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BALL POINT FOUNTAIN PEN

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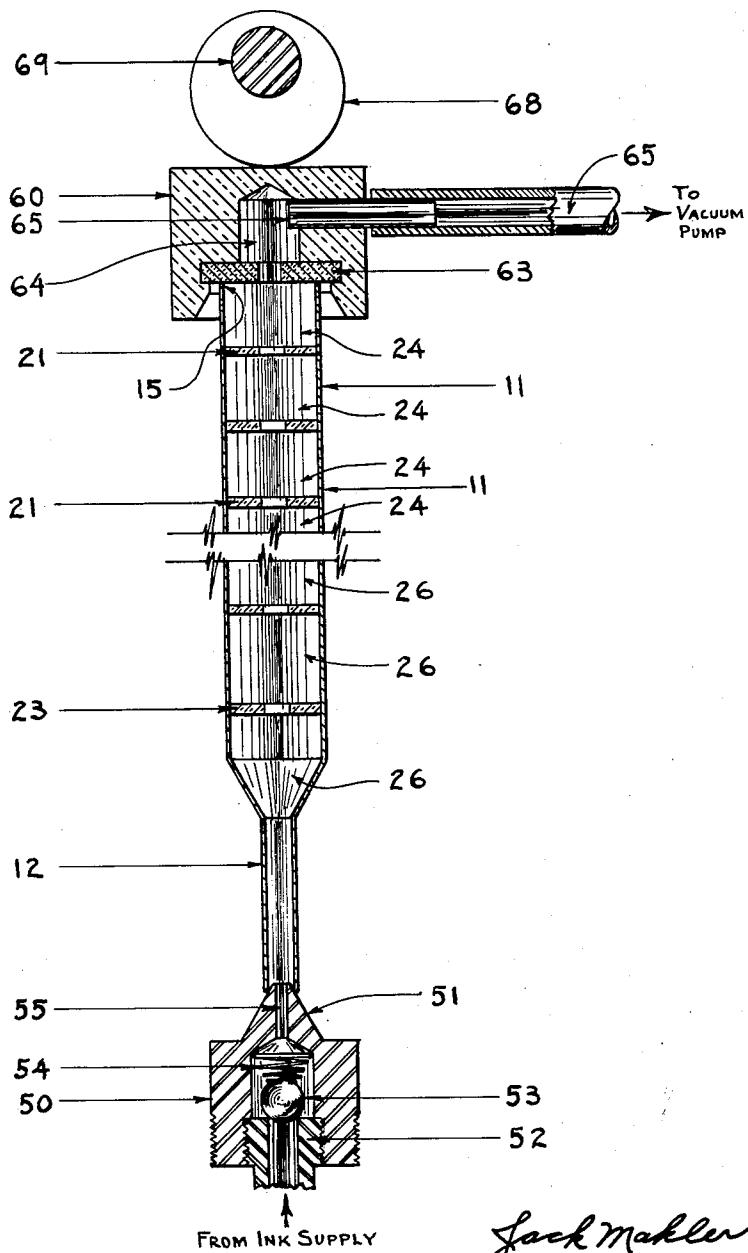


Fig. 7

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1

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BALL POINT FOUNTAIN PEN

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1 Claim. (Cl. 120—42.4)

This application is a continuation-in-part of application Serial Number 2,302, filed January 13, 1960, now abandoned.

This invention relates to ball-point fountain pens and to ink cartridges of such fountain pens, wherein a column of ink of relatively high viscosity feeds the ink to the ball point of the front end of their ink-holding casing space. The rear end of the ink-holding casing has a vent or air opening for applying atmospheric pressure to the rear end of the ink column. It is essential to prevent the ink from flowing or leaking out through the vented casing end when the pen is held in a position other than its normal writing position. A common expedient for suppressing such ink leakage consists in giving the ink-holding space a capillary cross-section or diameter which is at most approximately 0.100" or one-tenth of an inch. Although such pens having a capillary-width ink casing are given excessive length, their ink supply is not sufficient to be entirely satisfactory. In pens having such capillary-width casing space, the surface tension and the surface wetting angle of the ink along the wall surface at the rear end of the ink column retains the ink along the surrounding wall surfaces of the casing and suppresses ink leakage through the vent opening.

However, most ball-point pens require ink casings of larger diameter, for instance, a casing space of about $\frac{3}{16}$ " to $\frac{1}{4}$ " in diameter. In the past, certain contrivances have been adopted for suppressing the leakage of ink from such wide-diameter ink casings of ball-point ink cartridges, but they exhibit deficiencies.

Among the objects of the invention is a ball-point fountain pen or ink cartridge therefor, having an ink casing with a relatively large cross-sectional area, which will suppress leakage or escape of ink from its rear-end air opening and overcome the heretofore encountered deficiencies. Among the objects of the invention is also a process for rapidly filling the ink-casing space of such ball-points pens with ink.

The foregoing and other objects of the invention will be best understood from the following description of exemplifications thereof, reference being had to the accompanying drawings, wherein:

FIG. 1 is a vertical cross-sectional view of an ink cartridge of a ball-point fountain pen, exemplifying one form of the invention, together with a part of the pen casing of which it forms a part;

FIG. 2 is a top view of the ink cartridge of FIG. 1;

FIG. 3 is an elevational view of a modified form of baffle structure of an ink cartridge exemplifying the invention;

FIG. 4 is a top view of the baffle structure shown in FIG. 3;

FIG. 5 is a vertical, cross-sectional view similar to FIG. 1, of another form of baffle structure of an ink cartridge of the invention;

FIG. 6 is a top view of the baffle structure shown in FIG. 5; and

FIG. 7 is a vertical cross-sectional view of one form of equipment for rapidly supplying an ink filling to an ink cartridge in accordance with the process of the invention.

The flow of ink and other viscous liquids along wall surfaces and casing passages is determined by the viscosity of the liquid and also its surface tension. The physical phenomena connected with the flow of ink and similar vis-

2

cous fluids along wall surfaces and passages are well known, having been described, for instance, in the book, "Industrial Rheology and Rheological Structures," by Henry Green, published 1949, and the literature cited therein.

The present invention takes advantage of the known physical characteristics of viscous ink of the type used in ball-point fountain pens, by subdividing their relatively wide, ink-holding casing space with an array of transversely extending baffle plates of an integral baffle structure, into a column of interconnected ink-holding casing compartments, and providing the individual baffle plates with capillary-width orifices or baffle channels which tend to retain their ink content, thereby minimizing the leakage of ink from the individual casing compartments through the capillary-width baffle channel forming the rear wall of the respective casing compartments. In accordance with the invention, all capillary-width baffle channels of the baffle structure are axially aligned with each other along a common casing axis extending longitudinally through the casing space, thereby partially subdividing the long and relatively wide ink column into columnar ink sections which are joined into a continuous ink column by the axially-aligned, capillary-width ink-bodies which are retained in the individual baffle-channels of the baffle structure.

Furthermore, according to the invention, the baffle structure has sufficient baffle plates for subdividing the ink casing into at least six columnar compartments with at least two last rear compartments being substantially free or bare of the ink filling, and the capillary channels of the last three rear baffle plates providing vent openings to the ink column filling the forward ink compartments of the pen casing. The axial alignment of the capillary baffle channels of the baffle structure assures that the relatively wide, axially-partially-subdivided column of ink will continuously feed ink to the capillary ball-holding feed channel at the front end of the pen until the entire long column of ink is used up in writing. The axial alignment of the capillary baffle channels of the baffle structure also enables rapid filling of the relatively long subdivided casing space with ink, as by the filling process of the invention, hereinafter described.

As used herein, throughout the specification and claims, the expression "capillary" when applied to describe the diameter, width or cross-section of an orifice, channel or opening, means that such orifice, channel or opening has a cross-sectional area equal to a diameter of at most about 0.100", or one-tenth of an inch.

FIGS. 1 and 2 show one exemplification of the invention. It comprises a ball-point fountain pen of conventional shape, having an outer casing 9 (only a portion of which is shown) within which is held the elongated ink cartridge 10. The ink cartridge 10 comprises an elongated, tubular casing 11 of relatively large width for retaining in the interior casing space a relatively large volume of viscous ink of the type used in ball-point pens. The cartridge casing 11 is shown in vertical position, and has at its lower front end a relatively narrow feed tube 12 within which is held the inward channel portion of a conventional metallic feed channel 13 having rotatably seated in its pointed front end the conventional writing ball 14. The rear end of the cartridge casing 11 has a full-width casing opening 15 through which the surrounding air applies atmospheric pressure to the ink column within the casing.

The cartridge casing 10 may be formed of synthetic resin or of metal, and may have the conventional circular cross-section of relatively large area, such as an inside diameter of $\frac{3}{16}$ " to $\frac{1}{4}$ ". The conventional metallic feed channel 13 with its ball 14 are placed in the force-

3

fit seat within the narrow feed tube 12 of the casing 11 after its interior has been filled with the ink column, for instance by the process of the invention as described hereinafter.

In the long interior casing space of the wide ink casing 11, is seated a baffle structure generally designated 20, having a plurality of baffle plates 21, 22 and 23, extending transversely to the longitudinal axis of the casing 11 and subdividing its long interior casing space into a column of casing compartments consisting of a series of rear compartments 24, 25 and a series of front compartments 26. It should be understood that all structural parts of the ink cartridge which come in contact with the ink, have the property of being wetted by the ink. They may be made of metal or of synthetic resin. In accordance with the invention, each of the baffle plates 21, 22 has a channel orifice or passage 28 of capillary cross-sectional area or width, and the channel passages 28 of all baffle plates 21, 22, 23 are axially aligned along a longitudinal axis of the cartridge casing 11 so as to cause an ink column filling the space of the rear compartments 25 and the front compartments 26 to feed a continuous supply of ink to the writing ball 14 of the pen, and also to enable automatic filling of all these casing compartments with a column of ink through feed channel 12. The individual baffle plates have substantial thickness, such as .020" to .040", so that the capillary channel passages 28 will have substantial channel length, such as .010" to .030". The baffle plates 21, 22, 23 are shown joined into the integral baffle structure 20 by junction member 29, which is united to the individual baffle plates 21, 22, 23 along axially aligned peripheral regions thereof. As indicated by dash-line 29 in FIG. 2, the junction member 29 may be formed by a junction wall extending along a peripheral region of the aligned baffle plates, and having the shape of a cylindrical segment fitting together with the circular baffle plates 21, 22, 23 within the surrounding interior cylindrical surface of the cartridge casing 11. However, the cartridge casing space may have a cross-sectional area of other shape, in which case the baffle structure will have a complementary shape, fitting and insertable through the rear casing opening with a sliding fit within the interior of cartridge casing 11.

In accordance with the invention, the first and second rear compartments 24 adjoining the rear or upper end of the baffle structure, as seen in FIG. 1, are left free of ink. In addition, the axial length of the first two rear compartments 24 of casing 11 which are never filled with ink, and at least the adjoining two rear compartments 25 which are filled with ink, are made of sufficiently short axial length to assure that any ink which was forced into the empty second rear compartment 24 from the ink-filled third rear compartment 25, shall be retained by surface adhesion and surface tension along the interior wall surfaces of the casing walls facing the first two rear compartments 24, although the capillary cross-sectional area of the baffle-channel passages 28 in the baffle walls 21 of the rear compartments 24 is sufficiently small to cause a capillary ink-body held in these channel passages to be retained therein by the surface tension of the ink-air surface film of such capillary ink-body. In addition, all other casing compartments 25, 26 formed with the baffle structure 20 of the invention, are given sufficiently short axial length to assure that the momentum that may be imparted to the ink-body filling the respective compartments, as by sudden motion, will be limited and will not exceed that required for forcibly ejecting the entire ink content of such casing compartments 25, 26 through the capillary channel passages of their overlying rearward baffle plates.

In practice, effective suppression of ink ejection through the capillary channel passages 28 of the rear baffle plates 21, 22 of the ink-filled rear compartments 25 of the baffle structure, is obtained by making the axial length of at least the last four rear compartments 23 of the casing

4

structure between about .125" and .175" long. The other compartments 24 of the baffle structure extending toward the narrow feed tube 12 thereof, may be made of greater axial length, for instance, up to about .300".

As an example, in one form, the axial length of the rear compartment of the baffle structure is made about .150", and the axial distance between the baffle plates 22 forming the front compartment 24 is made about .250". In general, the capillary channel passages 28 of the baffle plates of a baffle structure such as shown in FIGS. 1 and 2, may have a diameter of .100", although these passages may be somewhat smaller or larger, such as .080" to .120" diameter, depending on the surface tension, wetting angle and other flow characteristics of the ink.

In accordance with the invention, the cross-sectional diameter of the channel passages 28 of the first three baffle plates 21 which form the two ink-free rear compartments 24 of the baffle structure, are given a smaller diameter, such as .020" to .040", because they serve only as air vents.

When a pen with an ink cartridge as shown in FIG. 1 is inverted or turned 180°, ink will not leak from the last ink-filled rear compartment 25. The pull of the surface tension around ball 14 is in upward direction, and balances the pull of the surface tension acting on the capillary ink-body held in the capillary channel passage of the underlying baffle plate of the last ink-holding rear compartment 25 of the cartridge casing, the atmospheric pressure being the same in the ink-air surface at the ball 14 as on the capillary ink-body held in the channel passage 28 of the rear baffle plate of the last ink-holding casing compartments 25, 26 of the casing, and also the ink-free rear compartments 24, if ink were forced into them.

As stated above, the casing 11 of the ink cartridge and its baffle structure 20, may be made either of metal or a synthetic resin, which is wetted by its ink. In the specific form of the invention shown in FIGS. 1 and 2, the casing 11 is of metal, and the baffle structure 20 is of synthetic resin. The particular form of baffle structure 20 shown in FIGS. 1 and 2, may be readily automatically produced on a mass-production basis by injection molding.

The baffle structure of the invention described above in connection with FIGS. 1 and 2, will suggest various modifications thereof. FIGS. 3 and 4 show a modified form of baffle structure generally designated 70, for a ball-point fountain pen exemplifying the invention. It comprises a plurality of baffle plates 71 extending transversely to the longitudinal axis of the baffle structure 70, in a manner corresponding to the baffle structure 20 of FIGS. 1 and 2. Each of the baffle plates 71 has a central channel passage 78 corresponding to the channel passages 28 of the baffle structure of FIGS. 1 and 2. The individual baffle plates 71 are joined to each other into the integral baffle structure 70, by a central junction wall 79 extending along the central longitudinal axis of the baffle structure 70. In accordance with the invention, the baffle structure 70 is formed of two complementary baffle sections which are joined to each other along complementary interfitting mating surfaces 79-1 extending along a plane subdividing the central junction wall 79 of baffle structure 70 into two mating halves. Each such half-section of the baffle structure 70 may be readily injection-molded by mass production, and thereafter joined to each other by heat-sealing or heat-welding along their mating surfaces 79-1, or by cementing after first applying to their mating surfaces a stratum of cement.

FIGS. 5 and 6 show a further form of baffle structure 80 for a cartridge of the invention. It comprises a plurality of baffle plates 81 extending transversely to the relatively long, elongated baffle structure, as in the corresponding baffle structure 20 of FIGS. 1, 2. The individual baffle plates 81 are provided with aligned channel passages 82 corresponding to the channel passages 28 of

5

the baffle structure of FIGS. 1, 2. The array of transverse baffle plates 81 are joined to each other into the integral structure 80, by two junction rods 83 extending parallel to the longitudinal axis of the baffle structure along opposite sides of the aligned channel passages 82 of the baffle plates 81. The baffle structure of FIGS. 5 and 6 may be injection-molded within mold cavities of a partable mold, by conventional, automatic, mass-production processes.

In accordance with the invention, the casing compartments of the cartridge casing of the invention are automatically filled with a continuous column of ink to the required ink level as the cartridge casings are automatically transported (as by a conventional transporting equipment) past the filling station. The cartridge casing, such as casing 11 with its compartments 25, 26, is filled before the ball-holding metallic feed channel 13 is inserted into the open front end of the narrow feed tube 12 of the casing 11. Since the cartridge casing of the invention is subdivided into a column of casing compartments which are interconnected by capillary channel passages, the ink has to be supplied to the casing compartments with special care to prevent formation or entrapment of air bubbles in its continuous columnar ink body. In accordance with the invention, automatic, rapid filling of the casing compartments of the cartridge casing of the invention with a column of ink filling each of the required number of columnar casing compartments, as well as all their channel passages, under elimination of air bubbles, is accomplished almost instantaneously, for instance within less than a second, by applying vacuum to one open end of the baffle-holding cartridge casing, while injecting a 100% dense column of ink through the opposite open end of the casing.

FIG. 7 shows by way of example, equipment of an automatic ink-filling station to which the individual compartmentalized cartridge casings, such as cartridge casing 11 of FIGS. 1, 2, with the baffle structure 20, previously inserted therein, are automatically brought, and from which such ink-filled cartridge casing is automatically removed. After arriving at the filling station having, for instance, the filling equipment of FIG. 7, the cartridge casing 11 is retained vertically upright, for instance. The open front end of its narrow feed tube is held in sealing engagement with the conical injection tip of an ink-injection nozzle body 50. The injection nozzle 50, of metal for instance, has a pump channel 52 to which ink is fed under pressure from an ink pump, in the upward direction indicated by the arrow applied to pump channel 52. The upward, open end of pump channel 52 forms a valve-seat surface and is closed by a conventional valve ball 53 which is held under pressure by a helical biasing spring 54 against the underlying valve seat of pump channel 52.

The upwardly extending injection tip 51 of the nozzle has an injection channel 55 through which the pumped ink is injected into the feed tube 12 and therethrough into the required number of column compartments 26, 24 of the cartridge casing 11. The upper opening 15 of cartridge casing 11 is enclosed with a vacuum-tight seal by a caplike sealing head 60. The upper sealing head 60 holds in a downwardly-facing cavity, a sealing gasket 63 of elastic sealing material, such as an ink-proof, rubberlike compound, which forms a vacuum-tight seal for the upper opening 15 of cartridge casing 11 when the sealing head 60 is pressed downwardly in vertical direction, as by the eccentric cam 68 of rotatably mounted shaft 69. The upper sealing head 60 has a channel space which is connected through a vacuum-tight duct 65 to a vacuum pump for evacuating the interior of cartridge casing 11. After vacuum is applied by the vacuum duct 65 of the sealing head 60 to the casing space of cartridge casing 11, the pumping action of the ink pump will inject with the required pressure the required volume of ink, past the pres-

6

sure-lifted valve ball 53, through injection nozzle channel 51, so as to fill 100% with ink the required number of casing compartments of cartridge casing 11. The pump may be a piston pump or another type of pump which in each pump stroke or operation, will inject into the cartridge casing 11 a column of ink which will fill without any entrapped air, each of the required number of columnar compartments of a cartridge casing such as shown in FIGS. 1, 2, for instance, up to the upper level of the rear compartment 25 underlying the two rear-end compartments 24.

The filling equipment of FIG. 7 is provided with automatic means for releasing the filled cartridge casings 11 from their sealing engagement with the injection nozzle 50 and sealing head 61, for instance by turning the eccentric cam 68 around its shaft 69, which automatically (by means not shown) causes raising of the upper head 60, whereupon the filled cartridge casing 11 is automatically transported to the next operating position in which the ball-tip feed channel 13 is inserted into the open lower end of casing feed tube 12, as another empty cartridge casing 11 is automatically brought into the ink-injection station of FIG. 7. Since the interior of the cartridge casing 11 is evacuated when the measured volume of ink is injected into its casing compartment, the filling of the cartridge casing may be done with the casing held either in the vertical position shown in FIG. 7, or any other position.

The features and principles underlying the invention described above in connection with specific exemplifications thereof, will suggest to those skilled in the art many other modifications thereof. It is accordingly desired that the appended claim shall not be limited to any specific features or details shown and described in connection with the exemplifications thereof.

I claim:

In a ball-point fountain pen, an elongated ink casing having an air opening at the rear end opposite the writing ball, the interior casing space of said ink casing having a relatively large cross-sectional area greater than that which would permit the ink-air surface film to be retained only by the casing side walls, an integral baffle structure insertible as a unit through said air opening into said casing space, said baffle structure having a plurality of at least eight baffle plates extending transversely to the axis of and subdividing the casing space into a column of at least six compartments bounded by said baffle plates, each of said baffle plates having a capillary channel passage and all of said channel passages being substantially aligned along a common longitudinal casing axis for causing ink from a continuous column of ink held in at least four of said compartments to flow continuously from said compartments to the ball as it withdraws ink, the axial length of at least the first, second, third and fourth of said compartments adjoining successively the rear end of said baffle structure being at most about .175", for causing ink entering from said third compartment to said second compartment to be retained in said compartments by ink-body portions held in said capillary channel passages and thereby minimize escape of ink from the channel passage of the baffle plate overlying said first compartment when the casing is held in other than writing position, the axial length of other of said casing compartments being at most about .300", said baffle plates being integrally joined to each other by an elongated junction member extending along aligned portions of said baffle plates; said baffle plates being joined to each other by two elongated junction members extending axially generally parallel along opposite sides of their aligned baffle openings, said two elongated junction members being formed of two integrally joined complementary member sections which constitute parts of two complementary baffle sections which are integrally joined to each other along

complementary mating surfaces subdividing each of said
baffle structures and its said two elongated junction mem-
bers into said complementary baffle sections.

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