CREAM SEPARATION

AND

BUTTERMAKING

KHAKI UNIVERSITY OF CANADA

Series 1.—No. 8.

KHAKI UNIVERSITY OF CANADA
MOS INTER BELLUM NATUS
1918

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and BUTTERMAKING

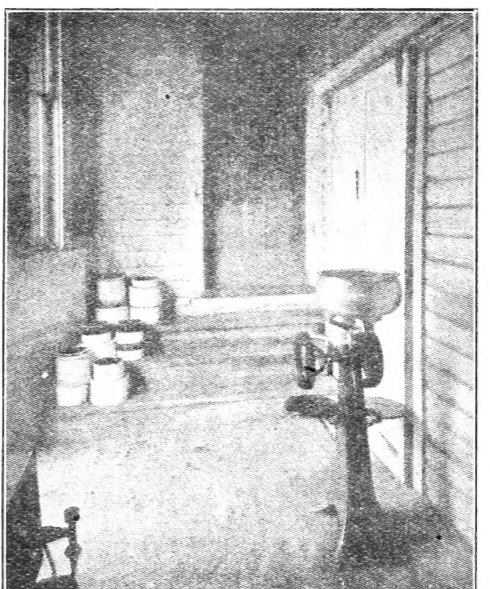

FIG. 80.—*A wood-shed may be a suitable place for a separator.*

Reprinted, with adaptations, from "CREAM SEPARATION" and "FARM BUTTERMAKING," *by E. S. Guthrie, in "Cornell Reading Courses."*

CREAM SEPARATION

E. S. GUTHRIE.

Cream separation is one of the important processes in the handling of dairy products. The dairyman who uses a cream separator is interested not only in the proper operation of his machine in order to prevent undue loss of milk-fat, but also in the proper location of the separator from the standpoint of sanitation and convenience. The purpose of this lesson is to give the persons operating cream separators an understanding of the principles of separation as well as a few suggestions concerning the operation, the location, and the care of separators.

SEPARATION BY THE FORCE OF GRAVITY.

The separation of cream and skimmed milk is possible because of the difference in the specific gravity of these two substances. The specific gravity of cream is difficult to obtain because cream is exceedingly variable in fat content and because it has a tendency to incorporate air. The specific gravity of milk-fat is .90 or .91. In view of the fact that about one-fourth to one-half of cream is milk-fat, it is readily seen that cream is much lighter

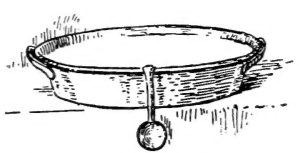

FIG. 81.—*The shallow-pan method.*

than skimmed milk. The force of gravity acts in direct proportion to the weight of matter. Skimmed milk is attracted to the earth with greater force than milk-fat because it is heavier. The lighter substance, cream, is crowded away from the earth, or to the surface of the vessel that contains whole milk. In ordinary phraseology, therefore, cream "rises."

There are three methods of cream separation depending on the force of gravity. They are the shallow-pan method, the deep-setting method, and the water-dilution method. In the first method, the cream is skimmed off with a shallow dipper, and in the other two methods the skimmed milk is drawn off leaving the cream. These gravity methods, however, have distinct disadvantages, one of the most important of these disadvantages being the loss of a small amount of milk-fat each time they are used. Tests of the relative merits of the gravity methods of separation have been made in order to determine how great this loss is.

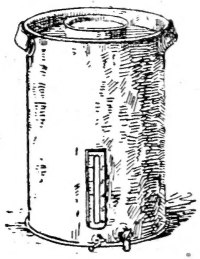

FIG. 82. — *The deep-setting method.*

According to experiments made by Hunziker,* the percentage of milk-fat in the skimmed milk separated from cream by these gravity methods of cream separation is as follows: water-dilution method, .68 of 1 per cent. of fat; shallow-pan method, .44 of 1 per cent. of fat; deep-setting method, .17 of 1 per cent. of fat.

* The Hand Separator and the Gravity Systems of Creaming. By O. F. Hunziker. Purdue University Agricultural Experiment Station. Bulletin 116.

This loss of milk-fat from the milk of a single cow giving 5,000 pounds of milk each year, is shown in Figure 81. The skimmed milk usually amounts to about 85 per cent. of the whole milk, which in this case would mean 85 per cent. of 5,000 pounds of whole milk, or 4,250 pounds of skimmed milk. In the manufacture of butter certain amounts of moisture, salt, and casein are incorporated. Thus it is possible to make more butter from a certain amount of milk-fat than there was original fat. This increase is known as overrun. In the computation shown in Fig. 84 allowance was made for an overrun of one-sixth of the original amount of milk-fat.

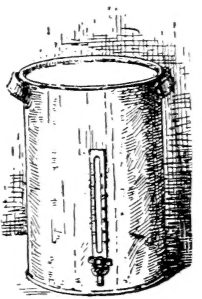

FIG. 83.—*The water-dilution method.*

According to the statements given, if the price of butter were 30 cents a pound there would be an annual loss of $9.60 on each cow by the use of the water-dilution method, and $2.25 on each cow by the use of the deep-setting method. These losses are computed on the basis of the amount of milk-fat lost through the use of these methods as compared with the amount lost if a modern centrifugal separator were used.

SEPARATION BY CENTRIFUGAL FORCE.

Centrifugal force acts in direct proportion to the weight of matter. The specific gravity of skimmed milk is greater than that of cream; therefore the skimmed milk is forced from the centre of a separator bowl with a greater velocity, and the cream is crowded, or concentrated, toward the centre of the bowl.

The purpose of the bowl devices in separators.

There is a device in all separator bowls which guides or feeds the whole milk into the region of the greatest centrifugal force. With one exception, all centrifugal separators with which the author is familiar have internal bowl parts, such as discs, cones, blades, and the like. The purpose of these parts is to form pathways for the

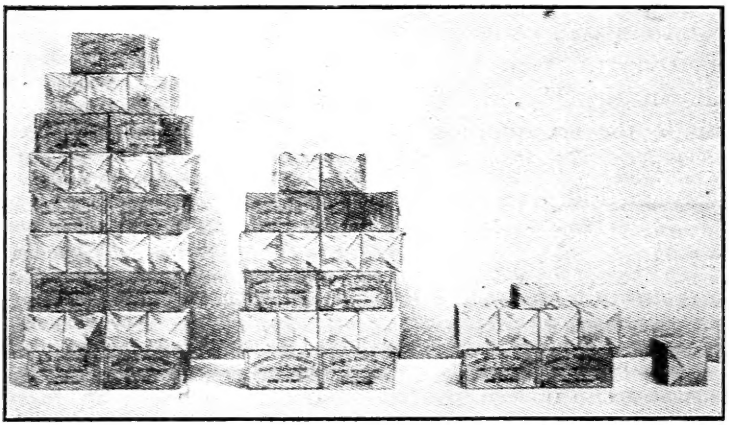

FIG. 84.—*A comparison of the amount of butter lost in the skimmed milk from one cow producing* 5,000 *pounds of milk in one year, by the use of different methods of cream separation. Reading from left to right: Water-dilution method,* 33 *pounds; shallow-pan method,* 22 *pounds; deep-setting method,* 8.5 *pounds; centrifugal method,* 1 *pound.*

skimmed milk and cream to pass each other. It must be remembered that these devices do not cause separation; they simply aid the centrifugal force. The introduction of these devices has made possible the use of a much smaller bowl for a given capacity. In the evolution

of improvement in this direction, the bowls of cream separators have become lighter, and they are consequently easier to turn and to handle. The separator referred to as being the one exception has a long and narrow tube-like bowl in the smaller sizes in which it is manufactured.

The regulation of the percentage of fat in cream.

The richness, or the percentage of fat, in cream derived from whole milk by the use of a centrifugal separator is regulated by either a cream screw or a skimmed milk

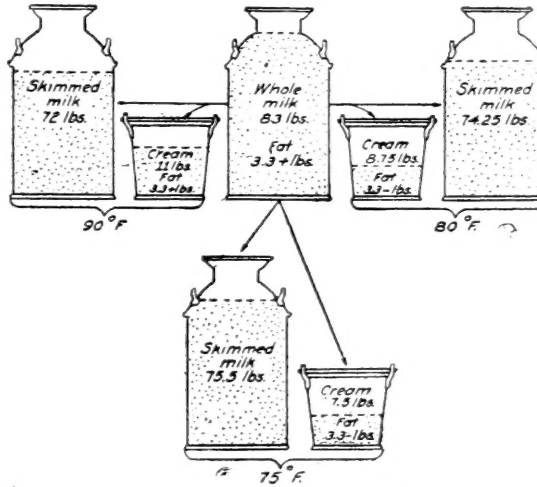

FIG. 85.—*A comparison of the amounts of cream from one can of whole milk separated at different temperatures. The pounds of fat in the whole milk and in each pail of cream are practically the same.*

screw. Two main facts should be remembered in this connection by the person operating a centrifugal separator when he sets either of these screws. The first of these facts is that the richness of the cream depends

on the point in the bowl from which it is drawn. The richest cream is that which is drawn from the centre of the bowl, and the richness decreases as the distance from the centre of the bowl increases. The other fact is that the smaller the proportion of cream is to skimmed milk, the richer the cream is in fat. The percentage of fat in cream should be regulated according to the use that is to be made of the cream. Ordinarily for churning purposes, the proportion of cream to skimmed milk should be approximately one to eight, or one to ten. For example, in one hundred pounds of whole milk testing 4 per cent. fat, there are four pounds of fat (100 pounds × 4 per cent. = 4 pounds fat). In ten pounds of cream that have been separated from the given 100 pounds of whole milk and that test 40 per cent. fat, there are approximately four pounds of fat (10 pounds × 40 per cent. = 4 pounds). If there is no waste, there are 90 pounds of skimmed milk (100 pounds — 10 pounds = 90 pounds). The ratio of the cream (10 pounds) to the skimmed milk (90 pounds) is one to nine. If cream having a lower percentage of fat is desired, this ratio will be less. Cream with a lower percentage of fat is often used on the table and for making ice cream. In separating cream for these purposes the ratio of cream to skimmed milk should be about one to four, to five, or to six, depending on the percentage of fat in the whole milk. It is readily seen that a comparison of the quantities of cream and skimmed milk obtained in separation gives a close approximation of the percentage of fat in the cream. These ratios are shown in Fig. 85, which also gives the results of temperature study of one separator. This topic is discussed later in the lesson. The figure makes clear the fact that if cream with a high percentage

of fat has been separated, no more fat has been obtained from a given amount of whole milk than if the cream has a low fat content, for the weight of the cream is less.

If a well-made centrifugal separator is operated properly, it will separate cream containing as high as 45 to 50 per cent. of fat, and there will be only the normal loss of fat in the skimmed milk. Usually it is not desirable that cream should contain more than 40 to 45 per cent. of fat, for very rich cream is wasted by sticking to cans, dippers and other utensils, and it is difficult to obtain a representative sample of it for testing.

The fat content of cream cannot be controlled to a definite percentage by the regulation of the cream screw or the skimmed milk screw, and the percentage of fat in cream will not remain constant even when these screws are not changed. There are certain factors that affect the percentage of fat in cream to a greater or less degree as it is being separated*. The effect of these factors on the percentage of fat in skimmed milk is not so noticeable as their effect on the percentage of fat in cream.

Factors that affect the percentage of fat in cream and in skimmed milk separated by a hand centrifugal separator.

The temperature of the whole milk.—The temperature of milk that is being separated should be such that the milk will flow easily, in order to facilitate rapid and thorough separation of the cream and the skimmed milk. The temperature does not need to be as high as the body temperature of a cow, which is normally about 101.4° F.; however, if the separation is done on the farm, milk

* A more complete study of the conditions that affect cream separation is recorded in Bulletin 360 of the Cornell University Agricultural Experiment Station.

should be separated as soon as possible after it has been milked, especially in the winter. In creameries and in other places where milk is separated after it has cooled, the temperature of the milk should be raised to 85° to

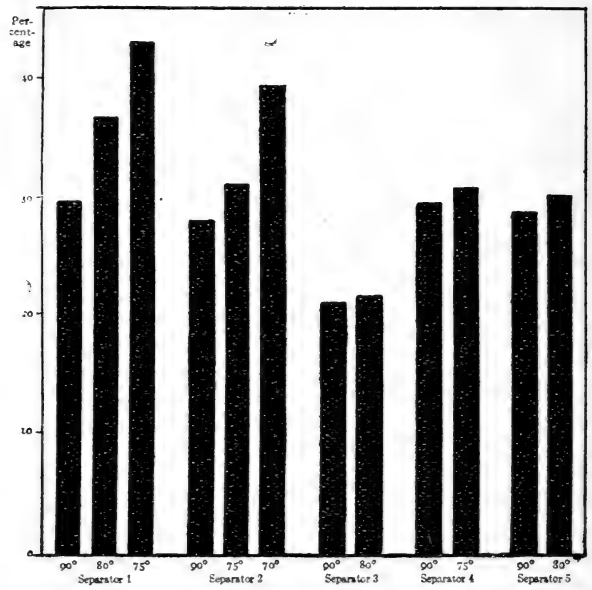

FIG. 86.—*A diagram representing percentage of fat in cream as influenced by the temperature of the whole milk. Temperatures are expressed in degrees Fahrenheit.*

90° F. before it is separated. The temperature of the whole milk has a direct effect on the percentage of fat in the cream and the skimmed milk. In order to show the exact effect of variation in temperature, tests of

cream and skimmed milk that had been separated by five different types of separators were made. The results of these tests are given in Figs. 86 and 87. The cream and the skimmed milk separated by all of the separators were not affected alike by different temperatures. From a study of Fig. 83, it may be thought that there is an advantage in having the whole milk at a low temperature

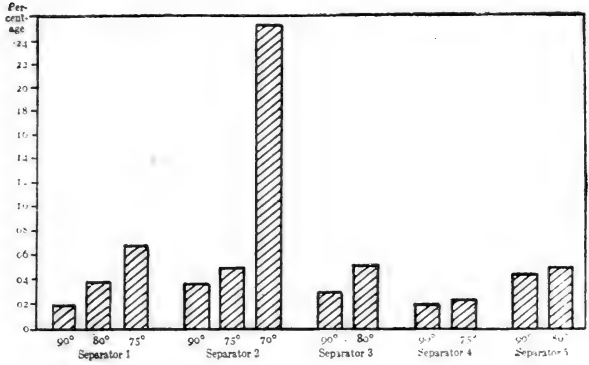

FIG 87.—*A diagram representing percentage of fat in skimmed milk as influenced by the temperature of the whole milk. Temperatures are expressed in degrees Fahrenheit.*

because the cream from two of the separators contained a much higher percentage of fat when the temperature was low than when it was normal. However, the loss of fat in the skimmed milk was comparatively greater, as shown in Fig. 87. When the amount of fat in the skimmed milk does not vary greatly, the amount of cream from a certain quantity of whole milk decreases in direct proportion to the increase of the amount of milk-fat in

the cream. This fact is clearly brought out in Fig. 85. It should be noticed in Fig. 85 that the weight of the fat in the whole milk and in all three pails of cream was approximately the same, but that there was a distinct variation in the weight of the cream.

The rate of speed.—The centrifugal force that causes separation in the modern separator is produced by the rapid revolving of the bowl. The separator bowl about

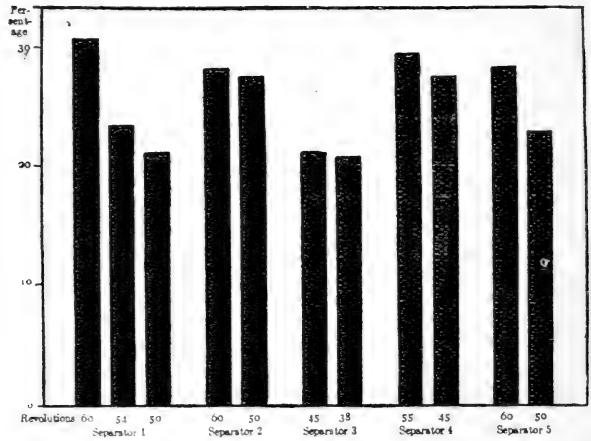

FIG. 88.—*A diagram representing percentage of fat in cream as influenced by the number of revolutions of the separator crank per minute.*

four inches in diameter makes approximately 9,000 revolutions per minute. Thus a point on the circumference of the bowl travels at the rate of somewhat less than two miles per minute. The number of turns of the crank necessary to effect thorough separation of

milk varies for different machines from 45 to 65 turns per minute. A slight variation in the speed of the crank has a great effect on the velocity of the bowl; and care must be exercised in producing a uniform speed, if uniform results are to be expected. The effect of a decrease of six or ten revolutions of the crank per minute on the percentage of fat in the cream is considerable, as shown in Fig. 88; and the effect on the percentage of fat in the skimmed milk is very slight, as shown in Fig. 89. A slight variation in the speed of the crank does not affect the amount of fat separated from the whole milk, but it does affect the quantity of the cream separated.

All hand separators have the number of revolutions of the crank necessary for efficient separation marked on the crank, and all power separators have instructions as to the proper rate of speed at which they should be

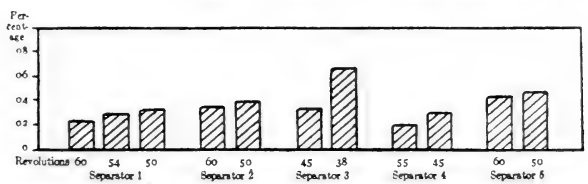

FIG. 89.—*A diagram representing percentage of fat in skimmed milk as influenced by the number of revolutions of the separator crank per minute.*

operated. Naturally the manufacturer is careful not to state a rate of speed for his separator that will give results just above the border line of poor separation. If these instructions given by the manufacturers are followed carefully, the separation of milk will be found to be thorough. The fact is, however, that the rate of

speed may drop several hundred revolutions of the bowl below the number designated for correct speed, and still the skimmed milk will contain approximately the same percentage of milk-fat as when the bowl is revolving at the so-called normal speed. In the case of the hand separators this amounts to five or ten revolutions of the crank less than the number given for normal speed.

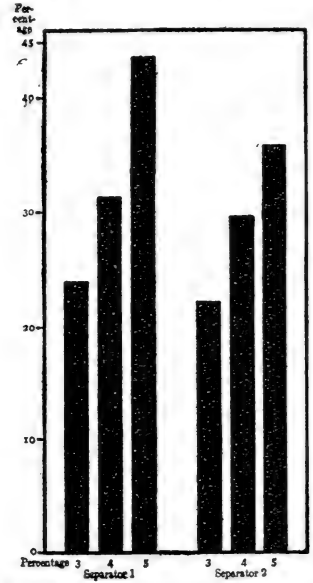

FIG. 90.—*A diagram representing the percentage of fat in cream as influenced by the percentage of fat in whole milk. The figures on the left of the diagram represent percentage of fat in cream, and those underneath represent percentage of fat in whole milk.*

Percentage of fat in whole milk.—The percentage of fat in whole milk is variable. In this respect the milk from individual cows may vary as much as two or three per cent. from one milking to another, and yet the cow may appear to be in a normal condition. The fat content of the milk of a herd is not so variable as the fat content of the milk from a single cow. Other things being equal, the larger the herd is, the smaller is the variation of the fat content of the milk. The difference in the percentage of fat in milk is not so great from day to day as it is from

milking to milking, and this variation is still less from week to week and from month to month. The influence of a variation in the fat content of the whole milk on the percentage of fat in the cream is shown in Fig. 90. The

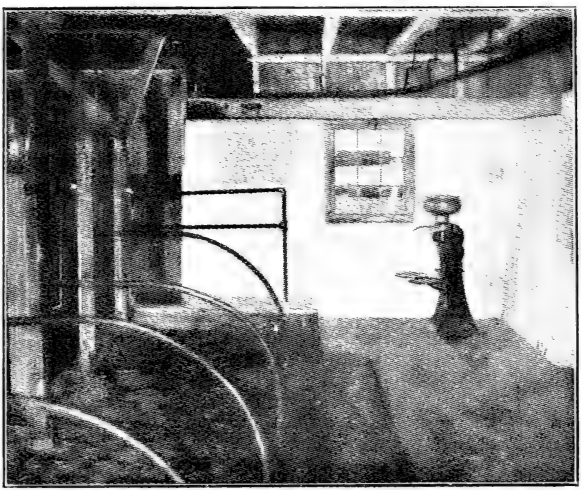

FIG. 91.—*The barn is not a desirable location for a separator.*

percentage of fat in the cream is in almost direct proportion to the percentage of fat in the whole milk.

Variation in the quantity of whole milk or in the amount of liquid used for flushing.—There is a variation in the quantity of milk from one milking to another, and this causes a variation in the amount to be separated from one time to another. There are very few persons operating

separators who use a fixed amount of skimmed milk or water for flushing the separator bowl. For the hand machines two or three quarts of flushing material are sufficient. The amount of flushing material that goes into the cream is only a small percentage of the total, and it affects only slightly the percentage of fat in the cream. Under average conditions these factors are not of much importance if approximately the same quantities of milk and flushing material are used each time.

Slime deposit.—If the passages for the cream and the skimmed milk in a separator are closed or partly closed by slime deposit, the efficiency of the separator will be affected. The slime deposit is composed of fibrin from the milk and of dirt, and it accumulates in a greater or less amount even from the best of milk. Generally, this accumulation is not sufficient to cause excessive loss of fat in the skimmed milk if the separator is run the length of time of the average separation. The length of the period of separation will be considered later in the lesson.

ADVANTAGES OF THE CENTRIFUGAL METHOD OF CREAM SEPARATION OVER THE GRAVITY METHODS.

1. Ordinarily, fewer utensils are used in the centrifugal method than in the gravity methods. If the herd is composed of only two or three cows, this may not be true; but if there are eight to ten cows, it is true.

2. The skimmed milk that has been separated from the cream by a centrifugal separator is fresher and warmer for use in feeding stock than the skimmed milk produced by the old methods. This may not be an advantage in some cases; however, in no case is it a detriment.

3. The fat, which is the most valuable constituent of milk, is immediately obtained in a small quantity and is

therefore more readily cooled and otherwise handled. If the old gravity methods of separation are used, about 36 hours are required for the cream to "rise."

4. Cream separation by the centrifugal method is more thorough than by the gravity methods because less milk-fat is left in the skimmed milk.

FACTORS TO BE CONSIDERED IN BUYING A CENTRIFUGAL SEPARATOR.

A question that comes to the purchaser of a cream separator is, "Which is the best separator?" Since improvements in the construction of separators are

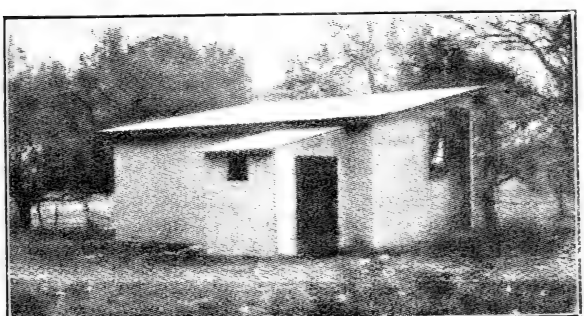

FIG. 92.—*A convenient and inexpensive building in which to make farm butter. The gasoline engine is located in the lean-to.*

being made constantly, it is impossible for any one person to collect sufficient data to determine this point. However, there are a few points concerning separators that should help to guide the buyer of one. The following is a list of these points:—

1. *Size.*—Ordinarily for farm use, a separator should be of such a size or such a capacity that it will separate the milk produced by a herd at one milking in one-half hour or less time. Usually a farmer's time is worth enough to make it cheaper for him to buy a separator that is large enough to do his separating in the proper length of time than it is for him to use more of his time in operating a smaller machine.

There are conditions on the farm that must be considered in the selection of a separator of proper size. It may be the plan of the farmer to increase or decrease the size of his dairy herd, and, since a separator will wear for many years, these plans for the future must be borne in mind. In buying a separator for creamery use, both the maximum and minimum amounts of milk for different seasons of the year should be considered.

2. *Supplies for repairing purposes.*—The obtaining of supplies without difficulty is one of the most important considerations in buying a separator, and this point should be especially emphasized in localities where transportation facilities are rather limited. Most of the companies manufacturing cream separators have supply centres in many sections of the country, so that in case of a breakdown new parts can be quickly obtained. Some dealers in separators carry a stock of supplies.

3. *Other factors.*—The other factors to be considered need but little discussion. The following ones are mentioned so that the prospective buyer of a separator may have a fairly complete list of the points to be considered. The factors are: preference to certain makes; price; amount of power required for operation; accessibility to parts; and number of parts to be cleaned; simplicity of entire construction; indication of dura-

bility; efficiency, as shown in the amount of milk-fat left in the skimmed milk and as shown in the ability of the separator to separate the guaranteed number of pounds of whole milk per hour.

THE LOCATION OF A CREAM SEPARATOR.

The location of a separator in a creamery is not so difficult a problem as the finding of a suitable place

FIG. 93.—*A satisfactory building in which milk may be handled in a sanitary manner, and a good location for a separator*

for a separator on some farms. The two main considerations in either case are sanitation and convenience. The separator should be placed in such a position that

during the period of separation the milk and the cream will not come in contact with bad odours and sources of contamination from micro-organisms. In creameries or other large dairy plants no such sources of trouble should exist. On farms separators are often placed in barns and in some cases behind the cows, as

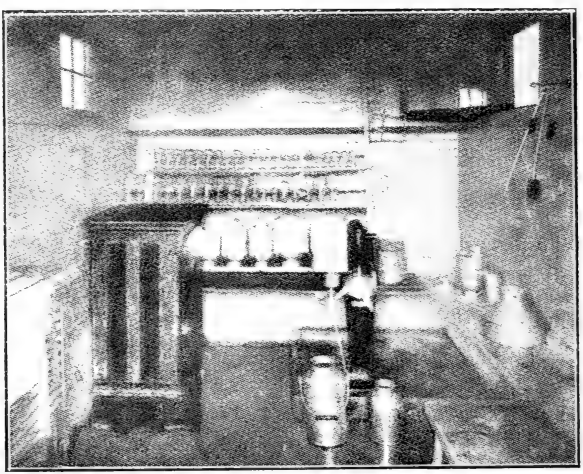

FIG. 94.—*Interior view of the building shown in Figure* 93.

shown in Fig. 91. Under no circumstances should a separator be placed in such a position, even though it is convenient to the cows, and to the calf pens and the pig pens where the skimmed milk is fed.

There are probably more hand separators located in the kitchen than in any other one place on the farm,

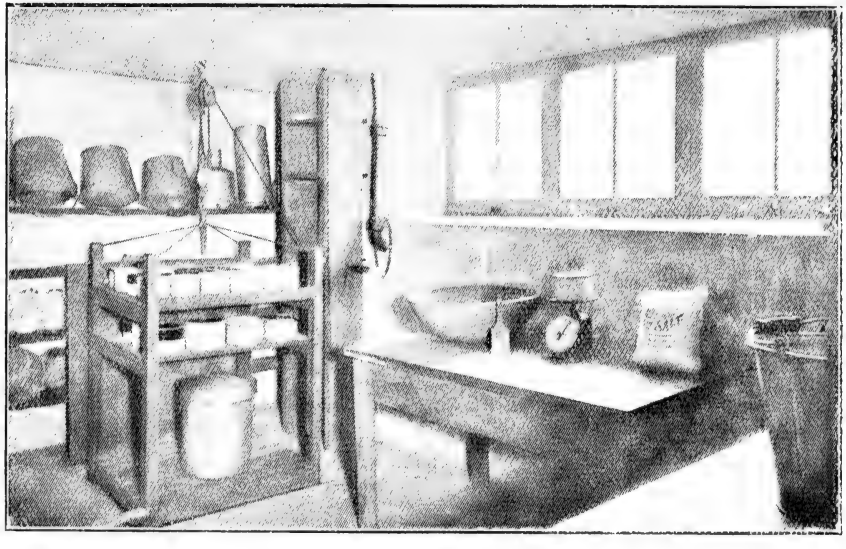

FIG. 95. *A well-lighted butter-making room, located in the basement of the house on Elm Place, owned by L. D. Cowden. The frame on which the butter jars and the cream pail are set can be lowered into the cooling pit*

especially during the winter. The kitchen is a convenient location for a separator because it is a comfortable place in which to work, and it is near the source of hot water, which is absolutely essential in the proper care of dairy products. The woodshed is also usually near the source of hot water and is likewise a convenient place for a separator. Either the kitchen or the woodshed may be used with satisfactory results if the floor is sufficiently solid to prevent vibration of the machine when it is in operation, and if proper precaution is exercised in ventilation and in the prevention of such odours as those coming from burned bacon, cabbage, onions, and the like. The one great objection to handling dairy products in the kitchen, which is often the living room of the house, is caused by the danger of spreading pathogenic organisms, in case any member of the family has a contagious disease. It is therefore preferable to have the separator in a separate room or building, even if it is necessary to take the moveable parts to the kitchen for cleaning.

A separate milkhouse, or dairy building, is recommended in cases where the dairy herds are larger than the average, which is probably less than ten cows if cream is separated on the farm; in cases where cream of a special grade is being produced; in cases where conditions in the house are too crowded; or in cases where it is desirable to use a power-driven separator. Examples of neat and simple buildings are shown in Figs. 92 and 93. The dairy house in Fig. 92 is a plain building with unfinished interior. It is twelve feet by sixteen feet in size, and the cost of construction, according to the owner's statement, was about $65. The drainage is through a trap into a drain leading to a gravel bed. This building houses a complete outfit for

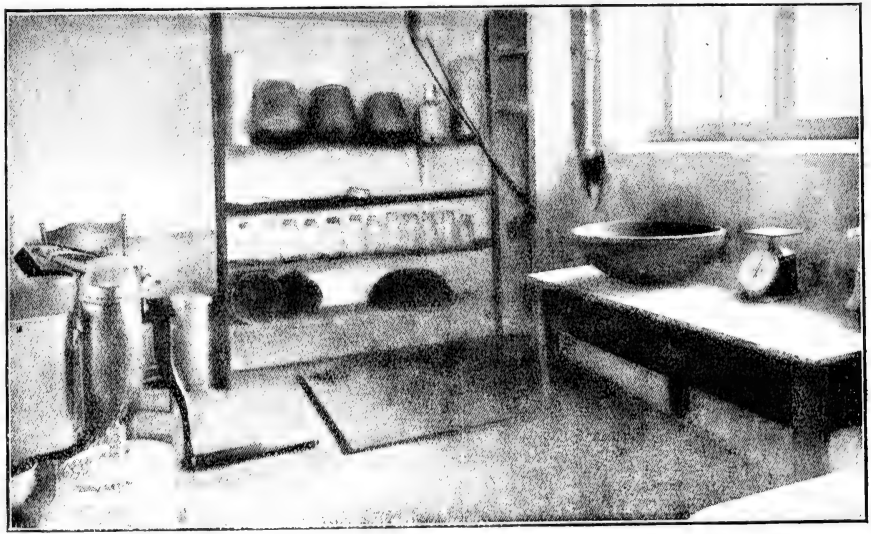

FIG. 96.—*The same room with the trapdoor closed over the cooling pit. The equipment is simple and substantial.*

making butter on the farm, including a cream separator. The building in Fig. 93 is a little more expensive and is better finished than the building just described. The view of it in Fig. 94 shows a brick veneer that makes cleaning a little easier than when the interior of the building is left unfinished. The size of this building is ten feet and six inches by fourteen feet.

SUGGESTIONS IN REGARD TO THE PLACING AND THE OPERATING OF A CREAM SEPARATOR.

1. *The placing of the separator.*—A centrifugal separator is a very delicate piece of machinery. It should be carefully placed in a level position on a solid and sanitary base. It should be held in place firmly but not rigidly. It is therefore advisable not to screw the lag screws down tight unless it is so directed by the manufacturers in the printed instructions that accompany each machine.

2. *The adjustment of the parts of the bowl.*—The bowl devices of a separator must be placed in the bowl in proper position so that the bowl will run with perfect poise. Many separators are turned with difficulty because the bowls are not properly balanced, and a separator cannot do efficient work when the bowl is not in proper working order. The rubber ring that is used to seal the bowl must be sufficiently soft in order to make the joint milk-tight. If the rubber ring is hard, it should be held in warm water until it is softened.

3. *The oiling of the separator.*—Constant care of a separator is necessary in order to supply the proper kind and amount of oil. Manufacturers of separators give directions concerning this subject.

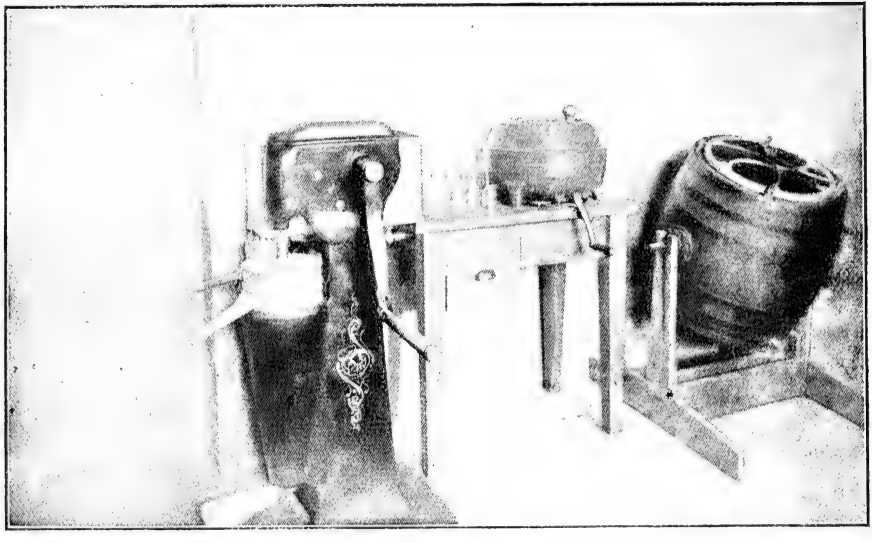

FIG. 97.—*Another view of the same room. The walls and floor are smooth, and thus are easily cleaned*

4. *The temperature of the whole milk.*—Mik that is to be separated should be of a proper temperature. This is essential to the efficient operation of the separator, and this fact is brought out in Figs. 86 and 87.

5. *The place for the milk when the separator is started.*—The supply tank should be be filled with whole milk before the separator is started.

6. *The cream container and the skimmed milk container.*—A pail and a milk can may be used as receptacles under the skimmed milk spout and the cream spout, respectively.

7. *The rate of speed.*—The rate of speed at which the separator is operated is important, as shown in Figs. 88 and 89. The subject is discussed in connection with these figures.

8. *The inflow.*—When a separator is running at the proper rate of speed, the gate of the supply tank should be opened wide so that the proper amount of milk will flow into the bowl. If this is not done, the separator is not likely to separate at its rated capacity. The float, if working properly, will maintain a uniform flow of milk into the bowl.

9. *The flushing of the bowl.*—The bowl should be flushed with enough skimmed milk or water to force the cream out of it. Usually skimmed milk should be used for this purpose because no additional micro-organisms can get into the cream and the skimmed milk through its use; whereas, if water is used, there might be some bacteria present that would cause the cream and the skimmed milk to become tainted with undesirable flavours, even though the water is good for drinking purposes. Usually two quarts of skimmed milk run through the bowl

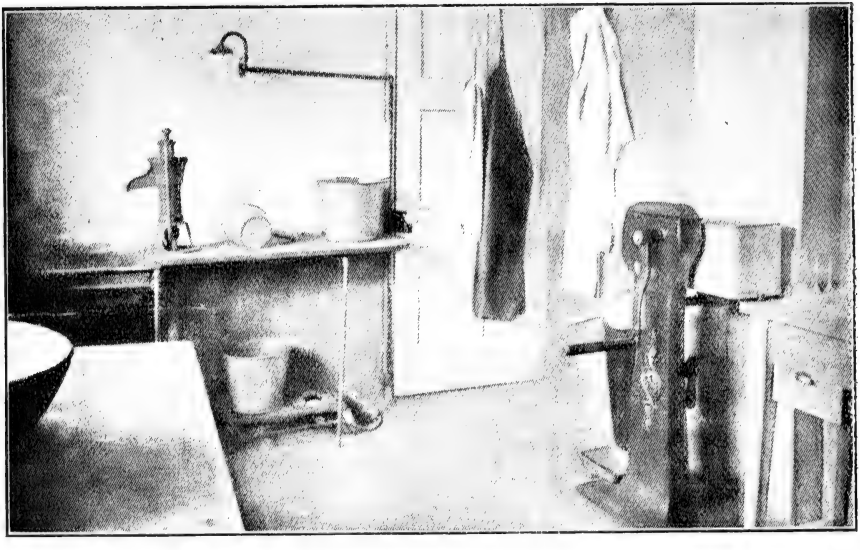

FIG. 98. — *View of the same room, showing the water supply and sink. Notice the clean clothes that are used for dairy work only.*

while it is revolving at the full rate of speed is sufficient for flushing, but the amount depends more or less on the size of the separator bowl, the percentage of milk-fat in the cream, and the temperature of the whole milk. If the cream is rich in milk-fat and the temperature of the whole milk is low, some warm water, having a temperature of about 120° F., should be run through the bowl in order to carry out the milk-fat. This should be done after the bowl has been flushed with skimmed milk. Care should be exercised not to use so much water that the cream will be greatly diluted.

10. *The setting of the cream screw or the skimmed milk screw.*—In case the percentage of fat in the separated cream has not been regulated, it is a good plan to run water through the separator bowl while it is revolving at the proper speed. The screws should be set so that about one eighth or one tenth of the water should flow from the cream spout, if the cream is to be used for churning purposes. A more complete discussion of this subject is given on page 8.

SUGGESTIONS CONCERNING THE CLEANING OF A SEPARATOR.

1. *Rinsing the parts of a separator.*—The interior parts of the separator that have come in contact with the milk should be rinsed with lukewarm or cold water. If hot water is used, the casein of the milk is likely to be precipitated on the utensils, and it is rather difficult to remove after it has hardened because it adheres very closely.

2. *Cleaning the parts of a separator with washing solution.*—Water alone is not sufficient to use for cleaning a separator. A very good washing solution may be

made by dissolving about a level tablespoonful of washing powder or a sufficient amount of soap in a gallon of water that is as hot as the hands can bear. The solution should be strong enough to remove all grease from the parts of the separator; and a brush, not a cloth, should be used in washing them, for the use of the brush is a more sanitary practice.

3. *Thorough scalding of the parts of the separator.*—All removable parts of the separator should either be plunged in water that is near the boiling point and kept there for at least a minute, or be thoroughly steamed. If hot water is used, it will kill most of the bacteria on the parts of the separator, will rinse off the washing solution, and will give sufficient heat to dry the parts. Do not use a cloth for drying these parts, for the bacteria on it are likely to be smeared on the clean surfaces. The hot-water receptacle should be large enough to hold a pail while it is being scalded, and it should be suitable for placing on the stove or over a steam jet. If the dairyman does not have such a receptacle, boiling water may be poured over the parts of the separator; however, this is not so effective as plunging the utensils beneath the surface of the boiling water. After the parts are dry, they should be placed where dust and flies cannot reach them.

The directions given for cleaning a separator should be followed in cleaning all of the utensils that are used in the care and handling of milk. Cleanliness concerning these utensils cannot be over-emphasized.

LOCATION OF THE BUTTER ROOM.

It is often difficult to determine the proper location of a room for making butter on the farm, because of the expense involved in construction. Probably the average

herd, on farms where butter is made, does not exceed ten cows. In New York State the average cow whose product goes into farm butter produces not over 150 pounds of butter-fat each year—at least less than one half pound daily. This would mean a churning of only ten pounds every alternate day. For this small amount of butter, or for even three or four times as much, only a small outlay for equipment can be made.

In Figs. 95, 96, 97, and 98 are shown different views of a small room which was provided in the cellar of the house on Elm Place, Fredonia, New York. Usually, the cellar is not considered to be the best place for a dairy room. It has certain advantages, however, if it is properly drained, is free from the usual odours of the cellar, and is well ventilated. First, it is near the kitchen where hot water may be obtained; secondly, the temperatures of a cellar are more easily regulated during the various seasons of the year.

It will be noticed that modern equipment has been obtained for use in this dairy of about twelve cows. The small-top milk pail and the Babcock test aid in the production of a high-class product and in the execution of business methods. The frame on which the cream and the butter sit may be dropped into the cooling pit. When the trapdoor is closed, fairly satisfactory temperatures are secured. The water is heated by gas. On farms where there is no gas, hot water can be conducted from the kitchen boiler.

CREAM-RIPENING.

It is difficult to advise the farmer regarding the souring, or ripening, of cream because of varying conditions. It is a question whether or not the average farm buttermaker can afford to use starter, which is a culture of

lactic-acid-producing organisms that should be used in creameries ; for, in the first place, few farmers are trained to handle the propagation of these bacteria properly, and, in the second place, the amount of starter that he would use is so small that he could probably obtain better results by spending his time in being more careful in the care of the milk and the cream. For information on the propagation of starter, see Circular No. 13 of the Cornell University Agricultural Experiment Station.

Under ordinary conditions the cream should be cooled to 50° F., or to a still lower temperature, as soon as it is separated. On the second day it should be ripened by raising the temperature to 70° or 80° F. and maintaining that temperature until a mild acid flavour is developed. The cream may be held for several days if the flavour remains good ; if it is likely to become strong it should be churned before reaching this stage.

Sometimes a bitter flavour develops. In order to prevent it, the cream should be ripened as quickly as possible after separation. In this case the ripening process might be conducted as follows : Set the freshly separated cream at about 70° F. When the next separation is made, put the warm cream into the can with the first separation, which is partly soured, and stir thoroughly. Continue this process for two or three days. Care must be exercised in controlling the temperature so that the cream will not be over-ripened. On the second and third days, perhaps, the ripening temperature will have to be dropped to 60° or 65° F.

Another method would be to add a small amount of buttermilk to the first batch of cream, which would serve as a starter. The reason why this method should be used in case a bitter flavour develops is that the bitter flavour is produced by bacteria which grow in

milk and cream at temperatures of 50° F. or below; the bacteria will not grow even at these favourable temperatures if the cream is sour.

CHURNING.

Nearly all churns are made of wood, for wood is a good non-conductor of heat. Metal churns are more sanitary than wooden churns, but are impracticable, for the fat adheres to them; and it is more difficult to control temperatures in metal churns.

Important factors in the churning quality of cream.

Temperature.—Temperature is the most important factor influencing the churning process. The butter-fat globules should be sufficiently warm to cohere, but on the other hand the temperature should not be so high as to cause greasy butter, increased loss of butter-fat in the buttermilk, or the incorporation of too much buttermilk in the butter. In the hand churn, with well-ripened cream testing 30 to 40 per cent. butter fat, the temperature should be 56° to 62° F. After the ripening process and several hours before the cream is placed in the churn, the temperature should be lowered to the proper degree for churning. The reason for this care in cooling the cream is that it requires some time for the fat to recrystallize, or harden.

The butter-maker should regulate the temperature, the richness of the cream, and all other factors, in order that the butter will not have a broken grain and be greasy, but will be firm and waxy. He must remember that the proper churning temperature is that at which the churning process will require 30 to 45 minutes when all of the other factors are normal.

Richness of cream.—It is easy to understand that rich cream, in which there is a comparatively small amount of serum, will churn more readily than cream containing a greater amount of serum, which interferes with the concussion of the fat globules. For easy churning the cream should contain 30 to 40 per cent. of butter-fat. Thin cream is often the cause of difficult churning. Sometimes it is necessary to churn cream with a low percentage of butter-fat, but this is done at the expense of time or the quality of the butter, and often of both. If the cream is too rich in butter-fat, it will adhere to the sides of the churn. This may also cause difficult churning.

Ripeness of cream.—Ripe, or sour, cream is less viscous than sweet cream, and it therefore churns more easily.

Condition of butter-fat.—The kind of feed given the cows has a marked effect on the condition of the butter-fat. In winter, when the cows are on dry feed, usually the fat is harder than in summer. The condition of the butter-fat is also affected by the breed of the cow, her individuality, the stage of her lactation period, and perhaps a few other factors. Hard fat requires a few degrees higher temperature in churning than soft fat requires.

Size of butter-fat globules.—The size of the butter-fat globules has a marked effect on the churning quality of cream. The large fat globules come in contact with each other much more readily than the small ones do. The size of these small divisions of fat in milk and cream are probably affected by the same factors that control the condition of the butter-fat. Very often a "stripper's" cream is difficult to churn because the fat is hard and the globules are small.

Amount of cream in churn.—The churn should be one third to one half full. There must be enough cream to fall nicely, and yet not so much that concussion does not take place.

Speed of churn.—The greatest possible agitation is desirable. Therefore, the churn must be speeded carefully, not too slow nor too fast. Just before the cream breaks, it is very thick and it adheres to the walls of the churn. At this stage of the churning process the speed should be lessened.

Abnormal micro-organisms.—Certain micro-organisms, such as ropy milk bacteria and yeasts, prevent the cohesion of the fat globules. Difficult churning is the result.

Steps in the manufacture of butter.

1. Have the temperature of the cream right.

2. Place in hot water all the woodenware (ladles, printer, and the like) that may come in contact with the butter.

3. Have the churn clean and so set that it will not turn over.

4. Pour the cream into the churn through a wire, hair, or perforated tin strainer. This operation should not be overlooked, especially if the cream is lumpy.

5. Add the colour to the cream in the churn. Usually one to two ounces of colour per 100 pounds of butter-fat is sufficient. This may vary with different brands of colour and market requirements. If the butter-maker forgets to put the colour in the cream, it may be mixed in the dry salt and worked into the butter. Probably it will be necessary in this case to overwork the butter somewhat in order to distribute the colour and the salt properly.

6. After securely fastening the cover, give the churn eight or ten revolutions and then pull out the plug in order to let the gas escape. It is usually well to hold the hand over the hole in such a way as to prevent the cream from blowing over the room. Return the plug, and revolve the churn fifteen or twenty times more, and again let out the gas. If the churn is not too full, usually two or three stops for this purpose are sufficient.

7. The churning process is nearing completion when the glass becomes clear. The particles of butter should be about the size of a pea or a kernel of corn, for the buttermilk drains off more readily when the granules are of this size than when they are very small. If churned too long, too much buttermilk is incorporated.

8. Drain off the buttermilk through a strainer.

9. In washing the butter, pour in just enough water to aid in draining off the buttermilk. Add about as much water as there was buttermilk drained off. The temperature should be about 54° or 58° F. If it is too high, the butter will be greasy. If it is too low, the butter will be too hard to work in the salt nicely. If the butter is hard, extra working is required and it is likely to be tallowy.

10. After washing, place the butter on the worker or in the bowl that has been thoroughly cooled and distribute the salt over it. If the salt is hard and dry, or cold, and dissolves slowly, it is well to place it in a vessel and just cover it with water at the same temperature as the wash water, or perhaps two or three degrees higher. After standing a few hours the salt will be softened and warmed and will dissolve in the butter much more quickly than when very dry or cold. The amount of salt will depend

on the market. The average is one to one and one-half ounces per pound of butter-fat.

11. The purpose of working butter is mainly to distribute the salt, and secondarily to compact the butter. Do not give the ladles a sliding motion over the butter as this will make it greasy. The working process may be done in a bowl, in the churn, or on a worker. Sometimes it is well to let the butter stand for the salt to dissolve before the working process is completed. If the butter has not been worked sufficiently, mottles may be found in it after it has been in cold storage for a day.

12. As soon as it is worked, the butter is ready to be packed. The packages should be clean and cool, and the butter should be packed firmly. If paper or wooden packages are used, particular precaution must be taken against mould. The kind of package must suit the market.

13. Butter absorbs taints very readily. It should not be kept in the refrigerator or cellar with vegetables, meats, and the like, unless in an air-tight package. In the majority of places where butter is stored, a sufficiently low temperature is not maintained. A refrigerator with plenty of ice is the most satisfactory method of cooling, and, at the present prices of butter, it is the most desirable means of maintaining low temperatures.

MARKETING BUTTER AND ITS BY-PRODUCTS.

The kind of market, the distance from market, the size of the herd, dairy equipment, and the like, must be considered by all dairymen in determining an outlet for their dairy products. If one is to make butter, how shall one obtain the very best trade ?

Above everything else the product must be uniformly good and it must have a neat appearance. If a special price is desired, the butter should be placed in one of the

best stores and be kept in an ice box away from the flavours of groceries. Sometimes butter can be sold on a milk route, the milkman receiving a commission for selling it. Often, a dairyman with a herd of medium size is too far from market to retail whole milk daily. In such a case he might make and sell butter, buttermilk and cottage cheese, and deliver such products only two or three times a week. He would then have the skimmed milk, and perhaps surplus buttermilk, for the stock.

For convenience not only to the consumer, but to the route man, packages of a uniform size should be used. One-pound prints are the best. (Some markets can be trained to take any good and convenient package.) The pound prints should be wrapped in parchment paper (8 by 11 inches). This parchment can be obtained for about $1 per 1,000 sheets. The use of a paraffined paper box or carton, just the right size for the print, is desirable, for it protects the butter from heat and dirt. Cartons and parchment can be purchased of paper or dairy supply concerns. The cartons cost about $3.50 for a single 1,000. The package consisting of the parchment wrapper and carton in small quantities would cost about .45 of a cent per pound of butter. In larger quantities the cost would be less.

Buttermilk sells at 10 to 20 cents per gallon. It can be delivered on the route in two-quart glass bottles. Cottage cheese in cubes of one quarter of a pound each, nicely wrapped in parchment, will sell for five cents.

In catering to a first-class trade, it is desirable that the route man be dressed neatly and that he shall not carry barn odours. It would be well for him to have a clean, washable suit to be worn only on the route. In winter he can wear an overcoat of the washable material over a heavy overcoat, or a jumper suit over his regular suit.

QUESTIONS.

Cream Separation.

1. Why is the question of cream separation so important to the farmer ?

2. Name and define the two forces which are made use of in separating cream.

3. Give the four methods of separation and compare them as to their value to the farmer.

4. Why do manufacturers put skimming devices in separator bowls ?

5. How is the percentage of fat in cream regulated ? Explain your answer.

6. Give the factors that affect the percentage of fat in cream and skim-milk from the separator.

7. What are the advantages of the separator method over other methods ?

8. In buying a separator what factors would you keep in mind ?

9. Where would you place the separator, and why ?
10. Describe the placing, care, and operation of a separator.

11. What is meant by saying that "the making of butter commences as soon as the milk leaves the cow's udder" ?

12. Define lactic-acid culture, cream-ripening.

13. Tell how you would ripen cream for butter-making.

14. What is the churning temperature ?

15. Name and describe eight factors affecting the churning quality of cream.

16. Name the steps in the manufacture of butter from the ripened cream.

17. What are the essentials of good marketing practice in butter and its by-products ?

18. Why is it that the man who sells butter as his chief farm produce has usually a fertile soil on his farm ?

19. In the circumstances under which you purpose settling, will it be good policy for you to engage in butter-making or dairy-farming for creamery business ? Give reasons for your answer.

20. Describe the care and operation of the churn.

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Printers and Stationers,
42-60., Goswell Road,
London. E.C. 1.