PASTEURIZATION

AND MILK PRESERVATION;

With a Chapter on

The City Milk Supply.

SECOND AND ENLARGED EDITION.

REVISED UP TO DATE.

PRICE, - - - FIFTY CENTS.

—PUBLISHED BY—

J. H. MONRAD,

WINNETKA, ILL.

In Connection with Pasteurization

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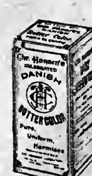

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L. Pasteur in his Laboratory.

LOUIS PASTEUR.

Born Dec. 27, 1822, this son of a tanner early showed his extraordinary talent, and if I was to attempt only to enumerate the results of his life's work, it would take more space than this pamphlet.

Nevertheless I cannot publish a treatise on Pasteurizing without hinting at some of the benefits which the farmers have derived from this great man's work.

He is the first one who studied this world of bacteria, or, as he called it, *"infinite little,"* in a systematic manner. Thus he proved how fermentations such as in beer, wine and milk are due to living organisms and that different bodies are acted upon by different ferments.

He also showed how most—if not all—epidemic or infectious diseases are due to these little fellows and that when once properly known the remedy for the disease may be found. Thus, he saved millions of dollars to the silk worm growers in southern Europe and to the sheep farmers of Australia.

The manufacturers of vinegar learned from him that the true vinegar ferment is a little fungus.

The wine growers learned that by heating their light wines to 140° and cooling them again, they could preserve them much longer.

The brewers received the hint that it was possible to make a uniform good beer, which would keep well, by the same process of heating and cooling (pasteurization) and the use of a pure culture yeast.

All these hints, even if they have not been developed practically by Pasteur, have saved millions of dollars to the farmers. Though Pasteur never took up the milk studies, he is said to have remarked to an English scientist with a sigh: "Ah! *there* is a rich field indeed for investigations."

Nevertheless the useful investigations of milk and its ferments made by other scientists such as Storch, Grotenfeldt, Weigman, Jensen, Freudenreich, Kramer, Adamets, Hueppe, Graeff, Duclaux, Conn, Russell and others, are all more or less excited by Pasteur's original work.

Hence I am correct in saying that if dairy farmers will only apply the lessons given by these men practically, Pasteur will also have been the means of saving them millions of dollars.

But all this may be said to refer only to dollars and cents, when I think of the human life which this man's work has saved, when I think of the human sufferings which he has alleviated, then I lay down my pen, no words of mine can express the gratitude which we all owe him.

Louis Pasteur died Sept. 28, 1895.

INTRODUCTION.

The following treatise on pasteurization must not be taken as an endorsement of the general introduction of the system, *far* from it:—

While conditions often exist which make pasteurizing highly profitable, it is much better if we can eliminate these conditions,—in short, *prevention is better than cure.*

However, we must take the conditions as we find them, and it is far better to pasteurize the milk than to use any of the different preservatives if it is desired to keep the milk sweet longer than is possible by simple cleanliness and ice.

Chemical preservatives of whatsoever name and however harmless for preserving other foods, should never be used in milk, as the latter may be given to *infants*, while the other foods are chiefly used by adults.

It seems to me that even if strict prohibition laws are not enforced, every milk producer, every milk dealer ought to have enough conscience to prevent them from using a preservative which may make them guilty of *manslaughter*.

Nor is there any excuse for using chemical preservatives, as pasteurization will do all that they can do, and more.

It is well, however, to understand clearly that pasteurization should not be confused with *sterilization.* The latter, to be *perfect*, involves the heating of the milk to such a high degree (240° to 250°) that it practically destroys it for commercial purposes, and even where a somewhat lower temperature is used, (212° to 215°) there is sufficient boiled flavor to make it more or less unpopular. Nor should the simple heating of the milk without cooling be termed pasteurization, which requires *both heating and immediate cooling.*

Meanwhile I shall show the different purposes for which pasteurization may be utilized, and describe many of the devices proposed and used.

It is my pleasant duty to acknowledge the use of Dr. H. Weigman's excellent little book on this subject "Milch conservirung," the works of Prof. Duclaux, Freudenreich and Leze, "Milch Zeitung," the Wisconsin and Royal Danish Experiment Station reports and the latest complete work on dairying by Dr. F. Stohmann.

Since publishing the first edition, the changes made in the pasteurizing heaters have been so many that several of those illustrated have become obsolete; but, while I have left out several, it seemed to me that the development is best shown by retaining many of them even at the risk of overloading the pamphlet with illustrations.

Although the chapter on City Milk *has been increased*, this subject cannot be done justice in so small a space, and I therefore confine myself to giving a few hints. If any one feel need of more information as to apparatus, it will pay them to send for the catalogues of the various dealers in *Dairy and Milk* supplies; many of them contain much information of value.

J. H. MONRAD.

Winnetka, Illinois, July, 1901.

CHAPTER I.

MILK AND ITS PRESERVATION.

Milk as it comes from a healthy cow fed on pure food is absolutely pure and sterile, that is, if we could secure it without admission of air in a sterilized bottle, it would keep—if not for ever—for a very long time indeed.

Practically this is of course impossible, and thousands of germs (bacteria) float in the dust laden air, adhere to the udder, the flanks of the cow, the hands and the clothing of the milker.

Even supposing that the utmost precaution is taken, that the cows are carded and brushed, that the udder, and the hands of the milker are washed, that the barn is thoroughly ventilated just before milking, even then remains the favorable breeding place for bacteria, the end of the milk duct in the teats of the cow where they find the best temperature and the best nutrition in the few drops of milk which remain from the previous milking.

But it must not be supposed that all these bacteria are undesirable, some of them do no harm, and some of them are useful, not only in the manufacture of cheese and butter but also in aiding us to digest the milk.

This explains why there is a difference of opinion among physicians as to the desirability of giving infants pasteurized or sterilized milk.

I am therefore of the opinion that wherever we are sure of getting milk from a healthy cow under veterinary inspection and with the above mentioned safeguards, as well as the additional one of using only *sterilized* vessels, or at least those which have been exposed to steam or boiling water for 10 or 15 minutes, we have done all that can be expected even in this "*antiseptic*" age.

But, when we come to the practical task of supplying large cities like Chicago and New York with milk at a reasonable price, we meet the difficulty of an effective control. In these cases I do not hesitate to recommend pasteurization for two reasons. (1). It will, without perceptibly changing the taste and digestibility, kill a great many if not all bacteria. (2) It will enable the milk producer and dealer, to preserve the milk sweet for 36 or 48 hours longer without fear of committing infanticide with *chemical preservatives.*

In order, however, to get the full benefit of pasteurization it should be done as quickly after milking as possible and the before-mentioned precautions in the shape of the utmost cleanliness must not be neglected.

CHEMICAL PRESERVATIVES.

The usual precaution taken by honest milk shippers, is to cool the milk before hauling it to the railroad, and where this is done properly and the cans kept clean, the dealers in the city manage by a liberal use of ice to sell most of it before souring.

But the eloquence of the agents for preservatives as well as the inherent laziness of human nature, which said agents know how to "work," has lately dulled the sense of responsibility in the shippers and induced them to use these preservatives extensively.

Their use is made illegal in most civilized countries, England excepted, where I find not less than 10 different (?) kinds advertised in the dairy papers for 1895 under the following names "Semper Dulcis," "Arcticanus," "Glacialine," "Sal Preservare," "R. J. J. & B. Preservative," "Preservitas," "Crystaline," "Periodate," "Tomlinson's Preservative" and Duncan's Preservative.

Add to this, sundry American fancy names, such as "Preservaline," "Milk Sweet," "Iceliene," "Freezine," "Formaline," etc., and it may be imagined to what extent the public is being imposed upon by the milk dealers who on their side are being imposed upon by the manufacturers who charge from two to ten prices for a fancy name!

Thus so-called "Milk Regenerene" was offered for sale in London in 1884 at 65c per pound, and it was claimed to restore the original taste and smell to sour milk. Dr. P. Vieth found it to be 1 part bicarbonate of soda and 2 parts of sugar, worth, at most, only 9 cents!

I shall not enter a discussion on their comparative value, be they composed of Bicarbonate of soda, Borax, Boracic acid, Salicylic acid or the latest by "Effront" Hydrofluoric acid, Fluorites or Formaldehyde.

No honest man should use either of them in the milk.

PRESERVING BY COOLING.

This has, as before said, been used more or less—generally less—by all milk producers, and, if properly done, is very effective.

Most of the bacteria do not develop at a low temperature, which, however, does not kill them.

It has been demonstrated by **"Cnopf"** and **"Escherich"** that they multiply in milk at 90° Fah. twenty-three times in 2 hours while at 54° they only multiply four times in the same time and while in four hours at 90° 215 times, they only multiply 8 times at 54°.

To show how enormous the increase is at the favorable temperature (90°) it is enough to say that in *6 hours they multiply 3800 times.* Just think of it! for every one of these little germs, hundreds of which may ride on a speck of dust floating in the air, or left in the seam of the milk can, there will be 3800 if the milk is left for six hours at 90°! If the milk is kept close to the freezing point the increase is hardly perceptible. *Ice* should thus be the basis for all honest and healthy milk supplies and the idea of freezing the milk into solid blocks lies near.

This has been done in Paris (France) by "G. B. Guerin." The milk was filled in vessels which when frozen by a refrigerator machine, were insulated for transportation. Frozen milk has been used for years on board ocean steamers.

As it takes quite a while to freeze milk solid, there is a drawback in its creaming during the process, so that the "block" consists of a very poor layer at the bottom with one of cream on top and a very concentrated not frozen milk in the funnel-shaped indenture in the middle of the block. Thus a thorough mixing after melting is made rather difficult.

This phenomenon has even been suggested for the condensing of milk instead of heat, which will be mentioned later on.

The Casse System (patented about 1894) is based upon the fact that milk partly frozen or in which lumps of frozen milk are kept floating, will keep almost indefinitely so long as there is any ice left, and will come out, when thawed, as fresh as new milk, ready to be distributed as wanted. A part of the new milk, say $\frac{1}{4}$ to $\frac{1}{2}$ is frozen solid by means of ice machines as used in the manufacture of artificial water-ice, as soon as possible after milking, and is then dumped into the rest of the milk. The cans may then be transported any distance in well insulated cars, and, on arrival at the city milk depot, placed in some insulated store room—care being taken that ice remains in the milk until it is to be distributed. When the milk is to be delivered, it is dumped, ice and all, into a melting tank, where the remaining ice is quickly thawed and the whole is thoroughly mixed, when it is ready for distribution in the same fresh condition as it was in at the time when it was frozen. If desirable, the milk may be pasteurized before it is frozen, and it may be filtered or run through the separator to remove the impurities, or subjected to any other suitable treatment. The main thing is that, properly handled, according to the Casse system, it will come out when thawed exactly as it was when frozen, and that therefore the difficulties of transportation at any distance, in any climate and of shortage or surplus, have been completely conquered. Another important point in favor of this system is the fact at first thought quite surprising, that, as long as there is ice left floating in the milk, the cream will not rise, but remains naturally distributed as in fresh milk, and that therefore no difficulty arises from that source as would be the case if the milk were kept simply in cans surrounded with ice.

The system, I understand, is used in Denmark, England, Belgium, and in Germany, where **Wilhelm Helm,** of **Berlin,** describes his plan in 1900 in a German health magazine, a plan which is virtually Casse's system, and operated under that patent. The milk is taken good care of by the farmer and cooled before hauling to the factory. Here it is tested for acidity, weighed and run through the pasteurizer, from which it is pumped on a large cylindrical cooler, the upper half of which is cooled by water, the lower by brine, so that the milk arrives in the cans virtually at 32° Fah. The cans are then run down into the half cellar (which is cooled by the refrigerator machine) and stacked in a solid square. When shipped a piece of milk ice, frozen in special forms in a freezing tank, is added to each can and thus preserved in transit to the city depot. This system is in actual operation at Rheinsberger. The cans used are illustrated in Fig. 1.

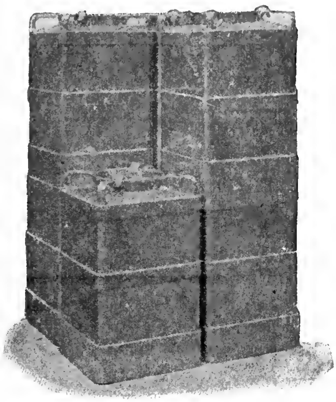


Fig. 1.

As will be seen the lower rim is wide enough to allow the handles and neck of the lower can to telescope into the upper one and thus they may be stacked solidly.

The advantages claimed are that a great saving of space is obtained and that owing to being packed virtually solid, there is little chance of change in temperature, if the outside is protected with straw mats.

All of which is true, but he does not discuss the extra expense (per quart) of these cans, nor the increased difficulty in keeping them clean, both of which objections are evident.

PRESERVING IN VACUUM.

In L'Industrie Latiere May 10, 1891, M. C. Nourry expresses his belief in this system, and though I do not share this belief, it may be of interest to put it on record here. Figs. 2 and 3 represent the proposed can, A is the body of the can preferably enamelled. C is the piston screw, which is

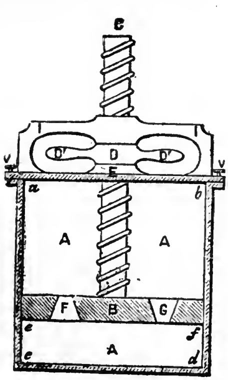


Fig. 2.

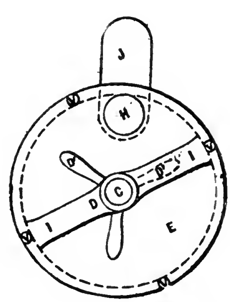


Fig. 3.

turned by the handle D. B is the piston head with valve G opening up and F opening downwards. H is the opening in the cover and J a slide which slides in a groove on the lower side of the cover.

Suppose the pistonhead B is at the top *ab*, the can is full of air. By screwing the pistonhead down to *cd* the air is expelled through the valve G.

The milk is now poured in by the opening H so as to fill the whole can and the opening H as well. This drives all (or nearly all) the air out and the slide J is closed.

The pistonhead is then screwed up to *ab*, letting the milk through by F into the space *c d e f* where it is free from air.

When the milk is needed, a few turns on piston will press some through G and it is poured out by H. The apparatus is cleaned by unscrewing the cover at V and the inside of the can as well as the pistonhead may be made of glass!

Granted that this process will do all that it is claimed, granted it will prevent the cream from rising, granted that the anaerobic microbes cannot develop unless their aerobic cousins have prepared the way for them and granted that the latter cannot live without air, granted all this, my readers will agree with me that the cost of such cans would preclude their use.

PRESERVING MILK UNDER PRESSURE.

Experiments on this line were made and reported by **Prof. B. H. Hite,** in Bulletin 58, 1899, of West Virginia Experiment Station. A 100-ton hydraulic press was used and in this the milk enclosed in a lead tube about 1 inch in diameter and 5 inches long was submitted to a pressure in a solid steel cylinder of from 5 to 30 tons for one to three weeks. The best results seemed to be obtained with a pressure of from ten to fifteen tons for ten to fourteen days, and the report says: "That the milk could be shipped a five or ten days' journey, there can be little doubt, but the cylinders capable of carrying such pressures would probably weigh more than the milk."

Experiments were also made using a pressure of from 5 to 20 tons and heating the milk to from 140° to 170° Fah. for from five minutes to four hours, and it kept sweet for 19 days.

Interesting as these experiments are, it seems to me there is no chance of the system coming into practical use, as the difficulties are too great when the system has to be applied on a commercial basis.

PRESERVING BY ELECTRICITY.

This, like butter and cheesemaking by electricity, has been talked about, but while experiments seem to have proved that electricity may, to a certain extent, paralyze microbes, nothing *practical* has been evolved as yet, as far as I know.

PRESERVING BY HEAT.

It has been shown how the bacteria germs develop best at about blood heat and how their development is reduced all the more, the colder they are kept,—but excessive heat has a better effect—it kills them. This has been known for ages and the preservation of milk and cream by boiling is a common precaution among housekeepers.

Yet, unless the milk is cooled down and kept cool, the effect is only to keep it sweet for 12 to 24 hours longer and the boiled taste, to which so many people object, prevents its general use. This taste is much more pronounced in milk heated in open vessels than in milk sterilized under steam pressure in the modern apparatus, and yet there is the same objection of its being made less digestible by the coagulation of the albumen. Compare the digestibility of a soft boiled and a hard boiled egg or that of a raw and boiled oyster.

In creameries the heating of the skim milk to nearly boiling point (195°) without cooling, is often miscalled pasteurization, but it has been proved by actual experiments in Denmark that though *pasteurization* may be better *if* the milk is cooled properly and the patrons' cans are cleaned before filling, the expense of cooling is too great, and hence, it is far better simply to heat the milk to such a degree that it will kill the bacteria in the little milk left in the unwashed cans. Here also have the creamery men been satisfied with heating, though I fear that in too many cases, the temperature is too low to do effective work.

PRESERVATION OF MILK BY CONDENSING.

Although the idea was first suggested in the beginning of the 19th century by the Frenchman **Appert,** it was not until in second half of that century that the problem was solved in a satisfactory manner. All the first atempts were simply to add 6 to 12 per cent sugar and evaporate in open pans often at temperature of 185° to 195°. In 1835 William Newton took a patent for an unknown foreigner whereby 1 to 7 per cent sugar was added and then condensed in vacuum, and thus the first step was taken in advance.

In America, **E. N. Horsford** took the lead and his assistant, Dalson, started a factory with Blatchford and Harris,near New York about 1850. In 1856 Blatchford used a vacuum pan and in the same year **Gail Borden** took a patent on using the vacuum pan for condensing milk without the addition of sugar, but it did not keep well and later he added sugar and canned it, thus making his name known all over the world, and indeed it was he who first started the business on a large scale and practical scale, and for years "Gail Borden" and "Anglo Swiss" (started 1865) brand virtually had a monopoly. Lately several large and many small factories have gained a fair reputation and are working on a paying basis.

About 1884 the Highland (Ill.) factory started successfully to make and can *unsweetened condensed milk* and tried to market it as such with but scant success until the "happy thought" (?) occurred to label it "Evaporated *Cream*," and at present nearly all the factories put it on the market under this false label. Illinois State Food Commission has taken the first step to prevent this fraud by demanding the explanatory words "an unsweetened condensed milk" on the front part of the label, but the use of the word *cream* should be prohibited.

I regret to say that other frauds are being committed. Thus by condensing skim milk, which is sold without labeling it as such,—and this is also used to the harm of the dairymen by adulterating cream, giving it a body which fools ignorant people.

Just to give those who have not seen a vacuum pan an idea of it, I illustrate one made by **Gaulin & Cie,** of Paris, France, in Fig. 4. There are three sizes. One for 500 lbs., price, $200; one for 1,000 lbs., $250, and one for 2,000 lbs., $325 f. o. b., Paris.

The milk is first mixed in a receiving vat, then passed over a pasteurizing heater into the tank, where 10 to 12 per cent sugar is added, and it is then pumped into the vacuum pan.

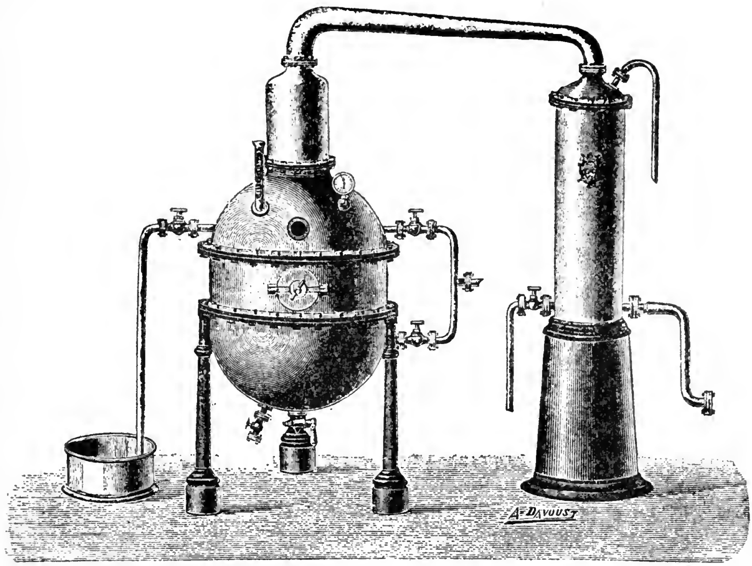


Fig. 4.

To the left is shown the tank from which the milk is drawn into the pan and to the right is the condensor where a spray of cold water condenses the stream and thus helps the air pump in creating the vacuum.

If the boiled taste were not objectionable, it seems to me that condensed milk without addition of sugar, would be a more rational way of solving the milk supply of large cities,but though this has been attempted in several large places, it can not be said to have become very popular, and it is chiefly used, as before said, for adulterating cream. Condensing milk with addition of sugar has been, and, I believe, will be the favorite method of preserving milk for ship's use and in mining camps, where the transportation of 75 per cent water is quite an item.

CONDENSING WITHOUT VACUUM.

F. Streckeisen (Switzerland) has introduced a cheap system of milk condensing for farmers. It consists of a pan (resting on four columns) in which rotate slowly one or two cylinders which are heated by steam. Fig. 5.

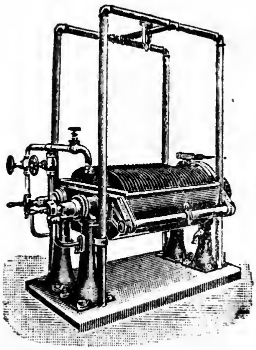


Fig. 5.

The shafts are hollow and provided with 39 hollow heating rings, about 18 inches in diameter, into which the steam escapes through holes in the shaft.

These rings are fitted closely to the shaft and held firmly by two nuts and may thus easily be removed for cleaning. The steam pipe runs through the shaft and does not rotate, but has 39 openings corresponding with those of the shaft and the rings. The condensed water escapes through the shaft into the columns.

The milk is picked up by the revolving drum and spread in a thin film whereby evaporation is promoted and as soon as the condensation is finished, the steam is turned off and cold water run into the drum in order to cool the milk. The condensing capacity is said to be 400 lbs., 800 lbs. and 1,200 lbs. respectively for the three sizes, figuring on a condensation to one-third, and the price quoted is $400, $700 and $960 in Utzenstorf, Switzerland.

This seems rather a step backward, as the condensing in vacuum has so many advantages.

PRESERVING IN POWDER FORM.

From evaporating to one-quarter volume, the idea lay near to evaporate to powder form, and it has been tried and announced again and again. Thus lately I had a sample of milk powder sent me from Denmark, made by a process patented in Denmark about 1899, by Ole B. Wimmer, but it dissolved very slowly and had a strong cooked flavor. I presume they are still working at it.

In February, 1900, Messrs. Bechel & Kittel patented a process for evaporating milk in vacuum at 104° and then drying it in ovens at the same temperature after which it is powdered. By adding bicarbonate of sodium it is said to be made more soluble in water.

If the problem of getting a quick and satisfactory solution of the powder in water is solved, then there are many attractions in this system.

CONDENSING BY FREEZING.

What the new system of condensing milk by freezing may turn out to be, I cannot foresee, but unless such milk is kept frozen or nearly so, it seems that its keeping quality must be very problematic.

It is claimed (McIntyre) that by freezing the milk in shallow metal pans it is possible to secure a thin layer of pure ice on top and by breaking this up the whole mass of milk is converted into a mixture of ice crystals and condensed milk.

This mixture is put into a large separator like those used in sugar factories and the condensed milk strained from the crystals by centrifugal force.

The remaining crystals are said to analyze 0.2 of solids. This system would have the advantage of a natural flavor, but I fear it will not prove practical, nor has anything more been heard of it since first announced some six or seven years ago.

PRESERVING BY PASTEURIZING.

While the heating of milk to boiling point, or there about, always gives a boiled flavor, it is possible to reduce this so as to make it barely perceptible by heating only to 150° to 155° Fah.

Experiments have shown that if the milk is kept at this temperature for 20 to 30 minutes most of the bacteria will be killed. First of all the lactic acid bacteria will succumb and this is the fellow which generally "loppers" the milk. But other and more dangerous bacteria among those which are most liable to be found, are also killed. Thus did **"Bitter"** find that 30 minutes at 155° killed the tubercle, the typhoid and the cholera bacillus.

But there are also others which require a temperature of 230° and more to destroy—and it is thus evident that a perfect safeguard is not even obtained by heating to 212° or 215°. And if this is so, it seems to me absurd to attempt to overcome the popular prejudice against the "boiled flavor" when we can secure a safeguard against the most common dangers by heating only to 155° which does not develop that flavor.

But it is not only the danger of boiled flavor which delays the introduction of pasteurization. The cream does not rise and make as good a showing in the bottles, the cream appears thinner, and hence people are led to believe that they get a poorer milk, a less rich cream.

Drs. Russell and Babcock showed (Wisconsin Report, 1896) that this lack of "body" in pasteurized milk was due to a change in the condition of the fat globules, a change strikingly illustrated in the illustrations of unpasteurized milk (Fig. 6) and pasteurized milk (Fig. 7), and they found by experimenting that the addition of a compound of sugar and lime would restore the viscosity (the "body") and recommended it —as it really is—as a harmless remedy.

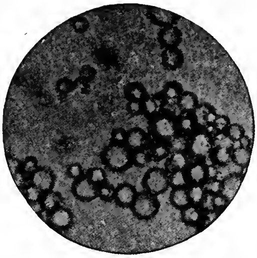


Fig. 6.

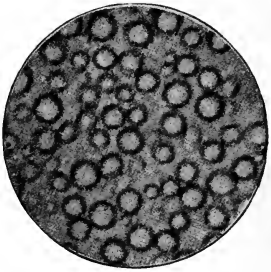


Fig. 7.

They little suspected that they thereby gave unscrupulous milk men a pointer how to increase the "body," that is, the apparent richness of unpasteurized milk and cream. That this has been the result is indicated by a well known supply house advertising: "*Viscogen* for restoring consistency of pasteurized and *separated* cream."

Meanwhile **Dr. Theobald Smith** in 1898 reopened the question as to the exact temperature and the time needed to kill the tubercle bacillus and in Wisconsin Report of 1899 **Profs. Russell and Farrington** tell us that they have confirmed Dr. Smith's experiments that heating milk to 140° for 15 to 30 minutes does not change the "body" of the milk, does not affect the rising of the cream, as does heating to 150° or above.

They also found that there was practically no difference in the keeping quality of milk heated to 140° for fifteen minutes and that heated to 150° for the same time, nor did the bacteriological examination indicate any advantage in using the higher temperature *always provided* that milk is agitated while being heated as otherwise—as in bottles—a film or skin which protects the bacteria, forms on top of the milk, so that even heating it at 140° for one hour will not be satisfactory.

This is a rather surprising result to those who have followed the tendency in Europe, which seems rather to be in the direction of demanding higher temperatures. In Denmark, as for instance, the law demands a temperature from 185 to 190° in the continuous heaters as against the old limit of 165° to 170°. Leaving the scientific questions aside, I consider that Drs. Smith, Farrington and Russell's work is of *the highest practical importance to the city milk suppliers.* The unpasteurized milk in these experiments kept for two days, while the pasteurized kept for at least six days.

It is thus sure that we can preserve milk by pasteurization without the before-mentioned drawbacks, yet it is significant that Dr. Russell in a reply (see further on) to an inquiry, says: "It will necessitate, however, the securing of better class of milk to begin with," and it must also be remembered that the patrons of Madison University creamery have been educated to deliver milk which undoubtedly is above the average quality received at our creameries. The question is then, Will the same results be obtained on milk of a poorer quality? If so, it seems to me this discovery should revolutionize our milk trade.

But, while heating to boiling point and even heating to 140° kills most of the bacteria, it does not kill their spores, and hence if the milk is left at a favorable temperature (between 80° and 100°) for any length of time, the germs will develop and the battle commence anew.

The milk must therefore be cooled immediately as low down as possible, at least to 50°, and it is of the highest importance that this is done *quickly.*

While scientists have and do even now insist on the necessity of keeping the milk at the desired temperature for a more or less extended time (according to the temperature) when pasteurizing milk for city supply, I have secured good results as to increasing the *keeping quality* with the continuous heaters where the exposure to the heat is only one or two minutes, and it is a question whether this is not due to the fact that the milk coming from these heaters is cooled so much more *suddenly* than in the tank heaters.

In order to get the latest American scientific opinion on this question, I wrote Drs. Russell, of Wisconsin, and E. N. Eaton, asking their opinion as to the practicability of continuous heaters for city milk, and quote from the reply of Dr. Russell:

" * * *We are still working on the subject of pasteurizing at 140°, as I think for commercial purposes this is very much preferable to the application of a higher temperature where the viscosity of the milk is so reduced. * * * *_It will necessitate, however, the securing of better class of milk to begin with._" * * *

"Regarding the question of continuous vs. intermittent pasteurizers, I may say that I have yet to see any device which warranted me in changing my previons opinions in regard to the desirability of continuous pasteurizers for city milk supplies. I am aware of the fact that there are a number of continuous pasteurizers upon the market for which more or less extravagant claims are made, but it is a fact that the most energetic of these concerns do not seem to be inclined to submit their apparatus to a strict bacteriological test; they prefer to sell it on the merits of practical demonstrations, as they say.

"There is no question that from the standpoint of capacity the field is theirs, and, in fact, their type of machine appeals to the man who pasteurizes milk, but I believe we must maintain the interests of the consumer as well as the producer of pasteurized milk, and I am not willing to commit myself to any continuous machine which it has been possible for me to test. We have subjected one or two of these to a more or less critical examination and find that they do not come within gun shot of their reputed claims. Of course, I do not say that there are none that may not give proper treatment, but we have tried earnestly to have the manufacturers of these machines send us one for close examination, and they have failed to do so."

And from Dr. E. N. Eaton, of Illinois:

"* * * As to the efficiency of continuous pasteurization we know that the tendency of late has been to decrease time and temperature below former standards. Elaborate experiments by microscopical, bacteriological and inoculation methods have shown that a temperature as low as 140° Fah. for 10 minutes especially in closed vessels will destroy pathogenic bacteria,

* Italics by J. H. Monrad.

or at least 'bacillus tuberculosis;' the object and end of pasteurization.

"Continuous pasteurizing machines have been in use some years with good practical results. The more recent ones have been scientifically examined and have given a good account of themselves, culture plates from such milk showing none but spore forming bacteria after a prolonged period of incubation. I have cursorily examined milk before and after entering continuous pasteurizer and found the latter to keep at least one-third longer at room temperature; the decomposition after standing being similar to that of normal milk. In this repect the milk differs from milk heated to boiling or so-called sterilized milk.

"The performance of the continuous pasteurizer cannot be explained on the ground of the heat being fatal to germ life, as many experiments have shown that a higher temperature for a longer time will not destroy all disease germs.

"The explanation of the efficiency of the continuous pasteurizer is very likely due to the extremes in temperature—to the rapidity with which the heat is applied and to the sudden cooling of the milk. When using the old Russell vat pasteurizer I noticed a great improvement in the product when the milk was cooled quickly to 50° Fah. or below. In practical use the milk was cooled to 120 to 100° Fah. in the machine, which could be accomplished in a few minutes and then it was drawn off through pipes conducted through a freezing mixture, bottled and stored in the refrigerator until ready for distribution. The results of this method indicated the advantage, if not necessity of quick cooling, and forecast the success of the continuous pasteurizer, utilizing this principle.

"Some of the best germicides possess the property of coagulating or combining with albumen—such, for example, as mercuric chloride, formaldehyde and heat. Yet other very good antiseptic agents have not this property and must depend for their necrophytic action on a different property. It is reasonable to suppose that the physical shock due to the sudden expansion and contraction of tissue would result in the destruction of the one celled organisms.

"Neither the taste nor the creaming of continuous pasteurized milk will be a bar to its acceptance, as it acts in these respects like normal milk. * * *"

Then, again, I find in L'Industrie Latiere, Feb. 23, 1900,

M. Galtier quoted as saying: "The result of my investigations is that milk, abundantly inoculated with tubercle germs, is not absolutely sterilized by heating for 6 minutes to 158°, 176° and even 185°, the milk from suspected animals should be *boiled* for consumption by man or beast."

Dr. Stohmann, in his book "Milch and Meiereiproducte," says, page 402: "*The killing of the bacteria will be promoted through the sudden change of temperature.*"

It seems to me there is a field open for careful experiments because pasteurization will hardly become popular on a large scale unless the continuous heaters and coolers may be used under the approval of the scientists.

But even if it is desired to keep the milk hot for a certain time, it is, as I have before suggested, possible to use a continuous heater and cooler by interposing three storage tanks, each holding one-third of the hourly capacity of the heater and cooler (if 20 minutes is the time) and thereby securing the advantage of continuous apparatus and the sudden chilling of the milk. In Fig. 102, page 99, Mr. A. H. Reid has solved the problem by interposing a sort of D. W. heater as a storage tank.

INTERMITTENT PASTEURIZATION.

Dahl (Norway) proposed to heat the milk inclosed in vessels to 158° for ¾ hour, then cool to 104° for the same time, then heat again and cool, in all four times. At last heat it to 175° or 212° for half an hour and cool to 55 degrees.

This is however neither sterilizing nor pasteurizing and is simply a modification of the intermittent sterilization proposed by Tyndall, and though very effective it is very complicated and expensive. Large quantities of milk have nevertheless been shipped to London from Norway, preserved by this **"Dahl"** method.

The theory is that the comparatively low temperature only kills the bacteria, and by cooling to 104° the germs are given time to develop so as to be killed in the second heating.

I have made a few experiments which lead me to believe that if an increased safety and keeping quality is desired the following process may be practical. It is simply a modification of Dahl's and is to heat to 155°. Keep it there for half an hour then cool to 100° and keep it between 90 and 100 for

2 or 3 hours, then heat to 155° for half an hour and cool to 50°.

While no bacteriological examination controlled these experiments I secured a prolonged keeping quality over and above the single heating and cooling of about 12 hours.

STERILIZING.

Though I consider it absurd to object to the insignificant "boiled flavor" which the best sterilizing apparatus leave in the milk, and though I acknowledge that if pasteurizing is good as a protection against infection and as a means of preservation, sterilizing is certainly better, I write for the great army of practical dairymen, and for these sterilizing with its rather expensive apparatus is of less interest, and hence I confine myself chiefly to pasteurizing and only illustrate a few of the latest sterilizing apparatus used, all of which, however, may be also used for pasteurization.

I just mention the apparatus shown at the Columbian Exposition by Popp & Becker, of Berlin, which is advertised in German papers under the name of "STERILICON" and for which F. Correll & Co., 132 Nassau street, New York, is agent. Neuhauss Gronwald Oehlmann also showed his apparatus both for bulk and bottle sterilizing and showed it in working order.

Besides this Dr. Weigman describes one made by Paul Ritter von Hamm.

Any one who studies the apparatus described for pasteurizing can easily adapt or modify some of them for sterilizing.

But if care is needed for pasteurizing, much more care is required for sterilizing as the object here is not only to kill most of the bad bacteria, but also to preserve the milk not for days or weeks, but for months.

I sampled milk sterilized in the "Sterilicon," which was claimed to be six months old and which was perfect.

Most of the sterilizers are tanks fitted for a high steam pressure in which the milk is exposed for the desired time in bottles, and the inventive energy has chiefly been directed towards solving the problem of an automatic closing of the bottles in the apparatus when hot. Success has been obtained more or less, and I illustrate the simplest and cheapest

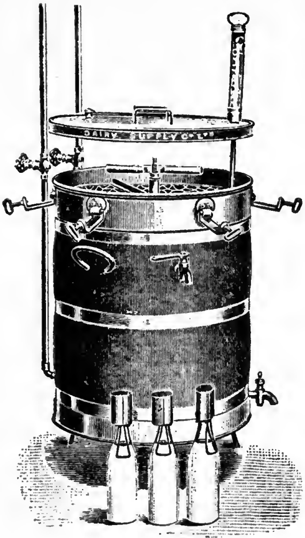


Fig. 8.

one in Fig. 8, the *Simplex*, from an advertisement of **The Dairy Supply Co** (London). The arrangement for closing the bottles automatically while in the apparatus is not quite clear, but I consider it immaterial, because the system first suggested by **Dr. Soxhlet** (Germany) introduced in 1891 is the simplest system of closing sterilized milk bottles. The mouth of the bottle is slightly funnel shaped and ground smooth. On this is laid a round sheet of rubber, 4 millimeters thick. (See Fig. 9). This rubber is held in place by a metal cap open in both ends. (See Fig. 10). When the milk heats the air and steam is free to escape and yet does not throw off the rubber, as it is held by the cap. As soon as the cooling commences the vacuum formed in the bottles holds the rubber tightly to the mouth of the bottle, closing it automatically. The great beauty of this system of sealing is that as soon as any fermentation starts the gases will

Fig. 9.

Fig. 10.

destroy the vacuum and release the stopper, giving notice that something is wrong.

Dozens of modifications of this idea have been introduced since then.

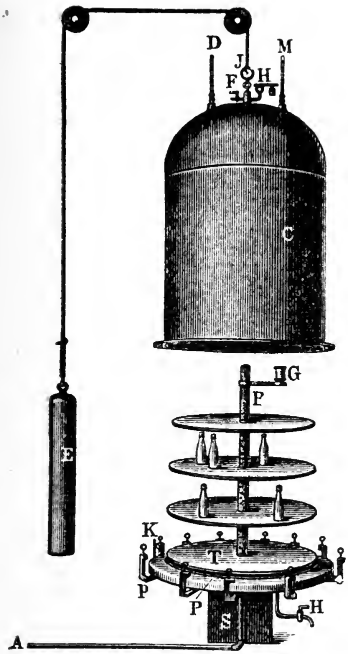


Fig. 11.

In Fig. 11, copied from Stohmann's book is shown the apparatus designed by **Prof. Backhaus** (Germany) in which small bottles of $\frac{1}{3}$ quart are placed. The bottles have a heavy, smooth, slightly conical edge on the neck in which there is a sort of channel. The rubber cover fits tightly at the top, but when expanded by the steam developed in heating it opens up the channel and lets the steam out. When cooling the rubber is drawn closely to the head of the bottle sealing it.

The apparatus itself consists of a cast-iron table P on a foot piece with a hollow column B in the center. On this are several movable circular shelves T. The steam is distributed through holes in the column by the pipe A, and also draws the cold air for cooling. Above this is hung a cupola C, made of copper (counterbalanced by E), which is let down on P and fastened steamtight by screws. The guide K compels the cupola to come in the exact place so as to let down the thermometer M into the cup G, which is filled with milk. The thermometer D shows the temperature in the cupola, which is also provided with Manometer J, a safety valve H and a blow off cock F. The cock H below the table lets the condensed water off.

A somewhat similar apparatus was used by Dr. E. N. Eaton in Minneapolis, where he prepared an imitation of human milk. He heated the milk, after modifying it, to about 212°, then cooled it to 100° and left it for three hours for the germs to develop, then reheated it and cooled the bottles by placing them on a cement floor and spraying them with cold water. Milk thus treated would keep for months.

Some objections have been made to the use of rubber stoppers, especially when they are new, they are liable to im-

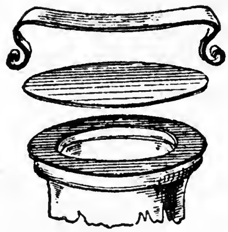


Fig. 12.

part a flavor to the milk. This supposed danger is reduced or rather removed by the system *"Rheinland,"* shown in Fig. 12. It consists of a wide-necked, nearly cylindrical bottle, ground smooth on the upper edge. On this is laid a rubber ring and a thin disk made of tin or aluminum. A spring holds both in position while heating, allowing air to escape, and is removed when the vacuum created by cooling holds the cover tightly. The opening of the bottle is done by simply inserting the point of a knife and letting in air.

PRESERVING BY CARBONIC ACID GAS.

H. de Lavallee (France) proposes to preserve milk by filling it in a cool reservoir at once after milking and submit it to the action of carbonic acid gas under a pressure of five or six atmospheres for four to five hours; then let the carbonic acid gas escape and treat it with oxygen under pressure of five atmospheres. It is claimed that both aerobic and anaerobic bacteria are killed by this treatment. The milk is transported in cans with oxygen under a pressure of two atmospheres. Like so many other systems it is condemned on the face of it—even if effective—on account of the unnecessary work entailed.

CHAPTER II.

THE PASTEURIZING HEATER.

Continuous Heater.

In writing the history of the apparatus which have been and are used practically, I try to mention them in their proper chronological order, but lay more stress on grouping them together according to the principles involved.

It must always be remembered that a pasteurizing apparatus must consist of a heater and a cooler unless indeed the same apparatus is used for both as in Prof. Russell's, John Boyd's, Potts' and others.

CONTINUOUS HEATER.

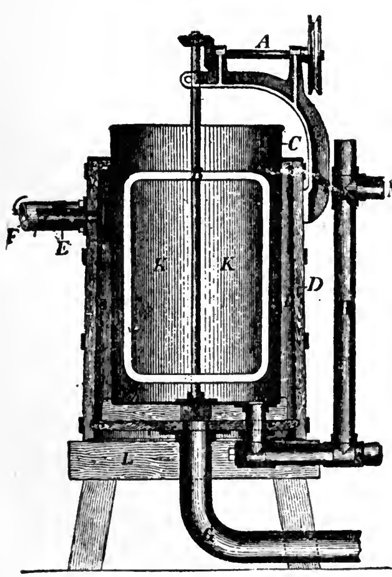


Fig. 13.

In Denmark the first heater used was the one constructed by the late Prof. Fjord for heating the milk for the separators Fig. 13. This consists of a strong wooden barrel D in which a tinned copper vessel C is inserted. A stirring apparatus K prevents the milk, which enters at M through H, from scorching on the side. Steam is introduced by F if exhaust and E if direct steam is used. Condensed water escapes through G. The milk outlet not shown in the illustration, is above the wood. When heating the skim milk at the creameries was recommended by Dr. Bang, this apparatus was made to perform the work, and in short time manufacturers adopted and modified it in various ways.

In England **R. A. Lister & Co.**, of *Dursley*, make the one illustrated in Fig. 14, and judging from appearance a very substantial and well made heater it is.

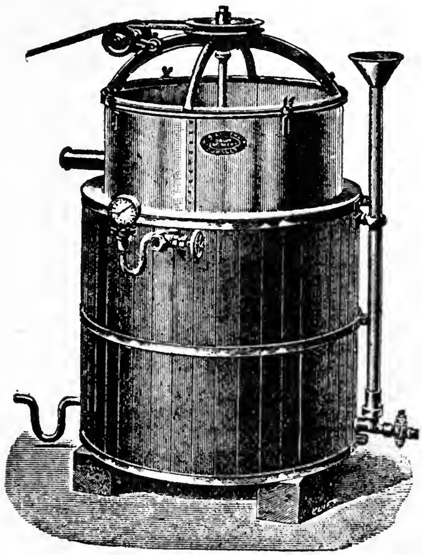


Fig. 14.

The De Laval Company's (Sweden) latest heater, which, by the way, they do not seem to push very much in America is shown in Fig. 17. The dasher H is hung on the spindle K, which passes through a pipe R (inserted in the bottom of the inner vessel), and is rotated by the steam turbine P in the lower compartment. The steam enters at M, and after having turned the turbine passes into the steam jacket (F G) and heats the milk to about 180°. If a higher temperature is desired live steam is let into the jacket by opening the valve I. The condensed water leaves at Y through a water lock. The milk enters through the funnel R and leaves at D, where a thermometer is inserted. The different sizes heat about 1,300 lbs., 2,400 lbs. and 3,600 lbs. milk per hour to 180°. The author tried one of these heaters in a cream heating experiment in Kansas, and was perfectly satisfied with it—his only trouble was that the capacity was too large for the cream from two Alphat separators.

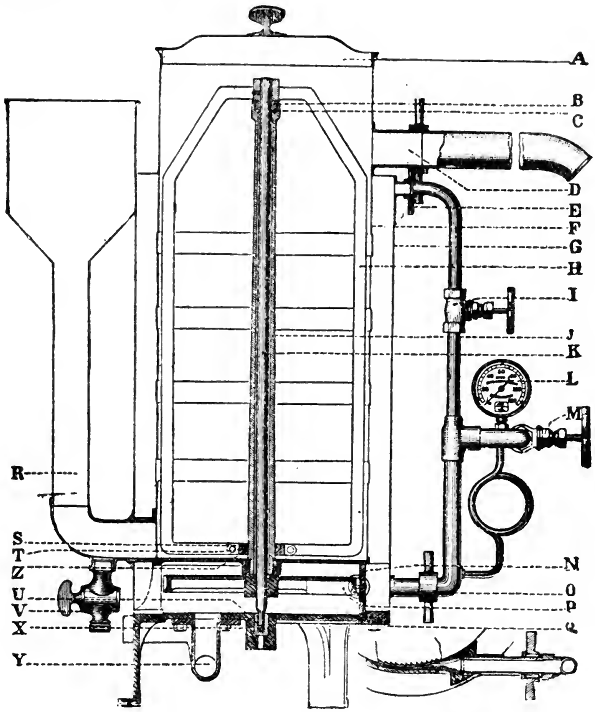


Fig. 17.

The well known manufacturer **Ed. Ahlborn** of Hildesheim (Germany) makes a very neat modification shown in Figs. 15

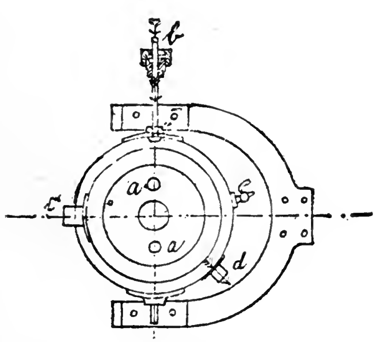


Fig. 15.

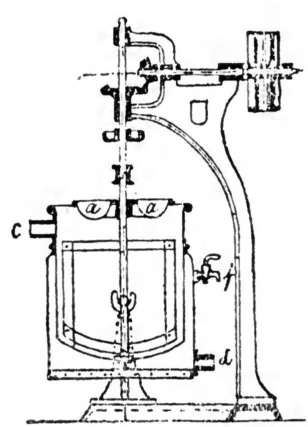


Fig. 16.

and 16. The apparatus is swung on pivots. The steam enters through one of them (b). This facilitates the cleaning of the apparatus. The condensed water escapes at d, while the milk enters by a cup a a which is connected with the stirring apparatus and provided with two tubes which lead to the bottom. The milk escapes by c.

A. Rossler, of Berlin, constructs a similar apparatus and so does **"Ahrens,"** but his apparatus has a larger capacity and thus exposes the milk to the heat for a longer time.

In fact the question of length of exposure is partly settled by finding out how many pounds of milk the apparatus holds when working and dividing this into the hourly capacity. As for instance, if the hourly capacity is 1,500 lbs. and the apparatus holds 50 lbs. then the milk remains in the apparatus 50—1,500, or 1-30th part of an hour, or only two minutes.

The object of the dashers is to prevent the milk from scorching and ensure a uniform heating.

It is evident that the capacity of a heater will be increased in proportion to the increase of the heating surface.

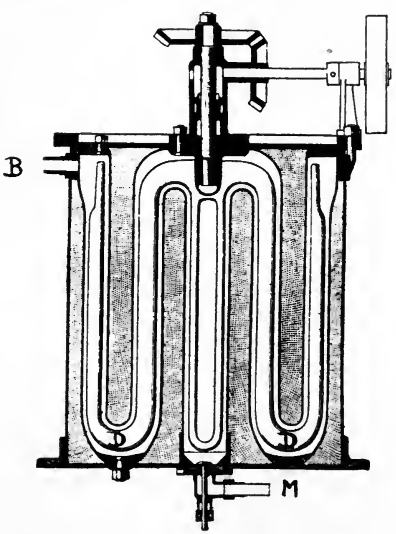


Fig. 18.

Mr. Kleeman, in his Pasteurizer and Sterilizer, Fig. 18, a simplification of his previous rather complicated but effective sterilizer, obtains a considerably greater heating surface. The milk enters at the bottom of the vessel at M in the center of the cone, flows upward and then down in the annular ring and up again compelled by a corresponding annular water tank, which is attached to the cover.

The steam or hot water is indicated by the dark shading and the milk leaves at B. The dasher D D prevents the scorching of the milk. The milk is forced through the apparatus and elevated from B up to the cooler by a force pump.

I. Wick of Stockholm (Sweden) patented in 1899 a heater shown in Fig. 19, where the heating is done by circulating hot water in pipes which stir the milk. There is an outer insulated jacket in which the milk cylinder is placed, and this has another cylinder which holds hot water. In the center of the latter is a hollow shaft through which the hot water enters and circulates through the dasher made of curved pipes which reach close to the bottom and then turn up again emptying into the space between the two inner cylinders from where it goes into the outside heating space and out.

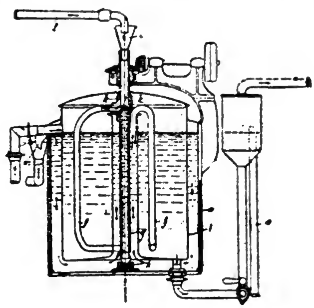


Fig. 19.

In spite of the stirrers running close to the walls of all these heaters, there will always be some coagulated albumen on the sides and it has been proposed to have the stirrers covered with brushes as shown in Fig. 20—a heater made by **Mr. W. Wetterling,** of Wismar, Germany. Two steam chambers are inserted in a barrel A, one G in the center and another E ringformed, leaving an annular space between them.

The milk enters into this by L and rises between the two steam chambers overflowing the outside steam chamber E and then down again between E and a rotating cylinder B and finally up in the barrel and out by M.

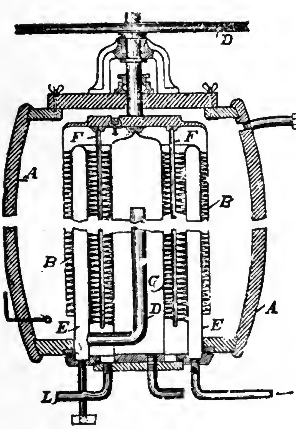


Fig. 20.

The rotating cylinder B has brushes attached and so have stirrers F, which are screwed in the top of the rotating cylinder.

The pulley D revolves the cylinder and the stirrers which brush the steam chambers on both sides continuously and thus prevent the scorching.

Dierck S. Mollman, of Osnabruck (Germany) also made a large, unwieldy apparatus with brushes shown in the first edition, but I now illustrate his latest construction, in Fig. 21, where they propose to prevent the milk from scorching on the heating surface and keeping this from coating by having an inner cylinder and covering the stirrer with brushes of same width as the milk space. The water is heated by Korting steam jet described on page 60, Fig. 62, We have in this heater the same idea which was first evolved by **Lefeidt and Lentch,** of Schoeningen (Germany) in their first centrifugal heater, namely, to get away from a large body of milk and secure its passage in a thin layer over the heating surface. This is illustrated in a sectional view, Fig. 22.

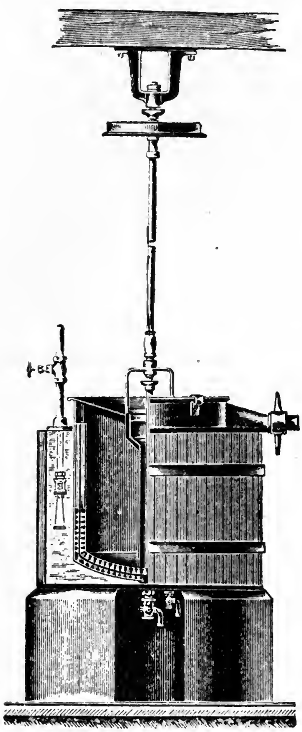


Fig. 21.

In a solid cast iron steam heated jacket revolves on a fixed spindle a separator bowl which is slightly wider at the opening. The milk is led into it through an opening in the cover. In the front part of the bowl is a partition with two holes (not far from the outer edge), through which the milk escapes, after leaving its sediment in the front,.

and passes over the edge of the drum between it and the steam jacket in a thin film 3 milimeters back to the front part where it is elevated through a pipe to the right by the centrifugal force of the wings on the drum. The steam enters the jacket through the other pipe. This gave me the idea of constructing a heater for **A. H. Barber & Co.,** of Chicago, sectional cut of which is shown in Fig. 23.

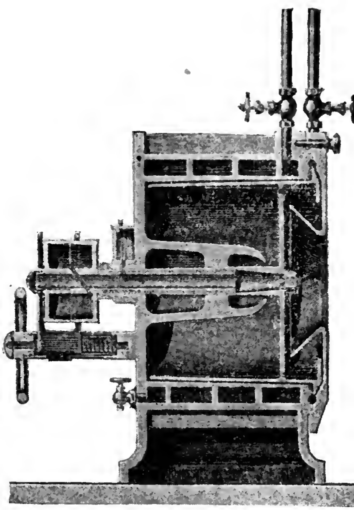


Fig. 22.

It consists of a cast iron base I, in which a turbine flyer f is inserted and driven by steam from pipe fs. It has also pipe T for the exhaust, but this is, as a rule, closed by the damper K, when not less than 1,000 pounds per hour is treated. Fig. 23 is a cross section of the heater where G is a galvanized cylinder riveted to the base and provided with an annular tin gutter H. D is a slightly conical tin drum soldered to a tinned brass or malleable iron bottom with a spindle which fits in the cup C revolved by the turbine flyer f. The drum D is strengthened by a hoop at the top, into which is riveted a cross (r) of four rods which again brace the 1-inch pipe P that acts as spindle for the drum. The cylinder G has a flat cover with a cross bar B, which is held in position by two thumb screws m. In the center of this bar is the upper bearing.

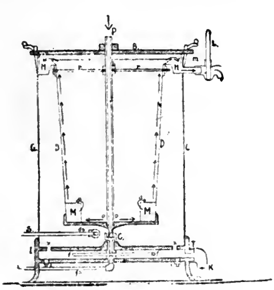


Fig. 23.

The milk enters at P through a regulating cup such as used for separators, and is thrown out of four small holes at the bottom of the pipe PP, and fills the space M where any possible dirt collects. It then overflows the ring d and flows in a thin film (shown by the arrows) and is thrown in the gutter H, leaving through the spout with the thermometer L.

The exhaust steam from the flyer f goes up through eight holes X X into the cylinder and heats the drum D. In running about 1,000 lbs. of milk per hour I raised the milk from about 54° to 155° with the exhaust steam alone, but when I ran 1,500 lbs. an hour I had to use some live steam, which is led through the pipe S under the bottom of the drum. If the steam pressure and milk supply is uniform this apparatus heats it steadily within a variation not to exceed 4° or 5° Fah. A wooden jacket would be advisable to economise steam especially in winter. The condensed steam escapes by K and by two small holes II in the bottom.

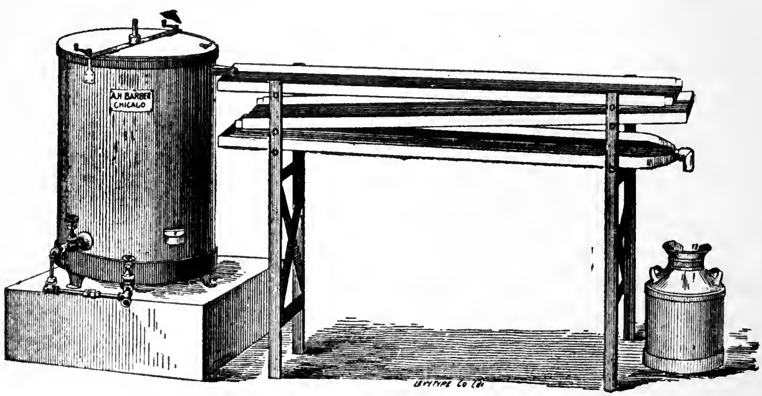


Fig. 24.

While the milk does not get any perceptible "boiled taste," there is, after running 3,000 lbs. through it, quite a layer of coagulated albumen, which takes some labor to clean off. Yet I would far rather clean that one drum instead of five or six cans, even if the albumen deposit is less there. In Fig. 24 the apparatus is shown as connected with three Baer coolers.

I also proposed to utilize the same idea by having the bottom of the drum cast with shovels on, and rotate it by a steam jet. By this application, or by driving it with a gearing at the top it is optional whether the milk shall be taken in from the top or through the bottom bearing. The advantage of the latter plan is obvious as the heater will act as an *elevator* at the same time, thus killing two birds with one stone. As the drum is twenty-eight inches deep it will be possible to lift the milk at least two feet from inlet to the outlet of the gutter, and with a higher speed than that used by me, 450 to 500, it may be arranged to elevate to any height.

Mr. A. H. Barber (Chicago) later substituted the **Hill** heater, Fig. 25, where the milk cylinder is kept rotating slowly by the steam jet, which heats the water. Inside this revolving cylinder is a stationary one which reduces the milk space to a very narrow one. The milk enters through a center tube and rises between the two cylinders. It is made with an hourly capacity of from 500 lbs. up to 2,500 lbs. and sold at from $35 to $75—the latter, if made of copper, cost $100.

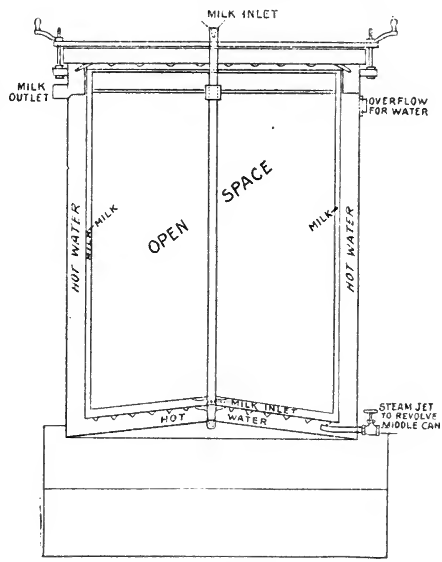


Fig. 25.

Another style is made where the cylinder is revolved by a rope belt from 15 to 30 revolutions per minute.

A cooler on similar principle is also made.

Mr. A. B. Reck's (Denmark) heater is shown in Fig. 26. Here the steam heat is applied to the inner drum B, which is revolved by a hollow shaft A with pulleys S and goes through the bearing b fixed on the frame not shown. The steam enters through this shaft and the condensed water is removed by two "skimming" tubes S, to a fixed pipe V. An outer stationary jacket C covers the steam drum, leaving only ½ inch space between them.

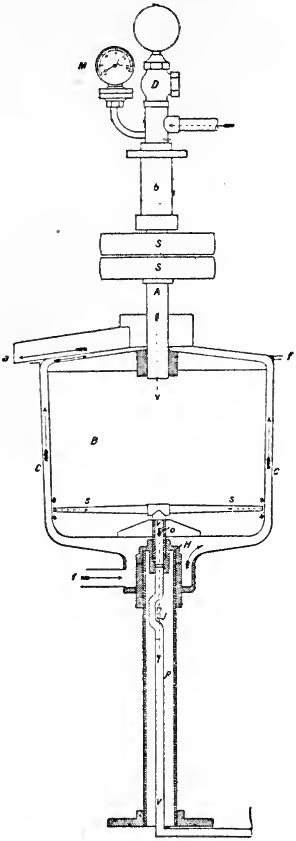


Fig. 26.

The milk enters at T and passes through this half-inch space, being prevented from following the revolving drum by some ribs on the outer jacket, and leaves at A. The cleaning is done by lowering the outer jacket, which slides on the pillar R, supporting the apparatus. The drum revolves about 170 times per minute, and the milk held in the apparatus is 30 lbs.

The Miller heater is a modification of the Hill (Fig. 25), and the Reck (Fig. 26), and seems to be constructed on a good principle, although I have heard varying reports of it, some praising it highly; others making light of the claimed advantage. Although Mr. Miller, who lives in Canton, Ohio, did not answer my inquiries, I had the opportunity of seeing it in operation at the progressive milk dealers, Mr. Sidney Wanzer & Sons, Chicago. The plant consists of one heater and two coolers. The heater consists of a wooden tub in which is inserted a tinned copper cylinder so as to leave a water space. In this the water is heated by a steam jet on a similar plan that Barber used so as to get a circulating motion in the heating water. This drum has an annular gutter into which the milk overflows. Inside, a revolving drum leaves the milk, introduced from the bottom, only a half inch space in which to rise while it is being heated from both sides. The inner and revolving drum has a curved ring which covers and overlaps the milk gutter so as to prevent the overflow water from getting in the milk. A steam jet sends hot water into the revolving drum and the overflow is sent over the curved ring into the outer water space.

With the heating water at about 170°, this heater heated milk from 60° to 158° at the rate of 1,600 lbs. per hour, and, no doubt, might do even a little better. Mr. Wanzer is careful in selecting the milk, and when rinsed while in motion with cold water and later soaked by pouring in a solution of lye, the surface showed no milk scorched on the drums when taken out and cleaned.

The center cooler with a half-inch stream of city water (54°) cooled the milk from 158 to 80°, and the brine circulation, which on an average was 22° cooled it from 80 to 50°. The coolers are made with the outer cylinder of galvanized iron instead of wood and the inner cylinder was soldered to this so that the exact system of circulation could not be seen, but the revolving drum was made like the heating drum. The cooling capacity of the brine cooler could be increased if the revolving drum was filled with crushed ice instead of water.

Take it altogether, while the manufacturers exaggerate in their circular, this is about as nice a *heater* of the hot water kind that there is on this market, and it is fairly well made, barring a few points which may easily be improved. The price is too high by about fifty per cent. As to the coolers, I fail to see why we should fool with revolving drums, etc., when we have so many excellent surface coolers where the milk is aerated much better.

The operator has to watch the steam valves all the time just as with the Monrad centrifugal heater, or indeed most all of them. This might be improved by having a small supply tank with a ballcock so as to have uniform pressure on the milk and the steam pressure might also be made more uniform.

The only original feature in this apparatus is the fine wire soldered spirally on the outside of the revolving drum. This is claimed to give additional motion to the milk and to increase the capacity, a claim which I cannot understand. There is surely motion enough in the flowing milk, and the capacity depends surely in the first instance on the size of the heating surface. Nevertheless it is a well made pasteurizer of its kind, and needs only a few improvements to make it the best of that class made in the States.

After I had run my heater for a month I was amused to hear that **K. Hansen & Schroder** had made a heater whereby they obtain the same result by other means, and though not strictly a centrifugal heater, I class it under these. As after all it is the centrifugal force of the dashers and the parabolic shape of the drum which spreads the milk in a thin film over the heating surface and elevates it. Fig. 27 represents this heater, consisting of

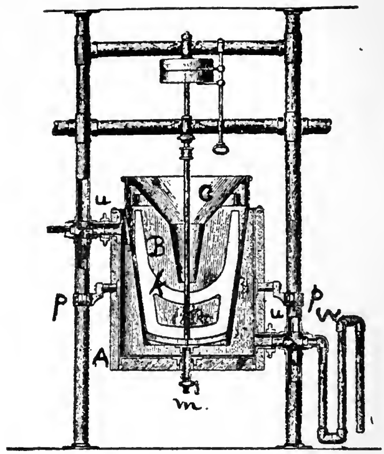


Fig. 27.

a wooden covered steam jacket A, which is swung on pivots P. Steam enters at U above and the condensed water escapes through the waterlock W, both being connected by a union U.

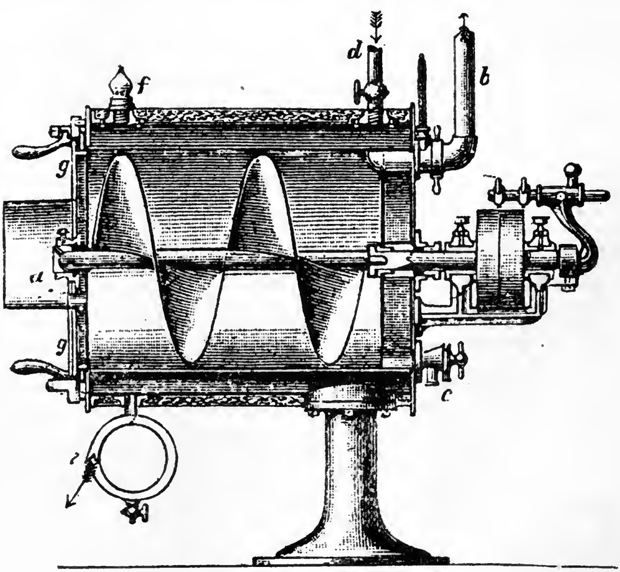


Fig. 28.

The milk enters the tinned copper vessel B by the funnel-shaped cover C and is forced through a pipe (not shown).

Shortly after this, or about the same time, **P. J. Buaas** (Denmark) constructed the heater *"Triumph"* in 1895, shown in Fig. 28. A tinned copper cylinder is closed tight by a cover in one end by using rubber packing and the patent fasteners g. On this cover is a sort of funnel a through which the milk enters the cylinder and is thrown on the heating surface in a thin film and at the same time moved forward by the fast revolving screw wing, and elevated through the stand pipe b, nearly 8 feet if so desired. The milk left in the drum is drawn by c. The steam enters the jacket, which is well insulated at d, and the condensed water leaves at e. A safety valve is placed at f.

A similar heater, under the same name "TRIUMPH," made by **The Sharples Company,** Chicago and Westchester, Pa., is illustrated in Fig. 29, showing the open end of the hopper

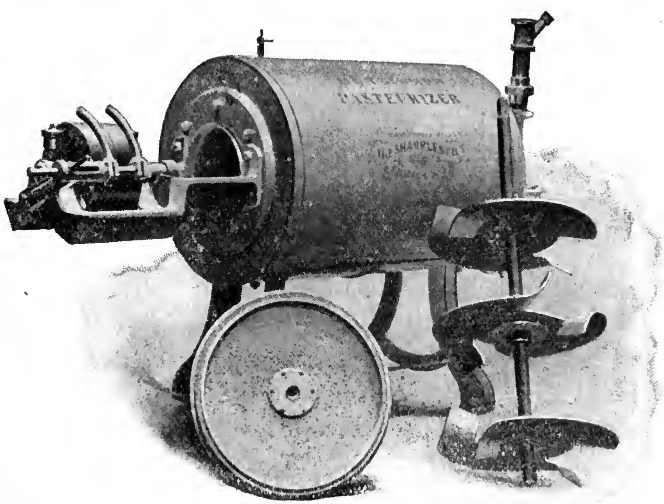


Fig. 29.

and the cylinder head and propeller removed. A protecting plate prevents the steam from heating the place of entrance too much, both direct and exhaust steam may be used. I understand Mr. S. is contemplating constructing a revolving inner drum with a spiral propeller soldered on the outside instead of the present one.

From this time on the "self-raising" heaters became more general.

Paasch, Larsen & Peterson (Denmark) make the heater shown in Fig. 30, which explains itself. The milk enters at A and is elevated to the conductor B, leading to the cooler. The steam enters at C and is forced to the sides by a plate protecting the can from being overheated. It will be noticed

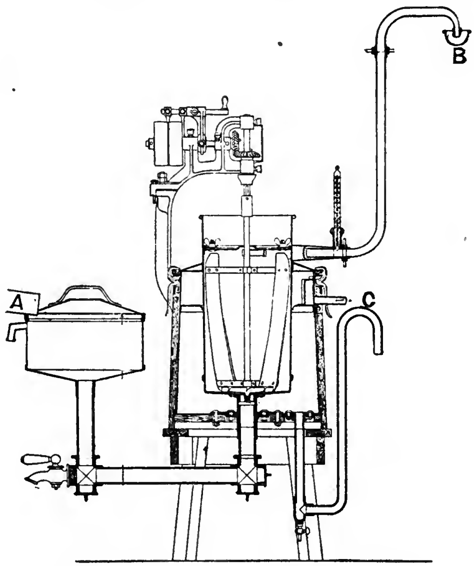


Fig. 30.

that no elbows are used on the milk pipes, but T's which have caps so that each length of pipe may be cleaned like a gun barrel.

Axel Malmquist (Denmark) built a heater where the main change consisted in dividing the heating jacket in 3 spaces. The middle one contains steam under pressure, the lower one contains the condensing water and the upper one warm water. He claims that by confining the hottest heating surface to the center scorching is made impossible.

The new Bergedorfer (Germany) heater, Fig. 31, is described in (M. Z. 1899, page 354) as follows. Instead of the

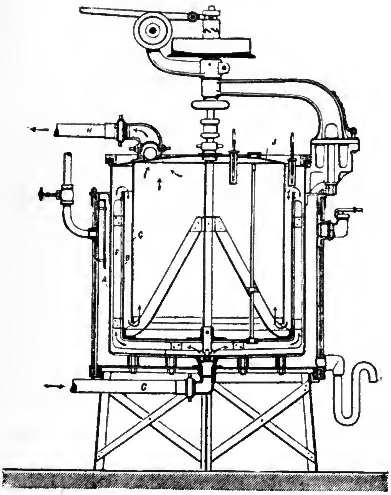


Fig. 31.

usual stirrer in the inner vessel there is a cylinder B on the side and bottom of which are fixed wings or dashers F on the outside reaching close to the vessel and thus compels the milk which enters at the bottom from G to spread itself in a thin layer over the heating surface until it reaches the top after reaching the desired temperature. It then goes over the rim of B and is forced downwards by the fixed cylinder C, which is attached to the close cover and reaches close to the bottom of the revolving cylinder B. The milk then rises in the inner cylinder C and leaves the apparatus at H, as indicated by the arrows. The smallest heats 2,800 lbs. per hour from 86° to 215° Fah, and the price is about $188. The largest heats 10,800 lbs., and costs $390 f. o. b. Bergedorf. Mr. Jos. Siedel reports favorably on this heater.

REGULATORS FOR HEATERS.

In working with continuous heaters the great problem is to be absolutely sure that all the milk that leaves the heater is of the desired temperature. Even if a man watches the thermometer pretty carefully he may miss it now and then. Hence the Royal Danish Experiment Station took up the work and Messrs. **V. Henriques** and **Stribolt** constructed the regulator shown in Fig. 32.

It consists of a box attached to the side of the heater. In this is a spring constructed of two bars, the inner of steel and the outer of brass, riveted or soldered together. One branch is fixed firmly to the side of the box, while the other is left free to move. As the brass bar expands more than the steel, but is firmly attached to it, the result is a lateral movement and this is utilized to shut off the valve on the milk supply

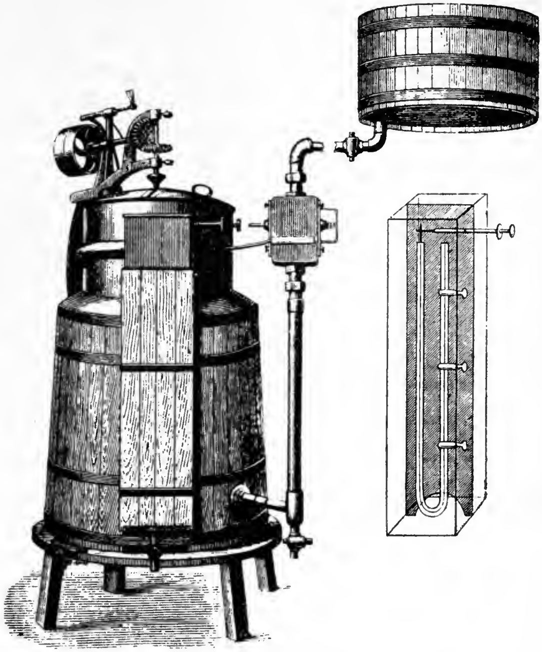


Fig. 32.

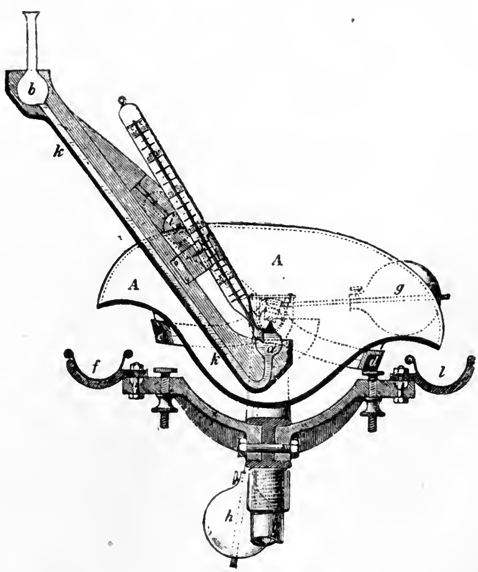


Fig. 33.

pipe. Although this regulator worked fairly well, it did not remain long in use and the following system gained on it.

T. C. Nielsen (Denmark) with his tipping regulator Fig. 33, proposed to solve this problem in another way by simply diverting the milk not hot enough back to the milk tank. This is done by letting the hot milk run into a cup AA with spouts on opposite sides. The cup rests on a frame d e, which is balanced on a three-cornered steel so that it may tip easily one way or the other to conductor f or l. The balance is regulated by two moveable metal balls g & h, so that a very small weight will tip the cup. To do this there is inserted a tube ab filled with mercury to the bottom of the bulb, b. In a there is also a drop of alcohol which is expanded by increased heat and thus forces the mercury from a to b, and this is enough to tip the cup AA. As soon as the milk becomes cooler the mercury falls back in a and the cup turns the milk stream into the other conductor. By using alcohol of various boiling points the temperature at which it acts may be varied.

The milk which is not warm enough may be made to pass a cylinder and act on a ball cock and thus either open the steam valve or partly close off the cold milk from the heater, but the main point is that the milk passing as pasteurized really has been heated to the desired degree.

These regulators were introduced in 1895-1896, but in 1899 Mr. P. V. F. Petersen, in a lecture, declared that they had not been adopted in the practical dairy work, although he does not seem to condemn them altogether. There can be no doubt that there is a crying need for some such device not only for pasteurizing but also for regulating the heating of milk for separating.

DANISH GOVERNMENT EXPERIMENTS WITH HEATERS.

When the Danish government proposed to make it compulsory for creameries to pasteurize all cream and milk barring that used for cheese making, the Experiment Station from 1897 to 1899 again took up the problem of pasteurizing heaters with special reference to their capacity and economy in using steam.

The first improvement was made by soldering on the outside of the heating drum a series of rings (Fig. 34) at a downward angle of 45°. These removed the water condensed on the drum quickly and thus prevented it from forming an insulating layer on the drum, and increased the capacity fully fifty per cent. In Fig. 35 is shown a remodelled Fjord heater with 8 such rings.

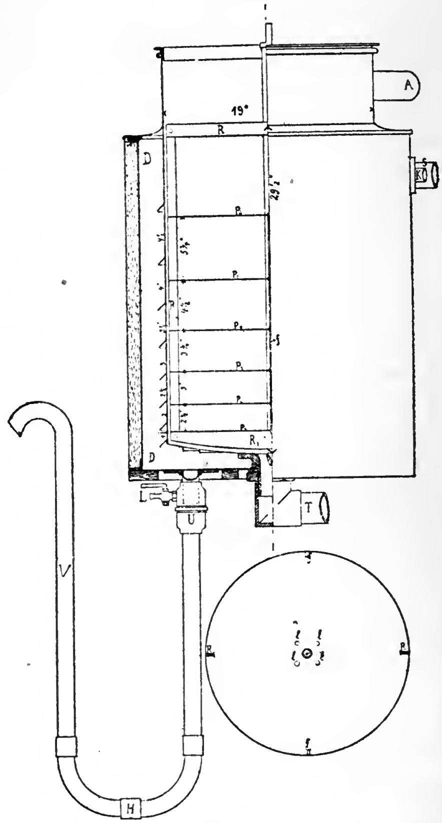


Fig. 35.

The second improvement was the fixing of an air cock (L. Fig. 35) on the waterlock V. This removes the air which is carried into the heating space with the steam and which accumulates there to the detriment of the heating capacity.

The third improvement was fixing six horizontal plates (P) to the dasher (R) which also increase the capacity by preventing the mixing of the milk layers all having different temperatures. Take it altogether, such an apparatus with a milk drum of 19 inches diameter and a height from bottom to top of

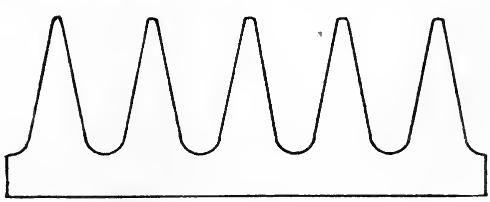


Fig. 34.

the heating surface of 30 inches, will heat 8,000 to 10,000 lbs. per hour (the last amount when the surface is clean) from 104° to 185°—a wonderful result indeed.

Later experiments showed how the plates on the dasher also tended to reduce the formation of foam and the apparatus was changed as shown in Fig. 36.

Just below the outlet (a) a plate (j) similar to those below, is fixed on the dasher, and the outlet is given the shape of a horizontal slit (5 inches long and ½ inch wide), placed just above the top of the heating surface.

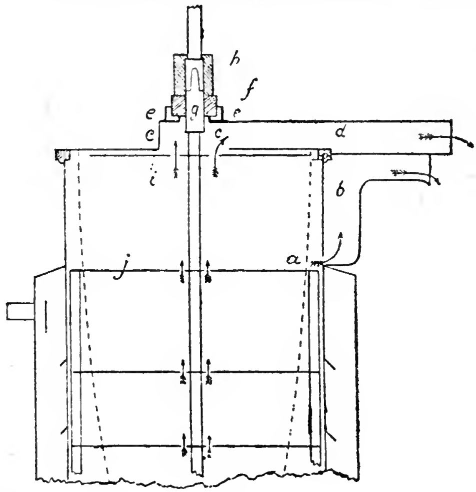


Fig. 36.

Outside the outlet is soldered a jug-shaped spout (b), so that the upper edge is just level with the cover of the apparatus. As the milk inside must always rise to the same height as in the spout, the outlet is always covered by a layer of milk (see dotted lines), which prevents the foam from escaping.

Finally a plate (i) is fixed on the dasher immediately under the cover, and between these two plates the foam gathers and is submitted to the centrifugal force. The foam which is not destroyed, makes its escape through six holes in the center of the upper plate to the spout (d). The result is foam-free milk comes from b, while air and now and then a little foam comes through d.

The relative weight of foam-free and foaming milk is given as follows: Foam-free 100, milk from separator 71 to 72, from the milk pump 62 to 65, from the improved pasteurizing heater 94 to 97. The speed of the dashers is 280 to 300 revolutions.

The above is taken from the report in Maelkentidende of an address by P. V. T. Petersen, Sept. 1, 1899.

One of the last up-to-date Danish heaters constructed according to the principles just described is shown in Fig. 37

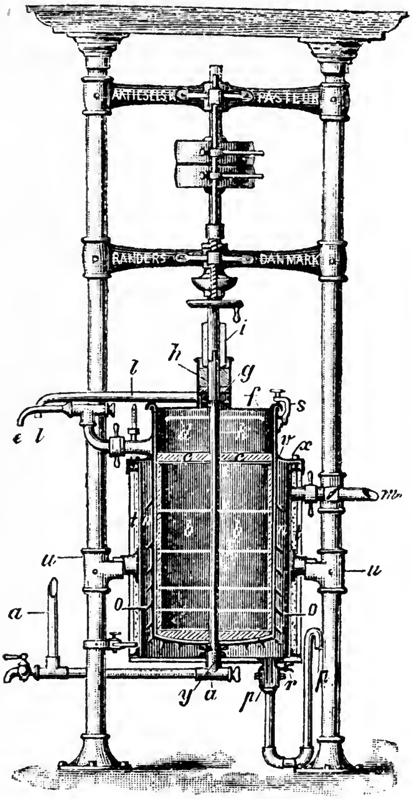


Fig. 37.

taken from the advertisement of the manufacturers, the stock company **"Pasteur"** of Randers (Denmark). It is hung on pivots U on a neat iron frame screwed on to the floor and ceiling. The steam is let into the well insulated jacket n from the pipe m, which is easily disconnected by a union. The condensed water leaves through the waterlock, having an air cock r. The tinned copper cylinder v is provided with rings or flanges o o, and the dasher c with plates. The milk enters at a and leaves through the lower opening e and what little foam which is not destroyed in the room d k leaves by l.

A. H. Reid, of Philadelphia, was the first American manufacturer who introduced the Fjord pattern heater with the elevating device. Fig. 38. On Dec. 14, 1899, he applied for patent on an improved heater (granted July 3, 1900), where he introduces the steam tangentially through an unobstructed opening in the side of the casing, and where it travels free in the spaces between ribs or rings which are fixed on the heating vessel as shown in Fig. 39, which explains itself. They differ from the Danish ring by the upbending of of every other lip.

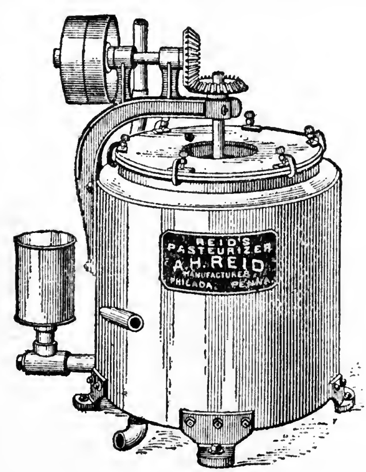


Fig. 38.

Mr. Reid's complete pasteurizing plant, with the new heater, is shown in Fig. 102, page 99, and Mr. A. Jensen's cream pasteurizing plant is shown in the chapter on Pasteurizing in Creameries.

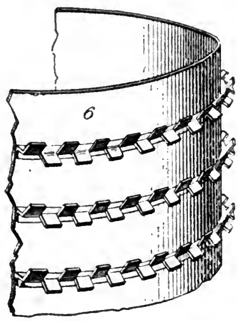


Fig. 39.

This virtually covers the evolution of the Fjord heater up to 1901.

SURFACE HEATERS WITH MILK EXPOSED AND COVERED.

In Sweden De Laval constructed a well made if rather

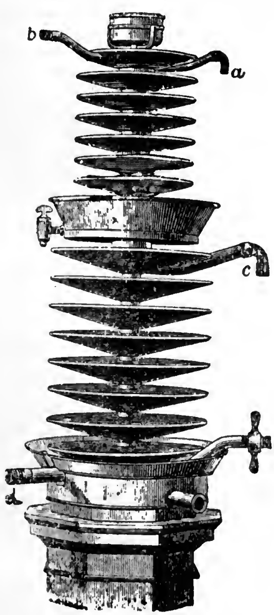


Fig. 40.

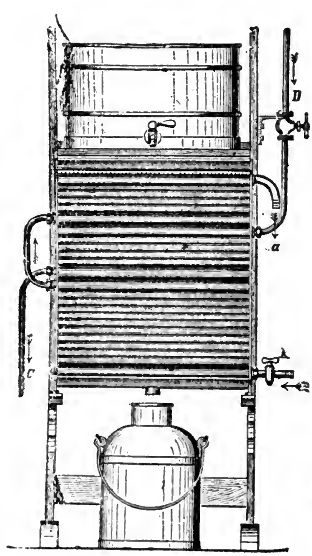


Fig. 41.

expensive combined heater and cooler, Fig. 40, which is in two sections, the upper one heated by hot water or by steam entering at b, with overflow at a, and the lower one cooled with ice water entering at the union to the left and leaving at c. The milk is distributed from the cup on top and leaves at d.

In Germany Hr. von F. Hochmuth adapted the Lawrence cooler to his purpose in a similar manner, as shown in Fig. 41. It is divided in three parts. The lower one acts as cooler, the water enters at the bottom and is then, when warmed at the top of the cooler led through a curved pipe into the upper part leaving at a. There the heat absorbed from the milk is utilized for the preliminary heating. Meanwhile the center part is heated by steam entering at D and the condensed water escaping at C.

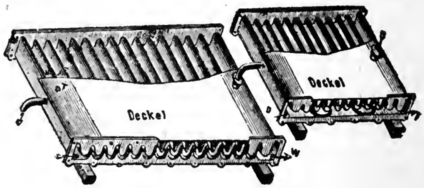


Fig. 43.

We find the same objection to this apparatus as to the Laval, in the great drop, which requires the milk to be pumped. This led Mr. Hochmuth to modify it and construct one with the heater placed horizontally, Fig. 42, and also one with both heater and cooler in a horizontal position. Fig. 43. In addition to this change, he also adopted a cover which protects the milk against the air as well as compels it to follow the curvature of the corrugated surface instead of flowing on top.

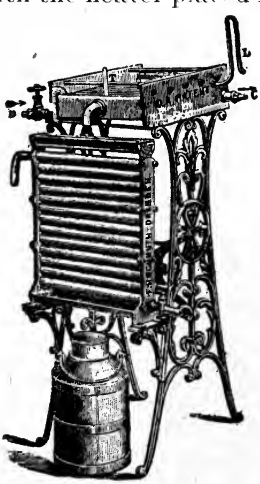


Fig. 42.

Similar system was used by Lawrence, where the upper section was covered, but I confess to a liking for the open surface for heating and for the first cooling, always provided the air is pure when the apparatus is used.

"Carl Thiel" (Germany) as early as 1886 adopted a system of heater Fig. 45, where the milk is not exposed to the

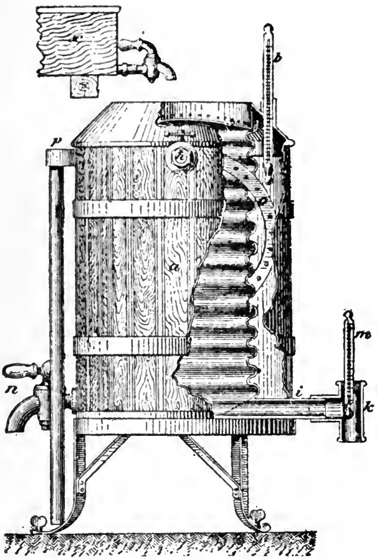


Fig. 45.

open air. It consists of a tin-lined wooden cylinder a between which and a corrugated cylinder is a perforated steam coil o with steam entering at h, thus heating the water to the desired temperature read off on the thermometer b. The overflow water escapes at p and is emptied at n.

The milk flows from the tank x on to the curved cover which is perforated so as to distribute the milk evenly on the inside of the corrugated cylinder from whence it flows to the bottom and out by i and k, the thermometer m showing the temperature.

Dr. Fleischman heated 1,250 fbs. of milk per hour from 66° to 140° Fah. with the heating water only 158°.

Thiel used a similar constructed cooler, but of course any kind of cooler can be used.

Kelch's (Germany) heater and cooler is shown in Fig. 46, with a sectional view in Fig. 47. It consists of two cylinders A and B, the latter set in the former. The narrow space between them K is used for either heating or cooling the milk

Fig. 46.

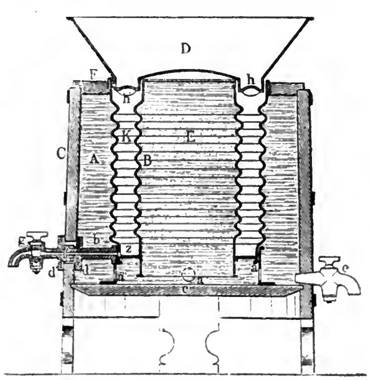


Fig. 47.

which is spread in a thin film over both the corrugated surfaces by fine holes in the funnel shaped cover D.

The bottom of the space K is covered with a ring Z, which lets the milk out by the faucet g.

This heater approaches in effectiveness one suggested by me in 1894 for cooler, namely by having two corrugated cylinders made with spiral corrugations so that the inner one could be screwed down in position, leaving only half or one-quarter inch space for the milk. I believe it would be the ideal heater (and cooler) where no motive power is to be used. The milk would hae to follow the corrugations somewhat as shown in Fig. 43. I once corresponded with manufacturers of copper expansion joints for large steam pipes, but the price seemed too high to make it practical.

A very simple device is shown in Fig. 48. Mr. Bentley, of Ohio, used it and I have also had one made, but with several sets of cans within each other. It is really an adaption of a cooler illustrated in Dr. Fleischmann's book, invented by Jellinek Romanowsky years ago. A tube H is soldered in the center of a shotgun can AAAA, having holes in the rim below. This is placed in a larger can BBBB. The latter is placed in a tank with water kept warm with a steam jet (or cold with ice if used as a cooler). The can AA is also filled with water, warm or cold, and the milk enters at H, flows through the holes in the rim of the can AA, and passes up between that and BB and out at M.

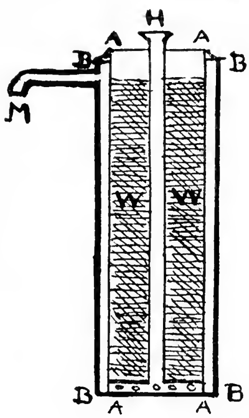


Fig. 48.

In Sweden De Laval solved the protection problem in a similar but more elaborate manner, as shown in Fig. 49.

This apparatus consists of two closed double vessels fitting one into the other in such a way as to form concentric narrow apertures of large surface, through which the milk is forced. The aperture is only about $\frac{1}{8}$ of an inch and the milk, which is kept in constant motion, is rapidly and evenly heated, without allowing any albumen to coagulate.

Each vessel has a pipe (a) which passes down close to the bottom; these two pipes are at the upper end joined at b where the steam enters.

Both vessels are also connected by a pipe (c) by which the condensed steam escapes from the inner vessel into the outer, from which it again flows through the pipe (d). The inlet of the milk is regulated by an ordinary regulator cup (e) with float, same as used on the separators. After the milk has passed down through the inner conical aperture, it rises through the outer one and flows over the rim of the annular receiver placed round the above named regulator cup, and flows off through the pipe (g). At the base of the outer vessel are fitted a faucet (h) (for drawing off the milk remaining in the apparatus after the work is finished) and a screw-plug (1) for emptying out the heating water from the outer vessel. The inner vessel is emptied of its water through the opening n, by means of a syphon.

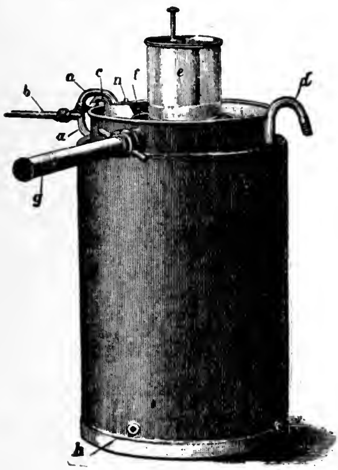


Fig. 49.

It is made in sizes to heat from 1,300 fbs. to 3,600 fbs. per hour.

D. H. Burrell & Co., of Little Falls, N. Y., have also adopted this idea in their double surface heater, Fig. 50. It

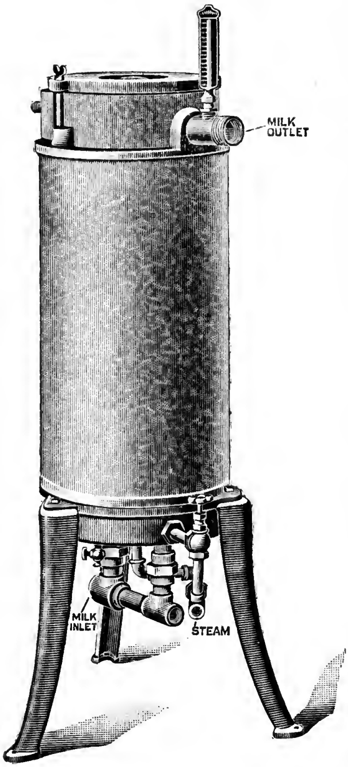


Fig. 50.

consists of a copper cylinder surrounded by a water jacket, and fitted with galvanized cast iron heads; the upper head having a removable cover, and the lower head having a screw collar on the inner side. Into the cylinder fits the inner core, which is held in place by being screwed on to the collar in the bottom of the outer cylinder. This screw joint between the outer and inner vessels establishes a passage for the heating water, which, being run into the filling funnel, fills both inner and outer vessels to the level of the overflow nipple. The steam is fed into the inner core by a central jet, and into the outer jacket by a second jet. The milk is introduced at the bottom into the thin space between the inner and outer cylinders. As it flows upwardly to the milk outlet it passes between the two hot surfaces.

TUBULAR HEATERS.

In France, Mr. F. Fouche constructed what he calls a multitubular pasteurizer. Fig. 51.

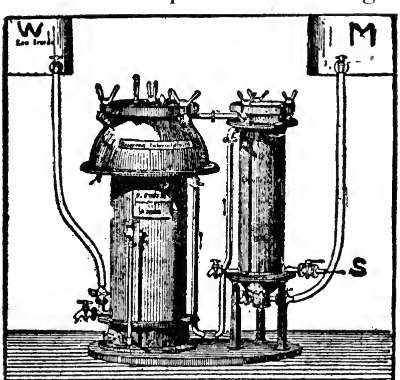


Fig. 51.

The milk leaves the tank M and enters the bottom of the heater which is heated by steam entering at S. After passing through a lot of straight tubes the milk leaves the heater and enters the cooler at the top. The tubes in the cooler are cooled by water from tank W. This apparatus fills the bill as far as excluding the air during the entire operation, but whether it has obtained any extensive use I do not know. It can be cleaned by loosening the top.

Sturges, Cornish & Burn Co., of Chicago, has put on the market a tubular heater shown in Fig. 52. It consists of a horizontal drum with a larger reservoir in one end. In the drum is a battery of tubes about $\frac{5}{8}$ inches in diameter and one end being accessible these can be cleaned like gun barrels, as they also open into the reservoir. In this there is a partition so that the cold milk enters at one side, passes through half the tubes to the other end and returns by the other half. The drum is filled with water through funnel on top and is also provided with an overflow; a steam jet at the Tee on the pipe below the bottom of the drum heats the water and keeps it in a lively circulation. This heater is certainly very effective and they also make vertical pasteurizers on the same principle only the tubes are one inch in diameter which makes them easier to clean. The tubes are made of drawn metal tinned and are as smooth as can be. This heater can easily be converted from an aerating to a completely closed one by having a tight cover on the reservoir for those who believe in total exclusion of the air.

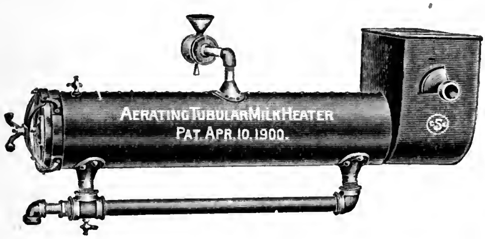


Fig. 52.

A NEW DEPARTURE IN HEATERS.

Lefeldt & Lentsch's (Germany) latest sterilizing and pas-

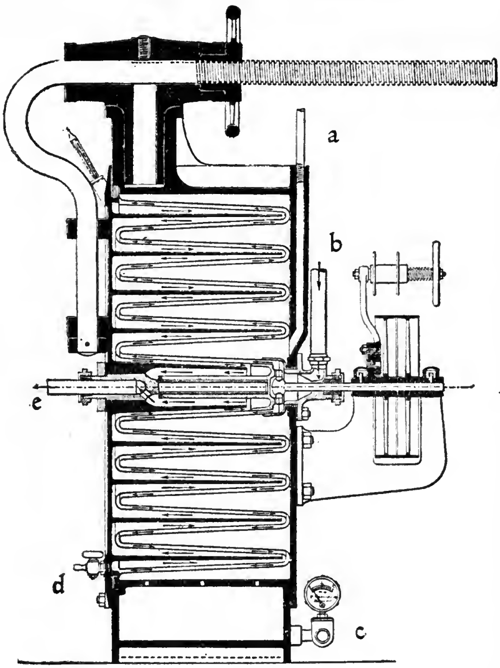


Fig. 53.

teurizing heater "REGENERATIVE," is the result of the European economic spirit, and makes the cold milk cool the hot, while the latter heats the former, thus saving both ice and coal. The outside is made of iron and is insulated. Inside this are two curved tinned copper drums, which fit into each other, leaving a narrow space for the milk to pass. Fig. 53 shows a sectional cut of the heater closed while Fig. 54 gives a general view of it, and Fig. 55 shows it opened for cleaning. In order to keep the milk in motion while heating the drum connected with the moveable side is revolved by aid of the pulley shown. The milk enters at b, following the direction of the arrows, is heated by steam entering through C into the fixed drum, and when it reaches the end of the heating surface the thermometer shows the temperature and it commences the return trip and is cooled by meeting the cold milk, leaving the heater at e. The condensed water is removed at a. The one with a capacity of 6,000 lbs. per hour holds 372 lbs. and there remains about 180 lbs. when the work is done. This is drawn off by the cock at d. The apparatus was tested by the agricultural society and shown to heat the milk to 225° without changing its color or giving it any pro-

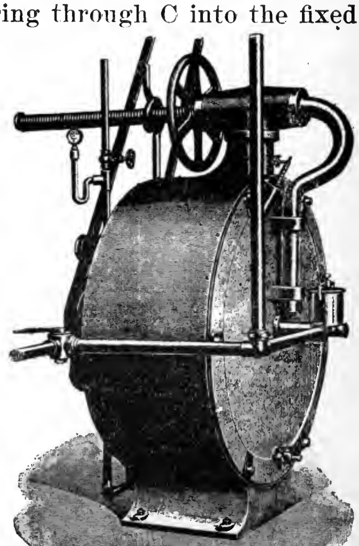


Fig. 54.

nounced cooked flavor (?) It left the heater at from 101 to 119° below its highest temperature. The price is about $500.00 in Germany.

Kleemann & Co. of Berlin (Germany) have also utilized this coal and ice saving idea, but they make use of two separate

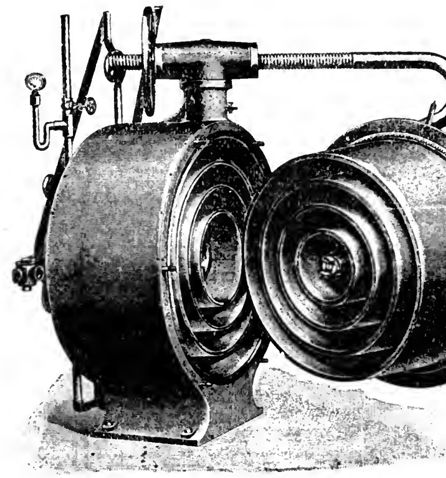


Fig. 55.

apparatuses. See Fig. 56. The one to the left is a high pressure heater with a cylinder revolved by pulleys from below. The cold milk enters at h and meets the hot milk in the regenerative apparatus to the right and passes, partly heated, through the pipe B into the heater where it reaches the high temperature leaving through pipe A to pass back into the first

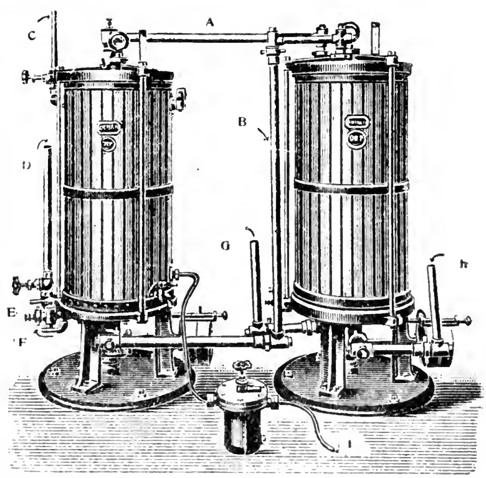


Fig. 56

apparatus, meeting the cold milk and leaving partly cooled at G. C is direct steam and D is exhaust steam inlets, E is a faucet for emptying the last milk and F is outlet for exhaust steam and I is outlet for condensed water. The price for both with a capacity of 6,000 to 8,000 lbs. per hour is about $812 f. o. b. Berlin. It is claimed to be easy to clean. As far as the incomplete description goes it seems that there are two cylinders inside the drum and that one is revolving while the milk goes between them, first up, then down and then up again.

TANK HEATERS.

To all the "continuous" heaters, the bacteriologists object—as before said—because even a large body of milk in transit there is no assurance that all the milk has been exposed to the high temperature for the time needed.

On this principle Prof. Russell, of Madison, Wis., constructed an apparatus illustrated in Figs. 24, 25 and 26, which he calls a "combined pasteurizer and cooler;" this is a misnomer, it is a "*pasteurizer;*" if it were not designed to cool as well as heat it would simply be a heater. I point this out as there is a tendency to call the simple heating of the milk pasteurizing; this is wrong, pasteurizing is both heating and cooling.

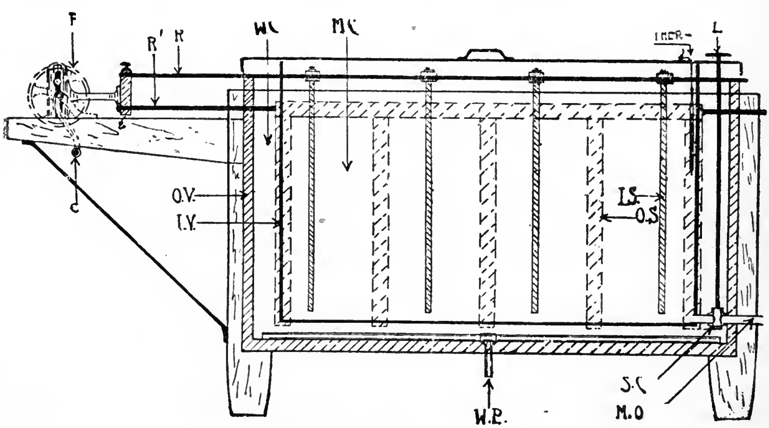


Fig. 57.

Fig. 57—Diagrammatic side view of pasteurizer—i. v.—inside vat for milk; s. c.—stop-cock in outlet tube; m. o.—milk outlet; l.—lever to control stop-cock; o. v.—outside vat; w. c.—water chamber; w. p..—water pipe (steam or water); ther. —thermometer in milk chamber; r.—brass rod to which i. s. (inside stirrers) in milk chamber are attached; r.—rod to

which o. s. (outside stirrers) are attached; c.—crank; p.—pulley.

Fig. 58—End view of pasteurizer showing double vat arrangement.—w. c.—water chamber; m. c.—milk chamber; i. v.—inside reservoir for milk; o. v.—outside reservoir for water; w. p.—water pipe; v.—vent of same; i. s.—inside stirrer in milk chambers; o. s.—outside stirrers, (three series); r. p.—binding piece of wood to which i. v. is attached. The ends of this rest on outside wooden vat, o. v.

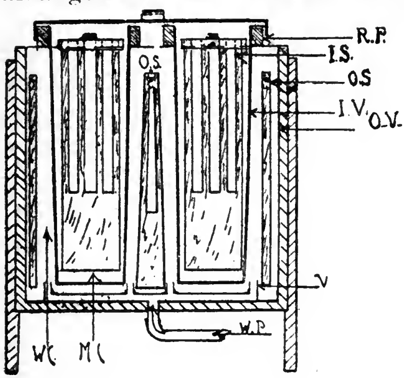


Fig. 58.

Fig. 59—Diagrammatic view of pasteurizer from above.—m. c.—milk chamber bounded by continuous black line; w. c.—water reservoir surrounding same; r. and r'.—rods from which stirrers are hung in milk and water chamber.

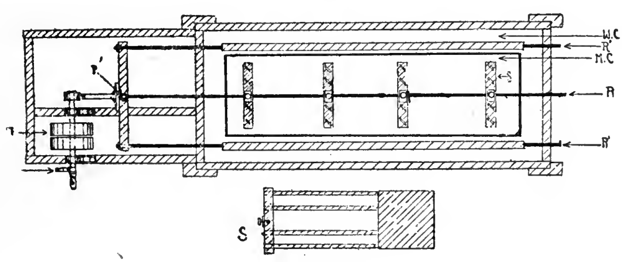


Fig. 59.

Left hand of figure shows wooden frame that supports the gearing for stirring; p.—the pulley on axle for automatic power; c.—hand crank.

Lower figure S.—Face view of one of stirrers in milk chamber. These can be removed from rod (r). Lower half of two stirrers is solid so as to mix the milk more thoroughly.

The apparatus consists of a wooden vat o v Fig. 24, with one or two narrow tin vats I V.

A rod R, Fig. 57, worked backwards and forwards by a crank, carries the milk paddles I S, and is connected with the two rods R', which carry the water paddles O S. One pipe

W P, introduces both water and steam. S on Fig. 59 represents the milk paddles. The whole is covered with a cover. The milk is filled in and the paddles are kept moving during heating, and when at the desired temperature is left for twenty minutes.

Then the hot water is drawn off and cold water is turned on during constant stirring until it is about 70°. When cold enough the milk is drawn by M O, by opening a special constructed faucet S C, with a straight cylinder. The temperature is observed at T H R.

This apparatus is used successfully in the Madison Experiment Creamery (Dairy School), for pasteurizing small amounts of cream sold in the city, and in many other pasteurizing plants. It is made by **Cornish, Curtis & Green Mfg. Co**, Fort Atkinson, Wis.

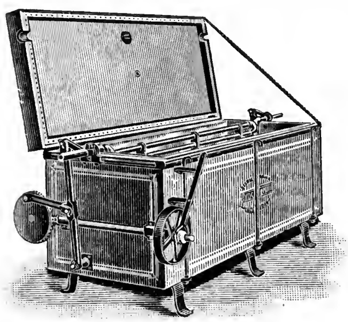


Fig. 60.

Among the tank heaters used for pasteurizing must be mentioned the improved Boyd cream vat, Fig. 60, miscalled "Cream Ripener," made and sold by **Sturges, Cornish & Burn,** of Chicago.

Potts' Pasteurizer, sold by **Creamery Package Mfg. Co.,** Chicago, has been improved upon so as to heat with hot water circulated by the aid of a steam jet instead of using steam directly in the jacket, Fig. 61. The drum is made of wood

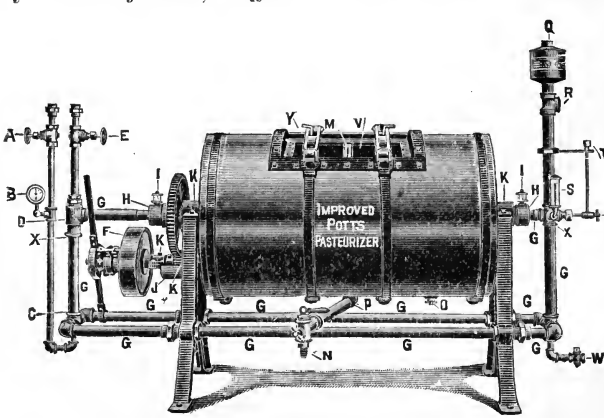


Fig. 61.

and the inner cylinder of heavy tinned steel plate or tinned copper. There is a space of one inch between the two. The water connection is at E, above which connection may be made with both the regular water supply and an ice water tank. Steam connection is made at A with a jet at C, which heats the water in the circulating pipes, GGGG, and in the space between the drums, the flow being upward through a check valve at D. An overflow escape is provided at R. At T L there is a cotton cup connected with the inner cylinder by an air pipe which allows steam and gas from the milk to escape. Y is an air vent open while filling the water space. The temperature of the milk is taken by a thermometer M in the cover V, and that of the water in the jacket at S. Inside the inner drum is a curved breaker, which stirs the milk or cream and thoroughly mixes it. When cooling, the cold water is turned on and passes directly into the space between the drums as the check valve at D prevents it from getting into the pipes G. The pulley F revolving at 60 to 90 revolutions will make the drum revolve 10 to 15 times per minute. The outlet pipe N is put on at P when ready to draw the milk off as is the lever Z on the cock, which is so constructed that it may be easily taken apart for cleaning.

It is claimed that with water at 150° and the milk at 130°, the temperature in the latter will rise showly to 140° after shutting off the steam, and that it may be cooled in 30 to 35 minutes on the large machines and 20 minutes in the small ones, but it is not stated what temperature the water must be to do this nor the flow. It is made with a capacity of from 400 lbs. to 2,000 lbs., at prices from $125 up to $250. If cooling by circulating brine is desired the inner cylinder must be made of copper and an extra charge is made.

Of all tank pasteurizers this seems to have gained the most favor, and at Madison Dairy School they seemed very much pleased with it, but I cannot say that I like the automatic vent T L, because it seems to me to be difficult to keep clean, and it would be a small matter to have a simpler vent and let the operator open it now and then.

Bitter (Germany), who also condemns all continuous apparatuses, constructed a small one where a dasher revolved between two steam coils in a round tank. It is evident that the keeping of these coils clean must relegate this apparatus to the museums as impracticable.

In the U. S. Agricultural year book for 1894, Dr. E. A. DeSchweinitz has a treatise on "The Pasteurization and Sterilizing of Milk," from which I gather that the Appleberg Hygienic Milk Co., at Rawlings, N. Y., has patented an "apparatus" for pasteurization.

It consists of a wooden box four feet square with a hinged lid. On the bottom is a steam coil. Inside the coils the (rectangular) milk cans, holding forty quarts, are placed and covered with perforated tin lids to permit the insertion of a thermometer. The cans fit closely together inside the coil.

During the process, the milk is kept thoroughly stirred (how?). The temperature varies from 16° to 180°, and steam is turned on from twenty to thirty minutes.

The milk is filled hot into the glass jars, which are placed in ice water to cool.

At Danby, N. Y., is also a plant for "sterilizing" the milk in bulk, hot water being used instead of dry steam.

HEATING BY DIRECT STEAM.

Under the heading of tank heaters I must mention the system of heating by leading steam (exhaust or direct) into the milk.

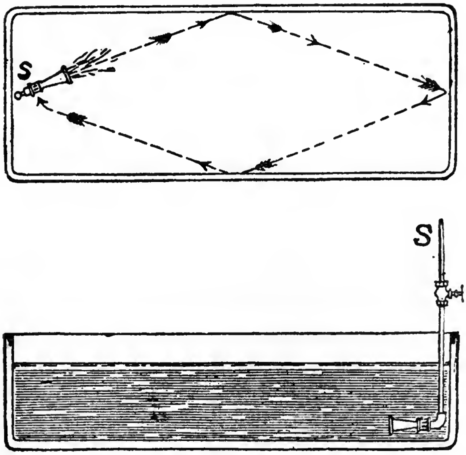


Fig. 62.

This has been used in some German creameries for skim milk on the "Korting" system, illustrated in Fig. 62, which shows how the current is directed diagonally against the sides. The heater consists of a trumpet-shaped end to the steam pipe with openings just behind the point of the steam jet on the same principle as our steam jet pumps and heaters. See Fig. 62.

A similar idea has been adopted by **Mr. Bentley,** called by him a "Germicide." This is indicated in Fig. 63, by two wide tubes in which two steam jets blow in different directions, causing a current in the milk, as indicated by the arrows. The steam pipes are joined together above (not shown in illustration) with a drip arrangement in the center so as not to introduce any of the steam condensed in the pipes.

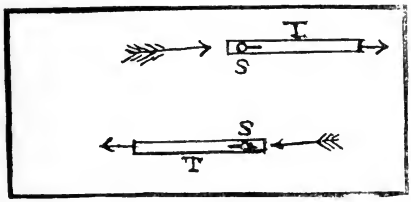


Fig. 63.

In Fig. 64 I have shown the simple Barber noiseless heater intended for water with which I have made start the current in any desired direction. By modifying this, a "heater" for direct steam can be made by anybody at a nominal cost. Steam enters at S through the reduced opening of the nipple s. The milk is sucked in at m and ejected at e.

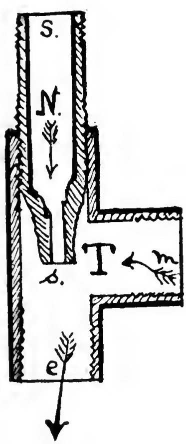


Fig. 64.

Mr. Newton, ex-President of Iowa Dairymen's Association, was the first to suggest the plan of elevating the skim milk into a bucket placed in the tank, and then have an exhaust steam pipe enter into the bucket, thus heating the milk, and **Mr. Jensen,** of Kansas, constructed a skim milk heater by having the milk pumped into a trough placed in the skim milk tank, and in the bottom of this trough is a perforated steam pipe whereby the milk is heated. In heating milk directly with steam there is, of course, a dilution. In one test I made it was 7 per cent, but it is often more, and add to this the danger of contamination from impure steam and it will be seen that it should not be encouraged where the milk is intended for human food.

STORAGE TANKS.

In view of the assumed necessity of keeping the milk or cream at the high temperature for 20 or 30 minutes, if it is to be sold and not manufactured, and in view also of the difficulties of heating all the milk in a body when we have to handle large quantities such as must be handled at milk shipping stations if pasteurizing is ever to be introduced generally, I have suggested the following plan:

Use any continuous heater which you find best, but instead of running the milk directly to the cooler, run it into a storage tank, which should hold one-third of the hourly capacity of your heater and cooler if you desire to keep the milk for 20 minutes at the high temperature or one-half if you want to keep it 30 minutes.

This tank may either be built with water space filled with water at 155° or better still be properly insulated so as to hold the temperature within 5°.

By having one partition in the tank and two attached to the cover the milk is compelled to go to the bottom first then up, then down and at last up and out to the cooler, and I challenge bacteriologists to show any reason why this arrangement does not solve the problem of combining a continuous apparatus with the strictest bacteriological demands!

What is more, I believe that this system of instantaneous (so to say) heating is better than the slower heating of a large body of milk in a tank unless indeed all the milk arrives at once and is left for hours at the dangerous temperature.

D. H. Burrell & Co. have adopted a better plan, and have all the partitions soldered on the tank, every other being soldered to the sides and bottom, and every other being open at the bottom; and A. H. Reid has adopted a vat similar to the Danish Weston separator heater. (See Fig. 102.)

Even if it should be found necessary to have several tanks each of a capacity to hold the milk absolutely for the required time, as proposed by Mr. J. D. Frederiksen, this would be better than the slow heating *and cooling* of 3,000 or 4,000 lbs. of milk.

If the milk is 60° or above, it is surely better, the quicker it is heated up. While I express this as my belief at present, I hope to see the experiment stations take the matter up in a *practical* manner free from scientific punctiliousness.

CHAPTER III.

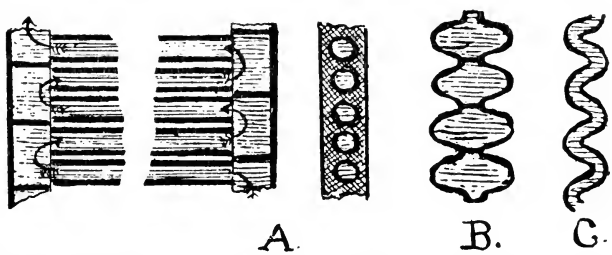
THE PASTEURIZING COOLER.

I have shown how in some pasteurizing apparatus the heating and cooling may be done in one vessel. I have also shown some of those where the same construction is used for both purposes separately. It remains now to mention a few of the coolers which have been used.

COOLERS WITH EXPOSED SURFACE.

Among those made on this plan the most effective are undoubhtedly those made on the Lawrence and Laval plan. The former has indeed been so thoroughly copied both in Europe

Fig. 65.



and America by most of the manufacturers, who thus have paid the inventor a high compliment. The latter is illustrated in the lower part of Fig. 40, and the former is represented in Fig. 65, which shows cross sections of the three different styles of constructing this cooler, A, B, C. To these should be added the cheap tin cooler made in America under the name of Danish Weston cooler, and the cooler made by A. H. Barber, of galvanized iron pipes, with close elbows and a partition of tin soldered between them.

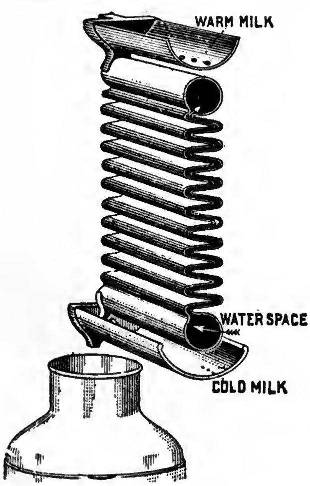


Fig. 66.

The Lawrence style of coolers are made in America by the **Star Cooler** Manufacturing Co., **Vermont Farm Machine Co.,** and **A. H. Reid,** of Philadelphia, the last of which I illustrate in Fig. 66, and are, when well made, undoubtedly among the most economical as far as utilizing the water.

It requires always a considerable fall, and this has prevented their use in many creameries.

Of the three constructions I believe C is the one which utilizes the water most thoroughly when made, with a very narrow water space; but this is less important where the supply of water is large enough.

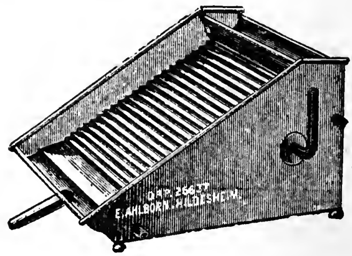


Fig. 67.

Modifications of this cooler, made to do away with the objection of its drop height, have been made. I illustrate a German one in Fig. 67, which is also used as heater.

This style has been in all angles down to nearly horizontal, as in Hochmuth's, but the great objection has been the tendency of the cold milk to flow straight down on top of that which is in the curves, thus diminishing the effect considerably. Hochmuth tried to overcome this in Fig. 43, where the cover is corrugated similar to those of the cooler.

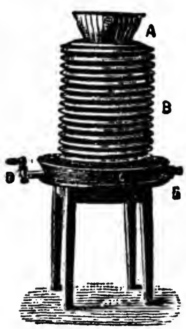


Fig. 68.

In Fig. 68 we have the W. Smith cooler, which style is very popular in Europe. B is a circular corrugated surface with a smooth cylinder inside, between which the water circulates. The milk flows from the distributor A over B into the gutter and out at D. While it in one way is more compact than the Lawrence style, it uses only one side of the cooling water and has the same objection of high drop, though not in the same degree.

Several years ago **Mr. U. S. Baer,** the expert separator man working for Laval, tried to overcome the objection of the creamery men to coolers with considerable fall and constructed a long shallow 1 foot wide gutter with a double bottom, in which the water was made to go zig zag by half partitions.

The only difficulty was the same as with all surface heaters that when not perfectly level the milk would run on one side only.

Mr. A H. Barber, of Chicago, who made this cooler, improved on this by making it as illustrated in Fig. 69, giving a view from above with part exposed and a cross section N M, which shows the corrugation which compels the milk to run in the little gutters and increases the cooling surface. Also in P the partitions which turn the current of the water which flows as the arrows show on the exposed part of the sketch. The milk flows, of course, in the opposite direction and on a length of 8 feet, 2 inches drop is fully enough; indeed, they may be placed nearly level.

Where they are not desired to be used as conductors as well as coolers they may be arranged zig zag, as shown in Fig. 24.

In a trial I made, 22 feet of this cooler reduced 900 lbs. per hour from 156° to 102° with the cooling water 74°, and the next 20 feet reduced it to 55° with water circulating over an ammonia coil (about 90 feet, 1 inch) which kept the water at 50°.

Mr. Barber makes these double width to order for pasteurizing purposes, and, if desired for brine circulation they are made of tinned copper.

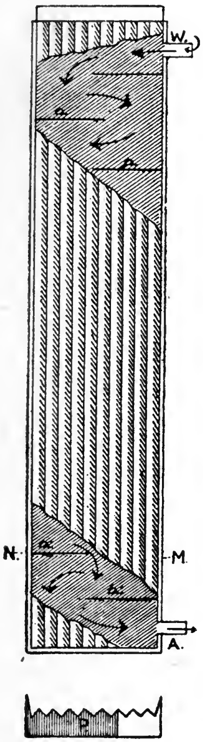


Fig. 69.

Numerous other surface coolers for running water have been devised, but these are the principal ones.

We now come to the coolers with protected surface.

While I feel inclined from a practical standpoint to overlook the demand of bacteriologists for a heater with covered surface, I am more inclined to acknowledge the value of protection against the air during cooling, especially the last cooling.

Prof. Russell suggests the one shown in Fig. 70. It consists of two tin cylinders with only $\frac{1}{8}$-inch space between each other, and here the milk flows through (MC). The cylinders can be taken apart at one end and inlet and outlet pipes can

Fig. 70. A—Sectional view of water cooler—m. c.—milk chamber between the two cylinders; w. c.—inside water chamber, water introduced on lower side, outlet on top; a—an inner core with partition (see B.) to force the water to flow the whole length of cylinder; o. w. c.—outer water chamber made by submerging the cooler in water; w. p.—inlet for water; m. p.—milk inlet and outlet. The arrows indicate the direction of flow of milk and water. Both the milk inlet and outlet are made with a ground joint connection like a sink plug, so that they can be easily detached and cleaned. The cylinders can be taken apart and thoroughly cleaned without any difficulty. Fig. 70 B.—Apparatus in cross section, showing relation of milk chamber to contiguous cold water spaces.

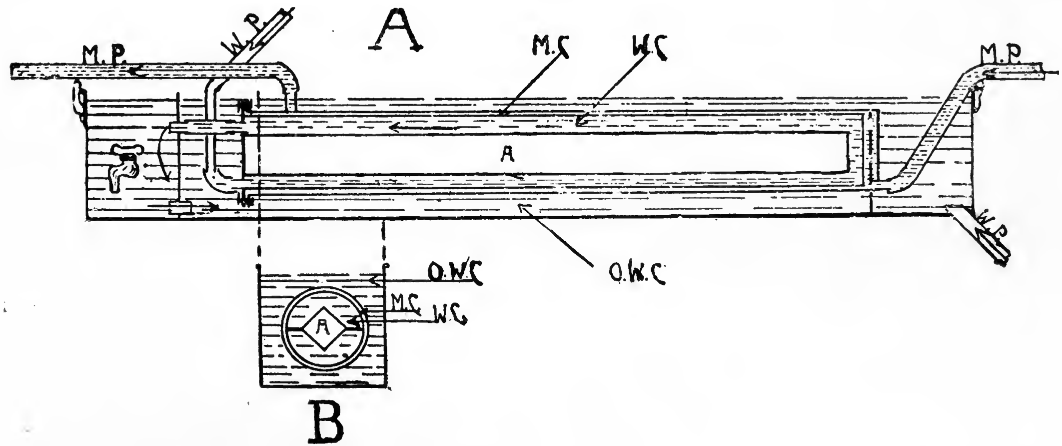


Fig. 70.

easily be removed by "a ground joint like an ordinary sink plug." They are submerged in a tank which is filled with water, which also passes through the inner cylinder as indicated in the illustration.

With this cooler and cold water the milk can be reduced from 25° to 40°, says the professor.

I have shown how Hochmuth and Lawrence protected the milk against the air by a mantel, and the exacting Prof. Bitter protected the Smith cooler, Fig. 68, by a cover.

Indeed nearly all these surface coolers are easily covered at a slight expense for those who so desire, and unless the air is pure it is certainly safer.

A. H Barber & Co. makes coolers similar to the Hill heater, and on the same principle are the Miller coolers described with his heater on page 36.

CENTRIFUGAL COOLERS.

THE BERGEDORFER Machine works (Germany) make a cream cooler illustrated in Fig. 71. It consists of an inverted cone of cast iron in which revolves a similar shaped drum driven by P. The cream enters from C, the lower bearing of the drum, and escapes through the perforated upper part of the drum into the gutter and leaves at CR.

The water enters at W and overflows through the siphon O.

The cream is here, as in the centrifugal heaters, spread in a thin film over the drum. The speed given is 800 revolutions per minute.

If the friction of the water be not a too great objection to this system in larger apparatus, it seems to me there are great possibilities in de-

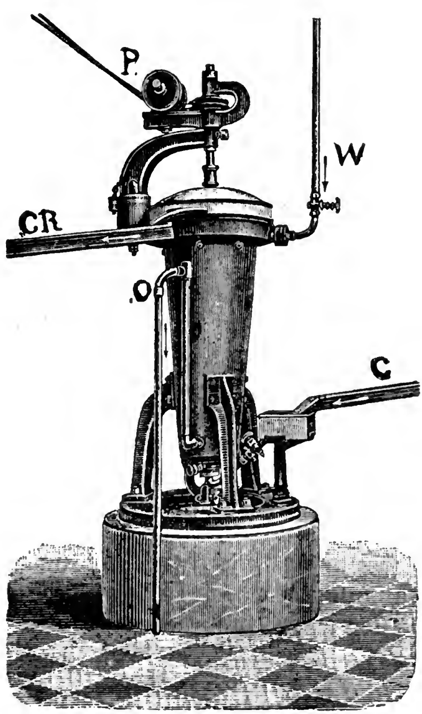


Fig. 71.

veloping this idea. I have thus suggested that the drum be rotated by aid of the cooling water. It may also be used for elevator, as indeed it is in Fig. 71.

The drum being wider at the top spreads the cream in a thinner layer where the cold water is sprinkled on the top of the drum, the lower three-fourths only of which is immerged in water. They are made to cool from 800 to 1,200 lbs. per hour—the latter being able to handle the cream from 8,000 lbs. of milk.

ICE COOLERS.

Where water is scarce and ice plenty the cream cooler originally designed by **Prof. Fjord,** Fig. 72, has been used. A tin can is placed inside another, leaving a space to be filled with crushed ice. On a bracket there is a funnel with four curved outlets. This is revolved by the action of the milk, which thus sprinkles itself against the ice cold walls of the can, flowing to the bottom and out.

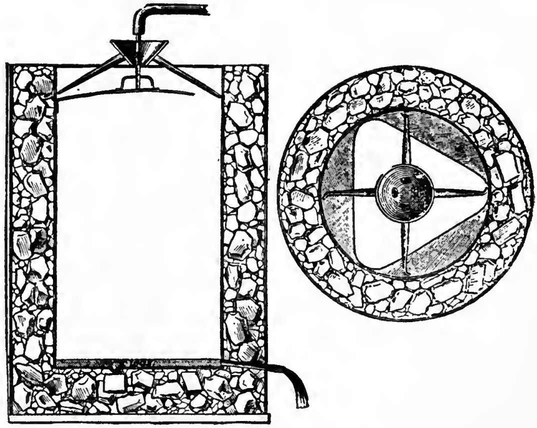


Fig. 72.

Prof. Russell suggests the ice cooler shown in Fig. 73. Finding that it was difficult, if not impossible, to cool the milk sufficiently with water, he proposes to have three rectangular reservoirs made as shown in the cross section. When the milk leaves the water cooler it flows down the side of the inner ice box, which is corrugated, and close to one side of the milk box M, which should be large enough to hold all of the milk from one heater.

The bottling arrangement by siphon explains itself.

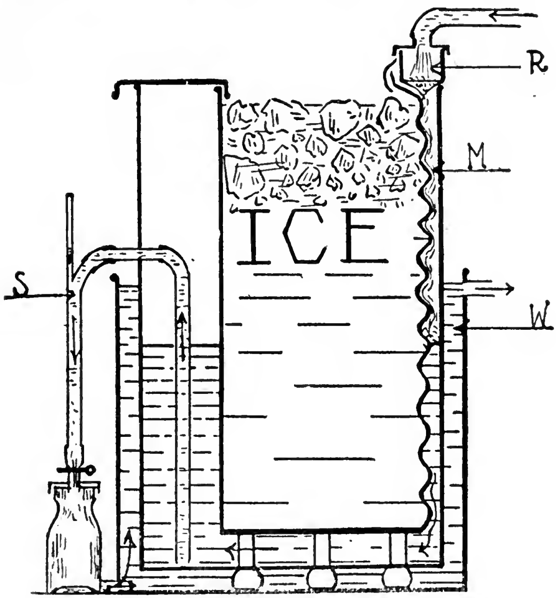


Fig. 73.

Fig. 73.—Sectional view of Ice Cooler.—w.—cold water chamber outside; m.—milk reservoir; r.—receiver from the pasteurizer, milk flows down corrugated side of the chamber and is collected in (m.); s.—siphon arrangement for drawing off milk. Arrows in water and milk chamber show direction of current.

It stands to reason that any and all of these ice coolers are not doing their best work unless there is some provision for stirring or moving the iced water, and while they may be used with water alone, they will be less effective, and it may be laid down as a rule that ice or a refrigerator machine is a necessity if pasteurizing is to be successful, unless indeed a flowing well of 48° or less is available.

CHAPTER IV.

PASTEURIZING IN THE CREAMERIES.

First as to skim milk. I have mentioned how it is much more practical not to pasteurize the skim milk, but to simply heat to 185° or 195° because this hot milk when poured into the cans will virtually kill any bacteria which may be in the little milk left in the cans, and pasteurizing: heating and cooling, should only be done where the cans are first cleaned and steamed, and even then I doubt the economy unless indeed a large flow of cold water might reduce the cost of cooling to next to nothing. It has been slow work enough to induce our creamery men to heat the skim milk by a steam jet (direct or exhaust) into the milk, so that it is in fear and trembling that I request those who do this to figure a little on the dilution and the increased cost of hauling this water back to the farm. It is at least worth considering whether this counterbalances the expense of one of the modern heaters which may be used chiefly with exhaust steam.

One thing is sure, every creamery ought to heat the skim milk for the protection of its patrons, and when once they (the patrons) have learned to appreciate the hot sweet milk then the butter maker will have his reward by getting better milk delivered, because if the patrons deliver milk too sour to heat they will get it back loppered. That this is the result has been testified to by too many creamery men to doubt it. And it also removes the danger of spreading tuberculosis, but full security against tuberculosis in the continuous heater is claimed by Danish authorities to be obtained only at 185°; indeed creameries are compelled by law in that country to heat it to that temperature.

One trouble in heating the milk is foaming. A device to prevent this made by **C. Mikkelsen** (Denmark) is shown in

Fig. 73½. The skim milk vat is made of heavy tinned steel plates with angle iron, round the top edge. This allows the clamping of the cover firmly and tightly. In

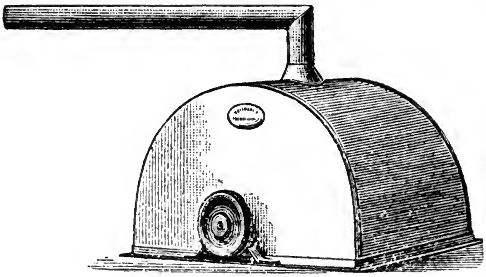


Fig. 73½.

the cover is an opening into which fits the half cylinder which is provided with two dashers revolving on a shaft driven with a cord pulley. The skim milk enters the vat through a closed pipe and the foam rises against the cover, where it is caught by the dashers and thrown against the cylinder, thus releasing the air which escapes through the ventilating pipe.

The latest Danish heater (See Fig. 37) kills this foam by having plates on the dasher.

SHALL WE MAKE PASTEURIZED BUTTER?

This is a difficult question to answer, as regards our home market, and yet I believe that it would pay in the long run. First of all it would secure us a better price for our surplus to be exported, and it cannot be denied that such surplus affects our home prices, more or less. If an unpasteurized surplus of 10 or 20 million pounds of butter of the usual varying quality has to be disposed of and only 16 cents can be realized, it is evident that the holders will rather take 16¼ cents at home, but if pasteurization would help us—*as I know it will*—to a greater uniformity and a better *average* quality of this surplus and thus raise the export value to 18 or 19 cents, it is evident that no butter would be offered for less than that price.

But I believe further that even for our home markets it would pay, because by careful ripening of the cream, we can get a uniform *clean* flavor and yet high enough to please, and much greater *uniformity*. It is the uniformity which has helped to introduce oleomargarine to many of our hotels and restaurants and not always the greed of the proprietors. They find that there is less kicking made by their patrons on a uniform "neutral" oleomargarine than on fine flavored butter today, rancid or off-flavored tomorrow, and indifferent the next day. In creameries where perfect milk is delivered all the year round it would be foolish to pasteurize.

I know well enough that I am perhaps before my time in taking this position, as not six out of ten, aye not four out of ten of our creameries are in a condition to pasteurize with any assurance of success. Only when we have buildings that may be kept *clean* will it be practical to adopt this system. There is no need of fancy buildings like the German creamery illustrated in this pamphlet on page 77, but brick buildings with cement floors and walls finished in cement, with plenty of light and ventilation, as well as good drainage and clean surroundings, is a necessity. If individual creamery men who, alas too often, rent a rotten building will not reform, it is high time for the farmers to *co-operate* and put up such a building rather than continue to patronize the present average creamery. It would certainly pay them well. Our buttermakers have lately learned the value of a "starter," but do they stop to consider the uncertainties to which they remain a prey? Sowing wheat in a weedy field is an old simile, but nevertheless true, and pasteurization will certainly help him in getting uniform results from his work.

I am not prepared to urge those who want to make pasteurized butter to adopt the heating of the new milk and skimming hot, but on the other hand I dare not condemn it. Personally, I should prefer to pasteurize the cream and heat the skim milk, as it comes from the separators. This is not a treatise on buttermaking, and hence suffice it to say: Continuous heaters are satisfactory for this purpose. Cool the heated cream *quickly* down to ripening temperature, say 70° to 80°, and add your starter, but be sure it is a good one, because you will have no lactic acid bacteria that might help to remedy your mistake, as it happens when using an inferior starter in a good unpasteurized cream. On the making of the starter will you stand or fall. When nearly ripe, say 34 to 35 cc on the Mann's test, with cream 25 or 30 per cent fat, cool down to 46° or 48°, and hold it there for not less than three hours and you will have no trouble with the "body" of your butter. Do not attempt to pasteurize unless you have complete control of your temperatures.

In Fig. 74 is illustrated a Danish outfit with automatic

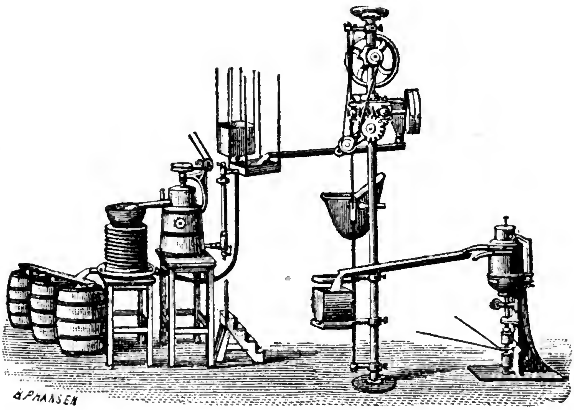


Fig. 74.

cream elevator, an old Fjord heater and Smith cooler and three cream barrels.

In Fig. 75 is shown an English continuous pasteurizing outfit made by the "Dairy Supply Co.," London. To the

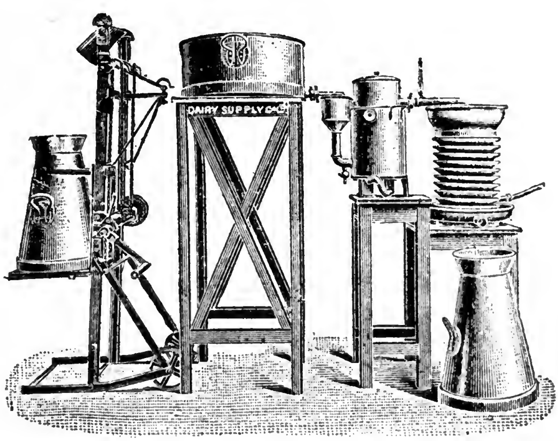


Fig. 75.

left is shown the typical English milk can (called milk churn in England) on a self-dumping elevator, which delivers the milk in the vat. The heater is of the Laval type shown in Fig. 17, and the cooler is of the "Smith" pattern.

Fig. 76 shows a Danish creamery outfit with three Triumph heaters, the construction of which is shown in Fig. 28.

The milk is received in H, from where it is run into the drum A, which has a steam mantel and a revolving horizontal screw, which heats the milk to separating temperature and elevates it into the separator.

From the separator the cream runs into a similar heater C where it is heated to 150 and then elevated to the cooler D, from which it runs into the cream tank E.

The skim milk runs into the larger drum B, and is heated to the boiling point.

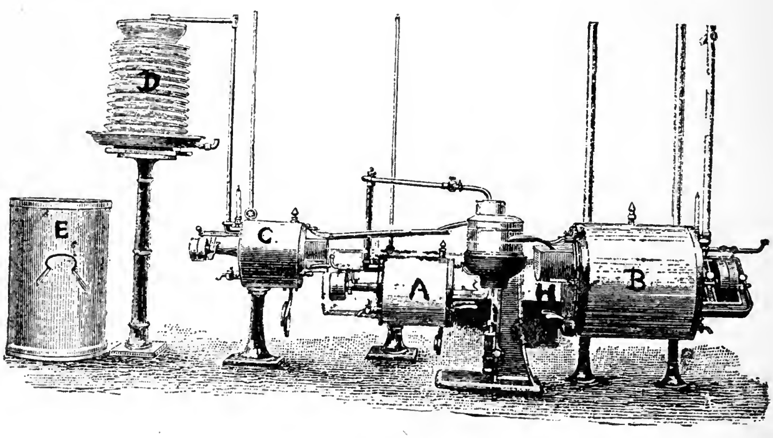


Fig. 76.

On page 99, Fig. 102, is shown the A. H. Reid outfit for pasteurizing city milk. By removing the hot milk storage tank it will represent one suitable for a creamery.

In reply to an inquiry about shipping hot cream from skim stations, I received the following reply from "the largest Creamery System in the world:"

" * * * We have about 100 Pasteurizers and coolers out (the "Jensen") and the rest of our stations are pasteurizing and cooling in cans, but just as soon as we can get the machines shipped we will pasteurize in them at all of our points.

"Now as to our success in shipping hot cream, will say it cannot be recommended to any great extent, as the cream invariably will show a scorched flavor that never leaves the butter after it is made. We are shipping cream hot from two or three points on account of not having sufficient water supply. Shipping hot should not be recommended when as cheap an arrangement as the Jensen cooler can be had, that will bring the cream down within two or three degrees of the temperature of the water used, and only using about three to four times as much water as cream run through.

"We think pasteurization is the only solution, as our experiment last year with held pasteurized butter turned out fine. The goods sold for fresh made butter on all the principal markets four to five months after being made. We pasteurize at our individual Skimming Stations and particular care is taken that nothing but first class milk is received.

"We think the demand we are having for our butter this year is something great, and the extra price we are getting for our product would pay for putting in pasteurizers on our whole system in two months.

"Yours truly,

"THE CONTINENTAL CREAMERY CO."

Topeka, Kan., June 3, 1901.

But the difficulty is to get cold water and enough of it in many localities, possibly if the modern low temperature of 140° could be maintained that would do away with the cooked flavor.

SOUR CREAM has been pasteurized by Mr. Bentley, of Circleville, Ohio.

Not having tried it, I cannot express any opinion, and regret very much that the experiment stations have not at once taken the matter up.

I lack information about the degree of acidity, but if it is sour enough to have wheyed off, leaving a very rich cream, I can understand it. In that case, I presume, the curd, hardened by the heat, will settle to the bottom and not be incorporated in the butter and cause white specks.

Mr. G. B. Lawson, of Grinnell, Iowa, writes me that he has been converted from his doubts by practical tests, and hence I presume that even if it will not do under any and all circumstances, there is enough in it for every gathered creameryman to investigate.

The fact remains that if there is any curd at all in the cream it will be hardened by the heating and, if not eliminated, cause more or less white specks and a very crumbly "body."

That gathered cream which often has a bad taint will be improved in flavor by pasteurizing is sure enough, but, if possible, I would rather see a system where the farmers learned to pasteurize it themselves or to deliver sweet cream.

I illustrate a cream pasteurizing outfit in Fig. 76½, used by the Continental Creamery Co. at their skim stations, and made by **A. Jensen,** Topeka, Kan. The heater is virtually on the Fjord plan, but the dashers are made (like those in ice

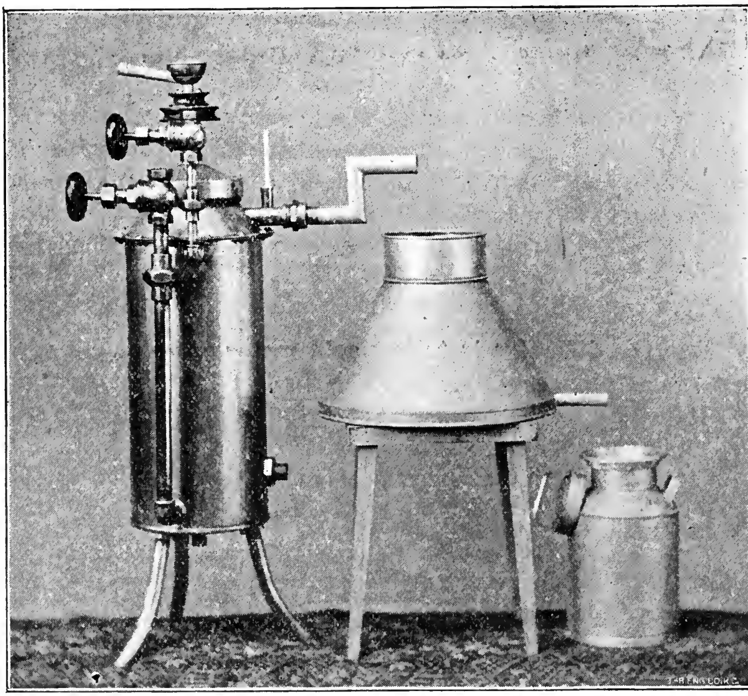
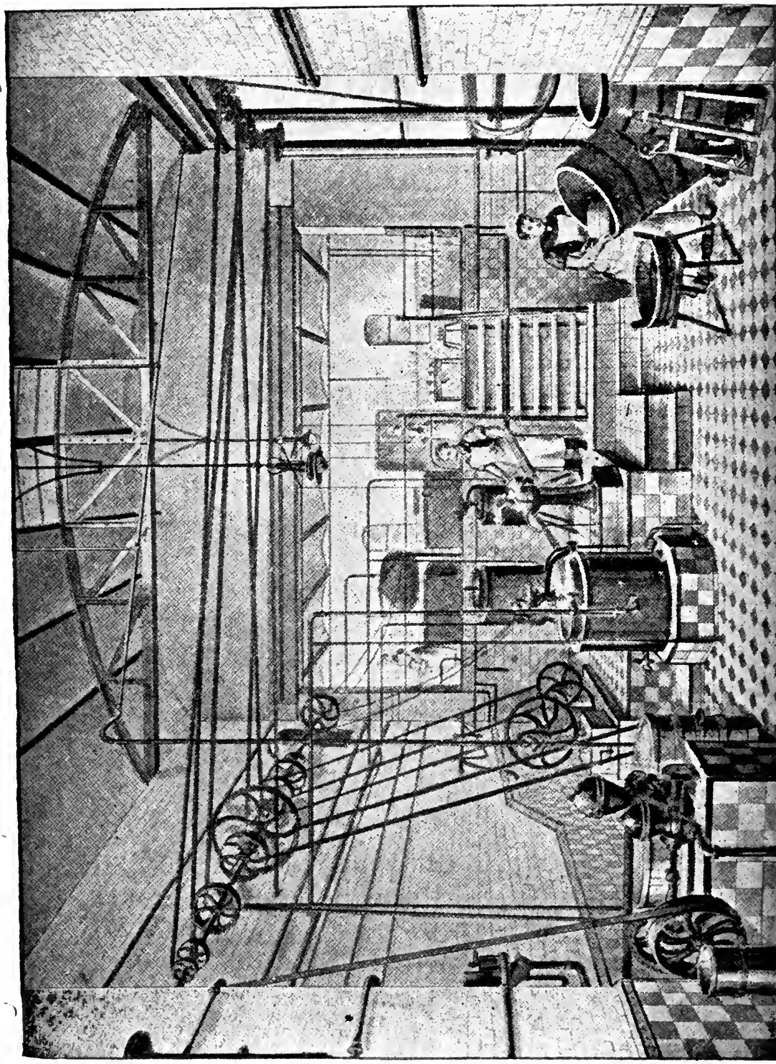


Fig. 76½

cream freezers) to hug closely to the wall which, Mr. Jensen claims, prevents all burning on. The cooler is of the McPherson type, but the water is let in from four sides and by the aid of nozzles set in a lively circulation. With five times the quantity of water it will cool to within four or five degrees of that of the water.



A Modern German Creamery from Martiny's Kirne and Girbe.

CHAPTER V.

THE CITY MILK SUPPLY.

The daily milk consumption in the United States of America does not aggregate less than 5,000,000 gallons. It takes about 2,000,000 cows to produce this, and an army of 200,000 men to care for them and milk them. So this is no insignificant industry and it deserves more attention than it has had up to date. We have in the States twelve dairy papers, and only two of them are exclusively devoted to city milk supply—The "Milk News," of Chicago, and the "Milk Reporter," Deckertown, N. Y.

Owing to the rapid development of railroad facilities radiating from all our great cities, the aspect of the city milk supply has changed greatly from the time when the source of supply of a necessity was very limited. It makes but little difference now whether the milk is produced within a few miles or within seventy, eighty, or even two hundred miles. With refrigerator cars the milk hauled 100 miles by rail is often better off than that hauled 10 to 12 miles by team.

KEEPING ACCOUNTS.

Hence producers of milk are now virtually compelled to base their prices on the price of butter or cheese and *no combination of producers will be strong enough to ensure a higher price than that with a reasonable addition for the necessary extra expenses.* If this is correct—and I challenge anybody to prove it otherwise—then the producers of milk for city consumption must (like those producing it for butter and cheese) carefully study the problem of cheaper milk production, economy in marketing and reduction of unavoidable losses.

Cheaper milk production depends first of all on the kind of cows kept, and while many farmers may make a pretty good "guess" at the relative value, it is astonishing how they will be surprised at the result of a systematic testing and account keeping. Many a cow that has made a good impression by a great flow of milk for a few months, will be found at the foot of the list at the end of the year! It is a surprisingly lack of business system not to know exactly what each cow is paying for her board, and it is much less work than people believe to rule a book like this,

Weekly recard of Cow No.... Born......... The...... calf dropped........ Served........ Due........

Date of test.	Milk in Pounds.				Babcock test.	Pounds Butter Fat.	Remarks.
	Morning.	Evening.	Total.	For week.			
... .	....	....	.... ..	....	....	....	....
....	... .	.... .	....	....	....	.. ....	....
....	......	....	....	....	....	....	....

and weigh each cow's milk once a week, testing it, if not once, then every other week. I say *testing* because it matters not whether the milk for city supply is now paid by the gallon, it is only a question of time when it will be paid according to butterfat.

Any spring scale hung up in the stable will do, though I prefer other scales, say something like the **Mahler** (Germany) scale illustrated in Fig. 77. It is made (as shown) to be bolted to the wall or for standing on the floor and has a desk for the record book. It seems to me that this should be more reliable than the spring scales, which will sooner or later be affected by rust.

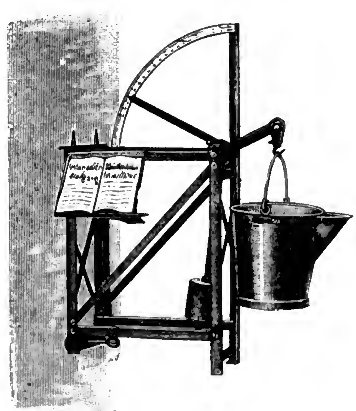


Fig. 77.

The keeping of such records will help to create an interest in the work of the milkers, an ambition to keep up the flow.

If co-operation is possible, the formation of TEST ASSOCIATIONS on the Danish plan is to be recommended.

Having the right kind of cows, the next question is the feed, but that is also too broad a question to take up here and Prof. Henry's book, Feeds and Feeding, should be read by every farmer. I shall confine myself to repeat a much needed reminder as to the economy of providing soiling crops in order to keep up the flow of milk if pastures give out, and to endorse the use of silage in moderation as the great "milk cheapener."

THE STABLE.

Cows will produce more and healthier milk if kept in *well ventilated* and *lighted stables*, and there is no need of expensive, fancy buildings. I quote from my A, B, C in Butter-making: "We may even make fairly good ones with a clay floor and the walls and roof of straw, if we only provide ventilation and light. The latter calls for the heaviest cash outlay, but sashes are now so cheap and the value of light of so great importance to the health of the cows that there is no excuse for not having plenty of it.

As to ventilation, I give in Fig. 78 a cross section of a stable 14 feet by 36 and 8 feet high. A wooden flue or two AA is placed along one wall and made high enough to give some draft at least four feet above the ridge of the roof.

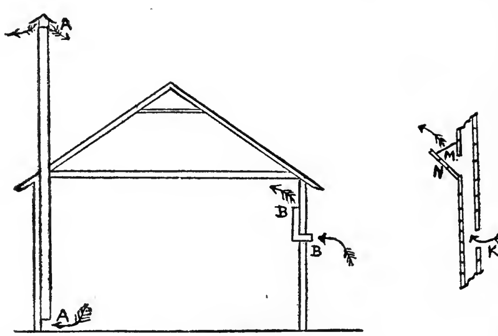


Fig. 78.

On the opposite wall are inserted two or three flues like B B, or, if the wall is a double boarded one, the air may be taken in by leaving a board out between two studs on the outside at K (on the piece of wall shown) and another one on the inside at N, but in that case a board M should be nailed in a slanting position with end pieces on either side so as to give the air a slant in direction of the ceiling.

As to the size of the flues, Prof. King, of Madison, Wis., considers that for 20 cows, they should have a cross-section 2 feet by 2 feet. The intake of fresh air need not be nearly so large, as there are always leaks at windows and doors and it is better to have several small intakes to prevent draught. This principle—air circulation without draught on the cows—can be applied to a straw stable as well as to the most expensive one.

Comfort is an important element in cheap milk production, and while fixed stanchion may make it easier to keep the cows clean, we need only observe them when lying in the pasture to know how cruel and unnatural their position must be in those "animal stocks."

Tying them, or—if it can be afforded—one of the modern stalls like the "Bidwell" or the "Drown" are the only right systems and a liberal supply of bedding will not only help to keep them clean and make them comfortable, but increase the manure heap, which the Danish farmers call their "gold mine."

To keep a cow tied up all winter is in no way a natural treatment, and though it is done by many good dairymen (thus universally in Holland and Denmark), the trend is now to do as Mr. H. B. Gurler recommends in his "*American Dairying*," give them lukewarm water outside, and if the weather is fairly mild let them remain there an hour or two at their option, but this advice should not be misunderstood as a defense for those farmers who turn their cows out to drink through a hole in the ice on the watering trough.

The more the cow is deprived of exercise, the greater the need of keeping the pores of the skin open by daily carding and brushing. Indeed, this is not only a question of health (cheap milk production), but also of cleanliness (pure milk). It is a wonder to me that the farmer who will give his time willingly to keep his horse clean, begrudges it to his cows. It is a question of health in both cases, but in the latter it is also a question of health to his own family and those who may drink the milk.

To illustrate this, Prof. Backhaus (Germany) tried with two cows, grooming them seven days, then leaving them fourteen days without grooming, and then grooming again for seven days. The result was in the fourteen days of each period:

	Grooming.	No Grooming.
Yield..	..575.4 lbs.	536.4 lbs.
Total fat...	.. 23.06 lbs.	21.33 lbs.

This makes an increase of ½ lb. butter per week in favor of grooming, which helps to pay for the extra work.

Whitewashing, at least twice a year, acts not only as a disinfectant but increases the light in the stable. It is a comparatively easy job if a spray pump is used.

MILKING AND MILKING MACHINES.

There is no doubt but that the greatest trouble of milk producers is to get good milkers—men or women. I say women, even at the risk of being called un-American, because I deem it no unwomanly work, *provided the stables and their surroundings are kept as clean as they ought to be*, and because women, as a rule, really make better milkers than men. They have more sympathy with the cows, as a rule; they understand, as Ex-Governor Hoard says, the "motherhood" of the cow better than men.

Milking is not a popular job because it is so confining; it has got to be done at regular hours, and no political or social engagement may interfere with it. This cannot be helped, but what can be helped by the milk producer is to pay their men (or women) decent wages and to refrain from running in milking as an extra chore instead of making it part and parcel of the day's work. A rough, noisy milker should not be allowed to stay a single day and cleanliness should be encouraged by providing a clean stable and clean surroundings, as well as water and towels for washing the hands.

The fact is that but few milk producers realize the importance of having the right kind of milkers, not only to secure pure, healthy milk, but to secure a large yield. Few men realize the necessity of the milker *making friends* with a cow—in fact to get her to "adopt" him—in order to make her give all the milk possible.

And this is the reason why I have been and am a little skeptical as to the possibilities of milking machines, so much so that I do not propose to illustrate and explain the various efforts in that line, but refer investigators to Dr. Stohmann's book where a full list will be found. Milking is not a pure mechanical work, and the cow compared with a machine is but a lame simile after all.

In my estimation, the best milking machine is a good, stout boy or girl, man or woman, who gets well paid and a little extra promised if the annual yield of the cows milked exceeds a certain amount. The question of milking is further treated in the chapter on sanitary milk, where nearly all the suggestions given may be adopted (somewhat modified) more or less by any and all milk producers to their own advantage and for the benefit of humanity.

CARE OF THE MILK.

The question of the care of milk for city supply is an all important one, but I regret that there is a general inclination to make a distinction between that and the care given to milk delivered at creameries and cheese factories. There ought to be none, at least as far as to the shipping station.

Having provided a clean stable as shortly outlined and having provided sound and fairly balanced food and pure water, the next question is the care of the milk. Even with all possible precaution against contamination, there is always need of some kind of purification. The means of doing this may be classed as straining, filtering and clarifying by centrifugal force.

STRAINING.

On few subjects has there been so much misunderstanding as on this way of purifying milk, and it is a noteworthy fact that Swiss cheesemakers prefer their patrons not to strain the milk because they may then *see* how careful the milkers have been in excluding straw, muck and dirt. There is a good deal of sound sense in this idea, because generally the straining of the milk is a delusion and a snare, and prevention is better than cure. Take a slovenly, careless milker, milking say ten cows. He gets up cross and imparts the same feeling to the cow, who promptly kicks and splashes some dirt in the first pail. This is kept back in the strainer and the milk of the next cow and the next is poured over it, nicely rinsing all the fine dirt and bacteria off the coarser and visible dirt and straws into the milk can.

Many are the devices, more or less effective, (generally less) invented to prevent this, but, as far as I have seen, they are all more or less difficult to keep clean. I prefer therefore a simple fine wire strainer to catch straws, etc., and beneath this a simple piece of light flannel fixed over the can with a deep sag in the middle by using four clothes pins on the edge of the can. If this is done, and if the milker will take the trouble to change or rinse it out *at once* when there shows any unusual amount of sediment, then all has been done that can be done under ordinary circumstances. Of the hundreds of various strainers, I illustrate only one, introduced by **Mr. John Boyd (Chicago)** in Fig. 9 which explains itself. This reduces the danger of washing the coarse dirt to a minimum as the milk will not be forced through it from above, and if the funnel tube were made with a tee and cap so as to be easier to clean, it would be a great improvement. The milk enters through the outside funnel and rises up through the inner one (over which is fixed a piece of flannel with a ring), and overflows into the can provided with a gate valve.

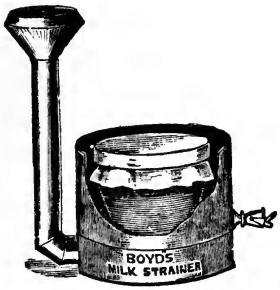


Fig. 79.

I also—chiefly as a curiosity—illustrate one of the latest German strainers, the **"Josef Fliegel,"** in Fig. 80. This

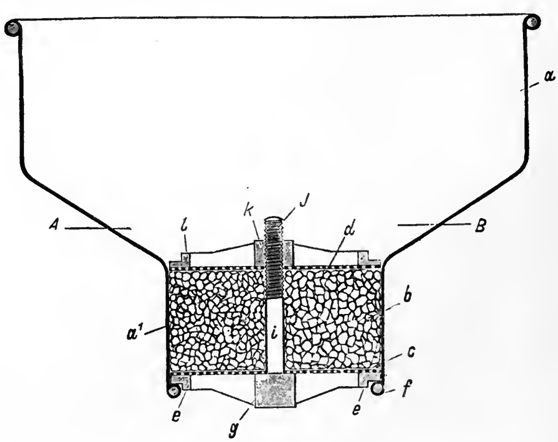


Fig. 80.

shows how far they go in their attempts in straining. It explains itself, being filled with gravel, which, of course, must be washed and sterilized every day.

Among other German strainers I mention the **"Dittmann's,"** which . consists of not less than 9 pieces, including four metal strainers and two "cushions" of a sort of felting. This has at least the merit of being possible to clean, as it can be taken to pieces. But as said before, prevention is better than cure, and no amount of straining will purify milk if pail after pail is poured on top of the dirt, and it may become a detriment if the strainer is not kept perfectly clean. A piece of flannel is easy to wash and when it felts too much for reasonably quick straining, a new one may be had at a small cost.

FILTERING MILK.

Among the systems of cleaning milk is the one used, I believe, first by the Copenhagen Milk Supply Co. They had an apparatus where the milk entered at the bottom and passed through a deep layer of sponges laid between perforated plates. The keeping of the sponges clean proved a terrible task and later layers of gravel were substituted.

A gravel filter designed by **Scheller and Schreiber**, of Germany, is shown in Fig. 81. The milk enters at e through a strainer, passes through the coarse gravel d, and then by the pipe f, through the perforated double bottom b in the lower compartment; through the fine gravel a to the outlet g. The apparatus is drained by the valve at h. Dr. H. Tiemann reports in Milch Zeitung some experiments with this filter, showing that 60 per cent of the original slime and dirt was removed, and that the number of germs in the unfiltered milk varied from 49 to 166 millions in one c. c., and in the filtered milk from 46 to 168 millions, showing but a small improvement from a bacteriological standpoint. The capacity of No. 00 is fully 600 lbs. per hour.

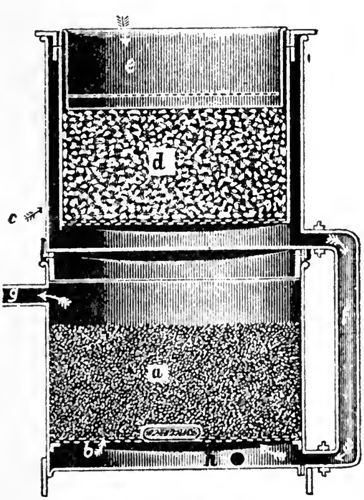


Fig. 81.

The gravel is washed in a perforated drum revolving in a trough.

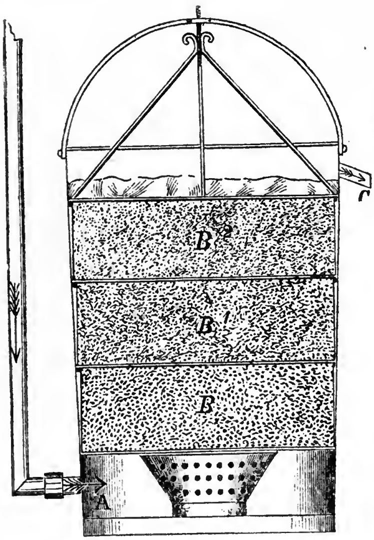


Fig. 82.

C. Bolle, the great milk man in Berlin (Germany) devised a gravel filter shown in Fig. 82. It consists of a large vessel where the milk enters at A, and passes through three layers, B, B1, B2, of gravel of increasing fineness. It is claimed to treat 2,400 to 3,000 lbs. per hour and to reduce the number of bacteria from one-third to one-half. The gravel is washed with boiling water, then with muriatic acid and then again with boiling water until all trace of acid is removed.

Dr. Backhaus uses cellulose in a mush-like shape as filtering material.

In Fig. 83 is shown the **International Filter** (Chicago) in position for operation. It consists of two perforated plates with layers of flannel or felting between, all enclosed in a cast iron casing, which can easily be opened. The milk has to have some pressure, and hence the milk vat is placed on the floor above from whence it enters the filter under the lower perforated plate, passes through the felting and from there into milk bottling tank. This filter seems to me the simplest possible and only the high price is an excuse for its not being used more extensively.

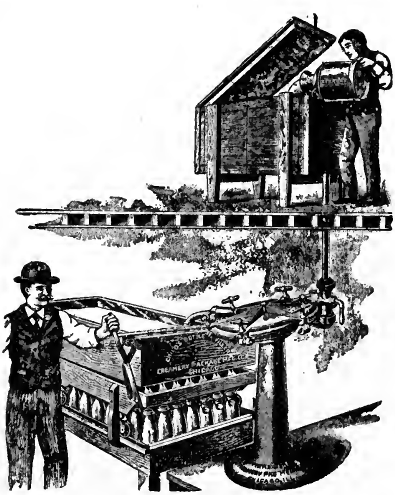


Fig. 83.

CLEANING MILK BY CENTRIFUGAL FORCE.

But what is the use of all these elaborate devices, with the daily cleaning of pipes, etc., when we have in the separator a device easy to clean and perfect in action, the only drawback being the power required.

When creaming milk by centrifugal force was introduced it was soon discovered that even the most carefully strained milk would leave a layer of sediment on the walls of the bowl. As this consisted of fine dirt and dung and scales which had passed the sieve and also fine bits of membrane from the milk, as well as bacteria adhering, the thought of purifying milk by centrifugal force lay near. F. Ludloff, of Berlin, (Germany) and others have made special

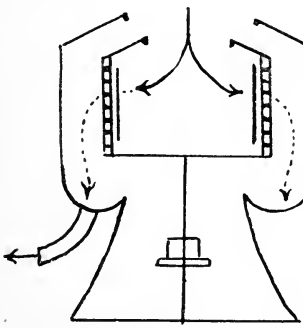


Fig. 84.

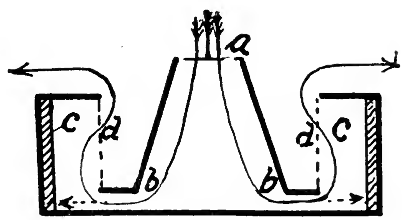


Fig. 85.

separators for this use, and **Profs. Dunbar** and **Kister** describe in Milch Zeitung, 1899, a separator constructed like those used in laundries with perforated bowls, Fig. 84. These bowls are lined with fine strainer cloth and the milk forced through by centrifugal force, as shown by the arrows, and this is in reality nothing but a filter, like the International filter, only the pressure employed is greater and in spite of this, the cloths will soon be clogged and have to be renewed.

Far better is the **Heines** milk cleaning separator, Fig. 85. The milk enters the bowl at a and the separation of the heavier dirt commences at b, and it gathers on the wall of the revolving drum, C C. The milk passes out of the separator through the filter cloth d, whereby any lighter foreign substance is retained. The drum is large and revolves only 1,000 revolutions per minute, and the capacity is about 2,500 lbs. per hour.

The milk used was better than the average, varying from 2.5 to 18.5 milligrams dirt per liter, while the milk delivered in Hamburg market for 1898 varied from 0 to 183.5, with an average of 13.5 milligram per liter. The result of eight tests showed on an average 9.5 milligram dirt in the new milk and 1 in the centrifugated milk.

Experience has shown that there is no need of employing specially constructed separators, as those used for skimming will do the work satisfactorily; thus Mr. H. B. Gurler uses a No. 3 Alpha De Laval in his sanitary dairy.

There has been some fear of difficulty in getting the milk and cream mixed again, but if the two streams are run together and passed *at once* over a cooler, there will be no trouble. A great advantage of this system is that it puts it in the milk man's power to deliver milk of a guaranteed percentage of fat by either removing part of the skim milk, or, in case of very rich milk, part of the cream.

It is true, this system requires power—steam or hand—but it is certainly the very best one for cleaning milk.

PRESERVING THE MILK FOR DELIVERY.

Having purified the milk by either of these mechanical means, the next step is to secure its preservation. As said before chemical preservatives should never be used—it is illegal as well as immoral, and the simplest and best system is cooling it at once as much as possible.

FARM COOLERS AND AERATORS.

A common system of cooling is to strain the milk into the shipping cans, which are placed in a water tank just outside the stable, and to rely on the wind mill to keep the water flowing. The milker is then supposed to give the milk a stirring up every time he pours in a pail, either with a dipper or one of the special hand stirrers or aerators of which I illustrate one in Fig. 86.

It is a bell-shaped cup at the end of a rod. In pushing it down through the milk it carries the air down and lets it

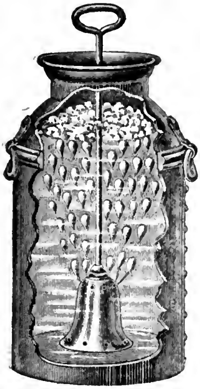


Fig. 86.

escape through fine holes in the top of the bell. But too often is this stirring or aeration neglected, and too often there is no wind mill or no wind, and pumping by hand is too much work. *For this reason I am decidedly in favor of using iced water.* Farmers ought to have a stock of ice any how, as it is a great economy in the household, and if a pond is within reasonable distance it can be laid down for $1.00 per ton. But even if it were to cost $3.00 per ton it would pay and an ice house can be built very cheaply. I have, in Sweden, preserved ice in a heap of saw dust, and it may be preserved in a bay of the barn by simply covering with straw, although the loss by melting will be greater than in a properly constructed ice house.

Of ice coolers for use without or with but little water, I illustrate the original McPherson in Fig. 87, where A is like a milk pail with a lot of fine holes at the bottom d and is placed on the ice pail B, which is filled with ice. The milk flows over B. being cooled and aerated and runs from the annular ring b into the pail. Similar coolers made are the "Champion," (Fig. 88), the "Model" and the two made by **Sturges, Cornish & Burn Co.** (of Chicago). The former (Fig. 89)

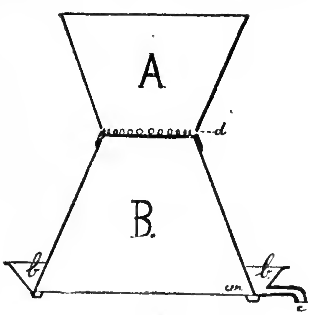


Fig. 87.

Fig. 88.

Fig. 89.

is on the plan of the Smith cooler, being made with corrugations. The latter has small concentric rings, which tend to delay the milk in its downward course. The upper tank is a good deal smaller in proportion than the original McPherson.

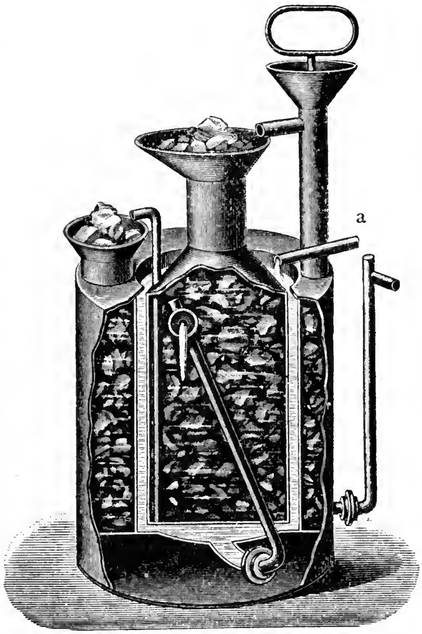


Fig. 90½.

In order to get the full benefit of the ice it is necessary to have some kind of device for stirring the ice or keeping the cooling water in motion. Mr. Brown, in his cream cooler, Fig. 90½, provides a hand pump. The cream runs in at a and out at the bent tube, which may be lowered to empty the can. In handling milk or cream, pasteurized or unpasteurized, for the market, too much stress can not be laid on a quick and thorough cooling, the nearer 34° the better. Where cold water is plentiful coolers on the Lawrence principle, such as the "Star," Fig. 91, or The Reid (see Fig. 68), and others are among the best of all coolers and aerators combined, and if water is scarce, the best system is to have a water tank filled with crushed ice and circulate that in the cooler.

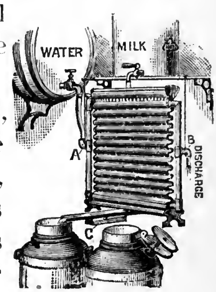


Fig. 91.

AERATION.

Meanwhile, if the combined coolers and aerators are not available, cooling by aeration only is better than nothing, although perhaps this may hardly be true when speaking about preparing milk for city shipment.

The simplest aeration is by lifting a dipper of milk

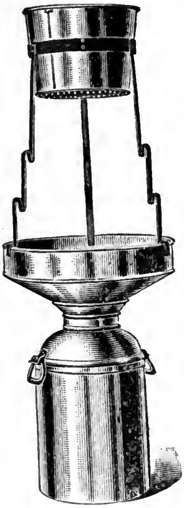


Fig. 92.

from the can and let it slowly fall back in a small stream. A Canadian, Mr. P. W. Strong, of Brockville, Ont., patented this simple and cheap device for aerating. Fig. 93 explains itself. Strain the milk through the bucket, which has a perforated bottom, and if more aeration is needed lower the bucket to the bottom of the shipping can, when a valve opens and lets in the milk, which is hoisted up again, and so on.

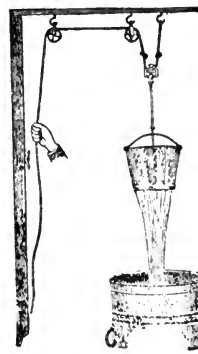


Fig. 93.

D. H. **Burrell**, of Little Falls, N. Y., makes the aerator, shown in Fig. 92, which explains itself. The bucket has a perforated bottom and the milk is strained into it, falling from there into the can.

Mr. **Boegild** (Denmark) constructed a hollow cylinder over which the milk flows in a very thin film and is cooled by the air which passes through the cylinder.

Hundreds of devices for aerating milk have been patented, but most of them depend upon perforated tin dividing the milk in fine streams as it is poured into the shipping cans, as Fig. 94, the so-called Vermont strainer and aerator, or like those previously described. Others depend on blowing the air into the milk like Mr. E. L. Hill, of West Upton, Mass.

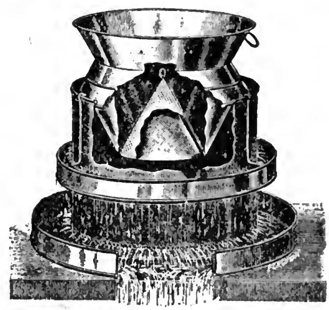


Fig. 94.

Fig. 95.

Fig. 95 shows the box with the blower, which is turned by a crank, and the hose connected with the nozzle, which is placed in the milk can.

Provided hose and nozzle are kept clean and absolutely pure air is available, this system does good work. Yet, I consider the combined aerators and coolers are much to prefer.

While Danish experiments have lately thrown some doubt on the benefit of aerating the milk on the farm near the stable, even if done in a special room, **the Danes have taken up the idea of aerating the hot cream in rather an enthusiastic manner, and several special devices have been** put on the market. Thus **Konstantin Hansen & Schroeder,** of Kolding, solves the problem as shown in Fig. 95½. In the usual Smith cooler is placed a tank "a" in the upper part of which a perforated plate "b" is fixed. The cooling water is led through the pipe "c," and forms a fine shower, leaving at "d." The air is forced through this by the pipe "e" and "f" to the aerating tank "g" from which it can only escape through the cream shower coming from the upper tank "h" and out by "k," while the cream leaves at "l" for the cooler. It seems to me a very neat way of aerating cream and a desirable one if the cream is tainted with turnip or weedy flavor, but I should lay great stress on securing pure air. The air is forced through by a small centrifugal blower running at 1,500 revolutions per minute, and is purified by

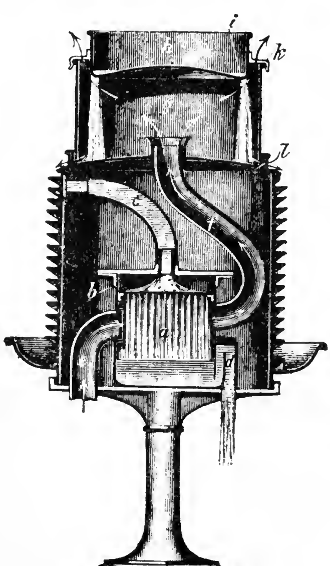


Fig. 95½.

passing through the water shower. It is even suggested to use oxygen for aeration if it can be obtained at a low enough price. The apparatus sells, as shown, for $40 in Denmark.

THE MILK PAILS AND SHIPPING CANS.

Interesting as it might be to discuss and illustrate the various pails and cans used all over, I shall here confine myself to draw attention to the importance of buying the best and those with the fewest seams carefully and smoothly soldered. There is no more dangerous lurking place for dirt and bacteria than an unevenly soldered seam. A few years ago the "Reform" can was introduced in Denmark, shown in Fig. 96.

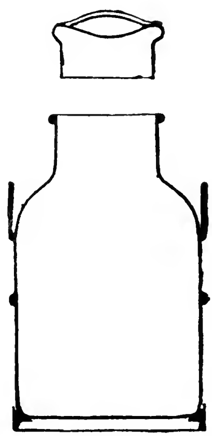


Fig. 96.

These cans are made of two pieces, pressed out of the very best English steel plate, joined in the middle of the side and heavily tinned. The cover is of one piece and the handles only are riveted. Dairy Counsellor Boeggild strongly recommended this can in *"Maelkeritidende."* The price for the 8-gallon size is $3.00 in Denmark, but if it is durable it would be cheap at $5.00.

It seems, however, after some years' experience that the tinning of these cans has not been satisfactory, and yet I hope that as, for instance, Messrs. Sturges, Cornish and Burn, who are stamping out seamless cheese hoops may take up this idea. It will be seen that the only seam is easily got at and visible, and if the tinning can be made to endure, they should fill the bill. Meanwhile it will pay milk producers to pay a little extra to get pails and cans soldered perfectly smooth and *with no sharp corners.* Cans when rusty may give the milk a very disagreeable taste when left over night by a combination of iron, as has been proved in Denmark. Finally it must be remembered that all the previous precautions and cleanliness may be love's labor lost if pails and cans are not cleaned properly and *sterilized* by steaming or rinsing with *boiling* water.

In this connection let me say that if milk shippers knew their own interest and city dealers theirs, no cans would be left standing and returned with a milk rest in them, but they would be rinsed at once with cold water, even if they are not thoroughly cleaned and steamed. It is an outrage to common sense not to do this, as any one, who ever smelled some of the returned cans left to bake in the sun for hours, if not for days, can testify. All utensils used for milk should first be rinsed with cold or lukewarm water, then scrubbed with soda water or some of the more expensive soap powders, never with soap, rinsed again and scalded. Rinsings with soap powders in should not be given to hogs as, according to Bulletin 141, Cornell Experiment Station, it may kill them.

There is one style of milk pail against which I must warn the dairymen, especially if they leave sour or partly sour milk in them. I refer to the plan—in order to prevent rust—of soldering a zinc plate on the bottom. German experience has shown that poisonous salts may form and it also makes it harder to keep them clean.

PASTEURIZING ON THE FARM.

The beauty of the pasteurizing process is that anybody may use it on a small scale without investing any money in special apparatus more than a small thermometer.

In Fig. 97 is shown a tin boiler in which a quart and a pint bottle is placed on a perforated loose bottom. This boiler is placed on the stove and the temperature raised to boiling point; when it is left alone for about 30 minutes, as a rule the temperature will not have fallen below 150°, and the bottles are then taken out and cooled.

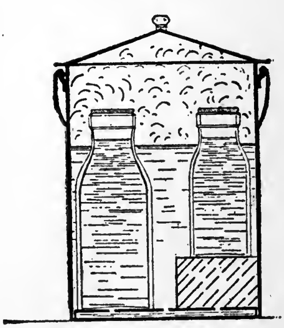


Fig. 97.

Having tried if the customers like it, and having seen the advantages, which, as before said, are all the greater the nearer the pasteurizing is brought to the milking time, there is no need of any expensive apparatus as long as the amount handled does not exceed 50 or 60, aye, even 100 quarts.

Get as many shot-gun cans, 8 inches in diameter and 22

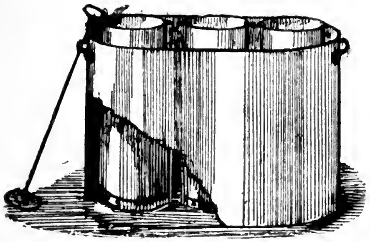


Fig. 98.

inches high, holding 40 ℔s. each, as may be needed. Place them in an oblong boiler (Fig. 98), made to order if necessary. Get a suitable tank for cooling, and a stirrer (see Fig. 98.) That is all there is required.

I acknowledge, however, that if money and steam is at command, it is less work to use some special apparatus than to keep four or five cans stirred by hand, yet part of this gain is counterbalanced by the increased labor in keeping the apparatus clean.

Stir the milk continuously until it is 140° or whatever higher temperature that may be decided on, and see to it that when it has reached that temperature the water in the boiler is only a degree or two higher.

If it should be higher, reduce it by adding cold water. Place the boiler where the temperature will remain stationary for 20 to 30 minutes and cover the milk can.

Meanwhile, have a tub filled with cold water, preferably with ice water, and place the milk can in it. Moving the can round with one hand (so as to stir the water), the milk is stirred with the other hand until at least 50° cold.

Where there is a tank with flowing cold water, it is enough to stir the milk, but where neither this nor ice are at hand, the quantity of water must be regulated according to its temperature.

If, as for instance, there are 20 ℔s. of milk at 155° that we desire to cool to 60° (50 would be better), we have to cool 20 ℔s. 95° or 1900 units.

Supposing then we have water at our command at 48°; then we must theoretically have $158\frac{1}{3}$ lbs. of this water to reduce the milk to 60°, but practically this is not enough and it would be too slow work, hence I consider that 300 ℔s. of such water would be nearer the mark.

The best way of cooling is to run it over one of the small surface coolers in a *clean* room.

This question of cooling is the great stumbling block which for years will prevent farmers from pasteurizing the milk. Indeed, I feel inclined to make the broad assertion that unless there is flowing water of not more than 48° or else a good supply of ice, pasteurizing should not be attempted.

But, as I have urged again and again, there is no reason why every farmer should not lay in a stock of ice, the theoretical amount required to cool 20 ℔s. 95° would be about 14 ℔s., but practically it will take about pound for pound unless the first cooling is done with water. In that case ½ ℔ of ice to 1 ℔. of milk may be figured on.

Pasteurizing costs money for fuel to heat and ice to cool, and the latter is the most expensive, but even if we take the highest amount of ice, the cooling will after all only cost 10 cents for 100 ℔s. if the ice is $2.00 per ton.

It is an easy matter for anyone who has a thermometer to make the above experiment on a small scale and convince himself of the effect.

When pasteurizing in cans for filling in bottles later, it is absolutely necessary to have the bottles sterilized. This is done by placing them (after cleaning, shortly before using) in a boiler with water and bringing it to a boiling point, then let the water cool to about 160°, take out the bottles and cool them, bottom up.

Meanwhile several pasteurizing apparatus have been constructed for use on the farm, or where no steam is available, and in Fig. 99 I illustrate the hand pasteurizing heater "LE FRANCAIS" made by Gaulin & Co. (Paris, France). It consists of a lower part, a low pressure boiler provided with safety valve, etc. Above this is the pasteurizing heater proper, the frame work of the stirring apparatus may be removed so as to make it easy to clean. The boiler is filled through the funnel, and the construction is otherwise of the Fjord pattern. It is made to work 250 ℔s., 500 ℔s. and 1,000 ℔s. per hour. The smallest is about 4½ feet high, and sells for about $110.

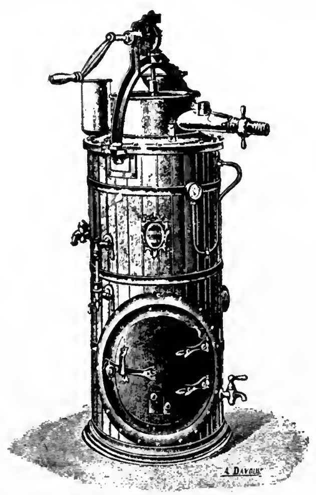


Fig. 99.

Kleemann & Co. (Berlin, Germany) constructed a hand pasteurizing heater shown in Fig. 100. To the left is an iron low pressure boiler (B) connected with the jacket of the heater by a pipe below and above, by which a constant circulation of the heating water is obtained, heating the milk in the tinned copper vessel A. A hand stirrer is provided to agitate the milk. The smallest size holds 100 lbs. of milk, will heat to 190° and costs about $90. It seems to me that this idea could be modified so as to have shut off cocks on the pipes connected with the heater and water connections for cooling.

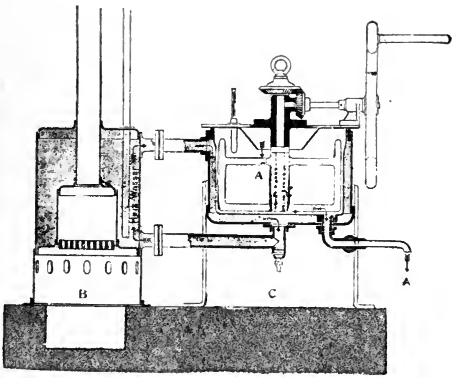


Fig. 100.

Creamery Package Mfg. Co. (Chicago), has a farm pasteurizer similar to the "Pasteur" for places where no boiler is available. Fig. 101 gives a general idea of it. It consists of a cylinder, in the lower part of which is a fire place for heating the water, in the upper part, where an inner cylinder provided with a hand-stirring device, holds the milk. When heated, the fire is drawn and ice water is circulated between the two cylinders from an overhead tank. It is made in sizes of 10 gal., 20 gal. and 40 gals. This firm also sells a vertical tank pasteurizer devised by Nelson, and a continuous one, the Ideal, which seems to be like the original Fjord.

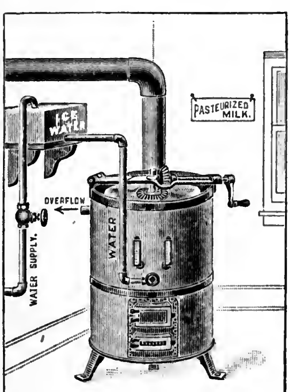


Fig. 101.

It will thus be seen that there is no excuse for the individual milk producers and dealers to neglect taking up this question right away, but I shall now outline my ideas of the proper system of the city milk supply.

CO-OPERATIVE MILK SHIPPING CREAMERIES.

I head this "CO-OPERATIVE" because it is my firm belief that ultimately the farmers will have to learn true cooperation if they are to hold up their end in these days of "expansive" trusts. But the system which I shall outline shortly may be established—indeed it is established partly in some states—by the large city milk dealers. I refer to milk shipping creameries. It is absurd waste to ship a surplus of milk to the cities, and make it into butter unless indeed there is a market for *fresh* buttermilk at fancy prices. When this was tried in Chicago the freight amounted to about 6 cents per pound of butter. With a complete system of shipping stations and especially if the milk is pasteurized or frozen, or both, there is no need of having any surplus.

No milk should be accepted for pasteurizing or shipping which shows more than the Farrington limit of 0.2 per cent acidity or 11cc by the Mann's acid test, but I feel inclined even to reduce this to 9 cc by the Mann's.

I hope to see co-operation introduced among the farmers in each district and the building of permanent buildings, if not so elegant, at least as sanitary, as the German creamery illustrated on page 77. I want to see the city milk paid by the Babcock as well as that sold for butter and cheesemaking purposes. I want to see these milk shipping creameries fitted out with separators for cream raising and milk cleaning purposes, with continuous pasteurizing outfits on the line suggested by me in the first edition of this pamphlet and illustrated in **Mr. A. H. Reid's** (Philadelphia) pasteurizing outfit, Fig. 102. The milk is elevated by the pasteurizing heater to a milk tank with partitions which compel the milk to go zig zag to the cooler. Or, if preferred, a system of three storage tanks could be used for the hot milk, each tank holding one-third of the hourly capacity of the heater and cooler. Of course, those who prefer tank pasteurizers may use the Potts or similar ones, but I strongly recommend the sudden chilling by using surface heaters, even if covered. I want to see a good Re-

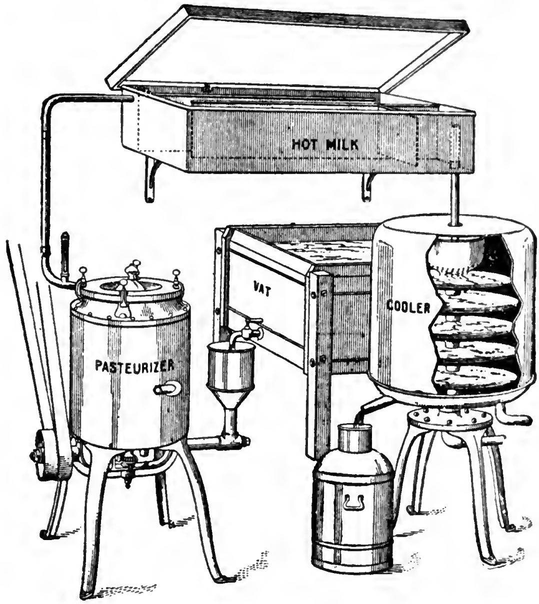


Fig. 102.

frigerator Machine and a good stock of ice put in. I want to see a complete bottling outfit and arrange-

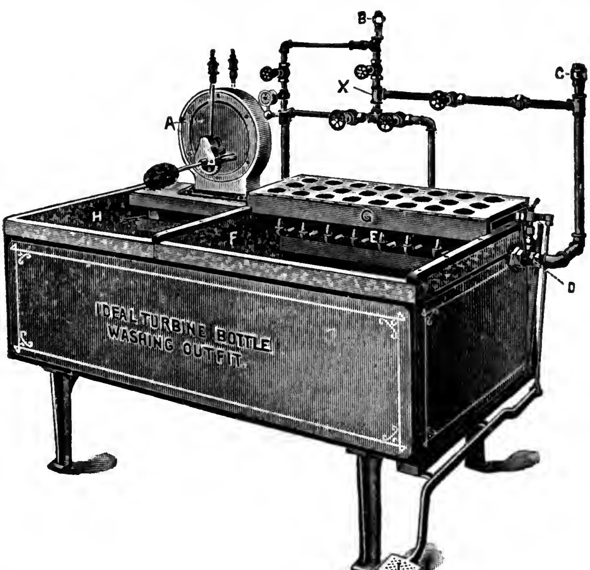


Fig. 103.

ments with the railroads to fit cars with racks for the bottle boxes so that the freight may be kept down to about the same price as for milk in cans. If such creamery shipping stations were made the gateways for all milk sent to the cities, the farmers could get their milk paid by the test and they would not need to get up in the middle of the night because with pasteurization or with freezing, or with both combined, it would matter but little whether the milk was shipped early or late, and the milk dealers would have no surplus waste. In this bottling outfit there should be the very latest and best bottle washers. I illustrate the "Ideal Turbine" in Fig. 103. It is sold by **Creamery Package Mfg. Co.** (Chicago). It consists of a tank with two compartments. Behind the one to the left H is a turbine bottle brush A, and in the back of the other F is a bottle rack in which the bottles are inverted over the 24 spray pipes E through which cold or hot water or steam may be applied by an automatic foot lever I. Cold water comes through C. Steam through B and at X there is a steam jet. Smaller tanks with a bottle washing brush rotated either by steam, belt or foot power are also in the market. The latter is illustrated in Fig. 104. The operator stands on the opposite side of the tank and revolves the crank with his foot. Tank holding about seventy quart bottles and cleaner complete cost only $10.00.

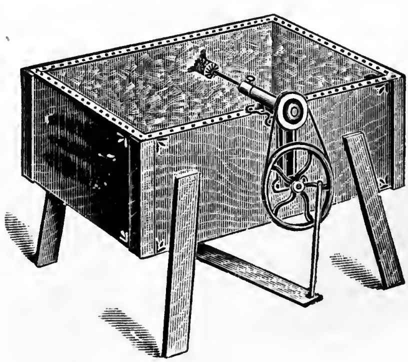


Fig. 104.

STERILIZING OVENS.

While it may be possible to keep bottles clean with water, there is hardly any reason why every farmer with ten or more cows should not have a so-called feed cooker so as to produce steam, even at a low pressure, and thus have the means of properly cleaning his cans and dairy utensils. They are sold cheap enough, varying from $35 to $75, and are as a rule, built in America, like a vertical boiler.

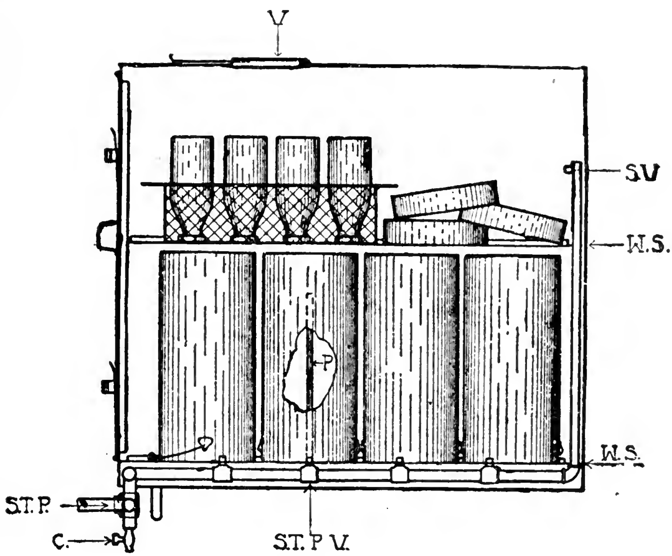


Fig. 105.

I said a very low pressure would do, yet if *perfect* sterilization is to be obtained, there should be a pressure of not less than twenty lbs. and great boiler like ovens have been built for sterilizing bottles, but as far as I can learn there is an objection to the high heat which seems to act on the glass and keeps it "cloudy" so that bottles are not bright. Furthermore low pressure steam should be all sufficient.

Prof. Russell suggested a galvanized iron box (Fig. 105) taken from Wisconsin bulletin. There is a square box made of galvanized iron with a door and a vent for the escape of steam V. The steam enters at St. P through a pipe provided with a dropcock C, and with four openings ST. PV with pipes P inserted, and one SV opening into the upper part of the box. There are two shelves WS of wire netting, and the lower space is used for cans placed directly over the steam pipes P, while the upper shelf is used for bottles, covers, etc. This and similar boxes are made in any size or styles to suit, by manufacturers of dairy supplies and machinery. Mr. H. B. Gurler built a steam-tight, cement-plastered room, into which he rolls the large bottle racks.

Whatever system is used, boiling in water, steaming in the open or in closets, it is all important to submit the bottles, cans, etc., to a temperature of about 212° or more for ten to twenty minutes if the whole pasteurizing process shall not be a delusion and a snare. *Indeed I believe* if we had to give up either it would be better to give up pasteurizing than sterilizing the cans or bottles.

THE BOTTLES.

Fig. 106.

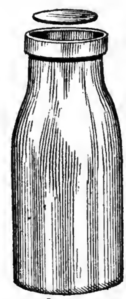


Fig. 108.

There are many milk bottles in the market, with all kinds of patent tin covers and closing devices. In Fig. 106 I illustrate some bottles used in France.

Lately, however, the "Common Sense" milk bottle, Fig. 108, or its imitation, the "Ideal," is absolutely gaining the ground, and wherever they can be transported "right side" up, they are, undoubtedly, the simplest and easiest to keep clean. The paper cap is renewed each time, and there is no wire or tin to be in the way of cleaning. The cap is made of paraffined paper, and as a rule fits so well as to allow the bottle to be held upside down without spilling a drop. It is indeed claimed that they may be submerged in water with safety, and there is no trouble at all if they are handled in cases like Fig. 109.

For shipping and delivering are used wooden boxes with partitions for twelve bottles and if desired they are made like Fig. 109, with a removable galvanized iron lining. The milk can be iced down and the case closed, thus serving as a perfect refrigerator at all times with no fear of water dripping from the case when the ice melts. And for delivering from wagon, a wire basket, like Fig. 110, is often used.

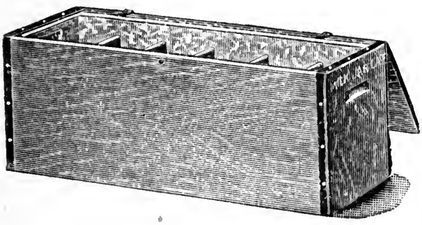


Fig. 109.

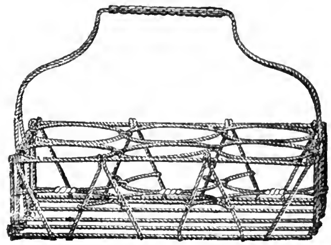


Fig. 110.

BOTTLING AND SEALING.

Various bottling devices have been put on the market, more or less complicated and difficult to keep clean. If only a limited number of bottles are to be filled a jug with a glass funnel, the stem of which reaches nearly to the bottom of the bottle, placed so that it does not prevent the escape of air, is the simplest. But small fillers can also be had from the dealers. **The Childs** filler is the one most used and known and I shall here only illustrate the UP-TO-DATE bottle filler, the latest device sold by Creamery Package Mfg. Co., in Fig. 111. The bottles are pushed into position four at a time by a bar and by pressing a foot lever they are raised up against the valves, which open automatically, while a rubber cushion prevents any overflow. The milk is sprayed against the walls of the bottle, while the air escapes through the air tube in the center of the valve.

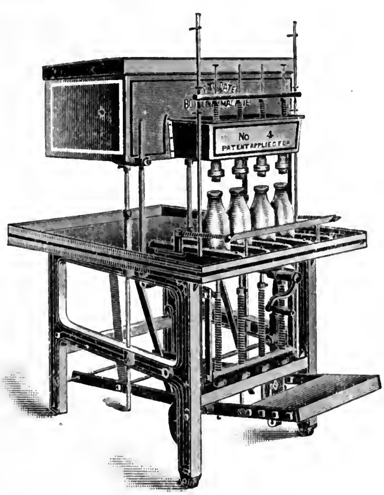


Fig. 111.

These are also made with a rotary stand and a capping device. I have not had reports of its work, but it seems promising to me and well worth investigation.

One of the greatest problems which meet dealers in placing sanitary (certified) milk on the market is the danger of dishonest agents and customers' servants tampering with the milk. The Common Sense bottle having no wire fastenings which might be sealed, Mr. H. B. Gurler planned a special cap to cover the paper one, Fig. 112, stamped out of tin and sealed with a lead seal, in which the date of filling may be embossed if so desired.

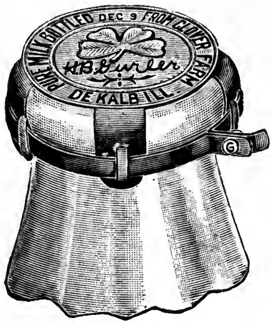


Fig. 112.

THE CITY MILK DELIVERY.

This is one of the most unsatisfactory phases of supplying large cities. What terrible economic loss is there sustained by having ten or twelve delivery wagons pass over the same route? Here is a case where a large combination would be justified, but I should prefer to see the milk producers have the main say in such a combination. This enormous expense in delivering is not the only drawback. It is true we have in nearly all our cities several large companies who have excellent facilities for handling milk in a sanitary manner, but alas, we have also many small, dirty and unsanitary milk depots where there is not even the most primitive attempt at sanitation; where there is hardly decent facilities for washing the cans and bottles, and when such dealers peddle milk in bottles that system is a great farce. Small milk dealers or grocers and bakers who handle only one or two cans of milk should never place them in a refrigerator with other things; far better is it to have a special water tank lined with galvanized iron, as shown in Fig. 113, for two cans where the ice is placed between the two cans which stand on a wooden rack. Right here is the advantage of shipping the milk in bottles generally, such small dealers could handle the

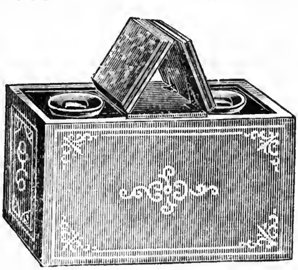


Fig. 113.

bottles in an ice box or refrigerator or even in the iced shipping boxes, and would be compelled to do an honest business without taking extra profit in the shape of one or two quarts of cream from each 32 quart can.

The delivery from cans still obtains to a great extent, and if the customers would only keep their receiving can or jug clean, there is, of course, a saving in cost. Yet, many are the difficulties. In Germany insulated wagons with large cans are used and faucets protrude from the side of the wagons with signs reading: Milk, — per quart; half skim, — per quart; skim, — per quart; buttermilk, — per quart. The wagons are locked and thus the honesty of the driver was deemed secure. But alas for human inventiveness! A smart driver had the happy thought to drive round to a quiet alley and apply a force pump connected with the faucet by a rubber hose, forcing the desired amount of water into the milk to his own profit and his employers dishonor! Later a patent faucet put a stop to this.

In England (and Germany, too) a tricycle, Fig. 114, is often used for small routes. A heavy can with faucet is swung on the bearings and a basket in front carries the bottled milk or cream.

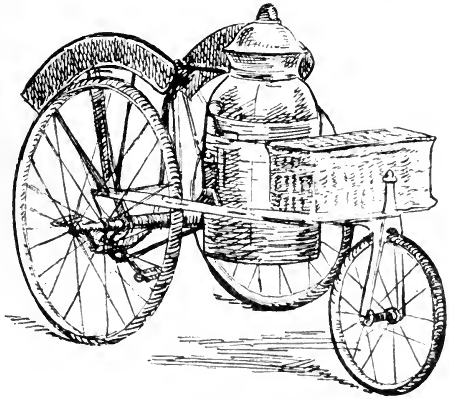


Fig. 114.

Neat wagons are of importance in delivering milk as well as a neat dress on the driver. In fact, I see no reason why he should not have a plain uniform. It costs no more than ordinary clothing, and is certainly attractive. Personal fancy plays, of course, the main part in selecting the style of wagon,

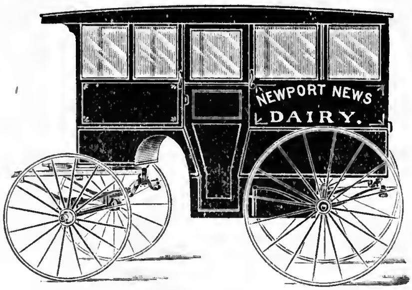


Fig. 115.

and dozens are offered in the market. It seems, however, as if the so-called "low down" wagon, of which I illustrate one in Fig. 115 is gaining favor.

The tendency of the cream to rise in the milk cans where the delivery is made from a faucet in large cans cannot be denied. But whether it is a question worth raising unless smooth asphalt streets and very soft springs under the wagons are in evidence *may be doubted.*

In Germany where the delivery is nearly exclusively from faucets, various devices have been used for preventing the cream from rising. Thus **Thiel & Sohne** (Germany) made a wooden floater and suspended several chains under this which swing back and forth and thus keep the milk stirred. Others attach a perforated tin tube to the faucet (Fig. 116) and others again place a perforated cone which is supposed to let to the faucet milk from all the different layers in the right proportion.

Fig. 116.

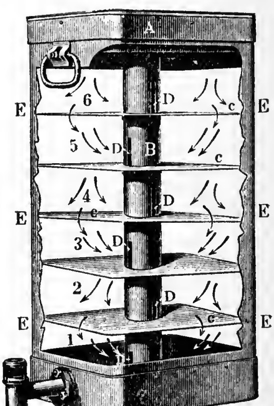


Fig. 117.

Koch & Co. (Germany) made a moveable apparatus for the cans shown in Fig. 117. It consists of a tube B with six horizontal plates reaching close to the wall of the can. In the tube are spirally arranged slits. The plates prevent cream from raising and when the faucet is opened a current is started, as shown by the arrows.

When in New Orleans (in 1898), I found large cans with faucets used extensively and the milk inspector assured me that he had repeatedly tested the matter and found that there no raising of the cream took place during the delivery, and that the last milk tested no richer than the first. In view of the conditions of most of the streets at the time of my visit, I did not feel inclined to doubt the assertion.

No doubt there has been too great a fear of this injustice to the first milk customers and even in Germany has Jos. Siedel demonstrated that with soft springs under the wagon the difference in the test of the first and last delivery was on a smooth street, 0.4 to 0.5 per cent, and with stiff springs on a similar road there was actually no difference. It is only when the cans are left standing for any length of time that there will be real danger of any injustice.

As an example of the better, but unpretentious, city milk delivery under the present system, I shortly describe that of Sidney Wanzer & Sons, Chicago. The front part is anything but imposing and the retail shop might be made more attractive, but the Wanzers have built up their business during the past forty years and preferred to put the money in the essential part, the milk rooms, etc. The new building is solid, with cement floors of the best description. When the milk comes in about 100 out of the 150 cans are selected and lifted on a platform and poured in a small receiving tank and some labor could be saved here by one of the English can elevators shown in Fig. 75. From this tank the milk runs through a Miller pasteurizing battery, consisting of one heater, one cooler for city water and one cooler for brine circulation. It is thus heated to about 158° and cooled to 50°, passing from there through an International filter, (see Fig. 83) to the bottling tank. A Childs bottle filler is used. The bottles are then placed in the boxes and stored in the refrigerator ready for delivery. A refrigerator machine furnishes the brine at from 16 to 28°, and a liberal supply of ice is at hand. There is no taking of a quart or two of cream, as most of it is bottled and sold as it is.

"SANITARY DAIRIES"—"CERTIFIED MILK."

While pasteurizing undoubtedly is of much benefit to the great masses of consumers as well as to the producers and dealers, we cannot refuse the verdict of the great majority of physicians that strictly sanitary milk is better, but how many consumers can afford to pay from ten to twelve cents per quart? And it is no especial money making proposition

View of H. B. GURLER'S Stable, DeKalb, Ill.

to produce and deliver it in the proper manner at that price.

So-called sanitary dairies must fulfill the following conditions to be entitled to the name and to the endorsement of physicians.

1. The cows must be tuberculin tested and inspected regularly by a veterinarian surgeon to be sure of their perfect health.

2. The stables must have plenty of light and good ventilation and have cement floors, walls and ceiling must be smooth and should be white washed once a month or there about. The drainage must be perfect and so must the surroundings. System of tying should be comfortable for the cows.

3. Cleaning of the stable should be done often and thoroughly, and the cows should be kept groomed like race horses. Both of these operations should not be undertaken within thirty or sixty minutes of milking so that time will be given for the dust raised to settle,

4. Milking should be done as aptly described in Mr. H. B. Gurler's circular: "One-half hour before milking the

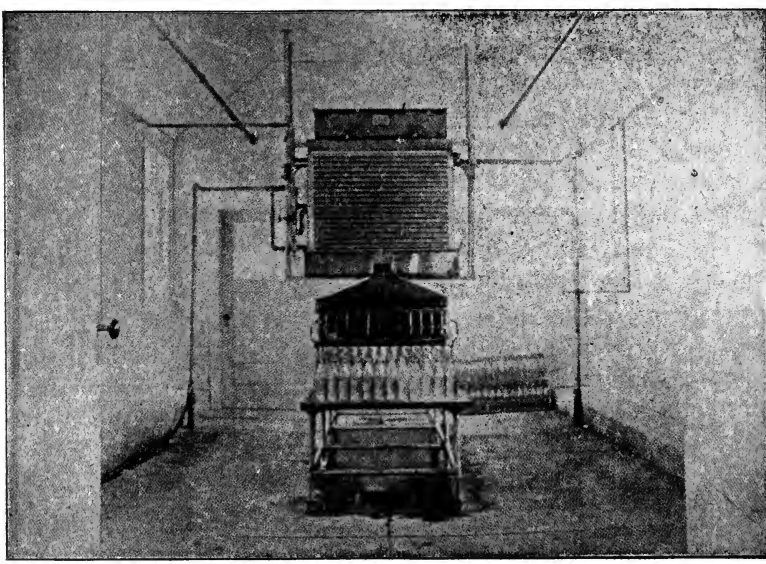
cows are groomed. The milkers are required to clean their hands and put on white milking suits. I have one man to clean the udders of the cows just in advance of milking, using a sponge and warm water for this purpose. I formerly required each milker to clean the udders of the cows that he was to milk before he commenced to milk, but learned the manipulation of the udder stimulated the secretion of milk and, if the milking did not immediately follow, that the results were unsatisfactory. We must work with nature to secure the best results. I secure better results from the cows when the milking follows closely after the cleansing of the udders. Each milk pail is furnished with a closely fitting strainer cover, into which is fastened a layer of absorbent cotton, so that all the milk passes through this cotton before entering the milk pail. The milk is poured out through a covered spout so the strainer is not removed from the pail until through milking, when it is destroyed and a new one is prepared for each milking. The milk pails, strainers, cans and all utensils used about, also the bottles in which the milk is shipped to the consumer, are thoroughly cleansed and then sterilized by live steam in a sealed room, the temperature of which is held at 212° Fah., for thirty minutes. The first milk from each teat is rejected as experience has shown that germs which sour the milk invade these passages and cannot be gotten rid of by the washing process."

5. The feed should be *sound*, varied and fairly balanced. The water should be absolutely pure and not ice cold.

6. The milk should also be treated on a similar plan as obtaining on Mr. Gurler's farm, where both ice and refrigerator machine is available, the latter not being indispensable if only a large enough tank of ice water is prepared in time.

"As soon as the milk is obtained it is run through a centrifugal machine, such as has been in use for some years in creameries, as a means of rapidly and economically separating the cream from the milk. I employ it for the purpose of holding the milk at a constant per cent of fat and at the same time separating from the milk any dirt or other solid matter which may have gotten into the milk in spite of the precautions previously used. Although in this operation the cream and milk are separated from each other, they are again mixed when they come from the separator and there is left behind in the machine a peculiar mass of mucus, germs, etc., which it is very desirable to have out of the milk. Immediately after leaving the separator it is cooled to a low temperature. This low temperature secured very quickly after milking is found to be very desirable as it improves the flavor and keeping quality of the milk. The milk is then bottled, each bottle stoppered with a wood pulp stopper, and a metal cap and seal put over the top in such a manner that the contained milk cannot be reached unless the seal is destroyed. On each seal is stamped the date of the bottling and my signature. This seal is a guarantee of genuineness to the consumer. Although this process seems complex, it is in reality carried out quite readily by the trained workmen in my employ."

The above mentioned seal is illustrated in Fig. 112. The bottles are shipped and delivered to customers in boxes filled with crushed ice.



"An eastern bottling room," from Major H. Alvord's bulletin No. 29, U. S. Agricultural Department.

A MILKING PARLOR.

The following proposal made by **Mr. J. D. Frederiksen,** of Little Falls, N. Y., manager of Chr. Hansen's Laboratory, is not so very Utopian and deserves a serious consideration by students of the problem, how to secure a sanitary milk supply:

"In handling and preserving milk, measures calculated to prevent contamination are infinitely better than remedies for defects allowed to develop in the milk at an early stage. Whether cooling or pasteurization or both are applied for its preservation, these means should be used while the milk is as fresh and pure as possible.

A friend of mine in Denmark who has devoted a large part of his life to the supply of the city of Copenhagen with pure milk and who is a confirmed opponent to pasteurization, recently told me that in his opinion intense cooling is the only proper means of preserving milk. "Cooling," he said, "checks any growth of deleterious bacteria, and I would have it applied before the germs have any chance of developing. I would milk into a pail in which the milk strikes a surface cooled by ice direct as it flows from the cow."

At a meeting of milkmen, farmers and physicians in New York last winter where the question was discussed what could be done to improve the sanitary condition of the milk supply, some of the health authorities demanded largely increased cleanliness in the barn, etc. A farmer, in despair at the exactions required, exclaimed: "Gentlemen, I would milk my cows in my parlor if I could get paid for it."

Now, these suggestions are neither ridiculous nor Utopian, but are measures which will be required and carried through, sooner or later, and the sooner the better.

In Farmers' Bulletin No. 63, 1897, issued by the United States Department of Agriculture, Dr. R. A. Pearson, Assistant Chief of the Dairy Division, in his admirable treatise on "Care of Milk on the Farm," shows how the milk is contaminated in the barn, how the bacteria adhering to dust, hair and other impurities enter the milk and develop with fearful rapidity and how in many cases this is the chief source of contamination. The very measures taken by the careful dairyman to keep the cows and the stable clean are apt to defeat their purpose. Just before milking, the droppings are raked down from under the cows, the bedding is shaken up, and the cows are groomed, all of which tends to fill the air with germ-carrying dust which settles in the milk during the milking, and the mischief is done which the greatest care in cooling and pasteurizing afterward can only partly undo or remedy. To prevent this I would "milk in the parlor." Not in the farmer's wife's parlor with carpet and curtains for dust and bacteria to stick to. But close to the stable I would have a small, separate room in which to milk, a trifle larger than a good-sized stall for each cow to be milked at one time. Before all, this room should be clean; floor, walls and ceiling washed and whitewashed every little while. I would have it conveniently arranged, comfortably heated in winter, a door at one end where the cow enters and another at the other end through which she passes out. A walk with guide-railing should lead to and from the milking room. After a few days the cows would know the way and, as soon as released, would walk into the milking room, and, after milking, out again to find their stalls in the stable. Immediately after milking each cow the milk should be poured through a funnel on the wall of the milking room whence it would run outside over an aerator and cooler (with ice) into the milk can. Or, preferably, I would build the milking room on the second story or sufficiently elevated so as to milk into a funnel whence the milk would run directly over the aerator and cooler into the can on the wagon outside or in a driveway next to the stable.

In this way the utmost cleanliness and absence of undesirable bacteria can be secured. The cow can be brushed before milking and her sides and bag wiped with a damp cloth so that she will carry no flying dust into the milking room. Provided there are more than one man to do the chores the milker does not need to leave the milking room and can keep himself absolutely clean, the room being furnished with soap and water.

Of course I anticipate objections to this plan; there always are to any innovation. In the first place it will be objected that it would cost too much to provide a separate milking room. Many new stables, however, are being built with a view of securing good sanitary conditions, and the additional expense of a separate milking room can easily be saved by making the rest of the stable less elaborate. For, when the cows are milked in their stalls, the whole stable must be much cleaner than where the milking is done in a separate room. Not that I would reduce the efforts for cleanliness in the stable itself. But the milking room may be quite small, and in most barns a convenient corner can easily be found to partition off for the purpose, or a small, plain room can be built as an addition at a moderate expense.

Next it will be objected that it will take too much time to release the cows, lead them to the milking room and back again to their stalls. If everything is conveniently arranged it will take but little more time than milking in the old way.

Take as an example a herd of ten cows attended by the farmer and his grown boy. Their present order of business is this: First they will clean the floor under the cows, rake out the droppings and shake up the bedding; next they will curry and brush the cows and wipe their flanks and udders with a damp cloth. Then they will start the milking. After milking each cow, the milk is carried out of the barn and poured over the aerator. Now consider the new way: The farmer first looks to his milking room that it is perfectly fresh and clean, fills the cooler with ice and adjusts the conductors to carry the milk from the funnel over the aerator and cooler. In the meantime the boy has been busy in the stable cleaning and brushing. He has groomed and released the first cow which is now waiting outside the door to the milking room ready to be admitted. After being milked she passes out and the next one which has now been cleaned and is waiting outside, enters. The first cow finds her stall and fastens herself or is fastened by the boy. A week's training will be ample to teach the cows this routine, and the whole proceeding will work smoothly, hardly taking any more time whatever than the old way. I do not speak of the old way where nothing whatever is done for cleanliness, but I take it for granted that efforts are made to produce healthful and clean milk, and, if such is the case, I claim that the work can be done in the same or but little additional time with a separate milking room, the only difference being that while formerly both hands first did the cleaning and grooming and afterwards the milking, now one attends to the cleaning, releasing and fastening of the cows while the other milks.

But even if it does take more time and expense, it has got to be done all the same. Health authorities ar clamoring for better sanitation, and consumers are willing to pay for it. Besides, there is plenty of room for improvements in the city milk supply by which economy may be practiced so as to allow the farmers a sufficiently higher price to enable them to introduce a better system, without raising the price to the consumers. Granted that the consumers are willing to pay 8 cents per quart for sanitary milk, the distributors can afford to pay 4 cents on the platform at the city end of the railroad, which would leave ample margin for the farmers to make the improvements suggested. Four cents is plenty to pay for the distribution. Let the distributers combine so as to have one wagon attend to certain streets where heretofore three or five have scrambled for the business. This item of saving alone is more than sufficient to allow for the improvements at the barn. Or, still better, let the farmers combine and take the distribution into their own hands.

In this brief article, however, I shall not attempt to go further into this matter. Suffice it here to say that from any point of view, practical or economical, there can be no serious objection to the above suggestions, viz.: to "milk in the parlor" and to let the milk flow directly from the cow over a cooler, at once reducing the temperature to near the freezing point. And there can be no question but that this would be an enormous step in advance for the production of sanitary milk for the city supply."

J. D. FREDERIKSEN.

Little Falls, N. Y., June 1, 1901.

I am not expecting the average milk producer to attain these high standards, but even one cent extra per quart will enable the farmer to take some of the most important steps towards sanitary milk so as to enable the milk shipping creameries to get the full benefit of pasteurizing or freezing.

A HINT FOR CITY CONTROL.

Two-thirds of the milk sold is sold by tickets and the customers seldom see the peddlers. Compel them to print on these tickets whether the milk is new, skimmed or half skimmed (if the latter grade is allowed). Or—better still—let them print the minimum percentage of fat which they will guarantee.

CHAPTER VI.—APPENDIX.

PASTEURIZING OR STERILIZING AT HOME.

Although I have explained the necessity of getting this work as near milking time as possible, there are conditions where people with a baby might desire to thus treat the milk *after buying it in the city.* Yet this should only be done according to the advice of the doctor, because some times it may be better to use unpasteurized milk. It is true late experiments in Italy seem to indicate that we have laid too much stress on the supposed decrease in digestibility and it is also true that for the great masses who cannot afford to pay fancy prices (10 or 12c per quart) for so-called *sanitary* milk, which in reality simply means *clean milk from healthy cows*, the safeguard of sterilizing or pasteurizing should not be neglected by the careful mother.

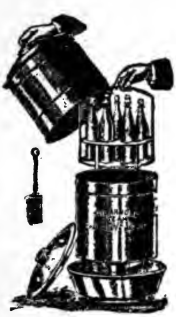


Fig. 118.

Arnold's Family Sterilizer or Pasteurizer is shown in Fig. 118, is recommended by many physicians and is especially adapted for handling small bottles. If the hood is left on, a temperature of 212° may be obtained, while for heating to 150 or 170° it may be left off. It may be bought from dealers in dairy and milk men's supplies or from druggists.

City people who do not know whence their milk comes may not even find pasteurizing sufficient and Dr. A. Stutzer in his pamphlet on children's milk recommends the following additional precaution:

It consists simply of a strong test tube of same diameter as the neck of the bottle and a short piece of rubber which fits tightly on both, with a pinch cock between.

When the milk is filled in the bottle, the rubber and tube is adjusted and the bottle turned upside down as shown in Fig. 119.

A few hours' rest will allow any possible dust or sediment to settle in the test tube, the pinch cock is closed, the bottle raised and the test tube removed.

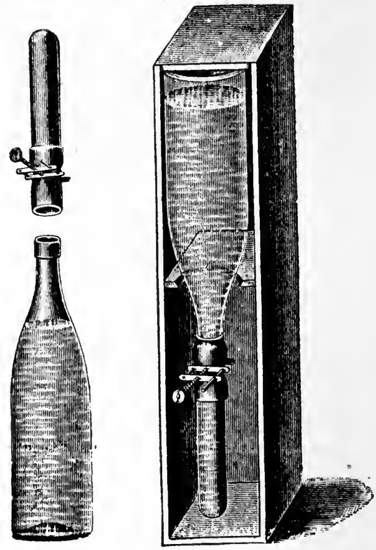


Fig. 119.

MODIFIED OR HUMANIZED MILK.

The composition of human milk varies from that of the cow, and in these days but too often has to be substituted.

"**Koenig**" gives the averages of 107 analyses of human and 793 of cow's milk as being:

	Water	Fat	Casein & Albumen	Milk Sugar	Ash	Specific gravity
Human...........	87.41	3.78	2.29	6.21	0.31	1.0270
Cow's............	87.17	3.69	3.55	4.88	0.71	1.0316

The object of modifying the cow's milk is to bring it as near as possible to the human milk. In most large cities this is done in milk laboratories like Gordon Walker's, and many are the systems for doing this work.

Modified milk should always be "prescribed" by a physician, and this is not the place to go nearer into it; hence, I only describe one system which seems to me the most practical, namely that of Prof. Gaertner (Germany).

Cool the milk at once after milking it; test it for fat and dilute it with an equal volume of boiled water. Run the mixture through a separator so that the skim milk contains the added water and part of the original water in the milk, so that the liquid coming from the cream spout has a higher percentage of fat, or rather as near as possible that of human milk. But if the percentage of fat is increased that of the casein is decreased to nearly half, as it is mixed with the added water and goes away with the skim milk. Add about 20 to 25 gram milk sugar to 1 litre and sterilize.

The result with this modification has been very good in the hospitals of Vienna. But the professors want the milk treated within an hour after it is drawn from the cow, and that it be consumed within 24 hours after it is prepared.

The following system in preparing milk for babies, using quite small bottles of only 4 or 6 ounces, was used in the Straus plant (New York).

They have a copper cylinder a little larger in diameter than the bottles.

The bottles with milk are placed in these cylinders which are filled with water so as to form a cushion and prevent scorching when heating, and bursting when cooling.

After they are heated for half an hour the bottles are corked and the cylinders placed in ice water to cool.

They gave two formulae for infant's milk.

I.

Sugar of milk....12 ounces
Lime water...One-half pint
Filtered water with the above to make...1 gallon
Milk.. ....1 gallon

II.

Milk.. ....1 gallon
Barley water.. ...1 gallon
White sugar.. ..10 ounces
Table salt.One-fourth ounce

These are mixed, filled in the bottles and pasteurized. I give them only as an example, but advise in each case to consult the doctor in the matter.

TESTING MILK FOR BUTTER FAT.

That milk sold for city supply ought to be sold according to test is so self-evident that no arguments are needed, and the simplest of all tests—the "BABCOCK," is so well known that it will only be illustrated by Fig. 120—The "OMEGA"

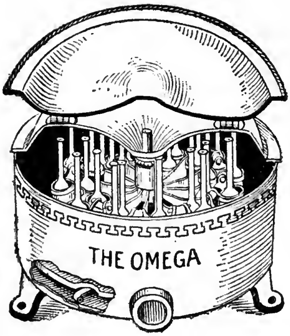


Fig. 120.

—made by **A. H. Barber Mfg. Co.** (Chicago) as a reminder to those who know about it, but do not use it as yet. The "IDEAL," the "FACILE,"— indeed, nearly all the modern power testers are now satisfactory. The whole question of Milk Testing is so well covered by **Profs. Farrington and Woll,** in their book "Testing Milk and Its Products," that it would be absurd to go into details here.

I have before referred to the advantage, aye of the necessity, of testing the individual cows if we want to get milk production on a solid business base, and also suggested the Danish plan of neighboring farmers co-operating and having a young man to do the work by visiting each farm and do the testing there.

It is true that another plan would be to have him bring the samples to the creamery and do the testing there if the creamery manager has the good sense to co-operate with his patrons and help in the good work.

In the former case the young man (or old one for all that) should have a convenient hand tester, easy to carry from place to place. When the test first came out I had Mr. D. H. Roe put up one of his four bottle testers for me in a telescope case. This was 16½ inches square and 10 inches wide, and there was a special rack for the glassware in the tester. But even this was not very convenient and the modern styles are all made much heavier so that this plan is not practical. The Illinois State Food Commissioner felt the need of a handy traveling outfit for the inspectors to use, and the State Analyst, **Dr. E. N. Eaton**. has just got up a modified Babcock Tester, with modified Sharples "Russian" bottles.

This is shown in Fig. 121, and Dr. Eaton thus describes his portable milk tester:

"The bottle consists of two parts—the bottle proper and the removable reading tube. The bottle is four inches long by one in diameter, and is divided into two compartments, the lower with a capacity of about 15cc for holding the milk and acid, and the top with a capacity of about 40cc for holding hot water to be used to elevate and keep fluid the layer of fat.

"The reading tube terminates in an inverted funnel so fitting into the top part of the bottle by means of a trap to

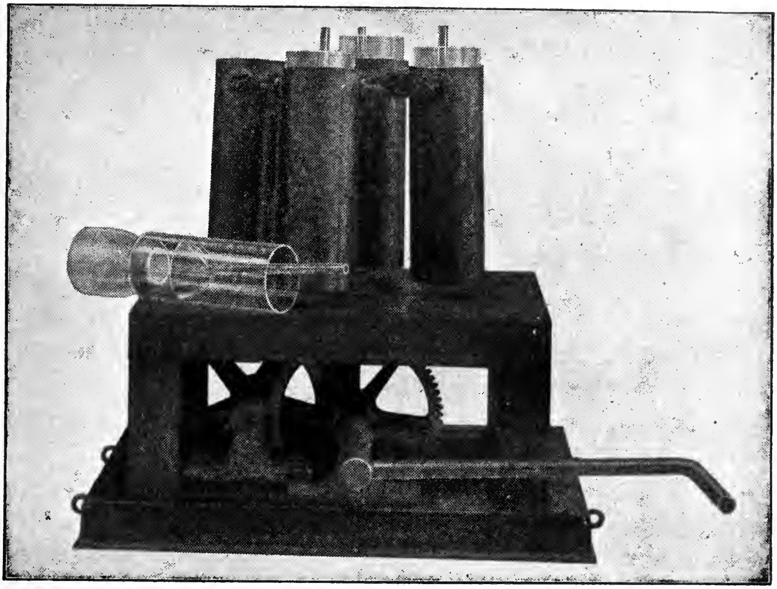


Fig. 121.

allow water to pass through, but effectually prevent the loss of fat. The tube is divided into sixty parts, each part representing one-tenth per cent fat with the zero mark at the top.

"The illustration sufficiently shows construction of working parts. The maximum speed is about 2,000 revolutions per minute, and the working speed 1,500 per minute, attained by 60 revolutions of handle per minute. The crank is removable. A substantial and handsome mahogany box with handle is fastened by means of hooks. The entire machine boxed occupies 8x8x9 inches.

"In the box may be carried two 100 cc bottles of acid (40 tests), a combined milk and acid pipette, a lactometer and thermometer.

DIRECTIONS FOR OPERATING.

"Measure five cubic centimeters of milk to be tested with milk pipette and allow to flow into bulb of bottle. Introduce an equal measure of sulphuric acid, Sp. Gr. 1.82-1.83, or that commonly supplied for Babcock test. Rotate with slight up and down motion to thoroughly mix acid and milk. Without delay place in machine, properly balanced and whirl at about 1,500 revolutions per minute (60 turns of handle) for three minutes. Introduce reading tube and fill to within a fraction of an inch of top with very hot water. Whirl for one to two minutes.

"The top of the column of fat should be at or a few tenths below O mark on scale. In reading deduct the amount below zero, if any, from the observed reading on the bottom of the column of fat, which gives the percentage of fat to one-tenth of one per cent.

"The reading tube may be inserted before first whirling; read "over all" as in Babcock.

"When a number of bottles are to be tested introduce milk in all; then acid, and finally mix and whirl.

"Keep bottles and tube clean, the latter by washing in alkali or soap solution after forcing water through or by swabbing with cotton. A stiff iron or copper wire makes a good ram rod!"

THE ACIDITY OF MILK.

Again the reader is reminded of the fact that the nearer we bring pasteurization (or cooling) to the time of milking the better it is, and if a certain amount of acidity has developed the work is useless. Prof. Farrington places the limit of acidity in milk to be pasteurized at 0.2 per cent (or 11° with the Mann's Test). Milk will seldom taste or smell sour before there is 0.3 or 0.35per cent acid. "Milk Testing," by Profs. Farrington and Woll.

It is therefore essential to use some test for the acidity, but I shall only illustrate the Mann's Acid Test in Fig. 122.

It consists of a graduated burette with a pinch cock, a 50 cc pipette, a glass tumbler and a glass rod. The test depends on the property of a certain chemical called phenolpthalein, labelled "indicator," which, while white when in acid solution, turns pink in an alkaline solution. Fifty cubic centimeters of milk are measured into the tumbler with the pipette and four or five drops of the indicator added. Meanwhile an alkaline solution (called neutralizer) (1-10 normal) is filled into the burette to the O mark and then run into the milk, a little at a time, while stirring until the pink color shows permanently. The number of cubic centimeters normal used is read off on the burette and indicates the acidity.

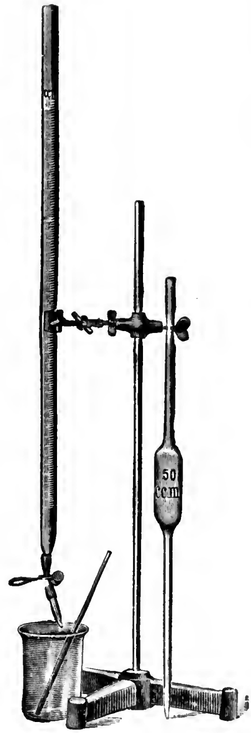


Fig. 122.

Prof. Farrington adapted the dry alkaline tablets colored red and a very simple and quick system for testing the milk at the weigh can in order to reject that which is too sour. Full description is given in his book on "Milk Testing," which should be found in every creamery and every milk shipping station,—just as Prof. Russell's Dairy Bacteriology should be found in the library of every milk producer.

The **Chr. Hansen's Laboratory,** of Little Falls, N. Y., suggested in their direction for use of their Lactic Ferment to use lime water as a neutralizer, and it seems to be approved of by the Scandinavian scientists. It has certainly a great many advantages both as to convenience and costs. The "Neutralizer" sold for Mann's test, even if correct, when made is liable to lose strength by exposure to air (like all others), and hence it will not do to buy it in large quantities, and the express increases the cost very much. If lime water is fairly reliable there is no reason why every creamery or milk shipping station manager should not prepare their own. **Dr. E. N. Eaton,** whose opinion I have asked, reports:

"USE OF LIME WATER AS A STANDARD SOLUTION IN TESTING THE ACIDITY OF MILK AND CREAM."

It was observed as long ago as 1877 that acidity and ripeness of cream bore a definite relation. The relation of sourness of milk to its marketability is as old as the centuries, but is creating more commercial attention since the discovery of the necessity of using perfectly fresh milk for pasteurization. For this purpose a test even more delicate than the sense of taste is required.

Fleischmann & Sebelien, in the old world, and Mann, in America, introduced the chemical method of titrating cream with standard alkali, using phenolphthalein for indicator. A modification of the same method is in common use for testing the acidity of milk. The alkalies almost universally used have been deci-normal solutions of sodium or potassium hydrate. Farrington has introduced the alkali in tablet form.

Wallace, the Chr. Hansen Laboratory, and probably others, have suggested lime water, and this alkali is now quite generally used in Denmark and Sweden.

According to Richmond, Storch uses a solution of lime (lime water) containing solid lime, as it remains constant in composition and is almost exactly twentieth normal. The strength of the solution remains constant as if any of the lime is removed by carbon di-oxide more is dissolved. Its strength is but little affected by climatical variation of temperature.

I am indebted to Mr. Monrad for the account of the following method of preparation which is probably that in use in Denmark and Sweden. "The lime is dissolved in a bottle carefully shaken and then left to settle again. In this way is obtained a solution which, by a reasonably uniform temperature will keep unchanged for several months."

Dr. E. Holm prepared two samples in this way which were

E. Holm prepared two samples in this way which were titrated from time to time at different temperatures and showed quite close agreement. Only slight variation was shown at different temperatures. Thus using 20 CC lime water,—one sample gave the following result:

At 18.°C	9.75 C C deci normal H Cl.
15.6	9.85
23.	9.70
22.	9.65
22.	9.62
15.5	9.90
17.5	9.90

This expressed in gms. of CaO per 100 CC equals, for the strongest solution (9.90) .1386, and for the weakest (9.62), .1347. The average strength would be about (9.75), .1366, all somewhat less than one-twentieth normal solutions (containing .1400 CaO per 100 CC.)

It may be noticed that while in a general way the strength of solution decreases with the degree of heat there is no uniform variation, a temperature of 23 holding about as much lime in solution as a temperature of 18. The results are, on the whole, very favorable to the use of lime water as a standard for practical work.

Lime water has several advantages for use as a standard solution if it can be prepared practically:

1st. It forms a weak solution of alkali which keeps in any climate.

2d. Contamination with carbon dioxide is immediately apparent by formation of calcium carbonate insoluble in water, whereas the alkali carbonates are soluble.

3d. It reacts exceedingly sensitively with phenolphthalein, much more sensitive than ammonia with the same indicator.

In titration of milk products, it has advantages over other alkalies due to the presence in milk of acid phosphates of calcium and carbon dioxide

4th, and most important, it offers an opportunity through the limited solution of CaO to prepare and standardize a solution, without the aid of a chemical balance. If the statement of Storch holds good it also reinforces itself to make up for absorption of carbon dioxide from the atmosphere.

There is a serious discrepancy in the published reports of the solubility of CaO in water at different temperatures. Some work has lately been done in this direction and a summary up to date of the solubility at O°, 100°c and between fifteen and thirty is as follows:

Temperature.	Lamy.	Grms. CaO per 100 CC. Maber	Gunthrie	Holm
0	.1381	.1318		
10	.1342	.1298	.1342	
15	.1299	.1248	.1320	.1386
20		.1264	.1293	.1366
25		.1203	.1254	.1347
30	.1162	.1160	.1219	
80	.0734	.0740		
100	.0576	.0609	.0597	

The lack of uniformity in these results are due:

1st. To difficult solubility of CaO.

2d. To supersaturation or incomplete sedimentation.

3d. To difficulty of filtering and titrating without loss of alkali, due to absorption of carbon dioxide.

4th. To difficulty of holding temperature constant when other than normal.

5th. To impurities in lime.

Lamy obtained different results on lime of different origin, although all samples were presumed to be pure, i. e.: were prepared from so-called pure chemicals.

In repeating some of this work I obtain the following results, employing pure lime:

Temperature.	CaO in 100 C. C.	
100	.0602	One determination as high as .0625
80	.0704	
80	.0698	
79	.0704	
80	.0698	

(These results were all on filtered samples and while uniform are probably somewhat low).

Seventeen determination at temperatures ranging from 20.5 to 25, some on unfiltered and some on filtered samples gave results from .1123 to .1220. The latter figure obtained on some rapidly filtered samples at the highest temperature is probably nearly correct. The method of preparation was to cool water and lime in refrigerator. Shake well and let stand twelve hours or more to room temperature.

Two samples of commercial lime were secured from dealers, washed and made up at low temperature and brought to room temperature as before. The results were at first low, and on repeating the process several times a little high, showing incomplete washing.

Without recording all the experimental work, it was found that thorough washing by decantation is necessary to remove all free alkali. That just as quick saturation may be secured at ordinary room temperature as by dissolving cold, and that if proper precautions are taken uniform results can be secured at a temperature not exceeding twenty-five and not below twenty-two (71° to 77° Fah).

The average of several closely agreeing figures for different lime, in which the temperature was not the controling element, gave a solubility of .1265 Gms. per one hundred, or forty-five per cent of and n-10 solution or 10-222 normal solution.

Using my results as a criterion Lamy and Maben are too low, probably due to contact with CO_2 during filtration as in my work with so-called chemically pure lime, working with comparatively small quantity. Guthrie's results are reasonably comparable with mine; are the latest results at hand and may be given more credence than older analyses. Holm's are certainly too high, the unwashed lime being probably contaminated with alkali carbonates. It should also be mentioned that the temperature employed by Holm is much below the usual temperature of working rooms in this climate.

My experiments do not justify the assertion that the loss by absorption of CO 2 is immediately corrected by further solution of the lime. However, if the contents of the bottle are thoroughly agitated and allowed to stand a day or two saturation is again obtained.

As a working method for the preparation of standard lime water, I would advise this procedure:

Slack a pound or two of fresh lime in a gallon or larger vessel, by adding double volume water. Fill with water and stir; cover; allow to thoroughly settle and pour off as much clear solution as possible. Repeat three or four times. Transfer the fine lime to a large bottle (the larger the better) throwing away any lumps which may be present. Wash again in bottle with ordinary well water, or better, rain water. Fill nearly full and shake at intervals for several hours, at temperature between twenty-two and twenty-five degrees C., preferable the latter. Allow to stand at least two days (stoppered, of course) when it is ready for use.

The clear lime water may be removed with a pipette when wanted, or it may all be transferred to another bottle by means of a syphon. The receiving bottle should be washed with the lime water. The original bottle may be refilled and drawn upon as needed. It is absolutely essential that lime water so prepared be kept free from air.

Another and probably better method of handling is to attach a syphon to the original bottle containing the lime water connected to a burette with two way stop cock. This makes an almost automatic refilling apparatus. A small hole must be placed in the cork, in which a tube containing lime may be placed, protected by cotton or cork from too free ingress of air. This, however, is not essential with solution containing solid lime as the $CaCO_3$ forms a crust on top which effectually prevents further absorption of $C\ O_2$. Even in the transferred solution this formation of $CaCO_3$ does not perceptibly weaken solution if of a depth of eight inches or more. This solution may be used as in the Mann's test, multiplying number of cubic centimeters of lime water used by .45 to get into terms of n-10 alkali. Or recorded results by Mann's test may be divided by this factor to get in terms of lime water, and all results interpreted in terms of C C of lime water rather than n-10 alkali.

It will be found more convenient to use 25 CC of cream for test on account of the dilute alkali used. Multiply results by 4 to get in terms of alkalinity per 100 C C.

If percentage of acid (calculated as lactic) is desired, convert lime water used into CC n-10 alkali per 100 CC of milk, that if 25 CC milk or cream were used, multiply by .45 and 4, and multiply results so obtained by .009. Results, Gms. lactic acid per 100 CC.

A simple method will be, when using 25 CC milk, to multiply cubic centimeters of lime water by 0.0162. If, as for instance, there has been used 12.2 CC lime water, the acid per centage is (with three decimals) 0.198. In ordinary creamery work no calculation need be made.

E. N. EATON.

TESTING HEATED MILK.

In Denmark the compulsory pasteurizing law made it necessary to devise a test, which, if applied to milk cream (or butter), should show whether the minimum temperature of 176° had been applied.

Prof. V. Storch devised the following simple test:—A teaspoonful of the milk (cream or whey) to be tested is poured into a test tube and one drop of a solution of hydrogen superoxide and two drops of a solution of Paraphenylendiamin is added and the milk shaken. If the milk immediately becomes strongly colored (milk and cream indigo blue, whey violet reddish brown) then it has either not been heated at all or has not been heated over 172°. If the milk assumes a bluish gray color at once or within ½ minute, then it has been heated to between 174° and 176°.

If sour buttermilk is to be tested half a teaspoonful of clear lime water is mixed well with it before adding the chemicals, and if a blue color does not show it is proof that the milk or cream from which the buttermilk came has not been heated to 176°.

Butter is tested by weighing about 25 grams which is melted in a suitable beaker in a water bath of not over 140°. After separating the clear oil, the sediment (brine and buttermilk) is mixed with about an equal quantity of water, and this mixture is treated as before described.

The solutions are prepared as follows: 1 gram *Paraphenylendiamin* is dissolved in 50 grams warm (distilled) water, is filtered through filtering paper and preserved in a *brown* glass bottle. It is safest to keep the solution in a cold place. As a rule it will be useless in two months. The commercial solution of *Hydrogen superoxide* is as a rule stronger than needed. If it contains about 1 per cent it may be diluted five times its volume, with water to which has been added 1 cc concentrated sulphuric acid per quart. This diluted solution is also preserved in brown glass bottles.

FILTERED WATER AND LONG KEEPING BUTTER.

I have again and again emphasized that the pasteurizing of the cream for buttermakers is only to be recommended. (1) At creameries where, in spite of all precautions, the milk delivered is "off," has weedy or other bad flavors. (2) At creameries where it is known that the butter is to be exported or even held for long cold storage. While there may be exceptions to the last, I am sure that all butter for export should be made from pasteurized cream.

Then, and then only, can we hope to work up a reputation for clean, pure flavor, combined with uniformity, which is all important on the world's market.

It is not my province here to treat buttermaking, but must emphasize the futility of pasteurizing the cream, if the butter afterwards is washed with any kind of water, a custom which I regret to say obtains generally.

If the water supply comes from a deep drive well it may be safely used, but in all cases it would be money well spent for any creamery to have it analyzed chemically and bacteriologically.

Where the water comes from shallow, open wells, or is pumped from creeks or rivers, it should always be boiled or filtered, at least all that is used for rinsing the cream vat, the churn and the butter worker, as well as for washing the butter.

PASTEUR FILTER.

This filter which—I regret to say—requires a pressure of at least 20 lbs. to the square inch to do practical work, and which is rather expensive, is not only a filter, but a complete sterilizing apparatus, as no microbe, no germs of microbes even, can pass through those wonderful hollow "candles" made of a composition of unglazed porcelain, prepared by Pasteur's associate, Prof. Chamberlain.

The idea of sterilizing milk this way lay near and would obviate the dreaded boiled flavor, but alas and alack, this filter is so powerful that only a very clear "whey" would be the result.

I have had some correspondence with the company in Dayton, Ohio, and they tell me that a filter for 250 gallons a day, which, I presume, would be enough for the average creamery, if used only for the washing of the butter would cost somewhere about $100, and this should not prevent their use if they prove otherwise practical. I refer to the trouble of cleaning the "candles" every day.

I hope to see this filter given a fair trial.

If our experiment stations had taken this matter up in a practical manner, I am sure they would long ago have demonstrated that much of the faulty butter on the market is due to the water.

From Mr. Boggild's excellent book "Danish Dairying," I take the illustrations Figs. 123 and 124, which represent a galvanized iron filter. The cross section, Fig. 124, shows first a loose perforated wooden bottom, then a layer of pebbles, then gravel, then sand, then another perforated bottom. On this there is a layer of charcoal and then a layer of scrap iron. The upper bottom has only one hole in the center, and is covered with pebbles. The height is 3 ft., 6 in., and the filter is filled with the above mentioned materials at least two-thirds. Fig. 123 represents the manner in which the filter (a) is fixed on the wall, with the supply pipe (e) and its cock (f) provided with a rod (g).

In order always to have filtered water in stock a storage tank (b) is provided. The latter ought, however, to have a cover not shown in the illustration.

I am of the opinion that the water, used for washing the butter, ought to be boiled and then cooled, unless indeed the Utopian age were here when every creamery has a pasteur filter.

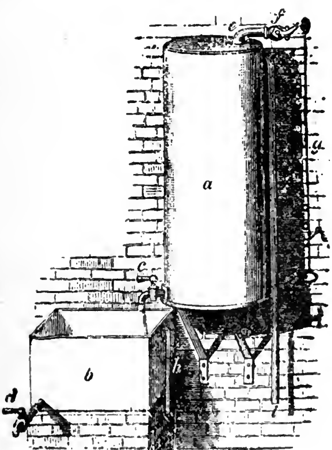


Fig. 123.

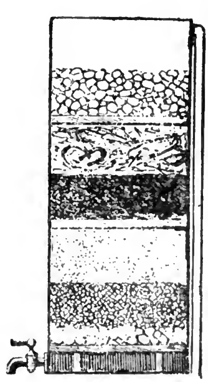


Fig. 124.

The simplest filter, though not doing as good work as the "Pasteur," is the "International" shown in Fig. 83, in use for milk.

—9

A PLEA FOR BETTER BUILDINGS.

It cannot be said that very many creameries are built so as to make it possible to keep them clean—bacteriologically clean—or, if you please—dairyologically clean.

I know I shall incur the criticism of those men, who, at their own risk, build creameries, so to say, on the suffrage of the farmers. These may at any time see the farmers build one in opposition.

Nor do I deny the justice of such criticism, calling my demand for creameries similar to the German one shown as an unpractical, unbusinesslike proposal, when looked at from *their* standpoint.

Yet I shall raise my voice and use my pen as long as I live for better creamery and cheese factory milk shipping stations and city milk depot buildings, and challenge any criticism *if made from the standpoint of the permanent interest of the milk producers.*

There is a great cry against expensive creameries, but that has been because these buildings were not better than the cheap ones, yet the objection always remains against the increased interest on money invested.

Let us investigate this question a little. In this country the interest is higher than in Europe, and hence I shall not challenge the claim that we can afford to put up a cheap wooden building for, let us say $3,000, for a 5,000-℔. creamery and rebuild it when rotten for the difference in the interest on a solid brick building costing double the money.

I shall not challenge this, I say, though there may be localities where the difference would not be great enough to do it, and though certainly fire insurance ought to be lower in the latter case.

But I am not only asking for a brick building, I want it finished somewhat in the style of the illustration. *I want a $10,000 building where there is now a $3,000 one.*

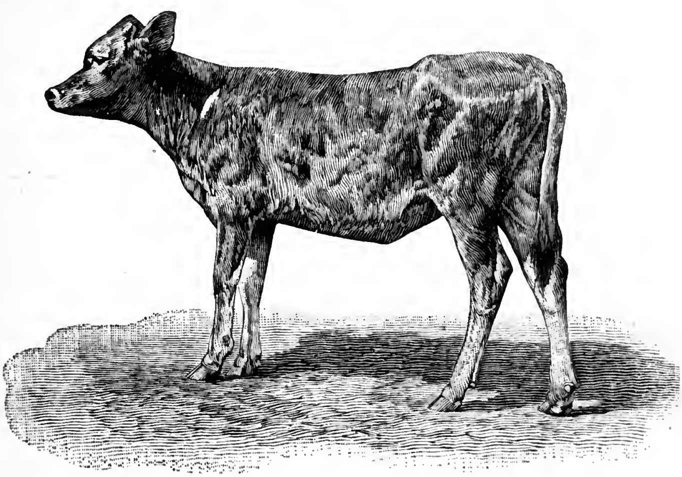
The interest account will thus be charged with say 6 per cent on $7,000 extra, or $420. But this will hardly be ¼ cent per pound of butter.

Leaving out the labor saved in keeping such a creamery clean, I claim that the simple moral effect on the men working in such a creamery will easily increase the value of the butter ½ cent per pound. Nor is the claim "theory" but it is based on 20 years close observation of the *practical* creamery work in many countries.

I said that my proposition would be impractical for "individual" creameries, as they are often called, but there is no reason on earth why the farmer should not build such creameries, or the banks lend money in them.

Take any community which has been blessed with the revelation of dairy truth, take any bank that has seen mortgages removed and good accounts opened by the aid of the cow and co-operation, and build such a creamery. Then tell me if it is not sure to make land more valuable in the neighborhood, just as does a good school, or a good county building, or a good road.

Surely there is no use arguing this point with practical men in this year of 1901. If pasteurization is to be generally adopted we must have better buildings.



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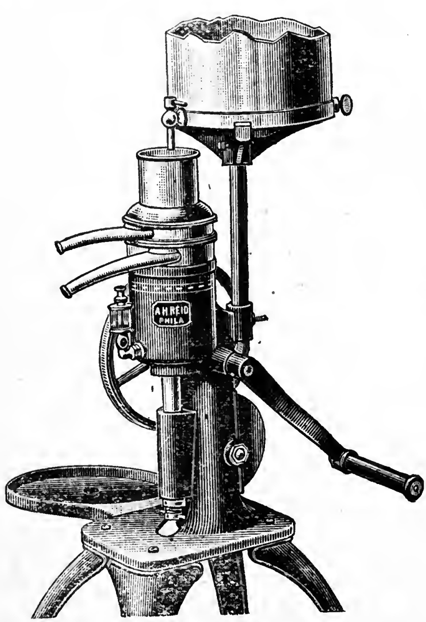

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