This invention relates to what I consider to be a new type of fountain pen. It is one of the objects of the invention to provide a fountain pen wherein leakage due to internal over external air increase is prevented. A further object of my invention is to provide a new and useful ink feed construction whereby this feed is substantially constant and instantly available.

A further object of my invention is to provide a construction in which the user can visually notice whether or not the pen is in condition for operation. While attaining the objects above stated, it is a further object to attain a construction that is extremely simple and low in cost of manufacture and yet effective in its operation. These and other objects and advantages will appear from a reading of the following specification wherein.

Figure 1 is a view on a much enlarged scale of the parts, except the cap which is not shown, in section except the air tube which is shown in elevation;

Figure 2 is a view of the upper end of the interior construction at the line 2—2;

Figure 3 is a longitudinal view of a modified arrangement of the air tube and associated part;

Figure 4 is a view at the line 4—4 of Figure 3;

Figure 5 is an end view of Figure 6 at the line 5—5;

Figure 6 is a part elevational and part sectional view on an enlarged scale of the air tube;

Figure 7 is a view similar to Figure 4 but of a modified construction;

Figure 8 is a curve showing the principles involved in my new construction;

In the various views wherein like numbers refer to corresponding parts, 1 is the barrel of the pen made of suitable plastic material which is transversely compressible but axially stiff. The barrel 1 is preferably made of transparent material such as Celluloid having a thickness of about .010 to .015 inch. Where a Celluloid is used I prefer to impregnate its inner surface with some anti-wetting agent as “dry-fill” and preferably under considerable pressure in order to prevent ink vapor leakage. Other synthetic plastic materials may be used such as polystyrenes or polyethylene. Other materials, colored, translucent or opaque, may be used or even thin stainless steel.

The barrel 1 is attached to a hood 2 which may be made of suitable material such as hard rubber or the equivalent. The hood 4 has the end which receives the barrel which is made in hollow cylindrical form and the end of the barrel is attached thereto preferably by a forced fitting joint 9 so that the elastic expansion of the barrel 1 will make a firmly ink tight yet separable joint, the surfaces of which are preferably covered with silicone grease or the equivalent to assist in making the joint and in keeping the same tight. Also it is shown in the drawing that the joint is made so as to provide a smooth surface 10 between the barrel 1 and the hood 2. The hood 2 tapers to a rounded point at 11 and has one side ground off at an angle of about 30° to the hood axis forming an oval shaped hole. The hood 2 has three bores of different diameters. The inner bore 12 is about ½ inch long and adjacent to this is a somewhat larger bore 13 which is about ¼ inch long and the largest bore 14 is about ½ inch long. In the bore 12 is force fitted an ink tight ink tube 3. I have obtained very satisfactory results for this tube by using a stainless steel hypodermic tube having an outside diameter of .065 inch and inside diameter of .046 inch. This tube extends from a point 15 adjacent the nibs 16 of the pen point 4, to a point on the axis of the barrel 1 short of the longitudinal volumetric center of the barrel indicated by the broken line 17. This inner end of the end tube 3 is flared outwardly into a small cup 18. Inside of the ink tube 3 is an air tube 5 which is somewhat longer than the ink tube 3 so that it may be projected slightly at both ends from the ink tube, which extends from the end 16 to the end 21 where it is anchored by soldering or spot welding to an oval plate 20, which is positioned in the oval surface formed in the hood 2. This plate 20 encloses the oval hole in the hood 2 and prevents ink from creeping into the open end 21 of the air tube 5. The air tube 5 has an outside diameter of approximately 2 to 4 mils smaller than the inside diameter of the ink tube 3 so as to form therebetween an annular capillary ink channel 6. I have obtained quite satisfactory results for this air tube, another stainless hypodermic needle like tube having an outside diameter of .042 inch and an inside diameter of .015 inch.

In order to get the capillary attraction I have found that surfaces which are etched, pitted or scored develop great capillary action preferably from other surfaces, as shown in Figures 5 and 6. One way of securing the desired effect is by forming on the outside of the air tube a plurality of triangularly shaped grooves 23. Besides serving to increase the capillary action this scoring as illustrated in Figure 5 serves an additional purpose in that it is made so that the maximum
diameter across two opposite scored parts is slightly in excess of the inside diameter of the end tube in that when the ink tube and air tube are assembled the air tube will be co-axially spaced within the ink tube. As shown in Figure 1 the co-axial arrangement is at least partially provided for by passing a thin stiff pin through the upper end of the two tubes 3 and 5 is that shown in Figure 3, wherein a strong ink resistant but wettable wire 22 is spirally wound in a coarse manner around the tube 5, at least the ends 25 and 26 being soldered or welded to the ends of a tube 5b. If necessary the wire 22 may be fastened to the tube 5b at one or more intermediate points. A still further way of co-axial arrangement as shown in Figure 7 is wherein the pipe 3e corresponding to pipe 5 is extruded so a rib 27 is positioned thereof in a spiral manner as shown in Figure 7. It is to be noted from Figure 1 that pen 4 has a split shank which securely fits into the bore 13 of medium diameter in the boss 17 while the larger bore 14 provides an annular space 7 outside the shank of the pen for cooperation with the space 8 provided by the medium diameter bore 13.

In Fig. 8 I have shown a curve made from measurement data to determine the capillary action that goes on within the pen constructed to the foregoing, this data being obtained at clean wettable surfaces of annular channels in the form of tubular bores in a glass tube having an inside diameter of 0.385 inch. By reference to the curve it will be observed that the height of climb of a good grade of fountain pen ink (“Sheaffer's Emerald Green Skrip”) varies inversely with the diameter of the capillary bore. This curve has been used to determine the radial-thickness of the various ink channels described, such as channels 6, 7, and 8 in relation to the length of these channels. The abscissae represent the radial channel thickness in mils and the ordinates represent the vertical height to which ink will climb to the surface of a vessel or be securely held in the tube when ink is removed from the vessel. The various heights are those in which capillary action just balances gravitational pull on the ink column in the ink tube. With increased height of ink column, gravity will pull out the excess ink and cause it to drip off at the bottom end of the tube or other channel, until the capillary attraction balances the gravitational pull.

However, when the capillary force in the tube balances the gravitational pull the ink column will still flow onto or be absorbed by an ink wettable surface or body contacting the lower end of the tube. Thus the ink so held in the tube is still instantly available for application such as writing on paper or the like.

The numerical values of the ordinates of this curve will vary somewhat with the nature of the ink comprising the capillary channel walls, even though these be free of grease or the like. Such a curve then as Fig. 8 is plotted from measurements of the capillary force of annular channels for the material and surfaces to be used and this curve is used for determining the radial-thickness of the several ink channels between the reservoir and the pen nib tips, in relation to the length of these channels. For example, if all of the channel surfaces have capillary forces in accordance with the curve of Fig. 8 and the ink tube has a length of 2¾ inches inspection shows that the radial thickness of the annular ink channel must be no greater than 3 mils, in order for it to hold this 2¾ inch high column of ink without over flowing. Likewise, if as an Figure 1, the length of ink collector spaces 1 and 8 are ½ inch. Their annular the air tube 5 and in order that the capillary forces there present may at least balance the gravitational pull on their continued columns of ink. Since the thickness, that is the inside diameter of the air tube is 15 mils, its capillary force even if its bore were wettable, could sustain an ink column of only about 0.7 inch as shown on the curve of Fig. 8. From the end of the ink tube 3 ink, which has filled the small cup, flows down through the annular channel 6 to its lower end 15. There it contacts the under surface of the plate 26 and flows over its surface to the pen bore and nibs, due both to gravitational and capillary action. It flows therefore into the annular collector space 8 and thence into annular collector space 1. Air in these spaces escapes around the edges of plate 16.

The butt end of the nib slit in the pen-point is preferably no more than one or two miles wide. This slit tapers to zero width at the tip ends of the contacting nibs. The capillary force in this slit is therefore very large and increases at the tip end, so that this will be ink-charged so long as there is ink above it as described. Thus far I have considered only the hydrostatic pressure due to gravity of the ink in annular channels 6, 7 and 8.

In order that their contained ink columns may not overflow when overbalanced by an addition, to their hydrostatic pressures of the usual hydrodynamic pressures set up by the usual axial motions involved in writing and in handling of such pens, these channels are made somewhat less in radial thickness than those indicated as sufficient, for hydrostatic pressures alone, by the abscissae values of the curve shown in Figure 8 or in similar curves for other annular ink-channel capillary surfaces. A reasonable factor of safety is thus provided as a guard against overflow, which may be the result of large enough to operate satisfactorily for such unusual hydro-dynamically-developed downward pressure additions, as these which occur, for example, when the pen is dropped, pointed down into an unfilled surface as a floor.

This new type of pen is filled with ink by submerging its point end in an ink supply and then alternately transversely squeezing and releasing the barrel a few times. Such transverse pressure reduces the volumetric capacity of the barrel and forces air out. Release of this pressure allows the elastic barrel to spring back to cylindrical shape thus reducing the internal air pressure and allowing the now higher external atmospheric pressure to force ink upwardly through both the air tube 5 and the ink channel 6 into the pen reservoir. Since the cross sectional areas of the bore of air tube 5 and of the annular channel 6 are approximately equal, their ink inflow rates are approximately equal. Since these have approximately equal cross sectional areas and lengths they will both approximately equal amounts of ink, upwardly and accordingly of the inner ends into the barrel. A few such operations suffice to fill the barrel up to or over the top ends of these tubes. If thus filled, over the tube levels, an additional one or two barrel
squeezes across the section occupied by these tubes, will raise the ink level in the barrel and also increase the internal air pressure, so that ink is forced out through the tubes, and the final level is about ¼ inch below the ends of these tubes. Additionally, this clears all ink out of the air tube but leaves the slightly lower-level ink tube filled with ink. The annular ink collector spaces 7 and 8 will also be filled with ink.

The aggregate amount of ink in the annular channel 6 and the annular collector spaces 7 and 8, is sufficient for a few pages of writing without further replenishment, after tapping when this ink has been written out it is only necessary to tilt the pen to point up or to a horizontal position, whereupon the rapid flow of ink in the reservoir will lodge another drop or two into the cup 19 and thus replenish the supply. Should an ink droplet become lodged in the air tube 5 it will soon be moved back into the reservoir or to the pen point by movement of air into or out of the pen. Likewise, a concurrent squeeze of the barrel with the tilting on shaking of the pen will insure quick transfer of the ink from the cup 19 or the open end of the air tube 5 to the pen point.

It may thus be seen that this pen has a small reservoir in the form of the spaces 6, 7, and 8, and a main reservoir in the barrel 1, and that these reservoirs are interconnected for ink passage in either direction, when the pen is filled as above stated; in either point-up or point-down position. The non-wettability of the outer surface of ink tube 3 prevents capillary rise of ink along and over the inner end of 3 to the channel 6, when the pen is point down. When the pen is point up, there is a completely effective air space between the ink in the reservoir and the inner ends of tubes 3 and 5.

When the pen is horizontal, even though the ink level may be at or slightly below the axes of tubes 3 and 5, ink inflow to these tubes is prevented by the non-wettability of the ends of these tubes. This non-wettability however does not prevent ink from flowing into the cup 19 as it flows rapidly past it in a penward direction. Once thus caught in this cup the ink drop forms into a bell like mass in good capillary connection with the entrance to the channel 6. When the ink supply in the barrel becomes low, mere tilting of the pen may be insufficient to lodge ink drops in the cup 19. Then a single axial shake of the pen will do so.

If the pen, after writing, is capped and put in the user’s pocket, point up, ink will remain in channels 6, 7, and 8, and held there by capillary force. Then upon reversion for writing, it will be instantly available at the pen point nib ends for writing.

The actual ink capacity of this pen filled as explained in a conventional size of ½ inch outside diameter by ¾ inch long over-all, but exclusive of cap, not shown, is approximately 4 cc, which is from four to six times that of conventional fountain pens of the same size.

It has been noted that the cross-sectional areas of the ink tube bore and the channel 6 are approximately equal. Infilling, as in expulsion of overfilled ink, both of these passages are flushed by rapidly moving ink streams so that any sedimentary ink deposits on their walls, left from continued, emptiness of disuse, will be wetted and flushed out. This flushing out occurs of course, with each refilling operation so that these passages are maintained in operable condition with ink in at least the barrel reservoir, these passages are bathed in aqueous vapors so that sedimentation will not occur. It is evident therefore that this pen construction and operation meets all of the operation conditions desirable of fountain pens, most of which are not found in such conventional pens. It is further evident from what has been said that this pen is simple, durable, and effective, of low manufacturing cost, and attractive in appearance and that it has an exceptionally large ink capacity, with completely visible operation. Of course many of the details can be varied without departing from the spirit of my invention and the scope of the appended claims.

Having thus described my invention, I claim:

1. A fountain pen having a hood carrying a pen with ink collector spaces around the shank of the pen, an ink barrel fastened to the hood, the barrel being of elastic material transversely compressible but axially stiff, an ink tube securely carried by the hood and extending on the barrel axis, from a point near the nibs to a point near the volumetric center of the barrel, a complete air tube located in the barrel, a closely spaced in air relationship within the ink tube, to promote capillary action between the tubes and extending from a point adjacent to the open end of the ink tube to a point near the nibs of the pen.

2. A fountain pen as set forth in claim 1 further defined in that the spacing between the inner wall of the ink tube and the outer wall of the air tube is of the order of 2 mils in radial distance as and for the purpose described.

3. A fountain pen as set forth in claim 1 further defined in that the inner end of the ink tube terminates in a cup as and for the purpose described.

4. A fountain pen as set forth in claim 1 further defined in that the spacing between the inner wall of the ink tube and the outer wall of the air tube is of the order of 2 mils in radial distance while the inner end of the ink tube terminates in a cup and means for centralizing the adjacent end of the air tube in the cup.

5. A fountain pen as set forth in claim 1 further defined in that the outer surface of the air tube has means thereon for promoting capillary action, said means comprising an outer scored surface made up of a plurality of projecting scores preferably extending longitudinally of the air tube.

6. A fountain pen as set forth in claim 1 further defined in that means are provided for coaxially aligning the air tube within the ink tube in said closely spaced, annular relationship, said means comprising, a relatively coarse spirally wound wire around the air tube and having its ends fastened to the ends of the air tube, said wire being preferably ink resistant but wettable.

7. A fountain pen as set forth in claim 1 further defined in that means are provided for coaxially aligning the air tube within the ink tube in said closely spaced, annular relationship, said means comprising a spirally formed integral rib extending along the length of the air tube.

8. A fountain pen as set forth in claim 1 further defined in that the pen end of the hood terminates in an oval shaped hole and the air tube terminates in an oval shaped plate that covers said oval hole in the hood as and for the purpose described.

9. A fountain pen with a hood having at one end a hollow cylindrically shaped formation while
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7 the opposite end tapers to a rounded point with one side ground off at an angle of about 30° to the hood axis, an ink barrel removably fitting over said formation of the hood by an ink tight smooth joint, the barrel being compressible transversely but axially stiff, the hood having three bores of different fixed diameters throughout their lengths in tandem alignment, the one of smaller diameter being at the bottom of the hollow part of said formation, an ink tube tightly fitting in said smaller bore and having one end extending to a point near the volumetric center of the barrel while its other end extends through a greater part of the two larger bores, a pen shaving its shank fitting in the middle bore, but spaced from the ink tube, a complete air tube co-axially spaced within the ink tube and having its inner end extending a short distance beyond the inner end of the ink tube while its other end terminates in an oval shaped plate located in the ground off part at the end of the hood, while the bore of larger diameter forms a space around the shank of the pen and extends down to a point adjacent the ribs of the pen.

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