The invention is an improvement over that disclosed in copending application Serial No. 257,728, filed November 23, 1951, now Patent No. 2,773,956, issued January 1, 1957.

To prevent air lock in fountain pens of the type described, it is necessary that the ink be maintained in a continuous column from the ball at the forward end of the column to the air-ink surface at the rear end of the column. As a consequence, the reservoir tube must be provided with an opening beyond the air-ink surface of the ink column to admit atmospheric pressure to the rear end of said column. This opening poses the problem of leakage therethrough. One way to solve this problem is to make the reservoir tube comparatively small in diameter, whereby the surface tension of the ink creates an air-ink surface across the reservoir of sufficient strength to maintain the integrity of the ink column, thus preventing air locks therein and flow of ink through the open rear end of the reservoir tube when this tube is turned on its side or upside down. It has been found, for example, that the usual ink employed in ball point pens will not leak out of a reservoir tube which is not over one-tenth of an inch in diameter. A reservoir tube of such small diameter has low ink capacity.

In the aforesaid copending application, there is disclosed means by which a reservoir tube of comparatively large diameter and comparatively large capacity, will maintain a continuous ink column from the ball point to the air-ink surface and at the same time will prevent the leakage of ink from this air-ink surface to and out of the open end of the reservoir tube. This means comprises a film supporting device immersed in the ink column to extend therealong and located in spaced relation to the reservoir tube wall. This film supporting device in conjunction with the reservoir tube wall supports the air-ink surface of the ink column at all levels within the reservoir tube between the wall and the center of the tube and maintains thereby the stability of said surface and this prevents leakage along the wall of the reservoir tube, when the open end of the tube is low enough to permit flow of ink by gravity. This allows for the use of a pen having much greater ink capacity than is possible with a reservoir tube having no special film supporting device therein.

One object of the present invention is to provide for use in connection with an ink reservoir a new and improved film supporting device, (1) which will permit an ink reservoir tube of comparatively large diameter and therefore of comparatively large capacity to be employed, by maintaining a continuous ink column from the ball point to the air-ink surface and by preventing thereby the formation of air locks in said column and leakage of the ink from the open end of the reservoir tube, (2) which can be assembled easily into a unit without the use of tools before being inserted and mounted in the reservoir tube, (3) which can be mounted easily and expeditiously as a unit into the reservoir tube and (4) which when so mounted centers its components automatically in relation to the reservoir tube and holds them against lateral instability.

Various other objects of the invention are apparent from the following particular description and from the accompanying drawings, in which—

Fig. 1 is a longitudinal section through a fountain pen shown in upright position and having a filler unit with a film supporting device embodying the present invention;

Fig. 2 is a perspective of the upper coil anchoring end piece forming part of the film supporting device of the present invention;

Fig. 3 is a perspective of the lower coil anchoring end piece forming part of the film supporting device of the present invention;

Fig. 4 is a transverse section of the filler unit taken along the lines 4-4 of Fig. 1.

Referring to the drawings, the filler of the present invention is shown comprising a cylindrical ink reservoir tube 10, which contains a body 11 of fluid ink of high viscosity and of the usual character and which has a minimum inner cross-sectional area greater than that which would permit the air-ink surface film to be supported only by the reservoir tube wall. Since the maximum critical diameter which will permit the air-ink surface to be supported only by the reservoir tube wall for the usual commercial inks employed in ball point pens is 0.100 inch, the cylindrical tube 10 of ⅜" outside diameter and having an inside diameter of .234 inch will be highly advantageous, for the purpose of the present invention.

The lower end of the tube 10 has an axial extension 12 provided with a feed channel 13 communicating with the lower end of said tube and leading to a ball 14, which is rotatably mounted in the normal manner in a seat at the end of an insert 14a in said extension, to serve as the writing element.

The reservoir tube 10 and the feed extension 12 are shown drawn from a single piece of metal but may be of built up construction to form a unit. The extension 12 being of smaller diameter than the reservoir tube 10, there will be formed an annular shoulder 15 at the lower end of said tube serving as a seat for a film supporting device 16. This shoulder 15 may extend at right angles to the longitudinal axis of the tube 10 as shown, or may be conical.

The film supporting device 16 of the present invention extends centrally in the reservoir tube 10 immersed in the body 11 of ink and comprises a central cylindrical rod 17 encircled by a coil 18, which is shown as a helix concentric therewith and which is retained thereon to form a unit therewith by means of end anchor pieces 19 and 20 on said rod preferably made of plastic. The end piece 19 on the upper end of the rod 17 is in the form of a cap and has a center hole 22 to receive loosely but snugly therein one end of the rod 17 and is of stepped construction to define an intermediate section 23 having a diameter slightly smaller than the internal diameter of the reservoir tube 10 to fit snugly therein with a friction hold sufficient to retain the film supporting device 16 in the tube against withdrawal therefrom by gravity, even when the tube is turned upside down. To permit the film supporting device 16 to be handled conveniently through manipulation of the cap 19, the outer end of said cap has an enlarged head section 24 at the diameter than the inside of the tube to serve as a finger piece.

To attach the helix 18 to the upper cap 19, said cap has at its inner end a neck section 27, which is larger in outer diameter than the inner diameter of the helix and which is provided with a helical groove 28 of substantially semi-circular cross-section, into which the upper end of said helix is threaded and snugly fitted for anchorage.
To permit the atmosphere to find access from the outside of the tube 10 to the air-ink surface, the cap 19 has a half round groove 24 cut into it. The bottom anchor piece 20 for the helix 15 is also cylindrically formed with an enlarged flange section 31 to fit snugly in the tube 10 and has a hole 32 to receive loosely but snugly therein the lower end section of the rod 17. The anchor piece 20 is provided with a series of channels 33, three being shown, equally spaced around its circumference and extending lengthwise thereof to form passageways by which the ink can flow freely from the ink supply into the feed channel 13. This cap 20 seats on the shoulders 15 formed at the bottom of the reservoir tube 10 when the filler unit is assembled and mounted in the tube 10, and to prevent blocking of the flow of ink through the channels 33 as a result of this seating condition, the flange section 31 of the cap has a radial channel 35 at the foot of each lengthwise channel 33 communicating with the feed channel 13, so as to hamper free flow of the ink between the ink supply in the reservoir tube 10 and the feed channel 12.

The bottom cap 20 also has a neck section 36 of reduced diameter greater than the internal diameter of the helix 18 and provided with a helical groove 37 of substantially semi-circular cross-section into which the end of the helix is threaded and snugly fitted for anchorage.

The helix 18 in unpressed condition is shorter than the distance between the end caps 19 and 20 on the ends of the outer rod 17 and in this condition has preferably 16 turns to the inch. This helix 18 has to be elongated to screw onto the caps 19 and 20 and an elongation of approximately to give 14% to 15 turns per inch is found suitable. Elongation causes the helix 18 to be stressed longitudinally in assembled condition of the film supporting device 16, so that the end caps 19 and 20 are firmly retained with endwise pressure on the ends of the rod 17 and the helix is slightly displaced in relation to the axis of the rod 17. To further hold the helix 18 central in the reservoir tube 10 throughout its length, at least three indentations 40 are made radially inward in the wall of said tube about midway of its length, the insides of these indentations providing narrow longitudinal surfaces at a uniform distance from the axis of the tube, so as to contact the helix and hold it central at that region. The length of the contact surfaces formed by the indentations 40 is slightly greater than the pitch of the helix 18 when axially extended in assembled condition, so that each one always contacts at least one convolution of the helix. Although only three indentations 40 are shown, more can be employed at the same level if so desired and additional sets of similar indentations at different levels can be used to further stiffen the helix laterally, if desired.

The channels 33 in the lower anchor cap 20 serve not only as ink passageways but are located circumferentially to clear the indentations 40 as the film supporting device 16 is inserted into the reservoir 10.

The diameter of the helix 18 is desirable such that the wire of the helix is midway between the outer surface of the rod 17 and the inner wall of the reservoir tube 10. For the best conditions, i.e., those conditions which hold the air-ink surface of the ink column intact with the lowest surface tension possible, it has been found that the diameter of the helix 18 must be such as to centralize the wire of the helix within the circumference of the outer surface of the rod and the inner wall surface of the reservoir tube 10 with exactitude which in practice can be achieved within plus or minus one thousandth of an inch. As liquids of higher surface tension are used, the diameter of the helix in relation to the internal diameter of the reservoir tube 10 and the diameter of the rod 17 becomes less and less critical.

It has been found that the dimensional relationships described locating the wire of the helix 18 midway between the inside of the wall of the reservoir tube 10 and the outer surface of the rod 17 serves to provide the same amount of total inner and outer perimeter per unit area inside and outside of the helix and this condition is conducive to the best results in maintaining the stability of the air-ink surface and the integrity of the ink column.

A specific example of the filler construction may be as follows: As already indicated, the inside diameter of a 1/4" O. D. reservoir tube 10 with sufficient wall thickness is about .234". This tube 10 is made preferably of non-ferrous material. The axial rod 17 and the helix 18 are desirably of hard drawn brass wire. The diameter of the rod 17 is .072" and the helix 18 is made of fine wire, 0.0319" in diameter wound 16 turns per inch, and has an outside diameter of .185". With the parts described so dimensioned, the radial distance between the inner wall of the reservoir tube 10 and the outside circle of the helix 18 will be .0245" and the radial distance between the inner circle of the helix and the outside circle of the axial rod 17 will be .0246", thereby fulfilling the conditions indicated above, requiring the wire of the helix 18 to be located midway between the inner wall of the reservoir tube 10 and the outside of the axial rod 17.

The approximate position of the air-ink surface 45 of the ink column is substantially of the same configuration at all levels of the pen in any one position thereof, including the horizontal position. This air-ink surface extends from the inner surface of the wall of the reservoir tube 10 to the outer surface of the wire of the helix 18 and from the inner surface of the wire of the helix to the surface of the axial rod 17. Thus, due to the adhesion of the ink to the reservoir wall, to the wire of the coil 18 and to the axial rod 17, the air-ink surface is supported continuously across the tube. The variation of the pressure differences across the surface 45 between points of support is greatly reduced, and the ink column will retain its integrity and stability as the result of the holding action of the surface tension at the air-ink surface with its support by adhesion to the tube wall and to the film supporting device 16. No air locks in the ink column will, therefore, be formed, and the ink from said column will not spill out of the outer end of the reservoir tube 10 during normal use or handling, regardless of its position.

The reservoir tube 10 containing the body of ink 11 therein and the film supporting device 16 assembled to form a filler and tube is enclosed in the usual pen holder 46 having the conventional cover 47.

It is apparent from the foregoing description, that the film supporting device 16 of the present invention forms a unit, which can be easily and expeditiously assembled without tools to form said unit, and which when so assembled can be fitted and mounted with the reservoir tube as a unit by a simple and quick finger manipulation.

In the specific example described, the reservoir tube 10 is cylindrical and the coil 18 would, therefore, be in the form of a helix of uniform diameter throughout its length. However, there may be reasons why a reservoir tube 10 tapering towards its lower end may be desired, as for example, to facilitate drawing operations, in which case, the coil would have a corresponding taper towards its lower end of one-half the taper of the tube 10, the rod 17 being midway between the wire of said coil midway between the inner wall of the reservoir tube 10 and the axial rod 17, throughout the effective length of said reservoir tube. In any case, the reservoir tube 10 would have a circular cross-section throughout its effective length and the coil 18 would consist of a series of successive circular axial convolutions.

Also, if desired, only the lower section of the reservoir
tube 19 may be tapered to present a seat for the lower anchor cap 20 of smaller diameter, large enough to receive said anchor cap freely and small enough to assist the indentations 49 and the upper anchor cap 19 in properly centering the film supporting device 16 in said tube.

While the invention has been described with particular reference to a specific embodiment, it is to be understood that it is not to be limited thereto, but is to be construed broadly and restricted solely by the scope of the appended claims.

What is claimed is:

1. In an ink filler unit for a fountain pen of the ball point type which has an ink reservoir tube having an opening at the end opposite the ball point through which ink in the tube could flow and having a cross-sectional area greater than that which would permit the ink-air surface film to be supported only by the reservoir wall, the improvement which comprises an ink film supporting device in the reservoir tube, said device extending throughout the effective length of the reservoir tube for immersion in an ink column therein and including a rod located within the reservoir tube and extending lengthwise with respect to said tube and a wire coil encircling said rod, said coil comprising series of successive convolutions extending lengthwise of the rod and in spaced relation thereto, said convolutions also being spaced from the inner wall of the reservoir tube.

2. In an ink filler unit, the improvement as defined in claim 1 wherein the rod is located in the center of the reservoir tube and the convolutions of the coil are spaced substantially equidistantly from the rod and the inner wall of the reservoir tube.

3. In an ink filler unit, the improvement as defined in claim 1 which includes members connecting the rod and coil at opposite ends thereof, each of said members having portions fitting into the ink reservoir tube, said portions being insertable in the reservoir tube as a unit with said rod and coil attached thereto.

4. In an ink filler unit, the improvement as defined in claim 3 wherein the members connecting the coil and the rod are threadably engaged with the ends of the coil.

5. In an ink filler unit, the improvement as defined in claim 3 wherein the member connecting the rod and the coil at one end thereof has at least one channel extending therethrough, said channel forming a passageway for the flow of ink therethrough and extending between the ink reservoir tube and a passageway communicating with a ball point.

6. In an ink filler unit, the improvement as defined in claim 3 wherein the member connecting the rod and the coil at one end thereof has at least one channel extending therethrough, said channel forming a passageway for the flow of ink therethrough and extending between the ink reservoir tube and a passageway communicating with a ball point and the member connecting the rod and the coil at the other end thereof has an opening extending therethrough for a distance of 10% of the column of ink in the reservoir tube.

7. In an ink filler unit, the improvement as defined in claim 1 which includes members connecting the rod and coil at opposite ends thereof, said members maintaining the coil in axially stretched condition and having portions fitting into the ink reservoir tube, said portions being insertable in the reservoir tube as a unit with said rod and coil attached thereto.

8. In an ink filler unit, the improvement as defined in claim 1 which includes a series of radially and laterally spaced indentations formed on the reservoir tube and extending inwardly therefrom, said indentations engaging with the exterior of the convolutions of the coil at spaced points and maintaining the coil in spaced relation to the remainder of the inner wall of the reservoir tube.

9. In an ink filler unit for a ball point pen of the type employing an ink reservoir tube having a ball located at one end thereof and being open at the other end thereof, said tube having a cross-sectional area greater than that which would support an ink-air surface film, the combination with said ink reservoir tube of a rod disposed centrally in said tube and extending lengthwise through the effective length thereof, a wire coil in the form of an expanded helix encircling said rod and extending lengthwise with respect to the rod, a member connecting the rod and the coil at one end thereof, said member fitting into the ink reservoir tube and having at least one ink channel extending therethrough, a second member connecting the rod and coil at the other end thereof, said second member having a portion fitting into the open end of the reservoir tube, said members maintaining said coil in spaced relation to the rod and the inner wall of the ink reservoir tube and being insertable therein as a unit with the rod and the coil.

10. In an ink filler unit, the combination as defined in claim 9 wherein the coil is maintained in an axially elongated condition by its connection to the end members.

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