(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
29 June 2006 (29.06.2006)

PCT

(10) International Publication Number
WO 2006/067748 A1

(51) International Patent Classification:
A61Q 11/00 (2006.01) *A61C 17/028* (2006.01) *A61K 8/73* (2006.01) *A61K 8/86* (2006.01) *A46B 11/00* (2006.01)

(21) International Application Number: PCT/IB2005/054339

(22) International Filing Date: 20 December 2005 (20.12.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/638,057 21 December 2004 (21.12.2004) US

(71) Applicant *(for all designated States except US)*: **KONINKLIJKE PHILIPS ELECTRONICS N.V.** [NL/NL]; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **DUINEVELD, Paul** [NL/NL]; P.O. Box 3001, Briarcliff Manor, New York 10510-8001 (US). **BRYANT, William E.** [US/US]; P.O. Box 3001, Briarcliff Manor, New York 10510-8001 (US).

(74) Common Representative: **KONINKLIJKE PHILIPS ELECTRONICS N.V.**; c/o Russell Gross, P.O. Box 3001, Briarcliff Manor, NY 10510-8001 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:
— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

WO 2006/067748 A1

(54) **Title:** A DROPLET CLEANING FLUID USED FOR CLEANING TEETH WHICH INCLUDES A POLYMER ADDITIVE

(57) **Abstract:** The fluid for use in a liquid droplet-based oral care system for teeth includes a water-soluble, human -consumable polymer additive of selected concentration and molecular weight which maintains the size of the resulting droplets to a desired range of 25-30 microns, at a flow rate within the range of 10-20 milliliters per minute.

A DROPLET CLEANING FLUID USED FOR CLEANING TEETH WHICH INCLUDES A POLYMER ADDITIVE

This invention relates generally to fluids used in high velocity fluid droplet systems for cleaning teeth, and more particularly concerns such a fluid which includes an additive to maintain a desirable droplet size.

U.S. application Serial No. 60/537,690 discloses an oral care system for cleaning teeth, including removing dental plaque, by the use of a spray of fine droplets directed at a selected, effective velocity against the teeth. The droplets may be generated in different ways, including forcing a liquid with high pressure through a plurality of nozzles, or by introducing fluid into a fast-flowing stream of air. Another droplet generating embodiment includes a piezoelectric element which produces a high-speed pumping effect on fluid, which accelerates the fluid through a set of nozzles.

Droplet size is important for proper cleansing action, particularly in view of practical operational limitations on flow rate and fluid velocity/pressure. If the droplets are too small, *i.e.* less than 10 μm, high velocities of up to 200 m/sec are necessary to produce a proper cleaning effect, including plaque removal. Such a high velocity is undesirable, since it dramatically increases the necessary pressure to be produced by the fluid pump, as well as increasing the energy supplied to the liquid. It has heretofore been difficult to produce droplets of desired size for good cleaning without using excessive flow rates or velocities.

Hence, it is desirable to be able to control droplet size while maintaining the droplet flow rate within acceptable limits.

Accordingly, the present invention is a fluid used for cleaning teeth in a droplet-based oral care system, comprising: a fluid which is dispersible into a spray of droplets useful in cleaning teeth in a fluid droplet-based oral care system, wherein the fluid contains a water soluble, human consumable polymer additive of selected molecular weight and in a selected concentration so as to result in a droplet size produced from the resulting additive solution, in a selected range, at least 80% being at least 10 μm in diameter, to produce plaque removal when the droplet spray is directed to the teeth.

Figure 1 is a schematic view of an oral care appliance using fluid droplets.

As discussed above, U.S. patent application Serial No. 60/537,690, filed on January 20, 2004, titled "Droplet Jet System For Cleaning", which is owned by the assignee of the present invention, the contents of which is hereby incorporated by reference, is directed toward a fluid droplet spray system for cleaning teeth. As disclosed in that application, the fluid droplets may be generated by various means.

It is important for convenient operation that the flow rate of the fluid be limited. Preferably, the fluid flow rate is approximately 20 ml per brushing event, with at a flow rate of 10 ml/min for a two-minute brushing. This is a typical convenient mouth capacity for a user for a brushing event. The flow rate could be somewhat higher, however, perhaps up to 100 ml total, without significant inconvenience to the user. A range could be 5-50 ml per minute.

The desired droplet size (diameter) in such an oral care system is 10-30 µm, or more, in some cases up to 100 µm, for efficient plaque removal. In certain droplet-generating systems, the flow rate is within acceptable ranges, but the droplets are too small, while in other systems, the droplet size is within the desired range, but the flow rate is unacceptably large.

In the present invention, a small concentration of a high molecular weight polymer is added to the fluid, such as water, prior to the generation of the droplets, to produce what is referred to herein as an additive solution. The polymer helps in the production of a desired droplet size. The droplets can then be applied with a destined flow rate to achieve convenient, effective cleaning. The additive solution can be used with any droplet-generating system. The high molecular weight polymers can also be added to oral care fluids other than water, such as for instance, mouthwashes.

The added polymer may be any one of a wide variety of possible polymers. The two general requirements are that the polymer must be water-soluble, and must be consumable, *i.e.* safe for human consumption. The possible polymers include both "stiff" polymers, such as Xanthan gum or "flexible" polymers, such as polyethylene oxide. Both the molecular weight of the selected polymer and the concentration of the polymer in the fluid of origin are important.

The concentration of the high molecular weight polymer should be relatively small so as to limit any increase of shear viscosity of the resulting additive solution. This is discussed in more detail below. The molecular weight of the polymer must be high enough that even at desired small concentrations, the elongational viscosity of the resulting additive solution increases significantly relative to the fluid of origin. The elongational viscosity is the resistance of the fluid to an elongational flow.

For instance, any Newtonian fluid of origin such as water will have an elongational viscosity of three times its shear viscosity. This results in droplets which break up sufficiently easily during formation that the resulting droplets are too small for oral care systems. When a small concentration of a high molecular weight polymer is added to the liquid of origin, the liquid becomes non-Newtonian, resulting in, among other effects, an increase in the elongational viscosity to values much greater than three times the shear viscosity. This increased elongational viscosity refers to the characteristic of a fluid which maintains a droplet configuration of a particular size without separating into smaller droplets. Basically, with a high elongational viscosity, existing droplets "stretch" considerably before separating into smaller droplets. A high elongational viscosity thus provides the desired result of maintaining larger droplet sizes during droplet generation. It has been discovered that the molecular weight of the added polymer should be sufficiently high that the elongational viscosity of the additive solution be approximately six or more times the shear viscosity of the additive solution to produce the desired droplet size.

The effect of the high molecular weight polymer, as indicated above, on the fluid of origin is to decrease the tendency of the resulting additive solution to break up into small droplets, *i.e.* the size of droplets which would be otherwise produced during droplet generation. This is accomplished by the increase in elongational viscosity of the additive solution accompanied by only a relatively small increase in shear viscosity, due to the small concentration of the high molecular weight polymer additive.

In addition, the high molecular weight polymer prevents the formation of satellite droplets during droplet generation, and further, decreases the drag of the fluid during turbulent flow, which occurs in one or more of the droplet generation systems described in the 60/537,690 application, particularly those embodiments using nozzles.

Xanthan gum, which is one of the example polymers, has a molecular weight of approximately 7.6 X 10^6 g/mol; polyethylene oxide, which is another example, can be made in a wide variety of molecular weights. The minimum molecular weight for this application is on the order of 0.1 X 10^6 g/mol. Both of these polymers will produce the desired result. The molecular weight of the additive polymer, as explained above, must be sufficiently high as to substantially increase the elongational viscosity of the resulting additive solution, with the concentration of the additive polymer being quite small such that any increase in shear viscosity of the additive solution is also small. The droplets produced are substantially all (at least 80%) approximately at least 10 micrometers in diameter. Typically, the percentage is much closer to 100%.

A particular term "intrinsic" viscosity [μ] of a solution is defined herein as:

$$[\mu] = \lim_{c \to 0} \frac{\mu - \mu_s}{\mu_s c}$$

where c is the concentration in mass per unit volume of original fluid, μ is the viscosity of the additive solution and μ_s is the viscosity of the original fluid. At a concentration c* which is larger than 1/[μ]), the shear viscosity of the additive solution will be significantly influenced, which can be undesirable.

For the additive polymer to be effective, the concentration should be between 0.1c*-10c*, but more preferably is in the range 0.25c*-2.5c*.

For xantham gum and water, c* = 0.0045% weight has been found to be effective.

A cleaning system involving the above-described fluid includes a power toothbrush, such as shown in Figure 1, generally at 10. The toothbrush includes a droplet-generating system, shown generally at 12. The fluid containing the polymer additive in operation is forced out through nozzles 14 in the brushhead 16. The fluid coming out of the brushhead breaks up into a fine spray, at a desired flow rate and velocity, as well as with a desired droplet size controlled to an extent by the high molecular weight polymer additive. The spray is directed to the teeth, resulting in cleaning of the teeth, in particular plaque removal.

Although a preferred embodiment of the invention has been disclosed for purposes of illustration, it should be understood that various changes, modifications and substitutions may be incorporated in the embodiment without departing from the spirit of the invention which is defined by the claims which follow.

Claims

1. A fluid used for cleaning teeth in a droplet-based oral care system, comprising:

a fluid which is dispersible into a spray of droplets useful in cleaning teeth in a fluid droplet-based oral care system, wherein the fluid contains a water soluble, human consumable polymer additive of selected molecular weight and in a selected concentration so as to result in a droplet size produced from the resulting additive solution, in a selected range, at least 80% of the droplets are at least 10 μm in diameter, to produce plaque removal when the droplet spray is directed to the teeth.

2. The fluid of claim 1, wherein the flow rate of the fluid is 5-50 millimeters per minute.

3. The fluid of claim 1, wherein the molecular weight of the polymer additive is sufficiently high and where the concentration is sufficiently small that the elongational viscosity of the additive solution is at least six times the shear viscosity thereof.

4. The fluid of claim 1, wherein the molecular weight of the polymer additive is at least 0.1×10^6 grams per molecule.

5. The fluid of claim 1, wherein the concentration of the polymer is between 0.1c*-10c*, where c* is 1/[μ] and

$$[\mu] = \lim_{c \to 0} \frac{\mu - \mu_s}{\mu_s c}$$

Where c is the concentration in mass per volume of the original fluid, μ is the viscosity of the resulting additive solution, and μ_s is the viscosity of the original fluid.

6. The system of claim 1, wherein the droplet size is in the range of 10-100 μm.

7. A system for cleaning teeth using a stream of fluid droplets, comprising:

a source of fluid, the fluid including a water-soluble human-consumable polymer additive of selected concentration and molecular weight;

a fluid droplet generator for creating a stream of droplets from the fluid, wherein the droplets have a size in a selected range, at least 80% of the droplets being at least 10 micrometers in diameter; and

a member for directing the stream of droplets onto a selected area of the teeth.

8. The system of claim 7, wherein the flow rate of the fluid is within the range of 5-50 milliliters per minute.

9. The system of claim 7, wherein the droplets are within the range of 10-100 micrometers in diameter.

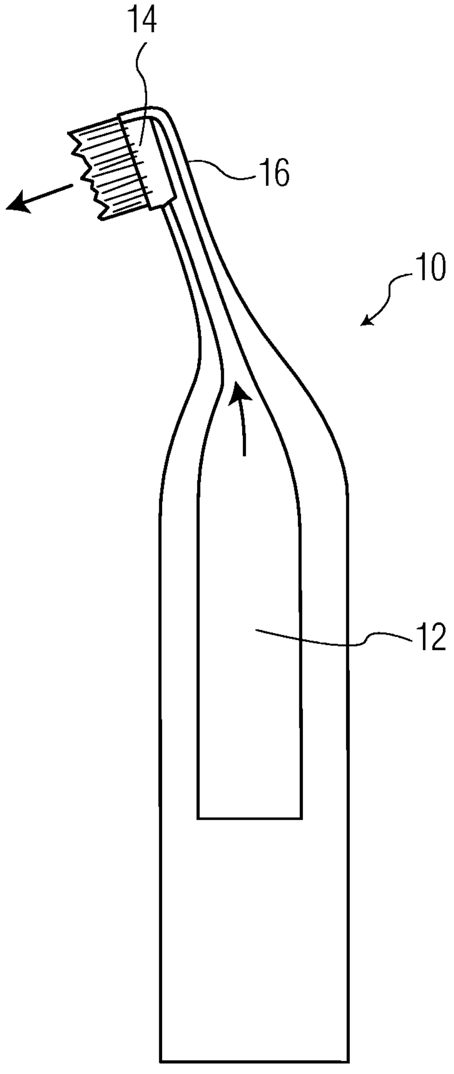

FIG. 1

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2005/054339

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61Q11/00 A61K8/73 A46B11/00 A61C17/028 A61K8/86

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61K A61Q A61C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, CHEM ABS Data, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 238 648 B1 (M. LEUSCH ET AL.) 29 May 2001 (2001-05-29) example 13	1-9
A	US 5 062 795 A (P. WOOG) 5 November 1991 (1991-11-05) the whole document	1
A	GB 1 328 551 A (INSTITUT DE RECHERCHE WOOG) 30 August 1973 (1973-08-30) the whole document	1
A	US 3 870 039 A (M. MORET ET AL.) 11 March 1975 (1975-03-11) the whole document	1

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 April 2006	18/05/2006

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Glikman, J-F

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2005/054339

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DATABASE CA CHEMICAL ABSTRACTS SERVICE, COLUMBUS, OHIO, US; XP002378637 retrieved from STN Database accession no. 126: 162016 abstract & JP 08 333226 A (LION CORP.) 17 December 1996 (1996-12-17) -----	1
A	DATABASE WPI Week 2004 Derwent Publications Ltd., London, GB; AN 2004-584394 XP002378639 & JP 2004 217609 A (LION CORP.) 5 August 2004 (2004-08-05) abstract -----	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2005/054339

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 6238648	B1	29-05-2001	AU	4024100	A	09-10-2000
			CA	2366627	A1	28-09-2000
			EP	1162939	A1	19-12-2001
			WO	0056276	A1	28-09-2000
US 5062795	A	05-11-1991	NONE			
GB 1328551	A	30-08-1973	CH	509078	A	30-06-1971
			DE	2050687	A1	06-05-1971
			FR	2065615	A1	30-07-1971
			HK	1579	A	12-01-1979
			NL	7015974	A	04-05-1971
US 3870039	A	11-03-1975	CH	563192	A5	30-06-1975
			DE	2401640	A1	01-08-1974
JP 08333226	A	17-12-1996	JP	3487023	B2	13-01-2004
JP 2004217609	A	05-08-2004	NONE			