Oct. 31, 1950 H. H. ZODTNER 2,528,408

FOUNTAIN PEN

Filed July 11, 1947 2 Sheets-Sheet 1

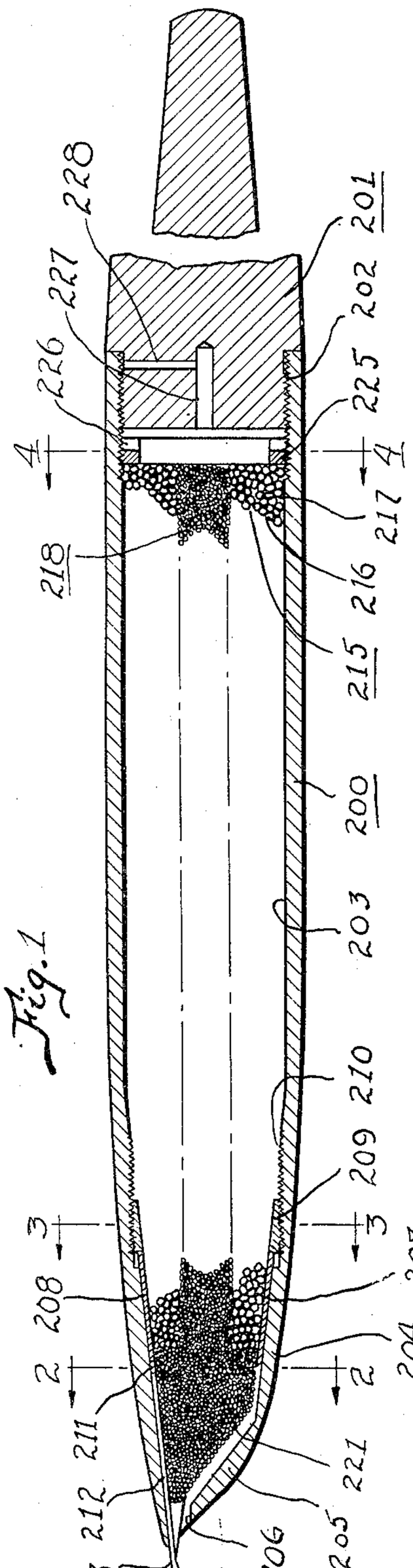

Fig. 1

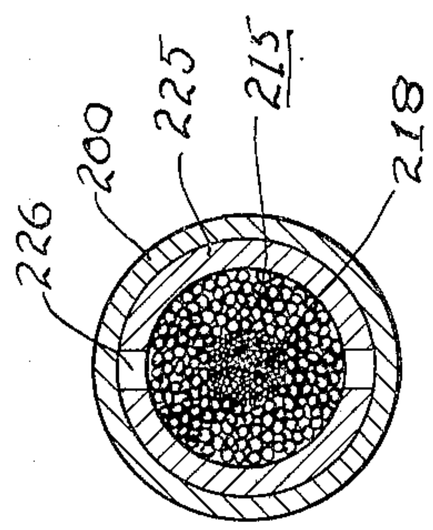

Fig. 4

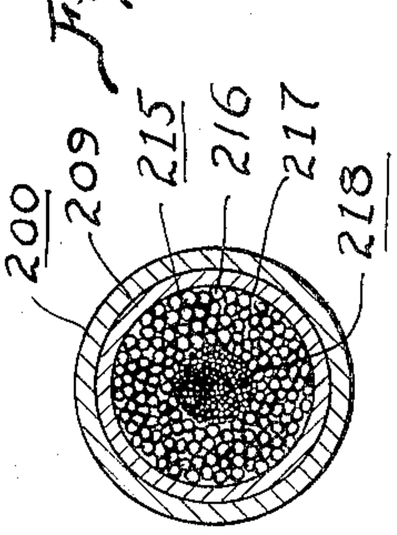

Fig. 3

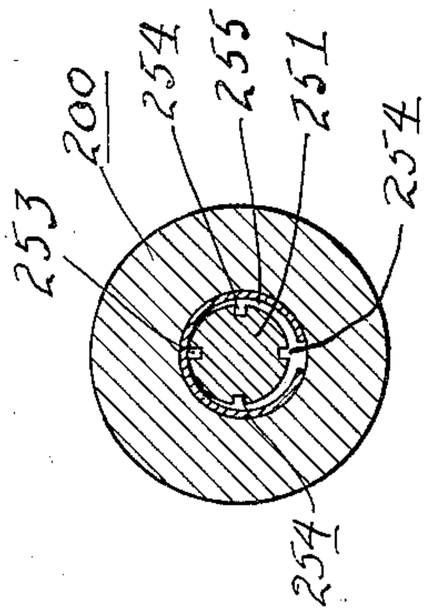

Fig. 6

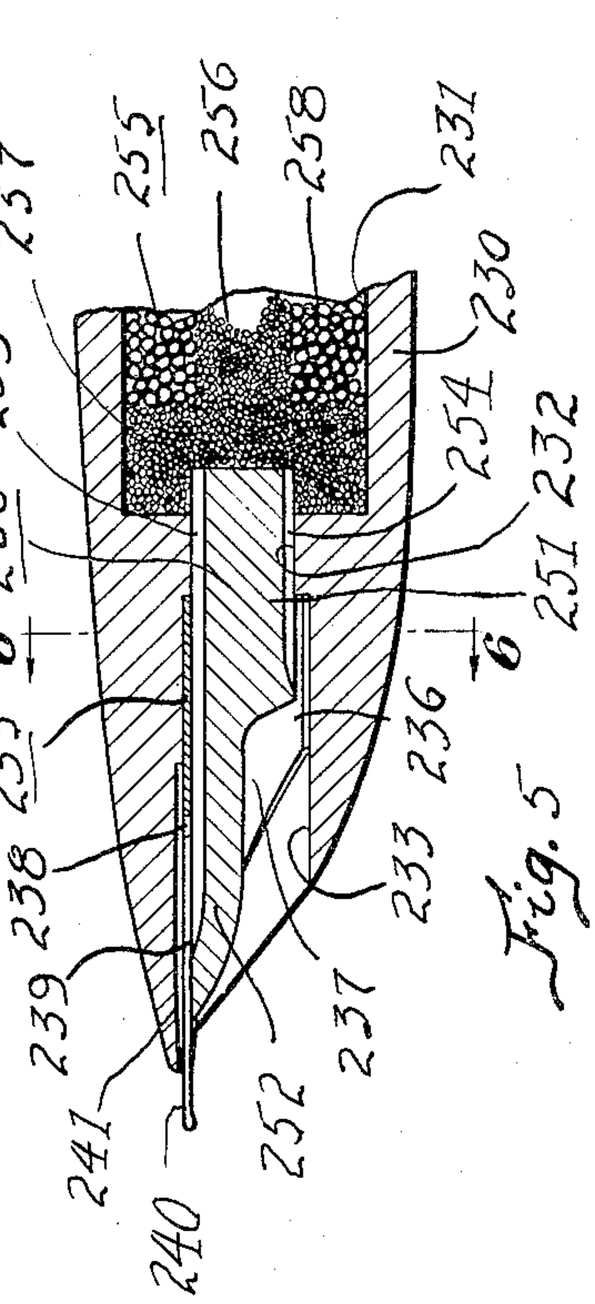

Fig. 5

INVENTOR
Harlan H. Zodtner
BY
Fidler, Counce & Beardsley
ATTORNEYS

Oct. 31, 1950

H. H. ZODTNER

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2 Sheets-Sheet 2

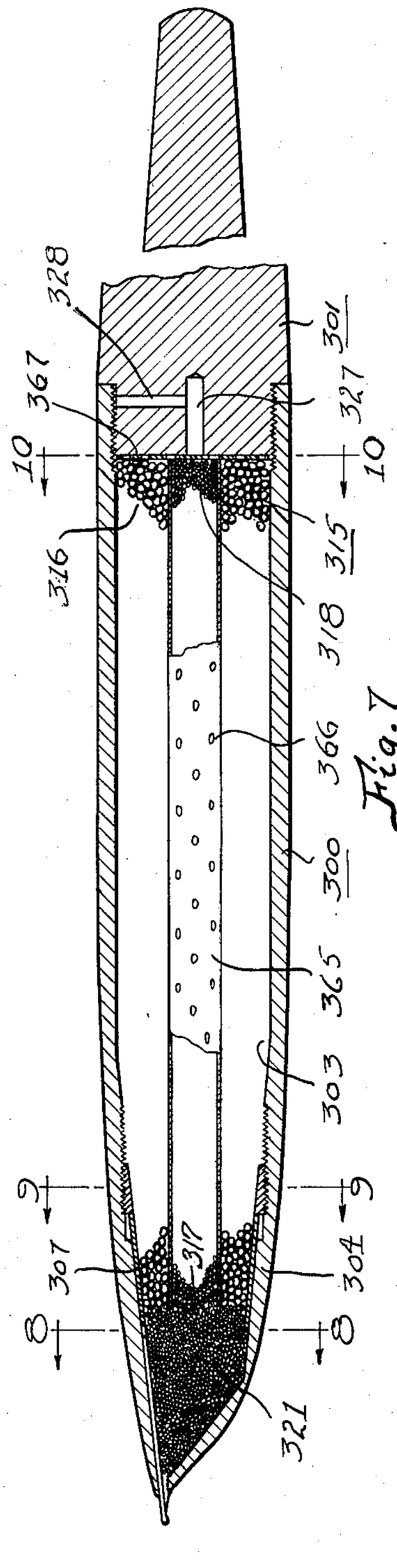

Fig. 7

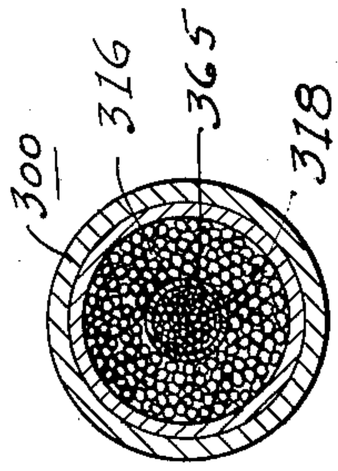

Fig. 9

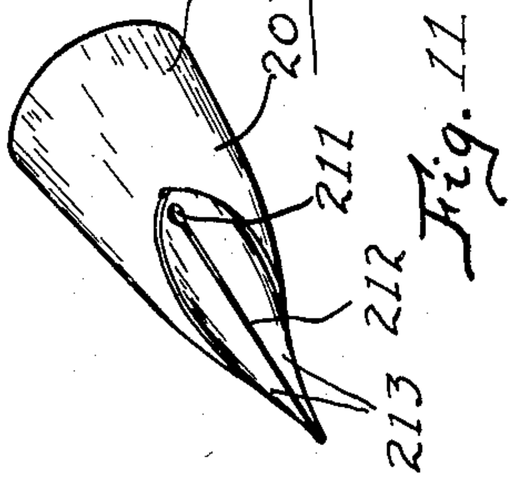

Fig. 11

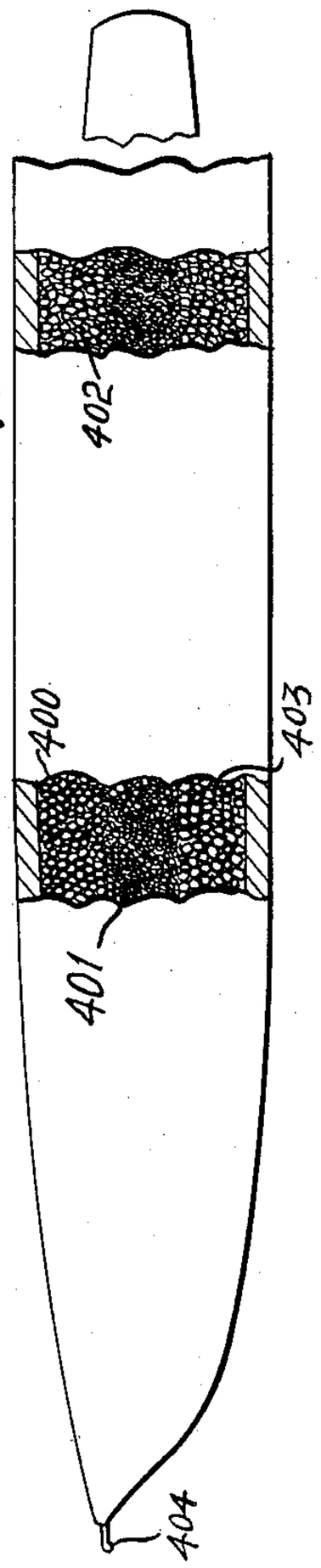

Fig. 12

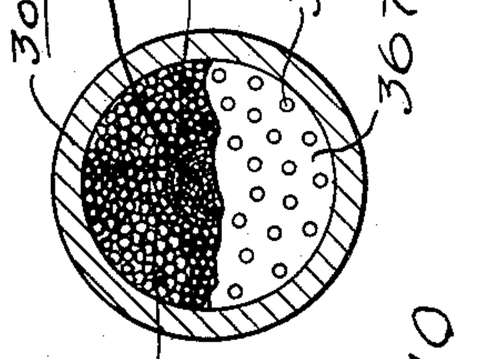

Fig. 10

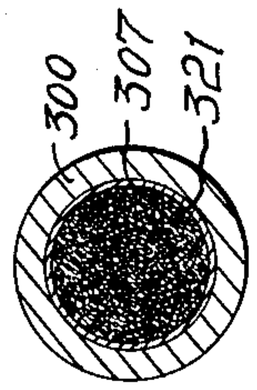

Fig. 8

INVENTOR
Harlan H. Zodtner

BY
Fidler, Comer & Beardsley

ATTORNEYS

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FOUNTAIN PEN

Harlan H. Zodtner, Janesville, Wis., assignor to The Parker Pen Company, Janesville, Wis., a corporation of Wisconsin

Application July 11, 1947, Serial No. 760,369

11 Claims. (Cl. 120—50)

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My invention relates to fountain pens and has to do particularly with a fountain pen of the type adapted to be filled by capillary action and embodying improved means for filling the ink reservoir and feeding ink from the reservoir to the writing point.

One of the objects of this invention is to provide an improved fountain pen of the foregoing type.

Another object is to provide an improved capillary filler-and-reservoir element of the type formed from a porous mass of material wherein the pores are interconnected and define a plurality of interconnected capillary ink storage spaces or cells.

Another object is to provide an improved capillary filler element of the granular type wherein a plurality of interconnected capillary spaces are defined by a mass of initially individual solid particles.

Another object is to provide a capillary filler element of the porous mass type having improved means for feeding ink from the capillary spaces to the writing element of a pen.

Still another object is to provide a capillary filler element of the porous mass type which may be formed easily and inexpensively, which is efficient in operation, and which has a relatively high refill and write-out capacity.

Still another object is to provide a capillary filler element of the porous mass type having improved filling and write-out characteristics.

A further object is to provide a capillary filler element of the porous mass type having improved air venting characteristics providing improved filling and writing performance.

Other and more specific objects of the invention are to provide a capillary filler element of the porous mass type having ink feed means incorporated therein for improving the feed of ink from the capillary ink storage spaces to the writing element; to provide a capillary filler element of the porous mass type having interconnected capillary spaces or passages for feeding ink to the writing element which are of greater capillarity than the remaining capillary spaces in the filler element thereby insuring that ink is always available at the writing point of the pen for instant writing; and to provide a capillary filler element of the porous mass type which insures complete filling of the capillary ink storage spaces when the end of the pen is inserted in a supply of ink.

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 sectional view taken through a fountain pen constructed in accordance with the invention;

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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 fragmentary, longitudinal, sectional view through the front end of another embodiment of the invention;

Fig. 6 is a transverse sectional view taken along line 6—6 of Fig. 5;

Fig. 7 is a longitudinal sectional view of still another embodiment of the invention;

Fig. 8 is a transverse sectional view taken along line 8—8 of Fig. 7;

Fig. 9 is a transverse sectional view taken along the line 9—9 of Fig. 7;

Fig. 10 is a transverse sectional view taken along line 10—10 of Fig. 7 with a portion of the structure broken away;

Fig. 11 is a perspective view of the nib of the pen shown in Fig. 7; and

Fig. 12 is a longitudinal sectional view of a further embodiment of my invention.

The present invention is disclosed in connection with a pen of the desk type but is applicable, with appropriate modifications in structure details, to pocket pens or pens which are convertible for use either as pocket pens or desk pens.

Referring now particularly to Fig. 1 of the drawings the fountain pen comprises a pen body which includes a forward body member 200 or a rear body member or section 201 which is suitably secured to the forward section as by threads 202. The body members may be formed of any suitable material such as hard rubber or a suitable plastic. The front section 200 is formed with a hollow interior or bore 203 providing a reservoir section and has a tapered forward portion 204 defining a feed section which latter is substantially closed at its forward end by an end wall 205 leaving only a small forward opening 206.

A writing element which may take the form of a nib 207 is secured in the feed section and has its writing tip extending through the forward opening 206 and exposed for writing. While the nib 207 may take any suitable form, I have found that a nib of the construction shown in Fig. 11 is particularly suitable, which nib includes a tapered generally conical body 208 having a tapered forward portion formed with a pierce 211 and a slit 212 extending from the pierce 211 to the end of the nib and providing two nib sections 213. The nib 207 is securely held in the feed section of the body member 200 as by a nib retainer which preferably takes the form of an externally threaded ring 209 screwed into threads 210 formed in the body member 200 and which ring

holds the nib in wedging engagement in the adjacent portion of the body 200.

Disposed in and substantially filling the reservoir chamber 203 is a capillary filler-and-reservoir element or cell structure 215 so formed as to provide a plurality of passages or cells of capillary sizes adapted to draw ink into the pen solely by capillary action during filling, retain ink therein against leakage when the pen is not in use and permit ink to be drawn to the nib by capillary action when the pen is used in writing. The capillary filler-and-reservoir element, also referred to as the capillary filler element, 215 preferably is formed of material which is capable of being wetted readily by the usual inks but which is relatively inert to such inks and will not react therewith to detrimentally affect either the ink or the capillary filler element. Among the materials which I have found suitable for this purpose are glass, hard rubber, metal such as silver, or plastics such as "Lucite" (methyl methacrylate resin) or "Saran" (vinylidene chloride type).

A preferred method of forming the filler element is to provide a mass of initially individual separately formed solid particles or granules 216 of suitable material and to dispose them in intimate contact with adjacent particles abutting. The particles 216 are of such size or sizes that the voids 217 defined therebetween are of suitable capillary dimensions. Preferably the particles, or granules, or what for convenience may be termed "beads" are of spherical shape and thus mutually abut over relatively small areas of their respective surfaces and provide capillary spaces which are interconnected and in communication with each other thereby forming, in effect, a series of capillary passages extending longitudinally and transversely throughout the stacked mass of particles.

The beads 219 which lie in a zone extending longitudinally, preferably throughout the length of the filler element and preferably centrally thereof, and which form a "core" 218, are of smaller size than the remainder of the beads, that is, the beads in the portion of the filler element surrounding the core. Accordingly, the capillary spaces 220 in the core 218 are of smaller size and greater capillarity than the spaces 217 formed by the larger beads. The smaller capillary spaces 220 of the core are interconnected with each other throughout the core and provide a plurality of passages leading to the forward end of the pen. The spaces 220 are also interconnected peripherally of the core 218 with the adjacent spaces 217 and thus serve to connect the latter with the writing element as will hereinafter more fully appear.

The core 218 extends into the feed section of the body and to the writing element and is formed with a forward end portion 221 constituting, in effect, a feed element which is in contact with the underside of the nib adjacent the pierce 211 and slit 212 thereby providing capillary passages leading into ink feeding relation with the nib pierce and slit.

While the beads forming the capillary filler element may be inserted in the pen body loosely and thereafter compacted to form a mass in which all of the beads are in intimate contact, as hereinafter explained more in detail, preferably the beads are formed into a unitary cellular structure in which each bead is attached to the abutting beads at the points of mutual contact. On the other hand, if desired, only the beads

forming the core may be joined into a unitary mass and the remaining larger beads may be packed around the core.

Where the beads are formed into a unitary cellular structure the latter may be suitably secured in the pen body by a ring 225 threaded into the forward body section 200 and against the rear end of the capillary filler element 215. The ring 225 may be provided with slots 226 in its rear face to permit insertion of a tool for screwing it into the body section 200.

The beads may be joined to form a unitary structure by arranging them in a stacked mass with adjacent beads in mutual abutment and then heating them just sufficiently to fuse them at their abutting surface portions to maintain them in fixed relation. The beads preferably are not heated enough to cause them to lose their spherical shapes or to increase the mutual area of contact more than is necessary merely to join them; thus no substantial change is made in the shape, size or arrangement of the voids. By way of example, in one particular case very satisfactory results were obtained by forming the beads of "lime glass" consisting of soda, lime and silica. The beads were thoroughly cleansed to remove all adherent foreign matter and placed in a heavy steel mold having a cavity of suitable shape and size to provide a mass approximately the size and shape of the desired capillary filler element. The mold was inserted in a furnace heated to an initial temperature of 1350° F. The beads were maintained in a nonoxidizing atmosphere by maintaining carbon dioxide in the interior of the oven surrounding the mold containing the beads. The heat supplied to the furnace was maintained but owing to the insertion of the mold, the temperature of the furnace cooled within three minutes to around 1240° F. After approximately four more minutes the temperature of the furnace again reached 1350° F. and this temperature was maintained for approximately five minutes more, after which the mold was removed from the furnace and allowed to cool in air. The resulting cell structure was firm and rigid with adjacent beads securely joined and with the void spaces between the beads approximately the same size and shape as in the initial stack of individual beads.

The reservoir chamber 203 is continuously vented to atmosphere in order to permit air to escape therefrom during filling, to equalize the air pressure exerted on the ink in the capillary filler element at all times, and to admit air to replace ink which is withdrawn from the pen in writing. Any suitable venting means may be employed which provides relatively free communication between the interior of the pen body and the atmosphere. However, I prefer to use the arrangement shown in the illustrative embodiment wherein the vent is formed by a passage 227 in the rear body member 201 and a connecting passage or port 228 extending therefrom to adjacent the joint between the body members 200 and 201. Preferably the joint adjacent the passage 228 is made sufficiently loose or free to permit air to pass therethrough. However, if desired, in order to permit a higher degree of venting where desired to speed up the filling operation, the rear body member 201 may be unscrewed slightly to fully expose the outlet end of the passage 228 to atmosphere.

To fill the pen, the writing end of the pen is inserted in a supply of ink to place at least the nib slit in contact with the ink. However, pref-

erably the pen is inserted into the ink sufficiently to place the forward end of the capillary filler element 215 in direct contact with the ink. Ink is drawn by capillary action into the filler element 215 and rises by capillarity along the walls of the beads 219 and of the beads 216; ink also may rise along capillary spaces formed between the walls of the pen body and the adjacent beads.

Air which is in the empty or partially empty spaces or cells 220 and 217 at the beginning of the filling operation is forced therefrom by the incoming ink and passes out of the filler element at the rear end thereof and through the vent passages 227 and 228. Since each space or cell is in communication with a plurality of adjacent spaces the air can pass with relative freedom rearwardly through the filler element and little if any pressure is required to eject the air. Owing to the greater capillarity of the smaller spaces 220 in the core 218 as compared to the spaces 217 ink rises faster in the core and is drawn from thence into the spaces formed by the beads surrounding the core. However, owing to the large number of passages or channels along which ink can rise in both the core and the surrounding portion of the capillary filler element there is little likelihood of air being trapped in the filler element but the air is entirely forced out of the filler element. If, for any reason, a small amount of air should be trapped in the filler element by the incoming ink this will not seriously impede the flow of ink upwardly within the capillary filler element especially since owing to the greater capillarity of the core ink will rise in the core and will be drawn therefrom into the surrounding beads.

In writing, when the point of the pen nib is placed in contact with a writing surface, the ink which is held in the nib slit by capillarity is brought into contact with the surface and the capillarity established between the surface and the nib is sufficient to overbalance the capillarity of the capillary filler element and ink is drawn therefrom and deposited on the writing surface. Ink drawn from the nib slit is replaced by ink drawn into the nib slit from the adjacent capillary spaces provided by the capillary filler element. Owing to the fact that the spaces 220 of the core 218 have greater capillarity than the spaces 217 of the surrounding portion of the capillary filler element, ink is drawn into the core and a continuous body or column of ink fills the spaces in the core and extends to the nib slit 212 so that ink is always available at the nib slit. As ink is drawn from the pen and the spaces defined by the capillary filler element are emptied from the rear end toward the forward end the level of the ink will fall but the ink at all times during writing will tend to stand at a higher level in the core than in the remainder of the capillary filler element so that at no time will there be any break in the continuous body or column of ink extending from the larger spaces 217 to the nib slit 212 by way of the core 218.

Air to replace ink withdrawn from the capillary spaces or cells is drawn into the capillary filler element through the vent passages above described and consequently the pressure of the air on the ink in the capillary filler element is maintained at all times substantially equal to a atmospheric pressure and there is no decrease in pressure within the pen which might tend to retard the flow of ink during writing. Moreover, the core, with its passages of greater capillarity, insures that ink is always drawn toward the writing end of the pen and thus there is no possibility of the creation of air bubbles within the capillary filler element which might tend to cause air locking with the consequent retarding or blocking of the flow of ink toward the writing end of the pen.

The capillarity of the cells in the capillary filler element is such that ink is drawn into the capillary filler element during filling to such a height as to completely fill all of the spaces. The capillarity of these spaces is predetermined by forming the capillary filler element of beads of suitable sizes. In certain cases it may be found sufficient to form the core entirely of beads of one particular size and the remaining portion of the capillary filler of beads all of another size. However, in certain cases it may be preferable to provide capillary spaces in the portion of the filler element most remote from the writing element which are of smaller size and greater capillarity than the spaces nearer to the writing element. In that event the beads surrounding the core are formed in two or more longitudinally displaced layers, the beads in successive layers being of decreasing sizes in a direction away from the writing element. This latter construction is illustrated in Fig. 12 wherein the filler element 400 is formed as a porous mass having a central core 401 and a surrounding portion which is formed in several sections, such as the sections 402 and 403, the spaces in each section being smaller and of greater capillarity than in the sections nearer to the writing element 404.

In one practical embodiment of a fountain pen embodying my invention and having overall exterior dimensions approximately equal to those of a conventional fountain pen excellent results were obtained by employing a capillary filler element, the outer portion of which was constituted by "No. 4" beads having an average diameter of 0.040" and a core formed from "No. 8" beads having an average diameter of 0.020" with the forward end of the core extending across the entire front end of the interior of the pen body and into contact with the nib in a manner similar to that illustrated in Fig. 1 of the drawings. The reservoir section was approximately 3/8" in diameter and approximately 1 3/4" in length from the rearward end of the nib to the rear end of the reservoir section and the feed section was approximately 3/4" in length from the rear end of the nib to the forward end of the pen body. The core extended throughout the length of the capillary filler element and had a diameter of approximately 1/8".

It will be understood that where beads are referred to herein as being of the same size they may vary slightly in size owing to manufacturing variations. It is desirable, however, that the beads be as nearly uniform in size as practicable and it has been found that entirely satisfactory results may be obtained with beads which vary in size up to 10% in their diameter. However, the more nearly uniform the bead sizes the more accurately the operational characteristics of the pen may be predetermined.

The capillarity of the several capillary spaces in the filler element may be increased by providing wall surfaces defining these passages which have a relatively high degree of wettability by the inks with which the pen is used. Thus the height of rise of the ink and consequently the capacity of the reservoir as well as the rate of filling may be substantially improved.

Satisfactory wettability of the wall surfaces of the beads may be obtained by forming the

beads of materials which are inherently suitably wettable by the inks used, as, for example, the materials above specified. I have found that beads formed from glass have very desirable surface characteristics, although beads formed of other materials such as "Lucite," hard rubber, "Saran" and metal have been found satisfactory. The wettability of such surfaces may be increased in many cases by appropriate treatment depending upon the nature of the surface.

Where the beads are formed from glass very satisfactory increase in the wettability of the surface can be obtained by suitably etching the surfaces of the beads. In one specific example the beads which were formed of soft lime glass and had a diameter of approximately 0.040" were placed in a lead receptacle and a 60% solution of hydrofluoric acid was poured over the beads to fully immerse them. The beads were allowed to remain immersed for approximately 60 seconds and were removed from the acid and washed thoroughly in water to remove all free acid. The etching reaction was allowed to proceed with the receptacle being unheated except for the heat of reaction between the hydrofluoric acid and the glass forming the beads. Similar etching processes have been successfully carried out on other sizes of beads of soda glass in a manner similar to that above-described. However, where the beads are of smaller size than above stated the immersion time preferably is somewhat shorter.

Further increase in wettability of glass beads may be obtained by additionally treating beads etched in the manner above described. In one specific example beads etched as above described were immersed in a molten bath consisting of 95% chemically pure cuprous chloride and 5% reagent grade of cupric sulphide maintained at a temperature of 1050° F. The beads were immersed for approximately 30 minutes and then were removed and allowed to cool in air, after which they were ready for assembly in a pen. In another specific example, etched beads were immersed for 30 minutes in a molten bath consisting of 90% silver nitrate and 10% sodium nitrate maintained at a temperature of around 1050° F. Excellent results also have been obtained by subjecting unetched beads to one of the foregoing treatments in the manner described.

Wettability of the surface of the beads may also be increased by a somewhat different process. In one example of this process two drops of formaldehyde solution were added to 20 ml. of silver nitrate solution and immediately thereafter the etched beads were inserted in the mixture and the mixture was swirled to thoroughly wet all surfaces of the beads. The contents of the dish were allowed to stand for five minutes and then 10 ml. of formaldehyde was added to the dish and contents thoroughly mixed. The beads were allowed to stand for ten minutes with occasional stirring of the mixture and the beads were then removed and thoroughly washed with distilled water. Thereafter the beads were dried in air at 250° F. and after cooling in air were ready for use. This process left a silvery deposit permanently adhering to the beads.

A third method of improving the wettability of etched glass beads consisted of immersing the beads in a solution consisting of 10% by weight of sulphuric acid and inserting the solution containing the beads in an autoclave. The solution containing the beads was maintained at a temperature of at least 250° F. under a pressure of 100 pounds per square inch for six hours. The beads and the solution were thereafter removed from the autoclave and the beads removed from the solution and allowed to cool and dry in air. Variations of this process consisted in employing in lieu of sulphuric acid such materials as sodium carbonate or lithium chloride.

A somewhat different method of treating the beads has been found successful which method is suitable for treating not only glass beads but beads formed from hard rubber, metal such as silver, or a plastic such as methyl methacrylate resin. In one specific embodiment of this method a suitable granular abrasive material is ground to a powder which will pass a 1250 mesh screen and is thoroughly mixed with water. The water is then forced under pressures from 50 to 100 pounds per square inch through nozzles which atomize the water. The beads are placed at a distance of from 4 to 10 inches from the nozzles and the vapor containing the entrained abrasive is projected against the surfaces of the beads with sufficient force to roughen or pit the surfaces. The beads thus treated have surfaces formed with very minute depressions and valleys along which ink will rise rapidly to thoroughly wet the surfaces.

Instead of forming the beads from glass as above described, they may be formed from "Lucite" (methyl methacrylate resin) having incorporated therein, or treated after formation with, a material which increases the wettability of the surface of the beads. Excellent results have been obtained by mixing with the methyl methacrylate while the latter is in monomer form from 2½ to 10% by weight, and preferably about 10% of Aerosol "O. T." (di-octyl sodium sulphosuccinate) and thereafter polymerizing the methyl methacrylate.

The wettability of the surfaces of beads formed from "Lucite" (methyl methacrylate resin) may be increased by suitably treating the beads after formation. In one specific form of such treatment the beads were moistened with water and allowed to absorb water. Thereafter, silicon tetrachloride in the vapor phase was allowed to react, at room temperature and atmospheric pressure, with the absorbed water. The beads then were ready for use and were found to have more readily wettable surfaces than beads formed from untreated "Lucite."

The several portions of the capillary system provided by the beads are defined by relatively fixed rigid members having definite and controllable fixed shapes and dimensions an consequently the capillarities of the several portions of the system can be readily predetermined. Moreover, such capillarities will remain substantially fixed during the life of the pen since the members defining the capillary passages are not subject to changes in shape, dimension or relative position during operation. The beads provide relatively smooth, substantially nonabsorbent, wall surfaces defining capillary spaces of such size that ink is drawn therein during filling and held therein when the pen is not in use but which permit substantially all of the ink to be drawn therefrom by capillary action when the pen is used in writing.

It will be understood that where spherical beads are employed in forming the filler element the spaces or voids therebetween may take any one of a number of shapes depending upon the manner in which the beads surrounding such

spaces arrange themselves and the stacking, or packing of the beads may vary throughout a predetermined range from the closest type of packing to the most open type of packing. However, where a relatively large number of beads of similar size are involved and the diameter of the capillary filler element is at least eight times the bead diameter, the percentage of each different type of packing will remain approximately constant in all cases where the beads are stacked without predetermined arrangement and consequently the ratio of total void space to total volume of the mass will be the same. Accordingly, the total capillarity of the mass and the range of variation of capillarity of the several spaces in the mass can be predetermined to a relatively high degree of accuracy by appropriate selection of the size or sizes of the beads. It will be understood that the portions of the cells or spaces immediately adjacent the points of contact of the adjacent beads may be of such small width between opposite wall surfaces of adjacent beads that the capillarity is sufficiently high to retain ink therein when the pen is used in writing. However, the remaining portion of the cell has a sufficient wall-to-wall distance that ink will not be contained therein when the pen is used in writing. The ratio between the amount of void space within the capillary filler element from which ink may be withdrawn in writing, or what I term the "effective usable void space," to the total void space may be predetermined by appropriate selection of the size of the beads forming the capillary filler element.

A capillary filler element formed in accordance with the present invention may be embodied in a pen having a feed bar for feeding ink from the capillary filler element to the writing nib. One form of such arrangement is illustrated in Fig. 5 to which reference now is made. A pen body **230** is provided which may be generally similar to the pen body above described except at the forward portion thereof which portion is shown in Fig. 5. The pen body **230** is formed with a reservoir section **231** communicating through a central bore **232** with a counterbore **233** which serves as a nib socket or seat. A nib **235** which may be of usual construction is seated in the seat **233** and includes a generally cylindrical slit body **236** and a tapered portion **237** formed with a nib pierce **238** and nib slit **239** extending from the pierce **238** and providing two nib sections **240**. The counterbore **233** may be relieved above the nib **235** to provide a capillary ink space **241** into which ink is drawn and maintained at all times and thereby insuring that a supply of ink is maintained at the nib slit so that the nib is always wetted and in condition for instant writing.

A feed bar **250** is formed with a generally cylindrical body portion **251** extending through the bore **232** and projecting rearwardly into the reservoir chamber **231**. The feed bar extends forwardly through the nib **235** and has a reduced forward portion **252** engaging the undersurface of the nib close to the writing end thereof. The feed bar is formed with a top feed slot **253** extending from the rear end of the feed bar to forwardly of the nib pierce and providing a capillary filler duct extending from the reservoir chamber **230** into feeding relation with the nib slit. The feed bar **250** is also provided with additional capillary slots **254** in its side end bottom walls which extend from the rear end of the body portion **251** to substantially to the forward end

thereof and thus provide communication between the ink reservoir chamber **231** and the space within the counterbore **233**. In certain cases it may be found desirable to form the body **251** of the feed bar of slightly smaller diameter than the nib thereby providing an arcuate capillary space **255** between the feed bar **250** and nib **235** with which space the slots **253** and **254** are in communication.

A capillary filler element **255** is disposed in the ink reservoir chamber **231** and includes a central core **256** having a forward end portion **257** extending substantially throughout the lateral extent of the chamber **231** abutting the forward end wall thereof. The enlarged end **257** of the core surrounds the rear end of the feed bar **250** and the capillary spaces of the core are placed in ink feed relation with the slots **253** and **254** of the feed bar. The capillary filler element also includes a mass of beads **258** surrounding the core **256** which beads are of larger size than the beads forming the core as explained hereinabove in connection with the capillary filler element **215** shown in Fig. 1.

While the capillary filler element **255** may be formed as a unitary structure in the manner described in connection with the capillary filler element **215**, it is generally preferable to form the filler element **255** of loose beads inasmuch as such beads will conform more closely to the shape of the projecting portion of the feed bar **250** and provide a more complete capillary connection between the capillary spaces in the core **256** and the capillary slots **253** and **254** in the feed bar **250**.

Where the capillary filler element is formed either wholly or in part of loose beads which are not joined in a unitary structure it is desirable to provide means for segregating, at least during the assembling operation, the small beads forming the core from the larger beads forming the remaining portion of the capillary filler element. One form of pen embodying such means is illustrated in Fig. 7 to which reference now is made. The pen of Fig. 7 may have a body formed in a manner generally similar to that illustrated in Fig. 1 and including a forward body member **300** having a reservoir section **303** and a feed section **304**, and a rear body member **300** have air vent passages **327** and **328**. A pen nib **307** similar to the nib **207** previously described may be employed as a writing element. It will be understood that where the pen of Fig. 7 is not described in detail it may be similar to the pen illustrated in Figs. 1 to 4 and described above.

In assembling the pen illustrated in Fig. 7, where the core is formed of loose beads, small beads for forming forward portion of the core **321** are inserted in the body member **300** to fill the feed section **304** to the desired distance from the forward end of the pen. Thereafter a tube **365** which may be formed of thin walled material such as metal or a plastic is disposed centrally in the body member **300**. The tube **365** may be formed either as a continuous cylinder or may be formed by rolling a sheet of material into generally tubular form. After the tube **365** is suitably held in the desired position and sufficient additional small beads **317** to substantially fill the tube are inserted therein thereby forming a central core **318**. Thereafter, sufficient beads **316** of larger size are inserted in the space surrounding the tube **365** to substantially fill this space and complete the capillary filler element **315**.

If desired, after the larger beads have been inserted in the pen body, the tube **365** may be withdrawn. However, it may be left in the capillary filler element to serve as means for confining the beads forming the core and thus insure against intermingling of the small beads with the larger beads surrounding the core. Where the tube is left in the capillary filler element it is formed with a plurality of small perforations or openings **366** providing relatively free communication between the spaces defined by the larger beads and the spaces defined by the beads forming the core. In this case the tube **365** may if desired be formed from screen material of sufficiently fine mesh to retain the small beads and yet sufficiently open to provide relatively free communication between the core and the surrounding portion of the capillary filler element.

The capillary filler element, and the tube where one is employed, are retained in the reservoir chamber **303** by the rear body member **301**, the inner end of which is adapted to abut the capillary filler element. Preferably, in order to prevent the smaller beads from entering the air vent passage **327**, a retainer disc **367** as a thin walled disc having perforations **368** or as a screen is interposed between the rear end of the capillary filler element and the inner end of the rear body member **301**.

It will be understood that in certain cases it may be found preferable to form the core as a unitary member in which the initially individual beads are integrally joined as above described and by disposing loose beads of larger size around the core to complete the capillary filler element. In this form of filler element it, of course, is not necessary to provide a central tube surrounding the core since the small beads forming the core are inherently retained in the desired position.

From the foregoing it will be seen that the present invention provides a capillary fountain pen having a capillary filler element of the granular type formed of initially individual particles which has improved filling and writing characteristics. Owing to the provision of the smaller capillary spaces in the core the feed of ink from the larger capillary spaces provided by the surrounding portion of the core is insured and ink is maintained at all times at the nib so that the pen not only is in condition for instant writing but the ink is fed continuously and evenly when the pen is used in writing. Moreover, the provision of the core insures that a very high percentage of the ink drawn into the pen in filling may be withdrawn from the pen in writing thus providing a pen having a relatively high refill and write-out capacity.

The capillary filler element is extremely simple in form and can be assembled easily and inexpensively from readily obtainable and inexpensive materials. The capillary filler element is such that there are no critical adjustments necessary during assembly. Moreover, there are no elements which are subject to malfunctioning or which require any maintenance or adjustments during a long period of use of the pen. If for any reason the replacement of the capillary filler element should become necessary as for example such as might occur if the pen were abused, the capillary filler element can be readily removed and replaced at a relatively low cost and without operations requiring a high degree of skill.

I claim:

1. A fountain pen comprising a pen body having an ink reservoir section defining a reservoir chamber, a writing element at one end of said pen body, and a capillary filler-and-reservoir element in said chamber including a porous mass defining a plurality of interconnected capillary spaces constituting the principal ink storage reservoir of said pen, the spaces in a zone centrally of said mass and extending substantially throughout the length of said mass and to said writing element being of smaller size than the remaining spaces of said mass, thereby providing a series of capillary spaces of greater capillarity than the remainder of the spaces, communicating with the latter and in ink-feeding relation with said writing element.

2. A fountain pen comprising a pen body having an ink reservoir section defining a reservoir chamber, a writing element at one end of said pen body, and a capillary filler-and-reservoir element in said chamber including a mass of initially individual solid particles disposed in intimate contact in said reservoir section and integrally connected to one another at their abutting surface portions to define a unitary porous body having a plurality of interconnected capillary spaces extending throughout said body and constituting the principal ink storage reservoir of said pen, the spaces in a zone extending longitudinally of said body and to said writing element being of smaller size than the remaining spaces to define capillary spaces of smaller size than the remainder of said spaces.

3. A fountain pen comprising a pen body having an ink reservoir section defining a reservoir chamber, a writing element at one end of said pen body, and a capillary filler-and-reservoir element in said chamber and defining the principal ink storage reservoir of said pen, said element including a first mass of solid particles of predetermined sizes disposed in intimate contact and defining therebetween a plurality of interconnected capillary spaces extending throughout said element, and a second mass of solid particles of smaller sizes than the particles in said first mass, disposed in intimate contact and extending longitudinally as a core throughout said first mass centrally thereof and to said writing element to define a plurality of capillary ink feed passages of greater capillarity than said capillary spaces and connecting those spaces which are adjacent said second mass in ink feeding relation to said writing element.

4. A fountain pen comprising a pen body having an ink reservoir section defining a reservoir chamber, a writing element at one end of said pen body, and a capillary filler-and-reservoir element in said chamber and defining the principal ink storage reservoir of said pen, said element including a first porous mass in said reservoir chamber and defining a plurality of interconnected capillary spaces, and a second porous mass extending longitudinally of said first mass and defining a plurality of capillary passages of smaller size and greater capillarity than said capillary spaces in said first mass for connecting said capillary spaces in ink feeding relation to said writing element.

5. A fountain pen comprising a pen body having a reservoir section defining a reservoir chamber, a writing element at one end of said pen body, and a capillary filler-and-reservoir element in said chamber and defining the principal ink storage reservoir of said pen, said element including a core of cellular form extending from said writing element and substantially throughout the

length of said reservoir section and having a plurality of interconnected capillary spaces therein, and a mass of solid particles surrounding and in intimate contact with said core and of such size as to define a plurality of interconnected capillary spaces of larger size than the spaces in said core with the spaces defined by said mass of particles communicating in ink feeding relation with the spaces in said core.

6. A fountain pen comprising a pen body having a reservoir section defining a reservoir chamber, a writing element at one end of said pen body, a capillary filler-and-reservoir element in said chamber and defining the principal ink storage reservoir of said pen, said element including a first mass of solid particles disposed in intimate contact in said reservoir section and having interconnected pores defining a plurality of interconnected capillary spaces therein, the particles in the portion of the mass farthest from said writing element being of smaller size than the particles nearer to said writing element and defining spaces of smaller size and greater capillarity, and a second porous mass extending throughout and surrounded by the particles of said first mass and having interconnected pores of smaller size than the smallest pores of said first mass and defining a plurality of capillary spaces connecting the spaces of said first mass to said writing element.

7. A fountain pen comprising a pen body having a reservoir section defining a reservoir chamber and a feed section, a writing element at one end of said pen body, a feed member in said feed section providing a capillary ink feed passage leading to said writing element, and a capillary filler-and-reservoir element in said chamber including a porous mass having a plurality of interconnected pores and defining a plurality of interconnected capillary spaces constituting the principal ink storage of said pen, the spaces in a zone extending longitudinally of said mass and to said feed member being of smaller size and greater capillarity than the remainder of the spaces, thereby providing interconnected spaces of greater capillarity than the remainder of the spaces connecting the latter to said feed passage in said feed member.

8. A fountain pen comprising a pen body having an ink reservoir section defining a reservoir chamber, a writing element at one end of said pen body, and capillary filler-and-reservoir means in said chamber defining the principal ink storage reservoir of said pen, said means including a first mass of solid, generally spherical particles, the smallest of which are approximately 0.040" in diameter disposed in intimate contact within said reservoir chamber and defining a plurality of capillary spaces and a second mass of solid, generally spherical particles approximately 0.020" in diameter disposed in intimate contact and extending as a continuous core throughout a substantial portion of the length of said first mass and defining interconnected capillary spaces communicating with the spaces in said first mass for feeding ink by capillary action to said writing element.

9. A fountain pen comprising a pen body having a reservoir section defining a reservoir chamber, a writing element at one end of said pen body, a capillary filler-and-reservoir element in said chamber defining the principal ink storage reservoir of said pen, said element including a

core of cellular form extending from said writing element and substantially throughout the length of said reservoir section and having a plurality of interconnected capillary spaces therein, and a mass of solid particles surrounding and in intimate contact with said core and of such size as to define a plurality of interconnected capillary spaces of larger size than the spaces in said core with the spaces defined by said mass of particles communicating in ink feeding relation with the spaces in said core, and means for venting at least said larger spaces to atmosphere.

10. A fountain pen comprising a pen body having an ink reservoir section defining a reservoir chamber, a writing element at one end of said pen body, and a capillary filler-and-reservoir element in said chamber defining the principal ink storage reservoir of said pen, said element including a first porous mass having interconnected pores defining a plurality of interconnected capillary spaces, and a second porous mass having interconnected pores providing a plurality of capillary passages of smaller size and greater capillarity than said capillary spaces for connecting the capillary spaces in said first mass in ink feeding relation to said writing element, said second mass having a portion extending across substantially the entire end of said reservoir chamber adjacent said writing element and a portion extending longitudinally substantially throughout said first mass.

11. A fountain pen comprising a casing having a reservoir section defining a reservoir chamber, a writing element at the forward end of said casing and a capillary filler-and-reservoir element in said chamber including a porous mass having interconnected pores providing a plurality of interconnected capillary ink storage spaces connected in ink-feeding relation to said writing element and constituting the principal ink storage reservoir of said pen, the capillary spaces in a continuous zone extending longitudinally throughout the major portion of the length of said filler-and-reservoir element being of smaller size and greater capillarity than the capillary spaces in other portions of said element whereby said smaller spaces draw ink by capillary action from said larger spaces as ink is withdrawn at said writing element, in writing, and means venting said chamber to atmosphere, at least certain of said larger pores of said filler-and-reservoir being exposed to the air in said chamber whereby air under atmospheric pressure may enter said spaces to permit ink to be withdrawn therefrom, in writing.

HARLAN H. ZODTNER.

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