This invention relates to ball point pen ink tubes and more particularly to an improved ink tube which is leak-proof even under dry socket conditions at the ball point and yet recoverable for writing when the dry socket condition has been eliminated.

The invention was the subject of a pending application Serial No. 476,479, filed July 29, 1954, by Herbert W. Sams, there is disclosed a leak-proof ball point pen ink tube or writing unit which is effective even under dry socket conditions, but in which the ink dries and forms a seal at the rear end of the tube so that re-use of the pen for writing purposes is not possible. The ink tube and ball point unit of the present invention constitutes a further advance and a development of substantial commercial importance in that this writing unit will recover from the dry socket condition when replaced in writing position and its normal use will thereafter be re-established. Also, this improved modification is entirely effective in preventing leaking from the rear end regardless of the use or position of the unit either by accident or design.

Prior attempts, which have not proven as successful as the arrangement disclosed in the above mentioned application Serial No. 476,479, have been made for eliminating the leakage of ink from the open rear end of ink tubes by incorporating a grease plug in the ink tube at the top of the ink column. While this arrangement is effective under some conditions of use, it is not completely dependable in preventing leaking from the rear end. Neither does it permit recovery for continued use after a dry socket.

Further, in the T. F. Brinson Patent 2,557,409, issued June 19, 1951, there is disclosed the use of a solid piston in the ink tube which is lubricated and sealed at its outer surface by the ink within the tube, this piston serving the purpose of following the body of ink in the tube in its motion toward the ball point whereby substantially all of the ink in the ink tube or reservoir of large capacity is used up in writing. This piston is formed with annular grooves or channels in which small amounts of the ink collect and in which the oil constituent of the ink serves as a lubricant for the piston.

It is significant to note that as of the date of the Brinson patent, and the date of application thereof, i.e., November 7, 1945, the inks used in ball point pens were of the oil base type and included, along with dyes and other components, an oil constituent which in the case of the Brinson pen served as a lubricant for the above mentioned follower piston. However, in more recent times the oil base inks have been generally replaced by quick drying inks which do not contain an oily vehicle and therefore do not possess good lubricating properties. Thus, the inks which would be normally used today in the ink tubes of this invention do not contain an oily constituent that might serve as a lubricant for the piston system used in the present pen. Accordingly, it is important to provide in this ink tube an oily material which will function not only as a lubricant for the piston system but also as a fluid seal. An important feature of this oily lubricating material is that it possesses certain yield values that are characteristically different from the oil constituent used in the ink of the Brinson type pen, and also fundamentally different from the above mentioned grease plug which has been used heretofore as the seal at the top of the ink column. These characteristic features of the sealing fluid, and its co-function with the piston system disclosed below, constitute technically important and commercially valuable aspects of this development.

The piston system and fluid seal combination which has been developed for use in the present invention has resulted from extensive research on this problem, especially from the standpoints of providing an ink tube that is foolproof as to leakage of the ink from the open rear end of the tube when it is inverted, and the equally important aspect of being able to continue with the normal use of the pen for writing purposes when it is re-inverted to normal writing position. This long desired result has not heretofore been obtained completely either by the grease plug seal proposals, or by the lubricated piston arrangement of the Brinson pen, or by the leak-proof, but non-recoverable, arrangement disclosed in the above noted Sams patent application.

In accordance with the present invention the heretofore non-obtainable results above described have been made possible for the first time by utilizing in the ink tube at the top of the ink column a special piston system and fluid seal combination wherein a front or forward component of the piston system is in contact with the top of the ink column. The fluid seal is located in back of this front piston component and extends partly therearound for sealing purposes to prevent escape of the ink around the piston, and finally a rear piston component, which is in contact with the fluid seal, and around which the fluid extends to effect a leak-proof seal between this rear piston component and the walls of the ink tube.

In addition to this combination of a two component piston with the sealing fluid deposited in between and around the piston parts for effectively preventing leakage of the ink, there is another important component of the arrangement which comes into play when the pen is inverted from its normal writing position and the ink column and piston system is caused to move back toward the open end of the ink tube. This component is in the form of a projection or spacing extension that prevents the rear portion of the piston system from forming an air tight seal at the end of the ink tube such that atmospheric pressure cannot be re-established within the ink tube when it is again re-inverted to continue normal writing use of the pen once the dry socket condition has been eliminated.

A dry socket condition as referred to herein is that condition which is oftentimes established at the ball point when the pen has been used in inverted position, causing the ink seal around the ball point to be broken. A dry socket condition is also commonly established when the ball point comes in contact with an absorbent type of material, such as in the wearer's pocket or purse, etc. A dry socket occurring from either of the above reasons opens both ends of the writing unit to the atmosphere thereby permitting the ink column to move in the direction of gravity dependent on the position of the writing unit. This invention completely controls this condition and under failure from a dry socket produces recycling of the ink supply assuring complete use of the ink supply in its use. Leaking from a dry socket can occur readily in brand new writing units but it is more likely to occur in writing units that have been in service and some wear having taken place in the socket causing greater clearances between the ball and socket allowing for freer admission of air.

The above important features, as well as further details of the ink tube of this invention, will be more clearly
understood from the following description taken in conjunction with the accompanying drawing in which:

Fig. 1 is a longitudinal section of a writing unit embodying the present invention;

Fig. 2 is an enlarged fragmentary view of the rear end portion of the writing unit shown in Fig. 1;

Fig. 3 is a similar enlarged fragmentary view of a modification of the piston system shown in Fig. 2;

Fig. 4 is a longitudinal section illustrating the normal action of the piston system upon inversion of the writing unit shown in Fig. 1; and

Fig. 5 is a corresponding longitudinal section illustrating a ready socket condition.

Referring now to the several figures, and generally in the order in which they appear in the drawing, the writing unit shown comprises a ball point insert assembly 10 and an ink tube 11 having the usual restricted portion 12 at the front end thereof, and a rear end 13 which is open to atmospheric pressure through an aperture in a vent plug 14. Contained in the ink tube 11 is a supply of ball pen ink 15 which substantially fills the ink tube except for the portion at the rear end thereof occupied by the piston system shown generally at 16. The several component parts of the piston system are more clearly illustrated in Fig. 2 wherein it is shown that in this embodiment the piston system actually comprises two separate pistons 17 and 18 with the sealing fluid material 19 located between these two pistons. The two pistons 17 and 18 are solid and generally cylindrical in shape and have conical points 20 and 21 which facilitate loading of the pistons in the ink tube and for preventing entrapment of air bubbles. With this construction it is not necessary to provide an air escape aperture in the piston elements.

The filling or loading operation for this ink tube comprises first injecting the ink into the tube from the ball point end, following which the ball point assembly 10 is inserted in position and the substantially filled ink tube is then ready for insertion or loading of the pistons 17 and 18 and the sealing fluid 19. This is accomplished by first dropping the forward piston 17 into the tube with the conical point 20 down so that it makes contact with the ink supply 15. Next the sealing fluid 19 is injected through the same rear end of the tube at which time the rear end vent plug 14 has not yet been inserted. Next the second or rear piston 18 is dropped in on top of the sealing fluid 19 and following which the vent plug 14 is inserted to seal the rear end of the ink tube 15 except at the venting aperture therein which is arranged through a forward extension of the plug 14 within the reservoir tube as indicated at 22. At the end of the loading operation the ink cartridge is placed in a cartridge, the operation of which causes the ink and the assembled parts to become stabilized in their respective positions and frees the ink and piston assembly from entrapped air. Where desired, or if found necessary, the centripetal driving operation may be carried out at any stage during the above described loading operation.

The modification shown in Fig. 3 functions similarly to the arrangement described above for Fig. 2 but utilizes a single or unitary form of piston instead of the separate piston components illustrated in Fig. 2. The piston shown in Fig. 3 comprises an annular base section 23, an intermediate conical portion 24, and a leading flange element 25. This form of piston also contains a longitudinal aperture or bore 26 and transverse bores 27 and 28, for introduction of the sealing fluid 29 therethrough. This sealing fluid 29 may be injected in the aperture 26 and will flow through the apertures 27 and 28 into the cavity between the surface of the conical piston section 24 and the wall of the ink tube 11. The sealing fluid 29 is thus deposited between and around the annular or cylindrical section 23 and the leading flange element 25 of the piston in a similar manner to the sealing fluid 19 in Fig. 2, which is located between the corresponding parts 17 and 18 of the two component piston system shown.

The operation of the above described piston system 16 shown in Fig. 2 in conjunction with the sealing fluid 19 is as follows:

In the normal operation of the pen, that is with the pen maintained with the point down in usual writing position, the ink supply 15 will be progressively depleted by feeding from the ball point during writing, and as the ink column lowers in the ink tube the piston assembly 16 will follow the ink column down toward the ball point of the tube and if no dry socket or other adverse conditions are encountered all of the ink in the larger diameter portion of the tube 11 will be used up, the relatively small part of the ink in the reduced section 12 remaining there and the piston system 16 at that stage will then come to rest on the shoulder 30 defining the entrance to a restricted portion of the ink tube. In other words, during the normal operation of the pen as the ink column moves downward the piston system 16 follows in contact with the ink column and serves for sweeping the entrained portions of the ink from the walls of the ink tube 11. When the ink tube 11 is composed of transparent material, such as, for example, polyethylene or similar transparent plastic, the ink level will be visible at all times and it can be easily determined when the ink supply has been used up. The following action of the piston system 16 also assures removal and use of the ink contained in the large bore section of the ink tube. In this normal operation of the ball point pen and so long as the ink tube remains in the point down or writing position, there is no problem of sealing or leakage of the ink from the rear end of the tube. However, upon inverting of the ball point pen such that the ball point is in an up position, the abovementioned problems of preventing leakage and the desired recovery properties of the pen for use thereafter become involved and important. A discussion of these problems and how they are effectively met by the improved ink tube of the present invention now follows, the description being directed to larger than capillary tubes but not limited to such as many of the advantages of this invention are obtained in tubes of capillary size.

When the pen is inverted from its usual writing position, and in the absence of a dry socket at the ball point, the ink supply 15 will tend to flow to the rear end of the ink tube 11 and would do so if the piston system 16 were not present. Under this condition, however, the piston system 16 stabilizes the ink column and actually overcomes the tendency to flow backward or downward to the rear end of the ink tube, as illustrated in Fig. 4. This is made possible by the function of the sealing fluid 19 extends loading operation of the piston 18 such that an interchange of air and ink past this piston cannot take place. Thus, in this inverted position, in the absence of a dry socket, the ink supply and piston assembly remain fixed in the ink tube.

Under dry socket conditions as above defined, the problem of ink flow and leakage is increased and although no leakage will result with the present piston system, the ink column and piston assembly will nevertheless move downward or rearward toward the rear end of the ink tube, as illustrated in Fig. 5. This is caused by the breakage of the ink film at the ball point establishing atmospheric pressure within the ink column and thereby causing the ink column and piston system to respond to the force of gravity. Under this condition, the ink column 15 and piston assembly 16 will continue to move toward the rear end of the ink tube until the flat end 31 of the piston 18 makes contact with the vent plug extension 22 which prevents any further forward movement of the piston 18. When this position is reached the ink column and the piston assembly can move no further and subsequent admission of air through the aperture 22 in the end plug 14 is assured, as mentioned previously above, by virtue of the fact that the plug extension 22 extends inwardly beyond the inner wall of the end plug 14 and prevents a seal being formed between this surface and the flat rear
surface 31 of the piston 18, leaving a narrow annular air space 32 between these two surfaces. Even though the ink tube and piston assembly have reached the rear end of the ink tube 15, as above described, under the dry socket condition at the ball point, no ink will escape from the rear end of the tube through the air vent 22 as would otherwise occur, because of the sealing function of the fluid medium 19 upon and around the contacting surfaces of the piston 18 and the inner wall of the ink tube 11. To maintain this seal and leak-proof condition, it is important to have in addition to the piston 18 the cooperation or co-function of the other piston 17 with the sealing fluid 19 interposed between these two pistons and extending around and upon the walls of the piston 17 as well as the piston 18. In the absence of this combination of the two pistons with the fluid seal between, the sealing fluid 19 would tend to rise in the ink column and permit the ink to leak around the piston 18 and hence out of the tube through the air vent 22. Through the combination of the two piston components with the interposed fluid seal, however, leakage of the ink even under this adverse condition is reliably prevented.

As above indicated, in addition to preventing leakage of the ink from the ink tube under dry socket conditions, it is commercially important also to be able to re-establish normal use of the ball pen when it has been re-inked and the point again placed in writing position. In the absence of the piston system of the present invention, this re-establishment of normal writing conditions, even if leakage of ink had been prevented, would not be possible. It is entirely possible and practicable, with the improved arrangement in the ink tube of the present invention, by virtue of the fact that the aperture 22 in the vent plug 14 has not become sealed. Accordingly, atmospheric pressure is maintained against the piston 18 thereby permitting gravity to cause this piston as well as the co-functioning fluid seal 19 and piston 17, again to move downward toward the ball point with the ink column. When this condition has been established and the ball point is rotated in contact with the writing surface, the ink will again flow from the ink supply and be used in normal manner for writing.

The foregoing description of the function of the piston system 16 shown in Figs. 1 and 2, under (a) inverted position of the ink tube without dry socket (as in Fig. 4), and (b) inverted position with the dry socket (as in Fig. 5), will apply in similar manner to the function of the single piston embodiment shown in Fig. 3.

In addition to the important combination of the two pistons, or two piston components, with the sealing fluid located between and around these piston components, as above described, for preventing leakage and permitting re-establishment of writing conditions in accordance with the present invention, it is also important to use the proper type and amount of sealing fluid. One of the important characteristics of the sealing fluid for proper operation as above described in this invention is the yield value of this material. The minimum yield value for this material must be such as to permit the material to function as above described for sweeping the walls of the ink tube as the piston system moves downward and also to provide an effective seal between the piston and tube surfaces such that the ink will not leak past these surfaces during normal operation as well as when the pen is inverted and in the presence or absence of a dry socket. The maximum yield value for this material must be such that the seal around the piston will not be broken even when the piston system is moving at the relatively rapid rate encountered upon inversion of the pen and dry socket conditions above described. Under this condition the piston system moves at a substantially more rapid rate than it does in its downward movement during normal operation of the pen.

Although it is important to have a small but definite yield value for the sealing fluid 19, this fluid is nevertheless relatively free to flow. Because of this characteristic it is important to use two pistons or two piston components above described. If, for example, the front piston, that is, toward the ball point, were omitted, the sealing fluid being in the nature of a relatively thin flowable liquid would tend to rise toward the ball point if the pen were inverted for prolonged periods. Similarly, if the rearward piston, e. g., piston 18 shown in Fig. 2, were omitted the thin sealing fluid 19 would tend to move toward the rear of the tube when the pen was inverted.

The amount of the sealing fluid to be used is relatively small but sufficient to effect an ink tight seal between the annular sections of the piston system and the adjacent inner walls of the ink tube so as to prevent any leakage therethrough, and in addition to provide a small surplus of sealing fluid to compensate for the small losses in this material during normal operation by adhering of some of this material on the walls of the ink tube. The thin fluid character of this sealing material minimizes the losses in the form of adhering material to the walls of the tube as it moves downward following the ink column, and the above described arrangement of the piston system provides a compensating adjustment for any such loss. Also, this same fluid character of the sealing material will adapt the piston system to the relatively fast movement which is involved when the pen is inverted and a dry socket is established, without breaking of the fluid seal around the piston elements.

A specific sealing fluid material which we have used with very good results is No. O Orange Solid oil, manufactured by Famous Lubricants, Inc., Chicago, Illinois. This product consists principally of a mineral oil bodied with a metallic soap, e. g., aluminum stearate. Another suitable form of sealing fluid material for use in this invention is a thixotropic liquid comprising alkyl resin made from coal oil, pentaxerylthrol and phthalic anhydride, and containing 5% of polyamide resin No. 93 (General Mills Corporation), dissolved in a mixture of Arochlore 1248 (Monsanto Chemical Company) and mineral oil according to the following proportions:

- Alkyd resin–polyamide mixture, 18.0%  
- Arochlore 1248, 46.8%  
- Mineral oil, 31.2%

This thixotropic liquid is of the same general type disclosed as a vehicle material in copending application Serial No. 527,987, filed August 12, 1955.

We claim:

1. In a ball point writing unit comprising an ink reservoir tube fitted at the forward end with a ball point and vented to the atmosphere at the opposite rearward closed end, and a supply of ink disposed in said tube for feeding therefrom under atmospheric pressure by said ball point, the improvement of a three component, leak-proof sealing system located within said ink tube between said supply of ink and the rearward vented end of the tube, and movable as an integrated unit for following and sweeping the ink supply toward the ball point when used for writing and for preventing escape of ink from the vented rearward end of the ink tube when said ink tube is inverted and even when a dry socket exists at the ball point, said sealing system consisting essentially of spaced pistons and a sealing liquid located between and around said pistons and constituting at all times an effective liquid seal between said pistons and the inner wall of the ink tube, each of said pistons having a smooth, continuous cylindrical portion with a diameter only slightly less than the inside diameter of the ink tube, to accommodate a thin film of said sealing liquid between said cylindrical portions and the inner wall of said ink tube and provide a sliding fit therebetween, said sealing liquid being a thin, flowable, non-evaporative, thixotropic liquid
having a minimum yield value that permits the liquid to sweep clean the adhering ink from the inner wall of the ink tube as the sealing system follows the ink toward the ball point when the ink tube is in writing position and within a maximum yield value that prevents breaking of the seal around the piston when the system is moving at the relatively rapid rate encountered upon inversion of the pen and under dry socket condition at the ball point, the supply of scaling liquid being located between the two pistons and being sufficient in amount to effect at all times an ink tight seal between pistons and ink tube and provide a surplus to compensate for the small amount of liquid that adheres to the inner wall of the ink tube and still maintain an adequate supply of liquid between and around said pistons at all times, the forward piston in the sealing assembly being disposed on top of and in contact with the ink supply and the rearward piston being disposed on top of and in contact with said sealing liquid supply, said pistons being spaced and said sealing liquid being retained therebetween so that said sealing system is maintained with the three components thereof disposed as an integrated unit in substantially their original relation under all conditions of operation and use of said ink tube until the ink supply therein is exhausted through feeding therefrom by said ball point, the density of said pistons being such that said forward piston substantially floats on said ink supply and the rearward piston substantially floats on said sealing liquid supply, the sealing system always moving as an integrated unit and the three components thereof maintaining their separate, spaced relationship so as to effect a leak proof seal between the ink and the vented end of the ink tube.

2. The improvement defined in claim 1 and characterized further by the thin flowable scaling liquid being composed of a mineral oil banded with a metallic soap.

3. The improvement defined in claim 1 and characterized further by the thin flowable sealing liquid being composed of thixotropic liquid containing mineral oil and a synthetic resin.

4. The improvement defined in claim 1 and characterized further by means for venting the closed rearward end of the ink tube comprising a vent tube extending forwardly within said ink tube from said closed end for preventing the rearward piston from displacing air entirely from said closed end when the tube is inverted and the sealing system moves rearwardly toward the vented end whereby atmospheric pressure is always maintained at the vented end of the tube and the tube is recoverable for writing after inversion and under dry socket condition at the ball point.

5. In a ball point writing unit comprising an ink reservoir tube fitted at the forward end with a ball point and vented to the atmosphere at the opposite rearward closed end, and a supply of ink disposed in said tube vented therefrom under atmospheric pressure by said ball point, the improvement of a three component, leakproof sealing system located within said ink tube between said supply of ink and the rearward vented end of the tube, said sealing system consisting essentially of two spaced pistons and a sealing liquid retained between and around said pistons, the movable as an integrated unit under all conditions of operation and use of said ink tube for following and sweeping the ink supply toward the ball point when used for writing and for preventing escape of ink from the vented rearward end of the ink tube when said ink tube is inverted and even when a dry socket exists at the ball point, said sealing liquid being a thin, flowable, non-evaporative, thixotropic liquid having a minimum yield value that permits the liquid to sweep clean the adhering ink from the inner wall of the ink tube as the sealing system follows the ink toward the ball point when the ink tube is in writing position and within a maximum yield value that prevents breaking of the seal around the pistons when the system is moving at the relatively rapid rate encountered upon inversion of the pen and under dry socket condition at the ball point, the supply of scaling liquid being sufficient in amount to effect at all times an ink tight seal between pistons and ink tube and provide a surplus to compensate for the small amount of liquid that adheres to the inner wall of the ink tube, the forward piston in the sealing assembly being disposed on top of and in contact with the ink supply and the rearward piston being disposed on top of and in contact with said sealing liquid supply, the sealing system always moving as an integrated unit and the three components thereof maintaining their separate, spaced relationship so as to effect a leak proof seal between the ink and the vented end of the ink tube.

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