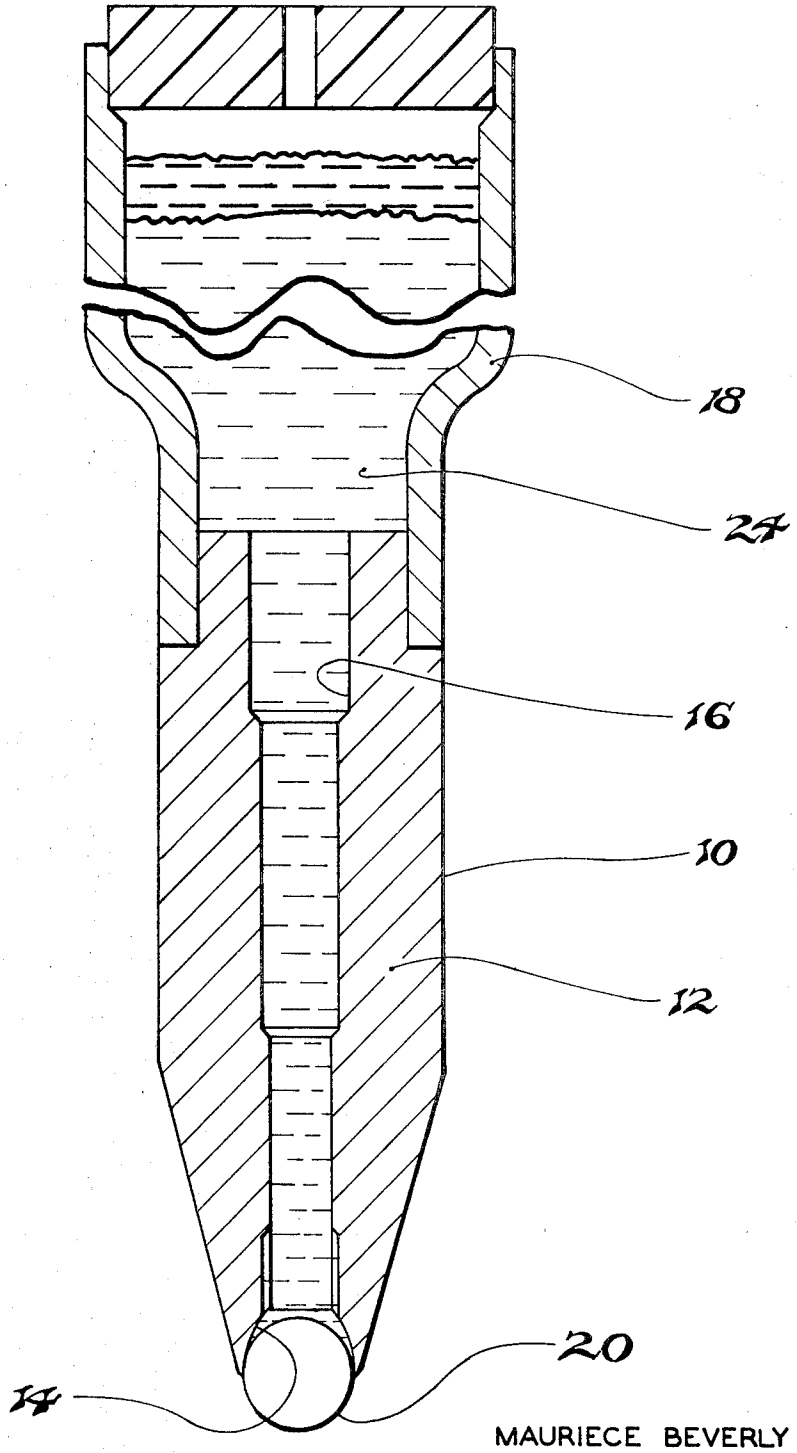
July 14, 1970 M. B. GORDON ET AL 3,520,630

BALLPOINT ASSEMBLY

Filed March 1, 1968



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3,520,630

Patented July 14, 1970

3,520,630

BALLPOINT ASSEMBLY

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Filed Mar. 1, 1968, Ser. No. 709,693
Int. Cl. B43k 7/10
U.S. Cl. 401—215 2 Claims

ABSTRACT OF THE DISCLOSURE

This application illustrates and describes a ball type dispensing assembly. There is provided a reservoir for a marking medium such as a liquid ink, cosmetic, or the like, and a dispensing assembly extending from one end of the reservoir. This assembly includes a rigid tip having a ball socket communicating with the reservoir through a conduit, and a ball rotatably housed within the socket for transferring the marking medium onto a surface as it rolls thereover. At least the outer or contact surface of the ball is composed of a multiplicity of randomly and compactly disposed crystals of aluminum oxide of an average diameter ranging up to about 20 microns, the crystals being sintered together to form a dense, substantially non-porous structure which is significantly stronger than a single crystal aluminum oxide ball, yet substantially less expensive.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention is directed to an implement for applying a marking medium and more particularly to an improved dispensing assembly of the revolving ball type.

Description of the prior art

In the usual ballpoint pen, proper and uniform deposit of ink throughout the life of the implement depends upon certain basic requirements that are directly associated with the writing assembly and particularly the surface characteristics of the ball. For instance, the surface of the ball should be sufficiently wettable to insure that a thin but continuous and uniform film of ink is present as the ball rolls into contact with the writing surface. There must be sufficiently greater paper-ball friction than ball-socket friction to insure that the ball will rotate evenly and continuously during use of the pen. Also, the ball should be inert to the ink and non-reactive with the tip in the presence of ink to prevent any detrimental chemical or elctro-chemical change in the system. Further, a minimum of wear should occur in the socket as a result of sliding engagement with the ball.

For the first few years after ballpoint writing pens were introduced in the mid 1940's, a polished carbon steel or stainless steel ball was employed in the usual pen. And while such balls performed reasonably well under optimum conditions, certain problems quickly became evident in their use. In some instances, their polished surfaces were not sufficiently wettable by the ink to assure an even unbroken film, and even more significantly they had a tendency to slide or skip on glazed, slick or greasy surfaces. Also, problems were encountered as a result of corrosion of the ball by the ink, as well as galvanic action between the ball and tip in the presence of the ink.

As a result of the ballpoint industry's early recognition of these various problems, a substantial amount of research work has been done on writing assemblies and particularly on the balls in an effort to provide a permanent ball surface which will not react with the ink or

tip and which will carry a uniform coating of ink while providing sufficient friction with the paper to assure continuous rotation. As one possible solution for some of these problems, it has been suggested that the surface of a steel ball be mechanically, chemically or electrolytically converted to a slightly roughened or "stain" finish. And while such converted balls initially appear to have reasonably good ink carrying capabilities and writing characteristics, such improvements generally are of a transient nature as the satin finish is gradually destroyed by the polishing action of the paper on which it is used. Thus, after extended use, such balls may lose much of their ink carrying and paper gripping capabilities resulting in a condition commonly referred to as "skipping." Further, in some intances such "satin" finishes have caused excessive wear of the ball supporting surfaces within the tip socket, thus resulting in undersirable ball recession with attendant problems of excessive ink flow, gooping and general messiness.

At a relatively early stage of this work by the industry, it was found that very good performance characteristics were obtained with a writing asembly containing a ball ground from a synthetic ruby or sapphire blank—a single aluminum oxide crystal containing a trace amount of an impurity such as chromium or iron. Such a ball was not only found to be inert to and readily wettable by ballpoint inks, but to give a minimum of socket wear while still writing well on slick and/or greasy surfaces that would cause a standard steel ball to skip badly.

Unfortunately, single crystal aluminum oxide ball have not proven to be commercially practicable except in a few high cost, low volume pens. Not only do they cost anywhere from about six to twenty times more than other balls, but even more importantly, they are extremely difficult to assemble into tips on a practical basis with modern high volume production equipment. Being of a single crystal, the balls appear to have natural areas or planes of weakness which extend from surface to surface and which cause a relatively high percentage of cracking and breaking as a result of stresses generated therein during the ball insertion, seating and lip spinning operations. Thus, aside from the initial expense of such balls, production costs are very high because of excessive losses in scrapping broken balls and inoperative tips. As a result, the use of the single crystal aluminum oxide balls has not been economically or practically feasible for medium and low priced ballpoint pens.

The above mentioned cracking problem can be alleviated somewhat by reducing the amount of seating and spinning pressures and consequent closure of the lip. However, such a solution generally is not commercially acceptable because of the objectionable "wet" or heavy ink deposit product by a tip closed in this manner.

SUMMARY OF THE INVENTION

The present invention not only provides all of the desirable characteristics and advantages of a ballpoint writing assembly containing a ruby or sapphire ball but improves upon them in many instances, while eliminating the serious cost and production problems previously inherent with such a ball. These surprising results and advantages were discovered to be provided by use of a writing assembly containing a ball having a surface which is composed of aluminum oxide base ceramic, such ceramic being characterized by a multiplicity of randomly oriented, minute aluminum oxide (corundum) crystals that are sintered together to form a strong, dense compact mass having little or no porosity.

This random orientation of small particles provides a structure in which there appears to exist no continuous surface to surface planes or areas of fracture, whereby its integrity will not be affected unless it is subjected to sub-

stantially greater force than that required to break a single crystal ball. Thus, a multicrystalline aluminum oxide ball of the type used in the present invention is sufficiently durable and crack resistant to permit its processing and assembly into writing tips in present day high volume production and assembly equipment.

In addition to its crack resistance, the present multicrystal ball is inert, it exhibits no galvanic action with a metallic tip in the presence of ink, it has good affinity for ink thereby not requiring roughening, it is highly resistant to wear, and it has the same smooth writing characteristics as, while being less expensive than, the single crystal aluminum oxide ball proposed heretofore. Even including the expense of forming ball blanks from and sintering the small particles or crystals, the present multicrystal ball can be made at a cost of less than 50 percent of that of prior single crystal balls.

Therefore, a principal object of this invention is the provision of a ballpoint assembly containing a non-metallic, crack resistant ball having a contact surface formed of a multiplicity of randomly oriented aluminum oxide crystals sintered together into a dense mass.

Yet another object of this invention is to provide a writing tip containing a writing ball composed of a multiplicity of minute crystals of an aluminum oxide, such crystals being randomly oriented and sintered together to form a dense, substantially non-porous mass which is highly resistant to cracking and wear.

A still further object of this invention is the provision of a writing tip containing a synthetic ball formed of aluminum oxide and having a hard, non-porous surface which is relatively smooth yet readily wettable by ballpoint inks, and an internal structure which is highly resistant to cracking under stresses normally encountered in ballpoint tip manufacturing and assembly operations.

Yet another object of this invention is to provide an improved writing assembly containing a crack resistant writing ball formed of aluminum oxide and which is substantially lower in cost than previously proposed ruby or sapphire writing balls.

Further and additional objects and advantages of this invention will be apparent from the following description when taken in conjunction with the appended drawing, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal sectional view of a ballpoint assembly embodying the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIG. 1, there is illustrated a ballpoint assembly **10**, which includes a substantially rigid tip **12** formed of a suitable material and provided with a ball socket **14** and an ink conduit **16** extending between the socket and the vented reservoir **18** on which the assembly **10** is mounted. As will be understood by those in the art, the tip may be fabricated or otherwise formed of a metal such as stainless steel or bronze, or a synthetic polymeric resin of which polycarbonate, polytetrafluoro ethylene, or polyacetal are a few examples.

Housed within the socket **14** for universal rotation therein is a writing ball **20** which is composed of aluminum oxide base ceramic characterized throughout by a multiplicity of minute crystalline particles of aluminum oxide, the particles being sintered together to form a dense mass having relatively little or no porosity.

The crystalline particles are disposed throughout the ball in a non-oriented or random manner. And even though each of the small individual crystalline particles may have one or more natural areas of weakness, as with a larger single crystal, it will be obvious that these areas are not oriented or connected. As a result, the ball **20** has no single fracture planes extending from one surface to another, as in a single crystal ball. The improvement

in crack resistance in the present ball is very graphically illustrated by a simple comparison between the break resistance of a group of the present balls with that of a group of single crystal balls. As indicated by the following table, the present balls were found to withstand an average of about 200 pounds of direct loading before breakage, as compared with an average of about 92 pounds for a group of single crystal balls.

TABLE I

Pounds of direct loading required for ball breakage

Single crystal ruby	Multicrystal aluminum oxide
215	250
127	249
120	206
101	198
91	193
75	191
71	189
53	184
43	174
25	164
High 215	High 250
Mean 92	Mean 200
Low 25	Low 164

The tests represented by above Table I were made on an Instron "TM" instrument, a testing machine commonly used in laboratories for compression and tensile strength testing. For this series of tests, the Instron was fitted with a standard 0–1000 lb. CD compression cell, and a steel plate having a shallow concave depression for positioning the ball properly relative to the compression cell.

The density of the fired ball should preferably be at least about 3.4 grams per cubic centimeter and the aluminum oxide crystals should preferably fall within an average range size not greater than about 20 microns in diameter, although they may go up to about 30 microns with satisfactory results. Particularly for balls having a diameter of less than about 1 mm., after polishing, by far the best results have been obtained with a fired ball blank having a density above 3.8 grams per cubic centimeter and an average aluminum oxide crystal size of less than 10 microns. The high density and small crystal size are apparently significant in the attainment of the desired smooth surface in the polishing operation.

In the above discussion of crystal size, it will be understood that the ranges given are not absolute but rather constitute an average of the crystals, and that a percentage of the crystals in any given range may be larger than the average. Also, it will be understood that in the context of this application, the term "diameter" is used broadly to include the size of a crystal in its largest dimension.

Alumina base ceramic contains upwards of about 85% by weight aluminum oxide an the remainder small amounts of mineralizers or glass forming oxides which can be added as silica, the silicates such as clay and talc, the alkali and alkaline earth oxides, carbonates, phosphates and the like such as the oxides, phosphates or carbonates of sodium, calcium, strontium and magnesium; and various other of the metal oxides such as chromium oxide, manganese oxide and the like known in the art for their glass modifying or grain growth inhibiting effect when used in small amounts in high alumina ceramics. Examples of specific sintered aluminum oxide base ceramics are as follows, the percentages in each case being by weight: 100% aluminum oxide; 99.5% aluminum oxide, .5% chromium oxide; 94% aluminum oxide, 4% silica, 2% calcium oxide; 85% aluminum oxide; 10% silica, 5% calcium oxide. In all of these examples where silica is present in the raw batch, either as such or in a combined form, the final ceramic structure after the

tity of sand, with the writing or marking assembly being mounted on the "wagon" and movable between a position spaced from the writing surface and a position contacting the surface under a predetermined load. For each unit, the coefficient of friction was determined to be the difference in the weight of sand required to move the "wagon" when the unit was in each of the two positions.

This reduced friction manifests itself in a much smoother and more controllable writing "feel," which difference is subjectively evident to most users.

It is to be understood that the foregoing description and accompanying drawings have been given only by way of example and illustration. For instance, the ball may be used in dispensing units for fluids other than ballpoint writing ink. Accordingly, this invention is to be considered as limited only by the following claims.

We claim:

1. A ballpoint assembly including a substantially rigid tip defining a ball receiving socket and a fluid conduit opening into said socket; and a smooth surfaced ball housed within said socket for universal rotation therein, said ball consisting of sintered aluminum oxide base ceramic having a density of at least 3.4 grams per cubic centimeter and containing at least 85% by weight aluminum oxide present in the form of randomly oriented

crystals having an average size not exceeding 20 microns.

2. A ballpoint assembly as set forth in claim 1 wherein said aluminum oxide base ceramic has a density of at least 3.8 grams per cubic centimeter and wherein the average size of the aluminum oxide crystals does not exceed 10 microns.

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