Sept. 19, 1950 F. E. BARTELL 2,522,555

FOUNTAIN PEN

Filed March 3, 1947 2 Sheets-Sheet 1

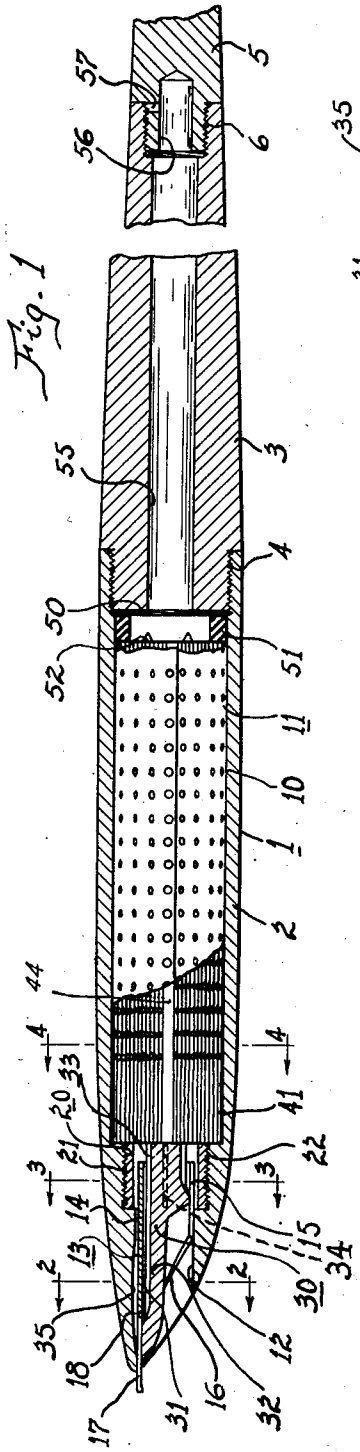

Fig. 1

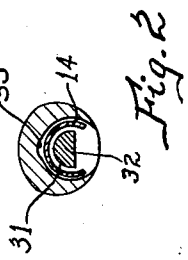

Fig. 2

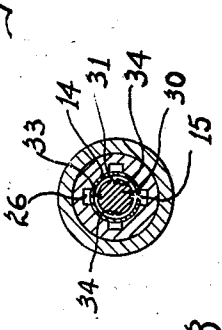

Fig. 3

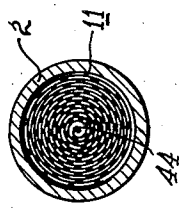

Fig. 4

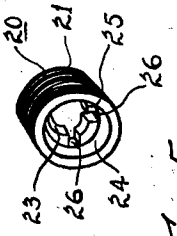

Fig. 5

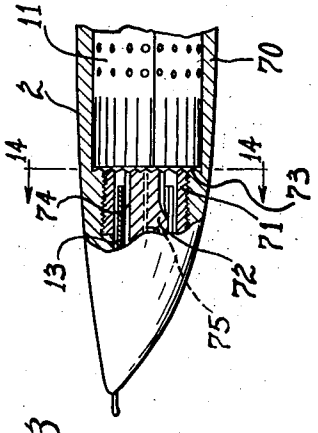

Fig. 13

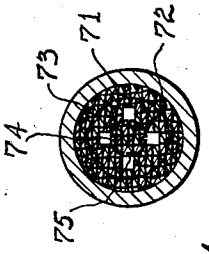

Fig. 14

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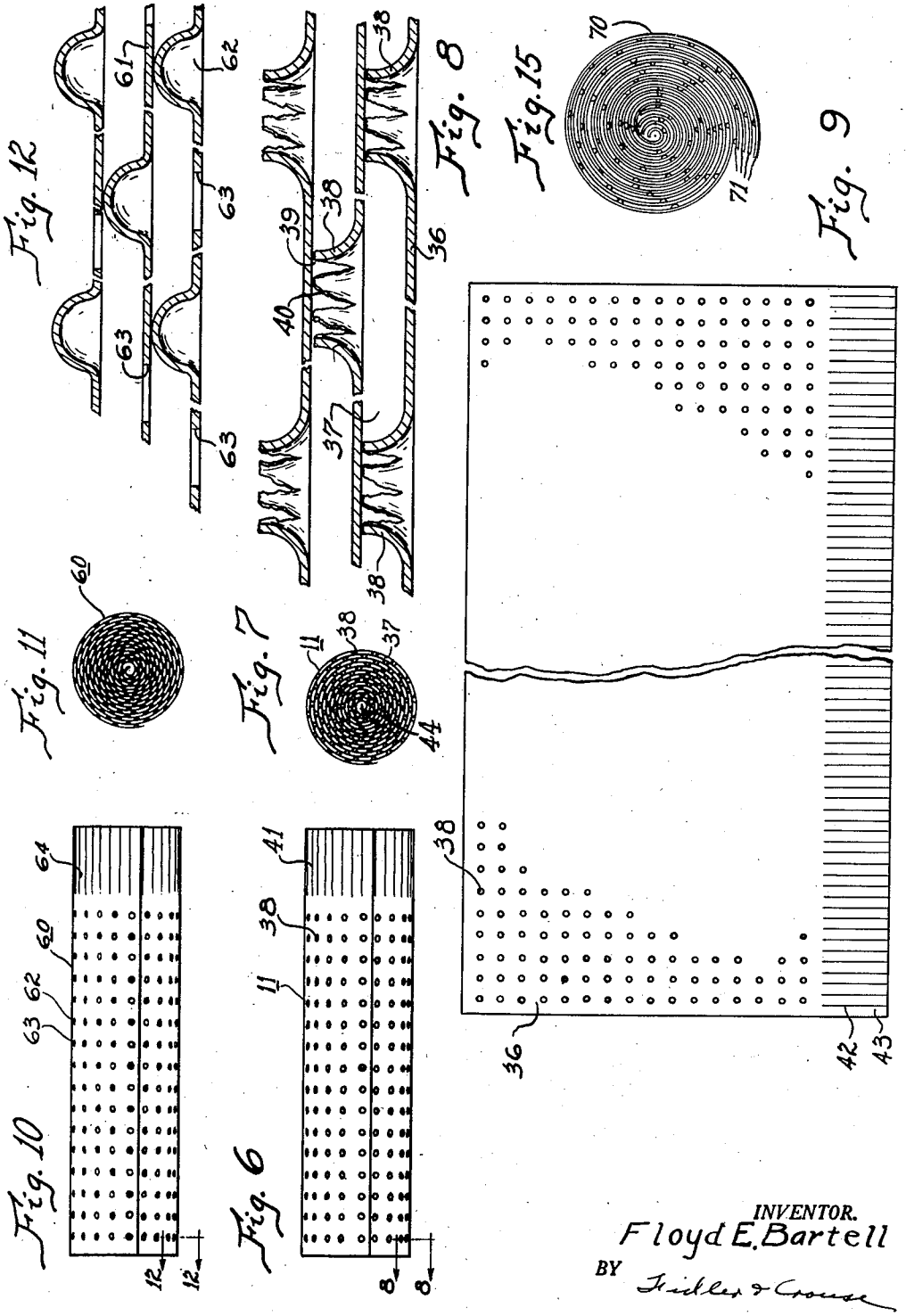
Sept. 19, 1950 F. E. BARTELL 2,522,555

FOUNTAIN PEN

Filed March 3, 1947 2 Sheets-Sheet 2



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Patented Sept. 19, 1950

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UNITED STATES PATENT OFFICE

2,522,555

FOUNTAIN PEN

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Application March 3, 1947, Serial No. 732,032

22 Claims. (Cl. 120—50)

1

My invention relates generally to fountain pens and it has to do particularly with fountain pens of the type having an ink reservoir adapted to be filled by capillary action and which retains the ink therein by capillary action, subject to discharge to a writing surface under control of capillary feed means.

An object of my invention is to provide an improved fountain pen of the foregoing character.

Another object is to provide a capillary filler element having improved means for maintaining the wall members which define the capillary ink space in pre-determined spaced relation positively throughout their length and breadth and without material obstruction of the capillary space defined therebetween.

Still another object is to provide a capillary filler element wherein the capillary ink storage space is defined by thin sheet material of convolute form, the several convolutions of which are positively self-spacing throughout substantially the entire extent of the filler element.

A further object is to provide a filler element of high effective ink capacity which is fully ventilated and which fills rapidly and completely retains the ink against leakage under conditions of varying temperatures and pressure, and writes out freely and completely without flooding or starving.

Still a further object is to provide a capillary fountain pen having improved venting means for equalizing the fluid pressure in all portions of the pen rapidly and completely, thereby maintaining balanced fluid pressure in the pen substantially at all times, even when the pen is subjected to varying conditions of temperature and pressure.

Another object is to provide a capillary filler element having a substantially continuous capillary space of convolute form wherein adjacent convolutions are interconnected at a plurality of portions thereof to permit relatively free flow of fluid between adjacent convolutions.

Another object is to provide a capillary fountain pen having improved means for feeding ink from the ink reservoir to the writing element.

A further object is to provide a capillary filler element having an improved feed integral therewith for feeding ink from the ink storage space within the capillary filler element.

A further object is to provide a capillary filler fountain pen having improved means for maintaining the capillary filler element in position in ink feeding relation to feed means connecting the filler element to the writing element.

2

Still another object is to provide a capillary filler fountain pen wherein a capillary filler element formed from thin sheet material is firmly positioned in the reservoir in such manner that it is not subjected to damaging stresses thereon and the effective volume of the ink reservoir is not substantially decreased.

A further object is to provide a fountain pen having an improved capillary filler element which is simple and easy to manufacture and assemble in a pen, which has a high effective ink capacity, and which will not deteriorate or decrease in efficiency over a long period of use.

Other objects are to provide a capillary filler fountain pen having a capillary system formed with a minimum of sharp corners and sudden changes in cross-sectional area; to provide a capillary filler fountain pen having a capillary ink space of relatively large total cross section and which is at the same time capable of rapid filling; to provide a capillary filler fountain pen having a large number of small capillary passages connecting the ink storage space with an ink feed connected to the writing element; to provide a capillary filler element which may be readily assembled in and removed from a fountain pen body; to provide a capillary filler element which may be formed from a single sheet of material and in which the several portions of the sheet defining a capillary ink storage space are positively spaced apart substantially throughout their length and breadth; to provide an improved capillary filler element which lends itself readily to economical quantity production; and to provide a capillary filler element which is self-venting and requires no separate air vent leading from the several portions of the filler element.

Other objects and advantages of the invention will appear from the following description taken in connection with the appended drawings wherein:

Figure 1 is a longitudinal view of a fountain pen embodying my invention;

Fig. 2 is a transverse, sectional view taken along line 2—2 of Fig. 1;

Fig. 3 is a transverse sectional view taken along line 3—3 of Fig. 1;

Fig. 4 is a transverse, sectional view taken along line 4—4 of Fig. 1;

Fig. 5 is a perspective view of the bushing or sleeve for mounting the nib or feed bar;

Fig. 6 is a side elevational view of the capillary filler element of the pen shown in Fig. 1;

Fig. 7 is a rear-end view of the capillary filler element shown in Fig. 6;

Fig. 8 is an enlarged, fragmentary sectional view taken approximately along line 8—8 of Fig. 6;

Fig. 9 is a plan view of the sheet from which the filler element is formed, after completion of the formation of the projections and fringe but prior to spiral wrapping or rolling of the sheet.

Fig. 10 is a side elevational view of another form of capillary filler element embodying my invention;

Fig. 11 is a rear-end view of the capillary filler element of Fig. 10

Fig. 12 is an enlarged fragmentary sectional view taken approximately along line 12—12 of Fig. 10;

Fig. 13 is a fragmentary view partially in longitudinal cross section showing a modified form of feed connection between the filler element and the writing element;

Fig. 14 is a transverse sectional view taken along line 14—14 of Fig. 13; and

Fig. 15 is a somewhat diagrammatic end view of another embodiment of a filler-and-reservoir element.

The present invention is illustrated in connection with a fountain pen of the desk type, but it is to be understood that the invention is equally well adapted for embodiment in a fountain pen of the pocket type, or of the dual purpose type wherein the pen is adapted to receive either a short tail piece for use as a pocket pen or an elongated tail piece for use as a desk pen.

Referring now particularly to Fig. 1 of the drawings, there is shown for illustrative purposes a fountain pen comprising a body or casing 1 formed of suitable material such as a plastic and which, for convenience in manufacture and assembly, is formed as a plurality of separate members or sections. The body 1 includes a barrel or forward section 2, a rear section 3 connected thereto as by a threaded joint 4, and an end or tail piece 5 attached to the rear section 3 as by a threaded joint 6. The forward section 2 is formed with an axially extending bore which defines an ink reservoir chamber 10 and which is adapted to receive a capillary filler-and-reservoir element 11 hereinafter described more in detail. An opening 12 extends axially from the reservoir chamber 10 through the forward or writing end of the forward section 2 and is adapted to receive the writing element and feed hereinafter described.

A writing element of suitable form is carried at the forward or writing end of the body 1 and is connected by suitable ink feed means to an ink storage reservoir hereinafter described in detail. The writing element may comprise a nib 13 disposed in the opening 12 with its writing tip projecting beyond the forward end of the body 1 and exposed for writing. The nib 13 may be of any suitable construction and preferably includes a general cylindrical body portion 14 having a slot 15 in its under side, and a tapered arcuate forward portion 16 provided with the usual nib slit 17 terminating inwardly in a pierce 18. The nib 13 preferably is mounted by a bushing or sleeve 20 secured by external threads 21 in a counterbore 22 formed at the inner end of the opening 12.

The bushing 20 (Fig. 5) has a bore 23 and a counterbore 24 which provide an external flange 25 adapted to serve as an abutment for the rear end of the nib 13 when the latter is inserted in the bushing 20. The bushing 20 snugly receives the nib body 14 and serves to position it with

respect to the other members with which it cooperates. A plurality of slots 26 (Figs. 1, 3 and 5) extend through the flange 25 to provide ink passages for a purpose hereinafter described. A feed bar 30 is associated with the nib 12 for feeding ink thereto and is frictionally secured snugly in the bore 24 of the bushing 20. The feed bar 30 extends forwardly in the nib 13 and is formed with a diameter slightly less than the nib body 14 thereby providing a generally arcuate capillary space 31 between the nib body 14 and the feed bar 30. The feed bar 30 is provided with a reduced forward extension 32, the forward end of which engages and supports the forward end of the nib 12 in the usual manner.

The arcuate capillary space 31 is connected in ink feeding relation to the reservoir by an ink feed slot 33 formed in the upper surface of the feed bar 30, which slot extends from the rear end of the feed bar 30 to forwardly of the nib pierce 18, in alignment with the nib slit 17 and nib pierce 18. Additional feed slots 34 preferably are provided in the sides and bottom of the feed bar 30 and extend from the rear end of the feed bar at least to the arcuate capillary space 31 to connect the latter with the ink reservoir.

The opening 12 in the forward section 2 preferably is relieved in its upper wall, above the nib 13, and defines with the nib an arcuate capillary ink space 35 (Figs. 1 and 2) extending above the nib slit 17 and pierce 18. Thus, whenever ink is contained in the pen, ink is always drawn into the space 35 by capillary action and maintains this space filled and thus the adjacent nib slit 17 and pierce 18 are maintained in wetted condition at all times and the pen, therefore, is always in condition for instant writing.

The present invention employs a capillary filler-and-reservoir element (also referred to herein as a "filler element") for defining an ink reservoir which fills by capillary action and retains the ink by capillary action in such manner that the pen will not leak even when subjected to conditions which might otherwise cause leakage, as, for example, changes in temperature or pressure, but which reservoir permits the ink to be withdrawn from the pen uniformly under capillary control when the pen is used in writing. According to the present invention the capillary filler-and-reservoir element 11 (illustrated somewhat diagrammatically in the drawings for a clearer understanding thereof) is formed from a thin-walled sheet of material 36 (Fig. 9) wrapped or rolled into spiral form (Figs. 6 and 7). Consecutive convolutions of the spirally wrapped sheet are spaced apart preferably equal distances to provide a continuous space 37 of generally spiral cross section and uniform capillary wall-to-wall width extending longitudinally substantially throughout the length of the filler element.

The capillary filler element 11 preferably is formed by spirally wrapping or rolling upon itself a thin sheet of suitable material such as metal or plastic which has such surface characteristics that it is suitably wettable by inks of the type customarily used in fountain pens and insures the desired capillary action for controlling the ink as hereinafter explained. The material forming the sheet 36 has sufficient rigidity to maintain its shape and position when rolled but is sufficiently flexible to permit it to be rolled readily. The sheet material also is suitably resistant to the ink used so that it is not adversely affected by the ink and does not deteriorate upon continual contact of the ink. Excellent results have been ob-

tained by using thin sheet material or foil formed from silver, although other materials may be employed as, for example, other metals, such as gold, magnesium alloys (one example of which is an alloy consisting of 9% aluminum, 0.1% manganese, 2% zinc and the remainder magnesium), also aluminum alloys (one example of which is an alloy consisting of 5.2% magnesium, 0.1% manganese, 0.1% chromium and the remainder aluminum), and plastics such as ethyl cellulose, Vinylite and others. The material from which the filler element is formed may be treated suitably in a known manner to provide a surface having increased wettability.

The filler element 11 is formed to provide a pen having the maximum practicable effective ink capacity for any over-all external dimensions of filler element, that is, the pen has the ability to draw in during filling and to retain the maximum amount of ink with the maximum write-out and refill characteristics. Accordingly, the pen is formed with as great as possible a capillarity, limited, however, to a capillarity not greater than that which will permit the ink to be written out of the pen. For any particular material having a particular degree of wettability, the capillarity of the filler element may be predetermined by suitably dimensioning the width of the capillary space defined between consecutive turns of the sheet. The filler element 11 preferably is made of such length that the capillary space defined thereby is substantially filled when the pen is filled by holding it in a vertical position and thus the pen will not be overfilled even if it is filled by holding it an an acute angle with respect to the surface of the body of ink from which the pen is being filled.

The sheet 36 from which the filler element 11 is formed is of such dimensions that when rolled into spiral form with the consecutive convolutions spaced at the desired distance, the diameter of the roll is such that the filler element fits snugly in the reservoir chamber 10. The length of the sheet, therefore, is selected to provide a roll of the desired diameter to substantially fill the reservoir chamber 10. The breadth of the sheet is so selected that, when it is rolled into spiral form, the capillary filler element is of such length that the desired ink storage capacity is provided. The capillary space 37 comprises the principal ink storage space and may, therefore, be considered for all practical purposes as being the ink reservoir space. It will be understood, however, that additional ink storage capacity may be provided, as, for example, by spacing the outer turn of the filler element 11 inwardly of the wall of the chamber 10 sufficiently to provide a capillary space therebetween.

In accordance with the present invention, means are provided for accurately and positively spacing consecutive turns of the capillary filler element 11 substantially throughout the length and breadth of the latter to insure that the width of the capillary space 37 is accurately predetermined and maintained without, however, causing any substantial obstruction of the space 37. This is accomplished by providing a plurality of small, spaced or discontinuous spacing elements associated with the convolutions of the filler element. Preferably the spacing elements take the form of spaced projections 38 (Fig. 8) extending from the convolutions of the sheet and abutting adjacent convolutions. The projections 38 may be provided conveniently by displacing the material of the sheet out of the plane thereof to form a

series of "bumps" or "pimples." While the projections 38 may extend in either or both directions out of the plane of the sheet, yet for convenience in manufacture and assembly, preferably they all extend in one direction, and when the sheet is rolled, all of the projections in a single convolution abut the next adjacent convolution of the roll. While the sheet may be rolled either with the projections facing inwardly or outwardly, preferably, to facilitate assembly of the filler element in the pen body, the sheet is rolled with the projections facing inwardly. The projections 38 are disposed in closely spaced arrangement substantially throughout the length and breadth of the sheet 36 and hence when the sheet is rolled they serve to maintain the several portions of the sheet in positively spaced relation. The sheet 36, when rolled into spiral form, provides a structure which is self-rigid and which may be handled and assembled in the pen body without disturbing the arrangement or spacing of the several convolutions thereof. Since the projections are of small diameter and are spaced both longitudinally and laterally of the sheet, the capillary space 37 is not materially obstructed and ink or air may flow freely therethrough. Any suitable arrangement of the projections may be employed but preferably they are disposed in equally spaced rows and columns.

The several convolutions of the capillary space 37 are connected along their longitudinal line of juncture as above described. However, in order to provide additional intercommunication between the several convolutions to permit substantially free flow of air or ink between the several convolutions, and to insure full pressure equalization of the fluid contents of the pen, additional communication between the adjacent convolutions of the space 37 is provided. This additional intercommunication is provided by forming a plurality of spaced openings 39 (Fig. 8) in the turns or convolutions of the sheet 36, thereby providing what I term "cross-venting." The openings 39 preferably are formed when the sheet is in flat condition and preferably are arranged in uniform rows and columns. However, if desired, other arrangements of openings may be employed. The openings 39 may be provided in the projections themselves, as illustrated in Figs. 6 to 8, or intermediate the projections, as illustrated in Figs. 10 to 12 and described hereinafter. The projections 38 and perforations 39 may be formed simultaneously in a convenient manner by punching the sheet 36 with a punch or a plurality of punch elements of suitable diameter which both raises the projections and perforates the sheet. The punching operation may be so performed as to rupture the sheet at each of projections 38 and thereby provide one or more side openings 40 in the side walls of the projections 38. Thus, even though each projection 38 at its uppermost portion may abut snugly against the adjacent convolution of the sheet 36, yet the side openings 40 provide a plurality of passages through the sheet and connecting the adjacent convolutions of the capillary space 37.

It will be understood that the capillary filler element may be formed from an unperforated sheet having bumps or projections formed therein in a manner similarly to the sheet 61 (Figs. 10 to 12) but preferably the filler element is formed from a sheet which is perforated to provide cross-venting as explained thereinabove.

The capillary filler element 11, after completion, is inserted in reservoir chamber 10 (Fig. 1)

with its forward end in abutment with the forward end wall of the reservoir and with the rear or inner faces of the mounting bushing 20 and feed bar 30, respectively, thereby placing the capillary space 37 in direct ink feeding connection with the slots 26 in the bushing and the feed slots 33 and 34 in the feed bar 30. To insure that ink is drawn from the capillary space 37 into the feed slots 33 and 34, feed means of greater capillarity than the capillary space 37 is provided adjacent the rearward end of the feed bar 30. Such means preferably comprises a fringe-like element 41 which may be formed integrally with the filler element by providing what I term a feathered edge on the sheet 36. The feathered edge is provided preferably by forming a plurality of short closely spaced slits 42 in a margin of the sheet 36 which slits define a plurality of tongues or feathers 43. When the sheet is thus slit and then rolled into spiral form the several slits 42 between adjacent feathers 43 become sufficiently open to provide a plurality of narrow capillary passages which, when the fringed end 41 of the filler element 11 is caused to abut the end walls of the bushing 20 and feed bar 30, connect the capillary space 37 with the feed slots 33 and 34 and the slots 26 in the bushing 20.

The capillary filler element 11 is positioned positively in the reservoir chamber 10 so that the forward end of the former remains in abutment with the forward end wall of the reservoir chamber 10 and with the rear ends of the bushing 20 and feed bar 30. While the capillary filler element 11 may be maintained against rearward displacement solely by abutment between the forward end 50 of the rear section 3 and the rearward end of the filler element 11, preferably I provide means for firmly maintaining the filler element 11 in position in such manner as to prevent it from being damaged by longitudinal stresses thereon. Such positioning means preferably includes an annular ring or washer 51, formed of rubber or other suitable resilient, yieldable material, which is interposed between the forward end 50 of the rear section 3 and the rearward end of the filler element 11. When the filler element 11 is in position in the pen body and the body sections 2 and 3 are assembled, the ring 51 exerts a slight yielding pressure against the filler element 11 sufficient to maintain it in its desired position during all conditions of customary use. The ring 51 may be provided with notches or slots 52 in its forward edge to permit air to pass from the outer turns of the capillary space 37 to the interior of the ring 51 for venting the air, as hereinafter explained.

The reservoir chamber 10 is vented to atmosphere in order to maintain the fluid pressure in the reservoir equal to atmospheric pressure and thus prevent the establishment of a pressure differential between the interior and exterior of the pen such as might occur, in the absence of such venting, upon a decrease in atmospheric pressure, or upon an increase in the air pressure within the pen, as, for example, when the pen is heated by the warmth of the hand. The cross-venting between the several portions of the capillary space provides relatively complete and substantially instantaneous equalization of pressure throughout all portions of the interior of the pen. The prevention of a pressure differential between the interior and exterior of the pen and the several portions of the interior insures that the feed of the pen will not flood or starve during periods of writing and that the pen will not leak during periods of non-writing.

In the embodiment of my invention illustrated in the drawings (Fig. 1), the pen body is provided with a venting system connecting the reservoir chamber 10 with the exterior of the pen, which system includes a passage 55 in the rear body section 3, a passage 56 in the tail piece 5, and a vent outlet 57 at the joint between the rear section 3 and tail piece 5. Thus when the tail piece 5 is unscrewed slightly, the outlet 57 provides free communication between the vent passage 56 and the exterior of the pen. On the other hand, when the tail piece is screwed on tightly, the outlet port 57 may be completely closed, but preferably the joint is not made air-tight and permits air to leak there-past at all times so that the interior of the pen is always sufficiently vented to maintain the pressure therein substantially at atmospheric pressure.

The pen is filled by merely dipping the forward or writing end into a supply of ink, the tail piece 5 preferably having been unscrewed slightly to provide free venting for the interior of the pen. Ink is drawn into the pen by capillary action and, by reason of the interconnection and capillary relationship between the several portions of the capillary system within the pen, rises to completely fill the capillary system. Ink is drawn into the pen, through the arcuate capillary space 31 between the nib 13 and the feed bar 30, and thence through the feed slots 33 and 34 and into the forward end of the capillary space 37 and also into the passages 42 defined by the fringe 41. Ink also may be drawn into the nib slit 17 and thence into the arcuate space 31. In addition, ink may be drawn into the pen through the space between the nib 12 and the body 1 and thence through the nib slit 17 and nib pierce 18 and into the capillary space 37 and also through the slots 26 in the bushing 20 and into the capillary space 37. Where the pen is inserted to a sufficient depth in the body of ink, ink may be drawn directly into the slots 26 and thence into the capillary space 37. The slots 26 provide filling passages of relatively large total cross section which permit rapid filling of the pen. Ink is drawn from the slots 26 in the bushing 20 and slots 33 and 34 in the feed bar 30 into the capillary feed passages 42 defined by the fringe elements 43 and also into the portion of the capillary space 37 defined by the consecutive turns of the filler element 11. Ink finds its way into all portions of the capillary space 37, inasmuch as all of the convolutions thereof are interconnected, both along their longitudinal lines of juncture and also by virtue of the cross-venting between consecutive turns which is provided by the openings 39. Ink thus rises in the capillary space 37 to a height which depends upon the capillarity of the filler element, the latter being so formed that it preferably causes ink to rise substantially to the top of this element when the pen is held vertically in respect to the surface of the body of ink from which the pen is being filled.

Air which is in the capillary space 37 when the filling operation is initiated is forced out by the incoming ink and finds its way through the vent passages 55 and 56 and the outlet port 57. All of the several turns of the capillary space 37 communicate with the vent passages 55 and thus air passes freely out of all portions of the space 37 at the rear end thereof and there is no likelihood of an air-lock retarding or blocking the

filling of the capillary space 37. The spiral capillary ink space 37 is self-venting owing to the fact that all the convolutions are vented at their rear ends and all are intercommunicating. Accordingly, it is not necessary to provide any separate venting passage within the filler element connecting the several portions of the space 37 and the rear vent passage 55. Thus substantially all of the void space within the capillary filler element 11 may be of capillary width and utilized as ink-storage space. In the event that an air bubble should form in any portion of the capillary space 37, such bubble would tend to rise in the capillary filler element until it passes out of the top of the latter since all of the several turns or convolutions of the space 37 are interconnected. If an air bubble is blocked against rising along a particular portion of the space 37, it will drift into another portion where it can find its way out of the rear end of the filler element 11. The cross-venting between adjacent portions of the capillary space 37 provides rapid flow of ink or air between the several portions and equalizes the fluid pressure within the pen rapidly so that any condition which might arise tending to cause air-block either during filling or writing would quickly be eliminated.

In a pen constructed in accordance with the present invention, the construction of the filler element provides substantially complete assurance against air-locking because of the relatively free intercommunication between the several portions of the capillary space. While the pen is so constructed that all portions of the capillary space are made to have as nearly equal capillarity as possible yet owing to slight variations in dimensions between the various portions of the space 37 which occur in manufacture the capillarity of the several portions of the space 37 will vary even if only to a very small degree. This slight variation will provide, in one portion of the capillary filler element 11, a capillary path having a slightly greater capillarity than in another portion of the filler element. Thus ink will tend to rise along the path of highest capillarity during filling and air will be expelled along the paths of lesser capillarity so that a condition is created which will tend to break up any air bubbles of such extent as might tend to cause air-locking. In addition, the filler element 11 may be provided with a central space 44 of slightly greater transverse dimension than the remainder of the void space, which central space provides a path of lesser capillarity and permits air to be vented therethrough during filling.

In writing, when the writing tip of the pen nib 13 contacts the writing surface, the capillarity established between the tip and the writing surface causes ink to be drawn from the pen. Ink to replace that which is withdrawn from the point during writing or which evaporates during periods of non-use is drawn from the capillary space 37 through the feed slots 33 and 34 and finds its way into the arcuate space 31 and thence into the nib slit 17. Ink also may be drawn into the space 35 above the nib and thence into the nib slit 17.

The feed connecting the capillary space 37 with the writing tip of the nib 13 is so formed as to insure that ink will be drawn to the writing tip of the nib at all times. Accordingly, the capillarity of the nib slit 17 is the highest of any portion of the capillary system which extends from the space 37 to the nib slit 17.

Air to replace ink which is withdrawn from the reservoir is drawn into the pen through the several vent passages in a direction opposite to that through which air is vented when the pen is filled.

The capillary filler element may be formed in various sizes with the several portions thereof variably dimensioned in accordance with the principle indicated in the foregoing description. In one practical embodiment of a fountain pen employing my invention and wherein the over-all dimensions of the pen were similar to those of a conventional fountain pen, excellent results were obtained by forming the filler element as follows: A sheet of silver foil approximately 0.001" in thickness and approximately 8" in length by approximately 1¼" in width was provided with perforated projections 38 arranged in rows and columns approximately $\frac{3}{32}$" apart extending substantially throughout the length and breadth of the sheet (Fig. 8), except along the forward marginal portion thereof. The projections were approximately 0.008" in height and the perforations therethrough were approximately 0.015" in diameter across their outer edges. A feathered edge was provided on the sheet by forming slits 42 extending inwardly from the edge approximately $\frac{3}{16}$" in length and spaced apart approximately $\frac{1}{32}$" longitudinally of the sheet. The sheet thus formed was spirally wrapped into a roll 11 approximately 0.310" in diameter with each convolution thereof abutting the inwardly extending perforating projections. The feed slots 33 and 34 in the feed bar 30 (Fig. 1) and the capillary space 31 were of less width than the spacing between opposite wall surfaces of the filler element but were wider than the nib slit 16 and generally were approximately 0.003" in width; the nib slit was formed approximately 0.001" to 0.0015" in width. It will be understood that my invention is not limited to the foregoing dimensions and the latter may be varied in accord with the principles hereinabove stated without departing from the invention. For example, excellent results have been obtained by forming filler elements from sheets ranging in size from 8" to 15" in length and 1¼" to 2" in width, in which filler elements the spacing between turns ranged from approximately 0.008" for an 8" sheet to 0.004" for a 15" sheet. Excellent results have been obtained with perforations from 0.01" to 0.04" in diameter although larger perforations may be employed. Excellent results have been obtained by spacing the perforations approximately 1 mm. apart in rows spaced at approximately 3 mm. but the spacing may vary substantially.

Various modifications may be made in the structure of the pen without departing from the scope of the present invention. For example, instead of forming the projections in the capillary filler element by puncturing the sheet from which the filler element is formed, the projections may be formed without openings as illustrated particularly in Figs. 10 to 12, inclusive. The projections 62 may be formed of generally hemispherical shape thus providing a relatively high degree of strength which strongly resists collapse of the projections even though substantial pressure may be applied to the sheet during the forming or assembling operations. In this case, if it is desirable to provide perforations in the sheet for cross-venting, such perforations may be provided intermediate the projections 62 as indicated at 63.

The capillary filler element 60 illustrated in Figs. 10 to 12, inclusive, may be formed of any

suitable material such as described in connection with the first embodiment above described and may be provided with a fringe 64 generally similar to that previously described.

If desired, the filler element may be formed from a plurality of sheets (such as the sheet 36 forming the filler element 11 shown in Fig. 6 or the sheet 61 forming the filler element 60 shown in Fig. 10) spirally wrapped together instead of from a single sheet. Such a construction is illustrated in Fig. 15 wherein the filler-and-reservoir element 70 is formed by a plurality of sheets 71 which preferably are similar to the sheets 36 above described. However, for simplicity in manufacture and assembly I prefer to form the filler element from a single sheet.

In order to aid in the feed of ink from the capillary space within the capillary filler element to the feed slots in the feed bar, and particularly to provide one or more feed paths directly connecting the outermost turns of the capillary space with the feed slots, a plurality of transverse feed passages may be provided adjacent the forward end of the capillary filler element intersecting the several turns of the capillary space at its forward end. Such an embodiment of my invention is illustrated particularly in Figs. 13 and 14 wherein the forward end wall of the body section 70 defining the reservoir chamber, the rearward end wall of the mounting bushing 71 and the rearward end wall of the feed bar 72 are provided with a series of grooves 73 such as may be formed by a knurling operation. Thus, a large number of intersecting feed passages are provided across the faces of the respective numbers, which feed passages serve to connect the forward ends of the several portions of the capillary filler element and the several feed passages such as the feed slots 74 and 75 in the feed bar 72 which lead to the nib slit (not shown).

Various arrangements of projections and perforations in the sheet may be employed in addition to those shown in Figs. 6 and 10. For example, they may be arranged in spaced rows extending at an angle to the direction of wind of the sheet. Also they may be spaced variably instead of uniformly, in the direction of wind. In the latter case the spacing of the rows may be graduated so that an equal or an approximately equal number of rows are disposed in each turn when the sheet is rolled into spiral form.

From the foregoing it will be seen that the present invention provides a capillary fountain pen wherein the capillary filler element may be formed simply and inexpensively from any one of a relatively large number of suitable materials. While the filler element may be formed if desired by simple hand operations, it lends itself readily to quantity production. The assembly of the filler element in the pen body does not require any special tools or the use of any accurately machined or close-fitting parts. While it is, of course, desirable that the nib and feed bar be accurately formed and positioned, on the other hand the capillary filler element itself requires no close fit with the associated members.

The capillary filler element is so formed that it provides in a pen of any particular over-all size a maximum of effective ink space, that is, a maximum volume of ink storage space which will fill by capillary action during filling of the pen, retain the ink during periods of non-writing and write out the ink during writing and which will refill and write out repeatedly. The wall member from which the capillary filler element is formed may be made of very thin metal and thus consumes a relatively small percentage of the total volume of the capillary filler element. On the other hand, by virtue of the novel construction of the capillary filler element, all of the wall portions which define capillary spaces are positively and accurately self-spacing to provide a relatively rigid filler element and to maintain the several portions of the filler element spaced throughout the assembly of the pen and all ordinary conditions of use. The self-spacing of the convolutions of the filler element provides a minimum of obstruction of the capillary space. Moreover the filler element being inherently self-rigid does not require any supporting or mounting means but may be inserted directly in the reservoir chamber of a pen body and may be supported solely by engagement with the end and side walls of the chamber. Where a resilient positioning member is provided as described hereinabove, such member may be of relatively small dimensions and thus does not consume any substantial space within the ink reservoir chamber.

The capillary filler element is so formed as to be self-venting and, therefore, will free itself of any tendency to air-lock either during filling or writing. The cross-venting between the several convolutions of the capillary space insures a high degree of equalization of the fluid pressure in all portions of the pen and thus prevents leakage which might otherwise occur owing to changes in temperature or pressure. Moreover the provision of relatively free intercommunication between the several portions of the capillary space, together with the provision of an ink space of relatively large cross section, permits rapid filling of the pen. The equalization of pressure within the pen and the numerous feed passages connecting the capillary filler element with the writing element insures a uniform and free feed of ink during writing and the pen does not starve or flood.

The capillary filler element is so formed that substantially all of the capillary space is of uniform capillarity and the capillary connection between the capillary space within the filler element and the writing element has a minimum of sharp corners or sudden changes of cross-sectional area and thus there is a minimum possibility of capillary edge effect occurring within the capillary path. Accordingly, the pen has a relatively high write-out capacity and a relatively high effective storage capacity.

I believe that the operation and advantages of my invention will be well appreciated from the foregoing description, and it is to be understood that, while I have shown and described several forms of my invention, other details and arrangements of parts may be resorted to without departing from the spirit and scope of my invention as defined by the claims that follow.

I claim:

1. A fountain pen comprising a body having a reservoir section and a feed section, a writing element at the forward end of said body, feed means in said feed section associated with said writing element, and a capillary filler-and-reservoir element formed of perforated sheet material disposed in said reservoir section and having spaced, opposed wall portions and means on said wall portions and abutting opposing wall portions for maintaining the spaced relation thereof whereby said wall portions define therebetween a capillary ink storage space extending longitudinally of said

reservoir section and in ink feeding relation with said feed means.

2. A fountain pen comprising a body having a reservoir section and a feed section, a writing element at the forward end of said body, capillary filler-and-reservoir means in said reservoir section including opposed wall portions of non-absorbent sheet material, means maintaining said wall portions disposed in predetermined spaced relation to define a plurality of capillary ink storage spaces therebetween, said wall portions having spaced openings extending therethrough providing communication between the capillary spaces on opposite sides of said wall portions, and capillary ink feed means in said feed section connecting said ink storage space in ink feeding relation with said writing element.

3. A fountain pen comprising a body having a reservoir section and a feed section, a writing element at the forward end of said body, capillary filler-and-reservoir means in said reservoir section including opposed wall portions of sheet material disposed in said reservoir section, at least certain of said wall portions having projections extending therefrom for abutting and spacing the opposing wall portions, whereby said opposed wall portions define capillary ink storage spaces extending along said reservoir section, and openings in said wall portions providing communication between said capillary spaces on opposite sides of said wall portions, and capillary ink feed means in said feed section connecting said ink storage space in ink feeding relation with said writing element.

4. A fountain pen comprising a body having a reservoir section and a feed section, a writing element at the forward end of said body, capillary filler-and-reservoir means in said reservoir section and retaining the ink therein by capillary action including a spirally rolled wall member of non-absorbent sheet material, and means on said wall member for spacing consecutive convolutions thereof predetermined distances apart to provide therebetween a continuous capillary ink storage space of spiral cross section extending longitudinally of said reservoir section, and capillary ink feed means in said feed section connecting said storage space in ink feeding relation with said writing elements.

5. A fountain pen comprising a body having a reservoir section and a feed section, a writing element at the forward end of said body, capillary filler-and-reservoir means in said reservoir section including a spirally rolled wall member having projections extending therefrom and abutting adjacent convolutions of said wall member thereby spacing consecutive convolutions to form a continuous capillary ink storage space of spiral cross section extending longitudinally of said reservoir section, and openings through said wall portions providing communication between the portions of the storage space on opposite sides of said wall portions, and capillary ink feed means in said feed section connecting said storage space in ink feeding relation with said writing element.

6. A fountain pen comprising a body having a reservoir section and a feed section, a writing element at the forward end of said body, feed means in said feed section associated with said writing element, and a capillary filler-and-reservoir element formed from non-absorbent sheet material disposed in said reservoir section and spirally wrapped upon itself, means spacing the convolutions of said sheet material predetermined distances apart to define therebetween a continuous

capillary ink space of generally spiral cross section, said sheet material having its forward end portion formed with a plurality of slits providing feed passages of greater capillarity than said capillary space and connected in feeding relation to said feed means.

7. A fountain pen comprising a body having a reservoir section and a feed section, a writing element at the forward end of said body, a capillary filler-and-reservoir element formed from a member of sheet material of convolute form, and having therein means spacing the convolutions of said sheet whereby they define a capillary ink storage space therebetween, and vent openings extending through said convolutions and providing communication between the portions of said capillary space on opposite sides of said convolutions, and capillary ink feed means in said feed section connecting said ink storage space in ink feeding relation with said writing element.

8. A fountain pen comprising a body having a reservoir section and a feed section, feed means disposed in said feed section, a pen nib associated with said feed means, capillary filler-and-reservoir means in said reservoir section including a sheet element of convolute form, means maintaining said convolutions in predetermined spaced relation to define a continuous capillary ink storage space therebetween of spiral cross-sectional shape and extending longitudinally of said reservoir section, said convolutions being provided with spaced openings therethrough of predetermined size and arrangement providing communication between the portions of said space on opposite sides of said convolutions, the innermost convolution defining an air vent passage of greater diameter than the spacing between adjacent convolutions and extending longitudinally of said sheet element member, said innermost convolution having spaced openings extending therethrough providing communication between said air passage and said ink storage spaces, and means for venting said air passage to atmosphere.

9. A fountain pen comprising a body having a reservoir chamber and an opening extending from said reservoir chamber through the forward end of said body, a nib in said opening, a feed bar in said opening and having a feed channel therein communicating with said reservoir chamber and in ink feeding relation to said nib, and a capillary filler-and-reservoir element in said reservoir chamber including a sheet of non-absorbent material spirally rolled upon itself to define a continuous spiral ink storage space of capillary width, the convolutions of said sheet having spaced projections of predetermined heights abutting adjacent convolutions for maintaining said convolutions in said predetermined, substantially uniformly spaced relation, said capillary filler-and-reservoir element being disposed with one end abutting said feed bar to place said spiral space in ink feeding relation with said feed channel.

10. A fountain pen comprising a body having a reservoir chamber and an opening extending from said reservoir chamber through the forward end of said body, a nib in said opening, a feed bar in said opening and having a feed channel therein communicating with said reservoir chamber in ink feeding relation to said nib, a capillary filler-and-reservoir element in said reservoir chamber and including a sheet of material spirally rolled upon itself, with consecutive turns thereof spaced apart to define a continuous spiral ink storage space of capillary width, said sheet being of sufficiently rigid material to maintain its

rolled shape, and having spaced openings of predetermined sizes and arrangement extending through adjacent convolutions thereof for connecting the portions of said spiral space on opposite sides of said convolutions, said capillary filler-and-reservoir element being disposed with one end abutting said feed bar to place said spiral space in ink feeding relation with said feed channel.

11. A fountain pen comprising a body having a reservoir chamber and an opening extending from said reservoir chamber through the forward end of said body, a nib in said opening, a feed bar in said opening and having a feed channel therein communicating with said reservoir chamber and in ink feeding relation to said nib, a capillary filler-and-reservoir element in said reservoir chamber including a sheet of material spirally rolled upon itself to define a continuous spiral space of capillary width, the convolutions of said sheet having spaced projections abutting adjacent convolutions thereof for maintaining said convolutions in said spaced relation, and spaced openings extending through said convolutions for connecting the portions of said spiral space on opposite sides of said convolutions, said capillary filler-and-reservoir element being disposed with one end abutting said feed bar to place said spiral space in ink feeding relation with said feed channel.

12. A fountain pen comprising a body having a reservoir section and a feed section, a writing element at the forward end of said body, ink feed means in said feed section and having a capillary ink feed passage connected to said writing element, a capillary filler-and-reservoir element in said reservoir section including a member of sheet material rolled upon itself, the convolutions of said member having projections thereon maintaining the convolutions in spaced relation to define a capillary ink storage space of spiral cross-section and openings through said convolutions providing communication between the portions of said ink storage space on opposite sides of said member, and resilient means abutting the rear end of said capillary filler-and-reservoir element for positioning said filler element in said reservoir section in abutment with said feed means to maintain said capillary space in ink feeding relation with the ink feed passage in said feed means.

13. A fountain pen comprising a body having a reservoir section and a feed section, a writing element at the forward end of said body, ink feed means in said feed section associated with said writing element, and having a capillary ink feed passage therein, a capillary filler-and-reservoir element in said reservoir section including a spirally wrapped member of perforated sheet material, means maintaining the convolutions of said member in spaced relation whereby the latter define a continuous spiral capillary ink storage space open at its forward end, with the convolutions of said space intercommunicating through the perforations in said sheet, and means for positioning said filler-and-reservoir element in said reservoir section in abutment with said feed means to maintain said spiral capillary space in ink feeding relation with said feed means.

14. A fountain pen comprising a body having a reservoir section and a feed section, a writing element at the forward end of said body, ink feed means in said feed section associated with said writing element, and having a capillary ink feed passage therein open at its rear end, a capillary filler-and-reservoir element in said reservoir section including a spirally rolled sheet, means maintaining the convolutions thereof in spaced relation whereby the latter define a continuous spiral capillary ink storage space open at both ends, said sheet having openings in said convolutions providing communications between portions of said ink storage space on opposite sides of said convolutions, a resilient annular member abutting the rearward end of said filler element and in axial alignment therewith for positioning said filler-and-reservoir element in said reservoir section in abutment with said feed means to maintain said spiral capillary space in ink feeding relation with said feed means, and a vent passage in said body extending rearwardly from said reservoir section, said annular member having a passage therein connecting the rear ends of substantially all of the turns of said spiral space to said vent passage.

15. A capillary filler-and-reservoir element for a fountain pen comprising a sheet of non-absorbent material spirally rolled upon itself and defining between the convolutions thereof a continuous ink storage space of spiral cross-section and capillary width, and spaced projections on said sheet abutting adjacent convolutions for maintaining the latter in predetermined spaced relation between approximately 0.004" and approximately 0.008".

16. A capillary filler-and-reservoir element for a fountain pen comprising a sheet of material spirally rolled upon itself, means maintaining the convolutions of said sheet in spaced relation whereby there is defined between said convolutions a continuous ink storage space of spiral cross-section and capillary width, said sheet having spaced openings extending through the convolutions thereof providing communication between the portions of said capillary space on opposite sides of said convolutions.

17. A capillary filler-and-reservoir element for a fountain pen comprising a sheet of material spirally rolled upon itself and defining between the convolutions thereof a continuous spiral ink storage space of capillary width, said sheet having spaced projections thereon abutting adjacent convolutions for maintaining the latter in spaced relation and spaced openings extending through said sheet providing communication between the portions of said capillary space on opposite sides of said convolutions.

18. A capillary filler-and-reservoir element for a fountain pen comprising a sheet of material spirally rolled upon itself and defining between the convolutions thereof a continuous spiral ink storage space of capillary width, said sheet having spaced projections thereon abutting adjacent convolutions for maintaining the latter in spaced relation and openings extending through at least certain of said projections providing communication between the portions of said capillary space on opposite sides of said convolutions.

19. A capillary filler-and-reservoir element comprising a sheet of non-absorbent material spirally rolled upon itself and defining between the convolutions thereof a continuous ink storage space of spiral cross-section and capillary width, said sheet being formed at a marginal portion thereof adjacent an end of said filler-and-reservoir element with a slit defining a capillary feed passage of greater capillarity than said storage space and connected in ink feeding relation to said spiral capillary space.

20. In a fountain pen having a pen body

formed with a vented reservoir chamber, and a writing element at one end of said body, a capillary filler-and-reservoir element in said chamber comprising non-absorbent wall means defining a continuous, substantially unobstructed ink storage space of substantially uniform capillary width and generally spiral cross-section extending longitudinally substantially throughout the length of said reservoir chamber, the convolutions of said space being interconnected at predetermined spaced points throughout their length and breadth and open at both ends, and connected in feeding relation to said writing element.

21. A fountain pen comprising a writing element, and a capillary filler-and-reservoir element including a wall-forming member of non-absorbent sheet material rolled upon itself, means spacing the convolutions of said sheet apart whereby said convolutions provide spaced, continuous wall surfaces defining therebetween a continuous capillary ink storage space of spiral cross-sectional shape, said member having spaced openings of predetermined sizes and arrangement extending through the convolutions thereof and providing communication between the portions of said storage space on opposite sides of said convolutions, said ink storage spaces being connected in ink feeding relation with said writing element.

22. A fountain pen comprising a writing element, a capillary filler-and-reservoir element including a wall-forming member of sheet material rolled upon itself with the convolutions thereof

spaced apart and providing spaced, continuous wall surfaces defining therebetween a continuous capillary ink storage space of spiral cross-sectional shape, said member having spaced projections extending from said convolutions and abutting adjacent convolutions for maintaining the spaced relation thereof, and openings extending through at least certain of said projections and providing communication between the portions of said space on opposite sides of said convolutions, and capillary ink feed means connecting said ink storage space in ink feeding relation with said writing element.

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