

# First Lessons in Dairying

A HANDBOOK SETTING FORTH THE  
UNDERLYING PRINCIPLES OF DAIRY-  
ING FOR THE STUDENT BEGINNER IN  
THE LABORATORY AND ON THE FARM

*By*

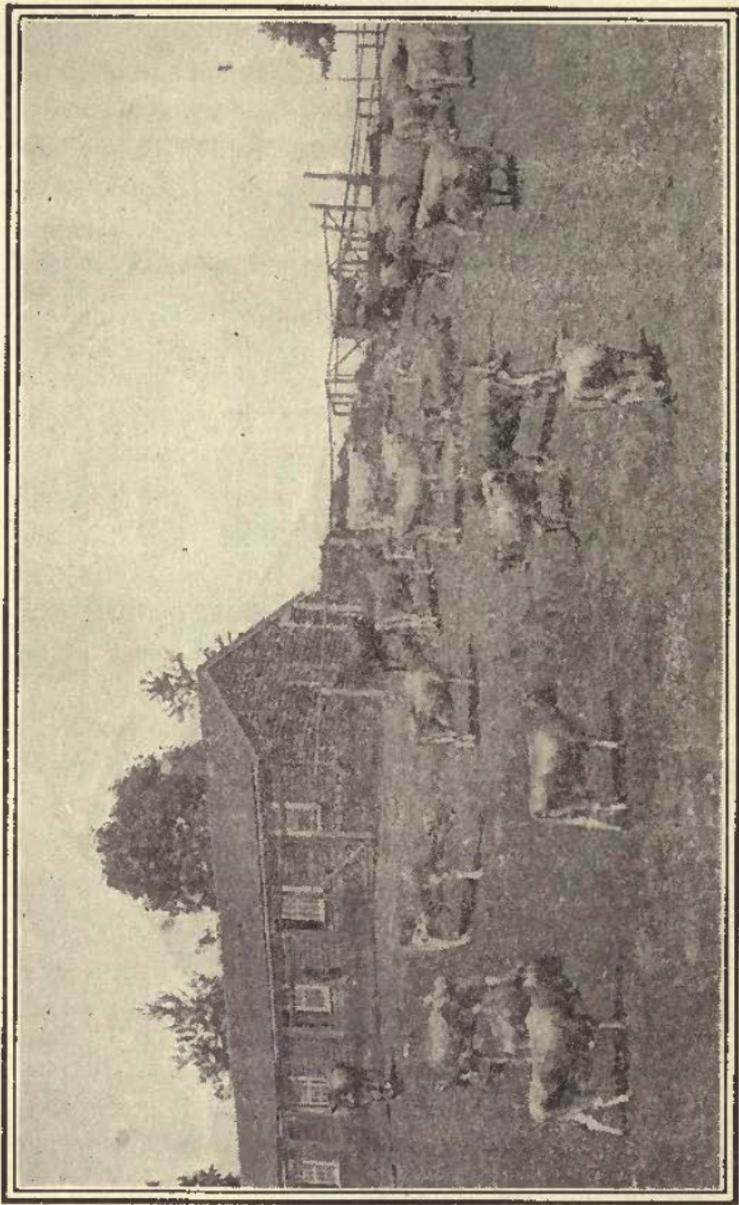
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*ILLUSTRATED*

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FAMOUS JERSEY HERD ON THE HOOD FARM

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GENERAL

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## PREFACE

THE writer was requested to prepare a book that should set forth briefly the underlying principles of dairying for the student beginner, unfamiliar with the terms and laws of bacteriology and chemistry, which are the foundation sciences of dairying, and to suggest practice adapted to the conditions of the farm as distinct from those of the creamery and cheese factory. The underlying principles are the same, but the practice is different in farm and factory butter making.

The accumulating store of dairy knowledge has become too great to satisfactorily present it all in one volume. The problems of the producer have been treated in a recent book, and it is only a year ago that the creamery butter maker was provided with a text book covering his work. Therefore, it is the needs of the farm butter maker and handler of milk for the factory or shipping station that the writer has attempted to meet.

No effort has been made to make detailed acknowledgment of the source of many facts presented, but the works of Profs. H. H. Wing, J. W. Decker, W. H. Dean, McKay and Larsen, John Michels and the Experiment Station bulletins have been freely consulted and literal quotations made without other acknowledgment than this. In other's words, "I have gathered me a posy of other men's flowers, and nothing but the thread which binds them is mine own." H. E. VAN NORMAN.

STATE COLLEGE, PA., January 1, 1908.

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# First Lessons in Dairying

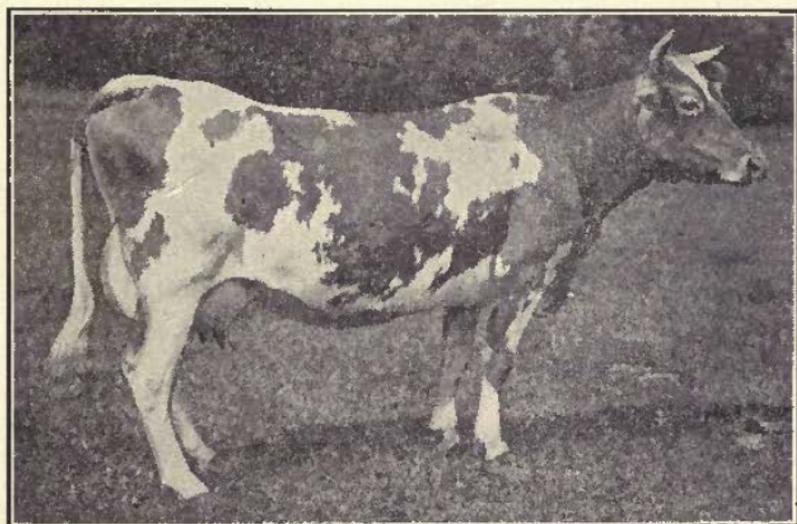
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## CHAPTER I

### Secretion of Milk

**Incentives to secretion.**—The birth of the young is the primary incentive to the secretion of milk by all animals which suckle their young. In some cases manipulation of the secretory glands has induced the secretion of milk.

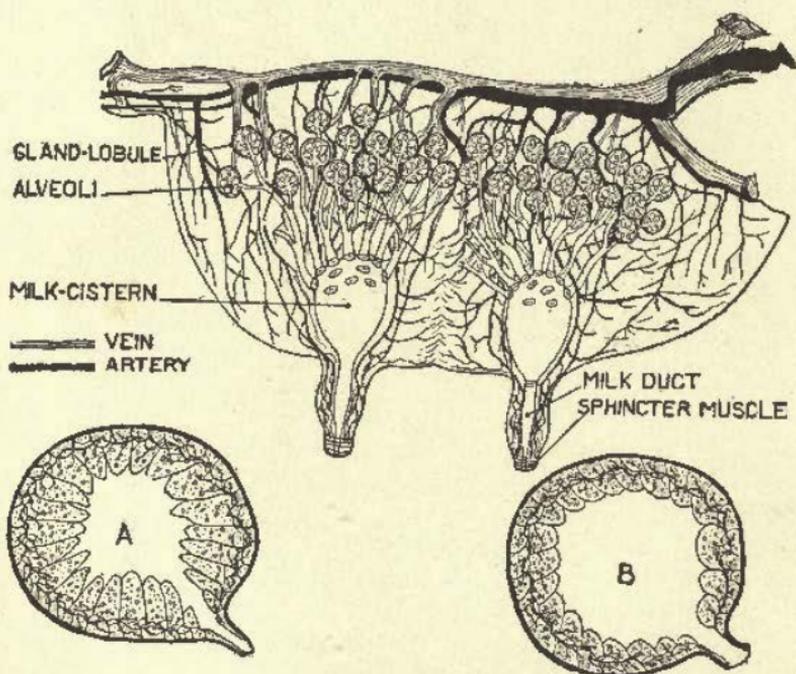
**Development of the udder.**—In the wild animals and the modern scrub cow the udder is small and imperfectly developed. Improved feeding, selec-



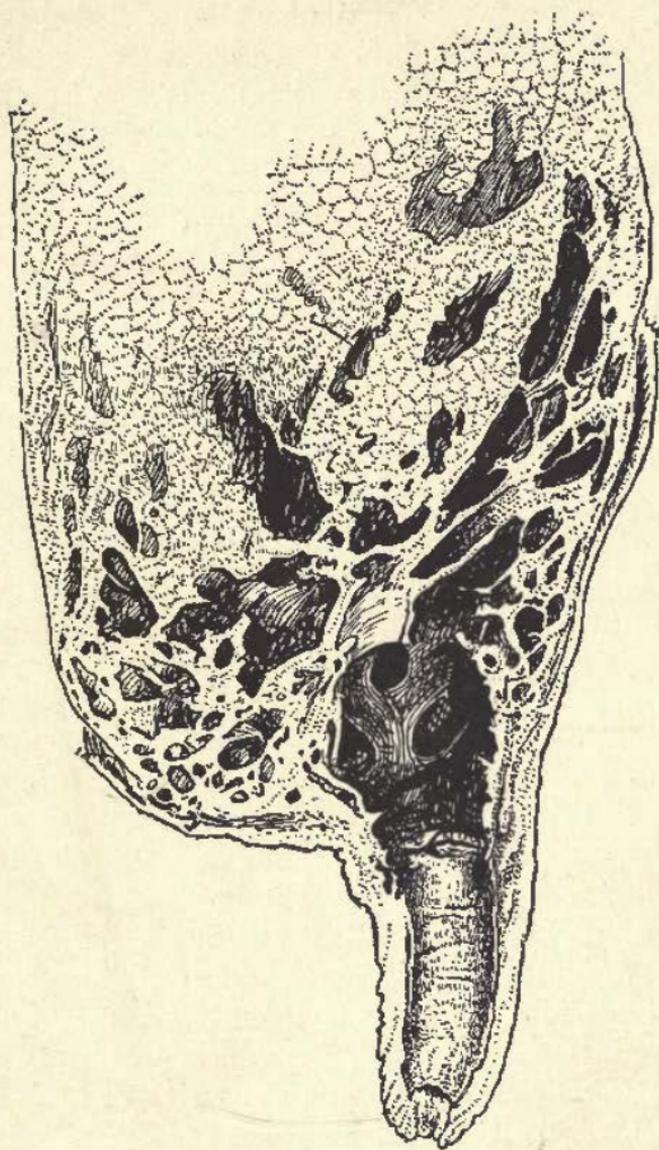
DOLLY BLOOM, FAMOUS GUERNSEY (12,770).  
RECORD: MILK, 17,297 POUNDS; BUTTER FAT, 836.2 POUNDS

tion and breeding have developed the udder of the cow until we have reports of an udder which weighed 41 pounds and 6 ounces; another which measured nearly 6 feet in circumference, or within 6 inches of the animal's heart girth; and others that have secreted over 100 pounds of milk in a day, another more than the animal's weight of milk in less than two weeks and its own weight of butter fat within a year, and over ten tons of milk within a year.

**Structure of the cow's udder.**—The udder of the cow is described as one large gland with four distinct



CROSS SECTION OF COW'S UDDER AND ENLARGED ALVEOLI SHOWING:  
*A*, EPITHELEAL CELLS ENLARGED, AS WHEN GIVING MILK, AND  
*B*, THE SAME WHEN NOT IN MILK



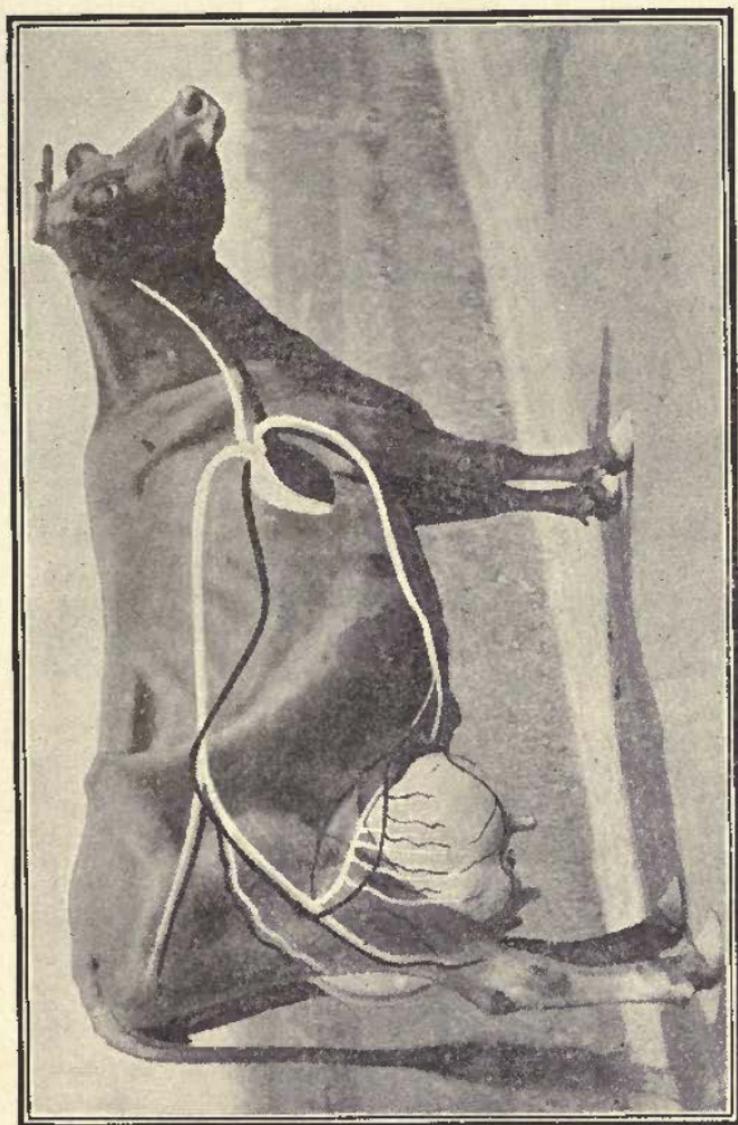
LONGITUDINAL SECTION OF A QUARTER OF AN UDDER

quarters, also as two separate glands. It is suspended from the abdominal walls in a fibrous capsule, and is held together by fibrous tissue. Doctor Bitting has shown by injecting colored liquids through the teats that the halves are again very distinctly divided into two parts, and that only the milk produced in any quarter can be drawn from the corresponding teat.

A longitudinal section of a quarter and teat shows that the opening of the teat is guarded with a sphincter muscle. A cavity through the length of the teat is lined with folds of tissue, and just above the teat is another cavity known as the milk cistern. This is not large, holding but a few ounces, and ducts open from this into the tissue of the gland. These ducts divide into smaller branches, which eventually end in little groups of cavities, the alveoli or ultimate follicles. These alveoli are in groups which may be likened to a small bunch of grapes. They are lined with epithelial cells and surrounded by a network of little blood vessels, which nourish them. They vary in size from  $1/250$  to  $1/100$  of an inch in length and from  $1/1300$  to  $1/800$  of an inch in diameter.

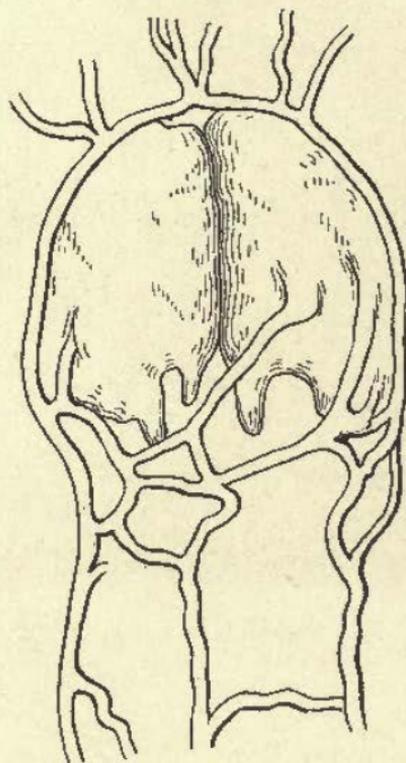
The blood leaves the heart through the posterior artery which divides in the region of the hips. Here it again divides into two arteries, the common iliacs, and again into two more arteries, from which, after these have divided into many small capillary arteries, the cell tissue in the alveoli is fed.

**Milk veins.**—The cells use such portions of the blood as they need, and capillary veins begin to



SCHEMATIC SHOWING OF THE CIRCULATORY SYSTEM BETWEEN THE HEART AND THE UDDER

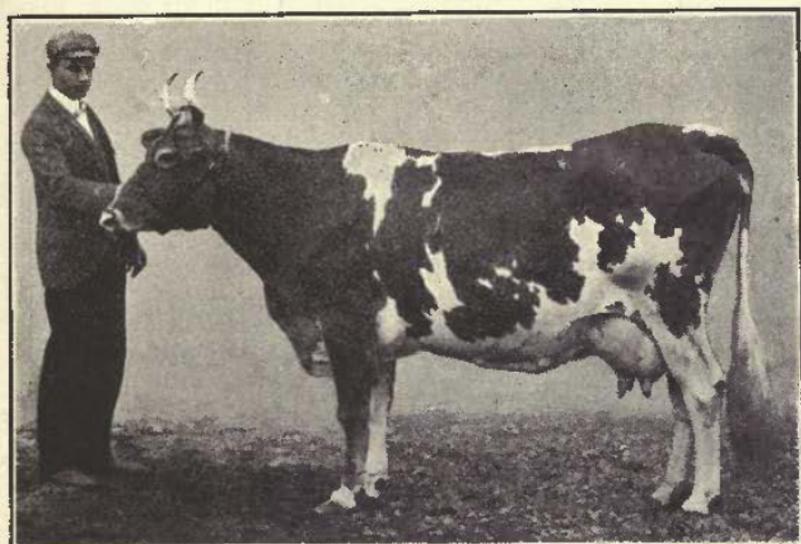
gather the venous blood into ever enlarging veins, until it is collected in large veins just under the skin and surrounding the upper part of the udder much like a rope tied around it. From this surrounding vein, or rather group of veins, for, accord-



THE VEINS AROUND THE BASE OF THE UDDER

ing to Bitting, there are from fourteen to seventeen of them, large veins run from the fore part and posterior part of the udder back to the heart. These are the so-called milk veins. They do not contain milk, but are an indication of the milk-making capacity of the udder, in so far as they

indicate the quantity of blood carried from the gland. If there happens to be pressure on the anterior veins, the blood may return to the heart by way of the posterior veins. The veins which run forward are often very torturous and may branch several times. They enter the chest wall through



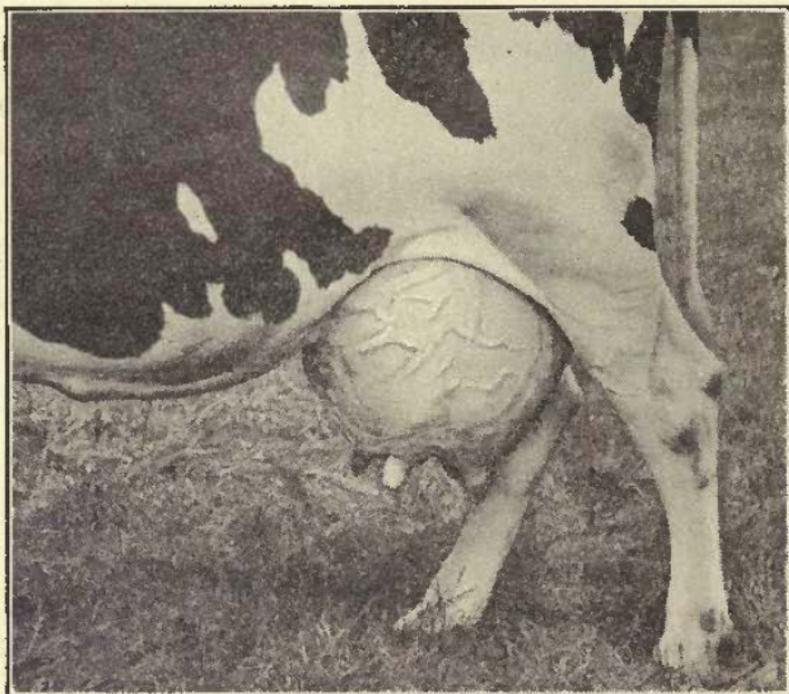
MARY MARSHALL, A GUERNSEY WINNER AT THE PAN-AMERICAN EXPOSITION; HAS LARGE, TORTUOUS MILK VEINS AND EXCELLENT DAIRY CONFORMATION

openings, termed milk wells, which are sometimes large enough to insert the end of the finger. Large tortuous veins are considered an indication of ability to secrete large amounts of milk. However, if the hole in the abdominal wall is small these large veins may be the result of congestion of the blood at that point.

**Theory of milk secretion.**—The work of the mam-

mary glands is secretory. Milk as such does not exist in the blood or elsewhere in the body. Dean says the source of the different milk constituents are probably somewhat as follows:

“The water is derived from the food and drink of



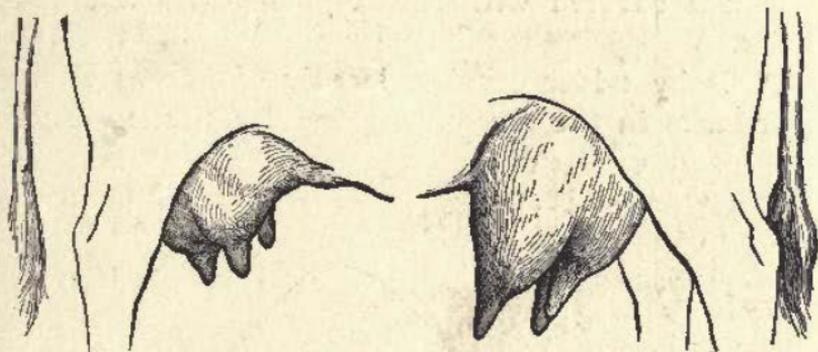
LARGE MILK VEIN, AND PROMINENT VEINS ON THE UDDER

the cow by transudation from the blood, hence the importance of clean food and pure water for the cow.

“The fat comes from the albuminous portions of the food, and also, in all probability, to some extent at least, from the carbohydrates and fat of the food.

"The casein, albumen, and sugar of the milk are probably derived from the nitrogenous parts of the food, through a special cell activity.

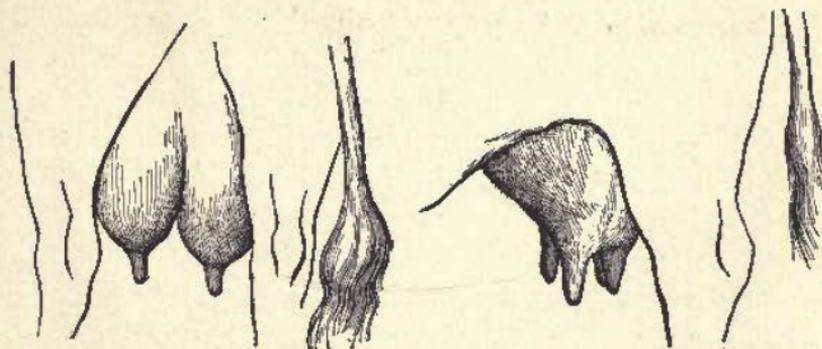
"The ash or mineral matter comes partly from the mineral matter in the food by transudation, and partly as a result of cell activity in the gland."



LACKING FORE UDDER DEVELOPMENT

AN ABNORMALLY SHAPED UDDER

These are brought together in the udder and discharged as milk. Much of the activity takes place during the milking operation, as the slaughter of cows which have been giving large amounts of milk



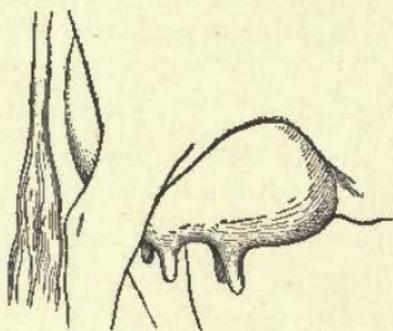
UNBALANCED AND BADLY CUT UP

FUNNEL-SHAPED UDDER

up to the time they were killed, with apparently full udders, showed only a small amount of milk in the udder immediately after death.

**Shape of the udder.**—The well-shaped udder is one that comes well forward, extends well up behind, has good-sized teats, squarely placed, and which is covered with elastic yellow skin and fine hairs.

A fleshy udder consists largely of fibrous tissue and lacks in the secreting glandular tissue. Such



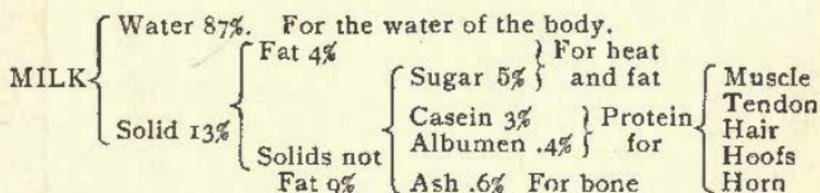
A WELL-SHAPED UDDER. RUTILA'S DAUGHTER (6,670). ONE YEAR'S RECORD: MILK, 8,988; BUTTER FAT, 489.8. OWNED BY H. M'KAY TWOMBLY, NEW JERSEY

an udder does not milk down when the milk is withdrawn. In the young animal the udder is held firmly to the abdominal walls, while in old age the muscles stretch, allowing the udder to become pendant.

## CHAPTER II

### Composition of Milk

MILK contains all the food elements and in the proper proportion for the development of the young animal. The proportion of each differs in the milk of different species of animals and of different individuals in the same species. It also varies from season to season and from day to day. Some variations are accidental, due to immediate environment; others seem designed to meet the requirements of the young growing animal for which it is the food; while others are characteristic of the breed and the individual. The following diagram represents the average composition of cow's milk, indicating also the principal portion of the body to the development of which it contributes:



The following shows the extreme percentage of each constituent as given by Koenig:

	Maximum	Minimum
Water .....	90.69	80.32
Fat .....	6.47	1.67
Casein .....	4.23	1.79
Albumen .....	1.44	0.25
Sugar .....	6.03	2.11
Ash .....	1.21	0.35

**Colostrum.**—Colostrum is the milk yielded the first few days after calving. It has a reddish color, is viscous and slimy, contains a less proportion of water and sugar, and an increased proportion of albumen and ash, together with colostrum corpuscles, which are probably broken-down cell structure from the gland. This milk has a medicinal effect, helping to stimulate to activity the digestive tract of the young calf, which should be fed on its mother's milk for the first few days of its life. The characteristics of colostrum milk are not so pronounced when the cow has not been dry at least a short time before freshening. Under ordinary circumstances, milk becomes normal within three or four days after parturition. Owing to the high percentage of albumen, colostrum curdles when heated. This is the common test to tell whether or not the milk is normal.

	Colostrum*	Normal Milk
Water .....	71.69%	87.0
Fat .....	3.37	4.0
Casein .....	4.83	3.0
Albumen .....	15.85	0.4
Sugar .....	2.48	5.0
Ash .....	1.78	0.6
	<hr/>	<hr/>
	100.00	100.0

**Fat globules.**—Fat globules of minute form exist in the milk, forming an emulsion. These globules vary in size from  $1/1500$  to  $1/40000$  of an inch in diameter; in other words, it would require 40,000,

\*Engling.

placed side by side, to make a row an inch long. It has been estimated that a single drop of milk may contain as many as 150,000,000 of fat globules. In order to count them, a definite quantity of milk is diluted and drawn into a very fine glass tube and examined under a microscope.

**Relative size of globules.**—The size of fat globules varies with different breeds and with different individuals in the same breed. The globules become smaller as the period of lactation advances. Generally speaking, Jersey and Guernsey milk has the larger fat globules, while the Ayrshire and Holstein milk has the smaller globules. The New York Experiment Station at Geneva reports the following observations on the average size of the fat globules in the fraction of an inch:

Holstein.....	$\frac{1}{12090}$
Ayrshire.....	$\frac{1}{12450}$
Devon.....	$\frac{1}{10370}$
Guernsey.....	$\frac{1}{9350}$
Jersey.....	$\frac{1}{9630}$

The larger globules in Jersey milk may be five or six times as large as the smaller ones. With most cows the globules are smaller late in the period of lactation.

**Butter fat.**—Butter fat is composed of several distinct fats with different characteristics. Some are volatile, i. e., may be driven off in vapor; others

are non-volatile. Some melt at a temperature of 57° F., while others require a temperature of 144°, yet when gathered together as butter the melting point is from 90° to 99°. Something of the difference in the character of fats may be seen by melting butter in a tall bottle and allowing it to stand at a temperature of 80° for several days. Richmond gives the following composition of butter fat:

Butter Fat	{	8% Volatile.....	{	Butyrin ... 3.85%	
			{	Caprion ... 3.60%	
			{	Caprylin ... .55%	
	{	92% Non-Volatile	{	Caprin .... 1.9 %	} Hard fat melt 144°
Laurin .... 7.4 %					
Myristin ... 20.2 %					
Palmitin ... 25.7 %					
Stearin .... 1.8 %					
			{	Olein ..... 35.0 %	=Soft, 57°

**Fat variations.**—The fat is the most variable constituent in the milk. The breed, individuality, period of lactation, first and last milk, periods between milkings, change of milkers, change of weather, change of feed, and abuse, all influence the per cent. of fat in the milk.

We have four distinct breeds of dairy cattle developed under markedly different conditions of feed and climate. The Channel Island breeds yield a moderate amount of milk with relatively large, fat globules and high per cent. of fat. The Scotch Ayrshires give a medium per cent. of fat and globules which are relatively small; and the big black and white Holsteins from Holland yield large amounts of milk relatively low in butter fat, the

globules being rather small, with some large ones. The New Jersey Experiment Station reports the following:

Breed	Total Solids	Fat	Milk Sugar	Proteids	Ash
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Ayrshire....	12.70	3.68	4.84	3.48	0.69
Guernsey...	14.48	5.02	4.80	3.92	0.75
Holstein....	12.12	3.51	4.69	3.28	0.64
Jersey.....	14.34	4.78	4.85	3.96	0.75

Individuals and grades of these breeds show wide departures from the average of the breed in the per cent. of fat and in other characteristics. These variations are characteristic of the breed and the individual and cannot be materially changed permanently. The following are temporary variations. With the advance in the period of lactation, the per cent. of fat decreases slightly the first two or three months and gradually increases through the period of lactation.

Month of Lactation	Per cent. of fat in milk
1	4.54
2	4.33
3	4.28
4	4.39
5	4.38
6	4.53
7	4.56
8	4.66
9	4.79
10	5.00

The first milk drawn may have as little as 0.8 to 2 per cent., while the last half pint may contain from 8 to 14 per cent. of fat, though the average in the entire mess might be only 4 per cent.

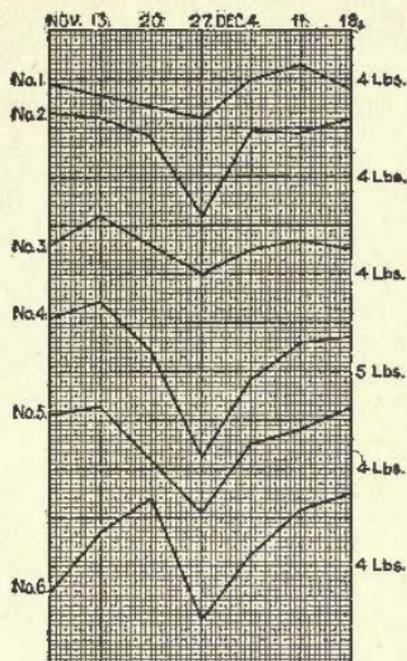
The night's and morning's milk usually differ in the per cent. of fat, the milk being richer after the shorter and quieter period.

Change of milkers disturbs the per cent. of fat unless the cows are regularly accustomed to having different milkers each time.

Departures from the regular time of milking may cause slight changes. Change of weather and feed, abuse or fright, all are reflected by a variation in the per cent. of fat. The yield of fat is more constant than the yield of milk, generally speaking, and any influence that lessens the milk yield temporarily will usually raise the fat percentage, and vice versa, both returning gradually to the normal. With cows in the normal condition, usually well fed, we have not yet learned how to materially increase the per cent. of fat in the milk for any considerable period of time, though good feeding can nearly always be relied upon to increase the total yield of both milk and fat, so that method of feeding which increases the milk yield increases the fat yield. Exposure to cold storms cuts down the yield of both fat and milk.

**Milk sugar.**—Milk sugar, or lactose, forms one-third of the solids of the milk and more than one-half of the solids of separator skim milk. It is less sweet than beet or cane sugar, and is obtained commercially from the whey at cheese factories. It

may also be separated by coagulating skim milk with acid, straining out the curd and then heating to the boiling point, when the albumen will be precipitated. Let this settle and decant the clear liquid, or filter it and then boil to dryness. The



THE MILK YIELD OF SIX COWS FOR SIX WEEKS, SHOWING THE SEVERE FALLING OFF IN YIELD OF BUTTER FAT THE WEEK OF NOVEMBER 20-27, AS A RESULT OF A SEVERELY COLD RAIN-STORM, NOVEMBER 17 TO 19. ARIZONA EXPERIMENT STATION

milk sugar and ash will be left behind in the form of a white powder. Milk sugar has not been studied as much as the fat and casein, but the amount in milk is reported to vary from 3 to 6 per cent., with an average of 5 per cent. It is a carbohydrate and is a valuable part of whey or skim milk for feeding to calves or pigs.

**Casein.**—The casein is suspended in milk in an extremely finely divided or colloidal condition. It is associated with the insoluble calcium phosphate. It is coagulated by rennet and dilute acids, but not by ordinary heat. It forms the basis of a great many kinds of cheese. In cheese making most of the fat is locked in the casein curd formed by rennet or acid.

**Albumen.**—The albumen is similar to the casein in composition, and in character resembles the white of an egg. It is not precipitated or curdled by rennet or acids, but is precipitated by heat. It contains some sulphur. In cheese making it remains in the whey. Together with casein, it forms the group spoken of as protein compounds or albuminoids. Rich in nitrogen, it contributes to the supply of vital tissue and lean meat in the body. The percentage of protein compounds is less variable than the fat. They increase with the fat and in the period of lactation, as Van Slyke shows in the following table:

Month of Lactation	Per cent. Protein	Per cent. Casein	Per cent. Albumen
1 . . . . .	3.00	2.45	0.55
2 . . . . .	2.96	2.45	0.51
3 . . . . .	3.08	2.15	0.67
4 . . . . .	3.10	2.48	0.62
5 . . . . .	3.10	2.55	0.55
6 . . . . .	3.75	2.65	0.92
7 . . . . .	3.66	2.91	0.75
8 . . . . .	3.77	3.00	0.77
9 . . . . .	4.03	3.15	0.88
10 . . . . .	5.05	3.66	1.39

There is usually three and a half times as much casein as albumen in cow's milk.

**Ash.**—The ash of milk is the mineral matter that is left after burning off the organic matter. It is necessary chiefly for the building up of the bony framework of the growing animal. It is complex and includes the following: Calcium, sodium, potassium, magnesium, iron, phosphorus, and chlorine. Some of these minerals exist in solution in the milk, while others are in suspension in minute particles and may be filtered out with a porcelain filter, which could not be done if they were in solution. The chemical form in which some of these minerals exist in the milk has an important bearing in cheese making. Heating milk sufficiently changes the chemical combination of some of the mineral salts so that rennet will not coagulate the milk.

**Coloring matter.**—The coloring or lactochrome of milk is associated with the palmitin fat. The amount of coloring matter varies with different breeds and different individuals at different seasons of the year chiefly because of the difference in the feeds characteristic of these seasons. Succulent feeds, such as pasture grass, silage, carrots, and beets, increase the coloring slightly.

## CHAPTER III

### Creaming

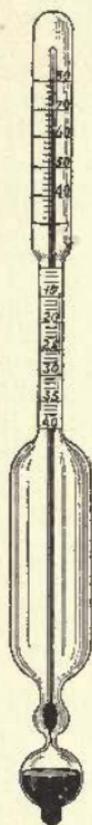
CREAM is that portion of the milk rich in butter fat which rises to the surface on standing or can be separated by centrifugal force.

**Principle.**—The fat separates or rises to the surface because of the difference in specific gravity between it and the milk serum; the latter, being the heavier, is drawn down by the force of gravity, thus crowding the fat to the surface and carrying with it some of each of the other solids.

**Specific gravity.**—The specific gravity of anything is the weight of a definite volume of it compared with an equal volume of water at 60° F. A vessel that will hold 1,000 pounds of water will hold 930 pounds of butter fat. The specific gravity of butter fat is, therefore, 0.93, while the vessel of whole milk would weigh 1,029 pounds (sp. gr., 1.029), and full of skim milk would weigh 1,035 pounds (sp. gr., 1.035).

**Lactometer.**—The lactometer is a weighted glass bulb with a long stem at the top, graduated to show the specific gravity by the depth to which it sinks in the milk. It sinks until it displaces a volume of milk equal to its own weight. The lighter the milk, the deeper it must sink to displace a volume equal to its own weight. Since the fat is light, the richer the milk, the lower the specific gravity. The determination of the specific gravity does not neces-

sarily show the quality of the milk, since the fat may be removed as cream and sufficient water added to restore the normal specific gravity.



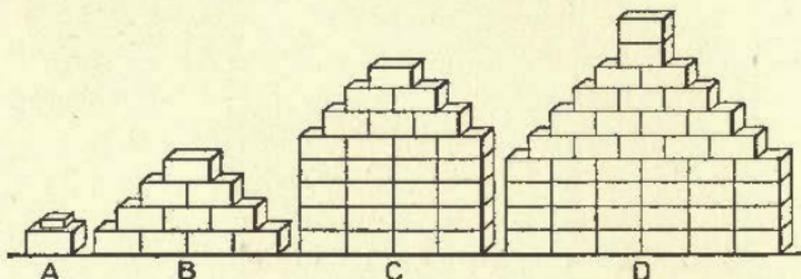
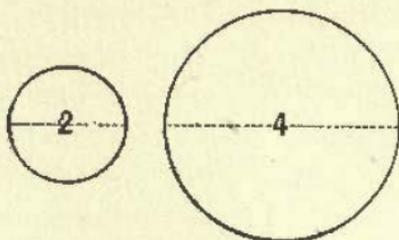
COMBINED  
QUEVENNE'S  
LACTOMETER  
AND  
THERMOMETER

Quevenne's lactometer, commonly used with milk, is graduated from 15 to 40, and this reading is converted into specific gravity by adding 1,000 and dividing the sum by 1,000, or, stated differently, by prefixing to the reading the figures 1.0.

**Creaming.**—The size of the fat globules materially influences the rapidity and thoroughness with which they rise. The larger the globules, the greater the upward pressure. This upward pressure of the fat globules of various sizes is in proportion to their volume, and this is in proportion to the cube of their diameter. If we have two spheres, one 4 inches in diameter, the other 2, the cubes of their diameters will be 64 and 8, so that the upward push of the larger one will be eight times as great as of the smaller one. They are retarded in this upward motion by the pressure of the liquid in proportion to the surface of the globules, which are to each other as the squares of their diameter. Their squares will be 16 and 4, and the retarding friction of the liquid

through which the globules must rise will only be four times as great on the larger one as on the smaller one, so that the greater the difference in size, the easier and more rapidly the larger ones rise to the surface.

**Methods.**—The principal methods of creaming are gravity, by the use of shallow pans, deep setting or dilution; and centrifugal force, by means of the mechanical separator.



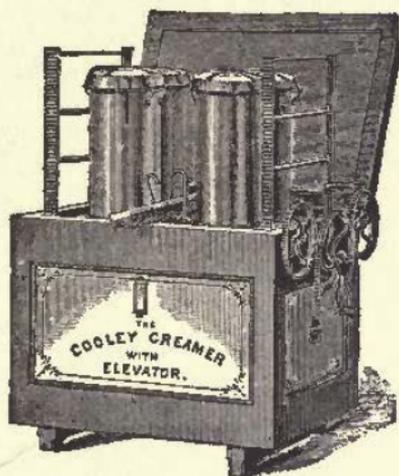
THE RELATIVE LOSS OF BUTTER IN THE SKIM MILK FROM ONE COW IN ONE YEAR BY THE DIFFERENT METHODS OF CREAMING. *A*, HAND SEPARATOR, 1.2 POUNDS; *B*, DEEP SETTING, 10.1 POUNDS; *C*, SHALLOW PANS, 26.2 POUNDS; *D*, WATER DILUTION, 40.5 POUNDS. [IND. BUL. 116.]

		Per cent. Fat Left
Cream Raising	Gravity	Shallow pan.....0.4 to 1.0
		Deep setting.....0.3 to 0.5
		Dilution (Hydraulic).....0.7 to 1.0
	Centrifugal	Hand separator.....
Factory separator....		} 0.02 to 0.05

For gravity creaming the greatest efficiency is usually secured when milk is set immediately after milking. Shallow pans are usually 3 to 4 inches deep, 12 to 14 inches in diameter, and should be set immediately after milking in a room with the temperature as near 60° as possible for from 24 to 36 hours. The pans of milk should be protected from dust, and from drafts of air. The latter dry the surface of the

cream and unchurned lumps are sometimes carried into the butter, appearing as white or yellowish white specks. The skim milk from this method will usually contain from 0.4 to 1.0 per cent. of fat.

In deep setting the essentials are a vessel 7 or 8 inches in diameter and 22 to 30 inches in depth, surrounded with water at or below 50° F., the nearer 40° the better. It should stand from 12 to 24 hours. The cream may be skimmed from the



A COOLEY CREAMER

surface with a conical skimmer. Some cans are provided with a faucet at the bottom from which to draw the skim milk, and with a glass gauge or window through which to note the approach of the cream line to the bottom of the vessel, when the valve may be closed, leaving the cream in the can. A sloping bottom insures the removal of any sediment with the skim milk.

In the Cooley creamer the cans were completely

submerged in water, the cover being so arranged that the gases given off by the milk were absorbed by the water. The valve at the bottom of the can through which the skim milk was withdrawn was so arranged that it could be set to run off the skim milk, leaving the cream in the can. This was done by raising the discharge end of the outlet tube as high above the bottom as the thickness of the layer of the cream on the skim milk. These cans stood on frames, by which they could be raised out of the water and the skim milk withdrawn without lifting them.

**Creamers.**—There are many forms of creamers on the market with different arrangements of the deep-setting system, in attractive cabinets, more or less conveniently arranged for the easy withdrawal of the skim milk and the easy cleansing of the vessels. The essential features are the surrounding of the milk with sufficient cold water to chill the milk quickly to or below 50°.

Since one pound of water is warmed approximately one degree in cooling one pound of milk one degree, the water must be several degrees colder than the temperature it is desired to cool the milk to, or else the quantity of water must be large.

A loss of from 0.3 to 0.5 per cent. of fat in the skim milk is to be expected from the deep-setting method.

**Dilution.**—Diluting the milk with water, either warm or cold, is usually the most expensive system of creaming offered. With the additional disadvan-

tage that the feeding value of the skim milk has been materially lessened, the holding capacity and the material to be handled is twice as much. Repeated experiments show that the loss in skim milk may be from 0.7 to 1.5 per cent. of fat.

**Mechanical separation.**—In mechanical separation of cream sufficient centrifugal force is developed to cause a practically instantaneous separation of the cream from the skim milk as the milk flows through the rapidly revolving bowl, any one particle of milk being subjected to the centrifugal force only a few seconds.

**Centrifugal force.**—Centrifugal force is that force which causes a body to fly away from the center around which it is revolving. In the shallow-pan and deep-setting systems, the force of gravity acting upon the heavier skim milk draws it to the bottom and forces the cream to the surface, requiring hours for complete separation. In the mechanical separator sufficient centrifugal force is developed to cause the skim milk and cream to form two distinct vertical layers in the rapidly revolving bowl during the short time they are in it, the skim milk layer being next the wall of the bowl.

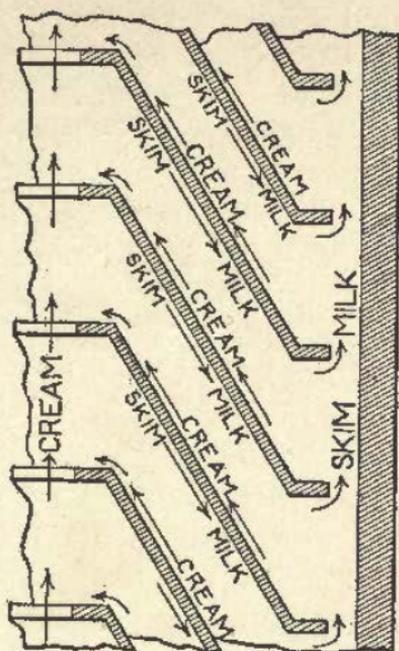
**Centrifugal separator.**—When a hollow vessel or bowl partly filled with a liquid is revolving rapidly enough, the contents are distributed around the sides, forming a vertical wall, with the center empty from top to bottom. If the liquid consists of two materials differing in their specific gravity, as fat and skim milk, the heavier will be drawn toward the outside, forcing the lighter to the center and

forming two walls or layers, one within the other. If outlets of proper size have been made, one opening into the vertical wall of skim milk, the other into the wall of cream, and a continuous supply of milk is delivered into the bowl near the bottom, it will push that which is already in out through the respective openings. Thus we have milk entering the bowl and cream and skim milk separating into distinct layers as they pass up through the bowl and escaping through the respective outlets. This is the principle on which all separators are based, although some may introduce the milk from the bottom, others from the top, while some take the skim milk or cream or both from the top, others from the bottom.

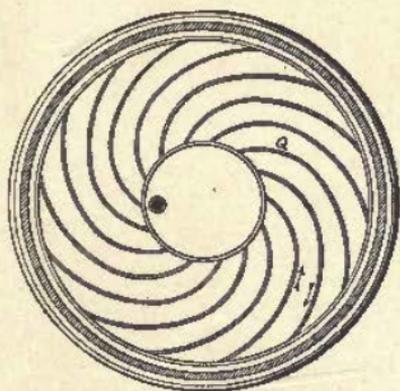
The introduction of internal devices either increases the amount of time required for the milk to pass through the bowl, or else divides it into thin layers, which permit the cream to more quickly find its way into the current moving toward the center of the bowl, unobstructed by the current of skim milk moving away from the center. Most of the clean skimming machines approach more or less closely this latter arrangement.

**Getting milk in motion.**—Most bowls have some interior arrangement which assists the milk in taking the motion of the bowl, otherwise the milk would revolve more slowly than the bowl.

**Efficiency.**—The thoroughness of mechanical separation depends on the force generated, the rate of inflow, the temperature of the milk, condition of the milk, and the smooth running of the machine. The



THE EFFECT OF THE DISCS ON THE MOVEMENT OF CREAM AND SKIM MILK IN THE DE LAVAL SEPARATOR BOWL



HORIZONTAL SECTION OF THE VERTICAL BLADES IN THE SIMPLEX, WHICH PERFORM THE SAME SERVICE AS THE DISCS IN THE DE LAVAL SEPARATOR

force generated depends on the diameter of the bowl and number of revolutions per minute. A bowl of large diameter need not be run so rapidly as a bowl of smaller diameter in order to do the same work. The speed recommended by the manufacturer should be maintained. If necessary, a slight increase of speed will increase the thoroughness of separation.

**Rate of inflow.**—This is usually fixed by the manufacturers of hand separators. However, if the inflow of milk is not sufficient, the cream may become too thick and clog the machine.

**Temperature.**—Milk separates easiest when separated quickly after drawn from the cow. If for any reason it is cooled to a temperature below  $80^{\circ}$ , or with some machines below  $70^{\circ}$ , it should be warmed by placing the vessel of milk in warm water. Milk that is slightly curdled cannot be successfully separated.

**Thickness of cream.**—The thickness of the cream is regulated in most machines by a screw which determines either the size of the cream outlet or its distance from the center of the bowl, usually the latter. The nearer the center, the thicker the cream will be. Most hand separators will do efficient work and skim cream varying in richness from 15 to 40 per cent., and in several cases to 50 per cent., of butter fat. An increase in the speed of the machine increases the richness and lessens the amount of cream, while a decrease in the speed increases the volume of cream and lessens its per cent. of fat. For ordinary purposes the cream screw

should be set so that the amount of cream is from about one-sixth to one-seventh as much as the milk from which it was separated. Reducing the inflow of milk will increase the richness of the cream.

If the adjustment of the separator is such as to make the cream too thick, it will clog.

**Smoothness of running.**—When the separator does not run smoothly or is not turned steadily, it is apt to leave an unnecessary amount of fat in the skim milk. A steady pressure should be maintained on the handle at all times on each revolution.

### SEPARATOR SUGGESTIONS

1. Study the manufacturer's directions carefully.
2. Place the separator on a base that does not shake or give, and in a location as free from dust as possible.
3. Level the machine across the middle of the bowl frame.
4. Wipe the oil from the tin parts of a new machine and wash with a strong solution of alkaline washing powder. Wipe dust and dirt from the bearings.
5. Use kerosene to clean the bearings and use the oil recommended by the manufacturer. Do not use a vegetable oil, such as castor oil, as it gums up the bearings.
6. Start the machine slowly, taking at least three minutes to bring it to full speed.
7. Fill the bowl with warm water as soon as it is

put in motion. This prevents the cream sticking to the sides of the bowl.

8. When at full speed, open the milk supply to its full capacity and see that the motion of the machine does not cause this to become partly closed.
9. Put an even pressure on the crank handle at all points in its course. Avoid heavy push or pull with no power applied when the crank is at the bottom or top of its circle.
10. Keep sufficient milk in the supply can to give the machine its full feed at all times.
11. If speed slackens materially while adding milk to the supply can, the valve should be closed. If the cream thickens so as to clog or partly clog the outlets, the bowl should be flushed with warm water.
12. When done separating, immediately flush the bowl with enough warm water to remove all cream. Skim milk may be used, though not quite so satisfactory.
13. Allow the machine to stop of its own accord. Do not apply a brake of any kind unless it is provided by the manufacturer.
14. Wash the machine after each time it is used; rinse first with cold or lukewarm water; cleanse thoroughly with a brush and warm water in which an alkaline washing powder has been dissolved; rinse and scald with boiling water; do not wipe, but shake and allow to dry of its own heat.

**DIFFICULTIES**

**The machine runs hard.**—The bearings may be gummed up. They should be flushed with kerosene, and in extreme cases should be removed and wiped clean. Bearings may be out of alignment, bowl out of balance, or the machine not level, causing the bowl to tremble. The upper bowl bearing may be loose or worn.

**The machine leaks.**—This may be due to the bowl cover not being screwed down tight, rubber ring being omitted or broken or nicked, or the bowl may be too low to discharge into the skim milk or cream trays, or trays may not be down in place.

**Clogging.**—If the inflow of milk becomes reduced through partial closing of the valve or lessened supply of milk in the can, the cream will become thick enough to wholly or partly clog the cream outlets. Flushing the bowl with warm water will usually clear the outlets, without having to stop and wash the bowl.

**Variations in the cream test.**—The per cent. of fat in the cream will vary from day to day with the same herd and the same persons doing the work, because of the variations in the per cent. of fat in the milk and the temperature of the milk, the amount of milk in the supply can, the variation in the speed of the bowl, the amount of water or skim milk used to flush the bowl, partial closing of the valve of the supply can, imperfect cleaning of the bowl, or especially of the cream outlets.

**Advantages.**—The chief advantages of the

mechanical separator are an almost complete removal of the fat, avoiding exposure of the cream during the hours required for gravity creaming. The removal of some foreign material in the bowl slime which includes some albumen and casein and bacteria. This bowl slime should be burned and not allowed to dry or clog up drains. Again, the skim milk still warm with the animal heat has an increased feeding value over that secured by the gravity method.

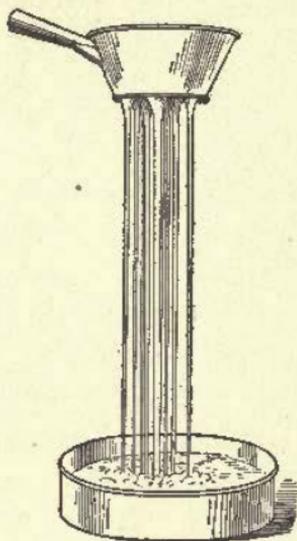
## CHAPTER IV

### **Fermentation**

THE changes commonly occurring in milk and popularly called souring are caused by minute forms of plant life, called bacteria, most of which gain access to the milk after it leaves the cow, not being found in the udder of the healthy animal, except in the ducts of the teat. These bacteria during the process of their growth change the constituents of the milk, forming new products, such as gases, acid, bitter flavors, and sometimes colors, as pink or blue milk, and sometimes producing slimy or ropy milk. Others produce the flavors that are so much desired in good butter and other dairy products. With many varieties always present, the kind that will dominate depends largely on the temperature at which milk or cream is kept. All bacteria are not, therefore, undesirable or harmful. Bacteria are like the higher forms of plants, many beneficial to man, some harmful and undesirable. Knowledge of method of growth and multiplication enables man to control them and make them serve his interests.

**Bacteria.**—They consist of a single cell, and are so small that a drop of milk may contain millions; they grow rapidly at a temperature of from 60° to 90°; they require food and moisture like higher forms of plant life, milk furnishing an ideal medium

unless quickly cooled, as it is at a temperature for their rapid growth; they are prevented from growing by cold; are killed by moist heat, most of them by a temperature of boiling water; they remain inactive in the spore form for a long time, then grow rapidly when conditions again become favorable; they grow or multiply usually by division, which may happen every twenty minutes, or may re-



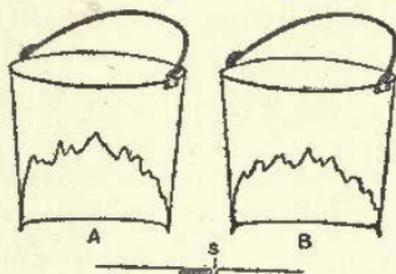
SLIMY OR ROPY MILK

quire several hours; in the process of their growth they cause changes in the material in which they are growing. These are many, some desirable, as in the souring of milk, when the milk sugar turns to lactic acid; in vinegar making, when the fruit sugar turns to acetic acid; and in wine, when the grape sugar is converted into alcohol. In Swiss cheese the eyes are formed by the imprisonment of gases developed by bacteria.

Among the undesirable products are the gases by bacteria associated with stable filth, a common illustration being the pinhole or "spongy" cheese; bitter flavors, which are most common when milk is held for some time at a low temperature, especially in winter; ropy or slimy milk that is apparently not so when drawn from the cow, but becomes so after standing. Bacteria causing this trouble come from stagnant water. Cows wading

in such places become spattered with the water, which dries on the udder and flanks, and during the milking process the dust and bacteria are shaken off and by the milk distributed over the utensils. It requires extra pains and thorough boiling to rid utensils which have had slimy milk in them of this kind of bacteria.

**Distribution of bacteria.**—These minute forms of life are very widely distributed, and wherever there is dust there are many kinds of bacteria. The hands and clothing of the person, the dust of the house and stable, cobwebs and dusty or loose stable ceilings, and dust on the body of the animal are all fruitful sources of con-



SEAMS A-S IMPROPERLY AND  
B PROPERLY SOLDERED

tamination, especially if these sources are so handled as to disturb the dust. Cracks, seams, and corners of dairy utensils in which milk or wash water is allowed to remain will seed the milk with bacteria, cream it is seeded with many different kinds of bacteria.

**Control.**—In the ordinary handling of milk and cream it is seeded with many different kinds of bacteria.

The character of the changes which will occur will be largely determined by the kind of bacteria present, whether from the dust of the air, dusty hay, the flanks of the animal, the seams of imperfectly washed utensils, from a good home-made

starter or a commercial starter from a pure culture. The changes may be retarded by excluding bacteria, by stopping their growth with cold; for, like other forms of plant life, they do not grow when too cold. Few forms common to milk develop rapidly at a temperature of 50° or below, and practically no development takes place at the freezing temperature. They may be destroyed by subjecting them to heat. Complete destruction i.e. to render sterile requires that milk be heated to the boiling point for twenty minutes on three successive days. Manifestly, this is not commercially practicable. Pasteurization is heating the milk or cream sufficiently to destroy the vegetative forms, which include the commoner disease and putrefactive bacteria. In the vegetative form the bacterium is ready for active growth. In the spore form it can resist great extremes of heat and cold and may retain life for a long period of time, ready to grow and multiply rapidly when conditions become favorable. The changes may be hastened by introducing bacteria, or by a favorable temperature. The rapidity of the change will depend on the numbers of bacteria present and whether the temperature is favorable to their rapid growth or not.

## CHAPTER V

### **Cream Ripening**

THE ripening of cream is the treatment given it to prepare it for churning. Upon this, together with the previous care of the milk, depends the quality of the butter. Ripening depends on the character and the number of bacteria, the temperature and the length of time which the cream is held.

**Object.**—The purpose of ripening the cream rather than churning immediately is to produce the desired flavor, which is the result of bacterial growth and accompanying changes, to increase the churnability and to increase the keeping quality of the butter.

**Flavor.**—While it has not been conclusively shown that any one species of bacteria will produce the desired flavor, it is essential to have the lactic acid forms predominating. Some of the pure cultures on the market include two or more species of bacteria, while others have only one. Under cleanly farm conditions the lactic acid forms predominate.

**Churnability.**—The formation of lactic acid during the ripening process lessens the viscosity of the cream, i. e., the tenacity with which the particles hold together, as molasses is viscous; at the same time the cream becomes thicker yet less viscous,

as a sandy mud may be thick and flow with difficulty yet not cling together as a viscous syrup.

In the less viscous ripe cream the fat globules seem to move more freely, gathering together with greater ease as a result of the agitation of churning.

**Improved keeping quality.**—The bacteria which produce lactic acid do not injure the keeping quality of the butter. If during the ripening the putrefying and objectionable forms which do not thrive in the presence of the lactic acid have been held in check, the keeping quality of the butter will be improved.

**The bacteria.**—Fortunately, nature has provided that the bacteria which will produce the desired flavor are most likely to predominate in the cream if the milk has been handled under good, cleanly conditions. The ripening of the cream under farm conditions usually depends on the bacteria which have accidentally gotten into it. This is called the natural method as distinct from the use of a starter which may be home-made, as butter milk or cream saved from the last churning, skim milk which has been ripened, or a commercial starter prepared with a commercial culture of flavor-producing bacteria. Ordinarily, good results can be obtained by keeping the cream sweet at a temperature of 45° to 50° until enough is gathered for a churning, which should not be more than two or three days. The entire lot should be thoroughly stirred each time new cream is added. Eighteen to 24 hours before churning time the cream should be warmed to a

temperature of 70° or 75° and not allowed to fall below 65° until ripe, i.e. has the desired acid flavor.

Sweet cream should not be added to that which is to be churned for at least six hours before churning, as it makes churning more difficult and increases the loss of fat in the buttermilk. The less ripened cream does not give up its fat as easily as that which is properly ripened, and the butter will be overchurned before it separates completely from the buttermilk or the churning stopped too soon with a corresponding loss of fat.

The temperature can be more easily controlled during the ripening if the can of cream is placed in a larger vessel and surrounded with water at the right temperature. It may be warmed or cooled by changing the water and stirring the cream. In cold weather it may be desirable to so arrange the vessel of water containing the can of ripening cream that a lamp can be placed under it and thus maintain the temperature during the ripening.

Usually the best butter can be made from cream that is ripened and ready to churn within 24 or 36 hours from the time it is drawn from the cow.

Under farm conditions, the use of a starter is only to be recommended where large quantities of the best butter are desired, and the extra labor required to prepare them right is justified, since a poor starter will just as surely make poor butter as a good one will good butter, or where difficulty is experienced in getting the cream sour, or where undesirable bacteria have become distributed on the

utensils, preventing the securing of the proper flavor in the butter.

For large churnings and in factory work, it is possible to secure a commercial culture which is merely a pure culture of desirable flavor-producing bacteria, and is put on the market by laboratories which make it a business to prepare it.

**Home-made starter.**—A home-made or skim-milk starter may be made by selecting the milk, if possible, from a cow that has been fresh within two or three months. This may be run through the separator before the other milk and put in two or three ordinary fruit jars or milk bottles which have been sterilized by placing them in warm water and bringing it to a boil, then cooling, keeping bottles or jars inverted until ready for use. The skim milk should be warmed to a temperature of  $90^{\circ}$  and held as nearly at this temperature as possible until the milk begins to coagulate. If for any reason the temperature falls too low, say below  $70^{\circ}$ , it may be raised by placing the bottles in warm water. It will help to keep the milk warm if the jar is placed in a larger vessel of water at the desired temperature. When coagulated, the starter should have a pleasant acid flavor, free from undesirable taints. The ripening of two or three starters from different lots of milk at the same time will afford an opportunity for comparative study and for the selection of the best starter to use. Buttermilk or cream from a previous churning may be used if the butter was of satisfactory quality, and the buttermilk or cream does not have to be kept a day or two before

it is used. There is always some risk that any faults will be more apparent in the succeeding churning.

**Commercial starter.**—Directions for preparing a starter from commercial cultures usually accompany each package of culture, the several manufacturers recommending slight differences of procedure. Some cultures develop more rapidly than others. The following, however, is the general practice. To a pint and a half of skim milk which has been thoroughly pasteurized for 20 minutes at a temperature of  $180^{\circ}$ , or better at  $200^{\circ}$ —this may be done by placing the vessel of milk in a larger one of water and heating on the stove, and then cool to  $90^{\circ}$ —add a small bottle of pure culture, care being exercised to avoid exposure to other contaminations. This should be kept warm from 12 to 24 hours, depending on the culture used. This is best accomplished by placing the jar in a wooden vessel of water at the desired temperature. At the end of this time it should be just coagulating, and should have a pleasant acid flavor free from undesirable taints and odors. This is commonly called the mother starter. From two to five per cent. of this mother starter should be introduced into another lot of pasteurized skim milk and ripened in the same way at a temperature of  $65^{\circ}$ . The starter may be propagated from day to day as long as it remains good, usually one to three weeks, depending chiefly on the skill of the maker in properly sterilizing the utensils and avoiding contamination. The starter is usually better after the second

or third propagation from the pure culture. From two to ten per cent. as much starter may be used as cream. The larger the amount of starter, the less time will be required to ripen the cream and the greater the probability that the characteristics of the good starter will predominate in the ripening cream.



## CHAPTER VI

### Churning

CHURNING is the gathering together of the fat, which carries with it a little moisture and some curd, to which is added some salt, altogether constituting butter. Easy and thorough churning depends on the ripeness of the cream, its temperature, and the nature of the agitation.

**Ripeness of the cream.**—When ready for the churn the cream should have a pleasant acid flavor, a smooth, velvety appearance, and should be thick enough that it will adhere in a thick coating to the paddle or spoon.

Farm conditions hardly justify the use of any of the tests for determining the ripeness of the cream. These tests are based on the fact that a definite quantity of alkali will unite with a definite quantity of the acid in the cream. By using an alkali of known strength, it is easy to measure the amount of acid that has developed during the ripening. From five and a half to six and a half tenths of a per cent. of acid at churning time is usually sufficient.

The tests for this purpose, with directions for their use accompanying, which may be purchased from any dairy supply firm, are the Farrington's, Van Norman's, and Mann's.

**Temperature.**—The globules of fat are supposed

to exist in the newly formed milk in the form of a liquid, and low temperature and agitation cause these to solidify. Just when this occurs is not important. The fact remains that when the cream



FLOATING  
DAIRY  
THER-  
MOMETER

has been held at churning temperature or lower for a couple of hours before churning begins, the butter will be harder than if the cream was cooled to churning temperature and then immediately put into the churn. The fat changes temperature more slowly than does the serum in which it floats. Since the fat of all cream is not equally hard at the same temperature, the churning should be done at that temperature which will produce a firm butter in from 15 to 40 minutes of churning, if other conditions are right. Generally speaking, the higher the temperature of the cream, the quicker the churning and the larger the loss of butter fat in the buttermilk; while the lower the temperature, the slower the churning, the harder the butter, and the less fat there is left in the buttermilk. A temperature between  $55^{\circ}$  and  $64^{\circ}$  will usually give satisfactory results. With some cows, and when gluten feeds are fed, a lower

temperature may be required. Butter has come soft from such cream when churned as low as  $48^{\circ}$ . On the other hand, the cream from Jerseys and Guernseys may need the higher temperature, while the feeding of cottonseed meal usually raises

the churning temperature from two to six degrees.

**Agitation.**—In most churns the agitation is a combination of friction, i. e., slipping of the particles of cream one against the other, and concussion, i. e., the shock due to the falling or dashing against the sides of the churn. Generally speaking, that churn is best which produces the most concussion and the least friction.

**The churn.**—The revolving or swinging churns without inside fixtures usually give the most concussion, the least friction, and are easiest to clean.

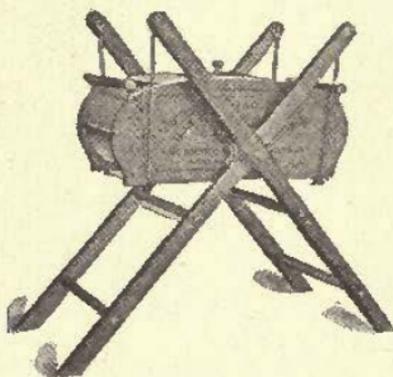


BARREL CHURN

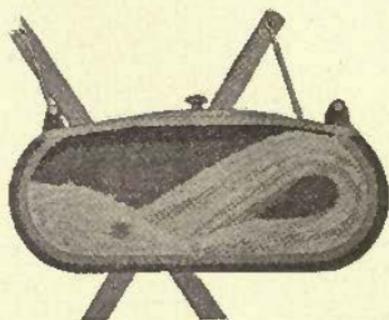
They should be of such size as never to be filled over one-half full, and better and easier work can be done if not over one-third full. Good work can be done in this kind of a churn with a very small amount of cream if it is not too thick. With a barrel churn, the speed at which it is turned will

depend on the thickness of the cream. The speed should be such as to carry the cream to the top and allow it to fall at each revolution of the barrel. If run too fast, the cream will adhere to the ends and not fall because of the centrifugal force developed. If run too slow, the cream will slip along on the lower side with very little agitation. The right speed can best be determined by the person

turning the churn. This may be faster at first than when the cream thickens just before breaking. When ripe cream is agitated in a tight churn it should be opened two or three times after churning begins to permit the escaping of gas which has been set free by the agitation. As the particles of fat



SWING CHURN



THE MOTION THE SWING CHURN  
GIVES ITS CONTENTS

gather together in the process of churning the cream seems to become thicker and may adhere to the walls of the churn. This can be prevented or remedied by adding a little water at the same temperature as the cream is.

**Preparation of the churn.**—Before placing cream in a clean churn, the churn should be scalded with boiling water. This swells the wood and makes it easier to clean. It should next be thoroughly chilled with cold water to prevent unnecessarily warming the cream. If it becomes dry before the cream is ready, it should be wet. When scalding a tight barrel or box churn, the vent should be opened after each of the first few revolutions to permit escape of the air expanded by the heat.

**Color.**—The general market requires that butter be as nearly the June color as possible throughout the year. If necessary to secure this, butter color may be used. The standard butter color is harmless and cannot be detected if used only in such an amount as is required for cream. The standard coloring matter is prepared from the coating of the annatto seed combined with a neutral oil. The color unites only with the butter fat, and more color will be required with rich than with thin cream. It should be added to the cream just before starting to churn. Twelve to fifteen drops of color for each gallon of cream that will churn out two and a half pounds of butter will be about right in the fall and winter, while less may be required during spring and early summer.

**Stopping.**—Churning should be stopped when the butter is gathered in granules about the size of wheat grains and floats freely on the buttermilk. Gathering of the butter into large lumps should be avoided. The buttermilk can easiest be removed through a hole provided for the purpose at the bottom of the churn. If the butter separates from the milk with difficulty, the addition of a little cold water, salt or brine will usually help. Churning is not sufficient until the buttermilk will drain out freely. If the butter comes very fine and fails to gather together, it may be necessary to warm it. If the cream is already thin, not rich in fat, water should not be added to it, but a vessel of hot water may be set into the cream and both stirred, or the cream removed from the churn and submerged in

warm water until the desired temperature is secured.

**Straining.**—If the buttermilk is strained through a cheese-cloth or hair strainer as it runs from the churn, it will catch crumbs of butter that will be lost otherwise. If the butter does not separate so as to strain readily, it is probable that the churning has not been carried far enough. If the cream is very rich, it may be necessary to thin the buttermilk with water in order to draw it off easily.

**Washing.**—The keeping quality and flavor of butter are much increased by the thorough removal of the curd. This can be more easily and thoroughly done if the churning is stopped when the butter is in granules, than if gathered into a solid mass. Butter should be washed once or twice with water about the temperature of the buttermilk. The washing is sufficient when the moisture left in the butter is clear and free from milkiness. Excessive washing may remove some of the volatile oils, lessening the delicate flavor of the butter. If the rinse water is more than three or four degrees colder than the churning temperature, the outside of the butter granules will be hardened, while the inside will remain soft. If salt is added while the butter is in this condition, it will not be evenly distributed and mottled or streaked butter will result.

**Salting.**—The best salts made for use with butter should be used. They are not so fine, dissolve more easily, and usually have less insoluble matter in them than do the table salts. The salt may be added in the form of brine. This method insures a mild

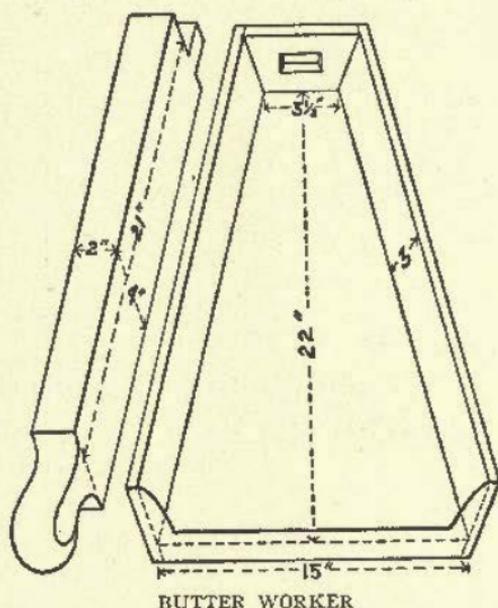
salting, the disadvantage of which is that not enough salt can be incorporated to suit many consumers. Much more salt must be used in making the brine than is actually incorporated in the butter, thus causing a waste. The salt can be most evenly and easily added by stopping the churning when the butter is in small granules. The salt may be sprinkled on the butter while it is yet in the churn, then the churn revolved a few times until the butter begins to pack together, after which it should be allowed to stand if possible one-half hour or more until the salt is thoroughly dissolved, and then finish the working.

The butter may be removed from the churn while in the granular form, spread on a worker, and the salt sprinkled over it, worked a little to incorporate the salt, and then allowed to stand until the salt dissolves, after which the working can be finished.

The amount of salt used must be determined by the demand of the market and the brand of salt. Ordinarily, one ounce of salt to one pound of unworked butter will give satisfactory results. Since uniformity of product from one churning to another is a very important factor, it is necessary to have some rule for salting. If it is not convenient to weigh the butter and salt, use a small definite measure of salt for each definite amount of cream. With hand-separator cream, this method will usually give uniform results.

**Working.**—The butter is worked to incorporate the salt, expel the surplus moisture, and gather the butter into a compact mass. This should be done

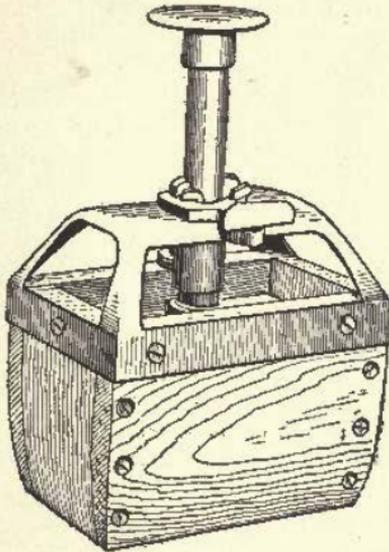
by pressure, avoiding the slipping of utensils on the butter, as this makes it greasy. The working should be uniform throughout all parts and should be stopped when the butter breaks with a slight tendency to string out in short pin points. If not



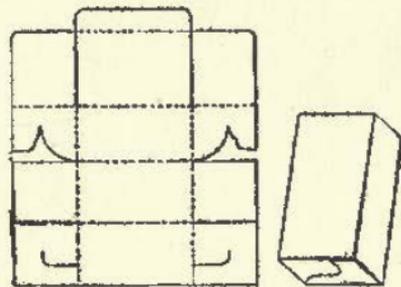
worked enough, it will break off short and crumble; if overworked, it will lose its character and become greasy. More butter is injured by overworking than by insufficient working. The finished butter should be firm and waxy in body and free from apparent moisture. A lever butter worker of suitable size is one of the important labor-saving devices the farm butter maker can have, making it much easier to work the butter, especially if a little hard.

**Package.**—While each butter maker must study

to please his purchasers, the standard pound print  $2\frac{1}{2}$  by  $2\frac{3}{8}$  by  $4\frac{5}{8}$  inches is gaining very rapidly in public favor. Prints of this size pack nicely for shipping and cut conveniently for service on the table. The printer may be carved so as to leave a design either raised or sunken in the butter. If well done the first is more attractive, but suffers in



EUREKA BUTTER PRINTER

CARTON FOR ONE-POUND  
PRINT OF BUTTER

handling. The latter will usually remain more distinct if the butter is to be handled. Each print should be wrapped in first-class parchment paper, never in wax paper. If placed in manila cartons, they will reach the consumer in much better shape. The carton and the parchment may be printed to indicate the maker of the butter, as between two lots of butter of equal intrinsic value, the one put up in the most attractive shape will command the

premium on a brisk market, while the other will remain unsold on a slow market.

**Marketing.**—Private customers who will contract for a regular supply at a fixed price are usually the highest priced customers available for first-class dairy butter. The prevailing express charges do not justify the shipping of small lots. The time required for the delivering of butter to a number of customers is often worth more at home than the difference in price secured, when compared with a grocer with a high-class trade who will contract for a considerable amount at a fair price. Absolutely uniform quality from week to week and regularity of delivering are requisite if the highest prices are to be secured.

## CHAPTER VII

### **Marketing Milk**

THE marketing of milk has developed from the distribution by the owner of the milk of a small herd to the consumers within driving distance, to a business where it is an industry in itself, with problems peculiar to it and distinct from those of the producer. Some of the large distributing concerns in the cities number their delivery wagons by the hundreds, and receive milk produced in several States and shipped as much as 300 miles before it reaches them.

**The relative returns for milk.**—It is necessary to take into consideration the fat content of the milk in determining the returns from the different methods of marketing. While it is hardly practicable to put it in figures, the cost of making the butter, the value of skim milk, buttermilk and whey, the time required for delivery, cost of bottles, loss of cans when shipping are all factors that must be counted on and allowance made.

In the following table 100 pounds of 4 per cent. milk is considered worth \$1.00 or 25 cents per pound of fat and the value of the other product figured on the basis of the amount that could be made

from 100 pounds. In many places this may be too low a price for the milk, in others too high.

100 lb. of 4% milk at \$100 per cwt. would be equivalent to

11.5 gal. of milk at	8.7 cents
10 lb. cheese at	10 "
2.4 gal. of 20% cream at	41½ "
1.9 " " 25% " "	25½ "
1.3 " " 40% " "	76 "

**The markets.**—The markets, some or all of which may be available to the milk producer, are the creamery, cheese or condensing factory, shipping station, cream buyer, retail milk delivery or family butter making. The creamery relieves the home of considerable hard work, and it also offers the advantage of returning the skim milk for use on the farm in the feeding of calves and pigs. Its value for this purpose is often overlooked when comparing the probable income from the different markets. Many creameries are now accepting hand-separator cream, which leaves the skim milk at the farm to be fed while yet warm with the animal heat. While the objection is made that the creamery does not make as good butter from hand-separator cream as from whole milk, it is not the fault of the hand separator. It is due to the failure to properly cool and care for the hand-separator cream, and holding it too long before delivering it to the creamery. The creamery usually affords a market throughout the year, while a great many cheese factories shut down during the season when the farmer should have the most time to care for his cattle, and when the dairy would afford profitable employment through the

winter for the labor that is needed in the summer time.

**Cheese factory.**—The returns for milk delivered to the creamery and cheese factory have depended largely on market prices for butter and cheese, varying from one season to another. The whey has a less feeding value than skim milk because there is little or no casein in it. When sweet, the sugar and albumen in it make it a desirable feed for hogs especially.

**Condensing factory.**—The condensing factories have paid the highest prices and been the most exacting buyers of milk, probably not exceeded and in but few cases equaled by the requirements of the purchaser for shipping: The process of condensing seems to require that milk should be particularly free from taints and faults; if not, the loss is almost complete, not merely a slight reduction in the price for which the product can be sold. This led to strict requirements as to feed used, efficient cooling, and regular delivery. Because of these requirements and the profits possible, prices paid by the condensing factories have made the most attractive markets the milk producer has who is within reach of one of them.

**Milk shipping.**—The shipping of milk in cans by the individual has been superseded in many sections of the country by the shipping station where the producer delivers his milk to be cooled and shipped in refrigerator cars. For the Boston market, milk is handled almost entirely in two-gallon cans filled and loaded on to the train by the producer. It is claimed

that the small cans permit the user to thoroughly cool the milk with the facilities found on the ordinary New England farm. It also insures full cans and only a small amount to keep at home, if a partly filled can is left over.

**Retailing.**—Many producers are so situated that they can deliver their own product in the form of milk, cream, or butter. In some towns there is a market for a first-class article at a price enough above the prevailing price to justify extra labor sufficient to produce a superior quality. This is especially true in the case of milk for infant feeding, as is evident by the demand for certified milk.

**Certified milk.**—Certified milk is that which has been produced from healthy cows given clean feeds, milked under cleanly conditions, the milk immediately cooled and bottled. Some disinterested parties, such as a medical milk commission, make regular examination of the animals, their feed, attendance, and the product, and certify to the consuming public whether or not the conditions and products conform to the standards agreed on as necessary for such certification. Milk as ordinarily cared for sours in from one to three days, yet certified milk has been frequently kept 10 to 14 days, and recently it has come to the writer's attention that certified milk was returned from Europe by a traveler who took his supply with him. On the thirty-first day after the milk was drawn from the cow it was still sweet and palatable and commented on by persons to whom submitted, as having a good flavor.

**Cream.**—The increasing use of ice cream makes a market for large quantities of sweet hand-separator cream. Ice-cream makers usually pay good prices. In addition to the cash returns, the skim milk is left at home to feed sweet and warm.

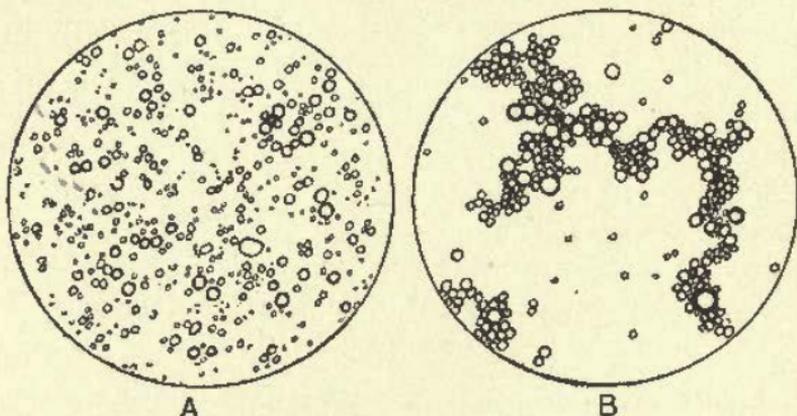
**Pasteurization.**—The pasteurization of milk for retail delivery is advocated as a means of protecting the consuming public against evils associated with improper care of the milk, particularly when the milk is not distributed by the producer. The chief of these evils are the products of bacterial growth, especially of those bacteria associated with the intestinal tract. The death rate of babies has been very materially lowered by improving the quality of the milk in respect to this evil. It is argued that since it is impossible to guard all milk against infection, the next best thing is to pasteurize it and kill those bacteria which produce products that may be injurious to the delicate stomach of the infant or invalid. At best, it appears that pasteurization is a makeshift to lessen the evil of carelessness and improper care of the milk, lack of cleanliness, insufficient cooling, and exposure to contamination with infectious diseases.

Another evil which it is sought to guard against by pasteurization is the danger of communicating tuberculosis to man by the use of milk from infected animals. It would appear to the writer that the wisest plan is to learn by testing the animals whether or not they have tuberculosis. If they have, the milk should be pasteurized and such steps taken as circumstances permit to eradicate the dis-

ease from the herd, not only because of the danger to the milk consumer, but because of the loss and increasing danger from allowing it to spread in the herd.

There is no better milk than that from healthy animals, and which is clean, cooled immediately and consumed fresh.

Pasteurization of milk makes it seem thinner or less viscous. Babcock has shown that this is due to the destruction of the grouping or clusters of fat

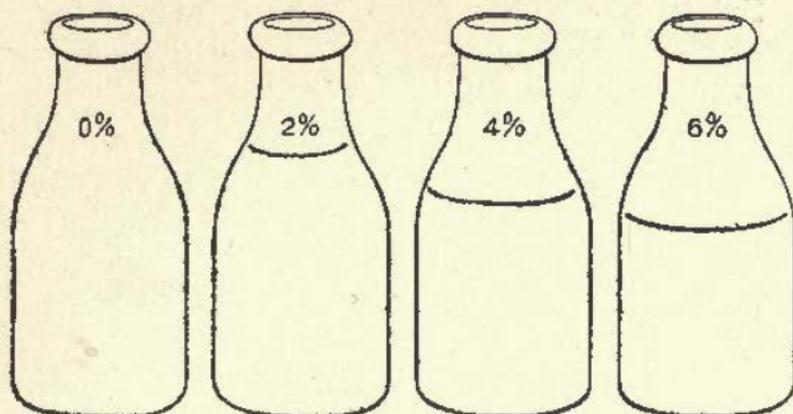


A—THE DISTRIBUTION OF THE FAT GLOBULES IN THE MILK AFTER PASTEURIZATION.

B—THE NORMAL GROUPING OF FAT GLOBULES IN RAW MILK.

globules in the raw milk. If the heating is carried much above  $162^{\circ}$  the cream does not rise so as to make a plain cream line when the milk is bottled for delivery.

**Standardization.**—The standardizing of milk or cream means making it contain a definite per cent. of fat. This may be done by adding cream or rich milk to that which is low in its fat content, or



THE RELATIVE AMOUNT OF CREAM ON MILK STANDARDIZED TO CONTAIN DEFINITE PER CENTS. OF FAT

diluting that which is high with skim milk or cream and milk having lower per cent. of fat. Michels gives the following:

### FORMULAS FOR STANDARDIZING MILK AND CREAM

**Problem 1.**—A producer contracts to deliver 450 pounds of milk testing 4.0 per cent. fat. His milk as it comes from the herd tests 4.3 per cent. How many pounds skim milk must he add to this to reduce it to 4.0 per cent.?

*Formula:*  $X = \left( \frac{A \times B}{C} \right) - A$ , in which

- $X$  = number pounds skim milk to be added.
- $A$  = number pounds original milk.
- $B$  = test of original milk.
- $C$  = test desired.

Substituting, we get:

$$X = \left( \frac{450 \times 4.3}{4.0} \right) - 450 = 33.75 \text{ pounds.}$$

**Problem 2.**—Suppose that the 450 pounds of milk tested 4.0 per cent. and it is desired to raise it to 4.5 per cent. by extracting skim milk; the amount of skim milk to be extracted is determined from the following formula:

$$X = A - \frac{A \times B}{C}$$

in which  $X$  equals number of pounds of skim milk to be extracted, and  $A$ ,  $B$ , and  $C$  are the same as in the preceding formula.

Substituting, we get:

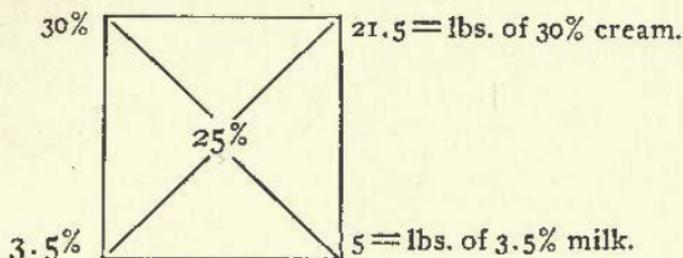
$$X = 450 - \left( \frac{450 \times 4.0}{4.5} \right) = 50 \text{ pounds.}$$

The test of cream can be raised or lowered in the same way by the use of the two preceding formulas.

The following simple plan, which may be used with skim milk or with milks or creams of different degrees of richness, is suggested by Prof. R. A. Pearson, of Cornell University.

Draw a square with diagonals as here shown. At the left-hand corners place the per cents. of fat in the milk or cream to be mixed. In the center place the per cent. desired, and at the right-hand corners place the difference between the center figure and that diagonally opposite. These differences will represent the number of pounds required of the material the test of which is horizontally opposite.

Example: How many pounds each of 30 per cent. cream and 3.5 per cent. milk are required to make 25 per cent. cream?



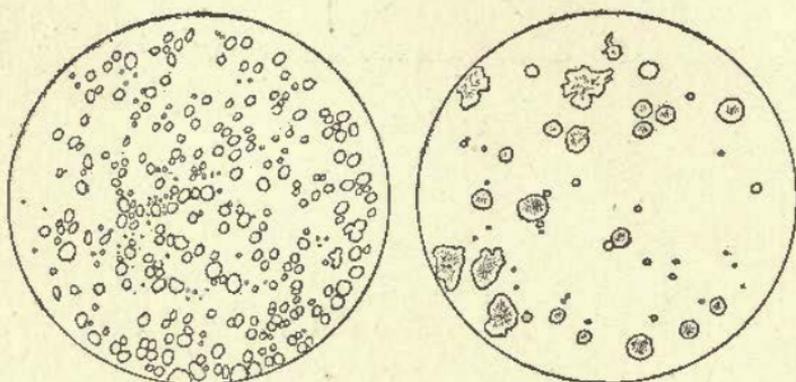
21.5, the difference between 3.5 and 25, is the number of pounds of 30 per cent. cream needed; and 5, the difference between 30 and 25, is the number of pounds of 3.5 per cent. milk needed. Therefore, any given amount should be mixed in the proportion of 5 parts milk to 21.5 parts cream.

### MARKET MILK

**The essentials.**—The rapidity with which milk deteriorates and the impossibility of really making it perfect after it has been neglected, especially when it is remembered that much of the milk shipped does not reach the consumer until it is 36 to 48 hours old, make it imperative that milk should have the right care from the start. The essential features for good market milk are that it shall be from healthy cows, fed on feeds free from strong odors and flavors. Dust and manure, especially, with their accompanying load of bacteria, should be kept out of the milk, and it should be immediately cooled

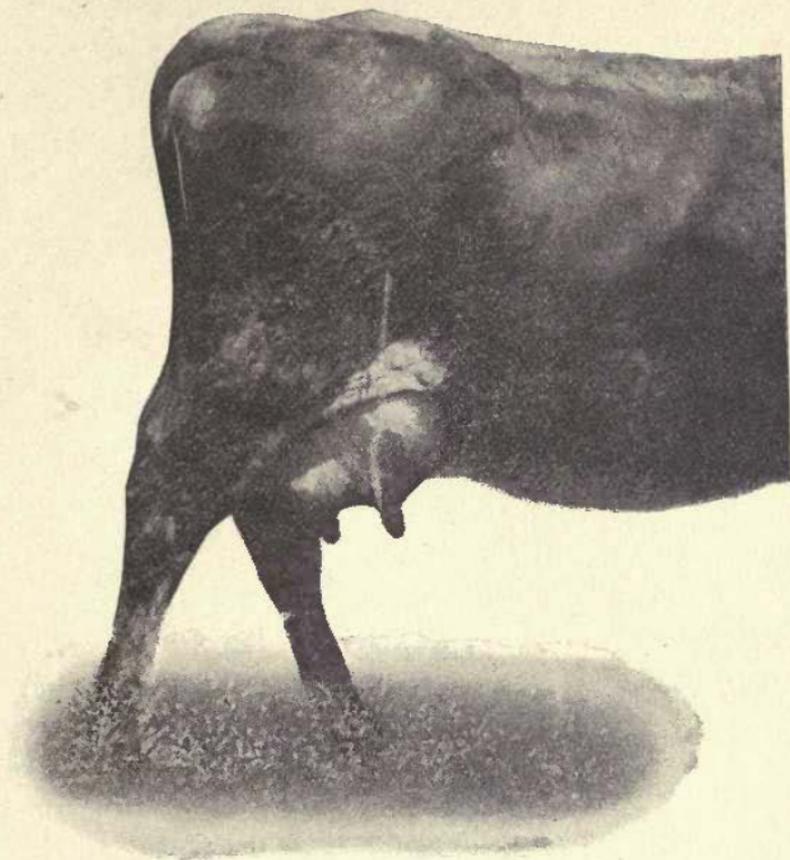
to a temperature below  $50^{\circ}$  to retard the growth of those bacteria which gain access in spite of the precautions taken. The whole story briefly is: keep the milk clean and cold.

**Preventing infection.**—The cows should be admitted to the milking stable long enough before milking to permit the dust to settle which has been

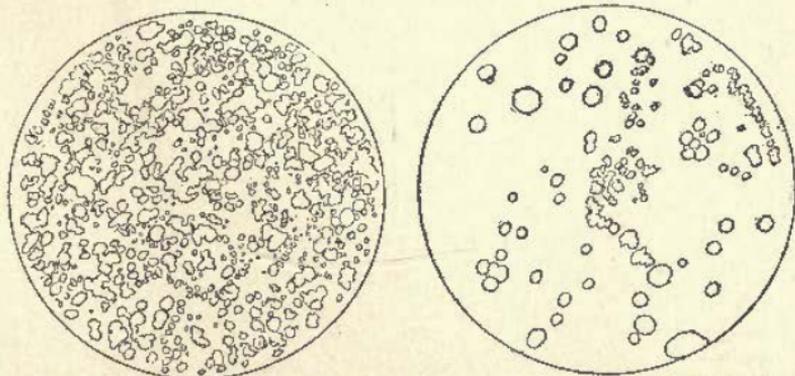


THE RELATIVE NUMBER OF BACTERIA IN THE AIR OF WELL AND POORLY KEPT STABLES.—ILLINOIS EXPERIMENT STATION BULLETIN

stirred up by their entering. Hay or bedding should not be handled immediately before or during milking. The udder, flanks, and adjacent parts of the body should be brushed and, better, wiped with a damp cloth or sponge. The clothes of the milker should be free from dust and the milking done with dry hands. Haecker has shown that the dampening of the hair on and near the udder with clean water is as efficient in reducing the number of bacteria in the milk as the use of water with a disinfectant in it or the use of vaseline.



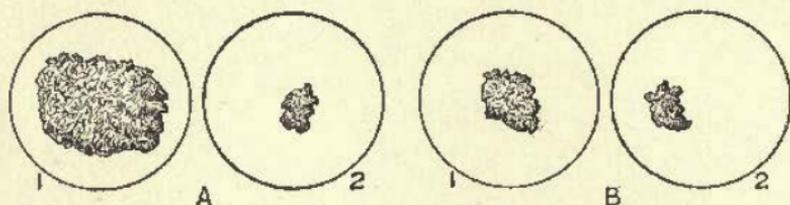
UNCLEAN FLANKS—A COMMON SOURCE OF MILK CONTAMINATION.



A—RELATIVE NUMBER OF BACTERIA FALLING FROM AN APPARENTLY CLEAN UNWASHED UDDER. AND B, FROM A WASHED UDDER



Fraser reports experiments in which 90 times as much dirt fell from a muddy udder, and 18 times as

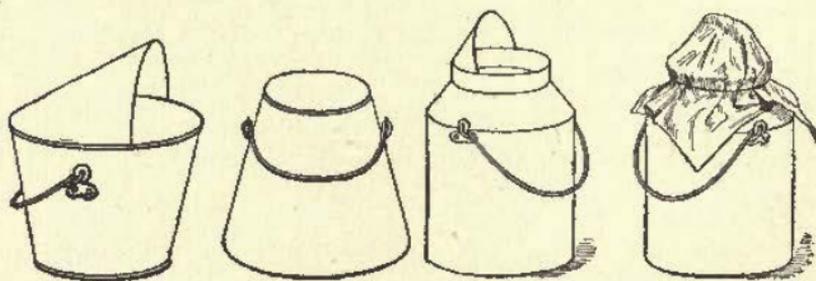


A—RELATIVE AMOUNT OF DIRT FALLING FROM A MUDDY, UNWASHED UDDER, 1, WAS NINETY TIMES AS GREAT AS FROM THE SAME UDDER WASHED, 2; WHEN ONLY SLIGHTLY SOILED, B, EIGHTEEN TIMES AS MUCH, 1, AS AFTER WASHING, 2.

much from a slightly soiled udder as from a clean washed udder.

The first streams of milk should be rejected from each teat, as they are heavily loaded with bacteria which have gained an entrance and found there favorable conditions for rapid growth.

A milk pail with a small opening will very materially reduce the amount of dirt falling into it during the milking operation. An opening



SMALL OPENING MILK PAILS ARE NOW BEING USED QUITE EXTENSIVELY. A PAIL WITH VISOR TO REDUCE AREA OF HORIZONTAL OPENING AND MANNER OF PROTECTING SAME WITH PAPER IS USED IN THE DAIRY DEPARTMENT AT CORNELL UNIVERSITY, AS SHOWN IN THE TWO FIGURES AT THE RIGHT.

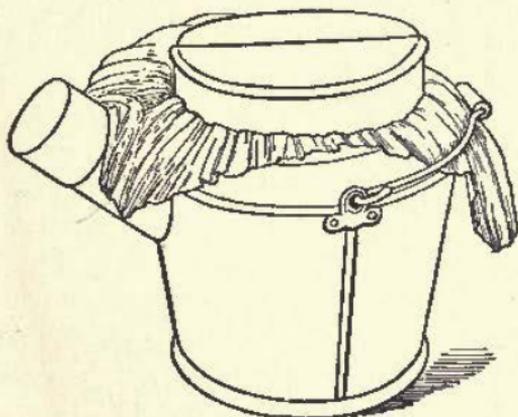
6 inches in diameter gives 28 square inches of surface open to catch the dirt, while a 12-inch pail, a very common size, though it is only twice as wide



COMBINED STRAINER AND SMALL  
OPENING MILK PAIL. DR.  
NORTH'S STYLE.

across, has four times as large an opening exposed for the collection of falling dirt, having 113 square inches.

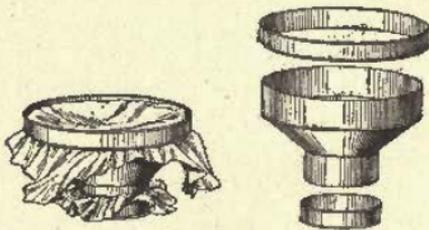
The strainer pail, which is entirely covered except the strainer through which the milk is admitted, serves to materially reduce the infection. In some cases the fine wire strainer is used; in others a layer of absorbent cotton is placed between



GUERLER MILK PAIL

two wire strainers of coarse mesh; and in still others two or three thicknesses of cheese cloth are used. The objection to the strainer of any kind is that chunks of foreign material falling on the strainer are pounded to pieces by the streams of

milk striking them, which thoroughly distributes their load of bacteria and soluble matter through the milk, whereas, with the small opening and no strainer, foreign matter getting into the pail floats on the foam or settles to the bottom, to be strained out on emptying the pail, leaving less in the milk than would be the case with the strainer pail. Notwithstanding these objections, the strainer pail is used by some of the most successful producers of certified milk; while others, equally successful, use the small opening and no strainer. There is no reason why the small opening pail without strainers

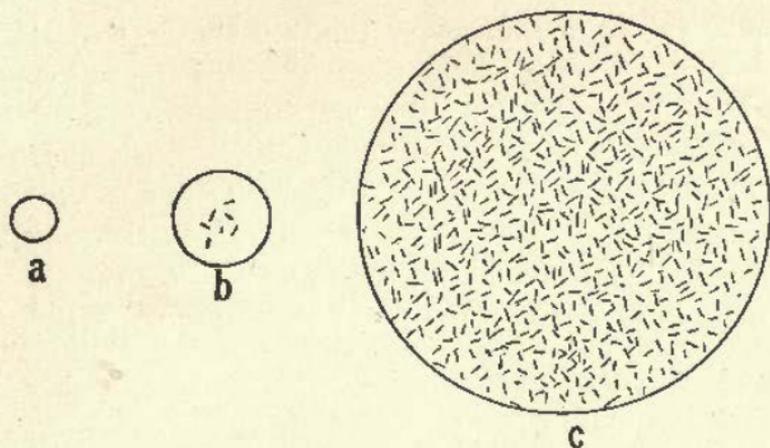


MILK STRAINER WITH TWO THICK-  
NESSES OF CHEESE CLOTH  
TOP AND BOTTOM

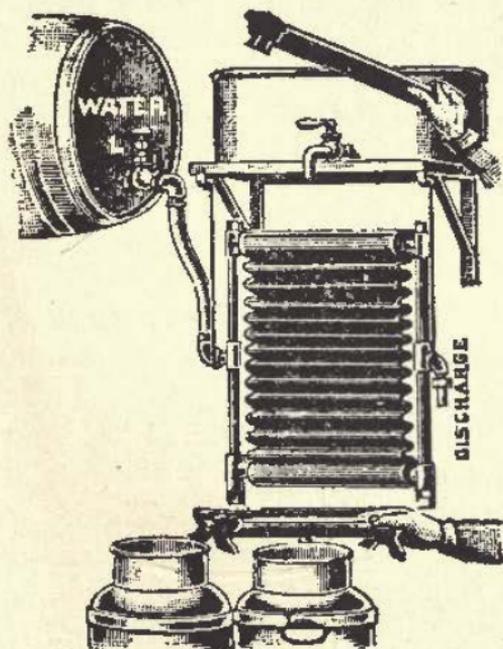
cannot be used on the ordinary farm, reducing materially the amount of dirt getting into the milk and avoiding the inconvenience of the strainer.

One of the best strainers for milk is made with two or three thicknesses of cheese cloth, providing the cloth is thoroughly washed, each time it is used, with lukewarm water, scalded with boiling water, and hung in the sunshine free from dust. Because of the ease with which these strainer cloths may be neglected, some large buyers of milk require their patrons to use only fine-mesh wire strainers.

**Cooling.**—Having excluded as much dirt and bacteria as possible, it is important that the milk be cooled immediately to 50° or as much lower as cir-

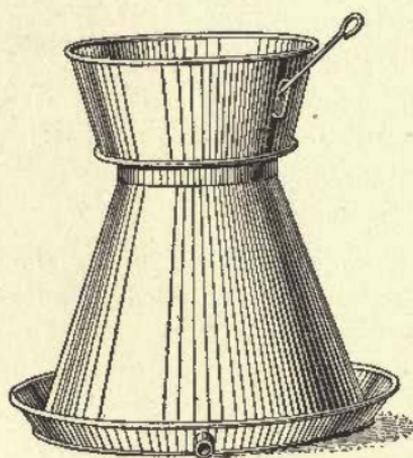


THE PROGENY OF ONE BACTERIUM, *a*, IN TWELVE HOURS IN MILK, *b*, PROPERLY COOLED, AND *c*, NOT COOLED

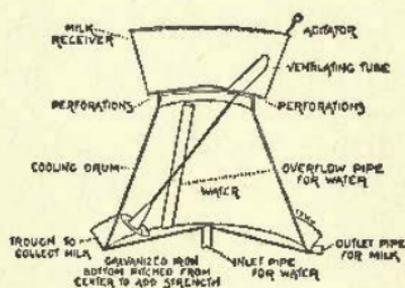


STAR COOLER

cumstances permit. Doctor Conn has shown that at a temperature of  $50^{\circ}$  bacteria multiplied five times in 24 hours, while at  $70^{\circ}$  they multiplied 750 times.\* Cooling may be done by surrounding the can of milk with cold water or running it over a cooler through which cold water is flowing. Most coolers are also aerators, exposing the milk to air. If this aeration is done where the air is free from dust and



CHAMPION MILK COOLER AND AERATOR



CHAMPION COOLER AND AERATOR,  
SHOWING INFLOW AND OVERFLOW  
FOR RUNNING WATER

odors, it is usually an advantage, permitting as it does the escape of gases more or less commonly present in the milk. It has been pretty conclusively shown that much of the so-called "cowy odor" is due to manure in the milk.

**Care of hand-separator cream.**—The marketing of the dairy product of the farm as cream is one of the most convenient methods available, involving

\*See "Practical Dairy Bacteriology," by Dr. H. W. Conn, published by Orange Judd Company, 1907.

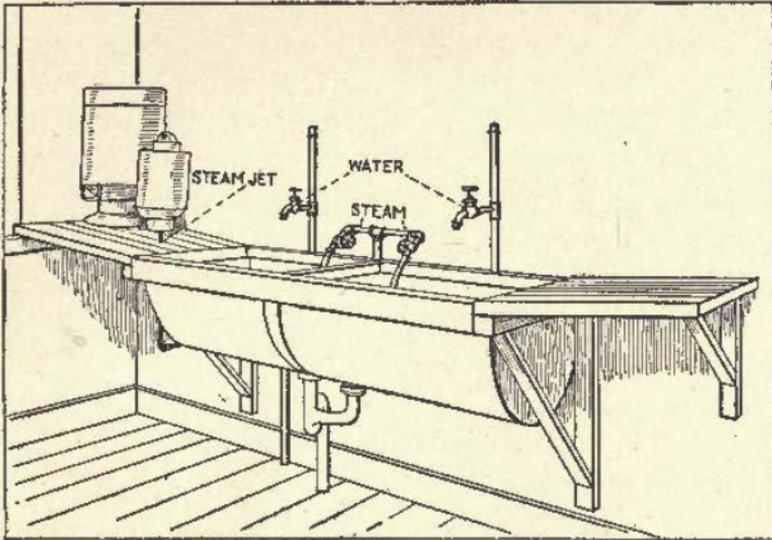
the minimum labor and usually bringing fair returns. The perfection of the paper, non-returnable package makes possible the building up of a trade for cream among retail consumers, without the annoying labor connected with the handling of glass bottles, the distribution being made by grocers or milkmen in connection with their regular business. The same care of milk for this purpose is required as where milk is shipped or retailed.

Where hand-separator cream is delivered to the creamery better care is required than is often given it. Cream should be delivered at least every other day, milk should not be allowed to stand in the barn, cream should be cooled immediately after separating, warm cream should not be mixed with cold cream, and the cream should be kept sweet until delivered. Unless the purchaser requires the thin cream, the richer it is, up to 45 per cent. of fat, the better it is and the less serum there is to deteriorate. It is the sugar of the serum which most rapidly undergoes the change. The separator should be washed after each using. Careful experiments show that no amount of rinsing by running warm water through it is a substitute for thorough washing with a brush.

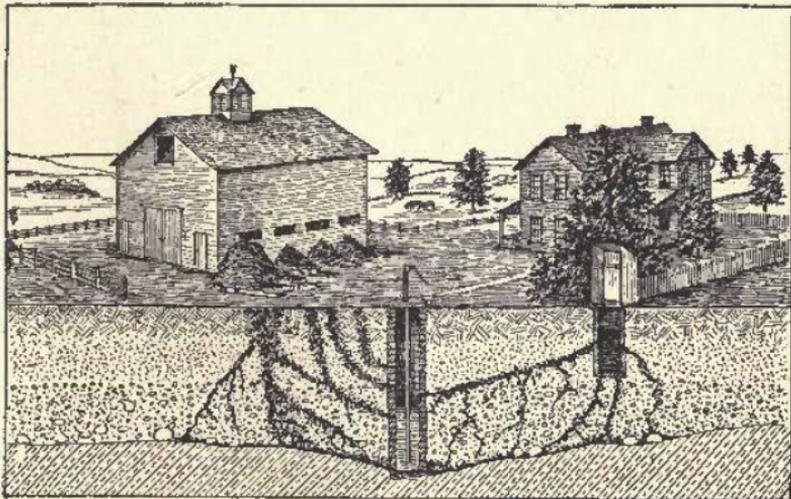
## CHAPTER VIII

### Equipment

**The dairy room.**—The making of butter as a regular part of the farm business, or the handling of the milk of a number of cows, makes it desirable that some room should be set apart for this work—a room where there will be freedom from odors of cooking, washing, stable odors and anything that may impair the quality of the product. The room should have good light, ventilation, a tight smooth floor and so located as not to receive the dust from passing teams. In addition to the necessary tinware and apparatus there should be a vat or small tank into which cans of milk or cream may be placed, surrounded with water to cool it. If butter is made there should be a refrigerator into which nothing is put but dairy products. A table of convenient height and shelving for the tinware should be provided. Page 71 shows a convenient arrangement of stationary sinks and drain boards. If steam and running water are not available the sinks can be used, as the round bottom makes possible the use of the least amount of water. The sinks can be made of galvanized iron, should be 18 inches wide, 12 inches deep, and 30 inches long. If 10-gallon milk cans are to be washed in them they should be six inches longer. The wash water with alkali in it is placed in the right-hand one, and in the left



WASH SINKS AND DRAIN BOARDS



CONTAMINATION OF WELL WATER BY SURFACE DRAINAGE

clean hot water for rinsing, after which the vessels are turned over the steam jet if available. In the absence of steam a wood-burning stove or water heater is convenient, while in some places an oil or gasoline stove will answer. These should be kept clean to avoid odors.

**The water supply.**—Water that looks clean is not necessarily free from contamination by surface drainage, as suggested in page 71.

**Washing utensils.**—The utensils that have been in contact with milk products should first be rinsed with cold, or better with lukewarm, water. This removes the casein, which might be cooked on if plunged into hot water immediately, or the crumbs of butter. After rinsing, wash thoroughly in warm water. For tinware, the addition of an alkaline washing powder free from fat or grease is usually desirable. There are several good washing powders made for this purpose. Brushes are much to be preferred to a cloth, because they get into the corners and are much easier to keep clean. Brushes of many shapes and sizes are available. Next rinse with clean water and scald with boiling water or live steam, and allow to dry without wiping. Wiping with a towel, though it be commonly called a clean one, adds about 300 to 3,000 times as many bacteria to the surface of the utensils as would be there if thoroughly scalded and not wiped. If possible to expose tinware to the sun, without also exposing to dust, it is a desirable practice, as the sunshine is an excellent germicide.

**The ice house.**—Every farm, and especially if pro-

ducing milk for market in some form, should have, if at all possible, a supply of ice. The well-built ice house is desirable, but not absolutely necessary. Studding may be set up and the top secured by horizontal ties, the ice stacked up so as to leave 15 or 18 inches between it and the studding, and this space well filled with sawdust. Boards should be placed against the studs, and sawdust added as the ice is stacked; then thoroughly cover the top with sawdust. A temporary roof may be put over this. An essential feature for an ice house is thorough drainage of the bottom. For a cheap house referred to above, the ice can be piled on ordinary fence rails, so located that the water can drain away; but it must have thorough protection around and over the ice. The sides may be a double wall, filled with sawdust, or the temporary structure referred to above. In any event, the roof should be so arranged as to permit circulation of air over the sawdust.

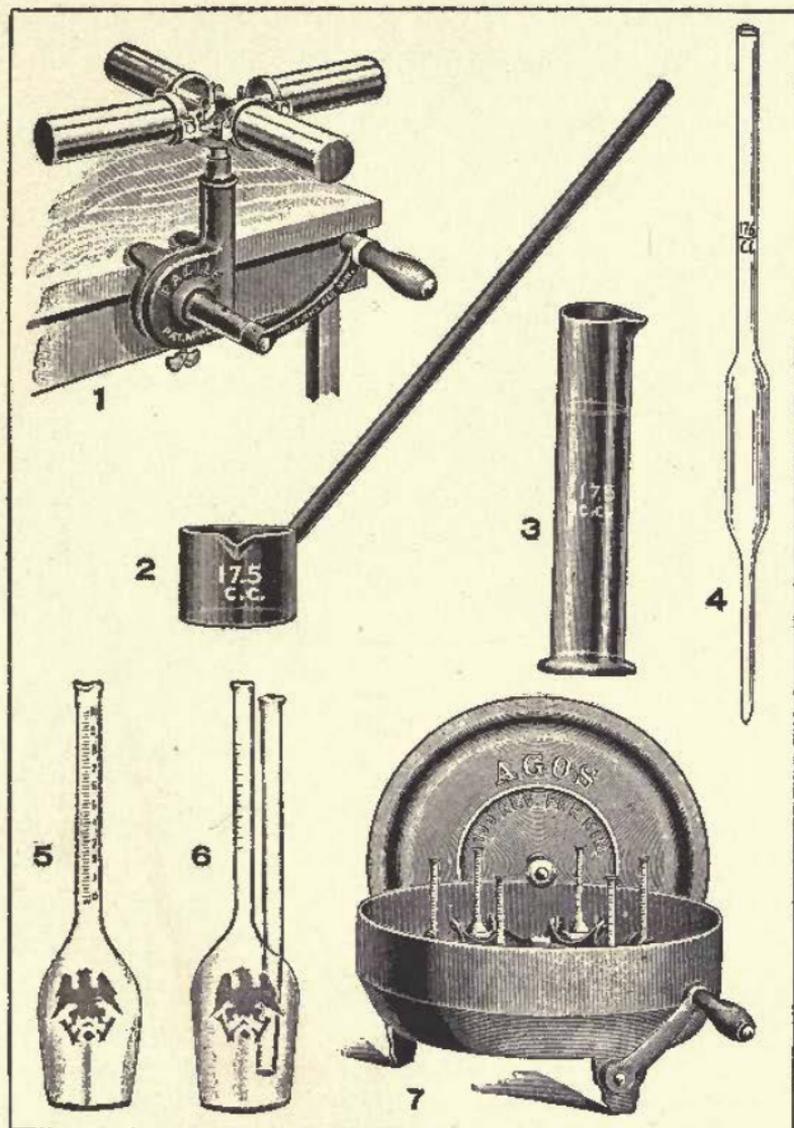
## CHAPTER IX

### **Babcock Test**

As previously indicated, this test is to determine the per cent. of fat in milk products. Every man who keeps cows for profit and markets his product on the basis of its butter-fat value should have a Babcock test and know how much each cow is producing annually. If he is selling cream, he should know what per cent. of fat it contains, and whether the separator has removed all of the fat from the skim milk, and, if churning, how much fat is being lost in the buttermilk. Well-made testers, which do not expose the neck of the bottle, can be bought for a price which makes them a profitable investment if used properly. Since every owner of a Babcock test should have one of the two good books on the subject, but brief mention will be made here.

**The principle.**—The principle of the Babcock test is that the solids of milk, other than fat, are so broken up by the action of sulphuric acid that the fat is set free and can readily be separated by centrifugal force and collected in the neck of a bottle, so graduated as to show by direct reading the per cent. of the milk which is fat.

**The sample.**—Care should be taken to see that the sample taken for testing represents the entire lot of milk. The milk should be stirred or, better, poured from one vessel to another before taking the sample.



1, INEXPENSIVE BABCOCK TESTER; 2, ACID DIPPER; 3, ACID MEASURE; 4, PIPETTE; 5, WHOLE MILK TEST BOTTLE; 6, DOUBLE BORE SKIM-MILK TEST BOTTLE; 7, AN INCLOSED IRON FRAME BABCOCK TESTER

When testing individual cow's milk it is necessary that the milking be completed and the entire yield of milk mixed before sampling. The milk from the several quarters of the udder may differ in the per cent. of fat. The first milk drawn may test only .8 per cent. fat, and the last 8 to 12 per cent.

**The acid.**—The acid used is commercial sulphuric, having a specific gravity of 1.82 to 1.83. If the acid is too weak, more must be used; if too strong, less may be used. Because of the power to absorb moisture from the air, the bottle should be kept tightly stoppered unless the acid is too strong and it is desired to thus weaken it. When adding to the sample, the test bottle should be so slanted as to allow the acid to run down the side of the bottle. The acid and milk should be mixed immediately, since standing allows the milk next to the acid to become burned.

**Whirling.**—After the acid and milk are mixed the bottle should be whirled in the centrifuge for five minutes; stopped and water added up to the neck of the bottle; whirled one minute and filled to the 8 or 9 per cent. mark, and whirled one more minute. The water used in hand testers should be boiling hot, and should be either rain water or well water that is free from lime or other foreign material. It can best be added with a narrow-lipped or spouted cup, or with the pipette. Care must be used not to burn the mouth when using the pipette.

**Reading.**—This should be done with the bottles at a temperature of from 120° to 140°. If necessary, the bottles can be placed in a bath of warm water

for a few minutes before reading. The reading should be done from the lowest point of the fat column to the highest point of the upper curve.

**Skim milk.**—In testing skim milk, slightly more acid and a little more speed should be used.

**Cream.**—In testing cream, where accurate tests are desired, the cream should be weighed on sensitive balances, rather than measured with the pipette, because of the different weight of creams of different fat content and a variable amount of cream sticking to the pipette. Slightly less acid is required for cream, and the mixture should be allowed to stand five or ten minutes before placing in the centrifuge, in order to allow better action of the acid.

## CHAPTER X

### Butter Judging and Grading

BUTTER varies greatly in those qualities which please the consumer. As yet no exact method has been devised for measuring those qualities; therefore they remain a matter of individual judgment influenced by those variations in physical condition to which all persons are more or less subject. For the purpose of education and commercial convenience, the qualities of butter are grouped under five heads, to which a mathematical value is assigned according to the relative importance of the respective groups. This constitutes the score card which is generally used by the State and national dairy associations and in the large butter markets.

#### SCORE CARD

No.....			
	Perfect	Score	Remarks
Flavor .....	45	.....	.....
Body .....	25	.....	.....
Color .....	15	.....	.....
Salt .....	10	.....	.....
Style .....	5	.....	.....
	<hr/>		
Total .....	100		
Date.....		Scored by.....	

For the purpose of examining butter in the market an instrument called a trier is used. If a tube 6 to 15 inches in length was split in two equal parts and a

handle attached to one of these halves, it would be a crude likeness of the butter trier. By plunging the trier into a package of butter and giving it a one-half turn, the plug is withdrawn for examination. The body or texture is first noted before it is softened by the temperature of the room.



BUTTER TRIER

**Body.**—The body should be firm and waxy to the pressure of the thumb, free from surplus moisture, the brine clear (not milky), and it should not be greasy, tallowy, spongy, or sticky.

**Flavor.**—The flavor should be clean, mild, rich, and creamy, with a mild, pleasant aroma. Some of the commoner faults are as follows:

*Flat*, lacking in flavor, which is due usually to insufficient development of the lactic acid in ripening.

*Rancid*, that is, an undesirable, strong flavor commonly caused by milk or cream being old or over ripe before churning.

*Unclean.*—This may be due to stable contamination or unclean utensils.

*Weedy.*—Flavors that are suggestive of weeds that are likely to be found in the pasture.

*Sour.*—Usually caused by insufficient removal of the buttermilk in working, and sometimes caused by very thin cream.

*Feverish.*—A comparatively new term describing a sickish flavor from cows in an unhealthy condition, such as sexual excitement or diarrhœa.

*Stable flavor.*—Unclean conditions surrounding the milk, such as cows not properly cleaned or milk exposed to the unventilated air of stables.

*Color.*—The commonest fault in the matter of color is unevenness, that is, streaked or mottled, due usually to uneven distribution of the salt or by the use of too cold rinse water. It may be too high or too low in color; this is usually a matter of markets. If too much vegetable color is used, it may be detected by the critical taster.

*Salt.*—The degree of saltiness is largely a matter of market requirements, and is, therefore, variable. It is important that the salt be evenly distributed and thoroughly dissolved.

*Style.*—Whatever the shape of the package, it should be neat, clean, and free from finger marks. The solid packed packages should be filled full, cut off with a wire, string, or straight-edge, and covered with a parchment circle. Prints should have straight, sharp edges, and if marked with monogram or other design it should be clear and sharp. The wrappers should be put on straight and folded smooth.

The following are the grades and classifications of butter in the New York market, as outlined by the New York Mercantile Exchange:

#### CLASSIFICATION

*Creamery butter.*—Butter offered under this classification shall have been made in a creamery from cream obtained by the separator system or gathered cream.

**Imitation creamery butter.**—Butter offered under this classification shall have been churned by the dairyman, collected in its unsalted, unworked condition, and worked, salted, and packed by the dealer and shipped.

**Dairy butter.**—Butter offered under this classification shall be such as is made, salted, and packed by the dairyman, and offered in its original package.

**Factory butter.**—Butter offered under this classification shall have been collected in rolls, lumps, or in whole packages, and reworked by the dealer or shipper.

**Renovated butter.**—Butter offered under this classification shall be made by taking pure butter and melting the same, and rechurning with fresh milk, cream, or skim milk, or other equivalent process.

**Grease.**—This shall consist of all grades of butter below Fourths free from adulteration.

**Known marks.**—This shall comprise such butter as is known to the trade under some particular mark or designation, and must grade as Extras, if creamery, and Firsts, if reworked butter, in the season in which it is offered, unless otherwise specified. Known marks to be offered under the call must previously have been registered in a book kept by the superintendent for that purpose.

Grades of butter must conform to all the following requirements, and shall not be determined by the score alone:

EXTRAS shall be composed of the highest grades of butter made in the season when offered, under the

different classifications; 90 per cent. shall be up to the following standard, the balance shall not grade below Firsts:

*Flavor.*—Must be fine, sweet, clean, and fresh, if of current make, and fine, sweet, and clean if held.

*Body.*—Must be firm, smooth, and uniform.

*Color.*—A light straw shade, even and uniform.

*Salt.*—Medium salted.

*Package.*—Good, uniform, and clean.

*Score.*—Shall average 93 points or higher.

FIRST shall be a grade just below extras, and must be fine butter for the season when made and offered, under the different classifications, and up to the following standard:

*Flavor.*—Must be good, sweet, clean, and fresh, if of current make, and good, clean, and sweet if held.

*Body.*—Good and uniform.

*Color.*—Reasonably uniform; neither too high nor too light.

*Salt.*—Medium salted.

*Packages.*—Good and uniform.

*Score.*—Shall average 87 points or higher.

SECONDS shall be graded just below Firsts, and must be good for the season when offered, under the different classifications, and up to the following standard:

*Flavor.*—Must be reasonably good and sweet.

*Body.*—If creamery or dairy, must be solid boring. If factory or renovated, must be 90 per cent. solid boring.

*Color.*—Fairly uniform.

*Salt.*—May be high, medium, or light salted.

*Package.*—Good and uniform.

*Score.*—Shall average 80 points or higher.

THIRDS shall be graded just below Seconds.

*Flavor.*—Must be reasonably good; may be strong on tops and sides.

*Body.*—Fair boring, if creamery or dairy, and at least 50 per cent. boring a full trier if factory or renovated.

*Color.*—May be irregular.

*Salt.*—High, light, or irregular.

*Package.*—Fairly uniform.

*Score.*—Shall average 75 points or higher.

FOURTHS shall be graded just below Thirds, and may consist of promiscuous lots.

*Flavor.*—May be off-flavored and strong on tops and sides.

*Body.*—Not required to draw a full trier.

*Color.*—May be irregular.

*Salt.*—High, light, or irregular.

*Package.*—Any kind of package mentioned at time of sale.

## CHAPTER XI

### Historical

THERE has been a great evolution in the business of preparing and handling dairy products for man's use since "Abraham put before his guests butter, milk, and a dressed calf" and "Jesse sent David to the camp of the army of Israel with ten small cheese." It is a far step from the goatskin filled with milk, hung on the branch of a tree or tied to the tail of a horse for a churn, to the modern use of the centrifugal separator, ripening of cream with pure cultures of bacteria, and the use of a churn that also works the butter before it is removed; while the large city user of modified, certified, or pasteurized milk has forgotten, if he ever knew, that in primitive times the milch animal was brought to the door of the purchaser to deliver the freshly drawn milk, and he is probably unconscious of the fact that his morning supply of milk may have crossed three States and taken two days to reach him "still fresh," or perchance he takes it from a tin can which was filled a year or more ago half way across the continent in a modern condensing establishment. Some of the conspicuous milestones in this march of progress are the following:

In 1810, cheese made on the Western Reserve in Northeastern Ohio was carted to Pittsburg for barter.

In 1820, Harvey Baldwin started for New Orleans with five tons of cheese, made near Aurora, Ohio, but sold it at Wheeling, Cincinnati, and Louisville.

In 1835, Charles R. Harmon bought cheese five days from the hoop and took it to Fort Dearborn (now Chicago), but, being unable to sell it there, took it to Milwaukee.

The modern cheese factory system started in 1851, when Jesse Williams and his sons, in Oneida County, N. Y., brought the milk from their several farms together to be made into cheese. Previous to this all cheese was made on the farms, and butter continued to be so made until the starting of the creamery in 1870. The cream was gathered by haulers and brought to the creamery to be churned, and still is in some parts of New England. The milk was set in deep cans of such diameter that one inch in depth of cream was expected to make one pound of butter. These were called gauges, and the cream was measured by the hauler and paid for by the gauge. With the coming of the factory centrifugal separator in the early '80s the whole milk was brought to the factory for separation and the skim milk returned to the patrons.

Thoroughness of separation, the reduced loss of butter fat, together with the improved quality of the butter, which could be made by separating the cream mechanically instead of allowing it to stand and rise, justified the time and labor required in hauling the milk to the factory and the skim milk home.

The development of the factory system brought an appreciation of the variation in value of different milks both for butter and cheese making. This, together with the ease and prevalence of adulteration by skimming and watering, made the need of a test for butter fat imperative.

The establishment of the experiment stations in each State and the research work made possible by the passage of the Hatch Act in 1887 stimulated experimental workers to devise a test that would show accurately the percentage of fat in milk, a test that was sufficiently inexpensive to permit its regular use in the factory and simple enough that the average butter maker could use it. With the chemists of several experiment stations working on the problem, it fell to the lot of Dr. S. M. Babcock, of the Wisconsin Experiment Station, in 1890, to perfect a test that met the requirements. So thoroughly was his work done that no modification in the essential features have been made since. Its accuracy has been confirmed by many chemists in America and Europe. So simple and accurate is it that it is almost universally used for the determination of the per cent. of fat in milk, and milk and cream are now commonly paid for on the basis of their fat content by creameries and cheese factories.

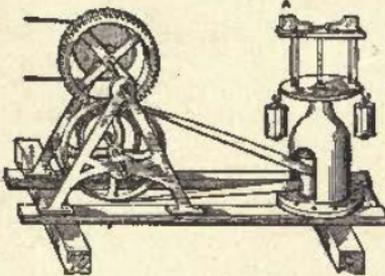
According to J. D. Frederiksen the first suggestion to employ centrifugal force for the separation of cream from the skim milk was made in Germany by Professor Fuchs, and was for the purpose of testing its richness.

About 1870 Rev. H. F. Bond, of Massachusetts,

succeeded in separating cream in two glass jars attached to a spindle making 200 revolutions a minute.

A Danish veterinarian in 1873, suspended two pails on a stick revolving horizontally 400 revolutions a minute, and secured the separation of cream.

The next step in the evolution of the separator was



FIRST CENTRIFUGAL SEPARATOR

the vertical drum or cylinder into which milk was put and after revolving till separation was secured "valves in the periphery of the drum were opened and the skim milk allowed to escape while in motion, then closed and the drum

stopped and the cream removed and a new supply of milk put in." This was in 1876. In another machine of this type holding 220 pounds of milk, it took ten minutes to attain a speed of 800 to 900 revolutions, and 24 to 33 minutes to come to a stop, when the skim milk was siphoned from under the cream, then the cream drawn through a valve in the bottom of the drum.

The third stage in the development soon followed. In 1877 and 1878 appeared machines into which the milk was fed continuously and the skim milk and cream was taken out similarly.

In 1879 in Denmark the Danish Weston and in Sweden the De Laval Separators were developed and marked the first great advance in the perfection of a commercially successful machine.

In 1890 De Laval discovered that certain internal

devices increase the efficiency and capacity of the separator. Soon after this the hand power separator was put on the market. Its most rapid introduction was in the Middle West in the nineties.

The successful introduction of the hand-power centrifugal separator about 1894, and rapidly since 1898, with the possibility of separating milk on the farm, has brought back in many sections the gathered cream system of factory butter making.

Along with the establishment of the coöperative creameries, in which practically all who supplied milk were part owners, and where the income from the sale of butter was divided proportionately after deducting the operating expenses, has developed in the Middle West the centralizing creamery with its hundreds of skimming stations scattered in sparsely settled sections and often bringing the cream from farms in two or three States, three or four hundred miles daily, to the central plant for manufacture. At first the great centralizing plants, in their eagerness for business, accepted cream of very inferior quality and tried with the aid of science to make first-class butter from it. This idea has had to give way to the truth that a perfect article cannot be made from an imperfect one, and a campaign of education is taking the place of the chemist and his chemicals. The odium which has rested on hand-separated creamery butter will be removed when hand-separator creamery patrons wash their separators every time they are used, cool their cream and deliver it to the creamery sweet and clean.

These historical notes would not be complete

without mentioning the arrival in 1906 of a milking machine which gives reasonable assurance that the mechanical milking of cows is commercially practicable, especially if in the hands of a man who has some knack in handling mechanical devices.

## Appendix

### A SUMMARY

THERE is a cause, whether known or unknown, of every effect. In the following the attempt has been made to present in such a manner as to be quickly seen the commonest causes of the effects or difficulties most frequently met in ordinary practice. It will be noticed that in most cases there are several causes which may contribute to a certain effect.

#### SEPARATING

<i>Causes</i>	<i>Effects</i>
Irregular inflow . . . . . }	} . . . . . Large loss
Vibration of bowl . . . . . }	
Irregular speed . . . . . }	
Cold milk . . . . . }	
Increased flow . . . . . }	} . . . . . Thin cream
Insufficient speed . . . . . }	
Flushing bowl . . . . . }	
Small cream exit . . . . . }	} . . . . . Thick cream
Increased speed . . . . . }	
Reduced inflow . . . . . }	
Uniform speed . . . . . }	} . . . . . Small loss
Sufficient speed . . . . . }	
Proper temperature . . . . . }	
Sour milk . . . . . }	} . . . . . Clogging
Too rich cream . . . . . }	
Cold milk . . . . . }	

Skims cleanest .....	} .....	Best separator
Smallest bowl.....		
Slowest speed .....		
Fewest parts .....		
Skims at lowest tempera- ture .....		
Best workmanship .....		
Easiest adjusted .....		
Lightest running .....		
Easiest cleaned .....		

## CHURNING

*Causes**Effects*

Gluten feeds .....	} .....	Soft butter
Oil meal .....		
High temperature .....		
Cream of unequal ripeness	} .....	Large loss in the buttermilk
High temperature .....		
Thin cream .....		
Sweet cream .....		
Low temperature .....	} .....	Small loss
Ripe cream .....		
Evenly ripe .....		
Rich cream .....		
Low temperature .....	} .....	Slow churning
Very thin cream.....		
Very thick cream.....		
Sweet cream .....		
Churn too full.....		
Slow agitation .....		
Cream from stripper cows		
Cream of unequal ripeness		

Cream exposed to odors. }	} .. Impaired flavor of butter
Overripe cream .....	
Decaying feed .....	
Moldy feed .....	
Impure drinking water..	
Stable odors .....	
Sick cows .....	
Overripe cream .....	} .....Specks in butter
Dried cream .....	
Foreign matter .....	
Uneven temperature .... }	} .....Mottles or streaks
Uneven salting .....	
Insufficient washing.....	
Insufficient working.....	
Sudden chilling .....	
Change of temperature.. }	
Over working .....	} .....Texture injured
Over heating .....	
Over churning .....	
Slipping of tools in work-	
ing .....	
Thin cream .....	} .....Difficult churning
Sweet cream .....	
Churn too full.....	
Cold cream .....	
Advanced period of lacta-	
tion .....	
Succulent feeds .....	} ....Higher colored butter
Summer feeds .....	
Cottonseed meal.....	} .....Light colored butter } .....Hard butter
Bran .....	} .....Hard butter
Legumes .....	

## TESTING

<i>Causes</i>	<i>Effects</i>
Too warm milk.....	}.....Chars fat
Too strong acid.....	
Too much acid.....	
Insufficient mixture.....	}.....Dark sediment
Foreign matter.....	
Cold milk.....	}.....White fat White sediment and light- colored fat
Cold acid.....	
Weak acid.....	
Insufficient acid.....	
Insufficient speed (tester)	}.....Low reading
Too cold.....	
Delay in reading.....	
Broken pipette.....	
Too hot.....	}.....High reading
Unclean bottle.....	
Unclean pipette.....	
Sample by weight.....	..... Cream
More acid.....	}.....For skim milk
Higher speed.....	
More heat.....	}.....For buttermilk
Double neck bottle.....	
Maintains uniform tem- perature.....	}.....Best tester
Maintains uniform speed.	
Easiest controlled.....	
Breaks fewest bottles....	
Does not tremble.....	
Easiest balanced.....	
Has top and bottom bear- ing.....	
Necks of bottles not ex- posed.....	

## MISCELLANEOUS DATA

## Temperatures

Milk when drawn.....	98°
for shallow setting.....	60°
deep setting.....	40° to 45°
separating.....	80° to 95°
ripening cream.....	65° to 75°
Churning.....	50° to 64°
Milk for city delivery.....	45° to 50°
Milk for calf feeding.....	95° to 100°
Reading test bottles.....	120° to 140°
Skim milk starter set at.....	90°

Keep above 75°; if necessary, warm up after 6 to 10 hours.

## Time

For cream to rise	
in shallow pans.....	24 to 36 hours
in deep setting.....	12 to 24 hours
cream to ripen.....	18 to 24 hours
churning ripe cream.....	20 to 40 minutes
First whirling of test bottles.....	5 minutes at full speed
Second and third whirling of test bottles	1 to 2 minutes

## Per cent. of Fat

Average milk.....	3.7%
Guernsey.....	5.0%
Jersey.....	5.0%
Shorthorn.....	4.1%
Ayrshire.....	3.7%
Holstein.....	3.5%
First milk drawn.....	0.8 to 2.0%
Last milk drawn.....	5.0 to 12 %
Rich cream.....	35.0 to 50 %
Commercial cream.....	20.0 to 25 %
Butter.....	83.0 to 88 %

**Loss of Fat should not be over**

In dilution skim milk.....	0.7 to 1.0 %
Shallow pan skim milk.....	0.5 to 0.7 %
Deep setting skim milk.....	0.2 to 0.5 %
Separator skim milk.....	0.03 to 0.05%
Buttermilk .....	0.1 to 0.2 %



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