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M. PETIT ET AL

3,704,140

STERILISATION OF TINS

Filed Dec. 19, 1969

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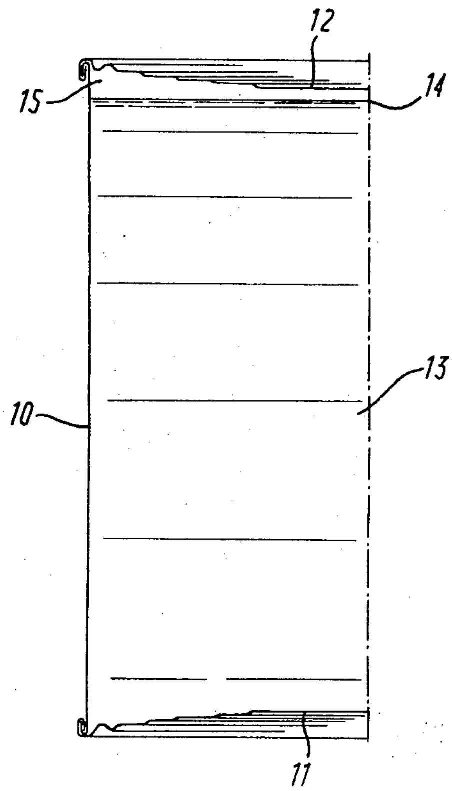


FIG.1

FIG.6

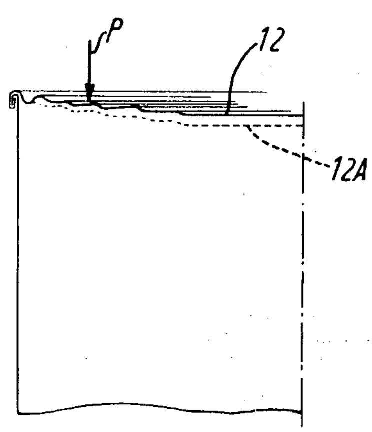
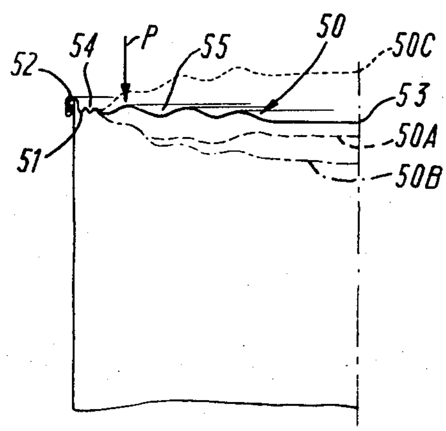


FIG.7



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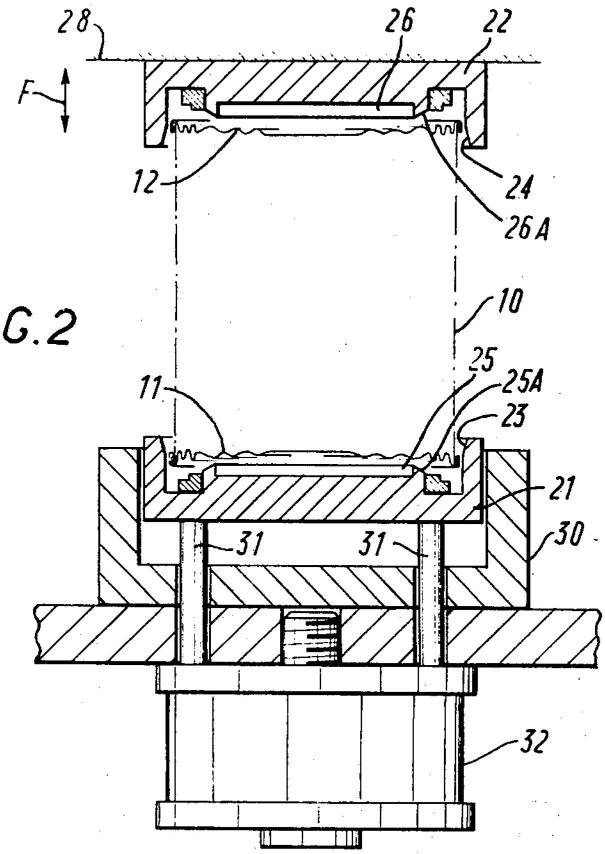
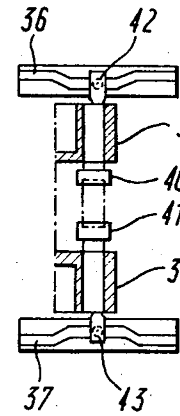


FIG.2

FIG.5



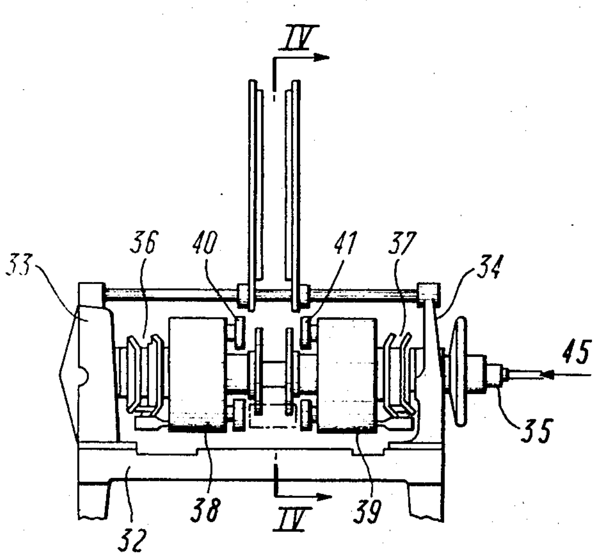


FIG.3

FIG.4

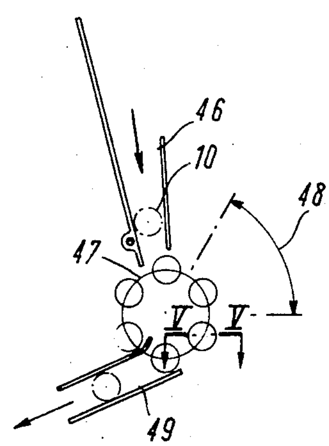


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FIG. 7A

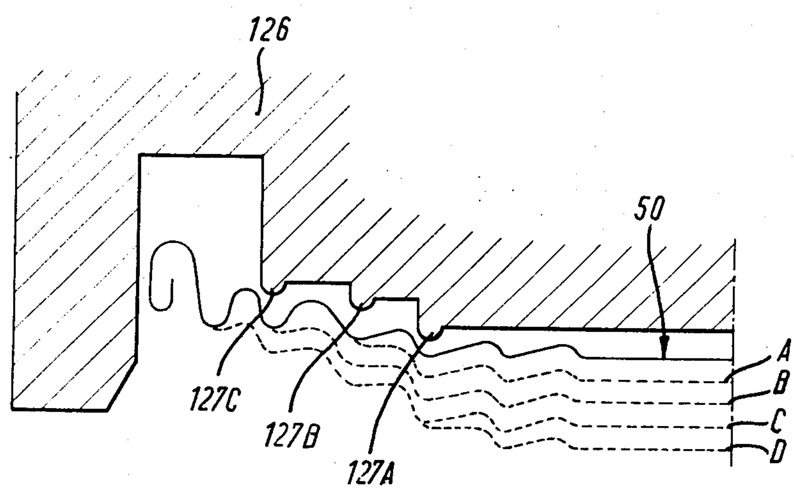

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FIG.8

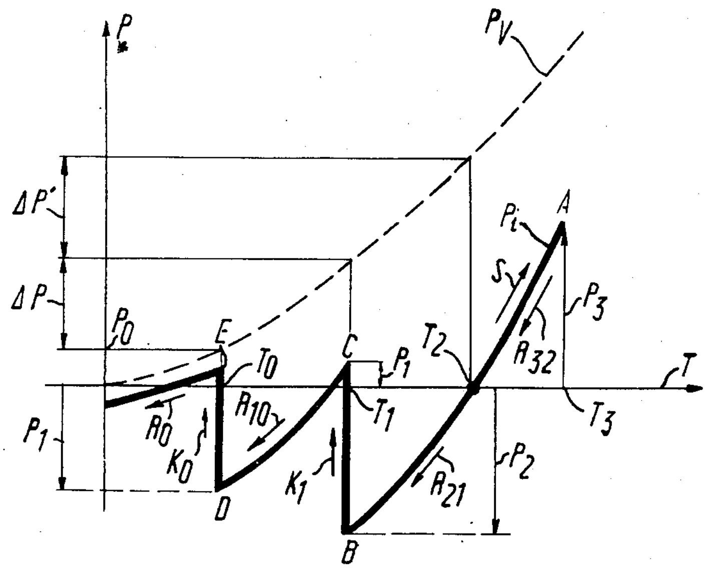


FIG 9

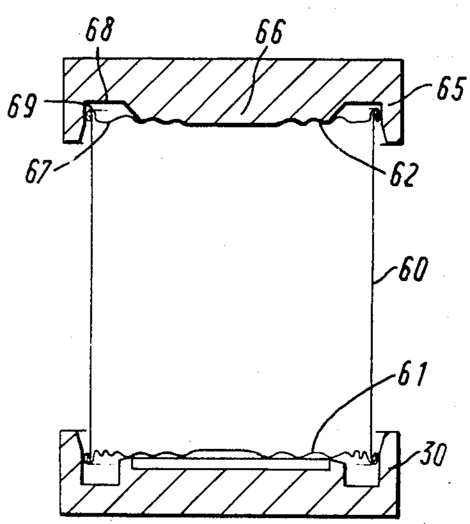
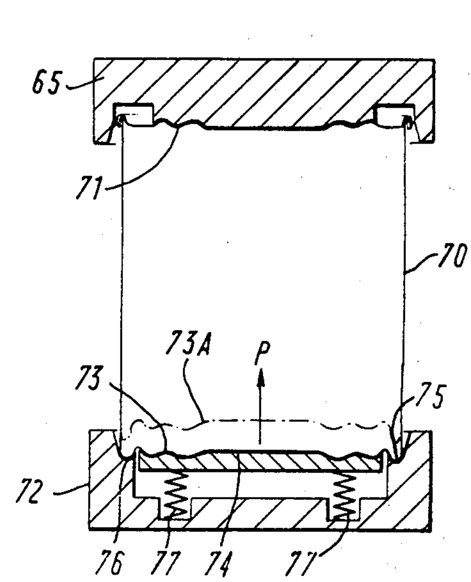


FIG.10



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STERILISATION OF TINS

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Int. Cl. A23l 3/02

U.S. Cl. 99—214 9 Claims

ABSTRACT OF THE DISCLOSURE

To prevent bursting of a can due to the vacuum formed therein on cooling after sterlisation a part of the can, generally an end thereof, is subjected to a permanent deformation, effected before the can is fully cooled, which reduces the internal volume of the can.

BACKGROUND OF THE INVENTION

(1) Field of the invention

This invention relates to sterilised hermetically sealed metal cans.

(2) Description of the prior art

One method of foodstuff preservation is known as the Appert process, or as "Appertisation" after the name of its inventor Nicolas Appert, and consists in heating food previously enclosed in a sealed can for a time of sufficient length and to a sufficiently high temperature as to ensure the total destruction or inhibition of the enzymes and micro-organisms, which are liable to cause deterioration of the food or to render it unsuitable or unfit for consumption.

It is also known that when food is preserved in metal cans, which are the containers most widely employed for this purpose throughout the world, once the can has been filled, fitted with its lid and sealed, it is inserted either into a hot-water bath, in the case of foods whose preservation can be assured by heating to a temperature close to 100° C., or into an autoclave or other appropriate sterilising apparatus which makes it possible to heat the can and its contents to a higher temperature than 100° C., most frequently to a temperature of between 110 and 130° C., but also to even higher temperatures.

The temperature and period of sterilisation represent an inseparable factor which is described by the expression "sterilisation scale," the period required to ensure the necessary sterilising action being the shorter the higher the temperature, according to mathematical relationships in which the dimensions of the metal can and the nature and consistency of the food play a part.

Numerous experimental studies have shown that it is of interest in the greater proportion of cases, for optimum retention of the nutritive value and of the organoleptic features of the food as well as for economy, to employ sterilisation scales applying a brief duration at high temperature; this renders it possible to obtain a saving of time during operation, the application of machinery of smaller size for one and the same production figure, and a lower expenditure of thermal energy.

The fact of heating a can and its contents from the temperature they had at the instant of sealing the can, to a higher temperature, causes an increase in internal pressure; it is essential for the can to oppose an appropriate resistance against this pressure, without undergoing permanent deformations and without impairing its hermeticity.

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Consequently, it will be understood that the mechanical strength of the can opposed to the internal pressure represents a limit on the temperature at which it is possible to perform the sterilisation.

A variety of measures, in respect of the structure of the can, as well as in the design of the sterilising machinery and in the application of the sterilising operation, render it possible to counteract this difficulty within definite limits; one of these measures consists in proceeding in such manner that, at the instant of sealing the can, the can and its contents are at as high a temperature as possible, which cannot exceed 100° C. in the case of foods rich in water, placed in cans at atmospheric pressure, but which may reach 104° to 105° C. for jams, jellies and marmalades, as well as for syrups, and may even exceed this level if the canning operation is performed at a higher pressure than atmospheric pressure.

The fact of sealing the can "when hot," renders it possible to heat the can to a higher sterilising temperature without exceeding the critical internal pressure; in point of fact, the final internal pressure is a function of, among other things, of the difference between the temperature at the instant of sealing the can and the sterilising temperature.

This remedy entails two shortcomings however: sealing in the hot state involves a vacuum being engendered within the can, when the latter cools, which is the more powerful, the higher the sealing temperature has been; on the one hand, this increases the risk of collapsing the cylindrical wall of the can under the action of atmospheric pressure or of even a light knock, and also intensifies the risk of recontamination of the contents of the can in the case of a leak caused by a faulty seam or by deformation of even a faultless seam following impact.

It is an object of the present invention to eliminate these shortcomings by reducing or eliminating the risk of can collapse and product recontamination.

It is also an object of the invention to allow sealing of cans at a temperature close to 100° C., or even higher if need be, by initially sterilising them at a high temperating for a very brief period whilst preventing the generation of an excessive internal vacuum and the drawbacks the latter could cause.

Another object is to provide a general improvement in the degree of quality of the products preserved.

Yet another object of the invention is to allow reducing the necessary gauge of the materials to be employed to produce the body and ends of the preserving cans, whilst retaining a degree of quality at least equal to the mean degree obtainable at present.

The invention is not limited to cans of circular cross-section; it is also applicable to cans of other cross-sections and to deep-drawn cans.

SUMMARY

According to the invention there is provided in a process for sterilising a can comprising at least one deformable wall element in which the can is filled, is sealed in hermetic manner and is heated for a predetermined period to a predetermined temperature, and is then exposed to a cooling action, the improvement which consists of permanently reducing the internal volume of the can during cooling thereof.

Preferably, at least one deformable wall element is incorporated in the structure of the can for the purpose of a volume reduction of this kind.

The deformable wall element usually consists of a can end and most cans have two can ends which usualy are of slightly concave initial shape. When a can which is filled and then sealed undergoes the sterilising heating action, the progressive rise in pressure has the result of imposing a temporary outward deformation on these deformable elements. During the cooling action, the can ends do not return to their slightly concave initial shape until the internal vacuum has become sufficiently powerful to draw them inwards; the risks of collapsing the wall of the can and of recontamination of the contents occur as early as the cooling stage, being linked to the internal vacuum.

The application of the operation for permanent reduction of the internal volume of the can according to the invention will thus advantageously be performed, according to another feature of the invention, in such manner as to keep the vacuum within a predetermined threshold value.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic section of a part of a filled conventional preserve containing tin or can,

FIG. 2 is a diagrammatic cross-section of apparatus according to the invention,

FIG. 3 is a diagrammatic elevation of a machine embodying apparatus according to the invention and arranged for interposition in a can sterilising line,

FIG. 4 is a diagrammatic cross-section on line IV—IV of FIG. 3,

FIG. 5 illustrates, to an enlarged scale, a detail taken on line V—V of FIG. 4,

FIG. 6 is a diagrammatic section of a part of a conventional can end,

FIG. 7 is a view similar to that of FIG. 6 but of a can end comprising a stiffening corrugation and flexible corrugations and illustrates different positions assumed by the can end consecutively during different stages of treatment in accordance with the invention,

FIG. 7A illustrates, to an enlarged scale, the stages of deformation of a can end according to the invention,

FIG. 8 is an explanatory diagram,

FIG. 9 illustrates the application of the invention to a can provided with a can end of the easy opening type, and

FIG. 10 illustrates the application of the invention to a deep-drawn can.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, FIG. 1 illustrates a conventional can body **10** of cylindrical shape, provided in conventional manner with can ends **11** and **12**. The can is filled to a predetermined level **14** with a product **13**. The level **14** may vary from one can to another, leaving a headspace **15** between the can end **12** and the product, which headspace contains air and steam. The product **13** may be in the solid state, in the liquid state, or in both states. The volumes respectively occupield by the product, by the steam, and by air, are each variable as a function of the temperature. A rise in temperature causes an increase in these volumes, by expansion of the product, by an increase in the vapour pressure and by expansion of the air and of occluded gases. The can ends **11**, **12** serve the purpose of withstanding the thrusts caused by these increases in volumes: the deformability of the can ends renders it possible, by passing from a slightly concave initial shape to a more or less convex or domed shape, to have a substantial increase in the internal volume and the consequent retention above the product of a headspace adequate to limit the pressure strains to permissible values, available for the steam, air and gases.

The contents contract during cooling and the can ends then return substantially to their initial position under the action of the vacuum caused by contraction and, if applicable, of the counter-pressure of a machine by which the can is sterilised.

As has already been stated above, the vacuum generated within the can may reach values which are the greater,

the higher the temperature level above ambient at which the filling and sealing of the can has been performed. For the reasons stated, the prevailing tendency is to perform the filling operation at the highest possible temperature, but under the restriction imposed by the risk of collapse caused by the vacuum. This risk varies according to the shape of the can. For example, the risk of collapse is practically absent under the normal conditions for cans having a diameter not exceeding 71.5 mms. and a height of 115 mms., whereas a can having a height of 118 mms. and a diameter of 100 mms. may collapse suddenly starting from a relative vacuum of 0.6 bar; and a can having a diameter of 153 mms. and a height of 250 mms. may collapse suddenly starting from a relative vacuum of 0.2 bar.

Apart from this risk of collapse, recontamination risks arise at the end of or after the sterilising process, especially if the can seams receive knocks which can impair their seal. Knocks are frequent however during and after the sterilising operation and may cause a seepage of cooling water into the can, this water generally not being biologically sterile.

These difficulties are eliminated or greatly reduced by reducing the final volume, that is the reduction obtained by a permanent deformation of at least one of the sides of the can in accordance with the invention, the reduction of the final volume resulting in a reduction or elimination of the vacuum generated by the cooling action.

According to one embodiment of the invention, the reduction in the volume of the can is produced by a punching operation performed by mechanical pressure exerted on at least one and preferably both of the can ends.

FIG. 2 illustrates apparatus for applying mechanical pressure to both ends of a can, the apparatus comprising two pressure-applying devices **21** and **22** each of which includes an annular centering portion with a lead-in taper **23**, **24** for guiding a can **10** towards two punch elements **25**, **26** having a configuration corresponding to that of the appropriate can end **11**, **12**. The punch elements advantageously each have an annular pressure-applying face **25A**, **26A** respectively encircling a recess. Whereas the pressure-applying device **22** is unitary with a reciprocable member **28** (reciprocation being indicated by the double-headed arrow F), the other pressure-applying device **21** is guided in a stationary guide **30** and is carried by rods **31** forming, for example, a part of a pressure limiting device **32** of the compressed air type, arranged to oppose a predetermined resistance against displacement of the rods **31**. As shown in FIG. 2 the pressure-applying faces **25A**, **26A** are outwardly sloping frusto-conical surfaces.

FIGS. 3 to 5 diagrammatically illustrate a machine of a kind known per se, but provided with apparatus as just described with reference to FIG. 2, for applying pressure to the can ends.

Referring to FIGS. 3, 4 and 5, a spindle **35** is rotatable in brackets **33**, **34** carried by a frame **32**. The brackets **33**, **34** support two fixed cams **36**, **37** and two drums **38**, **39** are keyed on the spindle **35** and rotate therewith. Each of the drums **38**, **39** are provided with a plurality of pressure-applying heads **40**, **41** which rotate with the drums **38**, **39**. The drums also carry cam follower rollers **42**, **43** which respectively cooperate with the cams **36**, **37**. The heads **40**, **41** are axially aligned in pairs and are moved towards and away from each other by the cams **36**, **37**.

Apparatus as described with reference to FIG. 2 is accommodated by each pair of aligned heads **40**, **41**. For example, each head **40** may form the reciprocable member **28** of a pressure-applying element **22**, whereas each head **41** comprises a pressure-applying element **21** with its pressure-limited device **32** which device is the pneumatic type. A compressed air connector **45** is connected to the spindle **35**, which is hollow, with the interposition of a rotary seal, and with passages (not shown) which extend radially from the spindle to feed compressed air to the devices **32** carried by the drum **39**.

In a machine as illustrated in FIG. 3 which comprises a horizontal spindle **35**, cans **10** are fed, as illustrated in FIG. 4, as they issue from a sterilising plant, not shown, and before they are completely cooled following the sterilising operation, gravitationally through a chute or funnel **46**, and are received by a rotatable transfer member **47** arranged to move the cans in succession between pairs of heads **40, 41**. The cams **36, 37** are arranged to effect the application of pressure to the ends of a can while the can is located in the sector shown at **48** and the release of treated cans occurs at the lower part through a chute or trough **49**.

The machine may, if desired, have a vertical spindle and may receive cans fed thereto and removed therefrom in an upright position by means of a conveyor of any suitable kind.

The pressure-limited device **32** may alternatively be operable by spring or by hydraulic pressure or the pressure exerted on the can ends may be produced by direct action of a pressurised fluid on the can ends.

FIG. 6 illustrates the development of the deformation resulting from a mechanical force P on a can end **12** of normal kind in which the pressure causes the can end to deform to a condition as indicated at **12A**. The maximum reduction of volume of the can which is thus possible to obtain by permanent deformation the can end close to the end seam is of the order of 3%, or 1.5% for each can end.

In describing the mode of operation according to the invention, reference will be made to a known kind of can end, British patent specification No. 1,170,877, indicated at **50** in FIG. 7, and which embodies an annular bead **51** connecting the end seam **53** to an annular stiffening corrugation **54** which in turn is connected to the center panel **53** by at least one flexible corrugation **55**. Under the action of mechanical pressure P, applied in accordance with the invention, a can end of this kind flattens out in final manner to a condition as indicated at **50A** thus allowing a considerably greater can volume reduction, which is of the order of 8 to 10%, or 4 to 5% per can end. Starting from the condition **50A**, the central areas of the can ends is liable to undergo a further resilient deformation to reach a position such as **50B** under the action of a residual internal vacuum. The line **50C** indicates an outward displacement the can end is liable to undergo at the beginning of the sterilising operation under the action of the internal super-atmospheric pressure, without permanent deformation and without the risk of unfolding of the end seam **52**.

FIG. 7A is an enlarged scale illustration of the final flattening of the base **50** of a can by means of a punch comprising three concentric annular pressure-applying rings **127A, 127B, 127C** which are axially displaced relative one to another. The broken line A indicates the outline of the can end **50** after the pressure exerted by the first ring **127A**, the broken line B indicates the outline of the can end after the pressure of the second ring **127B**, and the broken line C indicates the outline of the can end after the pressure of the third ring **127C**. The permanent deformation assumed by the base in each of these cases is that shown; the broken line D illustrates the resilient deformation which may then be incurred complementarily by the central portion of the base **50**.

The number of corrugations or folds of the can end affected by these deformations depends on the volume of the contents of the can at the temperature at which the pressure is applied, on the diameter of the can, and on the total number of pressure-applying rings of the punch.

The mechanically effected reduction in the volume of the can or of its headspace comprises a peripheral portion of permanent deformation by partial flattening of the flexible corrugations **55** while the center panel **53** remains flexible and follows the variations in the volume and pressure of the contents of the can. This is why, at the end of the cooling action, which generates a weak vacuum in the can, the center panel **53** of the can end passes resiliently from the position C to the position D.

Experience has shown that owing to the customary deviations from the filling level between one can and another for one and the same product, or from the filling temperatures between one can and another, it is desirable to contemplate possibilities of volume reduction of the order of 10%, so that in the greater number of cases, it will be preferred to employ can ends which, according to British patent specification No. 1,170,877, comprise the combination of an outer stiffening corrugation close to the end seam with flexible corrugations closer to the center. In case of a diminuation of the prevailing deviations, it may however be contemplated to employ less flexible can ends of conventional shape.

In the application of the invention, a pressure limit will be adopted, which should not be exceeded in the final stage, for example amounting to between −0.15 bar and +0.15 bar relative to atomspheric pressure. This condition determines the volume reduction to be effected, which will be a function of:

the filling temperature;
the filling level;
the quantity of gas in the can which is linked to the two preceding factors;
the expansion or contraction coefficient of the product.

The magnitude of the volume reduction to be effected being determined in this manner, it is appropriate to determine the instant in which it is to be performed.

In view of the risk of recontamination, it is undesirable to effect the volume reduction when the can is cold, since the damage may then already be done. It is thus desirable to apply the punching pressure to the can ends as soon as they have returned to a lower temperature than that of the filling temperature by a sufficient amount for the value of the vapour pressure to generate the vacuum required for spontaneous inward displacement of the can ends. If, for example, this operation is performed whilst the vapour pressure substantially still has a value of 0.2 or 0.3 bar, the continuation of the colling action will cause an additional drop in vapour pressure and a contraction of the product and of the air, that is to say an additional vacuum which may be sufficient to collapse the can body. Experience confirms that the magnitude of the contraction of the product and of the air is sufficient to generate a complementary vacuum which causes collapse of the can body unless definite precautions are taken.

These considerations result in arranging that the volume reduction during the cooling process is effected at a temperature level which is as high as possible, but below which the variations in vapour pressure become small; for example, the temperature level may be approximately 40° C. at which temperature the water vapour pressure reaches 0.075 bar and beyond which its decrease slows down appreciably.

The level of approximately 40° C. having been established, the value of the permissible filling temperature without risk of collapse can be determined for cans of each kind. This may be understood more clearly by reference to the diagram of FIG. 8 which shows the evolution of the pressure variations as a function of the temperature (T): the curve P_v shows the evolution of the vapour pressure variations, whereas the curve P_i illustrates the variations in the relative pressure within a particular can.

On the temperature axis T has been marked at T_0 the aforesaid temperature level of approximately 40° C. whose selection is determined by the corresponding value P_o of the vapour pressure, being for example, 0.075 bar. Based on the temperature level T_0 at which it has been decided to perform a volume reduction operation, a second temperature level T_1 is determined which will be that to be adopted for the filling and sealing of the can. This level is established by a definite maximum value delta-P of the vacuum which can be borne by the kind of can in question, without risk of collapsing.

Two cases may then be envisaged, depending on whether the temperature T_1 is considered adequate or insufficient for the sealing of the can. If it is considered inadequate, it is earmarked for performing an operation of volume reduction at the temperature, and another pressure stage delta P' is taken to determine another temperature level T_2 which will, in this case, be taken as being satisfactory as an intial level for sterilisation after the sealing of the can. This sterilisation (arrow S) will include the rise in temperature up to a definite level T_3 (point A), causing the generation within the can of a definite relative pressure P_3 and an inflation of the can ends (position 50C, FIG. 7). During the following cooling action, a first stage R32 initially restores the temperature to the sealing level T_2 at which the relative internal pressure is substantially nullified, so that the ends of the can will have resiliently returned to their initial position (50, FIG. 7). A next cooling stage R21 returns the temperature to the level T_1 (point B) with the drop delta-P' of the vapour pressure and the generation of a definite negative pressure P_2 which will moreover be greater than delta-P' owing to the effect of the contraction of the air and of the gases occluded and of the product itself. At this level, a first volume reduction operation is performed which generates a definite compression K_1, causing the internal pressure to rise to a denfiite positive value P_1 which determines the starting point V of the curve portion R_{10} illustrating the stage R_{10} of the cooling action leading to the temperature level T_0 (point D) at which it has in all likelihood been decided to perform a volume reduction operation. This operation causes a recompression K_0 which causes the internal pressure to rise to a definite positive level corresponding to the position of the point E. The last stage R_0 of the cooling action which cools the can to ambient temperature, restores the relative internal pressure to a value very close to nought and an assurance is gained that the can will retain a correct saleable appearance even if the climatic storage conditions were to heat the can to temperatures which may amount to between 5° and 40° C., for example.

The level or levels of internal vacuum, like P_1, P_2 will evidently be chosen to have lower values than the limit beyond which the can in question runs the risk of spontaneous collapse. This limit essentially is a function of the gauge of the metal of the can body, which renders it possible to emphasize the advantage of the invention, being the possibility of reducing this gauge without impairing the quality of the packaging.

The pressure force is limited to a lower value than that of bursting of the assembled can; this limitation, which is applied by the pressure-limiting device 32, FIG. 2, is a function of the shape and structure of the can. The can bodies will usually easily withstand a pressure of 3 bars, which renders it possible to contemplate relatively high pressure forces.

The technique of volume reduction according to the invention is applicable to cams provided with a can end of the so-called easy-opening type. In this case, the pressure-applying apparatus should make allowance for the fact that the easy-opening end should not be touched, and that only the can end at the opposite end of the can be acted upon. An example of an apparatus appropriate for this case is illustrated in FIG. 9 in which a can body **60** has a can end **61** analogous to that of FIG. 7, and an easy-opening end **62**. Facing the can end **61** is a pressure-applying element **30** analogous to that of FIG. 2; the pressure-applying element **65** arranged facing the can end **62** differs, however, from the element **22** of FIG. 2, in that its punch **66** provides the can end with a surface arranged to support it over its entire area except for a peripheral area; and the groove provided around the punch and in alignment with the unsupported area provides a part **68** for abutment against the end seam **69**. Because of this arrangement, the thrust displacement exerted on the can end **62** is limited to a small value, which may, if need be, be practically equal to nought, compatible with the deformability allowed by its peripheral area **67**.

FIG. 10 illustrates apparatus intended for application of the invention to a deep-drawn can **70** which is equipped with a can end **71** of the easy-opening type. Aligned with the can end **71** is a pressure-applying element **65** of the kind described with reference to FIG. 9. In this embodiment, however, the pressure-applying element **72** exerts pressure on the deep-drawn base **73** and comprises a groove **76** having a surface the section of which corresponds to the radius of curvature by which the base **73** is joined to the body of the can. The central portion **74** of the pressure-applying element exerts pressure against the central portion of the base by means of springs **77** to prevent the base from becoming convex. The clearance between the element **74** and its guide **72** is greater than the maximum value scheduled for the pressure displacement, which, in this case also, is determined by a pressure-limiting device (not shown).

The axial pressure P exerted under these conditions effects a displacement in axial translation of the whole of the supported portion of the base whilst rounding-off the portion **75** joining the base to the can body; this displacement may continue along a height as great as needed to secure the optimum final volume reduction defined by the condition of obtaining a final internal pressure between −0.15 and +0.15 bar, as described above. If the can end seamed to a deep-drawn can is a standard can end (and not one of the easy-opening type), it will evidently be capable of bearing a part of the volume reduction.

The process according to the invention is applicable not only to the can ends made of tin-plate or other steels, or of aluminium, but is also applicable to ends made of any other materials offering the qualities required for application as ends for cans. Further, the invention is applicable not only to circular cans as herein described, but also to prismatic cans or to frusto-conical or frusto-pyramidal cans of any desired cross-section.

When considering cans having a cross-section other than circular and referring to a punch provided with an annular pressure-applying face, the term "annular face" should be understood as meaning a surface which is defined by outlines conforming to the external contour of the can end processed and which leaves uncovered the central part of the can end.

We claim:

1. A process for filling and then sterilizing a can of the type having two deformable ends, said process comprising the conventional steps of filling the can with a product, hermetically sealing the filled can, heating the can and the product contained therein for a predetermined period to a predetermined temperature, and then cooling the can and the product; said process comprising the further steps of providing said deformable ends in the form of can ends each having at least one annular corrugation, and during an intermediate stage of said cooling of the can and the product contained therein mechanically opening out the corrugation of each end with punches moving axially in opposed relation and deforming the can ends axially into the can for reducing the internal volume of the can and preventing uncontrolled collapsing of the can due to an inherent reduction in volume of the product within the can due to cooling thereof.

2. The process according to claim **1** wherein the fill within the can is preheated prior to closing whereby the filled can may be heated to a higher than normal sterilizing temperature while holding internal pressures below critical internal bursting pressures.

3. The process of claim **2** wherein said preheating temperature is on the order of 100° C.

4. The process according to claim 1, in which the pressure exerted is predetermined and limited to a value determined by the bursting strength of the can.

5. The process according to claim 1, wherein each deformable end has a plurality of the annular corrugations, said volume reduction is effected in a series of said corrugation opening steps with each corrugation opening step being performed each time the internal vacuum of the can reaches a predetermined value.

6. The process according to claim 5, wherein at least one of said volume reductions is performed at a temperature level so chosen that the final pressure in the can is maintained within predetermined limits.

7. The process according to claim 6, wherein pressure limits amount to approximately plus or minus 0.15 bar relative to atmospheric pressure.

8. The process according to claim 6, wherein the temperature level is approximately 40° C. at the instant of effecting said permanent volume reduction.

9. A filled and sterilised can the volume of which has been permanently reduced by the process according to claim 1.

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