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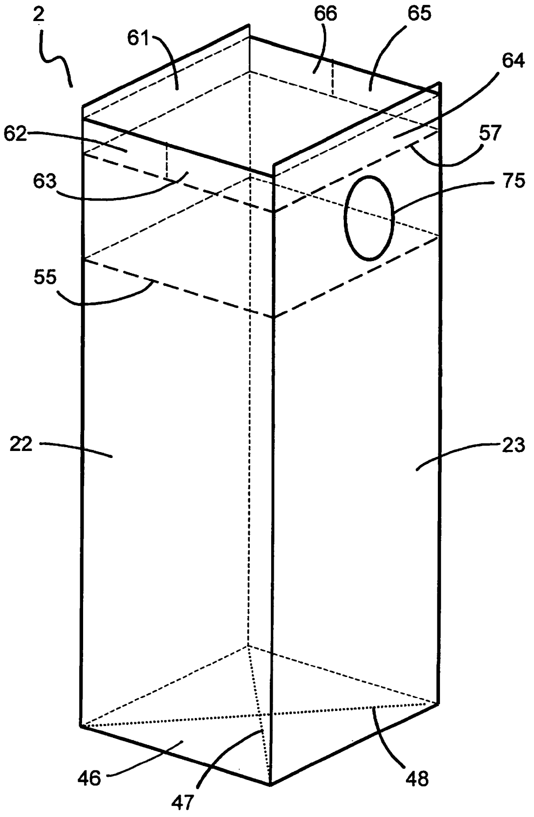
(54) Paperboard container for packaging liquids and process for the manufacture thereof

(57) The present invention relates to a paperboard container for packaging liquids, comprising a polymer which is able to confer the container a high tightness and high mechanical strength, and to a process for the manufacture thereof.

Fig. 2



EP 2 394 815 A1

Description

FIELD OF THE INVENTION

[0001] The present invention relates to a paperboard container for packaging liquids comprising a polymer which is able to confer the container a high tightness and high mechanical strength, and to a process for the manufacture thereof.

BACKGROUND OF THE INVENTION

[0002] Paperboard containers for packaging liquid substances have been known for a long time.

[0003] US patent No. 2,980,304 describes paperboard containers which are made with fibrous paper material and the inner and outer walls of which are lined with a layer of paraffin.

[0004] Today these containers are made using polyethylene-lined paperboard, namely a multilayer laminate, the main component of which is paper. Paper contains cellulose, a hydrophilic polymer, and, consequently, is not suitable on its own for containing liquids.

[0005] For this reason, the paper is combined with very thin films of polymers which are mostly of synthetic origin. In particular, the polyethylene-lined paperboard is made by combining polyethylene with at least one surface of the paperboard. In paperboard containers for packaging liquid substances, the polyethylene lines the inner surface of the container.

[0006] Polyethylene is a thermoplastic resin which may be easily heat-welded, thus avoiding the use of glues and adhesives for manufacture of the container. The outer surface of the container is lined with ethylene vinyl alcohol (EVOH), a resin which is characterized by a high permeability in respect of the inks used for printing of the packaging.

[0007] In the case where the paperboard container is intended to contain liquids for alimentary use, an aluminium foil may be interposed between the paper layer and the inner layer of polyethylene which form the container, in order to protect the contents from light and air which may alter the chemical and physical properties of the alimentary product.

[0008] In order to reduce the environmental impact, the patent WO 99/08939 describes a paperboard container obtained using a smaller quantity of material compared to known containers. In order to avoid using the aluminium foil, which requires a costly production process with a large amount of energy, the patent WO 96/16877 describes the use of a barrier layer which is chemically grafted onto the stiffening layer of the paperboard container. This barrier layer may be made of polyamide, polyvinyl alcohol or polyvinylidene chloride.

[0009] US patent No. 4,206,249 describes a process for producing a paperboard container having a high impermeability in respect of liquids, comprising the steps of (i) applying a solution containing at least one pre-polymer (hot melt) and a photosensitive component, both on the inner surface and on the outer surface of the container, and (ii) irradiating the coated surface with ultraviolet light in order to induce polymerization of the pre-polymer, thereby forming a liquid-impermeable coating. Step (i) is performed by means of air-free spraying of the solution containing the hot melt. The solution used in step (i) has a viscosity of at least 20 poises, at room temperature, and less than 100 centipoises, after heating.

[0010] The technique of applying a hot melt by means of spraying is the most commonly used technique and may be performed, for example, using spiral or gun-type sprayers. Other hot-melt application techniques comprise, for example, systems involving application by means of hot rotors, flat dies, spreading, the drip process and devices for dispersing powders which are subsequently melted.

[0011] The application of hot melts by means of spraying and subsequent UV irradiation, however, is not particularly advantageous. This process is, in fact, inefficient because it envisages long application times. Moreover, this process is not reliable since neither the thickness of the coating nor the degree of crosslinking of the polymer are homogeneous.

SUMMARY OF THE INVENTION

[0012] The Applicant has noted that, during the industrial cycle for packaging of the paperboard containers, problems may arise during operation of the machines which prepare and/or weld the containers. For this reason it is not possible to guarantee, during the continuous industrial manufacturing process, that all the containers forming part of the same batch have a perfect and identical tightness.

[0013] During the industrial packaging process, the sheets of polyethylene-lined paperboard are shaped until they acquire the desired form. Then the zones of the container which come into contact with each other, on the bottom of the container, are heat-welded by means of melting of the polyethylene layer which lines the inner of the container.

[0014] The Applicant has noted that, during this step, points which are not perfectly heat-welded and may adversely affect the tightness of the container, namely the capacity of the container to withstand permeation of fluids, may be formed.

[0015] The liquid may escape from the container via these not perfectly heat-welded points and/or penetrate into the structure of the polyethylene-lined paperboard, causing leakages and/or seeping of the liquid through the bottom of the container and, by means of capillarity, within the walls of the container.

[0016] Consequently, it has been noted that there is also a reduction in the mechanical strength of the container, namely a diminishing of the consistency of the polyethylene-lined paperboard which forms the containers, in particular during storage.

[0017] The Applicant has noted that, if the container has points which are not perfectly heat-welded, the problems of tightness and mechanical strength arise whatever the liquid contained inside the said container. The problem is even more evident if the container contains aggressive liquids (for example, liquids with extreme pH values).

[0018] The Applicant has now found that the application of a polymer inside the container is able to overcome the disadvantages described.

[0019] According to a first aspect, the present invention therefore relates to a paperboard container for packaging liquids, comprising a polyethylene-lined paperboard structure, characterized in that the inner surface of said paperboard container is coated with a layer of at least one polymer chosen from the group consisting of ethylene vinyl acetate (EVA) copolymers; styrene-butadiene-styrene/styrene-isoprene-styrene (SBS-SIS) copolymers; metallocene polyolefin polymers and copolymers; and mixtures thereof with polyolefins.

[0020] In particular, said layer of at least one polymer covers the inner surface of the bottom of said paperboard container and is applied after closing and welding said bottom.

[0021] Preferably, said layer of at least one polymer covers the welding zones of the bottom of said paperboard container. Said welding zones correspond to the portions of the paperboard container which are welded together in order to close the bottom of said container.

[0022] The Applicant has also developed a process for improving the tightness of the container and for ensuring a mechanical strength of the container superior to that provided by the containers at present commercially available.

[0023] According to a second aspect, the present invention relates to a process for manufacturing a paperboard container for packaging liquids, comprising a polyethylene-lined paperboard structure, characterized by a step of applying to the inner surface of said paperboard container at least one polymer chosen from the group consisting of ethylene vinyl acetate (EVA) copolymers; styrene-butadiene-styrene/styrene-isoprene-styrene (SBS-SIS) copolymers; metallocene polyolefin polymers and copolymers; polyolefins; and mixtures thereof.

[0024] The Applicant has found that the polymer used according to the present invention must possess given chemical and physical properties.

[0025] In particular, the polymer must have a good chemical resistance to aqueous dispersions/emulsions/solutions which have a neutral, strongly acidic and strongly alkaline pH value.

[0026] Preferably, the polymer must not contain organic solvents, in order to avoid both costly removal operations before and during use in the industrial process, and deterioration and/or contamination of the container and its contents.

[0027] Advantageously, the polymer must adhere perfectly and stably to the material which forms the inner surface of the container, without however causing deterioration thereof.

[0028] In particular, the polymer must have a flexibility comparable to that of the material onto which its is applied.

[0029] The Applicant has also found that the polymer used according to the present invention must satisfy certain requirements related to the industrial process.

[0030] Advantageously, the polymer used must be stable and able to be easily applied to the operating conditions of the continuous process.

[0031] Preferably, the polymer must has a viscosity at the operating temperature which is compatible with the applicational parameters of the machine used.

[0032] Finally, it must be possible for application of the polymer to take place at a temperature which does not degrade the layer of material which forms the inner surface of the container.

DRAWINGS

[0033]

Figure 1 shows a view of the paperboard container according to the present invention in the unfolded condition;
Figure 2 shows a schematic view of the open paperboard container according to the present invention:
Figure 3 shows a schematic view of the sealed paperboard container according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0034] The present invention therefore relates to a paperboard container comprising a polyethylene-lined paperboard structure, characterized in that the inner surface of said paperboard container is coated with a layer of at least one polymer chosen from the group consisting of ethylene vinyl acetate (EVA) copolymers; styrene-butadienestyrene/styrene-isoprene-styrene (SBS-SIS) copolymers; metallocene polyolefin polymers and copolymers; and mixtures thereof with polyolefins.

[0035] Preferably, said layer of at least one polymer is applied onto the bottom of said paperboard container and even more preferably at least along and around the welding zones of the bottom of said paperboard container.

[0036] Said welding zones correspond to the portions of the paperboard container which are welded together in order to close the bottom of said container.

[0037] Preferably, said polymer is applied after welding the bottom of said paperboard container.

[0038] Preferably, said polymer is solid at room temperature.

[0039] Preferably, said polymer has a softening point higher than 40°C and more preferably between 70°C and 200°C.

[0040] Preferably, said polymer is insoluble in water and is elastic, namely has the capacity to be deformed without breaking when subjected to compression and/or mechanical stressing and to return to its original form when said stressing ceases.

[0041] Preferably, said polymer has a viscosity, measured between 100°C and 180°C, of between 250 and 1800 cPs, more preferably between 400 and 1000 cPs.

[0042] Preferably, said polymer is an ethylene vinyl acetate (EVA) copolymer.

[0043] Advantageously, said polymer is a styrene-butadienestyrene/styrene-isoprene-styrene (SBS-SIS) copolymer;

[0044] Preferably, said ethylene vinyl acetate (EVA) copolymer contains vinyl acetate monomers in a percentage amount of between 5% and 40% by weight.

[0045] Preferably, said EVA has an average molecular weight of between 15,000 and 50,000 Daltons.

[0046] Preferably said EVA has a polydispersity index of at least 6, more preferably of between 7 and 20, said polydispersity index being defined as the weight ratio between the weight average molecular weight and the numeral average molecular weight of said polymer.

[0047] Examples of EVA polymers, which can be used according to the present invention, are the products Icamelt™ 1915 - supplied by the company ICAT (Italy), 99S™- supplied by the company Savarè (Italy), Termomelt™ C747 - supplied by the company Leunberger +C (Crema - Italy).

[0048] Preferably said styrene-butadiene-styrene/styrene-isoprene-styrene (SBS-SIS) copolymer has a styrene content of between 30% and 70% by weight and more preferably of about 50% by weight.

[0049] Preferably, said SBS-SIS has an average molecular weight of between 2,000 and 300,000 Daltons.

[0050] Examples of an SBS-SIS copolymer, which can be used according to the present invention, is the product ET032S™ - supplied by the company Savarè (Italy).

[0051] The metallocene polyolefin polymers and copolymers include, as is well-known in the art, polymerized polyolefin polymers and copolymers using a metallocene catalyst.

[0052] Examples of metallocene polyolefin polymers and copolymers, which can be used according to the present invention, are the products Plastomelt™ Excelta LM1; Plastoflex™ CW MV and Plastoflex™ HS 8741, supplied by the company PARAMELT (Holland).

[0053] With reference to Figure 1, the paperboard container 1 comprises a plurality of lateral elements 21-24 and a sealing element 25.

[0054] Each element 21-25 is divided from a corresponding top element 31-35 by a first horizontal folding line 55. Moreover, each element 21-25 is divided from a corresponding bottom element 41-45 by a second horizontal folding line 56. The individual lateral elements 21-25, top elements 31-35 and bottom elements 41-45 are further divided by vertical folding lines 50-53. Tabs 61-67 are situated at the end of said top elements 31-35 and are divided from said top elements 31-35 by a third horizontal folding line 57. A tab 70 is present next to at least one bottom element. One of the top elements 31-34 is provided with an opening 75 which indicates the area in which the container closure (not shown in Figure 1) will be positioned.

[0055] Preferably said opening is formed in the element 33 and has a circular shape.

[0056] As used in the description and in the following claims, the terms "bottom" and "top" refer to the unfolded view as shown in Figure 1 and to the containers as shown in Figures 2 and 3.

[0057] With reference to Figure 2, the open container 2, according to the present invention, comprises a bottom 46 which is formed during a preliminary step in the process for manufacture of the paperboard container. During this preliminary step, the bottom elements 41-45 and the tab 70 are automatically folded, during a folding step, so as to create zones of contact between said elements 41-45 and said tab 70. Subsequently, during a welding step, welding zones are formed on the bottom of the container, corresponding to said contact zones. Said bottom 46 may have a square, rectangular or other flat shape.

[0058] Preferably, said bottom 46 has a square shape.

[0059] Said welding zones correspond to the portions of the paperboard container which are welded together in order to close the bottom 46 of said container and more particularly correspond to the diagonals 47 and 48 which define the bottom of said container.

[0060] Preferably, said welding zones are formed by means of heat-welding, in particular by means of plates which are heated (to 180°C - 380°C) and which melt the inner polyethylene lining.

[0061] The container 2, as shown in Figure 2, is closed at the bottom and opened at the top.

[0062] With reference to Figure 3, the container 3, according to the present invention, is sealed by means of a packaging machine. The paperboard container 3 comprises a top part 36 which is formed by folding the top elements 31-35 and which is provided with an opening 75 which indicates the area in which the container closure (not shown in Figure 2) will be positioned. Said top part 36 terminates at the top end in a zone 37 obtained by sealing the tabs 61-67. The container 3 also comprises a bottom 46 formed during a preliminary step by folding and sealing the bottom elements 41-45 together.

[0063] The present invention also relates to a process for manufacturing a paperboard container comprising a polyethylene-lined paperboard structure, said process comprising the steps of:

(a) providing an open paperboard container 2;
(b) filling said open paperboard container 2 with a liquid;
(c) folding the upper elements 31-35 and welding the tabs 61-67 of said open paperboard container 2 so as to obtain the sealed paperboard container 3;

characterized in that said process comprises a step of applying to the inner surface of said paperboard container at least one polymer chosen from the group consisting of ethylene vinyl acetate (EVA) copolymers; styrene-butadiene-styrene/styrene-isoprene-styrene (SBS-SIS) copolymers; metallocene polyolefin polymers and copolymers; polyolefins; and mixtures thereof; said application step being performed between the step (a) and the step (b) of said process.

[0064] Preferably, said polymer is applied onto the bottom of said paperboard container and even more preferably said polymer is applied at least along and around the welding zones on the bottom of said paperboard container.

[0065] Preferably, said polymer is applied by means of spray or atomization of at least one liquefied polymer. More preferably, said polymer is applied by means of spray of at least one liquefied polymer.

[0066] Preferably, said spray of a liquefied polymer is performed at a temperature of the polymer of between 50°C and 300°C and more preferably at a temperature of 180°C.

[0067] Preferably, said spray of a liquefied polymer is performed at a pressure of between 5 and 60 bar and more preferably between 20 and 40 bar. Advantageously, of about 30 bar.

[0068] Preferably, said spray of a liquefied polymer is performed via a nozzle comprising 1 to 10 spray channels.

[0069] Preferably, said nozzle comprises one channel and the polymer is applied by means of at least five spray, said spraybeing performed during the continuous industrial manufacturing process in a single station or in five successive stations.

[0070] More preferably, said nozzle comprises five channels and the polymer is applied by means of a single spray performed in a single station during the continuous industrial production process.

[0071] Preferably, said nozzle comprising five channels is designed so as to have a central channel and four lateral channels arranged symmetrically with respect to the central channel.

[0072] Preferably, said central channel is perpendicular to the resting plane of the container.

[0073] Advantageously, said lateral channels are arranged so that the spray angle is between 1° and 45° relative to the vertical and more preferably is between 5° and 20° relative to the vertical. Advantageously the spray angle is 8° relative to the vertical.

[0074] Preferably, said five channels are formed so as to direct the spray of liquefied polymer respectively towards the point of intersection of the diagonals crossing the bottom of the container and near to the four corners of the container bottom.

[0075] Preferably, each of said five channels has a diameter of between 0.1 and 5 mm and more preferably of 0.5 mm.

[0076] Preferably, the spray time of said polymer is between 0.05 and 0.50 seconds and more preferably is equal to or less than 0.2 seconds. Advantageously said spray time is between 0.10 and 0.15 seconds.

[0077] Preferably, said spray of a liquefied polymer is performed at a height of between 1 and 60 cm and more preferably at about 30 cm from the bottom.

[0078] Preferably said spray of a liquefied polymer is followed by a step involving blowing of pressurized air, said blowing step having the aim of spreading the polymer on the bottom of the container.

[0079] Preferably, said blowing of pressurized air is performed at a temperature of the air of between 5°C and 200°C, preferably between 10°C and 170°C, and even more preferably at a temperature of between 20°C and 130°C.

[0080] Preferably, said blowing of pressurized air is performed at a pressure of between 0.1 and 10 bar and more preferably between 1 and 6 bar.

[0081] Preferably, said blowing of pressurized air is performed by means of a gun comprising a nozzle having from 1 to 10 channels and more preferably having five channels.

[0082] Preferably, the blowing angle of said channels is between 1° and 45° relative to the vertical and more preferably is 43° relative to the vertical.

[0083] Preferably, each of said five channels has a diameter of between 0.1 and 5.0 mm and more preferably of 2.0 mm.

[0084] Preferably, the pressurized air blowing time is between 0.1 and 5.0 seconds and more preferably is between 1.0 and 1.5 seconds.

[0085] Preferably, the overall time for spray of the liquefied polymer and blowing of the pressurized air is between 1 and 5 seconds and more preferably is between 2 and 4 seconds.

[0086] Preferably, said blowing of pressurized air is performed at a height of between 1 and 60 cm and more preferably is performed at about 3 cm from the bottom.

[0087] Preferably, the welding performed during steps (a) and (c) is performed by means of heat-welding using heating plates.

[0088] Preferably, said heating plates have a temperature of between 200° and 380°C and preferably of about 280°C. Advantageously, the duration of contact between said heating plates and the bottom of the paperboard container 2 is between 0.5 and 8 seconds and preferably between 2 and 4 seconds.

[0089] Preferably, said manufacturing process comprises a step involving sterilization of said open paperboard container 2.

[0090] The following examples illustrate further the invention without, however, limiting it in any way.

EXAMPLES

Test A- Evaluation of the physical and application characteristics of polymers which can be used as a coating for the polyethylene-lined paperboard container.

[0091] The following polymers 1-18 have been considered. All these polymers are inert in relation to the polyethylene which lines the inner surface of the paperboard container and may be applied at a temperature lower than the melting point of the polyethylene.

1. Paraffin (solid hydrocarbon) supplied by the company SER (Torino - Italy) with a melting point (m.p.) of 56-58°C.
2. Mixture composed of 70% paraffin (polymer 1) and 30% of the hydrocarbon fluid EXXOL™ D40 (distillation fraction 162-202°C), supplied by the company EXXON (USA).
3. Mixture composed of 70% paraffin (polymer 1) and 30% of the silicone fluid TEGOPREN™ 6924 (amino functional silicone oil, 100% concentration), supplied by the company TEGO (Germany).
4. Polyethylene, VESTOWAX™ A01535, supplied by the company EIGENMANN & VERONELLI S.p.A. (Rho, Milan - Italy) with m.p. 110 °C.
5. Isotactic polypropylene (PP - synthetic polymer) supplied by the company FRANA POLIFIBRE (Bergamo - Italy) with m.p. 160°C.
6. Ethylene vinyl acetate (EVA - synthetic polymer) supplied by the company ESSEBI (Italy) with m.p. 150°C.
7. PLASTOMELT® EXCELTA LM1 (complex mixture of resins, polymers and refined hydrocarbon waxes) supplied by the company PARAMELT (Holland) with m.p. 160°C.
8. PLASTOFLEX® CW MV (complex mixture of resins, polymers and refined hydrocarbon waxes) supplied by the company PARAMELT (Holland) with m.p. 130°C.
9. Mixture composed of 50% PLASTOMELT® EXCELTA LM1 (polymer 7) and 50% PLASTOFLEX® CW MV (polymer 8), with m.p. 150°C.
10. PLASTOFLEX® HS 8741 (complex mixture of resins, polymers and refined hydrocarbon waxes) supplied by the company PARAMELT (Holland) with m.p. 140°C.
11. ICAMELT™ 1915 (ethylene vinyl acetate copolymer characterized by low viscosity at 180°C and very long solidification temperature) supplied by the company ICAT (Italy), with m.p. 150°C.
12. Mixture composed of 30% VESTOWAX™ A01535 (polymer 4) and 70% ICAMELT™ 1915 (polymer 11).
13. Linxar™ 101 (metallocene polypropylene), supplied by the company EXXON MOBIL (Italian distributor SAVARE'), with m.p. 150°C.
14. 99S™ (ethylene vinyl acetate copolymer) supplied by the company SAVARE' (Italy), with m.p. 130°C.
15. ET032S™ (complex polymer based on hot-melt thermoplastic rubber, styrene-butadiene-styrene/styrene-isoprene-styrene) supplied by the company SAVARE' (Italy), with m.p. 110°C.
16. Mixture composed of 25% PLASTOMELT® EXCELTA LM1 (polymer 7), 25% PLASTOFLEX® HS 8741 (polymer 10) and 50% EVA (polymer 6), with m.p. about 145°C.
17. TERMOMELT™ C747 (ethylene vinyl acetate copolymer characterized by low viscosity at 180°C and very long solidification temperature) supplied by the company Leunberger +C (Milan - Italy), with m.p. 150°C.
18. TERMOMELT™ ECOTOP 12 (metallocene propylene) supplied by the company Leunberger +C (Milan - Italy).

[0092] The polymers 1-18 were heated to a temperature higher than the respective melting points, but lower than their decomposition temperatures, until a homogeneous liquid was obtained. In the case where the polymer consisted of a mixture of different materials, their compatibility was verified, checking at the above-mentioned temperatures for the possible presence of separate phases.

[0093] After obtaining a homogeneous liquid and, optionally, with a single phase (demonstrating the compatibility between the different polymers forming the mixture), the temperature of each polymer was lowered by 5°C.

[0094] 5g of the melted mass were applied onto an open sheet of polyethylene paperboard and immediately spread with the aid of a metallic steel blade until a homogeneous film of 0.2 mm thickness (±0.1) was obtained. The film was allowed to cool down for 15 minutes until it reached room temperature (about 20°C) and, after checking for solidification of the polymer, the characteristics shown in the following Table 1 were evaluated for each of them.

[0095] In Table 1 the viscosity has been evaluated for each polymer at the application temperature.

Table 1

	Application temperature (°C)	Viscosity (cPs)	Elasticity	Adhesion
1	100	200	very poor	good
2	100	180	poor	poor
3	100	Not evaluated		
4	150	250	adequate	good
5	200	1800	poor	good
6	180	1900	excellent	good
7	180	1200	excellent	good
8	160	300	very poor	good
9	180	600	good	good
10	180	700	good	good
11	180	400	good	good
12	180	600	good	good
13	180	900	good	poor
14	170	600	good	good
15	150	500	excellent	excellent
16	170	500	good	good
17	180	600	good	good
18	180	800	good	poor

[0096] The polymers 1, 2, 3, 5, 8, 13 and 18 did not have suitable application properties. In particular, the polymers 1, 2, 5, 8, 13 and 18 did not possess good elasticity; in other words they were not flexible enough in relation to the open sheet of polyethylene-lined paperboard and/or did not adhere perfectly to said sheet. The polymer 3, instead, had two immiscible phases after melting.

[0097] The polymers 4, 6, 7, 9-12 and 14-17, instead, had both a good elasticity, namely a flexibility comparable to that of the open sheet of polyethylene-lined paperboard and a good adhesion to said sheet. These polymers were subjected to chemical resistance tests.

Test B - Tests for resistance to chemical agents

[0098] The aim of these tests was to find chemical compounds which could accelerate and, at the same time, highlight the permeability process in untreated containers.

[0099] The untreated containers, model Gable Top 1000 ml, used in the following examples, were provided by Italpack Cartons (Avellino). These containers have a square base with a side dimension 72 mm, height of 236 mm and thickness of 0.5 mm. The internal lining consists of polyethylene and the external lining consists of EVOH. These containers were packaged using the packaging machine RG21 UCS, series B-style, produced by GALDI (Treviso).

Test B-1 (comparison test with ethanol)

[0100] During this test ethanol was used, i.e. a short-chain alcohol, the properties of which as solvent and soaking agent, which does not create major pollution problems, are well-known.

[0101] In order to demonstrate that ethanol was a suitable comparison product which could rapidly highlight the tightness defects of a paperboard container in critical conditions, two untreated containers with welding defects were filled with a mixture of ethanol and a dye (Basic Yellow 29), which has the specific and sole function of a tracer, and were stored under different conditions. The first container was stored at room temperature (20°) and the second container was stored in an oven at a constant temperature of 50°C in order to amplify the soaking power of ethanol and to further reduce the tightness time.

[0102] The evaluation was carried out repeatedly by means of a visual inspection at 1-hour intervals, checking to see whether there were any collapsed points on the outer surface of the containers and in particular on the bottom of the container.

[0103] In both cases, the impermeability time was very brief: in the case of the first container, stored at room temperature (20°C), it was 12 hours and, in the case of the second container, stored at 50°C, it was only 2 hours.

[0104] The term "impermeability time" is understood as meaning the time which lapses from the start of the test to the appearance of the first signs of leakage of the liquid highlighted by the dye.

[0105] These results show that with the method used it is possible to evaluate rapidly the behavior of the untreated containers and identify immediately those containers which had a tightness defect.

<u>Test B-2 (comparison test with complex mixtures)</u>

[0106] The aim of this test was to evaluate the resistance to chemical agents of varying types and check which mixture, from among those tested, was the most aggressive one for use in the subsequent tests, so that an indication of the effective degradation of the polymers could be obtained within a short space of time.

[0107] The test was carried out using untreated paperboard containers with welding defects, introducing the following complex mixtures (in the form of an aqueous solution/dispersion/emulsion) directly into the containers.

[0108] The following mixtures were chosen on the basis of the chemical properties which were considered to be critical both as regards the chemical composition and for the various final pH values. A dye with the specific function of a tracer was added to each mixture.

Mixture 1 (pH between 7 and 8)

-	Water	q.s. at 100
-	C12-15 pareth-7	about 10%
-	Benzene sulfonic acid, mono-c10-13-alkyl derivatives, sodium salts	5-10%
-	Isodeceth-5	5-10%
-	Sodium cumene-sulfonate	10-15%
-	Sodium c10-16 pareth-2 sulfate	< 5%
-	Trisodium HEDTA	1-2%
-	Perfume	< 1%
-	Dimethicone	< 1%
-	Alpha amylase	< 1%
-	Hydroxyethyl laurdimonium chloride	< 1%
-	Protease (subtilisin)	< 1%
-	Fluorescent brightener 134	< 1 %
-	Diethylene glycol	< 1%
-	Dye	< 1%

Mixture 2 (pH 8)

-	Water	q.s. at 100
-	Benzenesulfonic acid, mono-c10-13-alkyl derivatives, sodium salts	5-10%
-	C11-13 pareth-9	< 5%
-	Sodium cumene-sulfonate	2-3%
-	C12-15 pareth-7	1-2%
-	Sodium c10-16 pareth-2 sulfate	1-2%
-	Sodium polyacrylate	< 1%
-	Perfume	< 1%

(continued)

Mixture 2 (pH 8)		
-	Sodium diethylenetriamine pentamethylene phosphonate	< 1%
-	Dimethicone	< 1%
-	Hydroxyethyl laurdimonium chloride	< 1%
-	Dye	< 1%
Mixture 3 (pH 6)		
-	Water	q.s. at 100
-	C12-15 pareth-7	5-10%
-	Sodium cumene-sulfonate	about 10%
-	Benzenesulfonic acid, mono-c10-13-alkyl derivatives, sodium salts	7-10%
-	Isopropyl alcohol	about 5%
-	Trisodium HEDTA	1-2%
-	Perfume	< 1%
-	Hydroxyethyl laurdimonium chloride	< 1%
-	Dye	< 1%
Mixture 4 (pH 2.5)		
-	Water	q.s. at 100
-	Dihydrogenated tallow hydroxyethyl ammonium methosulfate	10-15%
-	Perfume	< 1%
-	Isopropyl alcohol	1-2%
-	Dimethicone	< 1%
-	Hydroxyethyl laurdimonium chloride	< 1%
-	Dye	< 1%
Mixture 5 (pH between 8 and 9)		
-	Water	q.s. at 100
-	Benzene sulfonic acid, mono-c10-13-alkyl derivatives, sodium salts	4-6%
-	Trideceth-8	2-3%
-	Sodium cumene-sulfonate	2-3%
-	Sodium c10-16 pareth-2 sulfate	1-2%
-	Sodium citrate	< 1%
-	Sodium polyacrylates	< 1%
-	Perfume	< 1%
-	Trisodium HEDTA	< 1%
-	Hydroxyethyl laurdimonium chloride	< 1%
-	Dye	< 1%
Mixture 6 (pH 12)		
-	Water	q.s. at 100
-	Tetrasodium pyrophosphate	8%
-	Sodium silicate	6-7%
-	Pentasodium triphosphate	4%
-	Sodium ethylhexyl sulfate	2-3%
-	Dimethicone	< 1%
-	Xanthan rubber	< 1%
-	Perfume	< 1%
-	Dye	< 1%
-	Sodium hypochlorite	< 1%

[0109] The paperboard containers, filled with each of the above mixtures, were stored in an oven at a constant temperature of 50°C. As already described above, this high temperature amplifies the soaking power of the mixtures, reducing the tightness time.

[0110] All the tests were carried out in triplicate in order to obtain a greater incidence in respect of any packaging error of the container and achieve more significant results. The evaluation of the physical condition of the containers was carried out by means of a visual inspection after 24 hours.

[0111] It was found that the containers with mixture 3 collapsed already after 72 hours.

[0112] The containers with the other mixtures, after 5 days of storage, showed signs of deterioration in their appearance and consistency.

Test C - Tests for resistance to chemical agents

[0113] A sheet of polyethylene-lined paperboard yet to be folded was arranged in the form of a bowl able to receive the liquid products. Small holes were then made in the base of the polyethylene-lined paperboard with a needle. The polymers selected during the preceding test A (polymers 4, 6, 7, 9-12 and 14-17) were applied inside these containers, ensuring that the perforated parts were covered, and then filled with ethanol and with mixtures 1 to 6 (used during the comparison test B-2). The test was duplicated for each polymer.

[0114] The polymers were deposited in accordance with standard conditions (as described in Test A), in particular:

- melting temperature of polymers: 180°C
- application of the liquefied polymers with the aid of a steel blade so as to form a homogeneous film with a thickness of 0.2 mm (± 0.1-0.3 mm);
- temperature of the substrate: 20°C;
- Solidification time: 15 minutes until complete hardening.

[0115] The containers thus prepared were stored in an oven at a constant temperature of 50°C and inspected after 24 hours.

[0116] The following Table 3 shows the maximum number of storage days without signs of defects (for example, leakages and/or softening) in the containers.

Table 3 - Number of days stored in oven at 50°C

Polymer	Ethanol	Mix1	Mix 2	Mix 3	Mix 4	Mix 5	Mix 6
4	5	30	30	15	30	30	30
6	30	30	30	30	30	30	30
7	5	30	30	15	30	30	30
9	5	30	30	15	30	30	30
10	5	30	30	15	30	30	30
11	5	30	30	15	30	30	30
12	5	30	30	15	30	30	30
14	5	30	30	15	30	30	30
15	30	30	30	30	30	30	30
16	5	30	30	15	30	30	30
17	5	30	30	15	30	30	30

[0117] The results obtained show that all the compositions used for coating the containers were able to ensure a significant increase in the tightness and mechanical strength, even under critical conditions.

[0118] In particular, in the test using ethanol, the material treated with the polymers shown in Table 3 started to deteriorate after five days of storage at 50°C and even only after 30 days in the case of the polymers 6 and 15 (while in test B-1, the untreated containers at 50°C collapsed in 2 hours).

[0119] Similarly, in the test using mixture 3, the material treated with the polymers shown in Table 3 started to deteriorate after 15 days and even only after 30 days in the case of the polymers 6 and 15 (while in the case of B-2 the untreated containers with mixture 3 at 50°C collapsed in 72 hours).

[0120] Finally, in the tests using the other mixtures (1-2, 4-6), there were no signs of any defects in the material treated with the polymers according to Table 3 after 30 days (while, in the case of test B-2, the untreated containers with the other mixtures at 50°C showed signs of a deterioration in appearance and consistency already after 5 days).

[0121] At the same time a test was carried out to compare the behavior of the containers when stored at room temperature.

[0122] In the test using ethanol, the material treated with the polymers according to Table 3 started to deteriorate after 70 days of storage at 20°C and even only after 180 days in the case of the polymers 6 and 15 (while in test B-1, the untreated containers at 20° C collapsed in 12 hours).

[0123] Similarly, in the test using mixture 3, the material treated with the polymers according to Table 3 started to deteriorate after 120 days of storage at 20°C and even only after 180 days in the case of the polymers 6 and 15.

[0124] Finally, in the tests using the other mixtures (1-2, 4-6), there were no signs of any defects in the material treated with the polymers according to Table 3 even after 365 days of storage at 20°C.

Test D - Application in the industrial process

Characteristics of the machine used

[0125] The machine for applying these polymers was chosen from the machines produced by the company PREO (Corsico, Milan).

[0126] The machine used (EASY 10KG, SERIES W, GEAR PUMP, supplied by the company PREO) had a melting section where the polymer is liquefied by means of heating (operating temperature between 50° and 230°C), a pump for spray the liquefied polymer (maximum operating pressure 60 bar) and a gun (gun, series NEW LIFE) for performing spray, controlled by an electric valve. Moreover, the following parameters had to be observed during application of the polymer:

- temperature of the polymer contacting the surface of the container: less than 200°C;
- quantity of polymer sprayed: less than or equal to 3.0 g;
- spray process time: less than or equal to 2 seconds.

[0127] Application test performed on a container with closed bottom

[0128] The following tests were carried out on a packaged container open at the top end.

[0129] In order to perform the tests indicated below, the polymer 15 used in Test A was chosen on the basis of both its chemical and physical properties and the results obtained in Test C.

[0130] During the tests it was avoided inserting the gun inside the paperboard container since the time available for depositing the polymer during the continuous industrial process was very short (less than 3 seconds).

[0131] The following Table 5 summarizes the main operating conditions during the tests (e-m).

[0132] In all the tests (e-m), the polymer spray height, understood as being the distance between the end of the nozzle and the bottom of the container, was kept at 30 cm and the quantity of sprayed polymer was always equivalent to 3.0 grammes.

[0133] In the tests (e-f-i), the polymer and the air were respectively sprayed and blown through the same nozzle, under the conditions shown in Table 5.

[0134] In the test (h), instead, the polymer was sprayed through the nozzle and the air blown at high pressure using a gun.

[0135] In the test (m) the machine used was prepared with an air blowing station situated after the polymer spray station. The gun, which had a nozzle with 5 channels, diameter of 2.0 mm and blowing angle of 43°, was inserted down to a height of about 3 cm from the bottom of the container. The air spray height was kept at 3 cm.

Table 5

	Test e(*)	Test f(*)	Test g(*)	Test h(*)	Test i	Test l	Test m
No. of channels in the nozzle	1	1	4	1	1	5	5
No. of polymer spray	1	1	1	1	5	1	1
Polymer spray time (s)	0.1	0.1	0.1	0.1	0.1	0.1	0.15
Air blowing time (s)	1.3	1.3	-	1.3	1.3	-	1.3
Spray of polymer followed by air	yes	-	-	yes	yes	-	yes
Spray of polymer and air together	-	yes	-	-	-	-	-
Spray pressure of the polymer (bar)	30	30	30	30	30	30	30
Air blowing pressure (bar)	< 2.0	< 2.0	-	6.0	< 2.0	-	6.0

(continued)

	Test e(*)	Test f(*)	Test g(*)	Test h(*)	Test i	Test l	Test m
Polymer temperature (°C)	180	180	180	180	180	180	180
Air temperature (C°)	130	130	-	130	130	-	20
(*) comparison							

[0136] Test (e) produced an unsatisfactory result since the polymer did not spread in a uniform manner, probably because, within the closed containers, there was turbulence in the air which affected the linear travel of the latter in relation to the polymer.

[0137] Even when the polymer and air spray mode was changed (test f) a satisfactory result was not achieved since the air, not being sufficiently hot, caused rapid solidification of the polymer which consequently did not adhere to the bottom of the container. Moreover, after spraying, solid filaments were present on the walls of the container.

[0138] Test (g) was conducted using a nozzle with four channels directed along the corners of the container bottom (inclination of 9° relative to the vertical). The result was not satisfactory both because, without air, the polymer was not suitably spread and because the point of intersection of the diagonals on the container bottom was untreated and consequently tightness was not ensured.

[0139] Test (h) was conducted increasing the air blowing pressure up to 6.0 bar. In this case the polymer was spread properly, but a single polymer spray was still insufficient to cover the critical points on the bottom of the container.

[0140] Test (i) was therefore conducted using a nozzle with one channel, but spraying the polymer five times at the desired points, namely at the points where diagonals on the bottom of the container intersect and in the corners of the container bottom. Despite the fact that the pressure of the air was less than 2.0 bar, the result was satisfactory because the five spray were aimed at the critical points on the container bottom.

[0141] In order to reduce the time required for application of the polymer during the industrial process, a nozzle with five channels was developed (test l), this nozzle being characterized by a specific geometry which allowed spray of the liquefied polymer in a single spray in the five desired positions.

[0142] In particular, said nozzle had five channels, one of which was perpendicular to the point of intersection of the diagonals on the bottom of the container and the other four of which were directed along the diagonals into the vicinity of the corners of the bottom of said container. Each of these four channels had an angle of 8° relative to the perpendicular channel. The five channels each had a diameter of 0.5 mm. The application operation produced positive results.

[0143] Finally, test (m) was conducted using the same nozzle as in test (l), but with air being blown after the polymer spraying step, at a pressure of 6.0 bar and at a temperature of 20° C. The application operation produced positive results.

Test E - Stability tests for the paperboard containers according to the present invention

[0144] Seven containers, obtained using the procedure (m) described in the previous test D, were filled with mixtures 1 to 6 (described above). All the containers were stored in an oven at a constant temperature of 50°C and inspected at 24-hour intervals over a period of six months.

[0145] At the end of the test period, the appearance and consistency of all the containers remained unchanged.

[0146] The results obtained showed that the container according to the present invention ensures a high tightness and mechanical strength compared to the containers which have not been treated.

Test F - Stability tests for paperboard containers with simulation of a packaging defect

[0147] This test was conducted deliberately simulating a packaging defect in the containers in order to demonstrate further the validity of the present invention.

[0148] In particular, the containers indicated below were all manufactured using a temperature of 250°C for heat-welding the bottom of the container. This temperature is lower than the temperature normally used (300° C) and simulates a situation which could actually occur during the continuous industrial process, with consequent defects in the tightness of the containers.

[0149] The containers were stored at 50°C and the tests were conducted in triplicate. Evaluation was carried out by means of a visual inspection, if necessary with the test being voluntarily interrupted after 6 months.

[0150] Table 7 below shows the impermeability time values recorded for the untreated containers and the containers treated using the procedure (m) of Test D.

Table 7

Contents	Impermeability time of untreated containers*	Impermeability time of treated containers
Mixture 1	240 minutes	6 months
Mixture 2	120 minutes	6 months
Mixture 3	60 minutes	6 months
Mixture 4	180 minutes	6 months
Mixture 5	180 minutes	6 months
Mixture 6	120 minutes	6 months
(*) comparison		

[0151] The results obtained showed that the container according to the present invention ensures a greater tightness during the storage period.

Claims

1. A paperboard container (2,3) for packaging liquids, comprising a polyethylene-lined paperboard structure (1), **characterized in that** the inner surface of said paperboard container (2,3) is coated with a layer of at least one polymer chosen from the group consisting of ethylene vinyl acetate (EVA) copolymers; styrene-butadiene-styrene/styrene-isoprene-styrene (SBS-SIS) copolymers; metallocene polyolefin polymers and copolymers; and mixtures thereof with polyolefins.

2. The paperboard container (2,3) according to Claim 1, **characterized in that** said layer of at least one polymer covers the inner surface of the bottom (46) of said paperboard container (2,3).

3. The paperboard container (2,3) according to Claim 2, **characterized in that** said layer of at least one polymer covers the welding zones (47,48) of the bottom of said paperboard container (2,3).

4. The paperboard container (2,3) according to Claim 1, **characterized in that** said polymer has a softening point higher than 40°C, preferably between 70°C and 200°C.

5. The paperboard container (2,3) according to Claim 1, **characterized in that** said polymer has a viscosity, measured between 100°C and 180°C, of between 250 and 1800 cPs, preferably between 400 and 1000 cPs.

6. The paperboard container (2,3) according to Claim 1, **characterized in that** said polymer is an ethylene vinyl acetate (EVA) copolymer.

7. The paperboard container (2,3) according to Claim 1, **characterized in that** said polymer is a styrene-butadienestyrene/styrene-isoprene-styrene (SBS-SIS) copolymer.

8. The paperboard container (2,3) according to Claim 1, **characterized in that** said polymer is a metallocene polyolefin polymer or copolymer and mixtures thereof with polyolefins.

9. A process for manufacturing a paperboard container comprising a polyethylene-lined paperboard structure (1), said process comprising the steps of:

   (a) providing an open paperboard container (2);
   (b) filling said open paperboard container (2) with a liquid;
   (c) folding the upper elements (31-35) and welding the tabs (61-67) of said open paperboard container (2) so as to obtain the sealed paperboard container (3);

   characterized in that said process comprises a step of applying to the inner surface of said paperboard container at least one polymer chosen from the group consisting of ethylene vinyl acetate (EVA) copolymers; styrene-butadiene-styrene/styrene-isoprene-styrene (SBS-SIS) copolymers; metallocene polyolefin polymers and copolymers;

polyolefins; and mixtures thereof; said application step being performed between the step (a) and the step (b) of said process.

10. The process for manufacturing a paperboard container according to Claim 9, **characterized in that** said polymer is applied onto the bottom of said paperboard container.

11. The process for manufacturing a paperboard container according to Claim 10, **characterized in that** said polymer is applied along and around the welding zones.

12. The process for manufacturing a paperboard container according to Claim 9, **characterized in that** said polymer is applied by means of spray at a temperature of the polymer of between 50°C and 300°C and at a pressure of between 5 and 60 bar.

13. The process for manufacturing a paperboard container according to Claim 9, **characterized in that** said polymer is applied by means of at least five spray via a nozzle comprising from 1 to 10 spray channels.

14. The process for manufacturing a paperboard container according to Claim 9, **characterized in that** said nozzle comprises a central channel and four lateral channels arranged symmetrically with respect to the central channel.

15. The process for manufacturing a paperboard container according to Claim 9, **characterized in that** said central channel is perpendicular to the resting plane of the container and said lateral channels are arranged so that the spray angle is between 1° and 45° relative to the vertical.

16. The process for manufacturing a paperboard container according to Claim 9, **characterized in that** said step of applying at least one polymer is followed by a step involving blowing of pressurized air preferably at a temperature of the air of between 5°C and 200°C and preferably at a pressure of between 0.1 and 10 bar.

17. The process for manufacturing a paperboard container according to Claim 16, **characterized in that** said blowing of pressurized air is performed by means of at least one blow through a nozzle comprising from 1 to 10 blowing channels.

Fig. 1

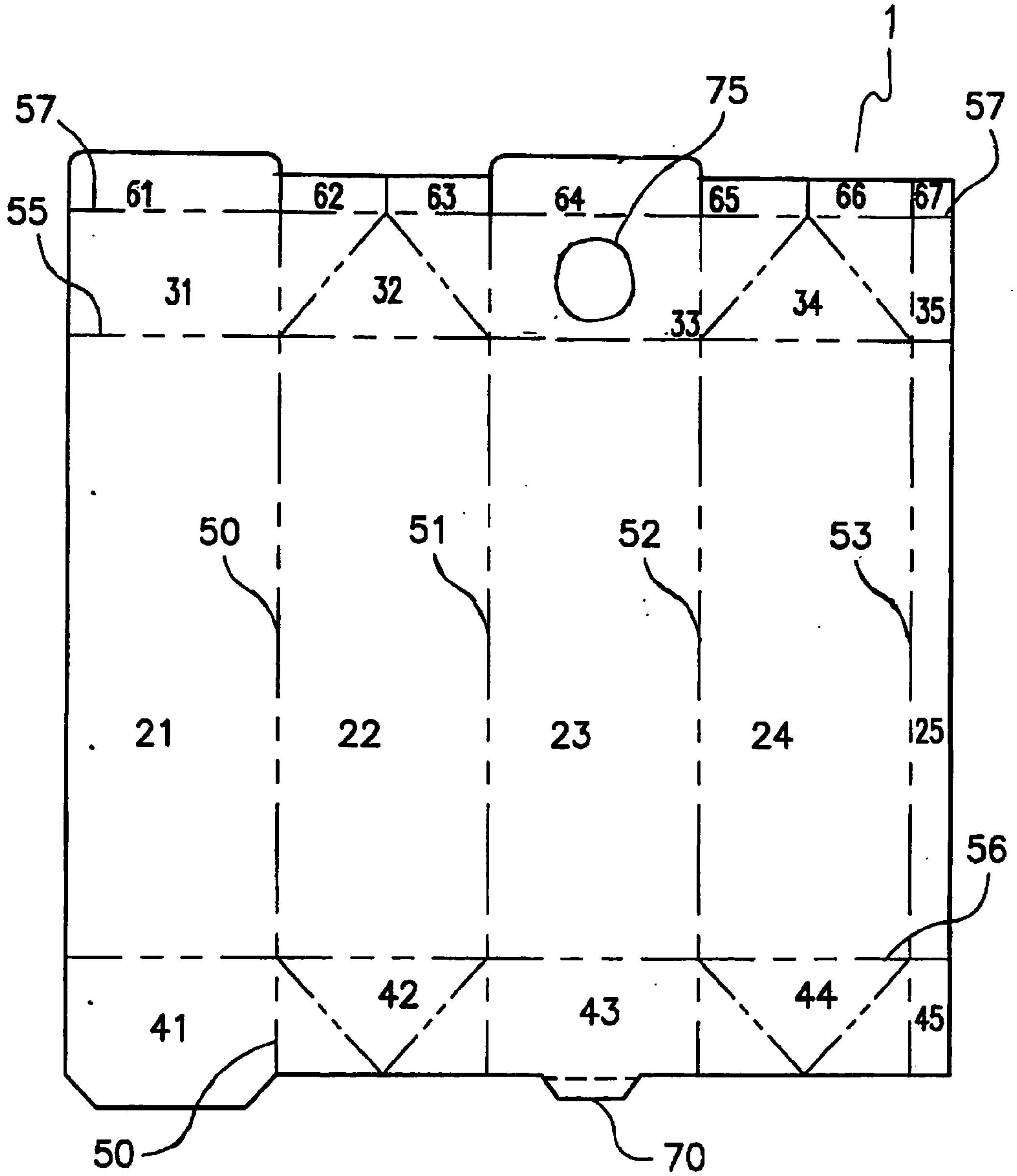

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Fig. 2

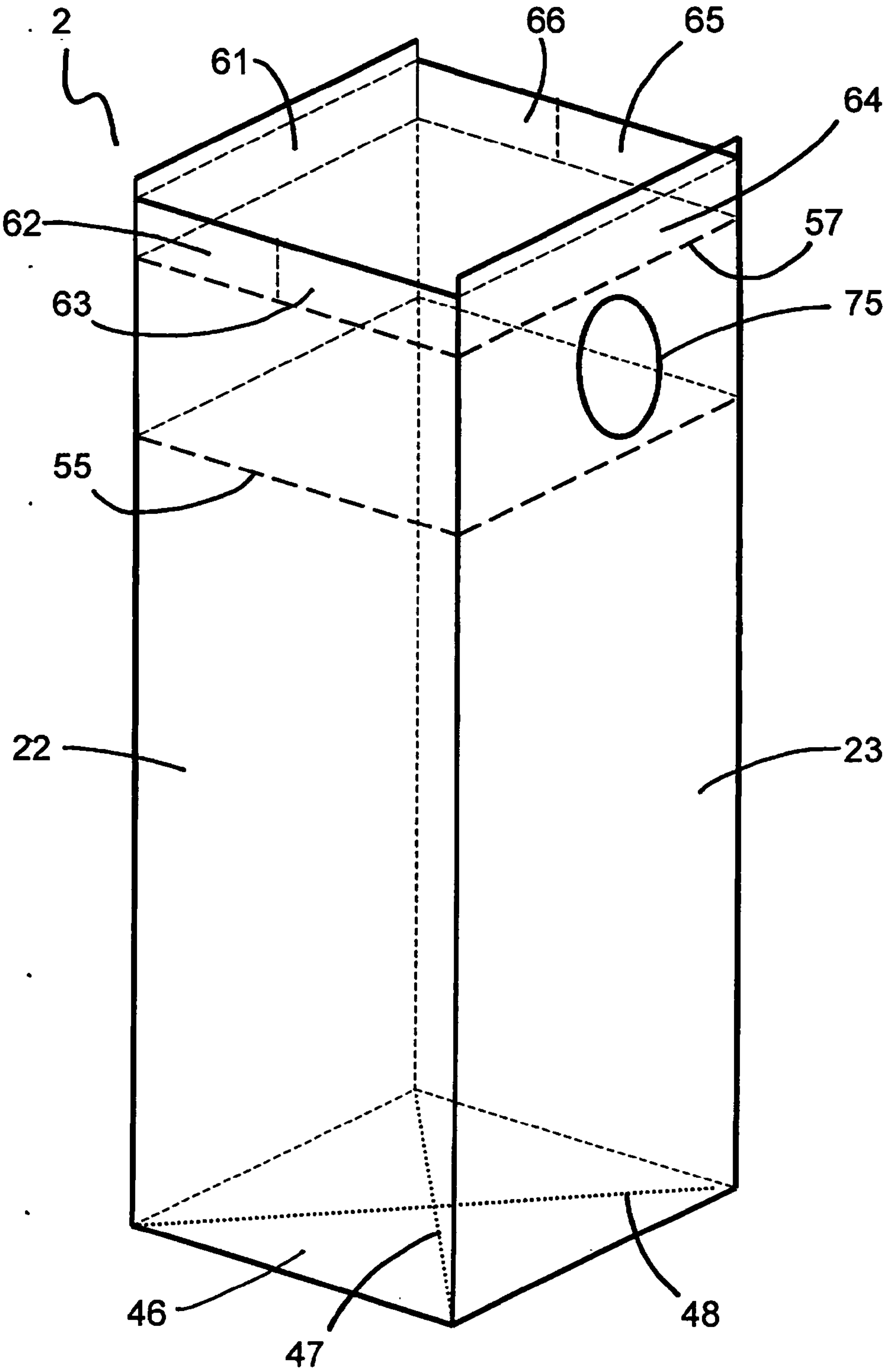
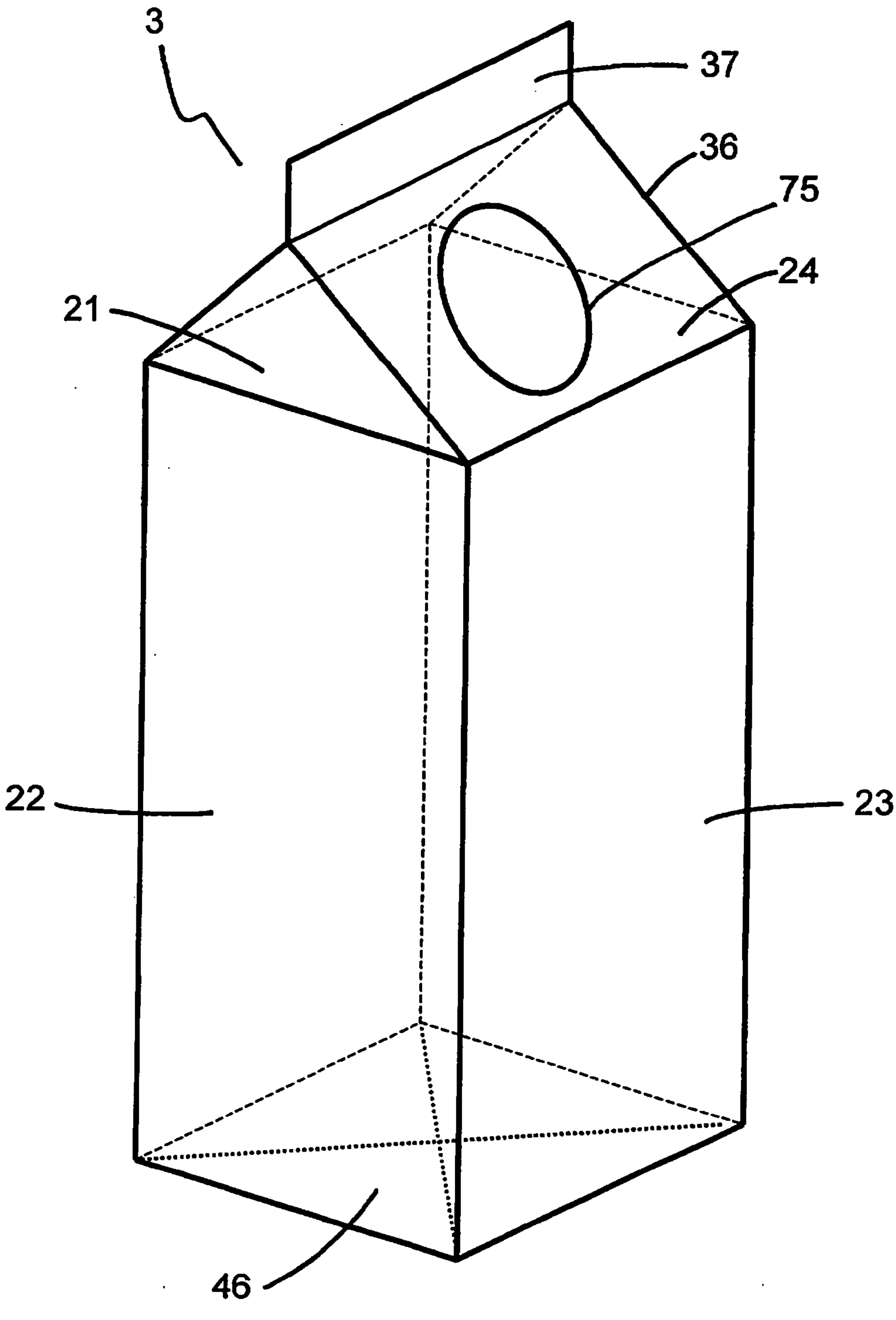


Fig. 3



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EUROPEAN SEARCH REPORT

Application Number
EP 10 42 5191

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X	DATABASE WPI Week 199710 Thomson Scientific, London, GB; AN 1997-103404 XP002616791 -& JP 08 337237 A (TOPPAN PRINTING CO LTD) 24 December 1996 (1996-12-24) * abstract; figures * -----	1-17	INV. B32B27/32 B32B29/00 B65D77/00
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The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
Munich	4 February 2011	Schweissguth, Martin

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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04-02-2011

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