April 28, 1964 F. A. ECKERLÉ 3,130,711

POSITIVE PRESSURE BALL PEN FEED

Filed Nov. 22, 1961

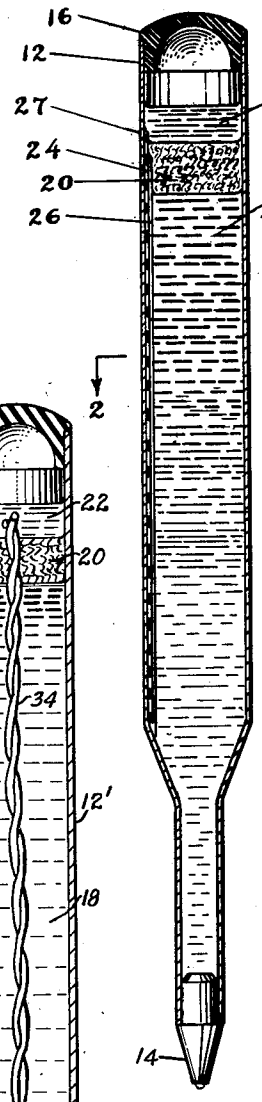

Fig. 1

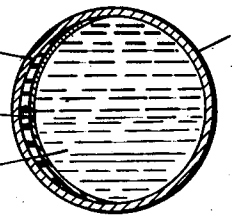

Fig. 2

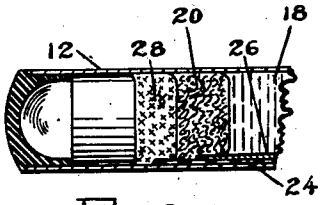

Fig. 3

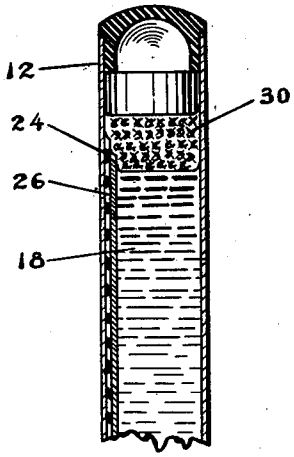

Fig. 4

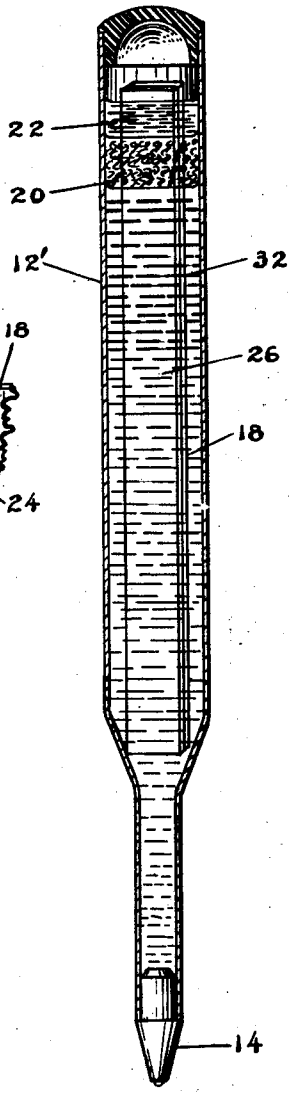

Fig. 5

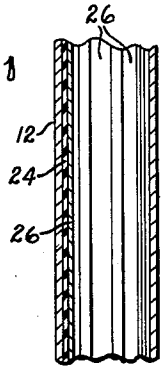

Fig. 6

Fig. 7

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POSITIVE PRESSURE BALL PEN FEED

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This invention pertains to ball point pens, and aims to provide such a pen, or a cartridge therefor, in which the ink or marking medium is maintained automatically under a precisely regulated positive pressure head throughout the life of the ink supply.

An important drawback of known pens of the ball type is their inability to write for any extended period if the pen is upside down, or even if the pen is used in a horizontal position for a period. For example, known ball point pens will usually fail to write more than a few linear inches if the material being marked is in a vertical plane; as when a document is held against a wall or other vertical surface. In fact, mere storage of a partly empty pen or cartridge in an inverted position will often result in hard starting unless the pen is vigorously shaken. This adverse result of the use of gravity feed is especially noticeable with so-called "fat" cartridges which have a larger-than-capillary transverse diameter.

A pen which is able to write constantly when inverted, or in a relatively horizontal position, is especially valuable as the marking element in recorders such as paper chart recorders and the like, because presently used gravity fluid and capillary feeds needed to overcome the limitations of the pen position have many drawbacks and limitations. However, the ability to write in any position is of real value even in pocket pens.

There have been numerous proposals for the use of positive-pressure feed in ink cartridges and pens, including the use of gas pressure generated by chemical reactions, fermentation and the like. However, no such proposal has proved successful, because of the impossibility of regulating the reactions, or of positively preventing the reaction during storage and shipment of the pen or cartridge, resulting in a very limtied "shelf life."

My invention overcomes all of the stated disadvantages, and provides a pen or cartridge in which the proper feeding pressure is maintained throughout the entire life of the device, whether in use or in storage, in an entirely automatic manner. To this end, I prefer to employ an electrolytic action between dissimilar metals within the pen or cartridge, and I arrange matters so that the pressure head inside the device (which is initially established in the manufacturing process), and which would decrease steadily as the ink was discharged during use, is automatically restored to (or maintained at) the proper value for optimum ink feed. In combination with the known fluid follower or grease plug, this arrangement absolutely ensures a continuous ink feed, during writing, independent of gravity and hence of pen position.

A collateral advantage of my invention is that the cartridge is substantially completely sealed against evaporation of the ink or its solvent.

Basically, the preferred embodiment of my invention utilizes electrolytic action between two metallic components which have different positions in the electromotive series of metals. One metal may be the cartridge or container body (usually brass) while the other may be a thin coating of zinc applied to portions of the inner surface of the container. The latter coating is provided with an insulative protective layer which is insoluble in the ink, but is soluble in the hydrocarbon grease plug which acts as an ink follower in the usual way. A body of fluid electrolyte is disposed behind the follower (relative to the ink), and hence comes into contact with the dissimilar electrode metals exactly to the extent to which the ink

becomes depleted. Since the metals are in contact with one another at one point in the circuit, and in contact with the electrolyte at another point or points, they form a short-circuited eletrolytic cell whose reaction produces gas in an amount which can be precisely regulated by the thickness and configuration of the selectively-exposed metal forming one electrode. The action is thus entirely self-regulating, and gas generation ceases completely if, after a certain amount of use, the pen is left idle for any period. The action leaves the internal pressure head at the calculated value, ready for further use at any time.

The invention will now be described in detail in connection with several typical embodiments, it being understood that such details are not intended as limitations on the scope of the invention, which scope is defined in the claims appearing at the end of the specification. In the accompanying drawings,

FIGURE 1 is a vertical central section taken through a typical ink cartridge embodying the invention.

FIGURE 2 is a horizontal section of the same embodiment, taken on line **2**—**2** thereof.

FIGURE 3 is a view similar to FIG. 1 of a modified form of the invention.

FIGURE 4 is also a view similar to FIG. 1 of a further modification.

FIGURE 5 is also a view similar to FIG. 1 of a further modification.

FIGURE 6 is a plan view of a portion of the interior surface of a cartridge illustrating a distributed pattern of the coating of one of the electrode metals thereon.

FIGURE 7 is a view like FIG. 1 of a further form which the invention may assume.

Referring first to FIGS. 1 and 2 of the drawings, I have shown a typical "fat" cartridge **10** including a relatively large-diameter barrel portion **12** and a relatively narrower end portion to which is connected the usual ball point writing tip **14**. The end of the barrel **12** is shown as closed against the external atmosphere as by a rubber plug **16** or the like, and at the time of manufacture the interior of the cartridge is placed under a moderate head of pressure before the device is finally sealed. This head of pressure is of a magnitude slightly greater than the maximum barometric pressure of the outside atmosphere to be expected in normal use of the instrument, but not so high as to cause leakage of the contained ink from the point **14**.

For example, if the barometric pressure is the expected value of about **15** pounds per square inch, the internal pressure provided before sealing the device may be about 17 pounds per square inch (2 pounds per square inch gage pressure), which will maintain a desired positive internal pressure even though the environmental temperature changes may vary the value of internal pressure by several percent. This internal pressure may readily be provided by accomplishing the final sealing of the cartridge in an elevated-pressure working atmosphere, or by injection of compressed air or other gas into the cartridge by a needle, or by other means familiar to those skilled in pressure-packing operations.

In normal manufacture, the cartridge will be nearly completely filled with a body of the fluid or semi-fluid ink **18**, at the exposed boundary of which will be placed the usual and well-known "follower" **20** consisting of a body of grease or pasty material which is immiscible with the ink. This follower acts in the manner of a piston which moves along the enlarged barrel **12** as the ink is dispensed, to maintain the ink in a coherent body for such purpose.

Within the space above the ink **18** and follower **20**, I place a quantity of a suitable electrolyte **22** which is immiscible with the material of follower **20**, and which may also be of pasty or semi-fluid composition. Along at least one lengthwise strip or stripe of the barrel portion

12, I apply a coating 24 of a metal, such as zinc, which stands at a different point in the electromotive series of metals from the metal of barrel 12, which may be brass (copper and zinc alloy). At other regions of the inside surface of the barrel, the brass itself will thus be exposed; that is, not coated with zinc. I further cover at least one of the exposed metallic surfaces (zinc or brass, in this example), with a layer 26 of insulating material which is soluble in the grease comprising the follower plug 20. A suitable layer for this purpose is a varnish composed of a solution of styrene plastic in toluene or like solvent, and it will be recognized that this layer can be sprayed or otherwise applied to the entire inner surface of the barrel, including the zinc-coated portions, since the layer will be removed by the solvent action of the plug follower 20 as it progresses downward (in FIG. 1) along the barrel when the ink is depleted.

It is important that the protective insulating layer 26 not be soluble in the ink 18, as otherwise the electrolytic action would commence as soon as the cartridge was assembled, and the fast build-up of pressure would cause all the ink to be driven out of the writing tip 14. The essential feature of inventive concept, and which distinguishes it from all prior proposals of which I am aware, is the progressive initiation of the gas-producing action precisely in accordance with the degree of depletion of the ink (whether fast or relatively slower) so as to maintain the head of pressure within the cartridge in the desired range as already indicated. Thus, as the ink supply is used up, the motion of follower 20 along the barrel successively dissolves away an area of the protective layer 26 proportional to the amount of ink used up, exposing both of the couple (or electrolytic cell electrode) materials (metals) to the electrolyte 22, with the consequent generation of a proportional volume of gas (a mixture of hydrogen and oxygen if the electrolyte is aqueous), which operates to prevent any substantial reduction in the positive differential or excess of internal pressure established at the time the device was sealed off.

It will be recognized that one simple way of establishing the "initial" internal pressure is to leave off or selectively remove a portion of layer 26 at the upper extremity of the barrel (as at 27) just prior to completion of the sealing operation, so that the initial pressure differential is built up to the prescribed level by electrolytic action, even before any usage of the cartridge. The area and thickness of the zinc coating, in the example now being described, are to be adjusted so that the volume of generated gas will be just sufficient, for each specified increment of ink depletion, to maintain the internal pressure at the optimum value. These adjustments are readily made from the stoichiometric calculations pertinent to the particular metals involved.

In the FIG. 1 embodiment of the invention, the cartridge body is shown as brass (with a copper component) and the opposite metal is zinc which is coated onto a part only of the interior brass body, along one lengthwise strip. It is obvious that if such a pen were to be used for an indefinite time in the horizontal position (say), the electrolyte would reach more or less of the exposed zinc depending upon its rotational position about the lengthwise cartridge axis. A degree of equalization, or at least the provision of some degree of pressure-replenishment, could be obtained by coating the zinc onto the inner surface in a more distributed pattern, as indicated in FIG. 6 of the drawings. However, under normal use or duty cycles for such pens, the electrolyte will be able to reach all of the exposed zinc within a resonable time before the internal pressure has dropped to a value that might impair the feeding rate of the ink. It will be seen that the action is self-metering in this respect, the usage of a certain volume of ink leading ultimately to the precise amount of electrolytic action (sooner or later) needed to restore the pressure, or to maintain it at the optimum value.

FIG. 3 of the drawings illustrates a modification of the pen or the cartridge for use in applications where there cannot be expected to be periodic turning of the device into an upright position, and hence where the electrolytic action might not be obtained in the requisite amount. In this form, the electrolyte 28 is shown as itself of paste or jelly form, having such a stiffness that it also (like follower 20) is maintained in its indicated position with respect to the follower against the action of gravity, even if the pen is kept in a completely inverted position. The action of the gas pressure within the empty space of the cartridge will then always tend to force the electrolytic body 28 to "follow" the follower 20, thus reach all of the exposed portions of the zinc layer 24.

In a further modification, shown in FIG. 4 of the drawings, the function of the electrolyte may be incorporated into a suitable composite "follower" 30, which (*a*) acts as stiff or pasty piston-type follower, (*b*) as a solvent for the protective insulating layer 26, and (*c*) as the electrolyte for the galvanic action desired.

While it has been said above that the follower grease acts as the solvent for the protective layer 26, it will be apparent that this is not essential, as the protective layer could equally well be dissolved away by the direct action of a properly-constituted electrolyte fluid. It is sufficient if either of these materials will operate to dissolve the protective layer away from only the portion of the zinc layer exposed above the level of the ink. It will also be obvious that such a protective layer is not required if the ink itself is not capable of acting as an electrolyte and thus energizing the shorted electrolytic cell to produce any gaseous product.

FIG. 5 of the drawings illustrates a modified form of the invention applicable to any cartridge, but especially useful where the body or barrel portions 12′ are not of metallic construction; for example, of a plastic material. In this form of the invention, the galvanic or electrolytic action results from the contact of the electrolyte 22 with the opposite major surfaces of a composite bimetallic strip 32 of copper, for example, having a zinc coating on one side. The entire strip may be fabricated and coated with a protective insulating varnish or lacquer layer 26 as already described, and a proper length of such coated strip merely dropped into the cartridge before it is sealed. The greasy follower 20 and body of electrolyte 22 are of course incorporated as before.

In the form illustrated in FIG. 7 of the drawings, the two dissimilar metals are formed as individual wires or conductors, twisted together to establish electrical contact between them, and then coated with the protective insulating layer. The assembly 34 is then merely inserted into a cartridge with the ink and the grease follower plug in place as before. In both the forms of FIGS. 5 and 7, the length of the strip or wire unit is gauged so as to maintain it in a definite lengthwise position, thereby to effect the metering of the electrolytic action strictly in accordance with the quantity of ink dispensed through the writing tip.

The invention is to be basically distinguished from prior and known proposals merely to use gas pressure as an aid in the dispensing of ink from a cartridge, and in which the extent of the action, or the amount of gas pressure developed, are not directly related to the actual quantitative extent of the use of the ink, and hence of the volumetric depletion of the cartridge. Thus, the generation of internal gas pressure by the merely adventitious mixing of two chemical agents, or by uncontrolled bacterial action, and such proposals, are excluded from the ambit of the present invention. According to my invention, the internal over-pressure is constantly and automatically maintained at substantially a constant value throughout the useful life of the cartridge, and regardless of the aggregate times of writing use and non-use. With the constructions described above, and contemplated by the invention, there is no possibility of any undesired over-pressure such as

might cause leakage of the ink, or which could lead to a reduced storage or shelf life of the device.

What is claimed is:

1. A dispensing cartridge for ink or the like including a capillary dispensing tip and being otherwise entirely sealed against the external atmosphere, a body of ink or the like therein in communication with said tip, a semi-fluid material formed as a follower body at one boundary of said body of ink, an electrolyte disposed beyond said material, means defining an electrolytic couple of two dissimilar metals extending lengthwise within the cartridge, and an insulative protective layer covering at least one of said metals to protect it from contact with said electrolyte; said layer being insoluble in said ink and being soluble in at least one of said material and said electrolyte.

2. A cartridge in accordance with claim 1, in which one of said two metals constitutes the containing body of said cartridge.

3. A cartridge in accordance with claim 2, in which the other of said two metals is in the form of a coating deposited in a lengthwise strip directly upon the inner surface of the containing body of said cartridge.

4. A cartridge in accordance with claim 1, in which said couple constitutes an elongate assembly of a pair

of dissimilar metals in contact with one another, said assembly being supported lengthwise in said cartridge.

5. A cartridge in accordance with claim 4, in which said assembly is connected to a sealing plug forming a closure for said cartridge.

6. A cartridge for dispensing a fluid through a pressure-feed tip, and other than at said tip being entirely sealed against the external atmosphere, comprising means within said cartridge defining an electrolytic cell of two dissimilar metals and an electrolyte, and means responsive to the depletion of the fluid dispensed from said cartridge for selectively activating said cell to generate gas pressure within said cartridge in proportion to the amount of fluid so dispensed, whereby to maintain within said cartridge a positive pressure head of a predetermined magnitude.

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