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BY A. P. C.

S. B. CRESPI

PROCESS FOR THE TREATMENT OF MILK AND OTHER ALIMENTARY AND ESPECIALLY GLOBULAR LIQUIDS, TO IMPROVE THEIR PRESERVATION AND RENDER THEM MORE EASILY DIGESTIBLE, APPARATUS AND PRODUCT RELATIVE TO THE SAME

Filed Jan. 30, 1941

Serial No. 376,698

3 Sheets-Sheet 1

Fig.1

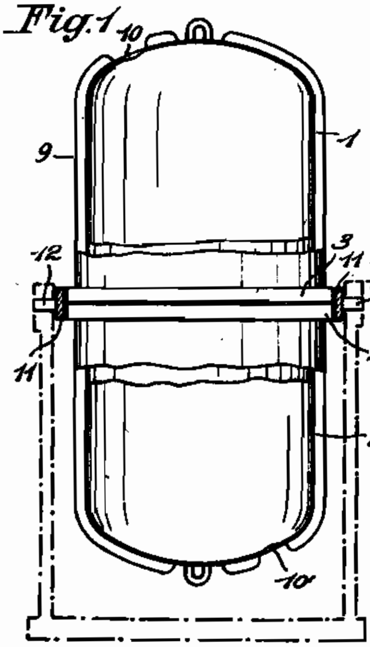


Fig.2

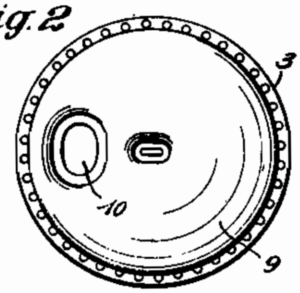


Fig.3

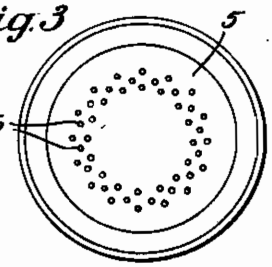


Fig.4

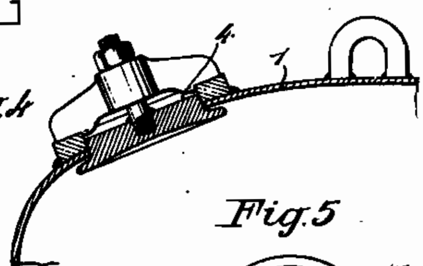


Fig.5

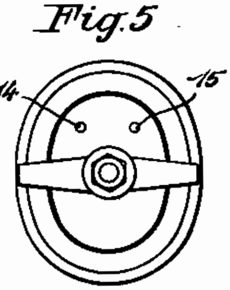
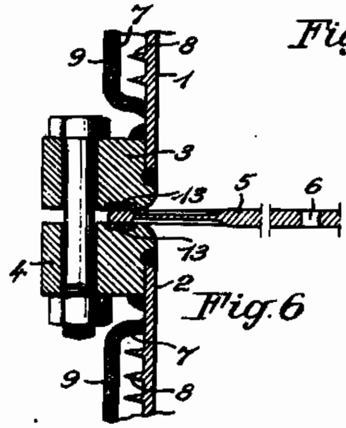


Fig.6



Inventor,
S. B. Crespi

By: Glascock Downing & Seebold
Attys.

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3 Sheets-Sheet 2

Fig. 7

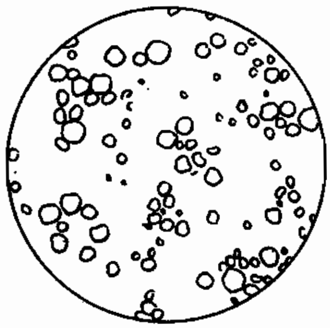

Fig. 8

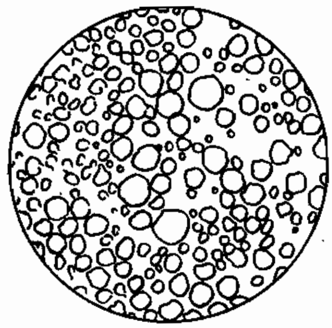

Fig. 9

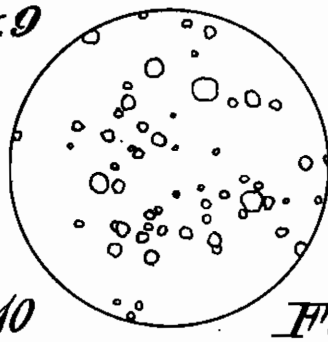

Fig. 10

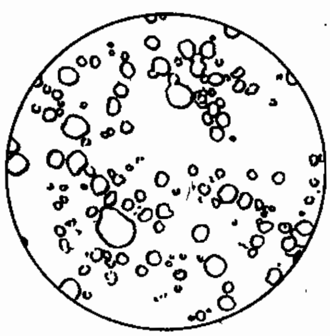

Fig. 11

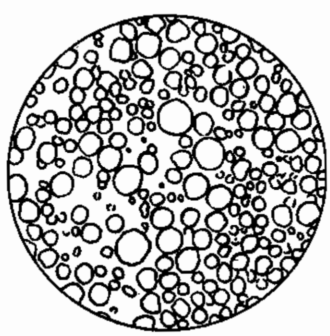

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Fig. 12

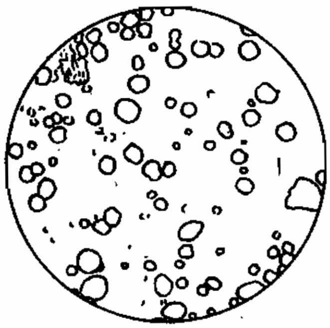


Fig. 13

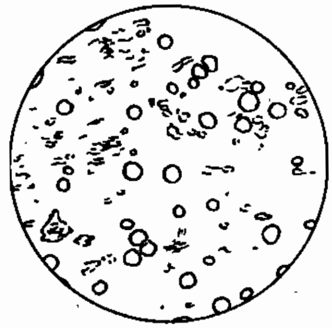


Fig. 14

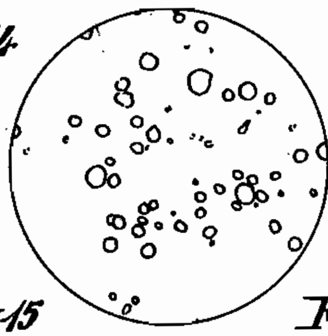


Fig. 15

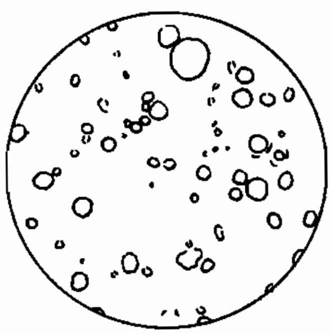
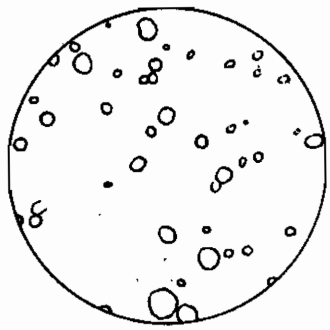


Fig. 16



Inventor,
S. B. Crespi

By: Glascock Downing & Seebold
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ALIEN PROPERTY CUSTODIAN

PROCESS FOR THE TREATMENT OF MILK AND OTHER ALIMENTARY AND ESPECIALLY GLOBULAR LIQUIDS, TO IMPROVE THEIR PRESERVATION AND RENDER THEM MORE EASILY DIGESTIBLE, APPARATUS AND PRODUCT RELATIVE TO THE SAME

Silvio Benigno Crespi, Milan, Italy; vested in the Alien Property Custodian

Application filed January 30, 1941

It is well known that milk or cream can be kept for a long time if it is put into air tight containers and treated with oxygen at high pressure at a temperature below 8° C., and that if milk is heated to a temperature between 48 and 59° and then treated with oxygen at a pressure above 8 atmospheres and cooled down to a temperature not above 24° C. the result is a purification from noxious germs which is a great deal more effective than that obtained by pasteurisation and other widely diffused similar methods, (milk pasteurisation centrals), and the resulting milk may be preserved for a long time in normal conditions: i. e. at medium temperatures of from 18 to 28°. Milk treated in this manner retains the organoleptic properties and the vitaminic tenor of pure milk and may be transported over great distances by land or sea with low cost.

However until now both the first and the second treatment could only be safely effected in small apparti made of inoxydable steel or of common enamelled steel, and the industrialisation of such treatments has not yet been attained: i. e. the application of apparti having large dimensions (for instance 500 litres) and low cost, rendering the said treatments cheap and safe, has not been made use of.

A treatment on industrial scale of milk at an oxygen pressure above 8 atmospheres with the above mentioned object, requires:

1. Containers having a normal, and not an excessive cost as is the case with inoxydable steel ones.

2. A perfect penetration of the oxygen molecules into the milk molecules: i. e. a perfect emulsioning of the milk with the oxygen.

3. A rapid heating of the milk above 48°, without ever rising above 60°, which is the critical temperature of milk: i. e. the temperature at which its structure becomes altered.

4. That the temperature be maintained for a certain lapse of time (from one hour and a half to five hours) at above 48°.

5. A rapid cooling of the mass of milk.

6. An easy bottling operation of the emulsionated milk, the froth being prevented from getting into the bottles, and an equal distribution of milk in all the bottles being thus obtained.

I have satisfied all these requirements for a treatment on an industrial scale, and after long study and numerous experiments I have resolved all the problems in question with an apparatus and a method of treatment for the preservation of milk, cream and other alimentary liquids, forming the object of the present patent application.

I have thus created a new type of industrial apparatus, which forms the first object of the present patent application.

Always according to the present invention, I have found that the partial or incipient homogenization which, as aforesaid, is effected by causing a mass of milk (or other alimentary liquid, especially a globular liquid as for instance blood) and of gaseous oxygen (or other gas having an analogous behaviour) at a high absolute pressure to pass through an apertured diaphragm, while maintaining a very moderate pressure differential between the two diaphragm surfaces, produces an useful output varying greatly as function of the diameter and length of the canals or apertures crossing said diaphragm.

Obviously other agents influence the quality of the treated milk, as the temperature, the absolute pressure, the differential pressure, the number of apertures or canals and the number of times that the milk is caused to pass through the latter. As far as the present invention is concerned, however, only the first above mentioned agents, i. e. the diameter and the length of the canals or apertures, have essential importance. According to the invention, these values must be placed in relationship with the medium diameter of the corpuscles of solid substances constituting the milk and disgregating themselves up to a certain measure while passing through said canals or apertures.

By systematical experiments I have been able to discover that there are optimum values for the diameter and for the length of the canals crossing the diaphragm. These values could not have been foreseen, independently from experiment, on the sole basis of the preceding technical notions. In other words, I have discovered the existence of a particular field of conditions, within which the treatment forming object of the present invention gives results which are superior to those obtained with values outside said field.

To be more accurate, the optimum values of the diameter and of the length of the canals or apertures depend on the pressure differential applied to the fluids in correspondence with the two surfaces of the diaphragm; for instance, with a differential pressure of about 40 centimetres of a column of water, better results have been obtained by using a diaphragm crossed by apertures having a diameter of 1 millimetre and a length of 10 millimetres, whilst with a greater differential pressure, the other conditions remaining as before, the same effect was obtained by using apertures which were slightly wider or shorter.

The annexed drawings illustrate, by way of an example, a manner of execution of the invention.

Fig. 1 is a diagrammatical illustration of the apparatus forming an object of the present invention shown in front view with parts in section.

Fig. 2 is a view from above of the same.

Fig. 3 shows a diaphragm fixed to the inside of the apparatus.

Fig. 4 is a section, in larger scale, of a detail.

Fig. 5 is a view from above of the aforesaid detail.

Fig. 6 is a section of a detail of the fixture of the diaphragm of Fig. 3, also shown in a larger scale.

Figs. 7, 8, 9 are graphic reproductions of three microphotographs showing the globules of milk.

Fig. 10 shows a microphotograph at 1200 enlargements of the fat globules contained in normal pure and raw milk.

Fig. 11 shows a microphotograph at 1200 enlargements of the fat globules contained in the same milk after a normal pasteurisation at 63° C.

Fig. 12 is a microphotograph similar to the preceding ones, showing the fat globules of the milk after heating and oxygen pressure treatment.

Fig. 13 is a microphotograph similar to the preceding ones, showing the same milk treated with heat and under oxygen pressure, but in an air tight container with a diaphragm having apertures of 10 millimetres diameter.

Fig. 14 is a microphotograph similar to the preceding ones, showing the same milk treated with heat and under pressure, but in an air tight container with a diaphragm having apertures of 2 millimetres diameter.

Fig. 15 is a microphotograph similar to the preceding ones, showing the same milk treated with heat and under oxygen pressure, but in a closed container with a diaphragm having apertures of 1 millimetres diameter and 2 millimetres length.

Fig. 16 is a microphotograph similar to the preceding ones, showing the same milk treated with heat and under oxygen pressure, but in an air tight container with a diaphragm having apertures of 1 millimetre diameter and 2 millimetres length.

The apparati according to the invention are enamelled steel pressure reservoirs, consisting of two half calottes 1 and 2, whose cylindrical parts vary in length. The calottes are flanged by flanges 3 and 4 and are riveted to each other in such a way as to enable them to oppose resistance to the internal operating pressure of 10 atmospheres and of 15 atmospheres in hydraulic test.

A disc 5 is grasped between the two calottes and is punctured by apertures 6 having special disposition and measures.

Each calotte forming the pressure reservoir is covered by a skirt 7 of little sheets of steel, and preferably spiral ribs 8 are soldered between the outside part of the calotte and the inside part of the skirt. Openings provided with taps are furnished both at the top and bottom of each skirt.

A layer of insulating material 9 is applied to the outside of the skirt.

A small man hole 10 is provided on the dome of each calotte. On the cover of the top man hole a small valve of non-oxidizable steel is applied for the introduction of oxygen, a manometre and a tube, penetrating into the pressure reservoir as far as the milk level, are also furnished, the introduction of a thermometre being thus rendered possible. Whereas a big outlet valve also of non-oxidizable material is applied to the bottom man hole cover.

An iron ring 11, carrying two trunnions 12 is disposed round flanges 3 and 4 which join and secure the two calottes by means of rivets. Ring 11 is riveted to the flanges. Trunnions 12 are placed on two bearings carried by a strong trestle, not shown in the drawings, which can be provided with wheels.

All the weight of the pressure reservoir, skirt and insulating layer included, comes to bear on the trunnions and consequently on the two bearings, hence the whole pressure reservoir may oscillate and rotate on the axis of the two trunnions.

In the construction of such pressure reservoirs, the following rules must be kept in mind:

1. The inside of the pressure reservoir must be suitably smoothed so as to allow a proper enamelling.

2. The enamelling must be executed with enamels having a resilience not lower than that of steel, and as ordinary enamels are less resilient than steel, it is obvious that they would crack under a pressure of 10 atmospheres and thus allow the milk to come into contact with the steel and consequently to be spoilt.

The enamels must be impervious to the combined actions of the acids contained in milk, of the heat and of the oxygen under a 10 atmospheres pressure.

Lacquers obtained from synthetic resins and reduced to enamels are suitable for this scope. They are very resilient, easily reparable in case of breakage and their eventual scales are not noxious to the human organism, as would be the case with scales of vitreous materials if they were to be swallowed with milk.

3. In disc 5, grasped between flanges 3 and 4, by apposite packings 13, a certain number of small apertures must be punctured in the position indicated on the drawings.

When the pressure reservoir is filled with milk for $\frac{8}{10}$ and with oxygen for the remaining $\frac{2}{10}$ of its capacity, if it is in a standing up position, all the oxygen remains above the milk level. If it were turned upside down very rapidly and kept perfectly vertical, the oxygen would remain under the milk and theoretically it could not filter through the milk. But if the overturning movement takes place slowly, then the action of the apertured disc is such that inside the pressure reservoir different hydrostatic pressures are formed, and the oxygen filters through the apertures of the disc crossing the whole mass of milk.

Thus energetic filtrations are formed, and the smaller apertures 6 are and the bigger the number of overturning movements is, all the more energetic and efficient the filtration becomes and all the more apt it is to break the larger fat globules contained in the milk and to reduce them to globules smaller than usual.

Hence the beginning of a homogenization process rendering the milk better because it becomes more digestible. In fact we know that a homogenization, i. e. a disgregation, by means of a very fine filtering under very high pressures of the fat globules, renders milk very easily digestible and therefore more suitable for children and weak stomaches in general.

This simple and economical treatment of milk combined with the use of a diaphragm having small apertures and the consequent reduction of the fat globules keeping them detached without having recourse to great presses, which forms the object of the present invention, is an absolute novelty and a great improvement on the treatment method in comparison with the pasteurizing treatment. In this way an excellent emulsion facilitating the preservation of milk for several days is obtained. This can easily be seen from the three microphotographs graphically reproduced on the annexed drawings, in which:

The first (Fig. 7) shows the globules of raw milk, i. e. as it comes out of the cow sheds.

The second (Fig. 8) shows the milk globules enlarged and brought nearer to each other by pasteurisation.

The third (Fig. 9) shows the milk globules rendered smaller or anyhow detached from each other by the milk treatment of my invention (disc with small apertures, slow overturning movement of the pressure reservoir repeated several times).

4. The heating of the milk up to the most suitable temperature within the limits between 49° and 60° will be obtained either before the milk is poured into the reservoir, by making it pass through coils kept in hot water, or through plates of an ordinary pasteuriser; or otherwise after the milk has been poured into the pressure serervoir by circulating very hot water in the spirally ribbed skirt.

The ribs, especially if they are spirally disposed, increase the heating surface, and a few overturning movements of the pressure reservoir are sufficient to stir up the fluid mass bringing all the parts into contact with the heated walls. This second heating system will be very useful in small centres, where preheating apparati are rarely to be found.

5. The most suitable temperature, between 48° and 60°, will be easily preserved by emptying the circulation water out of the skirt and closing the taps. A thick layer of insulating material is applied on the top of the skirt. Thus the skirt forms an insulating air case and the insulating material, together with said air case, ensures a perfect preservation of the heat of the milk mass contained in the pressure reservoir, said mass cooling only very slowly indeed.

6. A rapid cooling of the mass of milk will be obtained by circulating cold drinking water in the spirally ribbed skirt. As the waste surface is considerable and as the mass of milk is stirred by the overturning movement of the pressure reservoir, the subtraction of heat is rapid and sure.

7. An easy bottling operation with elimination of froth will be obtained by placing the pressure reservoir or reservoirs on a plane higher (for instance about 3 or 4 metres) than that on which the bottling machines are mounted. The outlet valve of the pressure reservoir will be connected by tubes to the bottling machine. When the outlet valve is opened, the pressure reservoir being kept vertical, the froth will remain at the top. The pressure, which will have to have been reduced, pushes the frothless liquid downwards along a descent corresponding to several metres, bearing in mind the residue pressure, and so the milk reaches the bottling machines free from froth, while during the operation said froth continually diminishes in volume, melting into liquid milk.

With the above described pressure reservoirs the operation is the following:

After having been filtered, the milk is introduced unto the pressure reservoir, at the bottom through valve 10' if it has been preheated by means of coils or plates. Whereas if it is to be heated in the container itself by means of hot water circulating in skirt 7, the milk is introduced through the top opening.

When the pressure reservoir is $\frac{9}{10}$ full of milk, top man hole cover 10 is applied, and through valve 14 oxygen is introduced from an ordinary gas bottle, and the pressure is controlled by manometre 15 until it reaches approximately 15 atmospheres. Then inlet valve 14 is closed.

Then the pressure reservoir is slowly overturned either by hand or by mechanical means, causing it to accomplish several revolutions, rotating on the axis of trunnions 12 and thus causing all the milk to pass through the small apertures of the diaphragm. The number of revolutions will be as function of the homogeneisation, but must not be such as to cause formation of butter.

The pressure reservoir will then be placed and secured in a vertical position. Valve 14 is opened and the oxygen allowed to escape, thus all the air and all the mephitical gasses from the cow shed, which any milk contains in a varying quantity, is got rid of.

Then the pressure reservoir is again filled with oxygen to obtain a pressure of approximatively 10 atmospheres, or anyhow a pressure above 8 atmospheres. The pressure reservoir is again caused to rotate and a certain amount of time is allowed to lapse to enable the oxygen to accomplish its task and destroy the germs noxious to the milk, while the milk still retains certain acidifying elements.

As I have said, an hour and a half is sufficient to destroy the pathogenic elements, three hours are sufficient to preserve milk for a week, in five hours the best treatment is obtained, because then the milk lasts several weeks.

Lastly, the milk is cooled either bringing it to the bottling machines through a refrigerating apparatus provided with coils or plates, or by circulating cold water in the spirally ribbed skirt.

It is advisable to maintain the milk in an emulsion condition causing the container to accomplish one or several rotations every twentyfour hours.

The milk can be transported over great distances either by land or sea in the pressure reservoir containers described above, and they will benefit particularly in transport if they are constructed as movable railway cases.

Once bottled the milk will keep about 72 hours at temperatures of from 20 to 22° C. and up to ten days in cells maintaining their temperature below +10° and at limits very little below.

With the container or pressure reservoir above described, the modern milk collecting system can be radically renewed.

Actually in the countries best organised for the production and collection of milk, the cow sheds of a restricted circundary send the fresh milk to a nearby collection centre, where the milk is emptied from the cans into a capacious alluminium container, filtered and highly cooled (+4°) with refrigerating machines which are costly both as far as installation and upkeep are concerned. Then the milk is put into cans again and sent to the pasteurising centre in lorries.

Supposing the milk to arrive at 30° at the collection centre, 25 frigories will be necessary to cool it, these frigories require from 25 to 75 calories for their production.

With my new apparati the collecting centre will no longer need the big alluminium container and one will only have to fill the pressure reservoir after having filtered the milk. In the pressure reservoir itself, or before it is introduced into the same, the temperature of the milk will be raised from 35° to 55° employing 25 calories which will always cost less than the aforesaid 25 frigories. The milk heated to 55° will be treated with the double injection of oxygen and emulsionated in the manner above described.

The pressure reservoir mounted on wheels will be brought to the central and during the journey and the eventual stops it will condition itself perfectly as meanwhile the hours necessary for the distruction of the noxious germs will pass by. When the pressure reservoir arrives at the central the cooling and bottling operations take place.

Obviously this new method will be more economical and hygenically safer than the actual method. The milk will be knocked about less and better able to preserve all the good qualities it possesses at the moment of its being drawn from the cow. However small, it is known that any cooling operation is noxious to these good qualities.

The experiments shown in the microphotographs of Figs. 12, 13, 14, 15 and 16 have been made in containers having identical dimensions.

The enormous difference between the fat globules visible in the microphotograph of Fig. 11 (plain pasteurised milk) and the fat globules shown in Fig. 16 (milk treated with a diaphragm having apertures of 1 millimetre of diameter and 10 millimetres of length) is evident; the pasteurised milk (Fig. 11) shows a conspicuous condensation of globules having a large diameter, whereas the milk treated according to the present invention presents few globules of normal diameter and a very great quantity of globules having an exceedingly redueed diameter, thus rendering the milk illustrated in Fig. 16 more ressemblant to homogeneised milk proper than to raw milk (Fig. 15).

As for bacteric contents, I have ascertained that in my invention it is much lower than in ordinarily pateurised milk, and especially after 24, 48, 72 hours in open receptacles placed in rooms having a medium temperature of 24°.

As regards preservation, it has been ascertained that with my invention it is superior both at normal and cold temperatures. Milk treated with my system and brought up to optimum reached til now, i. e. in conditions similar to those illustrated in the microphotograph of Fig. 16, has lasted in perfect conditions for seventy days in the container under pressure and then been bottled and kept in a cellar at +7° C and has been preserved for three more weeks.

Thus I have prooved, with the realisation of my invention, that milk may be preserved in bottles and ordinary containers much longer than it was heretofore possible with other methods.

Generally speaking, I can say that the best field for the realisation of my invention is that comprehending canals having a diameter smaller than 3 millimetres and a length not greater than of 2 millimetres, although I do not exlude that one can attain quite good results with superior diameters and shorter lengths.

The present invention has been illustrated and described in a preferred embodiment with reference to the treatment of milk, but it is understood that it may be analogously applied to other alimentary liquids, especially globular or coagulatable liquids, as for instance blood, and that constructive changes may be introduced therein without departing from the scope of the said invention.

SILVIO BENIGNO CRESPI.