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(71) Applicant (for all designated States except US): **SCA HYGIENE PRODUCTS AB** [SE/SE]; S-405 03 Göteborg (SE).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **LARSSON, Björn**
[SE/SE]; Örsviksvägen 1, S-427 50 Billdal (SE).

(74) Agent: **ALBIHNS GÖTEBORG AB**; Box 142, S-401 22 Göteborg (SE).

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(54) Title: ANODIZED COATING FOR ALUMINIUM ARTICLES

(57) Abstract: The invention relates to a surface coating for an aluminium surface of a household or restaurant appliances and articles, said surface coating having a predetermined abrasion resistance. The surface coating is an anodic oxide coating with an abrasive resistance less than 0,1 µm per kg of sand.



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ANODIZED COATING FOR ALUMINIUM ARTICLES

TECHNICAL FIELD

The invention relates to anodized coating for aluminium surfaces of household and restaurant appliances and articles, in particular for dispensers for individual webs, provided with a coating having an optimized abrasion resistance and a high performance corrosion resistance, which coating is manufactured in a cost effective and environmentally safe manner.

BACKGROUND ART

The outer surfaces of household and restaurant appliances and articles, such as a dispenser for individual folded webs, which articles are often exposed to abrasive wear. In the case of dispensers, the outer surfaces may comprise a metal such as sheet steel. In addition, it is well known that many metal surfaces corrode over time when exposed to the atmosphere. Such corrosion typically results from oxidation of the exposed metal on the surface, as for example when iron rusts. Corrosion of metal surfaces is generally undesirable, as it weakens the structural integrity of the metal and degrades the appearance of the metal surface.

To prevent corrosion, coatings have been applied to metal surfaces to shield the metal surface from the atmosphere and prevent oxidation. Simplistic coatings, well known in the prior art, include paints and varnishes which are applied over the surface of the metal. While efficacious in preventing corrosion, such coatings are generally coloured, and cover the surface to prevent viewing the metal surface. In addition, coatings of this type may not provide sufficient abrasive wear properties.

The use of stainless steel may partially solve the problem of abrasive wear. However, stainless steel has severe limitations with respect to how it may be

shaped. For this very reason, such products are as a rule limited to products that may be produced from steel sheet or by pressing or stamping.

A material that can be shaped using most metalworking processes, including extruding, is aluminium. Aluminium and its alloys have found a variety of industrial and household applications in the form of sheets, strips, bars, rods, tubes, structural members, household appliances and utensils, hardware and a host of other articles. Because of its light weight and tendency toward surface corrosion, it has been necessary to provide a suitable resistant coating on the surface of the metal in order to impart structural strength thereto and to protect it against corrosion, abrasion and/or environmental degradation. Some protection has been afforded the metal by painting or enamelling its surface. However, the protection afforded the metal by painting or enamelling has not been satisfactory because such organic coatings degrade at high temperatures and frequently they adhere poorly to the metal surfaces, particularly when subjected to temperature variations.

One type of coating that is clear and has been used for metal surfaces is the type derived from alkali silicates. For example, alkali silicate coatings have been used for aluminium surfaces, and generally consist of a transparent or translucent glass-like layer over the surface of the metal to shield it from the atmosphere. While possessing desirable clarity properties, the prior art silicate coatings are generally unsuited for high performance corrosion protection. This is because prior art coating processes are incapable of producing a silicate coating that is free from microscopic defects. Where such defects exist on the surface of the coating, there is increased likelihood that the coating will fail, and the metal surface may become exposed to the atmosphere at the point of the defect, with resulting corrosion. Metal surfaces coated with prior art silicate coatings are therefore susceptible to "pitting" over time, the pits appearing at points on the surface where defects are present in the coating.

In order to provide a more suitable coating for improved protection of aluminium metal and its alloys, the metal may be anodized in a variety of electrolytic solutions. While anodization of aluminium afford the metal surface is a more effective protective coating against corrosion or degradation than painting or enamelling, the resulting coated metal has not always been satisfactory that it is not sufficiently resistant against abrasive wear. Some anodizing processes do not allow a sufficient coating thickness to form, while other processes are too costly, too time consuming, or involve the use of environmentally hazardous chemicals. A number of alternative processes, with their pros and cons, will be discussed in the following text.

Consequently, there exists a need for an improved anodized coating for aluminium surfaces provided with a coating having an optimized abrasion resistance and a high performance corrosion resistance, which coating is manufactured in a cost effective and environmentally safe manner.

DISCLOSURE OF INVENTION

It is therefore an object of the present invention to provide an anodized aluminium article, such as a dispenser for individual webs, which solves the above problems. This is achieved by an article according to claim 1 and its dependent claims.

Anodizing or anodic oxide coating is a coating of aluminium oxide that is grown from the aluminium by passing an electrical current through an acid electrolyte bath in which the aluminium is immersed. The purpose of anodizing is to form a layer of aluminium oxide that will protect the aluminium beneath it. The aluminium oxide layer has much higher corrosion and abrasion resistance than aluminium. There are some types of anodizing that produce a porous oxide layer that can be coloured with organic dyes or metallic pigments giving the aluminium a decorative and protective finish.

CURRENT ANODIZING PROCESSES

Type I A Conventional coatings produced from chromic acid bath	Thickness 0.5 μm -8 μm
Type I B Low voltage chromic acid anodizing (20 volts)	0.5 μm -8 μm
Type II Conventional coatings produced from sulphuric acid bath	2 μm -28 μm
Type III Hard coat (Uniform anodic coatings)	12 μm -115 μm

Commonly used processes, for instance, batch and coil anodizing, may be accomplished in five carefully controlled, calibrated, quality-tested stages:

1. Cleaning.
5 Alkaline and/or acid cleaners remove grease, and surface dirt.
2. Pre-Treatment.
 - Etching. A matte surface finish is created with hot solutions of sodium hydroxide to remove minor surface imperfections. A thin layer of aluminium is removed to create a matte or dull finish.
 - 10 • Brightening. A near mirror finish is created with a concentrated mixture of phosphoric and nitric acids to chemically smoothen the surface.
3. Anodizing.
The anodic film is built and combined with the metal by passing an electrical current through an acid electrolyte bath in which the aluminium is immersed. The coating thickness and surface characteristics are tightly controlled to meet end product specifications.
15
4. Colouring.
An optional step that may be achieved in one of four different ways:
 - Electrolytic Colouring
 - 20 • Integral Colouring
 - Organic Dyeing
 - Interference Colouring

5. Sealing.

This process closes the pores in the anodic film, giving a surface resistant to staining, abrasion, crazing and colour degradation.

The surface of the aluminium itself is toughened and hardened to a degree unmatched by any other process or material. The coating is 30 percent thicker than the metal it replaces, since the volume of oxide produced is greater than that of the metal replaced. The resulting anodic coating is porous, allowing relatively easy colouring and sealing.

A Type I A anodizing process involves the use of chromic acid. This is not suitable for alloys with more than 5% copper. The film is thinner, but very durable. The very thin film is also a benefit when very close tolerances must be maintained. However, because chromic acid is a very nasty chemical, its use on an amateur basis is discouraged, and its commercial use may be closely regulated.

For a Type II anodizing process a commercial plant will first clean and etch the surface in a caustic solution, such as lye (sodium hydroxide), followed by a thorough wash. The parts are placed in an acid solution, such as 15-25% sulphuric acid, and connected to the positive source of a power supply. The part(s) comprise the anode, and a cathode, that may be lead, lead sheet, or the whole tank might be lead. An appropriate current density is applied, e.g. 1.5 A/dm² (12 asf) over a period of 15-25 minutes if no dying is planned, or 45-60 minutes for dying. Dying is an optional step before sealing of the surface. Sealing is then done by means of hot water seal, which changes the film from gamma aluminium oxide a hydrated form called boehmite. This process may take about 20 minutes.

The predominant anodizing process today is the Type II process, which is also the process used for the invention. Coatings 2-25 µm thick may be formed in a 15 % solution sulphuric acid, 1.1-2.2 A/dm² (10-20 asf), 18-24 volts, 20 °C for 10-60 min. Approximately one third of the resulting coating

thickness is build-up, while the other two thirds of the coating is penetration into the aluminium. This coating is optionally organically dyed or coloured with deposited metals (two-step). Most anodizing involves this method, although other acids are available for specialty purposes. An example of
5 such acids is organic acids. These integral one-step processes employ 90-100 g/litre solutions of organic acids, containing a small amount of sulphuric acid for increased conductivity. Operating conditions may be 20-27°C, 2.7 A/dm² (25 asf), voltage up to 75; produces amber, bronze and black coatings. The resulting oxide coating is light-fast and weather resistant.

10 Alternatively, the electrolytic process comprises immersing the aluminium metal in the bath, in which aluminium serves as the anode A second metal which is cathodic with respect to aluminium is also immersed in the bath# Alternatively the bath is placed in a container which itself is cathodic relative to: the aluminium metals A voltage "shock" is then applied to the aluminium
15 metal by imposing a voltage potential between the two electrodes which is quickly raised to about 300 volts within about 2 to about 10 seconds Thereafter, the voltage is increased gradually to about 450 volts within a few minutes to form the desired coating thickness.

Clear anodizing usually means sulphuric acid anodizing followed by hot water
20 seal. This is the most widely used anodized coating. It may be used on some aluminium alloys as a final surface finish. Optionally, immersing the anodized coating in a dye solution before sealing may create an attractive coloured surface for consumer products.

A Type III anodizing process, also known as Hard Anodizing, is a term used
25 to describe the production of anodized coatings with film hardness or abrasion resistance as their primary characteristic. These coatings are usually thick by normal anodizing standards (greater than 25 µm) and they are produced using special anodizing conditions, such as very low temperatures, high current density 2.7-3.8 A/dm² (25-35 asf), and using
30 special electrolytes. They find application in the engineering industry for

components which require a very wear resistant surface such as piston, cylinders and hydraulic gear. They are often left unsealed, but may be impregnated with materials such as waxes or silicone fluids to give particular surface properties. Like other forms of anodizing (such as Type I Chromic Acid Anodizing or Type II Sulphuric Acid Anodizing), Hard coat Anodizing (Type III) is produced by immersing the aluminium components into an electrolyte solution. Because the acid bath used for hard coating is maintained at a cool temperature, there is no risk of thermal or physical distortion of the aluminium parts. Hard coat penetrates the base metal as much as it builds up on the surface. Hard coat anodizing may be provided in thicknesses from about 13 to 115 μm , but in commercial applications it is commonly used in thicknesses in excess of 25 μm . Commonly, the term "coating thickness" includes both the build-up and the penetration. This applies to all embodiment and examples given in this text.

Anodizing is sensitive to the type of alloy. For example, alloys for die casting have a lot of silicon, which makes it pour and mould well, but it makes anodizing almost impossible.

As stated above, the process preferred for the invention is the Type II Sulphuric Acid Anodizing process. This process yield a harder surface than the Type I A/B processes, as it allows for a thicker coating. The process is also preferable over the Type III hard anodizing process, which requires a higher current density and a longer period of time to complete the process. This makes the process more expensive and time consuming compared to the Type II process. Also, special electrolytes may be required, which may involve handling of environmentally hazardous chemicals. Waste water from an anodizing plant can be treated and purified in a municipal sewage water treatment facility.

The invention primarily relates to household and restaurant appliances and articles, such as a dispenser for individual folded webs, which articles are exposed to abrasive wear

According to the invention as described in the following examples, the dispenser is preferably, but not necessarily, designed for dispensing folded sheet products from a stack of individual folded webs. The term "individual webs" is defined as including either of individually stacked webs, overfolded webs or interfolded webs, or similarly arranged sheet products. The webs may or may not be joined by manually separable perforations or by a number of local attachment zones or connecting points. The stack of individual folded webs may be a stack of fibrous webs. Desirably, the stack of folded webs is a stack of absorbent sheets or webs such as, for example, absorbent non-woven products. More desirably, the stack of folded webs is a stack of absorbent fibrous or paper sheets or webs such as, for example, napkins, towels, tissues or the like.

By providing an article such as a dispenser made from aluminium with an anodized coat having a preferred thickness, a number of advantages are achieved in view of one or more properties such as durability, colour stability, ease of maintenance, cost, as well as health and safety. The thickness should be in excess of 10 μm , preferably in excess of 15 μm , or most preferable between 15 and 25 μm .

With respect to durability, most anodized products have an extremely long life span and offer significant economic advantages through maintenance and operating savings. Anodizing is a reacted finish that is integrated with the underlying aluminium for total bonding and unmatched adhesion. Exterior anodic coatings provide good stability to ultraviolet rays, do not chip or peel, and are easily repeatable. Scars and wear from fabrication, handling, installation, frequent surface dirt cleaning and usage are virtually non-existent. Rinsing or mild soap and water cleaning usually will restore an anodized surface to its original appearance. Mild abrasive cleaners can be used for more difficult deposits. Anodizing offers a large increasing number of gloss and colour alternatives and minimizes or eliminates colour variations. Unlike other finishes, anodizing allows the aluminium to maintain its metallic appearance.

A lower initial finishing cost combines with lower maintenance costs for greater long-term value. Anodizing by means of a Type II process is a safe process that is not harmful to human health. An anodized finish is chemically stable, will not decompose; is non-toxic; and is heat-resistant to the melting point of aluminium. Since the anodizing process is a reinforcement of a naturally occurring oxide process, it is non-hazardous and produces no harmful or dangerous by-products. The anodizing process does create a by-product composed primarily of aluminium hydroxide, some aluminium sulphate and water, which products may be recycled for e.g. water treatment purposes. It is harmless because it contains no significant amounts of heavy metals.

BRIEF DESCRIPTION OF DRAWINGS

In the following text, the invention will be described in detail with reference to the attached drawings. These drawings are used for illustration only and do not in any way limit the scope of the invention. In the drawings:

- Figure 1 shows a dispenser provided with an anodized surface coating according to the invention;
- Figure 2 shows a diagram for the wear resistance of anodized coatings with a thickness of 28-29 μm ;
- 20 Figure 3 shows a diagram for the wear resistance of anodized coatings with a thickness of 20-22 μm ;
- Figure 4 shows a diagram for the wear resistance of anodized coatings with a thickness of 12-15 μm ;
- Figure 5 shows a diagram for the wear resistance of anodized coatings with a thickness of 10 μm ;
- 25 Figure 6 shows a diagram for the average wear resistance of the anodized coatings of Figures 2-5;

- Figure 7 shows a diagram for the wear resistance of powder coated sheet steel with a coating thickness of 145-157 μm
- Figure 8 shows a diagram for the wear resistance of coloured plastic;
- Figure 9 shows a diagram for the wear resistance of stainless steel;
- 5 Figure 10 shows a diagram for the scrub resistance of anodized coatings having an initial thickness of 17-18 μm ;
- Figure 11 shows a diagram for the scrub resistance of a test sample of powder coated sheet steel with a thickness of 108-119 μm .

MODES FOR CARRYING OUT THE INVENTION

- 10 The invention relates to anodized coating for aluminium surfaces of household and restaurant appliances and articles, in particular for a dispenser for individual webs. Figure 1 shows a dispenser according to a first embodiment of the invention, which dispenser 1 comprises a central body 2, a front panel 3 and a rear panel 4 at opposite ends of said body. The front
- 15 panel 3 is provided with a dispensing opening 5 for folded paper products such as a paper napkin 6. The central body is made from an extruded aluminium section that may be provided with an anodized, or anodic surface coating. Such an anodized coating has an optimized abrasion resistance and a high performance corrosion resistance, which coating is manufactured in a
- 20 cost effective and environmentally safe manner.

In the current example, the aluminium section is processed in a number of steps before the final surface coating is applied. In a first step the section is given a relatively thin anodized surface of 1-3 μm , which allows it to be handled in subsequent steps without damaging the outer surface. In a

25 second step the section is machined to provide openings and guide surfaces for at least one locking mechanism and an optional window for monitoring the level of remaining webs in the container. In a third step the outer surface is brushed to remove any burr from the machining step and to round off all

edges and corners accessible to the operator or user of the final dispenser. The brushing operation also gives the outer walls a surface structure that, when anodized and sealed, is relatively insensitive to fingerprints and gives an aesthetically pleasing appearance. Finally, the section is anodized to the
5 required coating thickness and sealed.

The anodizing process used for the invention is the Type II process, which is also the process used for the invention. Typically, coatings 2-25 μm thick may be formed in a 15 % solution sulphuric acid, 1.1-2.2 A/dm^2 (10-20 asf), at 18-24 volts, 20 °C (room temperature) for 10-60 min. However,
10 thicknesses up to about 30 μm are, possible to achieve with this method. Approximately one third of the resulting coating thickness is build-up, while the other two thirds of the coating is penetration into the aluminium. In the subsequent text, the coating thickness referred to is the thickness including both the build-up and the depth of penetration into the aluminium.

15 The wear resistance of the anodized coating used for the invention, and for a number of comparative examples, has been tested using a modified Swedish industrial standard (SIS) testing method SIS 18 41 65. This method will substantially correspond to the US testing method ASTM D968-51.

According to SIS 18 41 65, the test is performed at an ambient temperature
20 of $23 \pm 2^\circ\text{C}$ and at 50 ± 5 % relative humidity. The test involves a particular type of sand that is allowed to fall at a predetermined rate onto a test surface angle at 45° to the horizontal plane. The wear resistance is given as the wear on the coating in μm over the amount of sand used in kg.

The modification to the test method involved using aluminium oxide with an
25 average grain size of 360 μm , instead of the prescribed carborundum sand. This choice was made to achieve a better correlation to the actual conditions of use of the type of article tested. However, in the following text, the aluminium oxide used for the test will be referred to as "sand". The reduction in thickness of the anodized coating was measured at regular intervals for a

number of different samples to give the diagrams shown in Figures 2-5. Comparative measurements were performed for a number of alternative material samples, such as powder coated steel sheet, stainless steel sheet and coloured plastic, which diagrams are shown in Figures 6-8. The tests
5 were continued until the underlying, coated surface was exposed over an area having a diameter of approximately 4 mm. For the non-coated samples, comprising plastic and stainless steel, the sand created a crescent-shaped area. This was also the case for the anodized samples. The non-coated samples were exposed to a total amount of 400 kg of aluminium oxide sand.

10 For dispensers and similar household and restaurant appliances and articles it is common that cleaning involves some form of scrubbing using water or a liquid detergent. For dispensers, a commonly used surface coating is powder coated steel sheet. An additional test was performed to compare the scrub resistance of an aluminium dispenser having an anodized coating, with a
15 standard dispenser made from powder coated steel sheet. The test used was a modification of the Swedish industrial standard test SIS 16 41 64.

According to SIS 16 41 64, the test is performed at an ambient temperature of $23 \pm 2^{\circ}\text{C}$ and at $50 \pm 5\%$ relative humidity. The test involves a particular type of brush that is held against a test surface under a predetermined load.
20 The brush is rubbed back and forth over a test surface in a horizontal plane over a number of cycles, where each movement back and forth constitutes one cycle. The scrub resistance is given as the wear on the coating in μm over the number of cycles (n).

The modification to the test method involved replacing the standard brush
25 with a pad of Scotchbrite® "Heavy Duty Scour Pad" including an abrasive material. Also, the standard soda solution was replaced by a solution comprising water and 1 ‰ of Yes® dishwashing liquid. This choice was made to achieve a better correlation to the actual conditions of use of the type of article tested. To achieve a surface load of $0,1 \text{ kg/cm}^2$ on the pad,
30 corresponding to a manual scrubbing operation, a Modig® milling machine

was used for this test. The reduction in thickness of the anodized coating was measured at certain intervals over a number of cycles to give the diagrams shown in Figure 10. Comparative measurements were performed for a alternative material sample, in this case a powder coated steel sheet, which
 5 diagram is shown in Figure 11.

The coating thickness for anodized aluminium and powder coated steel sheet was measured using a "MiniTest 2100" coating thickness gauge made by ElectroPhysik ®. Each of the test values given in the Examples 1-4 below represents a series of five measurements.

- 10 Abrasive wear on the non-coated samples made from plastic and stainless steel was measured using a "Johanssons Safir 7" device that uses the original surface as a zero reference. Subsequent wear on the surface will give a negative value relative to the reference surface, with an accuracy within $\pm 3 \mu\text{m}$.
- 15 Figure 2 shows the wear resistance of anodized coatings having an initial thickness of 28-29 μm . The test series was performed on three samples. Three test series are plotted with the symbols (Δ , $\square$ and $\diamond$), and a curve indicating the average values of the series is plotted with the symbol (X). Measurements of the coating thickness were taken for every 40 kg of sand,
 20 up to 400 kg.

Example 1

Kg sand	0	40	80	120	160	200	240	280	320	360	400
Thickness (μm)	29,0	25,5	23,6	18,0	15,4	12,9	11,1	7,9	5,5	3,3	0,0
Thickness (μm)	28,5	26,3	23,6	18,1	16,7	13,6	12,4	9,6	7,6	5,2	3,0
Thickness (μm)	28,2	28,1	27,0	25,0	24,0	20,0	18,0	16,2	15,0	6,0	4,9
Average (μm)	28,6	26,6	24,7	20,4	18,7	15,5	13,8	11,2	9,4	4,8	2,6

Figure 3 shows the wear resistance of anodized coatings having an initial thickness of 20-22 μm . The test series was performed on three samples. Three test series are plotted with the symbols (Δ), ($\square$) and ($\diamond$), and a curve
 25 indicating the average values of the series is plotted with the symbol (X).

Measurements of the coating thickness were taken for every 40 kg of sand, up to 280 kg.

Example 2

Kg sand	0	40	80	120	160	200	240	280
Thickness (μm)	20,0	19,8	17,4	12,4	10,8	8,4	5,2	3,6
Thickness (μm)	21,1	19,8	18,5	14,1	10,4	7,9	4,4	3,6
Thickness (μm)	20,8	19,0	17,0	15,0	11,2	8,7	5,3	3,4
Average (μm)	20,6	19,5	17,6	13,8	10,8	8,3	5,0	3,5

Figure 4 shows the wear resistance of anodized coatings having an initial thickness of 12-15 μm . The test series was performed on three samples. Three test series are plotted with the symbols (Δ), ($\square$) and ($\diamond$), and a curve indicating the average values of the series is plotted with the symbol (X). Measurements of the coating thickness were taken for every 40 kg of sand, up to 160 kg.

Example 3

Kg sand	0	40	80	120	160
Thickness (μm)	14,6	12,1	10,1	8,0	3,1
Thickness (μm)	12,7	12,3	10,1	5,7	3,7
Thickness (μm)	12,6	11,9	10,6	6,3	3,6
Average (μm)	13,3	12,1	10,3	6,7	3,5

Figure 5 shows the wear resistance of anodized coatings having an initial thickness of about 10 μm . The test series was performed on two samples. Two test series are plotted with the symbols (Δ), ($\square$) and ($\diamond$), and a curve indicating the average values of the series is plotted with the symbol (X). Measurements of coating the thickness were taken for every 40 kg of sand, up to 120 kg.

Example 4

Kg sand	0	40	80	120
Thickness (μm)	10,0	9,9	8,0	4,6
Thickness (μm)	10,1	9,4	6,0	4,4
Average (μm)	10,1	9,7	7,0	4,5

Figure 6 shows the average wear resistance of each of the anodized coatings of Figures 2-5. Four averaged test series for the different thicknesses are plotted with the symbols (Δ), ($\square$), ($\diamond$) and (X). The average values are taken from the tables of examples 1-4.

- 5 Figure 7 shows the wear resistance of a test sample of powder coated sheet steel having an initial thickness of 145-157 μm . The test series was performed on three samples. Three test series are plotted with the symbols (Δ), ($\square$) and ($\diamond$), and a curve indicating the average values of the series is plotted with the symbol (X). Measurements of coating thickness were taken
- 10 for every 40 kg of sand.

Example 5

Kg sand	0	40	80	120	160	200	240	280	320	360	400
Thickness (μm)	156,0	149,4	132,8	116,0	96,7	80,4	61,0	50,0	34,3	10,4	0,6
Thickness (μm)	156,8	136,8	123,2	108,4	94,9	84,3	72,4	56,5	44,7	30,0	17,5
Thickness (μm)	144,6	126,2	108,8	88,8	70,6	44,7	27,6	3,4	0,0	0,0	0,0
Average (μm)	152,5	137,5	121,6	104,4	87,4	69,8	53,7	36,6	26,3	13,5	6,0

- Figure 8 shows the wear resistance of a test sample of coloured plastic (coloured throughout). The test series was performed on a single sample. The test is plotted with the symbol ($\diamond$), resulting in a curve indicating the
- 15 amount of wear into the surface of the sample from an initial surface level. Measurements of surface wear were taken for every 100 kg of sand, in the interval 200-400 kg.

Example 6

Kg sand	0	200	300	400
Thickness (μm)	0,0	-195,0	-340,0	-416,0

- Figure 9 shows the wear resistance of a test sample of stainless steel sheet.
- 20 The test series was performed on a single sample. The test is plotted with the symbol ($\diamond$), resulting in a curve indicating the amount of wear into the surface of the sample from an initial surface level. A measurement of surface wear was taken for a single point at 400 kg of sand, where the surface wear was assumed to be constant. Apart from surface wear caused by the flowing

sand, an unexpected, noticeable deformation at the point of impact could be observed after completion of the test. Although the total value for the measurement after 400 kg of sand was -42 μm , the deformation was determined to be 20 μm . Hence, the actual surface wear was -22 μm .

5 Example 7

Kg sand	0	400
Thickness (μm)	0,0	-22,0 (-42,0)

Figure 10 shows the scrub resistance of anodized coatings having an initial thickness of 17-18 μm . The test series was performed on three samples. Three test series are plotted with the symbols (Δ , $\square$ and $\diamond$), and a curve indicating the average values of the series is plotted with the symbol (X).

- 10 Measurements of coating thickness were taken for every 2000 cycles, up to 10.000 cycles. The average value has been extrapolated to 10.000 cycles.

Example 8

Cykles	0	2 000	4 000	6 000	8 000	10 000
Thickness (μm)	17,8	11,0	9,0	4,6	3,2	
Thickness (μm)	17,0	11,2	6,2	5,2	0,0	
Thickness (μm)	17,0	9,2	5,4	4,6	1,6	
Average (μm)	17,3	10,5	6,9	4,8	1,6	0,0

- Figure 11 shows the scrub resistance of a test sample of powder coated sheet steel having an initial thickness of 108-119 μm . The test series was performed on three samples. Three test series are plotted with the symbols (Δ), ($\square$) and ($\diamond$), and a curve indicating the average values of the series is plotted with the symbol (X). Measurements of coating thickness were taken for every 2000 cycles, up to 10.000 cycles.
- 15

Example 9

Cykles	0	3 000	6 000	7 000	8 000	9000	10000
Thickness (μm)	108,0	84,0	44,0	22,0	11,0	7,0	4,0
Thickness (μm)	119,0	96,0	67,0	39,0	31,0	22,0	4,0
Thickness (μm)	117,0	71,0	40,0	40,0	23,0	15,0	5,0
Average (μm)	114,7	83,7	50,3	33,7	21,7	14,7	4,3

The results of the above surface tests were as follows.

	Wear resistance ($\mu\text{m/kg}$)	Scrub resistance ($\mu\text{m/cycle}$)
Anodized Al. 25 μm	0,065	-
Anodized Al. 20 μm	0,062	-
Anodized Al. 15 μm	0,061	0,002
Anodized Al. 10 μm	0,046	-
Powder coated steel 150 μm	0,366	-
Powder coated steel 115 μm	-	0,011
Coloured plastic	1,036	-
Stainless steel	0,050	-

From the above figures it is obvious that a coloured plastic material is not suitable for the intended purpose. Although widely used in articles such as dispensers, it is clear that powder coated steel sheet is inferior to anodized aluminium, with respect to both wear and scrub resistance.

Stainless steel is comparable to anodized aluminium with respect to wear resistance. However, the material has a number of disadvantages, such as shaping and colouring limitations, sensitivity to fingerprints and relatively high costs for manufacturing said articles. The tests also revealed that a stainless steel sheet in the thickness used for a dispenser or similar articles may be prone to surface deformation.

Anodized aluminium has nearly the same wear resistance as stainless steel. Advantages associated with aluminium are properties such as low weight and ductility. The latter property allows it to be extruded into very complex profiles, which can substantially reduce manufacturing costs. In addition, the anodized surface is not sensitive to fingerprints and may be coloured without using an additional surface coating.

By providing an article such as a dispenser made from aluminium with an anodized coat having a preferred thickness, a number of advantages are

achieved in view of one or more properties such as durability, colour stability, ease of maintenance, cost, as well as health and safety. According to a preferred embodiment, the wear resistance, as measured by the above method, should be less than 0,1 $\mu\text{m/kg}$. In a further preferred embodiment
5 the wear resistance should be less than 0,07 $\mu\text{m/kg}$.

In a further embodiment, the thickness should be in excess of 10 μm , preferably in excess of 15 μm . In view of a long term use a most preferable thickness range is $20 \pm 5 \mu\text{m}$.

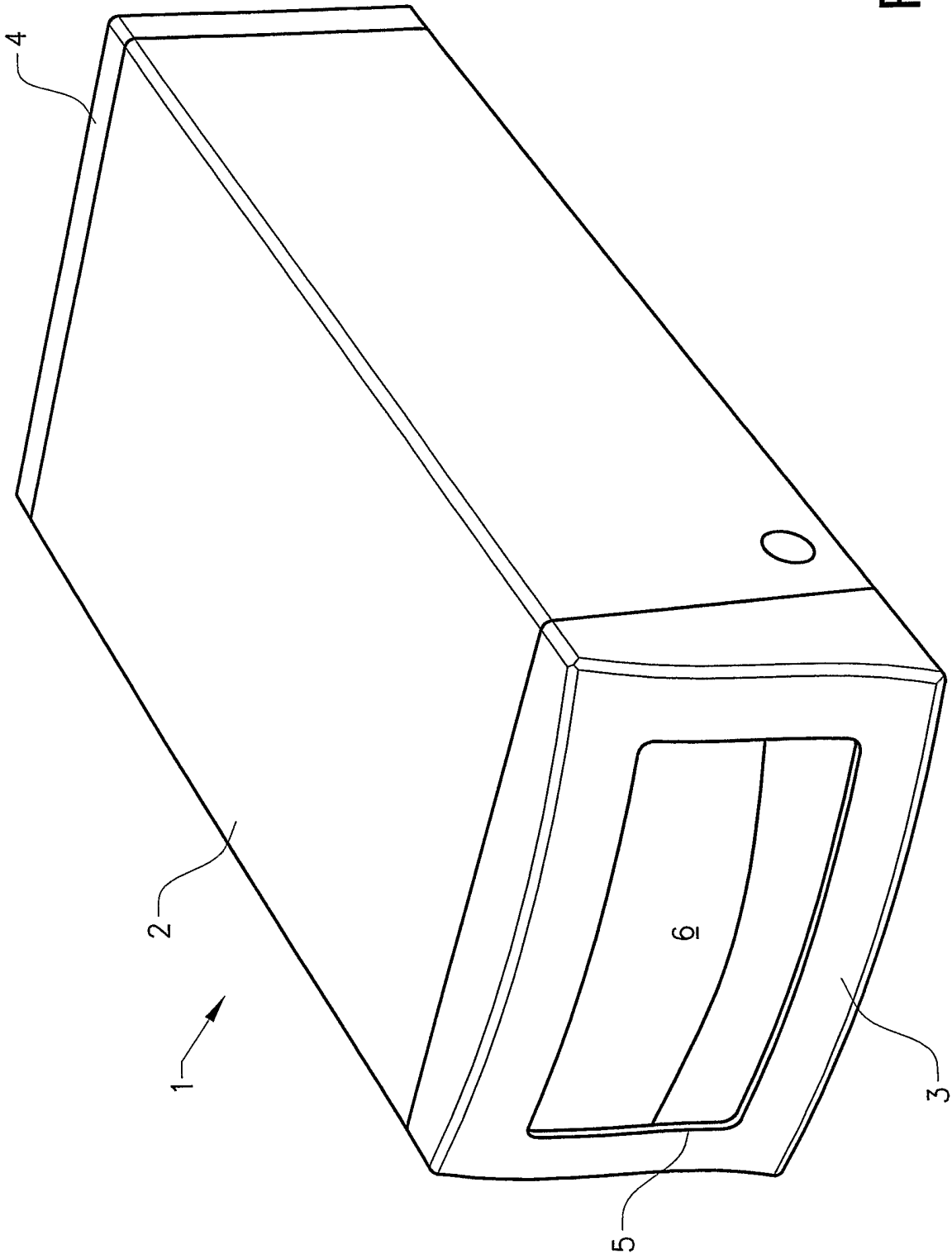
The invention is not limited to the embodiments described above and may be
10 varied freely within the scope of the appended claims.

CLAIMS

1. Surface coating for an aluminium surface of a household or restaurant appliances and articles, said surface coating having a predetermined
5 abrasion resistance, characterized in that the surface coating is an anodic oxide coating with an abrasive resistance less than 0,1 μm per kg.
2. Surface coating according to claim 1, characterized in that the abrasive resistance is less than 0,07 μm per kg of sand.
3. Surface coating according to claim 1, characterized in that the
10 surface coating has a thickness exceeding 10 μm .
4. Surface coating according to claim 3, characterized in that the surface coating has a thickness exceeding 15 μm .
5. Surface coating according to claim 4, characterized in that the surface coating has a thickness of $20 \pm 5 \mu\text{m}$.
- 15 6. Surface coating according to any one of the above claims, characterized in that the anodic oxide coating has been applied by means of a Type II sulphuric acid anodizing process.
7. Surface coating according to any one of the above claims, characterized in that the surface coating is applied on the outer
20 surface of a dispenser for individual webs.

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FIG. 1



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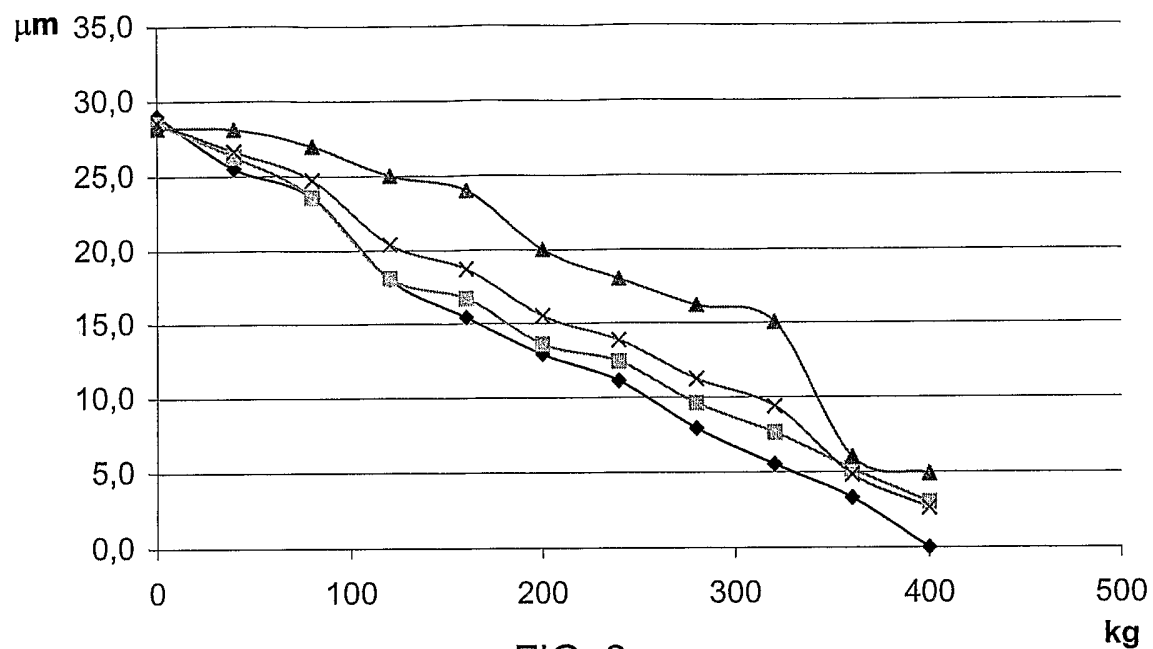


FIG. 2

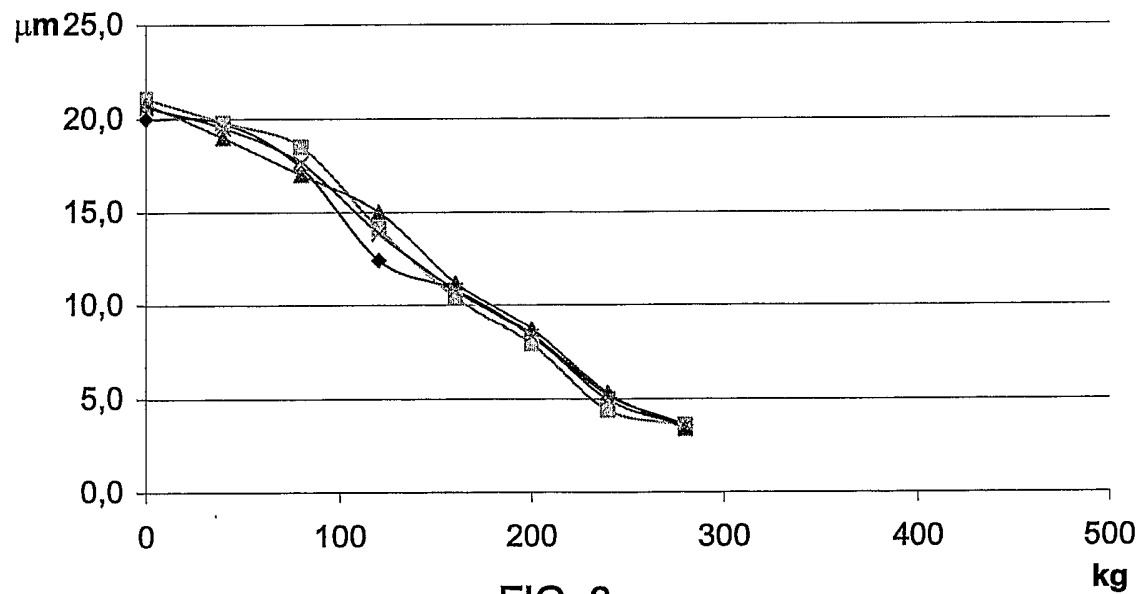


FIG. 3

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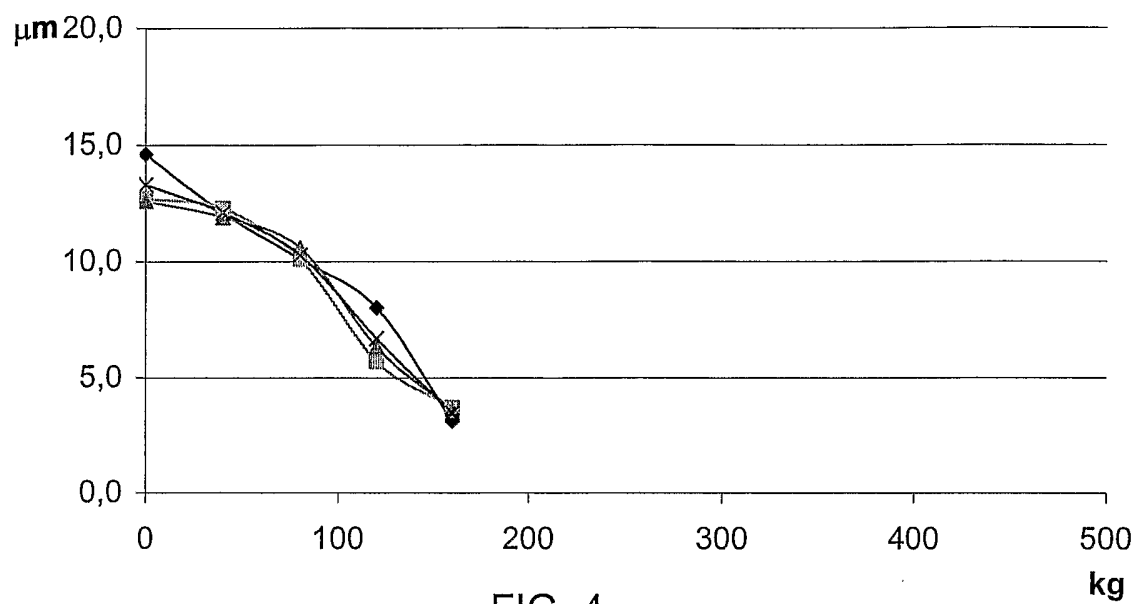


FIG. 4

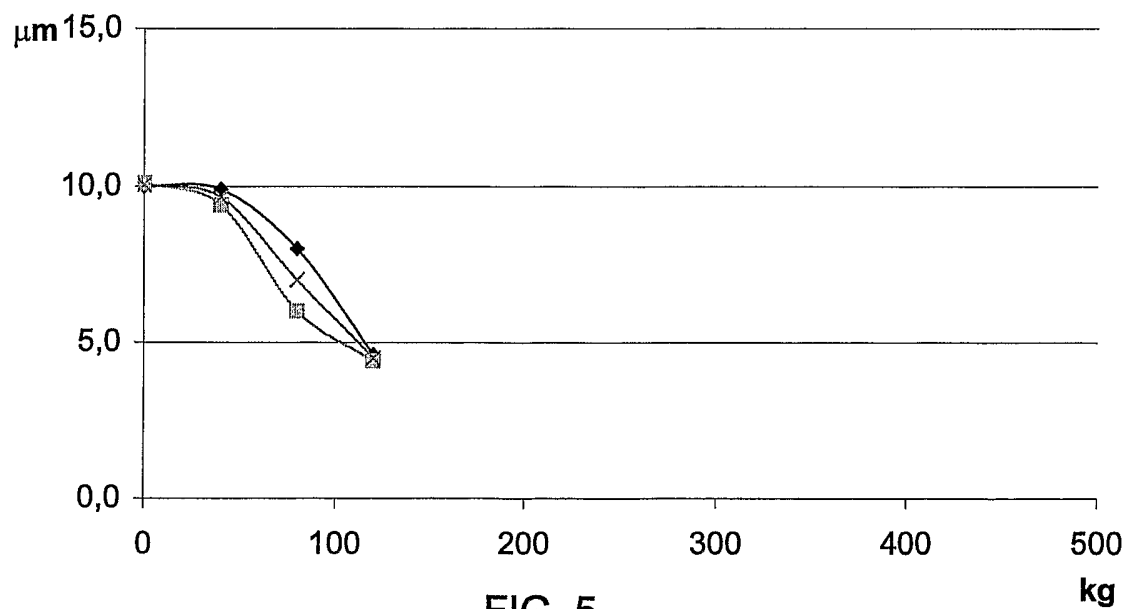


FIG. 5

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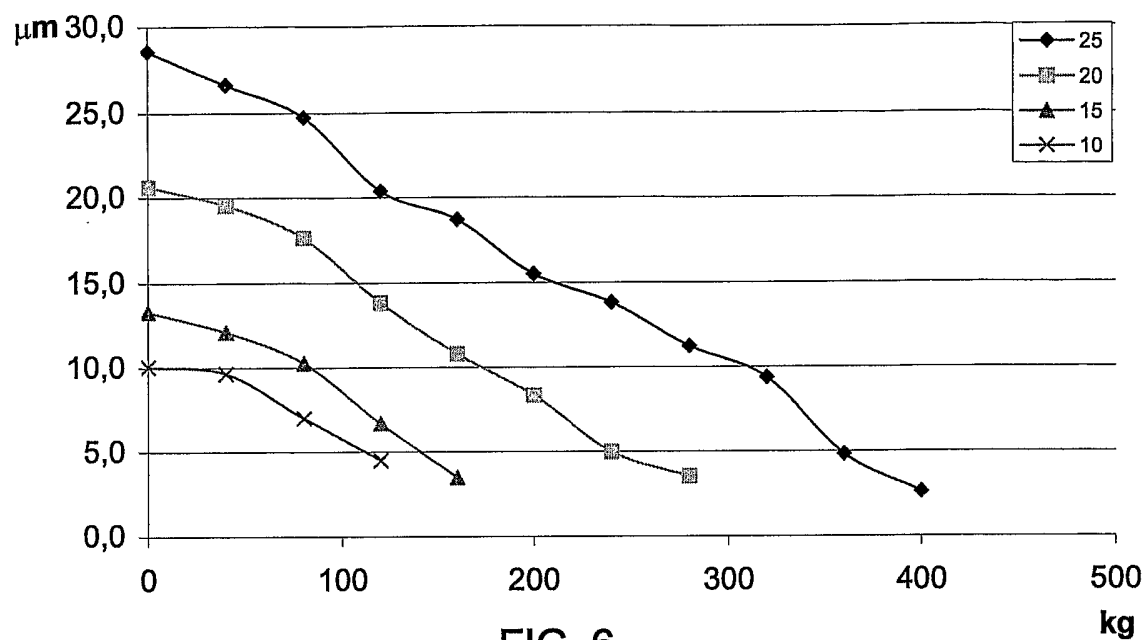


FIG. 6

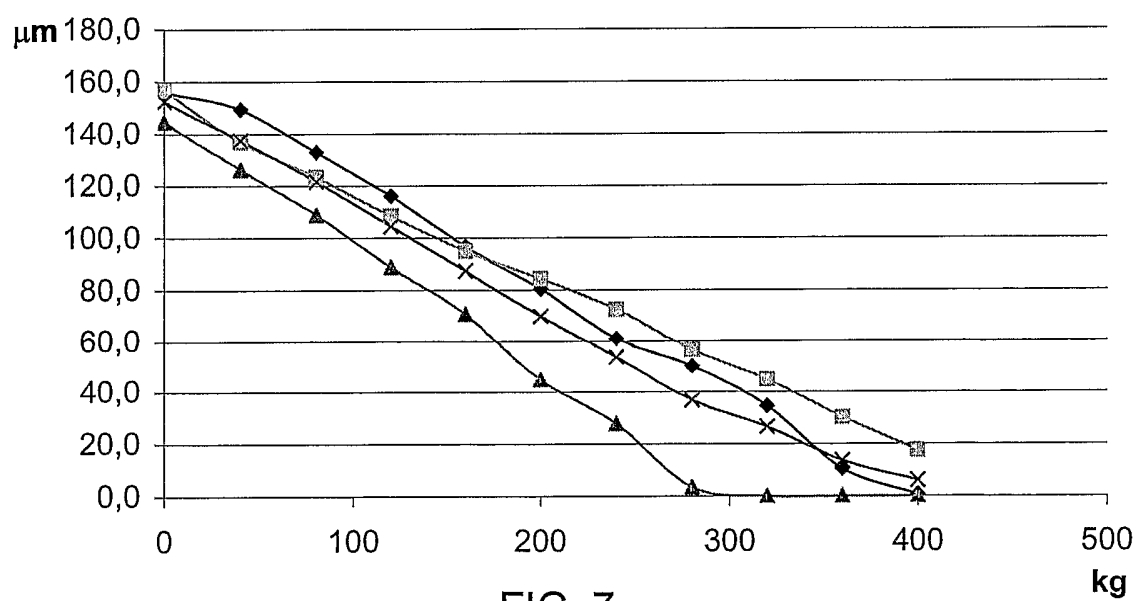


FIG. 7

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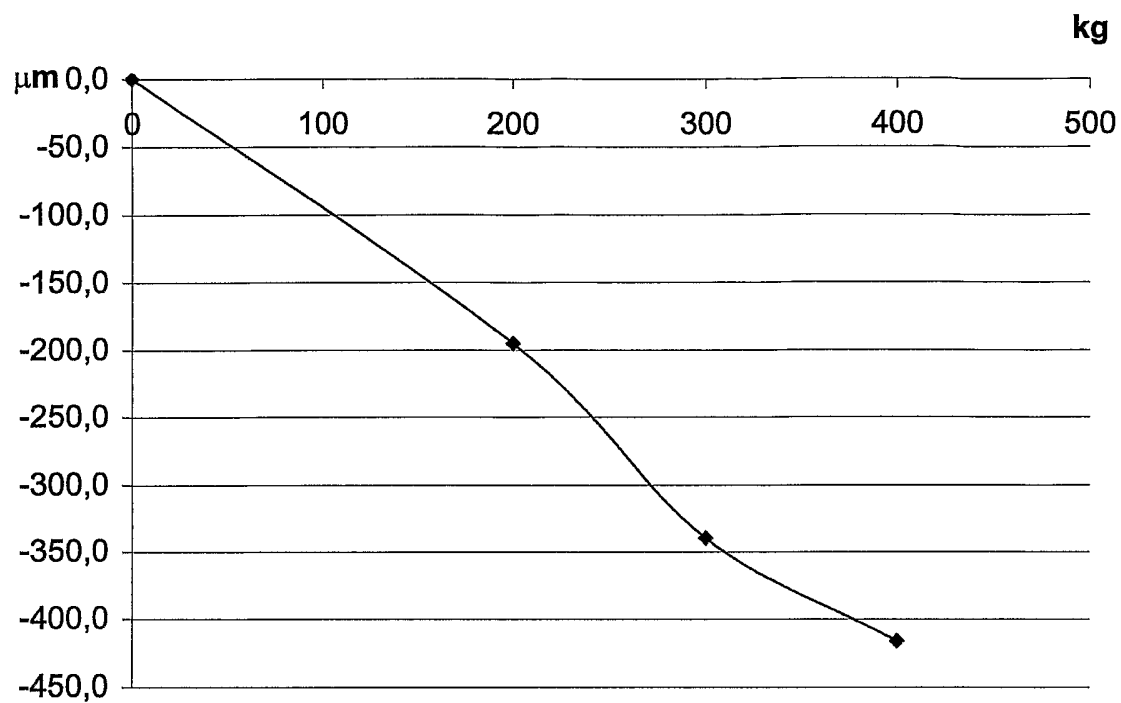


FIG. 8

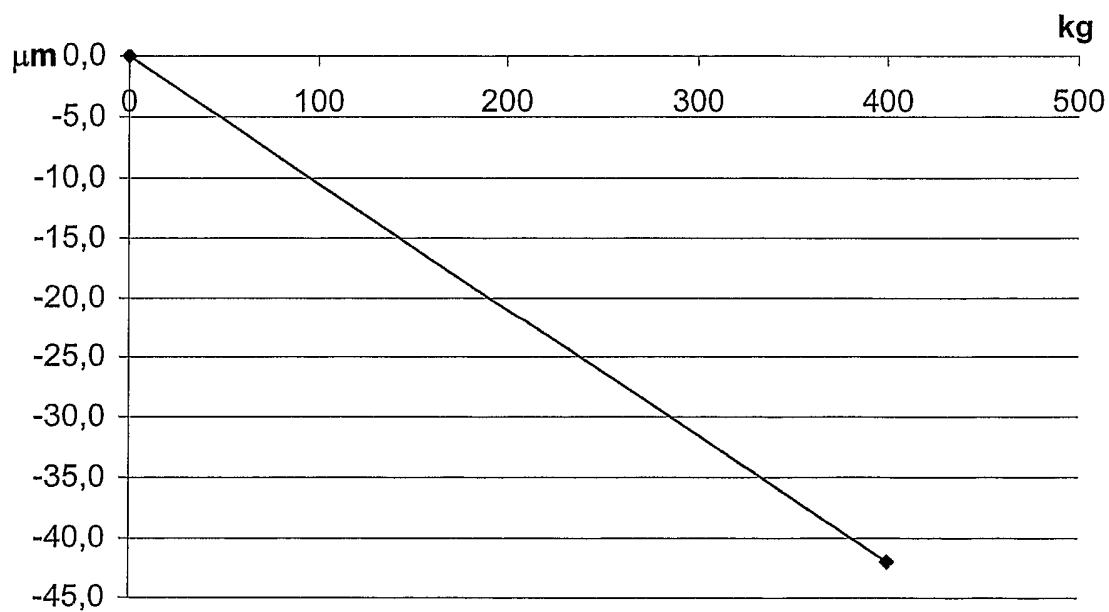


FIG. 9

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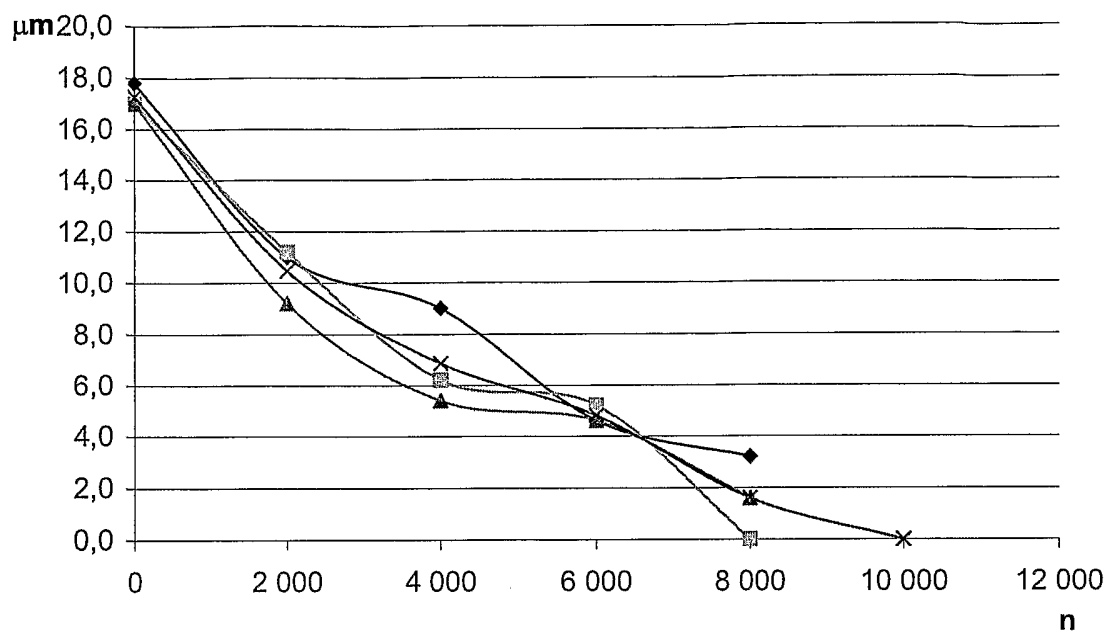


FIG. 10

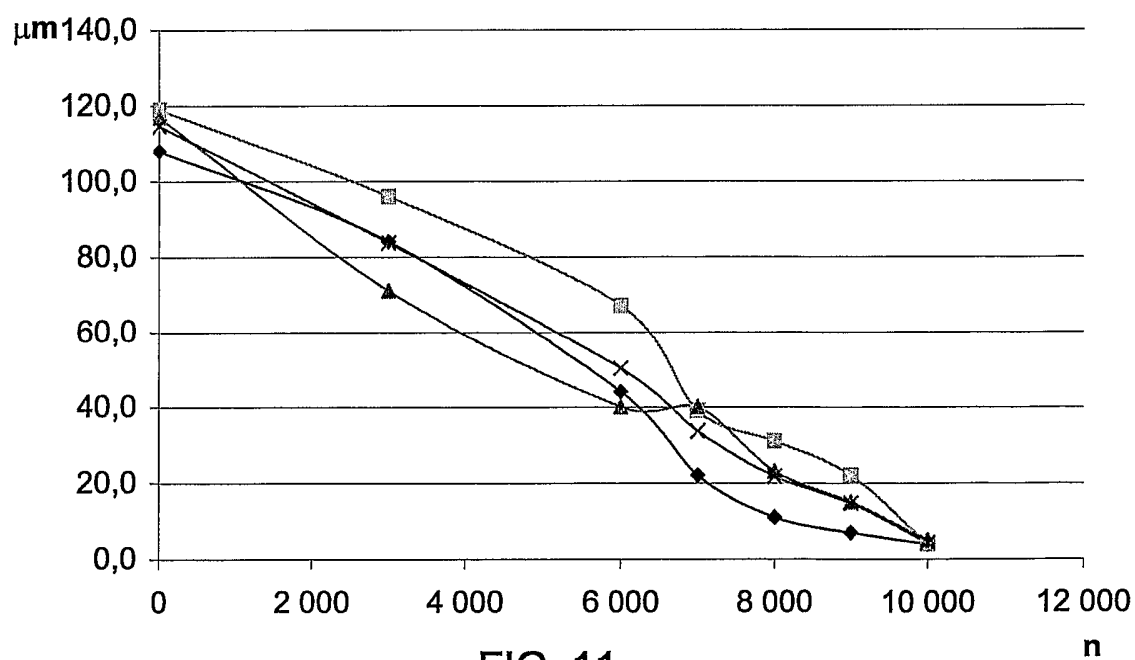


FIG. 11

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 2004/000702

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: C25D 11/08, A47G 21/16, A47K 10/42

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)

IPC7: C25D, A47G, A47K, B65D

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

SE,DK,FI,NO classes as above

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

WPI, EPO-INTERNAL, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CH 507378 A (RIKEN ALMITE INDUSTRY CO., LTD., KAWASAKI), 30 June 1971 (30.06.1971), column 1, line 1 - column 2, line 15; column 3, line 14 - column 8, line 4 --	1-7
X	US 2692851 A (CHARLES F. BURROWS), 26 October 1954 (26.10.1954), column 1, line 1 - column 5, line 60 --	1-6
X	DATABASE WPI Week 199506 Derwent Publications Ltd., London, GB; Class M11, AN 1995-041751 & JP6322590 A, (FUJIKURA LTD et al) 22 November 1994 (1994-11-22) abstract --	1-6

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

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"E" earlier application or patent 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

13 December 2004

Date of mailing of the international search report

15 -12- 2004

Name and mailing address of the ISA/

Swedish Patent Office

Box 5055, S-102 42 STOCKHOLM

Facsimile No. +46 8 666 02 86

Authorized officer

Ingrid Grundfelt/MP

Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 2004/000702

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	FR 2014388 A (GUGGENBERGER MICHEL KG), 17 April 1970 (17.04.1970), page 1, line 29 - page 2, line 7, claim 2 --	1-5
A	US 3919905 A (PAUL D. HOFFMAN), 18 November 1975 (18.11.1975), column 1, line 1 - line 37; column 6, line 22 - line 31, figures 7-13 --	1-7
A	GB 2134374 A (ALI NASSIRI-MOTLAGH), 15 August 1984 (15.08.1984), page 1, line 127 - line 130 -- -----	7

INTERNATIONAL SEARCH REPORT

Information on patent family members

27/11/2004

International application No.

PCT/SE 2004/000702

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				GB	8403471	D	00/00/0000