United States Patent

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[54] **INK FLOW CONTROL IN A FOUNTAIN PEN**

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[52] **U.S. Cl.** **401/227,** 401/133
[51] **Int. Cl.** **B43k 5/18**
[58] **Field of Search** 401/225–229, 132–135

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[57] **ABSTRACT**

Flow of ink from a storage compartment to the writing point of a fountain pen is controlled by a throttling portion in the air conduit which admits air to the ink compartment during writing. This portion is kept filled with air by a system of capillary ducts including three or more radial ducts in a front face of a partition which separates the compartment from the cavity in the front part of the pen barrel. The ducts communicate with an annular groove between the inner barrel surface and a feed bar assembly, and the groove intersects the air conduit immediately adjacent the throttling portion which is kept filled with ink by capillary forces unless the latter can be overcome by a sufficient pressure differential between the ink compartment and the atmosphere.

10 Claims, 8 Drawing Figures

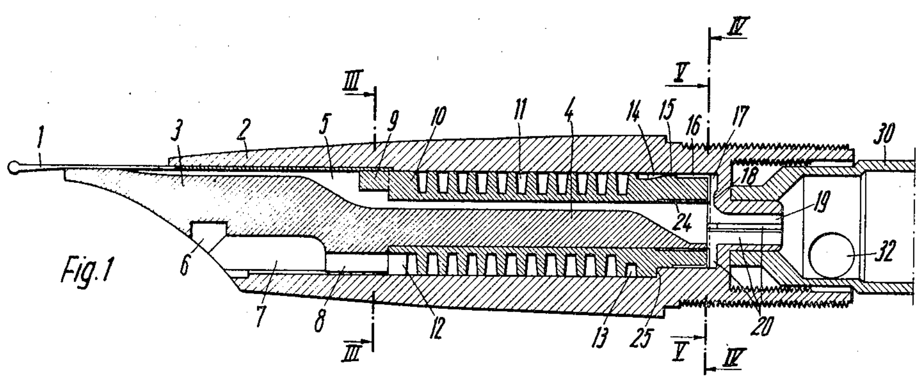

Fig. 1

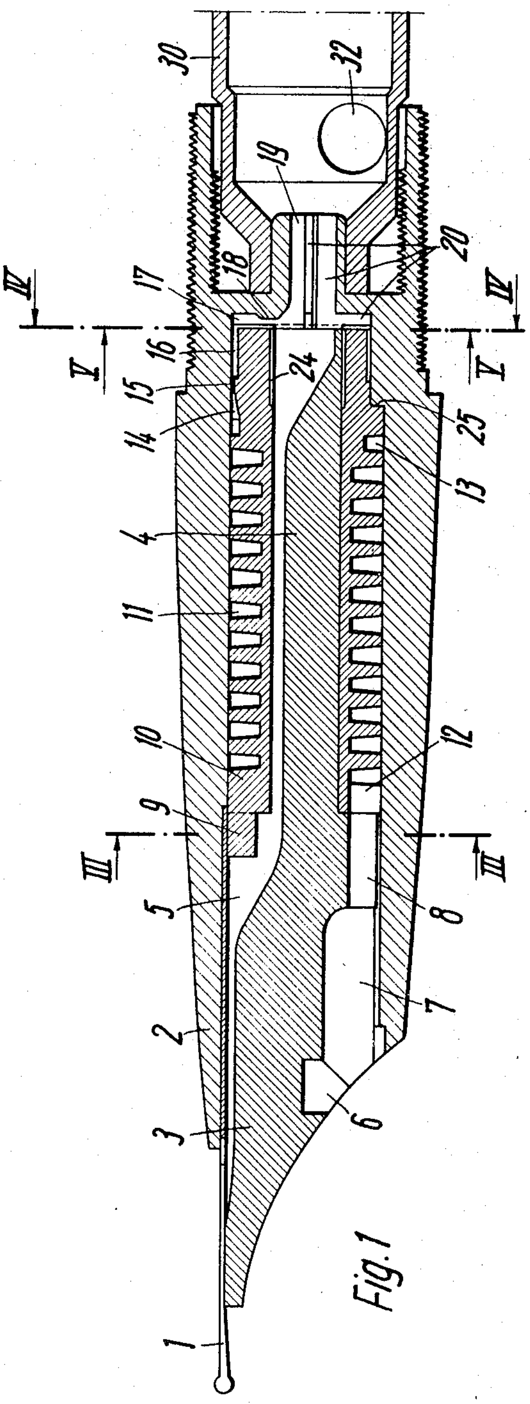

Fig.1

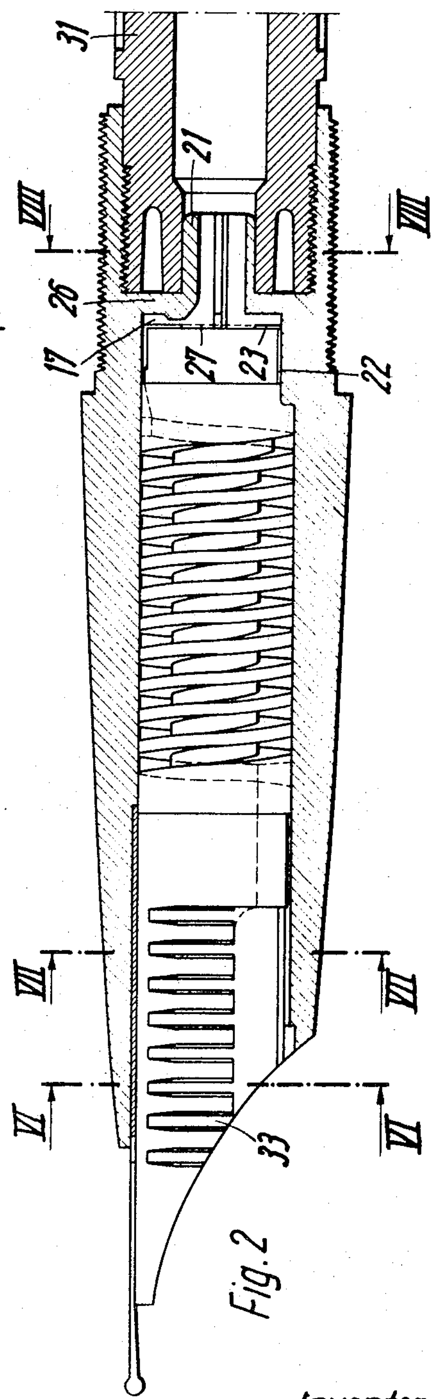

Fig.2

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Fig.5

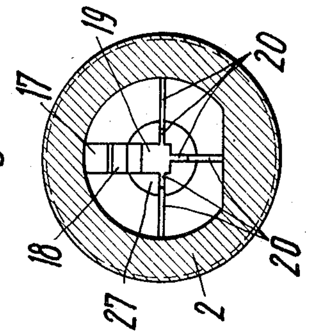


Fig.8

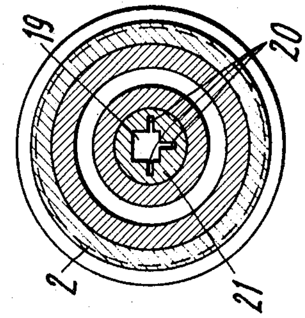


Fig.4

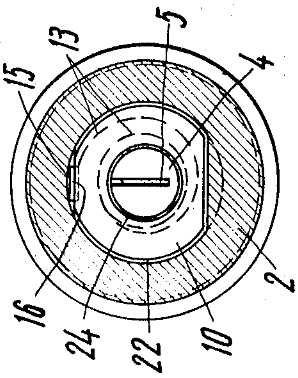


Fig.7

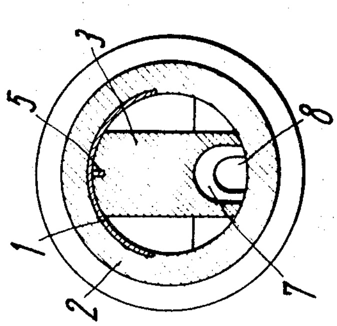


Fig.3

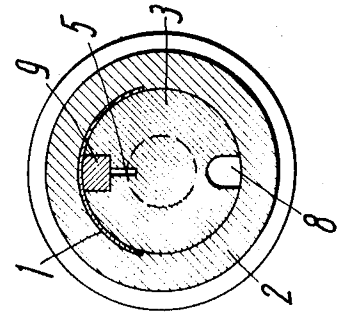
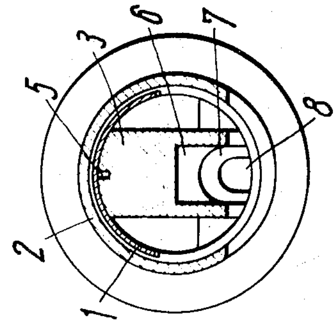


Fig.6



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INK FLOW CONTROL IN A FOUNTAIN PEN

This invention relates to fountain pens, and particularly to the control of ink flow from the ink storage compartment of the pen to a writing point.

With the wide distribution of ball point pens, the more expensive fountain pens are required to meet high-quality standards, and particularly to provide a steady ink supply to the writing point without spilling ink under unfavorable conditions in a manner impossible in ball point pens. A good fountain pen should not leak ink under conditions of low-ambient air pressure, as in an aircraft, nor when exposed to rising temperatures. It is often required that a fountain pen, particularly a cartridge pen, be made ready for use, that is, charged with ink, at the place of manufacture, and be transported over great distances as freight without releasing any of the charged ink although exposed to varying temperatures and air pressures, and being subjected to vibration and mechanical shock.

The known fountain pens meeting such requirements are relatively complex and correspondingly costly. They must be built to dimensional tolerances of 0.01 to 0.02 mm., and will not function properly when certain critical dimensions deviate as little as 0.05 mm. from the design value. They are assembled from a relatively great number of parts which are difficult to fit with the required precision.

An object of the invention is the provision of a fountain pen in which critical dimensions can be maintained relatively easily because of the paucity of constituent elements and the accessibility of critical parts for manufacture and inspection prior to assembly.

The invention is concerned more specifically with an improvement in a known fountain pen of the type in which a partition axially separates an ink storage compartment in the rear end of the elongated pen barrel from a cavity in the front end, the partition having a front face in the cavity and being formed with a bore connecting the compartment to the cavity. The writing point of the pen projects forwardly from the cavity, and is fed ink from the bore in the partition, while air is admitted to the bore from the ambient atmosphere. For this purpose, there is provided an ink conduit of capillary transverse dimensions and an air conduit having a throttling portion of capillary transverse dimensions and otherwise of transverse dimensions substantially greater than capillary.

More specifically, this invention aims at providing improved control over keeping the throttling portion of the air conduit filled with ink, and thereby preventing entry of ambient air into the ink compartment and the associated outflow of ink unless the pressure of the ambient air exceeds the fluid pressure in the compartment by a predetermined amount. The control arrangement of the invention and the axial surface of the barrel in the cavity define an annular groove of capillary radial dimensions about the barrel axis adjacent the front face of the partition. The annular groove intersects the air conduit adjacent its throttling portion. The front face of the partition is formed with at least three capillary ink ducts which extend from the aforementioned bore in the partition substantially to the axial barrel surface and communicate with the annular groove, thereby providing a capillary channel for ink flow from the ink compartment to the throttling portion of the air conduit.

Other features, additional objects, and many of the attendant advantages of this invention will readily become apparent as the same becomes better understood by reference to the following detailed description of a preferred embodiment when considered in connection with the appended drawing wherein:

FIG. 1 shows a fountain pen of the invention enclosing an ink cartridge in fragmentary side elevational section on the longitudinal axis of the pen barrel;

FIG. 2 shows the pen of FIG. 1 with a different ink cartridge partly in side elevational section on the barrel axis, and partly in side elevation;

FIG. 3 illustrates the pen of FIG. 1 in front elevational section on the line III-III;

FIG. 4 shows the pen in rear elevational section on the line IV—IV;

FIG. 5 is a front elevational section of the pen on the line V—V coinciding with the line IV—IV;

FIG. 6 shows the pen in front elevational section on the line VI—VI in FIG. 2;

FIG. 7 is a section analogous to that of FIG. 6 on the line VII—VII in FIG. 2; and

FIG. 8 shows the device of FIG. 2 in rear elevational section on the line VIII—VIII.

Referring now to the drawing in more detail, and initially to FIGS. 1 and 2, there is seen the front end of a cartridge-type fountain pen whose principal illustrated elements are a writing point 1, the front part 2 of the pen barrel, which is threadedly mounted on a nonillustrated rear part in the fully assembled pen, and a feed bar 3. An ink cartridge 30 (FIG. 1) or 31 (FIG. 2) is received in an ink storage compartment of the pen partly bounded by the illustrated front part 2 and otherwise by the nonillustrated rear part of the barrel.

The ink compartment is separated from a cavity in the front part of the barrel, which is open in a forward direction, by a partition 26 from which a tube 21 projects into the ink storage compartment and into the ink cartridge 30, 31, the initially sealed ink cartridge being opened by displacement of a ball valve 32 when the tube 21 is inserted into the cartridge.

The feed bar 3 projects from the front end of the barrel cavity. The writing point 1 is clamped between the feed bar 3 and the inner wall of the barrel part 2 and projects beyond the bar 3 in the direction of the longitudinal barrel axis. The rear portion 4 of the bar 3 is of circular cross section and generally cylindrical. The bar 3 is formed with a longitudinal slot 5 in a radial plane, the slot being of capillary width as best seen in FIGS. 3 and 4. The slot 5 is closed in a radially outward direction by a sleeve 10 which envelops the rear portion 4, and by the writing point 1 over the remainder of its length. The radial height of the slot 5 decreases from the radial rear face of the bar 3 in a forward direction, and the slot 5 ends behind the front end of the bar 3.

The writing point 1 extends about the bar 3 in an arc of less than 180° (FIGS. 3, 6, 7), and the orifice portion 7 of an axial air duct 8 is located diametrically opposite the writing point 1 in the obliquely sloping front face of the bar 3. The angular and axial position of the sleeve 10 on the bar portion 4 is secured partly by engagement of a wedge-shaped key 9 integral with the sleeve with a conforming recess in the front portion of the bar 3 communicating with the slot 5. A helical groove 11 is cut into the outer, mostly cylindrical face of the sleeve 10, and the front end 12 of the groove 11 is axially aligned in communication with the air duct 8. A transverse recess 6 at the front end of the orifice 7 permits a hook or key to be inserted in the feed bar 3 for withdrawing the bar from the barrel part 2. Slots 33 are provided in the front end of the bar 3 in axially spaced radial planes to retain ink surplus delivered to the writing point 1, as is conventional, and are sealed from the orifice 7, while communicating with each other.

The rearmost turn 14 of the helical groove 11 leads to an axial duct 14 provided in the surface of the sleeve 10 and tapering in a rearward direction to a throttling gap 15 followed by a radially slightly wider axial duct 16 which terminates in the radial rear face of the bar 3. As is best seen in FIG. 2, the ducts 14, 16 and the gap 15 are bounded in a radially outward direction by a cylindrically arcuate inner wall of the barrel part 2 and are segment-shaped in cross section, the height of the throttling gap being of capillary size and the ducts 14, 16 being at least partly of capillary height, as is evident from FIG. 4.

The front face 27 of the partition 26 is formed with a flat annular recess 23 opposite the rear face of the sleeve 10. The recess 23 thus forms a gap between the partition 26 and the sleeve which extends in a radial plane and is of capillary axial width precisely determined by abutting engagement of conforming shoulders 25 on a flat of the sleeve 10 and on the barrel part 2, the axial position of the feed bar 3 being precisely determined by abutting engagement of the rear portion 4 with the central portion of the face 27. Shallow and wide annular grooves 22, 24 about the outer and inner faces of the sleeve 10 at the rear end of the sleeve are closed radially by the barrel part 2 and the rear portion 4 of the feed bar 3 respectively. They are of capillary radial width and communicate with the gap 23 and communicate with the slot 5 and the duct 16.

Opposite the orifice of the duct 16, the face 27 of the partition 26 is formed with a relatively wide and deep radial groove 17, best seen in FIG. 5, which leads to a square axial bore 19 in the partition 26 and in the tube 21. A projection 18 in the bottom of the groove 17 near the bore 19 locally reduces the cross section of the groove 17 whose circumferential width is equal to the width of the bore 19, the groove leading into one side of the bore.

Three L-shaped capillary slots 20 extend radially inward of the tube 21 from the other three sides of the bore 19 and axially inward of the partition 26 from the face 27 so that the slots extend from the ink compartment and the interior of a cartridge 30, 31 therein to the radially outer circumference of the face 27, and are connected with the slot 5 and the duct 16 by the grooves 22, 24 and the gap 23, as is also evident from FIGS. 5 and 8.

During operation of the pen, ink is drawn by capillary action from the cartridges 30, 31 through the slots 20 into the gap 23, and partly through the grooves 22, 24, and partly directly into the slot 5, and is supplied to the writing point 1. Ink is also drawn by capillary action from the groove 22 into the duct 16, the throttling gap 15 and the adjacent portion of the duct 14. Eventually, enough ink is withdrawn from the partly illustrated compartment in the rear part of the barrel that lowered pressure in the ink compartment or in a cartridge retained therein prevents further outflow of ink as long as compensating air is not admitted.

Air enters the pen through the orifice 7, can flow freely through the relatively wide duct 8 and groove 11 to the duct 14 and the gap 15 which are blocked by ink until the pressure differential across the gap 15 permits the ink to be dislodged by entering air. The air then passes through the duct 16, the radial groove 17 and the square bore 19 of the tube 21 into the ink compartment to permit further release of ink, whereupon the gap 15 is quickly blocked again by air as the pressure in the duct 16 rises toward the pressure of the ambient air. Except for the gap 15 and closely adjacent throttling portions of the ducts 14, 16, the entire air conduit from the orifice 7 up to and including the bore 19 has a flow section too great to be filled by ink under capillary forces only.

As ink is consumed by writing, the gap 15 is opened and closed so as to permit the ink supply in the writing point 1 to be replenished at the same rate at which the ink is discharged from the point. The rate of air inflow is limited also by the throttling projection 18. When the pressure differential across the gap 15 is reversed by a reduction in the ambient air pressure, as in an airplane flight, or by heating of the ink storage compartment, the ink displaced by the expanding air in the ink storage compartment flows into the relatively wide helical groove 11 and the air duct 8 whose combined capacity is sufficient to prevent ink from being discharged from the orifice 7 under all but the most unusual conditions. When the normal pressure differential between the ink compartment and the ambient air is restored by cooling of the compartment or by increasing ambient air pressure, the ink is withdrawn into the compartment by suction, the slot 5 being sealed by the combined effect of the writing point 1 and of the ink tenaciously held in the long and narrow slot 5 unless drawn toward the point 1 by capillary forces.

The fountain pen described above and illustrated in the drawing consists of the writing point 1 and of four unitary pieces of plastic, one of the pieces being the rear part of the barrel, not shown. The partition 26 and the tube 21 are integral with the front barrel part 2, and the feed bar 3 and sleeve 10 constitute the other two plastic pieces. With the exception of the bore 19 in the tube 21, which is readily formed by coring, all other ink and air conduits consist of grooves in the plastic elements which are transversely open or of gaps between the several plastic elements. The necessaRy precise dimensional tolerances can therefore be maintained with relative ease, and can be checked readily.

The three capillary ink slots 20 in the tube 21, as a whole, constitute a system whose central axis is below the central axis of the bore 19 and the center of the orifice of the slot 5 in the rear face of the bar 3. It has been found that this arrangement causes the ink supplied to the writing point 1 mainly to be provided by the lowermost slot 20 diametrically opposite the radial groove 17, while the two slots 20, which are located in a common plane provide the gap 23 and the groove 22 with ink for operating the air valve at the throttling gap 15. Smooth ink flow under all operating conditions is provided by the radially elongated portions of the three slots 20 which extend over the full radial width of the partition 26 and to the groove 22 at the outer circumference of the sleeve 10.

While the number and arrangement of the slots 20 permit ink to be supplied in adequate amounts for all its functions, the location of the ink conduit intake below the air discharge at the rear end of the barrel part 2 in the normal writing position of the pen is instrumental in the proper distribution of the ink which is further assisted by the projection 18. As is necessary, the writing point 1 is located above the air intake orifice 7 on the same side of the barrel axis as the air discharge through the duct 16 and the groove 17 to the bore 19.

It has been found that the smooth ink flow characteristic of the pen of the invention cannot be achieved under normal writing conditions with the use of conventional ink with fewer than three slots 20, and that more than three are not usually required though not interfering with the desired results as long as the location of their common flow axis is chosen as described above, and the radial portions of the slots extend to the capillary groove 22 which intersects the air duct 16.

Obviously, other modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that, within the scope of the appended claims, the invention may be practiced otherwise that as specifically described.

What is claimed is:

1. In a fountain pen having an elongated barrel, the barrel having a longitudinal axis, a partition in said barrel axially separating an ink storage compartment in the rear end of said barrel from a cavity in the front end, said partition having a front face in said cavity and being formed with a bore connecting said compartment to said cavity, a writing point forwardly projecting from said cavity, and feeding means in said cavity for feeding ink from said bore to said point, and air from the ambient atmosphere to said bore, said feeding means defining an ink conduit of capillary transverse dimensions and an air conduit having a throttling portion of capillary transverse dimensions and otherwise of transverse dimensions substantially greater than capillary, and control means for keeping said throttling portion filled with ink unless the pressure of said ambient air exceeds the fluid pressure in said compartment by a predetermined amount, the improvement in the control means which comprises:

a. said control means and the axial surface of said barrel in said cavity defining an annular groove of capillary radial dimensions about said axis adjacent said front face,

b. said annular groove intersecting said air conduit adjacent said throttling portion of the same, and

c. said front face being formed with at least three capillary ink ducts extending from said bore substantially to said surface and communicating with said annular groove.

2. In a pen as set forth in claim 1, said front face and said control means axially bounding a gap of capillary width connecting said annular groove to said ducts, said gap extending substantially in a plane radial relative to said axis.

3. In a pen as set forth in claim 2, said front face being formed with a radial groove extending from said bore substantially to said surface, said throttling portion being bounded by said surface and said control means and axially communicating with said radial groove, the radially outermost portion of

said groove being axially aligned with said throttling portion, said groove constituting a part of said air conduit.

4. In a pen as set forth in claim 3, said radial groove having a portion of reduced cross section.

5. In a pen as set forth in claim 2, said control means including a feed bar and a sleeve on said feed bar, said writing point being received between said surface and said feed bar, and said feed bar and said sleeve jointly bounding a portion of said ink conduit, said sleeve having an end face opposite said front face, said faces axially bounding said gap, and abutment means on said sleeve and on said barrel axially engaged to define the relative axial position of said faces.

6. In a pen as set forth in claim 5, said sleeve and said surface defining said annular groove therebetween.

7. In a pen as set forth in claim 2, said control means including a feed bar and a sleeve on said feed bar, said writing point being received between said surface and said feed bar, said feed bar and said sleeve jointly bounding a portion of said ink conduit, said sleeve being formed with a helical groove bounded by said surface to constitute a portion of said air conduit, said throttling portion extending from said helical groove toward said gap between said sleeve and said surface and being segment-shaped in cross section.

8. In a pen as set forth in claim 7, said air conduit tapering in cross section from said helical groove to said throttling portion, a connecting portion of said air conduit connecting said throttling portion to said gap and intersecting said annular groove.

9. In a pen as set forth in claim 8, said front face being formed with a radial groove, one terminal portion of said radial groove communicating directly with said bore, the other terminal portion of said radial groove being axially aligned with said connecting portion of said air conduit, said gap extending between said other terminal portion and said connecting portion, said radial groove constituting a portion of said air conduit, said ink ducts being offset from said axis in a direction away from said one terminal portion.

10. In a pen as set forth in claim 1, said control means including a feed bar, said feed bar abuttingly engaging said front face.

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