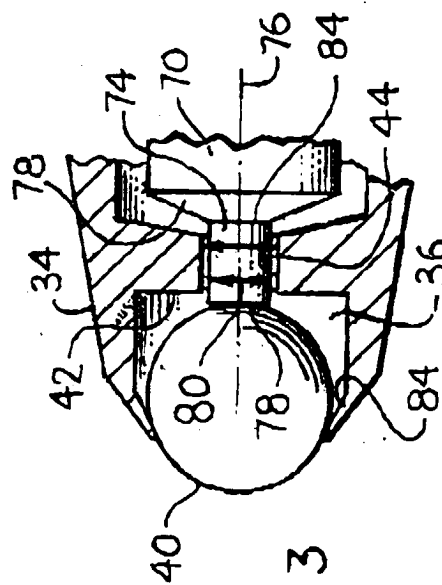


FIG. 3



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 30 9360

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.CL7)
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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.CL7)
			B43K B43M
Place of search		Date of completion of the search	Examiner
THE HAGUE		18 February 2000	Perney, Y
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 (P4/C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 99 30 9360

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
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18-02-2000

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