PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in or relating to Fountain Pens

We, THE PARKER PEN COMPANY, a Corporation duly organised under the laws of the State of Wisconsin, United States of America, of Corner of Court and Division Streets, Janesville, State of Wisconsin, United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to fountain pens, and more particularly to fountain pens in which capillary action alone is utilized for filling the ink reservoir, for retaining ink therein and for feeding ink therefrom to a writing surface when the pen is in use.

Fountain pens operating generally in this manner are disclosed in our Specification No. 634,735, which describes and claims a fountain pen including a pen body having a reservoir section and a feed section with a writing element carried at one end of the pen body, characterised in that there is disposed in the reservoir section a capillary ink filler and reservoir element having relatively fixed, rigid walls defining a capillary ink storage space of predetermined capillarity sufficient to draw ink into the storage space by capillary action when the filler and reservoir element is placed in communication with a supply of ink as when an end of the pen is inserted in a supply of ink and to retain the ink in the storage space by capillary action when the pen is not in use, and further characterised by a capillary ink feed element disposed in the feed section and providing a capillary ink feed duct connecting the storage space with the writing element and of predetermined capillarity sufficient to draw ink from the storage space by capillary action when the writing element is in contact with a writing surface.

In our said Specification No. 634,735 we show various forms of pen each having an ink reservoir comprising a plurality of annular spaces of capillary dimensions, with longitudinal passages interconnecting the said spaces and serving to feed ink therefrom to a writing element such as a nib when the pen is in use. The annular spaces may also be formed so that those farthest from the writing element are of greater capillarity than those nearer to said writing element.

It is an object of the present invention to provide an improved fountain pen which operates on the same principles as described in our said specification, and in pens according to the present invention we provide a capillary ink filler and reservoir element with an ink storage space which extends longitudinally throughout the length of the capillary filler and reservoir element and is of generally spiral cross-sectional shape.

It will readily be understood that such a construction lends itself to simple methods of manufacture, and we prefer to manufacture the capillary filler and reservoir element by rolling one or more members of thin walled material into spiral form so that the convolutions thereof define a spiral shaped ink storage space.

Pens according to the present invention have the particular advantage that the ink storage space provided by the ink reservoir and filler element is substantially unobstructed both longitudinally and laterally, thus providing a space of comparatively large total cross-section and facilitating rapid filling.

Means may be provided for maintaining wall members defining the said ink storage space in predetermined spaced relation, and such means may for example comprise projections from said wall members. The said wall members may be perforated to provide interconnection between adjacent portions of said ink storage space. In another form of filler and reservoir element a sheet of

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spacing material, e.g. matted fibrous material, having capillary spaces therein may be interposed between successive convolutions of a sheet of thin walled material defining the ink storage space. In this form of the invention woven material may be used as said spacing material in which event the threads extending longitudinally of the pen may be extended and bunched to form a wick-like feed member connecting the capillary filler and reservoir element to a writing element e.g. a nib.

Fountain pens according to the present invention also enjoy the various advantages common to all fountain pens in which capillary action alone is utilized for filling the ink reservoir, retaining ink therein and feeding it to a writing surface when the pen is in use. Among these advantages may be mentioned the absence of moving parts such as plungers or levers, associated with the filling mechanism, and the possibility of providing air vents and/or pressure equalizing passages so that changes in ambient pressure and/or temperature do not affect the operation of the pen.

In order that the invention may be well understood, preferred embodiments thereof will now be described, with reference to the accompanying drawings in which:—

Figure 1 is a fragmentary, longitudinal sectional view through a fountain pen embodying the invention;

Figure 2 is an enlarged, transverse sectional view taken along line 2—2 of Fig. 1;

Fig. 3 is an enlarged, transverse sectional view taken along line 3—3 of Fig. 1;

Fig. 4 is an enlarged perspective view of the bushing for mounting the nib and feed bar;

Fig. 5 is an enlarged, fragmentary, perspective view of a portion of the capillary filler element of the pen shown in Fig. 1;

Fig. 6 is a fragmentary, longitudinal sectional view showing a second embodiment of the invention;

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

Fig. 8 is an enlarged, transverse cross-sectional view taken along line 8—8 of Fig. 7;

Fig. 9 is a longitudinal sectional view of still another embodiment of the invention;

Fig. 10 is an enlarged, transverse sectional view taken along line 10—10 of Fig. 9;

Fig. 11 is an enlarged, transverse sectional view taken along line 11—11 of Fig. 9;

Fig. 12 is an enlarged, transverse sectional view taken along line 12—12 of Fig. 9;

Fig. 13 is a side elevational, somewhat diagrammatic view showing the capillary filler element of the pen of Fig. 9; with a portion of the outer turn of the sheet folded back to expose the spaced sheet;

Fig. 14 is an enlarged, fragmentary sectional view taken along the line 14—14 of Fig. 13;

Fig. 15 is a fragmentary, longitudinal sectional view of another form of the invention;

Fig. 16 is a side elevational view of the capillary filler element of the pen of Fig. 15;

Fig. 17 is a rear-end view of the capillary filler element shown in Fig. 16;

Fig. 18 is an enlarged, fragmentary sectional view taken approximately along line 20—20 of Fig. 16;

Fig. 19 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. 20 is a side elevational view of another form of capillary filler element embodying the invention;

Fig. 21 is a rear-end view of the capillary filler element of Fig. 20;

Fig. 22 is an enlarged fragmentary sectional view taken approximately along line 24—24 of Fig. 20;

Fig. 23 is a fragmentary view partially in longitudinal cross-section showing a modified form form of feed connection between the filler element and the writing element;

Fig. 24 is a transverse sectional view taken along line 26—26 of Fig. 23;

Fig. 25 is a fragmentary, longitudinal, sectional view of a pen embodying still a further form of the invention;

Fig. 26 is a transverse sectional view taken along line 28—28 of Fig. 25;

Fig. 27 is a transverse sectional view taken along line 29—29 of Fig. 25;

Fig. 28 is a transverse sectional view taken along line 30—30 of Fig. 25;

Fig. 29 is a transverse sectional view taken along line 31—31 of Fig. 25;

Fig. 30 is a reduced, fragmentary and somewhat diagrammatic view showing the capillary filler element of the pen of Fig. 25 in its condition during assembly thereof;

Fig. 31 is an enlarged, fragmentary, transverse sectional view through the capillary filler element of Fig. 30 and showing particularly the manner of spacing consecutive turns of the sheets

forming the filler element; and

Fig. 32 is a perspective view showing a slightly modified form of capillary filler element comprising three separate longitudinally abutting sections.

Referring particularly to Fig. 1 of the drawings, there is shown for the purposes of illustration a fountain pen comprising a body or casing 1 formed of suitable material such as a plastic, and which for convenience in manufacturing and assembling is constituted by a plurality of members or sections. Specifically, the body includes a barrel or forward section 2, a rear section 3 connected thereto as by a threaded joint 4, and a tail piece 5 connected to the rear section 3 as by a threaded joint 6. The forward section 2 is formed with an axially extending bore or chamber defining an ink reservoir 10 and has an axial opening 11 extending from the reservoir 10 through its forward or writing end.

A writing element is carried at the forward or writing end of the body 1 and is connected by suitable ink feed means to the reservoir 10. The writing element takes the form of a nib 12 supported in the opening 11 with its writing end projecting beyond the end of the forward section 2 where it is exposed for writing. The nib 12 may be of any suitable form but preferably is formed with a generally cylindrical body portion 13 having a slot 14 extending along the underside thereof and a tapered arcuate forward portion 15 formed with a slit 16 extending inwardly from the end to a pierce 17. The nib 12 preferably is mounted in the forward section 2 as by a bushing 20 secured as by external threads 21 in a counterbore 22 formed at the inner end of the opening 11. The bushing 20 (Fig. 4) is formed with a bore 23 and a counterbore 24 which provide an internal flange 25. The nib 12 is adapted to be received snugly in the counterbore 24 with its inner end seated against the internal flange 25, whereby the nib 12 is appropriately positioned with respect to the other associated members. Extending through the flange 25 is a plurality of slots 26 the purpose of which will be explained more in detail hereinafter.

A feed bar 30 is associated with the nib 12 and is supported by the bushing 20, the body of the feed bar 30 being received snugly in the bore 23 and extending forwardly therefrom and into the nib 12. The feed bar 30 is formed with a reduced forward extension 31 positioned to engage the nib forwardly of the nib pierce 17 in the usual manner. Preferably, the feed bar 30 is of slightly smaller diameter than the body 13 of the nib 12 and thus a generally annular capillary space 32 is provided between the feed bar 30 and the nib 12.

The capillary space 32 is connected with the ink reservoir 10 by an ink feed slot 33 formed in the upper surface of the feed bar and extending from the rear end of the feed bar 30 to forwardly of the nib pierce 17 in alignment with the pierce 17 and the slit 16. Preferably, additional feed slots 34 are provided in the feed bar 30 and extend from the inner end of the feed bar to the capillary space 32 between the nib 12 and the feed bar 30.

The opening 11 preferably is provided with a relieved portion in its upper wall, above the nib 12, which defines with the nib 12 an arcuate capillary ink space 11a extending along the nib 12 and communicating with the slit 16 and pierce 17. In the operation of the pen, ink is drawn into the space 11a by capillary action and maintains this space filled, whereby the adjacent portion of the pen is continually wetted and the pierce and slit always contain ink, and the pen therefore is at all times in condition for instant writing.

In accordance with the present invention, means are provided for filling the ink revervoir by capillary action and retaining the ink in the reservoir by capillary action in such manner that it will not leak therefrom even when the pen is subjected to conditions which might otherwise cause leakage as, for example, changes in temperature or pressure but which means permits the ink to be withdrawn uniformly from the pen under the capillary action established between the nib and the writing surface when the pen is used in writing. To this end the present invention provides a capillary filler element 35 (illustrated somewhat diagrammatically in the drawings for a clearer understanding thereof), which takes the form of a thin-walled member 36 spirally wrapped or rolled into convolute form, the consecutive convolutions or turns of which are spaced apart to define therebetween a capillary space 37 of generally spiral cross-section and extending longitudinally substantially throughout the reservoir 10. The turns or convolutions of the spirally wrapped sheet preferably are spaced uniformly to provide a space of uniform width throughout its several turns. Since consecutive convolutions of the wall member 36 are relatively close together, they have the effect of being circular and disposed substantially concentrically with the spaces defined between consecutive convolutions substantially annular in shape. In other words, these spaces constitute in effect a series of concentric spaces or chambers, each of

which merges or connects with the next adjacent space along a longitudinally extending line of juncture. However, while the construction of the filler element thus provides a space somewhat similar to a series of concentric chambers, all such chambers are connected for the flow of ink therebetween and actually form a single space.

The capillary filler element 35 is formed from a thin sheet of suitable material, such as metal or plastic, having a surface sufficiently wettable by inks of the type customarily used in fountain pens to exert the desired capillary attraction on the ink. The material has sufficient flexibility to permit it to be rolled into convolute form and sufficient rigidity to maintain its shape and position. In addition, the material is one which is suitably resistant to the ink used so that it is not deteriorated thereby and does not adversely affect the ink. Excellent results have been obtained by forming the capillary filler element from materials such as silver foil, gold foil, or Cellophane (Registered Trade Mark). The material from which the filler element is formed may be suitably treated in a known manner to provide a surface having increased wettability.

In order that the filler element may have the maximum practicable ink capacity, it is so formed as to have as great as possible capillarity, limited however to a capillarity not greater than that which will permit the ink to be written out of the pen. For a sheet formed from a material having any particular degree of wettability the capillarity of the filler element may be predetermined by suitable spacing the turns of the sheet to provide a capillary space of suitable width between opposing walls. The filler element preferably is made of such length that the capillary space therein is substantially filled when the pen is filled by holding it in a vertical position. Thus, even if the pen is filled by holding it at an acute angle to the surface of the body of ink from which the pen is being filled, the pen will not be overfilled, with the consequent possibility of leakage when moved to a vertical position.

The capillary filler element preferably is of such size that it substantially fills the space in the reservoir chamber 10. The width of the sheet, therefore, corresponds substantially to the length of the reservoir. The sheet is of such length that when rolled into spiral form, with the consecutive turns spaced the desired distance, the filler element is of a diameter to fit snugly in the reservoir. It will be seen, therefore, that the capillary space 37 provides the principal ink storage space of the pen and constitutes in effect the ink reservoir space. However, if desired, additional capillary reservoir space may be provided in the chamber in addition to that provided by the filler element as, for example, by spacing the outer turn of the filler element from the chamber wall.

The capillary filler element 35 after having been formed into its convolute shape is inserted in the reservoir with its forward end in abutment with the forward end wall of the reservoir and the inner end face of the mounting bushing 20, thereby placing the capillary space 37 in direct communication with the slots 26 in the bushing 200. While the feed bar 300 may terminate with its inner end flush with the rear or inner end of the mounting bushing 20, preferably it is of such length that it projects rearwardly into the reservoir 10, as shown in Fig. 1. In order to accommodate the projecting end of the feed bar 30, the capillary filler element 35 is formed with with an axial generally cylindrical recess 38 of such length and diameter as to snugly receive the feed bar 30. The recess 38 may be provided by forming the sheet 36 with a notch or cut out portion 39 at one side edge of the sheet and extending throughout a portion only of the length of the sheet. The sheet 36 is then rolled, beginning with the end edge adjacent the notch so that when the sheet is rolled into convolute form the recess 38 is formed. It will thus be seen that when the capillary filler element 35 is disposed in the reservoir 10 it receives and completely surrounds the projecting end of the feed bar 30 and that at least certain of the convolutions of the capillary space 37 are placed in direct feeding communication with the feed slots 33 and 34 in the feed bar.

The capillary filler element 35 is retained in position in the reservoir 10 in a suitable manner, as for example, by causing the inner end 40 of the rear body member 3 to abut against the rearward end of the capillary filler element 35. However, means preferably are provided for yeildingly positioning the capillary filler element 35 in such manner that it is held firmly in position without, however, subjecting it to damaging longitudinal stresses. This may be accomplished by inserting between the rear end of the capillary filler element 35 and the forward end 40 of the member 3 a resilient member such as a rubber ring of washer 41 having vent notches 42 therein.

Means are provided for venting the reservoir 10 to atmosphere in order to maintain the pressure in the reservoir

equal to atmospheric pressure and thus permit the pen to fill rapidly and to prevent leakage or choking of the pen such as otherwise might occur upon the establishment of a pressure differential between the interior and exterior of the pen as a result of a change in temperature of the pen or a change in atmospheric pressure.

In the specific embodiment illustrated in Fig. 1 a vent passage 45 is provided in the rear body section 3 which passage communicates through a vent passage 46 in the tail piece 5 with an outlet port 47 formed in the tail piece 5 adjacent the joint between the tail piece 5 and the rear member 3. Thus, when the tail piece 5 is unscrewed slightly the port 47 provides free communication between the vent passage 46 and the exterior of the pen. When the tail piece 5 is screwed down, the port 47 may be completely closed but, preferably, the joint is not made air tight and permits air to leak therethrough so that the interior of the pen is sufficiently vented at all times to maintain substantial equality in the pressure between the external atmosphere and the interior of the pen.

The pen of the present invention is filled by merely inserting the forward end of the pen in a supply of ink, the tail piece 5 preferably being unscrewed slightly to provide free venting of the interior of the pen. Ink is drawn into the pen by capillary action and rises in the capillary system by reason of the capillary connection between the several portions thereof. Ink is drawn into the pen through the annular space 32 between the nib 12 and the feed bar 30 and thence through the feed slots 33 and 34 in the feed bar 30 and into the adjacent portions of the capillary space 37. Ink also may be drawn into the nib slit 16 and thence into the annular space 32. Also, ink may be drawn in through the space between the nib 12 and the body and thence through the space between the nib 12 and the bushing 20 and thence through the slots 26 and into the capillary space 37. Where the pen is inserted to a sufficient extent in the supply of ink, ink may be drawn directly into the slots 26 and into the capillary space 37. The slots 26 provide filling passages having a relatively large total cross-sectional area and thus permit rapid filling of the pen.

While ink is drawn initially into those portions of the capillary space 37, which are in direct communication with the feed slots 33 and 34, and with the slots 26 in bushing 20, it finds its way into the remaining portions of the spiral capillary space 37 inasmuch as all of the convolutions of this space are connected to one another. Ink rises in the space 37 by reason of the capillary action effective therein to a height which depends upon the capillarity of this space. As explained hereinabove the capillary filler element 35 is so constructed that its capillarity is such as to cause ink to rise substantially to the top of this element and completely fill the capillary space 37.

Air which is in the capillary space 37 at the beginning of the filling operation is forced out by the incoming ink and finds its way through the vent passages 45 and 46 and the vent outlet 47 and out of the pen. Since all portions or convolutions of the convolute capillary space 37 communicate at the rear end of the capillary filler element with the vent passage 45, the air which is forced out of these spaces passes freely into the vent passage. The outer convolutions of the space 37, which terminate adjacent the positioning washer 41, may communicate with the vent 45 by reason of the fact that the abutment between the filler element 35 and the ring 41 is not sufficiently accurate to form an air seal. However, if desired, the ring may be provided with one or more vent slits or notches 42 to provide free passage of air through the wall of the ring 41.

The convolute or spiral ink space 37, defined by the wall 36 is self-venting and the capillary filler element does not require the provision of any separate venting passage in the filler element between the several portions of the space 37 and the rear vent passage 45. Accordingly, substantially all of the void space within the capillary filler element 35 may be made 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 at any time, and especially during the filling operation, such bubble will 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 capillary space 37 are connected, an air bubble, if blocked against rising in any particular portion of the space 37, will drift into another portion wherein it can find its way out through the rear end of the filler element 35.

While it is very unlikely that a circumferentially continuous body of air would ever be formed across the capillary space between an upper and a lower body of ink, yet even if this should ever occur the pen would not air-lock and filling would not be prevented. While the pen is so constructed that all portions of the capillary space 37 are made to have as nearly equal capillarity as possible, yet owing to slight variations in dimension between the vari-

ous 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 small variation will provide, in one portion of the filler element 35, a capillary path having a slightly higher capillarity than a path in another portion of the filler element 35. 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 which may be considered a condition of instability is created which will tend to break up any such continuous body of air and prevent it from causing air-locking of the pen. Moreover, the filler element 35 may be provided, in the course of rolling of the element 35, with a central space 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 12 is applied to the writing surface, the capillarity established between the writing tip and the writing surface causes ink to be drawn from the pen. Ink to replace that which is withdrawn in writing, or which evaporates during periods of non-writing is drawn from the capillary space 37, through the feed slots 33 and 34 in the feed bar 30, and finds its way into the annular space 32 and thence into the nib slit 6. Ink also may be drawn through the nib pierce 17 and into the space 11*a* above the nib, thereby providing a quantity of ink which maintains the nib slit wetted at all times so that the pen is ready for instant writing. As ink is drawn into the feed slots 33 and 34 from the adjacent portions of the capillary space 37, ink flows from the remaining turns of the space 37 to replace such withdrawn ink and to maintain the feed slots 33 and 34 continuously filled with ink so that there is no interruption in the feed to the nib.

Air to replace ink which is withdrawn during writing or which evaporates from the nib during periods of non-writing may be drawn into the pen through the vent passages in a direction reversely to that in which air is expelled during filling. Air also may enter through the opening 11 in the front end of the pen and pass between the feed bar 30 and bushing 20 and thence through one or more of the openings 26 in the bushing 20 and into the capillary filler element 35. For reasons generally similar to those discussed in connection with the filling of the pen, the pen is not subject to air-locking during writing but writes freely and evenly until substantially emptied.

The feed means connecting the capillary filler element with the writing tip of the nib 12 preferably is so formed that each section is progessively of higher capillarity toward the writing tip of the nib, thus ensuring that ink will be drawn from the filler element to the writing tip. Accordingly, the feed slots 33 and 34 in the feed bar 30, are of a lesser width than the space 37. The annular space 32 is of still lesser width, and the nib slit 16 has the least width and accordingly greatest capillarity of any portion of the ink path. On the other hand, the capillarity of the turns of the space 37 must be sufficient to lift ink to the desired height in the pen when the pen is held vertically and the writing end inserted in a supply of ink. While the width of such space depends upon a number of factors, such as the wettability of the surfaces of the material forming the filler element and the nature of the ink used, such factors are capable of ready determination and the necessary spacing readily may be determined.

The capillary filler element may be formed in various sizes and dimensions. In one practical embodiment of a fountain pen employing the invention and having over-all dimensions approximately equal to those of a conventional fountain pen excellent results were obtained by forming a filler element as follows: A sheet of silver foil approximately 0.001″ in thickness and approximately 8″ long by approximately 1—1/4″ wide was spirally wrapped into a roll (Fig. 1) approximately 0.310″ in diameter wherein the consecutive turns of the sheet were spaced apart approximately 0.008″ between opposite wall surfaces; the innermost turn was formed to provide an air vent passage of approximately 0.060″ in diameter. The feed slots 33 and 34 in the feed bar (Fig. 1) and the capillary space 32 were of less width than the space between opposite wall surfaces of the filler element but were wider than the nib slit 16, which was from 0.001″ to 0.0015″ in width, and generally were approximately 0.003″ in width. The invention is not limited to the foregoing dimensions and it will be understood that the latter may be varied 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 1—1/4″ 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.

The several portions of the space 37 may be directly connected to the ink feed,

thereby facilitating filling of the pen and ensuring a highly effective feed of ink from the capillary space 37 to the nib 12. This may be accomplished by providing, at the forward end of the capillary filler elements 35, means defining a plurality of feed passages extending from the feed bar slots 33 and 34 into communication with all of the several convolutions of the capillary space 37.

One form of pen embodying such a feed means is illustrated in Fig. 6, wherein a feed element which takes the form of a pad 61 of matted or woven fibers is interposed between the forward end of the capillary filler element 35 and the adjacent end of the reservoir 10. The feed bar 60 preferably terminates at its rearward end substantially flush with the forward wall of the reservoir 10 so that the pad 61 extends across substantially the entire area of the end of the filler element 35 and the corresponding faces of the end wall of the reservoir 10, the rear end of the bushing 20 and the rear end of the feed bar 60. The pad 61 thus provides direct communication between the several convolutions of the capillary space 37 and the feed slots 62 in the feed bar 60, as well as the slots 26 in the bushing 20.

The pad 61 preferably is formed in such a manner as to provide a plurality of capillary passages having a higher capillarity than the space 37 of the capillary filler element 35. Preferably, the fibers are constituted by a material, such as nylon, which is not adversely affected by the ink and which is not absorbent.

The feed element also may be defined in other ways as illustrated, for example, in Figs. 7 and 8 of the drawings. In this embodiment, no separate feed element is provided, but a series of grooves or slots 70 of capillary dimensions are formed in the forward end wall of the body section 2, the rear end wall of the bushing 20 and the rear end of the feed bar 60. Preferably, the slots 70 are formed along diameters of the end faces of the members just mentioned and by reason of the abutment between the forward end of the filler element 35 and these members each of the slots 70 intersects all of the several convolutions of the space 37 to place the latter in feed communication with the several feed slots formed in the feed bar 60.

The operation of the forms of the invention illustrated in Figs. 7 and 8, is substantially similar to that described in connection with the form shown in Fig. 1. However, the direct feed connection between the feed bar slots and the several convolutions of the space 37 provided by the feed pad 61 and slots 70 respectively permits more rapid filling owing to the greater cross-sectional area of the space 37 which is directly connected to the ink in the passages.

Referring now to Figs. 9 to 14 inclusive and particularly to Fig. 9 there is shown a fountain pen embodying another form of filler element constructed in accordance with the invention. This pen is generally similar to the pen illustrated in Figs. 1 to 8 and is described in detail only in respect to these features of construction and operation in which it differs from the previously described embodiment.

The pen includes a body 80 formed preferably by a barrel or forward section 81, a rear section 82 and an end piece 83 connected respectively by threaded joints 84 and 85, the latter of which may include a threaded bushing 86. The body 80 is formed with a bore defining an ink reservoir 87, a smaller bore 88 leading therefrom and a counterbore 89 extending through the forward end of the barrel 81.

A pen nib 90 which may be similar to but relatively shorter than the nib 12 is snugly seated frictionally in the counterbore 89 with its writing tip projecting beyond the end of the body 80. A feed bar 95 is associated with the nib 90 and has a body portion 96 fitted snugly into the bore 88 and a reduced portion 98 extending forwardly in the nib 90, with its forward end engaging the under side of the nib 90 forwardly of the nib pierce 91. The feed bar 95 is formed with a groove 97 extending longitudinally thereof from the rear end to short of the forward end for receiving a feed element hereinafter described more in detail.

Disposed in the ink reservoir 87 is a capillary filler element 100 adapted to function in a way generally similar to the filler element 35 described in connection with the pen shown in Figs. 1 to 8. The filler element 100 includes a wall-forming member 101 of suitable thin-walled sheet material and a spacer sheet 102 of woven material, which sheets are spirally wrapped or rolled together into convolute form to provide a capillary space 103 of convolute shape between the turns of the wall-forming sheet 101. The wall-forming sheet 101 preferably is formed from gold or silver foil or " Cellophane " (R.T.M.). The sheet 102 preferably is woven from threads or filaments formed from a material which is resistant to the inks used and is not absorbent, and may be, for example, glass fiber threads or plastic fiber threads. If desired, a plurality of each of these two types of sheets may be arranged in alternation and then roller together, but

preferably only two sheets are used, as explained hereinabove. When the sheets are roller together into convolute form the spacer sheet 102 serves to space consecutive convolutions of the wall-forming sheet 101 in a positive manner throughout the entire length of the sheets. The interstices between the threads 104 and 105 which form the spacer sheet 102 provide, within the continuous capillary space 103, a plurality of interconnected spaces or cells of capillary size extending throughout the capillary filler element.

The capillary space 103 is connected in ink-feeding relation to the nib 90 by a feed element 106 which preferably defines a plurality of capillary paths or channels, each having a capillarity greater than that of the cells in the capillary space 103. While the feed element may be formed in various ways, it preferably is provided by forming a fringe extending from the forward edge of the spacer sheet 102. This may be accomplished conveniently by removing from one end of the spacer sheet 102, prior to assembly with the other sheet, those threads 105 which extend spirally when the sheets are spirally wrapped, thus leaving only the longitudinal threads 104 at this portion of the sheet 102. Hence when the sheets 101 and 102 are rolled together, the longitudinal threads 104 extend from the end of the roll, as illustrated somewhat diagrammatically in Fig. 13 of the drawings. The extending ends of the threads 104 are brought together and inserted in the passage or space defined by the groove 97 in the feed bar 95 and, by the corresponding portion of the nib 90, and the threads 104 terminate at the forward end of the groove 97 adjacent the nib pierce 91 and slit 92. The threads 104 are compacted between the nib 90 and feed bar 95 and define a plurality of generally parallel capillary passages of small cross section and high capillarity.

The portions of the threads 104 which extend from the feed bar 95 rearwardly to the forward end of the capillary filler element 100 preferably are so arranged that they are progressively less compacted and thus the passages provided between such portions of the threads 104 decrease in capillarity from front to rear. Thus it will be seen that the capillarity of the filler element 100 and the several portions of the feed element 105 increases toward the nib and thus ink is drawn from the capillary filler element toward the nib at all times and the nib slit and pierce maintained in filled condition. The nib slit 92 has the greatest capillarity of any portions of the capillary system in order to ensure that ink is drawn therein from the adjacent feed element 106.

This form of fountain pen operates in a manner generally similar to the form above described. The pen is filled by inserting the forward end in a supply of ink, the rear end piece 83 preferably first having been unscrewed to freely vent the rear end of the reservoir 87. Ink is drawn into the pen through the space between the nib 90 and feed bar 95 and thence into the capillary passages defined by the feed element 106 and into the capillary space 103 in the filler element 100. Ink also may be drawn into the space between the nib 90 and the wall of the counter-bore 89 above the nib and thence through the nib pierce 91 and slit 92 and into the feed element 106. Ink rises in the feed element 106 and enters the capillary space 103 in the filler element and rises in the latter until it is filled. Air, which is in the space 103 at the beginning of the filling operation, is forced out in a rearward direction by the incoming ink and is expelled through the vent passage 110 in the body and a vent 111 in the bushing 86 adjacent the joint between the rear section 82 and tail piece 83.

When the pen is used in writing, ink is drawn from capillary space 103 in the filler element 100 along the capillary passages defined by the feed element 106 and thence into the nib slit 92. Owing to the increase in capillarity of the feed passages from the filler element in a direction toward the nib slit, as explained hereinbefore, ink is drawn toward the nib and maintained at the nib slit at all times when any ink is in the pen and the pen, therefore, is always ready for instant writing.

Various modifications may be made in the filler element illustrated in connection with the fountain pen shown in Figs. 9 to 14, inclusive; for example, the wall-forming sheet which is rolled with the woven spacer sheet may, if desired, be formed with a plurality of small perforations throughout the portions forming each convolution. Such perforations provide inter-communication between adjacent convolutions of the capillary space and permit ink or air to flow readily between adjacent convolutions. Accordingly the fluid pressure within the capillary filler element is equalized at all times. During filling, ink which is drawn into the capillary filler element may pass readily to all portions of the capillary space; also air which is in the capillary space may pass through the convolutions of the perforated sheet from one portion

of the capillary space to another.

If desired, the wall-forming sheet may be formed with a plurality of small corrugations extending longitudinally of the capillary filler element, which corrugations provide a plurality of longitudinally extending capillary spaces between the corrugated sheet and the adjacent turn of the spacer sheet, which spaces form a portion of the spiral capillary space defined between consecutive convolutions of the corrugated sheet. The longitudinally extending spaces defined by the corrugations thus provide additional ink capacity supplementing that provided by the interstices of the spacer sheet. This embodiment of the invention operates substantially as described in connection with the non-corrugated sheet shown in Figs. 9 to 14, it will be understood, of course, that when the pen is filled, ink enters and fills the longitudinally extending capillary space defined by the corrugations, as well as the spaces or cells constituted by the interstices of the woven spacer sheet.

In Figs. 15 to 24, a further embodiment of the invention is shown, in which the pen may be similar to that shown in Figs. 1 to 14. except as hereinafter particularly pointed out, the principal difference being in the construction of the capillary filler element. In this embodiment the capillary filler element 125 (illustrated somewhat diagrammatically) is formed from a thin-walled sheet of material 126 (Fig. 19) wrapped or rolled into spiral form (Figs. 16 and 17). Consecutive convolutions of the spirally wrapped sheet are spaced apart preferably equal distances to provide a continuous space 127 of generally spiral cross section and uniform capillary thickness extending longitudinally substantially throughout the length of the filler element.

The capillary filler element 125 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 ensures the desired capillary action for controlling the ink as hereinafter explained. The material forming the sheet 126 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 obtained 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% aluminium, 0.1% manganese, 2% zinc and the remainder magnesium), also aluminium 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 (Registered Trade Mark) 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.

Means are provided for accurately and positively spacing consecutive turns of the capillary filler element 125 substantially throughout the length and breadth of the latter to ensure that the depth of the capillary space 127 is accurately predetermined and maintained without, however, causing any substantial obstruction of the space 127. 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 128 extending from the convolutions of the sheet and abutting adjacent convolutions. The projections 128 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 128 may extend in either or both directions out of the plane of 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 128 are disposed in closely spaced arrangement substantially throughout the length and breadth of the sheet 126 and hence when the sheet is rolled they serve to maintain the several portions of the sheet in positively spaced relation. The sheet 126, 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 127 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 127 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 ensure full pressure equalization of the fluid contents of the pen, additional communication between the adjacent convolutions of the space 127 is provided. This additional intercommunication is provided by forming a plurality of spaced openings 129 in the turns or convolutions of the sheet 126, thereby providing what we term "cross-venting". The openings 129 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 129 may be provided in the projections themselves, as illustrated in Figs. 16 to 18 or intermediate the projections, as illustrated in Figs. 20 and 22 and described hereinafter. The projections 128 and perforations 129 may be formed simultaneously in a convenient manner by punching the sheet 126 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 128 and thereby provide one or more side-openings 130 in the side walls of the projections 128. Thus, even though each projection 128 at its uppermost portion may abut snugly against the adjacent convolution of the sheet 126, yet the side openings 130 provide a plurality of passages through the sheet and connecting the adjacent convolutions of the capillary space 127.

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 shown in Figs. 20 to 22 and hereinafter described but preferably the filler element is formed from a sheet which is perforated to provide cross-venting as explained hereinabove.

The capillary filler element 125, after completion, is inserted in reservoir chamber 10 (Fig. 15) 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 60, respectively, thereby placing the capillary space 127 in direct ink feeding connection with the slots 26 in the bushing and the feed slots 62 in the feed bar 60. To ensure that ink is drawn from the capillary space 127 into the feed slots 62, feed means of greater capillarity than the capillary space 127 is provided adjacent the rearward end of the feed bar 60. Such means preferably comprises a fringe-like element 131 which may be formed integrally with the filler element by providing what we term a feathered edge on the sheet 126. The feathered edge is provided preferably by forming a plurality of short closely spaced slits 132 in a margin of the sheet 126 which slits define a plurality of tongues or feathers 133. When the sheet is thus slit and then rolled into spiral form the several slits 132 between adjacent feathers 133 become sufficiently open to provide a plurality of narrow capillary passages which, when the fringed end 131 of the filler element 125 is caused to abut the end walls of the bushing 20 and feed bar 60, connect the capillary space 127 with the feed slots 62 and the slots 26 in the bushing 20.

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 filler element 125 is retained in position and the pen is vented in a manner similar to that described in connection with the pen of Fig. 1.

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 from the slots 26 in the bushing 20 and slots 62 in the feed bar 60 into the capillary feed passages 132 defined by the fringe elements 133 and also into the portion of the capillary space 127 defined by the consecutive turns of the filler element 125. Ink finds its way into all portions of the capillary space 127, 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 129. Ink thus rises in the capillary space 127 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 127 when the filling operation is initiated is forced out by the incoming ink and finds its way through the vent passages 45 and 46 and the outlet port 47. The spiral capillary ink space 127 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 127 and the rear vent passage 45. The cross-venting between adjacent portions of the capillary space 127 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. In one practical embodiment, excellent results were obtained by forming the filler element generally as described in connection with Figs. 1 to 14 except that the sheet was provided with perforated projections 128 arranged in rows and columns approximately $^3/_{32}$″ apart extending substantially throughout the length and breadth of the sheet (Fig. 18), 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 132 extending inwardly from the edge approximately $^3/_{16}$″ in length and spaced apart approximately $^1/_{32}$″ longitudinally of the sheet. The sheet thus formed was spirally wrapped into a roll 125 approximately 0.310″ in diameter with each convolution thereof abutting the inwardly extending perforated projections. The feed slots 62 in the feed bar 60 (Fig. 15) and the capillary space 32 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. Excellent results have been obtained with perforations from 0.01″ to 0.04″ in diameter, although larger perforations may be employed, and by spacing the perforations approximately 1.0 mm. apart in rows spaced at approximately 3 mm. but the spacing may vary substantially.

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 by the filler element 134 shown in Figs. 20 to 22. The projections 135 may be formed of generally hemispherical shape thus providing a relatively high degree of strength which strong 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 135 as indicated at 136. The capillary filler element 134 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 generally similar to that previously described.

If desired, the filler element may be formed from a plurality of sheets (such as the sheet 126 forming the filler element 125 shown in Fig. 16 or the sheet 126 forming the filler element 134 shown in Fig. 20) spirally wrapped together instead of from a single sheet. However, for simplicity in manufacture and assembly it is preferable 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. 23 and 24 wherein the forward end wall of the body section 2 defining the reservoir, the rearward end wall of the mounting bushing 20 and the rearward end wall of the feed bar 60 are provided with a series of grooves 137 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 members, 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 62 in the feed bar 60 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. 16 and 20. For example, they may be arranged in spaced rows extending at an angle to the direction of winding 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.

In order to ensure that ink will be drawn into the capillary space or spaces in the filler element to fill them substantially completely, when the end of the pen is inserted in a supply of ink, it is necessary that the space or spaces have such capillarity as will lift the ink substantially to the topmost portion thereof when the pen is held in filling position. The width of each portion of the space at any point throughout the length of the space theoretically should be such as to provide the necessary capillarity to lift a a column of ink to that particular point during filling. However, for convenience in manufacturing, this space may be made uniform in width throughout its length as illustrated in Figs. 1 to 24. On the other hand, the capillary filler element may be formed with a plurality of longitudinally adjacent sections each defining spaces of different capillarities, the space or spaces in rearwardmost section having the greatest capillarity and the space or spaces in the forwardmost section having the least capillarity with the space or spaces in the intermediate sections having intermediate capillarities progressively increasing from the forward toward the rearward end of the pen.

A pen formed in this manner is illustrated in Figs. 25—31 and includes a body of any suitable form and having, for example, a forward body section 185 and rearward body section 186 detachably secured thereto. The forward body section is formed with a bore or chamber 187 defining an ink reservoir space and having a dished forward end wall 188. A bore 189 leads forwardly from the chamber 187 and communicates with a counterbore 190 extending through the forward end of the pen body and which preferably is provided with an enlarged or counterbored portion 191 at the forward end thereof.

A writing element, which preferably takes the form of a slitted nib 192, is seated in the counterbore 190 and a shoe 193 cooperates with the nib 192; in the present embodiment, the nib and shoe are held in position solely by friction.

Leading from the chamber 187 and through the forward end of the pen are a plurality, and preferably two, filling slots 194 and 194a of generally V-shaped cross section which provide passages for the entry of ink into the pen during filling as hereinafter more particularly described.

Disposed in the chamber 187 is a capillary filler element formed by rolling together a plurality of thin walled sheets of suitable material such as metal or plastic having a surface sufficiently wettable by inks of the type customarily used to exert the desired capillary attraction on the ink. The material is sufficiently flexible to permit it to be rolled into convolute form and sufficiently rigid to maintain its shape and position. Excellent results have been obtained by forming the sheets from materials such as silver foil, gold fold or cellophane although it is preferable to use a metal for reasons which will hereinafter appear.

The sheets are rolled or wrapped together into convolute form to define therebetween spiral spaces of capillary thickness defining capillary ink storage spaces. In order to provide spaces of lesser thickness and greater capillarity at the portion of the filler element more remote from the writing end of the pen than at the forward end of the capillary filler element sheets having differing widths are employed as illustrated particularly in Fig. 32. By way of example, one sheet 195 has a width such that it extends the full length of the capillary filler element and the turns of this sheet define capillary spaces 196 having the greater thickness. A second sheet 197 of intermediate width is provided and the spaces 198 between the turns of this sheet and the long sheet 195 are of intermediate thickness. Where it is desired to provide capillary spaces of three different thicknesses, two additional sheets 199 are provided which define with the sheets 195 and 197, respectively, capillary spaces 200 which are of the least thickness. In forming the capillary filler element the four sheets are stacked with their rearward longitudinal edges in alignment and are rolled into a spiral as illustrated in Figs. 27 and 32.

It will be understood that instead of forming the filler element from a plurality of sheets as just described, it may be formed from a single sheet, suitably shaped so that when rolled into

convolute form it defines spaces or cells generally equivalent in form and arrangement to those defined by the plurality of sheets, except that but a single spiral passage is provided in each section of the filler element.

For the purpose of maintaining the desired spacing between the consecutive turns of the several sheets 195, 197, and 199, each of the sheets is formed with a plurality of spaced projections 201, which when the sheets are rolled into convolute form, abut the adjacent convolutions of the sheet or the adjacent sheet. The projections 201 are formed of such heights that they provide the desired spacing. Thus the projections 201a in the sheets 199 and in the corresponding portions of the sheets 195 and 197 are the lowest. The projections 201b formed in the sheet 197 and in the corresponding portion of sheet 195 are of intermediate height and the projections 201c formed in that portion of the sheet 195 which is rolled upon itself are of the greatest height. Preferably the projections 201 are provided by forming them from the material of the sheet itself. While the projections may be formed as mere indentations, it is preferable to form them by puncturing the sheet thereby providing openings 202 extending through the sheet which openings serve to place the spaces on either side of the sheet in communication, thus permitting relatively free flow of ink or air between adjacent spaces. If desired, the projections may be formed as imperforate indentations (not shown) and separate perforations (not shown) provided in the sheets intermediate indentations.

For the purpose of conducting ink by capillary action from the capillary cells in the filler element to the nib, a feed element 203 is provided which preferably takes the form of a wick of a material similar to that of pad 61 described hereinabove. The feed element 203 preferably extends centrally of and throughout the length of the capillary filler element and through the bore 189 and into the space defined by the nib and shoe. The forward end of the wick is maintained in abutment with the slit of the nib 192 and the capillary passages in the wick thus are connected in ink feeding relation with the nib slit. The feed element 203 preferably is assembled with the capillary filler element by placing it against the marginal portions of the sheets 195, 197 and 199 when they are assembled in flat form and the sheets are then rolled around the feed element which may serve as a core aiding in the rolling or wrapping of the sheets.

The capillary passages in the feed element 203 are in ink feeding relation with the innermost capillary spaces by reason of the openings in the convolutions of the several sheets immediately surrounding the feed element 203. The outer convolutions of the capillary spaces are in communication with the inner convolutions of the spaces through the openings in the intervening convolutions of the sheets. Moreover, by reason of the spiral form of the capillary spaces the several convolutions of a single space are connected and in communication in a circumferential or a spiral direction.

The capillary filler element may be maintained in the chamber 187 in any suitable manner and by way of example there is illustrated a ring or washer 204 of relatively soft resilient material, such as rubber, abutting the rear end of the capillary filler element and itself maintained in position by abutment with the forward end wall of the rear body section 186.

For the purpose of venting the interior of the pen body, in order to maintain the air pressure therein substantially at atmospheric pressure a port 205 preferably is provided in the rear body section which at one end is in communication with the chamber 187 and at its other end terminates adjacent the joint between the body sections whereby when the latter are slightly unscrewed the port is opened to the atmosphere. The pen also may be vented through the ink filling openings 194a and 194 at its forward end and in certain cases it may not be necessary to provide any vent passage at the rear end of the chamber 187 although this is preferable in order to ensure rapid filling.

In filling the pen, the end of the pen is inserted in a supply of ink preferably a sufficient distance to place the forward end of the capillary filler element below the level of the ink. Ink enters the pen through the filling passages 194a and 194 and enters the capillary spaces 196 at their forward end. Ink rises in the capillary spaces by capillary action and completely fills the spaces to the top or rear end of the capillary filler element. Since the forward ends of all of the capillary spaces are in communication with the space 206 between the forward ends of the capillary filler element and the forward end wall 188 ink enters all of the capillary spaces simultaneously and rapid filling takes place. Air which is in the capillary spaces at the beginning of the filling operation is forced out by the incoming ink and, when a rear end vent is provided, passes out through such vent; where no rear end vent is provided

the air is forced out through the forward end of the pen and bubbles up through the body of ink in which the pen is inserted. Inasmuch as all of the capillary spaces are in communication with adjacent spaces and since each space has an extensive cross-sectional dimension in a circumferential direction there is little, if any, possibility of an air bubble being trapped in any portion of the capillary space in a manner which would tend to block or retard the filling to any material extent.

In writing, the capillarity established between the writing tip of the nib and the writing surface draws ink from the nib which is immediately replaced by ink from the feed element 203. The latter in turn is maintained in substantially saturated condition by reason of its being in ink feed communication with the innermost capillary surfaces of the several sections of the capillary filler element. It will be understood that the capillarity of the feed element 203 is greater that that of the smallest spaces 200 of the capillary filler element and the capillarity of the nib slit is still greater, thereby ensuring that ink will be drawn to the nib slit by capillarity so long as any ink remains in the pen.

The capillary filler element is so constructed that the capillarity of the spaces 196 is sufficient to lift ink to the height of these spaces above the supply of ink and to maintain ink in these spaces at all times but insufficient to prevent ink from being withdrawn therefrom when the pen is used in writing. In a similar manner the capillary spaces 198 have sufficient capillarity to lift the ink to the height of these spaces above the supply of ink, and in a similar manner the spaces 200 have the greatest capillarity which is sufficient to raise the ink to the upper end of the capillary filler element during filling.

If desired, the spiral capillary filler element instead of being formed of a plurality of sheets of different widths may be formed in a plurality of sections each of which comprises a single sheet. A filler element 207 of this construction is shown in Fig. 37 and includes a plurality, preferably three, sections 208, 209 and 210. The forward section 208 is formed of a single sheet having projections 211 which space the consecutive turns of the sheet the desired distance apart to provide a single capillary space 214 of spiral form. The sheet 209 is formed with projections 212 of lesser height than the projections 211 and the sheet has a correspondingly greater number of turns so that while the section 209 is of the same over all diameter as the section 208 the capillary space therein has a lesser wall-to-wall thickness. The rear section 210 is formed of a sheet having the lowest projections and the capillary space therein has the least wall-to-wall thickness. A feed element 203 which may be generally similar to that illustrated in Fig. 25 is provided and is engirdled by all of the three sections forming the capillary filler element.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A fountain pen including a pen body having a reservoir section and a feed section with a writing element carried at one end of the pen body and a capillary ink filler and reservoir element disposed in said reservoir section defining a capillary ink storage space of sufficient capillarity to draw ink into the storage space by capillary action when the filler and reservoir element is placed in communication with a supply of ink as where an end of the pen is inserted in the ink, and to retain the ink in the storage space by capillary action when the pen is not in use, and capillary feed means connecting said space in ink feeding relation to said writing element, characterised in that said ink storage space extends longitudinally throughout the length of the capillary filler and reservoir element and is of generally spiral cross-sectional shape.

2. A fountain pen as claimed in claim 1 in which said capillary filler and reservoir element includes a member or members of thin walled material rolled into spiral form, the convolutions thereof defining said spiral shaped ink storage space.

3. A fountain pen as claimed in claim 2 in which said convolutions are spaced apart by a predetermined distance so as to provide an ink storage space of predetermined capillarity.

4. A fountain pen as claimed in claim 3 in which said thin walled member or members have projections thereon which serve to space said convolutions apart by a predetermined distance.

5. A fountain pen as claimed in any of claims 2 to 4 in which the several convolutions of said spiral space are in communication with each other by means of openings provided in said thin walled member or members.

6. A fountain pen as claimed in claims 4 and 5 in which said openings are provided in the portions of the convolutions intermediate the projections.

7. A fountain pen as claimed in claims 4 or 5 in which said projections are themselves perforated so as to provide communication between adjacent parts of the capillary space on opposite sides of a convolution.

8. A fountain pen as claimed in claims 2 or 3 in which said convolutions are spaced apart by means of a spacing sheet or sheets of woven material rolled into spiral shape together with said member or members so that a convolution of said spacing sheet or sheets is interposed between adjacent convolutions of said member or members.

9. A fountain pen as claimed in any of claims 2 to 8 in which said ink feed means includes a passage or passages of greater capillarity than the capillarity of said spiral space.

10. A fountain pen as claimed in claim 9 in which said ink feed means comprises a wick extending longitudinally along the capillary filler and reservoir element, said wick being disposed in ink feeding relation to the inner portions of said capillary ink storage space.

11. A fountain pen as claimed in claim 9 in which said ink feed means comprises a slotted feed bar extending from the capillary filler and reservoir element to a slitted nib, the slot or slots in said feed bar communicating with the slit in said nib.

12. A fountain pen as claimed in claims 9 or 11 in which said ink feed means includes a fringe formed by slitting the forward end of said thin walled member or members forming the filler and reservoir element so as to provide a plurality of narrow capillary passages in ink feeding communication with said ink storage space.

13. A fountain pen as claimed in claims 9, 11, or 12 in which said ink feed means includes a pad of matted fibrous material disposed between the forward end of said capillary filler and reservoir elements and the forward end of the reservoir section so as to provide a plurality of capillary passages to draw ink from said filler and reservoir element.

14. A fountain pen as claimed in any of claims 9 to 13 in which said ink feed means includes a plurality of capillary grooves in the forward end wall of the reservoir section.

15. A fountain pen as claimed in any of the preceding claims in which said capillary filler and reservoir element is formed of a plurality of thin walled sheets of different widths, rolled together with their rear edges substantially aligned so as to provide ink storage spaces of spiral cross-section the spaces defined by the sheets at the rear end of the element being narrower and of greater capillarity than those at the forward end.

16. A fountain pen as claimed in any of the preceding claims in which said capillary filler and reservoir element is formed in a plurality of longitudinally adjacent sections, each section having capillary ink storage spaces of progressively less width and greater capillarity than the spaces in the adjacent section immediately forward thereof so that the capillary of the spaces in said element increases from the forward to the rearward end thereof.

17. A fountain pen as claimed in any of claims 2 to 15 in which said thin walled material or sheet is formed from a substance inert to inks but having a surface wettable thereby such for example as silver, gold, magnesium alloy, a synthetic resin or the like.

18. A fountain pen substantially as described or as shown in the accompanying drawings.

Dated this 28th day of November, 1947.
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Fig. 1.

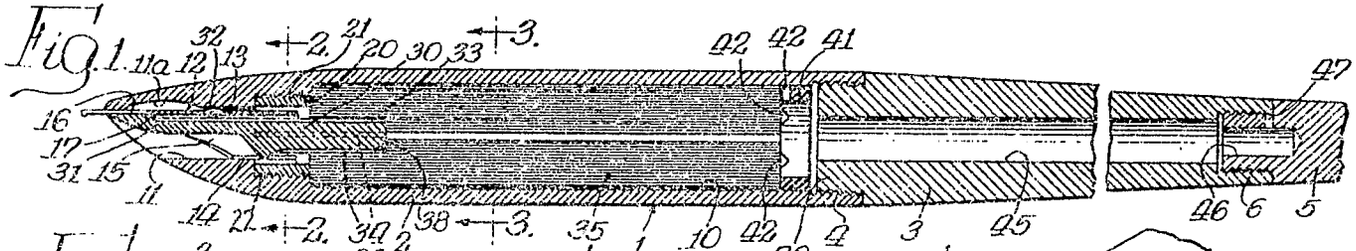


Fig. 2.

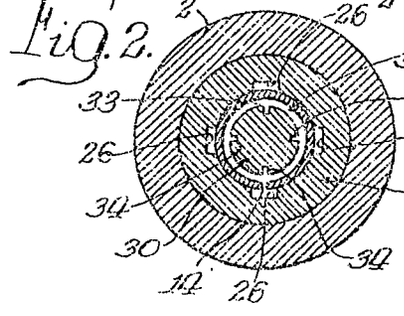


Fig. 4.

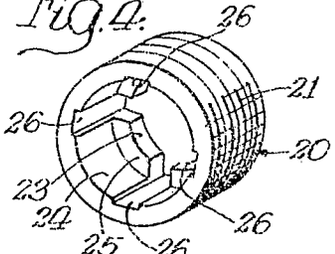


Fig. 5.

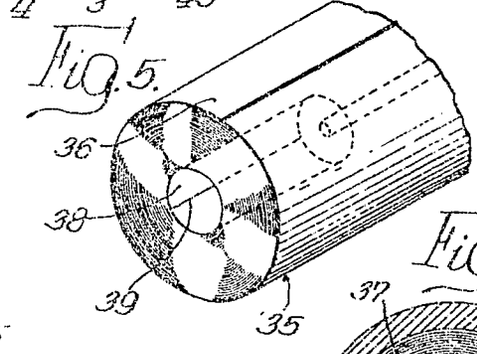


Fig. 3.

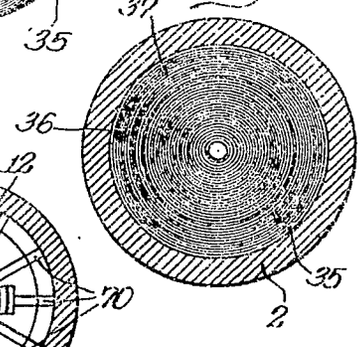


Fig. 6.

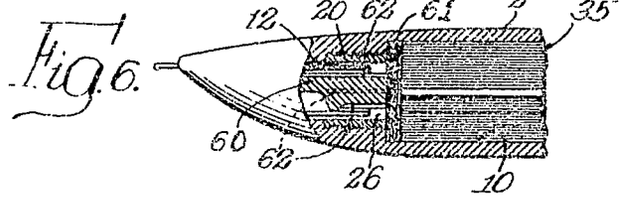


Fig. 8.

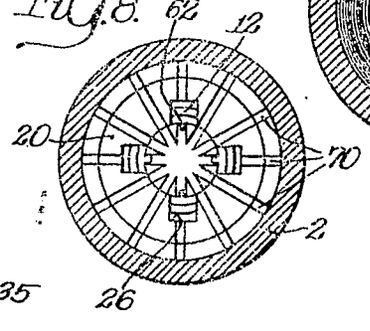


Fig. 7.

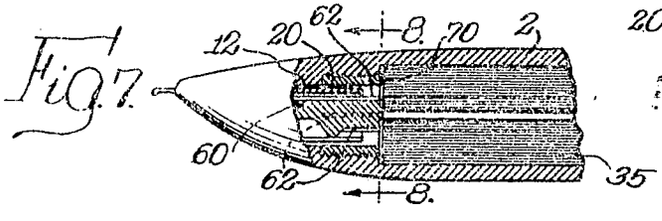


Fig. 7.

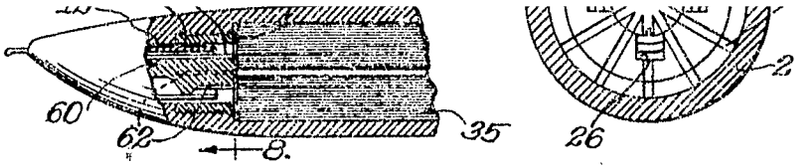
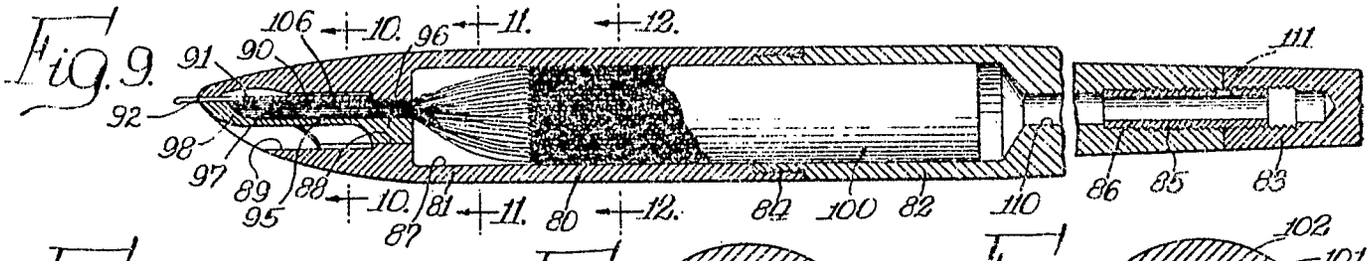


Fig. 9.



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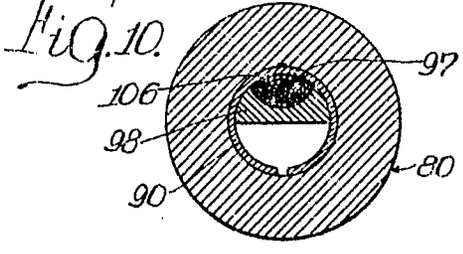

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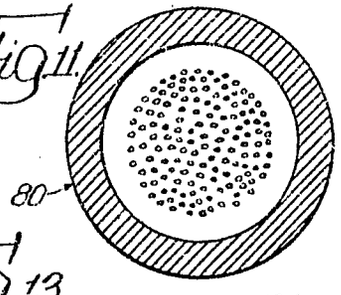

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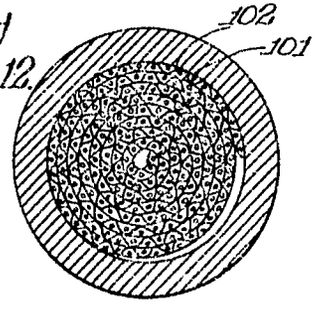

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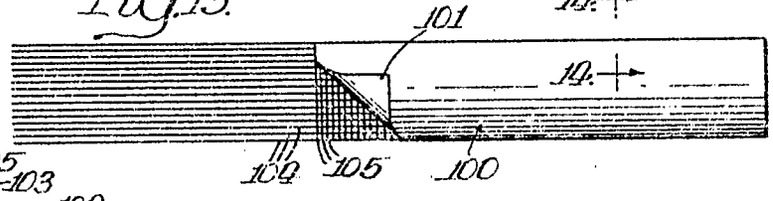

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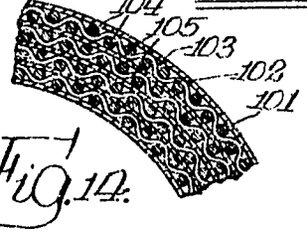

H.M.S.O.(Ty.P.)

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646726 COMPLETE SPECIFICATION

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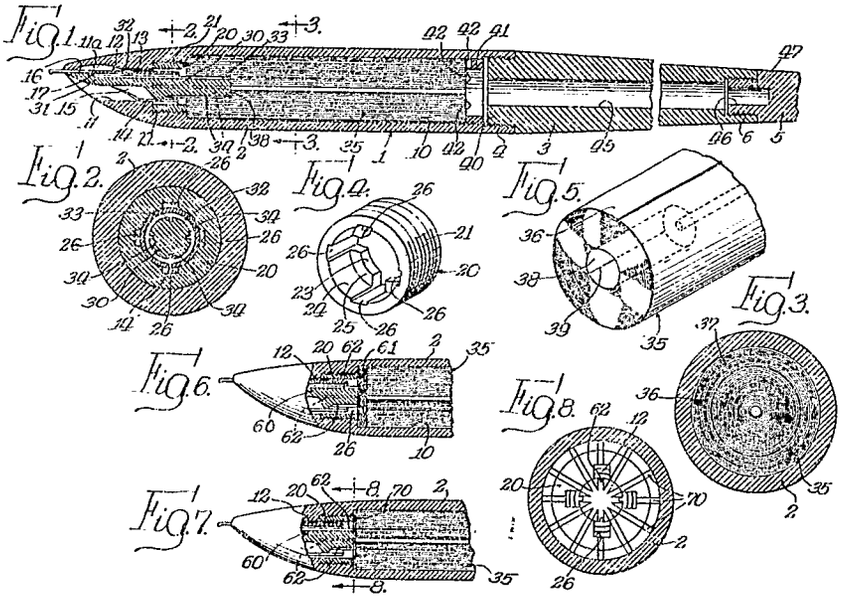
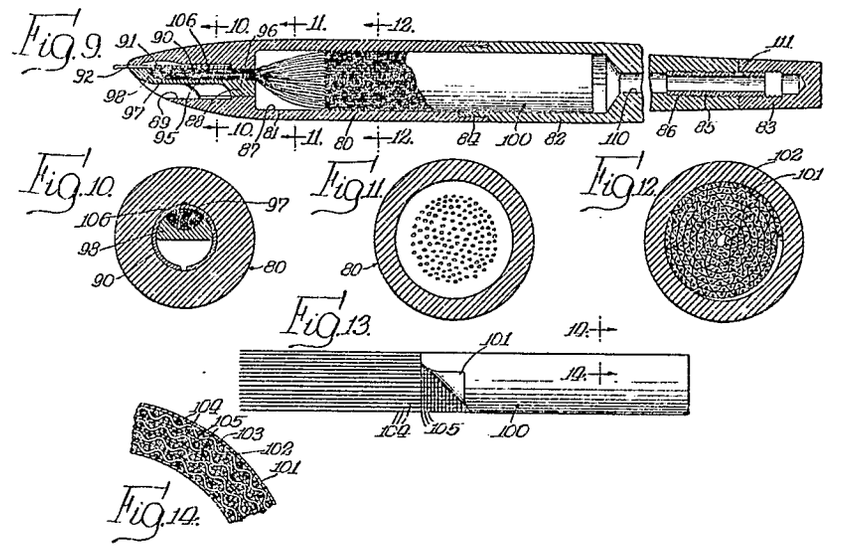


SHEET 2



4 SHEETS

H.M.S.O. (1y-P.)

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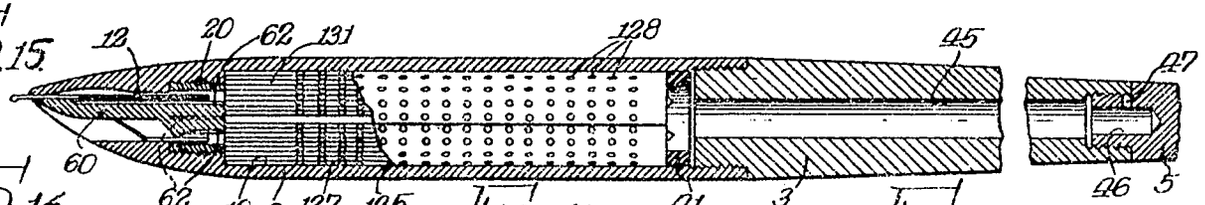
Fig. 15.



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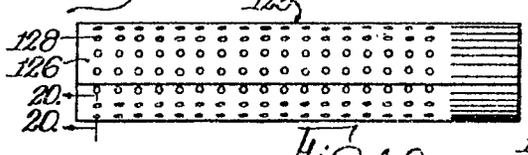

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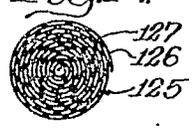

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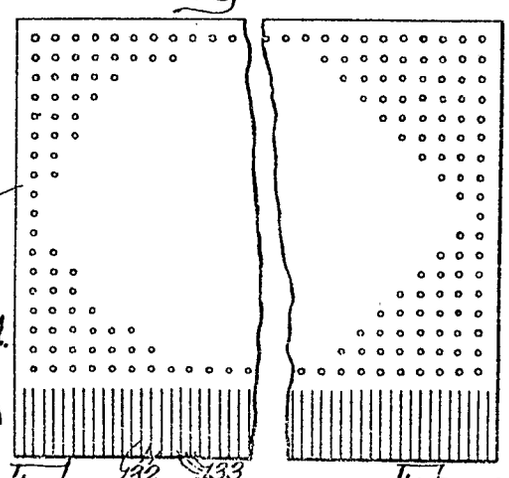

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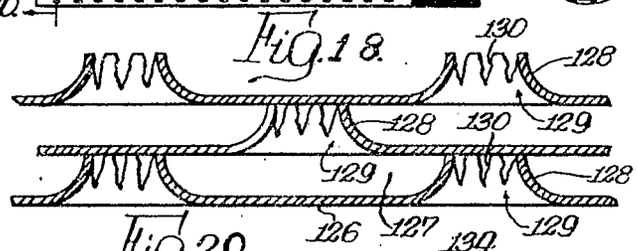

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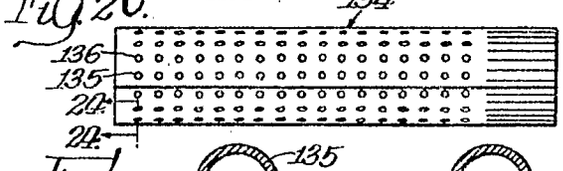
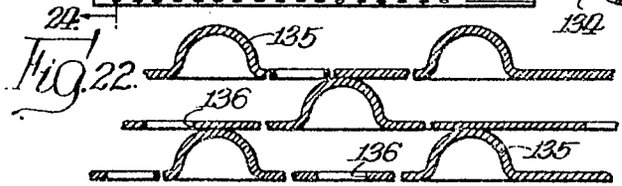


Fig. 21.

Fig. 22.



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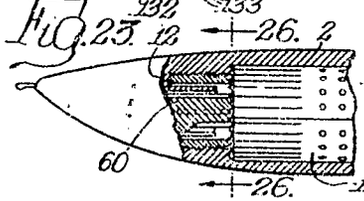

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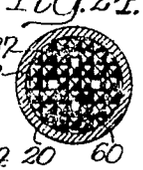

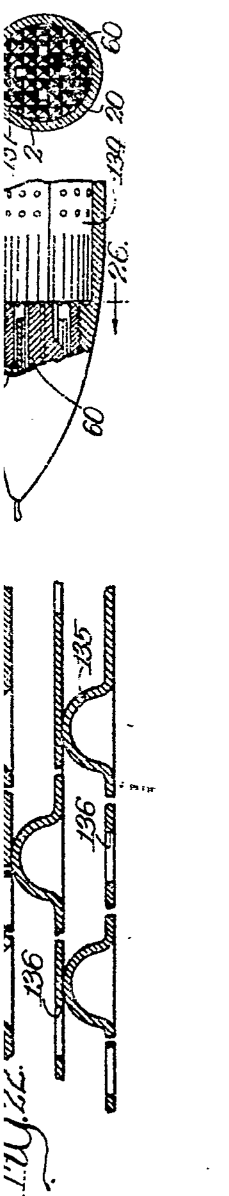

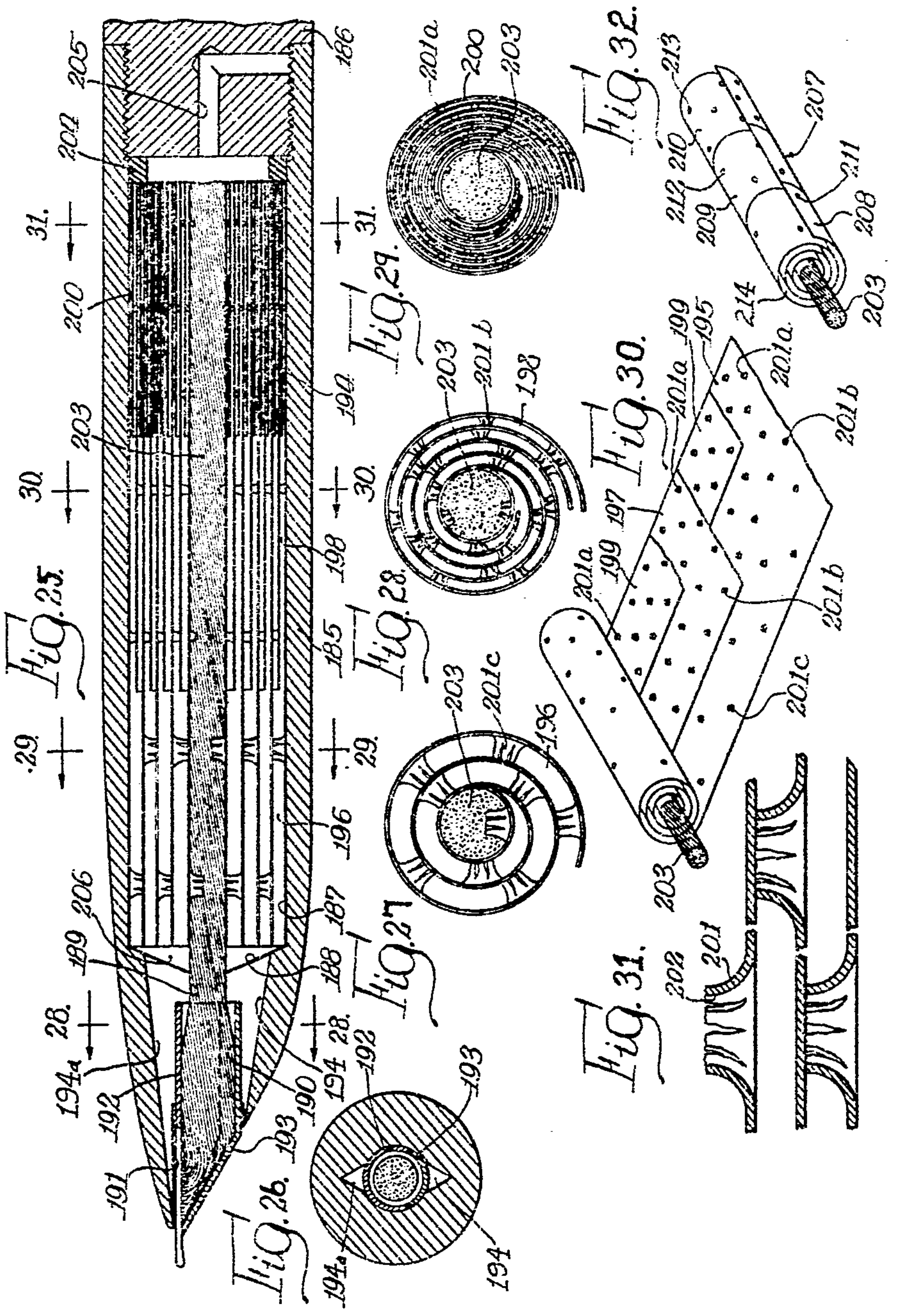

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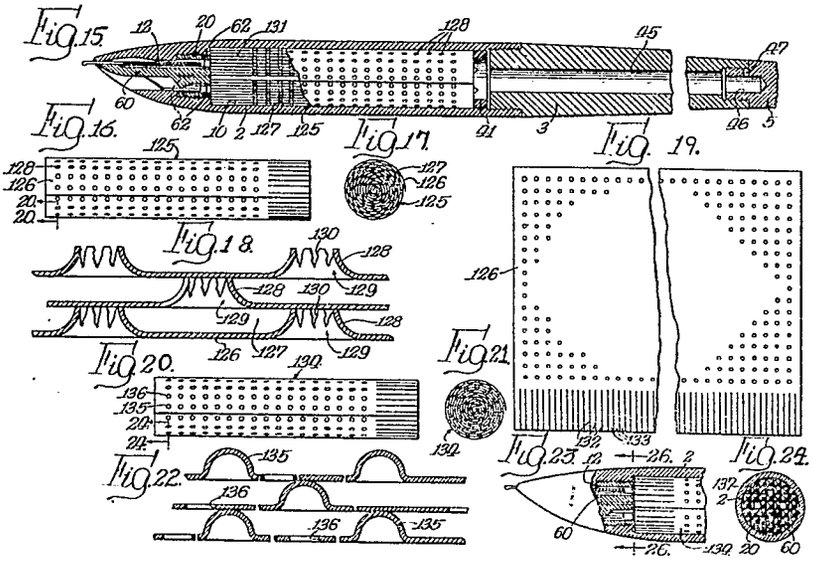
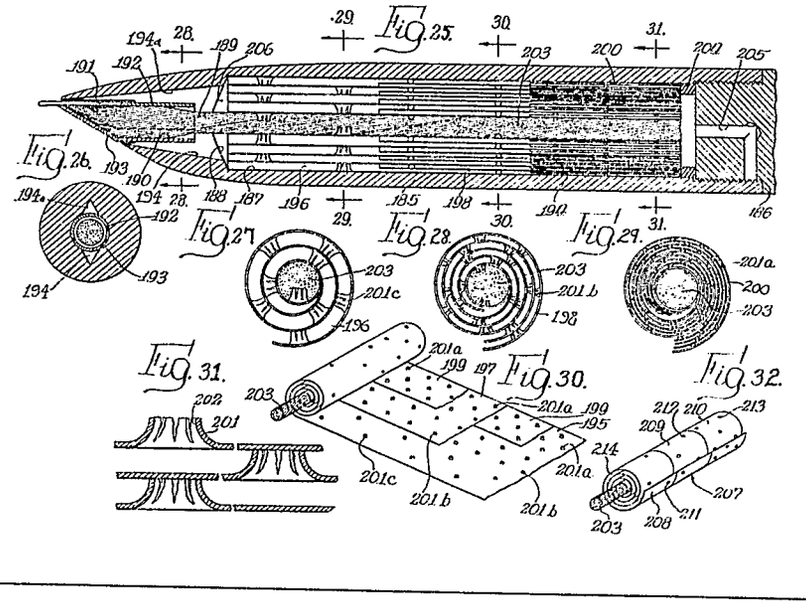
SHEET 3



4 SHEETS

SHEET 4



H.M.S.O. (1/4)