THESIS

Perpetuation of Milk Starters

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In the modern dairy, creamery, or cheese factory of to-day, a starter for securing the desired ripeness of the milk or cream has become an indispensible factor in making the best and most uniform quality of either butter or cheese. By the addition of a starter the ripening process is not only hastened, but in many cases the undesirable bacteria already in the vat are held in check by the predominance of the starter added.

The dairyman secures these starters in various ways,- some take buttermilk or skimmed milk, and set it aside under suitable temperature until it has become sour, thereby developing the germs in the milk. In this method it very often happens that the milk or buttermilk used as a starter contains undesirable germs, which are not held in check and multiply with the desirable ones, until when introduced into the vat, they very materially deteriorate the quality or flavor of the butter or cheese. Another way to secure a starter is to obtain a small amount of whole milk in the cleanest possible condition and put in a clean place to sour. While this is a better method than the first described and even though the milk is secured under the cleanliest conditions, yet there are many chances for undesirable germs to get into the milk and there increase from day to day until ultimately they seriously affect the final product. Still another, and the most common and best way of securing a starter,

is by purchasing a bottle of commercial starter which contains the bacteria in a concentrated form and when added to milk it gives a very strong and vigorous ripener. The contents of one of these bottles are emptied into a can of pasteurized milk, and this allowed to sour. A portion of this is then taken out as a starter for a new can of milk, the remainder being put into the vat. This process is continued until the starter, not being kept pure, becomes too weak for further use, which is usually about two weeks, when a new bottle must be purchased. While this is a very effectual method of securing a starter, yet there are many faults even to this method, among which are the following:

1. It necessitates buying a new bottle of starter every two weeks, which is an inconvenience not alone because of the cost, but since the starter will keep only a very short time, it must be purchased by single bottles from the manufacturer.

2. Oftentimes the bottle of starter becomes contaminated, and this contamination may cause trouble in milk or cream.

3. The dairymen seldom pasteurize their milk sufficiently to kill all the undesirable germs in the milk used as a starter.

4. The room temperature varies so from day to day that there is no uniformity of the starter as it goes into the vat, and hence no uniformity of the final product.

The object of our thesis was to devise or discover, if possible, some method by which the objections to the starters now in use would be obviated or at least decreased; in other words, to discover some method by which we could secure a starter consisting only of the desired bacteria, and free from undesirable ones, and one which would retain its vigor, and not in the least become attenuated, and thus do away with the expense of securing a new starter frequently. Such a process must necessarily fulfill seven essential requirements to make it successful. First. There must be a pure culture of the desired bacteria to start with, for if more than one species were present one might soon supplant the others. Second. To overcome the difficulty of using milk as a medium which is not thoroughly sterilized, some means must be afforded by which we could secure sterilized milk. Third. There must be an abundant supply of oxygen to promote the growth of the bacteria in the starter. Fourth. There must be a total exclusion of foreign germs, for if germs from the air were allowed to get into the starter it would soon become contaminated with undesirable germs and the desired bacteria would lose their supremacy. Fifth. A uniform temperature must be maintained, so that a certain strength of starter can be depended upon for a certain amount of milk used and a certain time of development. Sixth. The acidity of the starter at which the sterilized milk is introduced must be so regulated as to secure the most vigorous growth of the germs. Seventh. An effectual means must be secured of drawing off the ripened starter, from the vessel in which it is grown.

The first of these conditions, that of securing a pure culture, was perhaps the easiest to fulfill, the lactic acid germ of milk being very good for the ripening of cream or milk and giving a good flavor to the product. It grows well in a medium of milk under ordinary temperatures and conditions, so all that was needed to secure a pure culture was to isolate a vigorous lactic acid germ.

In securing each day a quantity of sterilized milk to be used as a medium we conceived that by a series of three cans so arranged that the milk could be heated in the first and then drawn off into the second can and heated there the second day, and, finally, drawn into the third and heated there the third time, that if such a process as this were secured, we could by introducing a certain quantity of milk into the first can eadh day be able to draw off from the third can the same amount of sterilized milk. Our main difficulty here was to secure a means by which the milk could be carried from one can to the other. At first we thought a series of syphons would do this, but on experimenting we found that because the specific gravity of the contents of the three cans were the same, the milk from one would diffuse throughout the other two. Later we concluded that if the cans were placed one above the other and connected with tubes closing by a "stop valve," that the milk could be run from one can to the other without mixing. The same arrangement would afford a means of conveying sterilized milk from the

cans to the vessel containing the starter. To supply plenty of sterile oxygen we conceived that since germs would not pass through cotton wool plugs or asbestos, openings could be made at the top of the starter can and these openings filled with cotton wool or asbestos. To exclude all foreign germs would mean that all covers and openings to both the cans in which the milk was sterilized and the vessel in which the pure culture was grown must be made with tightly fitting screw connections. The cheapest method of maintaining a practical uniform temperature for the starter can was to pad it with asbestos and leave a dead air space between the padded walls. One of the greatest difficulties in planning the entire device was to secure a valve simple enough to draw off the ripened starter and at the same time keep foreign germs out of the opening. After examining the construction of several different kinds of valves, we decided that a large "cut off" valve would accomplish this. For diagram of the entire device see page 10 with index to the same on page 11.

After this diagram had been made it was found that to make the device durable and perfect it must be made of tinned copper. Neither the time allotted to do the work or the financial means would allow us to construct the machine for our thesis work, so that to find out as far as possible the practicability of the device we had planned, we resolved to test it with a cheaper device. We had a tinsmith make for us a set of cans as on page 13. By the use of these cans and the

steam sterilizer in the Bacteriological Laboratory we were able to secure each day sterilized milk. For a starter can we were able to use a one and one-half leiter flask into which was put the pure culture lactic acid germ, to which was added, by means of a rubber connection, the sterilized milk from the cans. The ripened starter was drawn off by means of a glass syphon. Oxygen was supplied by allowing the air to pass through the cotton plugs. This apparatus was a very crude way of testing the device which we had planned., for there were many things which we could not control, such as the temperature of the starter and contamination with foreign germs,because of the crude connections used. Notwithstanding these difficulties,we succeeded in carrying on a pure culture for seventeen days without contamination, during which time we secured the following results, using each day 1000 c.c. of sterilized milk as a medium.

1. Time required for heating to fully sterilize 1000 c.c. of milk was thirty minutes each day for three successive days.

2. The acidity of the milk was apparently not changed by sterilization. The acidity varying from 15 to 25 degrees. It was found that if the acidity got above 25 degrees the milk would curdle upon heating.

3. We found that the amount of starter to be used to secure the desired thickness necessary for a first class starter depended entirely upon the temperature of the surrounding room. We found that when 20 c.c. of the culture was used and subjected to a temperature of 35 degrees C. that it required only about fifteen hours for it to sour.

On the other hand, if only 15 c.c. were used under a temperature of 10 degrees C. it required 48 hours for it to sour. Since it is most convenient for the dairymen to so develop his starter as to have it for use every 24 hours, we endeavored to establish as accurately as our crude apparatus would permit, a table stating the different amounts to be used for the different temperatures, so that each would have the proper development in 24 hours.

Table is as follows:

Amount of Milk Used.	Temperature.	Amount Starter Used.
1000 c.c.	12 C.	40 c.c.
" "	14 "	35 "
" "	15 "	32 "
" "	16 "	30 "
" "	17 "	25 "
" "	18 "	21 "
" "	19 "	18 "
" "	20 "	15 "
" "	21 "	12 "
" "	22 "	10 "
" "	23 "	8 "
" "	25 "	5 "

As it was impossible for us to completely control the temperature of the room, this is rather an approximate table, but it is accurate enough to prove that a direct relation

should exist between the amount of starter to be used and the temperature of the starter can.

4. We found that there was no trouble in the milk clogging because of the heating process, and also none in the ripening of the starter if it were drawn off at the time it had reached the stage of a first class starter, but if allowed to curdle or precipitate then there was considerable clogging.

5. It was found that we got the most vigorous growth of the germs when the sterilized milk was put into a starter of about 50 degrees acidity.

The conclusions of this thesis are as follows:-

From the work done with our temporary device we felt confident that the machine we had planned, if well made, would provide a starter which would be much better than the starters now used and at less cost and inconvenience than is necessary in securing the inferior starters now in use.

External appearance of the designed apparatus.

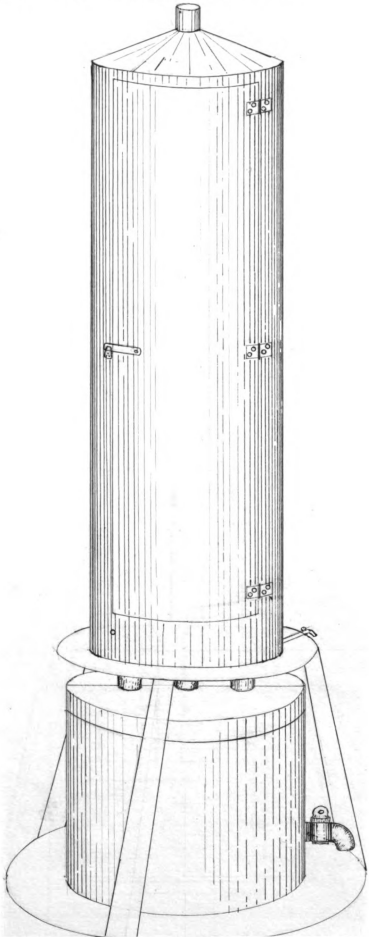
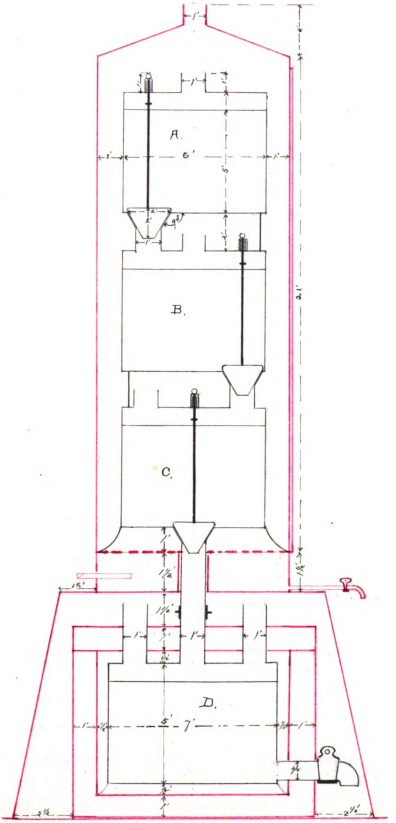


Diagram of the designed apparatus.



Explanations and Specifications for the Apparatus.

As a matter of convenience, the four departments through which the milk passes are lettered "A","B","C," and "D" in the diagram on page 10. Departments "A", "B", and "C" are the three cans through which the milk passes during the process of sterilization and are enclosed in a steam sterilizer represented by red lines. Department "D", below the sterilizer, is the starter can and is enclosed by a chest, also represented in the diagram by red lines. Each separate department has a vent in the cover, ("D" having two), in which a cotton wool plug is to be placed to allow air circulation but exclude germs. The cover of can "B" is firmly attached to the bottom of can "A" by means of two braces and the connecting flue, and the cover of can "C" is connected to can "B" in the same manner. The cover of can "D" is detachable from the bottom of can "C" by means of a screw coupling. This is to facilitate taking the apparatus apart when cleaning is necessary. All covers of the four departments screw on tightly. The double-walled chest enclosing can "D" is to be packed with asbestos to prevent as far as possible any fluctuation in temperature. The sterilizing cans, ventilators, plug valves and flues connecting the four departments are round a feature not shown in the diagram on page 10, but fairly represented in cut on page 9.

The measurements for departments "B" and "C" are not given. They are the same as those given for department "A."

The steam enters near the bottom of the sterilizing jacket, passes up through a perforated partition, and comes in contact with the departments "A", "B", and "C". The condensed steam is carried off through a small vent as represented in the diagram. The whole apparatus should be made of brass or copper, or a combination of both.

Diagram of the apparatus used.

Departments "A'", "B'", "C'" and "D'" correspond to departments "A", "B", "C" and "D" on page 10.

The flues connecting the departments are rubber, constricted with special clamps, to take the place of the plug valves in the ideal apparatus. Department "D" is a common 1 ½ leiter flask fitted with rubber cork and glass flues.