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(57) Abstract

The surface of items which are penetrable for high-frequency energy, like for instance food packagings of plastics which are manufactured by blow moulding or vacuum moulding, and in particular returnable bottles for soft drinks, are sterilised by providing a liquid film on the items, following which they are subjected to microwaves or high-frequency to heat the liquid film, preferably to the boiling point. The liquid is preferably water with a detensioning agent. An apparatus for performing the method is provided with wetting means, dripping off means adapted to leave a liquid film on the items during the dripping off, and heating means. The dripping off means are substantially constituted by transport means for conveying the items from the wetting means to the heating means. A system for sterilising plastic bottles may comprise a washing section, a rinsing section, transport means adapted to let the bottles drip off during transport, and a heating section.

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A METHOD AND AN APPARATUS FOR SURFACE STERILISING ITEMS AND A SYSTEM SUITABLE FOR STERILISING BOTTLES

The present invention relates to a method and an apparatus for surface sterilising items and a system suitable for sterilising bottles. The method is of the type described in the preamble of claim 1, the apparatus is of the type described in the preamble of claim 11 and the system is of the type described in claim 17.

From DE patent publication No. 40 18 142 a method is known for filling containers such as bottles, where microwaves are applied to the containers before filling for sterilising the containers. Hereby humidity present on the surfaces of the containers evaporates, and the heat developed by the vapour kills undesired microorganisms on the surfaces. Before or during the treatment with microwaves, water may additionally be applied to or injected into the containers; thereby vapour is created due to the treatment with microwaves, said vapour killing the microorganisms. The development of steam is stated to take place in the course of a few seconds.

From the correspondence relating to the prosecution of Danish Patent Application No. 2354/89 a microwave packing sterilising system for washing and sterilising plastic packagings is known, in particular for returnable bottles of polymeric plastic. In this system a washing of the packaging takes place at a temperature not exceeding 35-40°C to prevent shrinking of the packaging. To obtain, with certainty, an optical cleanness of the packagings at this low temperature, ultrasound is used, making it possible to avoid addition of lye to the washing water.

The washed packaging is not sterile after washing at such a low temperature, and therefore a sterilising using microwaves is carried out after the washing.

It is stated in the correspondence as a fact that the packaging would be heated to a temperature above deformation temperature if it was subjected to microwaves in a wet condition. This is explained by the fact that high amounts of energy would be transferred to the remaining moisture in and on the packaging. To prevent the applica-

tion of microwaves from heating the plastic material above the deformation temperature, it is therefore stated in the correspondence that during the sterilising treatment with microwaves an exact control of the microwave energy should be exerted as well as a removal of moisture from the packaging by means of a drying and cooling flow of sterile air.

It is, however, not described in the correspondence how this control of the microwave energy is to be carried out. It is only stated that the packaging can endure big amounts of microwave energy when it is dried, as it has a crystalline crystal lattice structure and consequently is not influenced by the microwave energy which exclusively kills bacteria and spores because they are "organic".

There is no detailed description in the correspondence of how the system is to be operated or worked in order not to heat the packaging in an inappropriate way and to in fact kill the microorganisms effectively, and it seems doubtful if a full sterilisation would be obtainable at all by following the instructions given in the correspondence.

Further, Swedish patent publication No. 462.281 discloses a method and an apparatus for sterilising empty packaging containers by application of steam under pressure, preferably at a temperature of 120-140°C, and preferably by additional use of hydrogen peroxide. Then microwaves are applied to the containers, which makes the temperature rise to around 145°C.

From Swedish patent publication No. 465.512 a method is known for sterilising a width of packaging material by spraying on a sterilising liquid such as a hydrogen peroxide solution, which is then removed from the width of material by applying infrared light, microwaves, high-frequency energy or hot air.

Finally, German patent application No. 34 14 268 discloses a method and an apparatus for killing germs in food containers, like for instance cups for dairy products, by applying hydrogen peroxide to the containers, the peroxide being atomized by means of ultrasound at a frequency

above 1 MHz. At the end of the process the containers are subjected to a thermal treatment by means of hot air or microwaves.

None of the methods described in these three publications may be used for sterilising heat sensitive items.

The object of the invention is to provide an effective surface sterilising of items which are penetrable for high-frequency electric energy, in particular items which do not withstand heat exceeding a certain limit. It is part of the object that a definite part of the surface of the item is to be sterilised. This part will often be the whole surface of the item, but if the item for instance is a container, the surface in question may be the whole interior surface of the item.

Important examples of said items are plastic containers which have been shaped by blow moulding or vacuum moulding in hot condition, for instance the commonly used returnable bottles for soft drinks made from PET (polyethylene glycol terephthalate) or the likewise commonly used flat trays of vacuum-shaped PE film (polyethylene), PS film (polystyrene) or the like for packaging for instance meat products in self-service stores. Such containers often possess a so-called elastic memory or "residual activity", by which is to be understood the phenomenon that the item may "remember" a shape and a size, which it had at an earlier stage of manufacture, and that it often is liable to return to this shape when heated.

Moreover, the items may for instance comprise containers for packaging preserves or semipreserves (for instance translucent containers with screw lids for marmalade, herrings, etc.) or for packaging non-preserved technical products like unpreserved plastic paint.

Said soft drink bottles are cast as a so-called preform, i.e. a bottle in which the mouth area with thread etc. has its final size and shape, but in which the container part is quite small and thick-walled. These preforms take up very little room and may therefore at a low cost be transported from a central place of manufacture to various

finishing places, often in other countries, where they are blown up in a hot condition for the container part to take up the desired shape and size. The container part may then be given a desired, individual shape according to the wish of the soft drink producer without the need for using different preforms.

It has turned out that these soft drink bottles tend to shrink on account of said elastic memory, already at temperatures slightly above 40°C. Therefore, known washing and sterilising processes are not suitable for cleaning such bottles, as the bottles are liable to shrink at the temperatures used in these known processes, typically around 60°C or above. Such shrinking is obviously undesirable, and a major part of the bottles have to be discarded after having been cleaned a few times using the known processes.

At the same time there is a considerable need for an effective cleaning and sterilising of such bottles, as partly the owners (the soft drink producing factories) want them to be refilled with differing products without any preceding sorting, which, as evidenced by experience, may give a distaste from the previously contained product, and partly the users after emptying the bottles notoriously use them for the most differing purposes, like for instance storing of petrol or diesel oil, or refilling with different strongly tasting beverages, like a Danish fashion drink "små grå" ("Small Grey Ones"; liquorice-and-ammonium-chloride-drops dissolved in vodka).

To meet the above object the present invention discloses a method, an apparatus and a system.

Said method is characterised by the subject matter of the characterising clause of claim 1. The desired sterilising is obtained by heating the liquid film, and the heating is carried out by subjecting the item to high-frequency electric energy.

Experiments have shown that it is extremely important that the liquid to be heated by the high-frequency electric energy is actually present on the item in the form

of a liquid film. Only in this way is the generation of a sterilising amount of heat ensured over the entire desired surface, without the heat development becoming so intense that an undesirable heating of the item itself takes place.

By providing the liquid film it is thus ensured that a substantial heating of the micro-climate on the surface of the item actually takes place. Besides, a total drying of microorganisms and germs on the item is avoided, whereby is ensured that they are optimally sensitive to high-frequency electric energy. Finally, the risk of sporogenous microorganisms creating spores is reduced, which will normally happen if these organisms are dried out.

Due to the fact that the liquid is present on the item just in the shape of a film, it is, as mentioned above, ensured that the amount of liquid is so small that during heating it cannot transfer sufficient heat to the item to heat the latter significantly.

By the liquid film established on the item being continuous, a sterilising is ensured of the surface of the entire item, or of a corresponding, definite part of the surface in its entirety, respectively.

According to the invention, the formation of the substantially continuous liquid film is ensured by using a liquid which is not repelled by the material of the item. Particularly for uses relating to food, water is preferred, which is, however, repelled by far the most polymeric materials. According to the invention, in this case a de-tensioning agent may be added. This also gives the additional advantage that the thickness of the liquid film to a certain extent may be controlled by controlling the type and the concentration of the de-tensioning agent. As de-tensioning agent may be used salts like for instance soda, organic solvents like for instance ethanol or surface-active agents. In particular surface-active agents are preferred, particularly the non-ionic type, as these may be used in lower concentrations and do not occasion substantial formation of foam. By the measures mentioned it is

obtained that the liquid film is established in a particularly simple way.

As mentioned in claims 2-4 the method according to the invention may advantageously be used for packagings, including returnable bottles and packaging trays for food. This is due to the fact being that the method according to the invention makes it possible to avoid using washing and sterilising chemicals, which is firstly undesirable in connection with packagings for foodstuffs and secondly considerably less detrimental to the environment.

By the subject matter of claim 5 a particularly effective and quick sterilising is obtained.

By the subject matter of claim 6 is obtained that any water-containing microorganisms which may be left after the removal of the liquid film, are killed.

By the subject matter of claim 7 is obtained that an appropriate loading of the microwave source, normally a magnetron, is taking place, even though the items with the liquid film present do not constitute any noticeable load.

By using the frequencies mentioned in claim 8, it is obtained that a comparatively high electric power may be used, as in most countries particularly easy rules apply for the use of these frequencies. By using the means mentioned in this claim a particularly simple tool is obtained for transferring high-frequency energy to the items.

By the subject matter of claim 9 is obtained that the same liquid which has been used for washing or rinsing the item may be used for the formation of the liquid film.

By the subject matter of claim 10 a particularly effective washing is obtained, which is a prerequisite for the adherence of the liquid film and for impurities not being present on the item, which impurities would be able to break the liquid film.

The said apparatus is characterised by the subject matter of the characterising clause of claim 11. By designing the apparatus with dripping off means in the form of transport means, required transport means are utilised also as dripping off means. By designing the transport means as

mentioned in the characterising clause of the claim it is furthermore obtained that in a simple and safe way a substantially continuous liquid film is left on the items without any risk of the film drying out.

By the subject matter of claim 12 blowing off of liquid is ensured which may have accumulated in cavities on the item and/or a desired smoothing of the liquid film and/or a desired cooling of the item prior to the treatment with high-frequency energy.

In claims 13-16 preferred embodiments are described of the wetting means for the formation of the liquid film and of the heating means for heating the liquid film.

The said system is characterised by the subject matter of claim 17. By constructing a system as described in this claim, the rinsing liquid used in the rinsing section may be used straight away for the formation of the liquid film for use in sterilising, whereby this liquid serves a double purpose. Hereby, a most compact system is obtained together with a washing and sterilising process which is optimally gentle towards the bottles in respect of temperature stress on the material of the bottles. This system is suitable for sterilising both returnable bottles and throw-away bottles.

By the subject matter of claim 18 it is obtained that the sterilising may be carried out immediately following washing of the bottles. When ultrasound is employed, the washing may be carried out with a minimum use of lay or quite without lay, and thus as little detrimental to the environment as possible. Such a washing will first of all be necessary when the system is being used for returnable bottles.

By the subject matter of claim 19 is obtained that the bottles may be conveyed for filling in a sterile way.

The invention will now be explained in the following by means of examples and with reference to the drawing. The invention will be explained with reference to washing and sterilising of plastic bottles, but the invention may be used for any other suitable items.

In the drawing,

Fig. 1 schematically shows an experimental arrangement for carrying out the method according to the invention,

Fig. 2 schematically shows an elevated view of a machine for washing, rinsing and wetting returnable bottles for soft drinks, and

Fig. 3 shows a sectional view of a run-through microwave oven for sterilising bottles which have been washed, rinsed and wetted by means of the machine according to Fig. 2.

Fig. 1 shows an experimental arrangement for carrying out the method according to the invention. On a laboratory table 1 with a sink (not shown) and a tap 2, two vessels 3, 4 are mounted, each having a volume of 41 l. The vessel 4 has an outlet 5 to the vessel 3. The vessel 3 is through a tube 6 connected with an outlet not shown. The vessels are of the brand SONOREX type R, provided with two ultrasound transducers (not shown) of each 1,000 W, driven from ultrasound generators at a frequency of 35 kHz built into the vessels and by means of which the water of the vessels 3, 4 may be brought into corresponding oscillation.

On the table 1 is further a microwave oven 7. The oven 7 has been made by modifying a microwave oven of the make VOSS, type 1.12, model MOA263-1. At the modification the grill element was removed and an extra (not shown) guide vane for the microwaves was inserted for obtaining a better distribution of the microwave energy over the volume of the oven. Moreover, the controlling of the magnetron was amended so that it could work continuously (not pulsating) in up to 5 minutes. Instead of a microwave oven a high-frequency heating system might be used, for instance of the type described in Danish patent No. 169.902.

The bottles are generally moved in the travelling direction 8, unclean bottles being supplied to the left in Fig. 1. The bottles 9 are placed in the vessel 3 and washed in water which has flown over from vessel 4 through the outlet 5, and under treatment with ultrasound. After this

washing they are moved to the vessel 4, where a rinsing is done in water, to which only de-tensioning agent has been added, and likewise under treatment with ultrasound.

After washing and rinsing the bottles 10 are covered by a quite thin, evenly distributed water film on the exterior and interior surfaces. The washing done has removed impurities which might break the water film, and the de-tensioning agent ensures that the water film adheres to the bottles even though they have been produced from a water-repellent type of plastic. The bottles are dripped off under simultaneous turning to let all water drip off from their interior and exterior surfaces and are then controlled visually.

The controlled bottles 10 are with a corresponding number of caps 11 conveyed into the microwave oven 7 and treated with high-frequency electric energy. Adequate measures are taken to avoid damaging the water film. During the treatment the water film is boiled off, whereby the microorganisms present in the water film is killed. The treatment may be continued, as the microorganisms may have a certain sensitivity to high-frequency electric energy, even after complete or partial drying. Bottles and caps are removed from the microwave oven after the treatment, and the caps are put on. The bottles 12 with caps may now be taken to a bacteriological control.

Even though an actual trial arrangement has been described, the person skilled in the art would realize that a system for cleaning and sterilising bottles or other types of packaging or other suitable items at a large scale might be built in the same way. The bottles 12 would then be delivered further for filling. They would have no caps on, but they might be temporarily protected against impurities in a similar way or for instance by means of a tent being filled with sterile air under a slight overpressure.

Some of the sections of such a large scale system may according to the invention for instance be organized as shown schematically in Figs 2 and 3.

Fig. 2 is an elevated view of a washing, rinsing and wetting machine 20 for returnable bottles for soft drinks of the type generally available in the sizes ½ litre and 1½ litre. The machine consists of a frame 21 of square tubing and has an endless chain 22 transporting bottles in the machine in the direction 39. The chain 22 is in its whole length provided with bottle holders 23, but these have for the sake of clarity only been shown in a few places on the chain 22 in Fig. 2. The chain 22 is driven and operated by chain wheels 28, 29, 37, 38 and guided by guides 27.

In a starting station 24 (not shown in detail) non-sterile bottles fresh from factory and returned bottles 25 are inserted in the bottle holders 23 and are brought around with the chain 22. The chain 22 first passes through a washing vessel 26, through which the bottles 25 are brought, submerged and in an upright position, whereby they are completely filled with washing water. In the vessel 26 is water with a de-tensioning agent in the form of a surface-active agent of the type used in household dish-washing machines (see below). The water is subjected to ultrasound by means of submerged ultrasound transducers (not shown), which are preferably distributed over the whole length of the vessel. In the vessel 26 remnants of the previous contents of the bottles and labels, etc. are loosened and removed. In the machine 20 shown the residence time in the vessel 26 is between 100 and 200 seconds, preferably approx. 150 seconds.

Then the chain 22 is running around a chain wheel 29 and back through a section 30, in which the bottles are emptied of washing water and further flushed free of remnants of previous contents and labels at flushing stations 31, 32.

The chain 22 with the bottles 25 then passes through a rinsing vessel 33 of the same construction and mode of operation as the washing vessel 26. In the rinsing vessel 33 is water with de-tensioning agent added. The water is led from the rinsing vessel 33 to the washing

vessel 26 and then away, in the same way as explained above in respect of Fig. 1.

After the rinsing the chain 22 is passed over a chain wheel 37, where it turns, so that the bottles are emptied and dripped off 36. The water dripping off is collected in a tray 34. In the machine shown the speed of the chain is 2½ m/min (42 mm/s), the speed being continuously variable in the interval approx. 1.7-3.3 m/min, and the distances around the rinsing vessel and the dripping off tray 34 are so adapted that the bottles after having left the rising vessel are emptied in the course of 108 seconds and then dripped off in the course of further 60 seconds. In the course of the following 54 seconds the bottles are conveyed around a chain wheel 38 and turned right, following which they are removed at a removal station 35 (not shown in detail) and taken to a heating section. The total transporting time to the heating section after finishing of the dripping off is in the shown embodiment of the machine 20 approx. 120 seconds.

Fig. 3 is a schematic vertical section in a heating section 40 for a machine 20 like the one described above. The bottles 41 are here reloaded on a conveyor belt 45 in the form of a chain 42 with superjacent carrier members 43 and driving dogs 44, the bottles being conveyed in upright position on top of the conveyor belt 45. The belt 45 runs through a box 46 constituting the oven compartment of a microwave oven. Devices (not shown) are arranged for providing microwaves and a suitably even distribution of these in the oven compartment 46.

To ensure an advantageously even load of the microwave source, normally a magnetron, the oven compartment may according to the invention be provided with microwave-absorbing water compartments or the like to compensate for the insignificant loading of the source from the bottles 41 with the water film.

A system according to the invention may also be built directly together with a plant for filling the bottles, and in a simple way a plant may be established in

which the bottles may be kept sterile during filling, so that an aseptic filling is obtained.

When sterile air under a slight overpressure is used for creating a sterile protective atmosphere as mentioned, the supply of the sterile air may advantageously be carried out in such a way that on account of the admission movement of the air, for instance in form of a jet or a curtain, a blowing away of possible water residues on the items and a cooling of the items is obtained before the treatment with microwaves or high-frequency power.

E X A M P L E 1

Nine bottles of PET were filled with dairy products (see the following diagram) and left for 30 days at room temperature. They were then emptied and washed in water, to which a de-tensioning agent of the brand SUN PROGRESS had been added (a common type for use in dish-washing machines), with the use of ultrasound.

After the washing the bottles was dripped off. Then five of the bottles (marked 2-6) were treated in a microwave oven of the household type with pulsating power 750 W in 85 seconds. Two of the bottles (marked 7-8) were not treated by microwaves, whereas two of the bottles (9-10) were treated like the bottles marked 2-6, but then capped and finally given treatment for additional 30 seconds in the microwave oven.

The bottles thus cleaned, of which the bottles 2-6 and 9-10 also had been sterilised by the method according to the invention, were subjected to a germ counting test according to Koch's plate technique and the following germ counts were observed:

Bottle No.	Contents	Germ Count
2	Double Cream	10
3	Cocoa Milk	30
4	Yoghurt	42
5	Low-Fat Milk	70
6	Buttermilk	2
7	Double Cream	7700
8	Full-Cream Milk	1200
9	Milk contaminated w/ Urine	2
10	Milk contaminated w/ Earth	4

E X A M P L E 2

With the arrangement according to Fig. 1, 150 returnable PET bottles for soft drinks were washed, the volumes being ½ and 1½ l. 100 of the bottles were selected at random among returned bottles and 50 were fresh from factory.

In the vessel 3 water from the outlet 5 from the vessel 4 was used and at a temperature not above 28°C.

The bottles were washed in the vessel 3 with the applying of ultrasound for 2 minutes for removal of residual contents, labels, label glue, etc.

In the vessel 4 was mains water, to which de-tensioning agent for household dish-washing machines had been added, the de-tensioning agent being of the brand neophos® from Skandinavisk Denckiser A/S, 2800 Lyngby, Denmark containing 5-15% non-ionic tensides and preservative agent, in a concentration of 0.28% (1 dl per 35 l water). The water was exchanged for every 25 bottles and its temperature was kept below 25°C.

The bottles were rinsed in the vessel 4 under influence of ultrasound for 2 minutes. Caps fresh from factory for the bottles were washed in the vessel 4 for 20

seconds. After the washing the bottles were checked as to optical cleanliness with satisfactory result, and the bottles were dripped off, i.e. they were turned, until all liquid had run off and no drops or only very few fell from the bottles irrespective of their position.

Bottles and caps were sterilised for 30 seconds in the microwave oven 7, set at 750 W, in batches of 7 bottles + 7 caps, following which the caps were put on.

During the treatment in the oven the water film disappeared from the bottles in less than 10 seconds. Only during the first 5-8 seconds was vapour or condensed drops observed on or in the bottles.

All handling was done manually in a non-sterile atmosphere in a test hall having a port leading to the open.

Finally, a germ counting test of all bottles was made in the following way: some sterile water was poured into each bottle, and after shaking, this water was removed and germ count tested by Koch's plate technique using nutritive media suited for cultivation of bacteria relevant in connection with carbonised soft drinks (i.e. soft drinks to which carbonic acid has been added). In respect of all bottles germ counts of less than 50 were found, which corresponds to the assessment "satisfactory".

E X A M P L E 3

2 x 25 mixed new and used returnable bottles of PET for soft drinks of a volume of ½ and 1½ litres, respectively were washed and sterilised with use of the arrangement according to Fig. 1 and the method according to Example 2. The volume and height of the bottles were measured before washing and sterilising, and after 5, 10, 20 and 25 times of washing and sterilising.

The volume was measured by filling the bottle to the rim, and the height measured by means of a calliper gauge mounted on a surface plate.

The measurement results listed below were obtained, each one being average values for the bottles measured. The

difference in the measurements of the volume is ascribed to measurement uncertainty of the measuring method used.

Number of sterilis-ings	½ litre bottles		1½ litre bottles	
	Volume ml	Height mm	Volume ml	Height mm
0 x	527,6	230,3	1575,1	334,2
5 x	528,0	230,3	1576,2	334,2
10 x	528,0	230,3	1576,2	334,2
20 x	528,1	230,3	1576,1	334,2
25 x	527,8	230,3	1576,1	334,2

E X A M P L E 4

16 returnable bottles of PET for soft drinks were washed and sterilised using the arrangement according to Fig. 1 and the method according to Example 2.

Then the bottles were filled with the products and undesired liquids, respectively, mentioned in the diagram below, and were left for the periods stated in the diagram.

After standing the bottles were washed again and sterilised under use of the arrangement according to Fig. 1 and the method according to Example 2, and then refilled with plain soda-water.

A trial tasting gave the ratings 1-3 stated in the diagram below and having the meanings:

1: satisfactory

2: not quite satisfactory (after-taste)

3: not satisfactory (after-taste).

The first-mentioned product in the diagram, "små grå" has been described in the introductory part of the present description. The two last products mentioned in the diagram are examples of the previously mentioned, undesirable liquids. The remaining products are different soft drinks, the major part of these being carbonized.

Out of 16 bottles four were considered satisfactory (1), four not quite satisfactory (2) and eight not satisfactory (3).

These ratings were alleged to be better than the ones obtained with the traditional cleaning methods.

Product	Standing Period						
	15 min.	1 week	10 day	2½ mth.	4½-6 mth.	10-17 mth.	un-known
"Små grå"		2	2	3	3		
Grape Apollinaris						3	
Bitter Grape lemonade						3	
Bitter Lemon lemonade						3	
Dry Lemon lemonade					1		
Orange lemonade						2	
Orange Juice					3		
Light Orange lemonade						1	
Cola						1	
Light Cola						1	
Apple Drink							3
Motor Oil	3						
Petrol	2						

E X A M P L E 5

In a test corresponding to the test according to Example 4 the following results were obtained, with similar meanings as in Example 4:

Product	No. of treat-ments	Stand-ing, months	Taste rating	Distaste
Bitter Grape lemonade	2	10	3	heavy orange
Bitter Lemon lemonade	2	10	2	fruity
Grape Apollinaris	2	10	3	heavy citrus
Orange Juice	2	5	2	distinct orange
Pineapple Drink	1	2½	2	distinct pineapple
Apple Syrup	1	2½	1	
Apple Juice	1	2½	1	
Apple Must	2	18	2	distinct plastic
Ice Tea	1	1	1	
Cocoa Milk	1	2½	1	
"Små grå"	1	3	3	heavy liquorice
"Små grå"	2	3	3	heavy liquorice
"Små grå"	2	6	3	heavy liquorice
Motor Oil	1	2½	1	
Diesel Oil	1	2½	3	heavily unclean
Petrol	1	2½	3	heavy petrol
Anti-Freeze	1	2½	3	heavy plastic, greasy

In the cases where the bottles are stated to have been washed twice (column 2 of the diagram) the result of the trial tasting has been "not satisfactory" after the first washing and refilling with plain soda-water. These bottles are then washed a second time and once more refilled with plain soda-water and trial-tasted.

As a whole the result of this test is considered to correspond to what can be obtained by the traditional cleaning methods.

E X A M P L E 6

Two PET returnable soft drink bottles fresh from factory and three used ones (recycled) with a volume of 1½ l were washed and sterilised under use of the arrangement according to Fig. 1 and the method according to Example 2. However, no de-tensioning agent was added to the water, neither in the washing vessel 3 nor the rinsing vessel 4.

A visual control after washing, rinsing and dripping off showed that water adhered to the interior surfaces of the bottles as a broken film, i.e. there were scattered dry areas of varying size, in which the water had gathered into drops and elongate "strips" in between areas covered by water film.

After sterilising as in Example 2 the bottles were cut open, and to the inner surface of the cylindrical part of the bottle wall a nutritive agent suited for water bacteria and in the form of a jelly was applied. After standing for 24 hours growth of bacteria colonies was demonstrated, the germ counts being 2-3,000, in scattered areas of size and form like the previously observed dry areas of the interior wall of the bottle.

This test result clearly indicates that it is of vital importance for an effective sterilising at the low temperatures used here, that the liquid is present on the item as an unbroken liquid film.

As will be seen from the examples, the invention makes it possible to wash items such as plastic bottles at a rather low temperature with satisfactory results, as due to the effective sterilising, a better cleaning is obtained in total than by using traditional cleaning methods.

Hereby the possibility is obtained to clean heat-sensitive plastic packagings, like for instance returnable bottles of PET for soft drinks, considerably many more times than is possible with the cleaning methods used today.

In this way the bottles may be recycled more times than is possible today, where they have to be discarded on account of shrinking long before they are worn out.

Moreover, the invention makes it possible to wash said items in water without addition of lye, or at least with a quite low concentration of lye. Addition of for instance soda lye to the washing water gives environmental problems, and moreover presents a particular problem at the washing of returnable bottles of PET for soft drinks. The stress, to which these bottles are exposed during use, causes the formation of many very small cracks in the plastic material, and sodium hydroxide is deposited in the cracks, which gives the material an undesirable grey appearance.

The cleaning methods used today necessitate the use of washing water at a temperature of 58-62°C and adding of soda lye to a NaOH concentration of 3-7%. By way of comparison it may be added that returnable bottles of glass for soft drinks are washed in water with a temperature of 92°C and soda lye being added to a NaOH concentration of 16%.

In short, the invention offers, in addition to what has already been stated, two very important advantages in comparison with the traditional cleaning methods for the same purpose, viz. a considerable saving of energy and a considerably reduced environmental detriment.

The saving of energy is obtained due to far less energy is used for the running of the ultrasound generators

and the heating means, such as the microwave oven, than is saved by only having to heat the washing water to 25-28°C.

The substantially reduced environmental detriment is obtained due to addition of environmentally detrimental substances, like soda lay, to the washing water being avoided. Finally, the effective sterilising makes it possible to reduce use of preservative agents in the products contained in the bottles.

C L A I M S

1. A method for surface sterilising an item made from a polymeric material and finished by hot deformation such as blow moulding or vacuum moulding, said method comprising treatment with high-frequency electric energy such as microwaves, c h a r a c t e r i s e d in that:

- a substantially continuous liquid film is provided on the item by applying to the item a liquid which is not repelled by the material of which the item consists, said liquid being preferably water to which de-tensioning agent has been added, in particular a surface-active agent, and the liquid is led away from the item and allowed to drip off, following which

- the item is subjected to high-frequency electric energy for heating the liquid film and sterilising of at least a definite part of the surface of the item.

2. A method according to claim 1, in which the item is a packing.

3. A method according to claim 2, in which the packing is a returnable bottle for beverages, said bottle being manufactured by blow moulding.

4. A method according to claim 2, in which the packing is a tray or a box, manufactured by vacuum moulding and intended for packing or storing of food like for instance meat products.

5. A method according to any of the preceding claims, c h a r a c t e r i s e d in that the liquid film at least locally is heated to the boiling point.

6. A method according to any of the preceding claims, c h a r a c t e r i s e d in that the item is still subjected to high-frequency electric energy after the boiling or evaporation away of the liquid film.

7. A method according to any of the preceding claims, c h a r a c t e r i s e d in that the high-frequency electric energy is supplied in the form of microwaves, and surplus microwave energy preferably is removed from the energy treatment place, particularly preferred by circulation of a liquid absorbing the surplus energy.

8. A method according to any of the claims 1-6, c h a r a c t e r i s e d in that the high-frequency electric energy is supplied at a frequency of 3-300 MHz, preferably one of the frequencies 13.56 MHz, 27.12 MHz or 40.68 MHz, and preferably by placing the item between two capacitor plate means, across which a high-frequency electric voltage is applied.

9. A method according to any of the preceding claims, c h a r a c t e r i s e d in that the sterilising is carried out immediately after a preceding washing or rinsing of the item, and in that the liquid is left on the item in a step of the washing or rinsing process, respectively.

10. A method according to claim 9, c h a r a c t e r i s e d in that ultrasound is being applied to the liquid used in the washing or rinsing process during the process.

11. An apparatus for surface sterilising items like for instance packagings, including returnable bottles for beverages, which items are manufactured from a polymeric material and finished by hot deformation like blow moulding or vacuum moulding, the apparatus being provided with wetting means for applicating liquid to the items, dripping off means for removing liquid from the items and heating means for subjecting the items to high-frequency electric energy, c h a r a c t e r i s e d in:

- that the dripping off means are substantially constituted by transport means for transporting the items from the wetting means to the heating means under simultaneous dripping off of liquid from the items,

- that the transport means are adapted to turn and/or move the items such that all liquid readily drips off therefrom, and

- that the transport time from the wetting means to the heating means is measured out such, relative to the prevailing temperature and air humidity, that a substantially complete dripping off of the items is ensured with-

out the liquid film on the items completely or partially drying away.

12. An apparatus according to claim 11, c h a r a c t e r i s e d in that the dripping off means comprise members for blowing air across the items, preferably sterile and/or cooled air.

13. An apparatus according to claims 11 or 12, c h a r a c t e r i s e d in that the wetting means are substantially constituted by a washing or rinsing device for washing and/or rinsing of the items.

14. An apparatus according to claim 13, c h a r a c t e r i s e d in that the washing or rinsing device is provided with means for applying ultrasound to the washing or rinsing liquid, respectively.

15. An apparatus according to any of the claims 11-14, c h a r a c t e r i s e d in that the heating means are substantially constituted by a continuous flow microwave oven.

16. An apparatus according to any of the claims 11-14, c h a r a c t e r i s e d in that the heating means are substantially constituted by a high-frequency heating system, preferably comprising capacitor plate means connected to an electric high-frequency generator for applying to said capacitor plate means a high-frequency electric voltage, and between which means the items are conveyed by means of conveyor means.

17. A system for sterilising bottles made from a polymeric material, said bottles being manufactured by hot deformation like blow moulding, which system comprises:

- a rinsing section for rinsing the bottles with water, preferably water to which a de-tensioning agent has been applied, and preferably under application of ultrasound,

- a heating section for applying high-frequency energy to the bottles, like for instance a through-flow microwave oven or a high-frequency heating installation, and

- first transport means for conveying the bottles from the rinsing section to the heating section, said transport means being adapted to allow the bottles to drip off substantially completely during transport and to protect the bottles against even partial drying, preferably by being constructed with a short transport path.

18. A plant according to claim 17 and further comprising:

- a washing section for washing the bottles with water or lye before the rinsing, preferably under application of ultrasound.

19. A plant according to claim 17 or 18 and further comprising:

- second transport means for conveying the bottles from the heating section to a bottling or packing section or machine under aseptic conditions, the transport preferably taking place in encased surroundings and in an atmosphere of sterile air under overpressure.

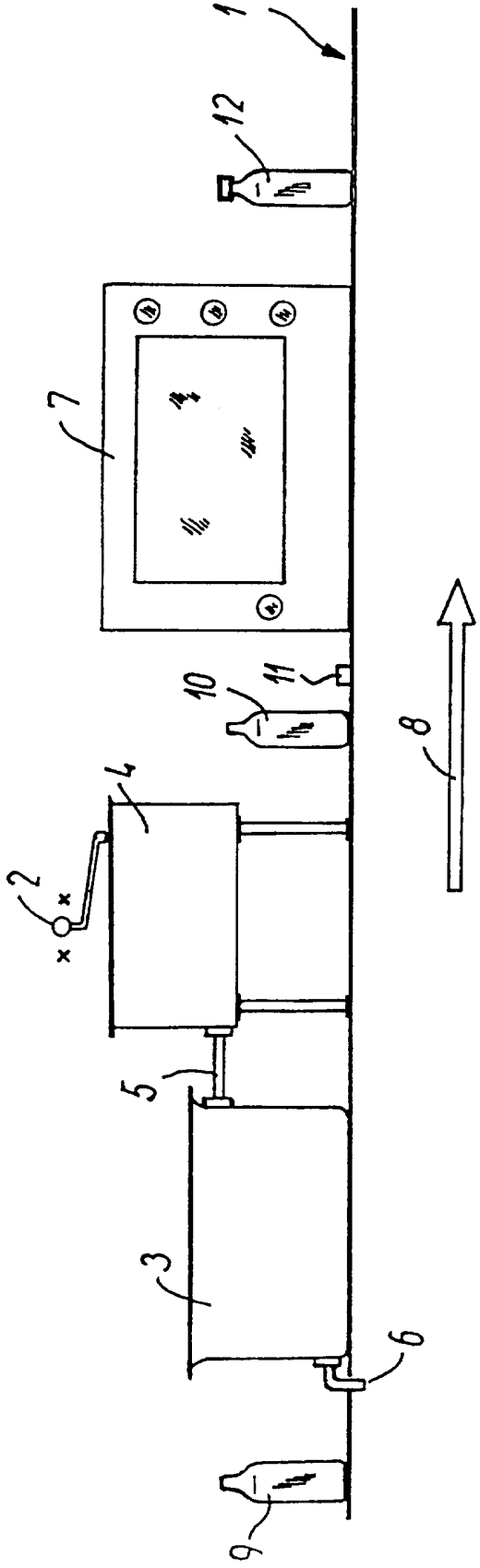

Fig. 1

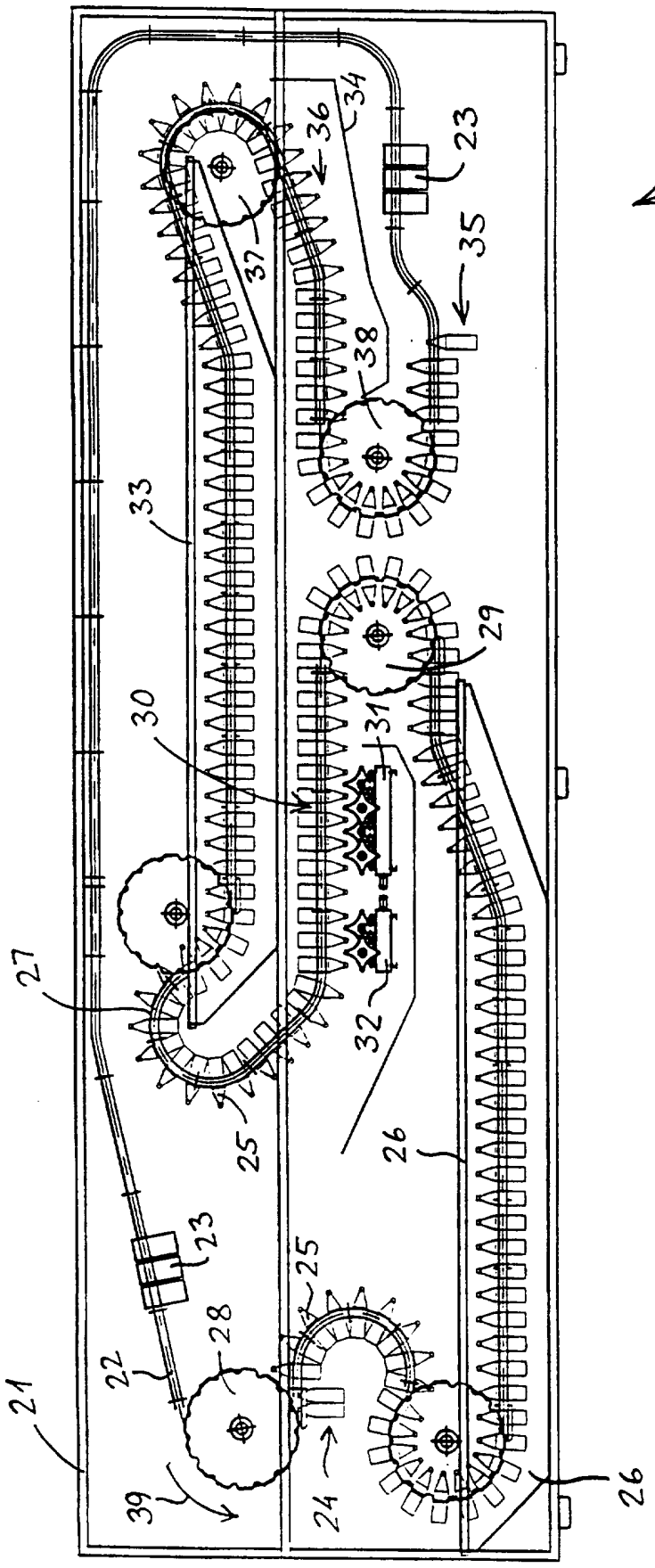

Fig. 2

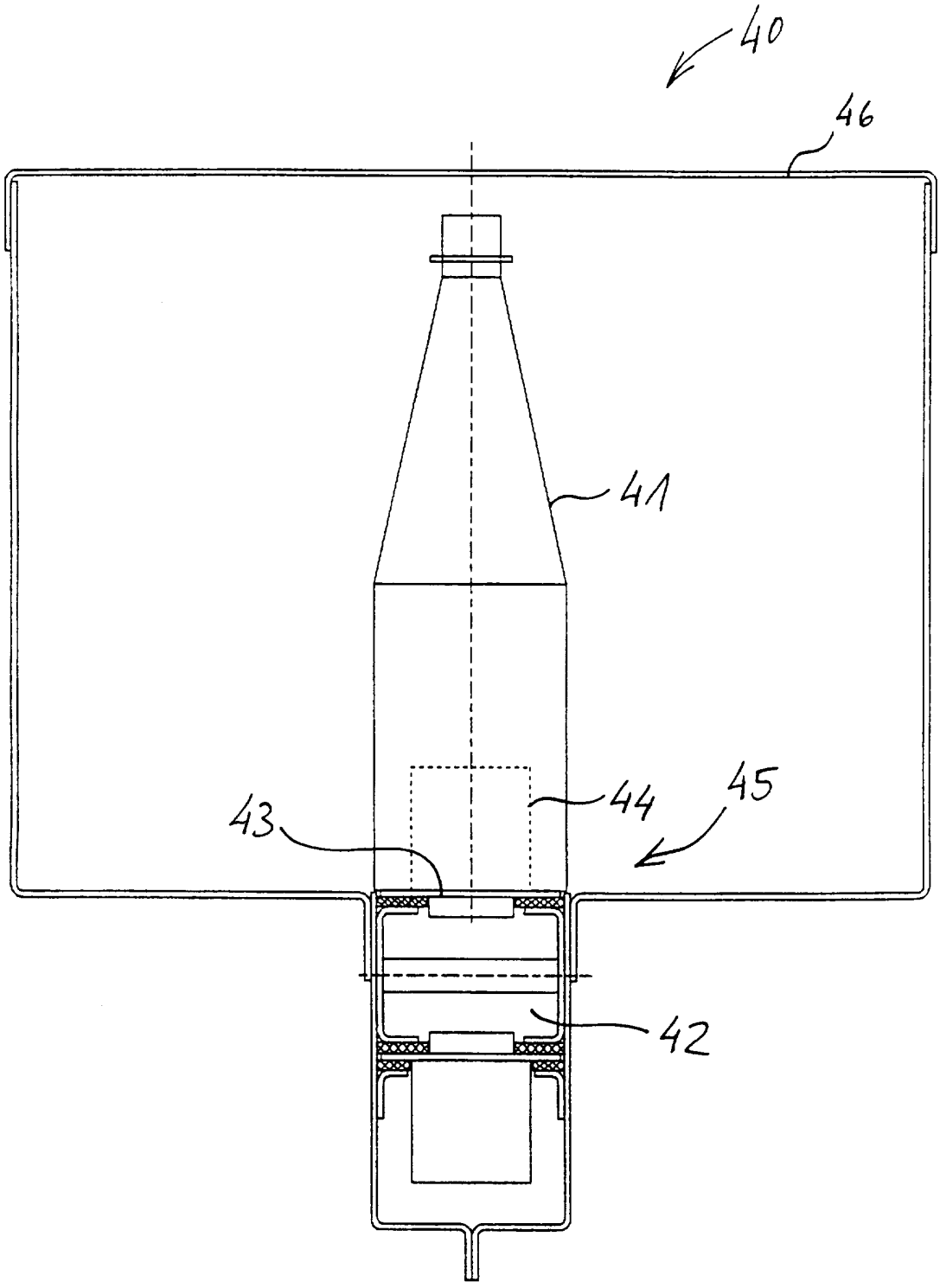

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 97/00056

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B65B 55/08
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)

IPC6: B65B, A61L

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 4018142 A1 (KRONSEDER, HERMANN), 12 December 1991 (12.12.91) --	1,2,5,9,11, 12,13,15,16
A	SE 465512 B (TETRA PAK HOLDINGS SA), 23 Sept 1991 (23.09.91) --	1-19
A	US 4680163 A (BLIDSCHUN ET AL.), 14 July 1987 (14.07.87) --	1-19
A	US 3674422 A (O.S. GRAY), 4 July 1972 (04.07.72) -- --------	1-19

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
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"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 prionty 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
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 May 1997	25.05.97
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 Kristina Pederson Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

Information on patent family members

02/04/97

International application No.
PCT/DK 97/00056

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US 3674422 A	04/07/72	NONE	